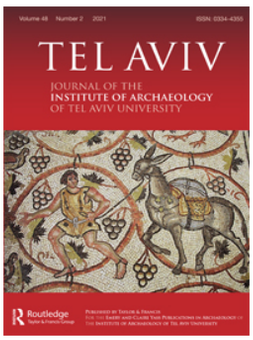

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The Debate on Negev Viticulture and Gaza Wine in Late Antiquity

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One hundred fifty years have passed since the first published reference in modern Western scholarship to ancient wine production in the Negev Highland desert, and much is now known about its hydrological, climatic, agricultural, economic, social and political context. Yet, in 2020 two studies reached opposite conclusions regarding the extent and intensity of Negev Highland viticulture, its relationship to Byzantine 'Gaza wine' and the associated regional wine trade. This raises wider questions on how to evaluate apparently conflicting archaeological evidence for ancient microregional production and trade, with relevance to longstanding debates on the nature of the ancient Mediterranean economy and the onset of the Middle Ages in Europe. We survey previous research on Negev Highland viticulture, including the two most recent papers, demonstrating problems of equifinality in the calculations-based approach to ancient production/consumption, and clarifying our own position regarding the relationship between archaeologically attested Negev viticulture and 'Gaza wine' of Late Antique historical texts. We then analyse additional sources of new evidence contributing to a more holistic synthesis of Negev Highland wine production and trade. At this sesquicentennial commemoration of Negev viticulture's historiography, we close with unresolved issues and promising directions for future research.[1]

Keywords Ancient viticulture, Economic archaeology, Ancient Mediterranean economy, Negev Highlands, Byzantine, Wine

When Edward Palmer's (1871) observations of evidence for ancient wine production in the Negev Highlands (Fig. 1) were published, the origins of the primitivist/modernist debate on the ancient economy started by Karl Bücher and Eduard Meyer were over two

[1] Supplemental data for this article can be accessed here: https://doi.org/10.1080/03344355.2021.1968626.

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decades away (Ghio 2015), and the establishment of a distinctly 'economic archaeology' under E.S. Higgs was nearly a century away (Higgs 1975; Sheridan and Bailey 1981). One hundred fifty years later, these topics have converged and the research on ancient Negev Highland viticulture offers a valuable case study for economic archaeology at the microregional, decadal-centennial scale.[2]

The primitivist/modernist debate in Greco-Roman economic history concerns the extent to which modern economic models can be used to understand the ancient economy, the nature of ancient markets and the roles of states and private enterprise in organising production and distribution (Polanyi *et al*. 1957 [eds]; Rostovtzeff 1957; Finley 1973; Polanyi 1977). The influence of this debate is ongoing (e.g., Temin 2013; Bandow 2015; Elliott 2020), while new archaeological methods and data offer relevant, unprecedented economic reconstructions (e.g., Izdebski *et al.* 2020). A recent article charting the rise and fall of Negev Highland viticulture based on charred seeds and pottery sherds in ancient trash middens supports a modernist view of the Byzantine economy in the 5th–6th centuries CE (Fuks *et al.* 2020). By tracking commercial-scale viticulture in a desert region on the margins of empire, and its involvement in Mediterranean trade, this study indicates the gravitational pull of the Byzantine economic system. However, the opposite conclusion—that there was no such appreciable scale of wine production and trade—was argued for in a contemporary study of Byzantine Negev winepresses' potential output and estimates of local consumption (Seligman 2020). Thus, the Byzantine Negev Highlands has its own primitivist/modernist debate, based almost entirely upon archaeological data, and with relevance to economic archaeology generally.

In addition to the nature of the ancient economy and the methodology of economic archaeology, the topic of Negev Highland viticulture is also related to fundamental questions concerning the onset of the Middle Ages in Europe. This connection derives from the suggestion that the Byzantine Negev Highlands may have sourced the acclaimed 'Gaza wine' described in historical texts as an apparently sweet white wine transported from the port of Gaza throughout the Mediterranean and beyond (Mayerson 1985; McCormick 2012; Decker 2013; Lantos *et al*. 2020). According to Pirenne (1957), the ruin of Mediterranean trade in wine under the early Islamic caliphates, along with that of papyrus, spices, olive oil and textiles, was a key trigger for the onset of Europe's 'Dark Ages'. Although the Pirenne thesis has been largely discredited by scholars of Late Antiquity (Lopez 1943; Havighurst 1958; Brown 1974; Hodges and Whitehouse 1983; Horden and Purcell 2000:

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[2] A note on terminology: This discussion focuses on the geographic and phytogeographic region alternately referred to as the 'Negev Highlands', the 'central Negev' and the 'central Negev Highlands' in the archaeological literature. This desert region includes seven large settlements which reached their peak in the Byzantine period (Elusa, Shivta, Nessana, Saʿadon, Ruheiba, Oboda and Mampsis) supported by extensive rainwater runoff agriculture (Shereshevski 1991). Evenari *et al.* (1961) further distinguish between the Negev lowlands and foothills which include Elusa, Shivta, Nessana,and Ruheiba, and the central highlands, which include Mampsis and Oboda. We adopt 'Negev Highlands' in reference to the entire region, for consistency with Fuks *et al*. (2020) and the botanical literature (e.g., Danin 2004). Moreover, although much of these 'Negev Highlands' are not very high altitude, their low hills and valleys are what made runoff farming in wadi beds possible, including grape cultivation.

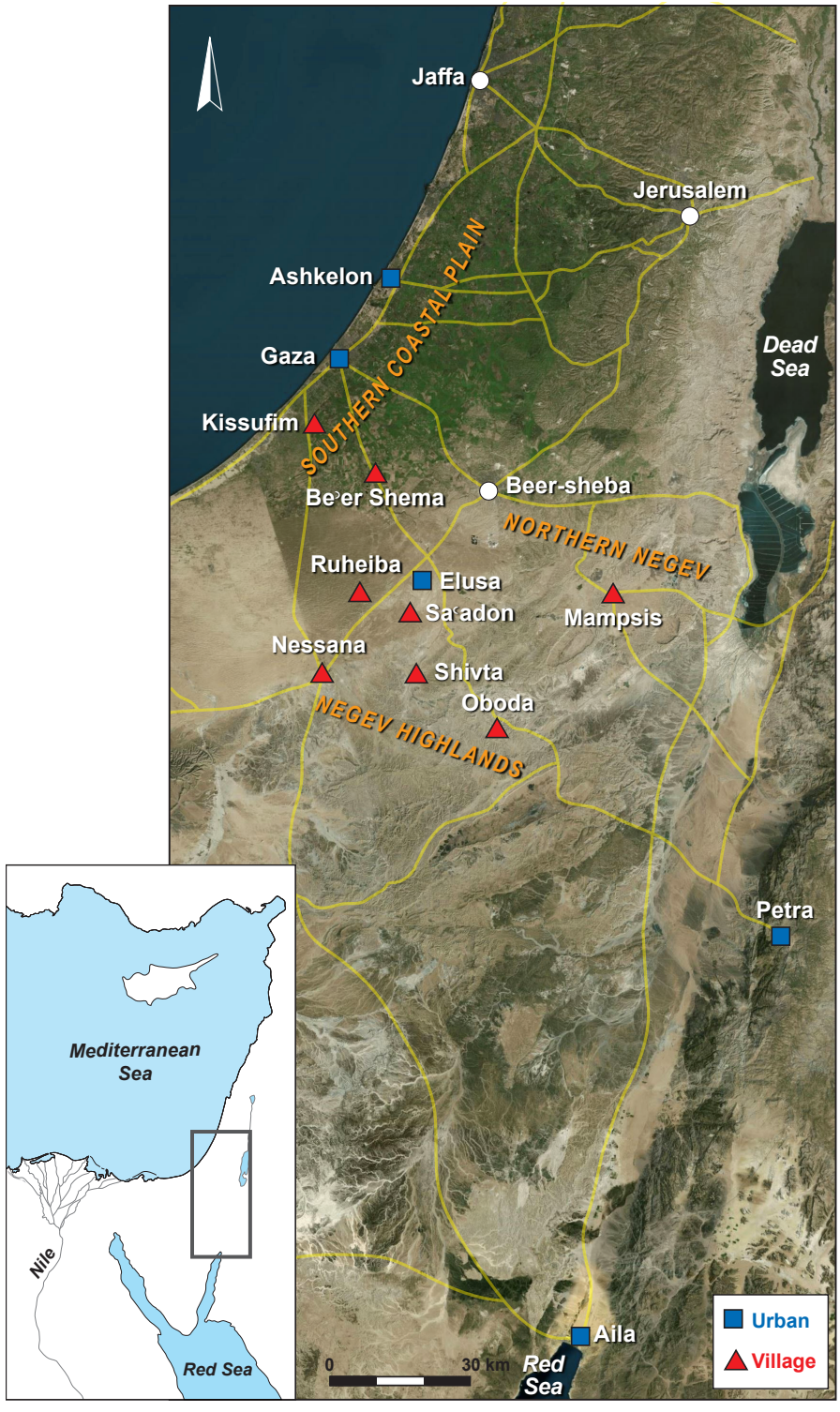

FIGURE 1 Map of study region and its Eastern Mediterranean context.

153–160), Byzantine Palestine's export viticulture is assumed to have floundered in the 7th century CE due to loss of European markets (Mayerson 1985; Mazor 2009; Decker 2013). Hence, interrogating the nature and chronological boundaries of this wine trade through regional studies is relevant to understanding the very essence of Late Antiquity.

Whereas Pirenne's paradigm relates to European connectivity across the Mediterranean, when adopting current global perspectives the story of Negev viticulture and Gaza wine becomes a component part of an even wider history of wine globalisation (Inglis 2019; in press). This history, in turn, is a subset of 'ancient globalisation' and 'food globalisation' (Jones *et al*. 2011; Liu and Jones 2014; Boivin *et al*. 2015; Jones *et al*. 2016; Van der Veen and Morales 2017; Liu *et al*. 2019). Thus, the story of Negev Highland viticulture offers a regional window onto much broader historical processes.

Given the wide-ranging relevance of research on wine in Late Antique southern Palestine to big questions of history and archaeology, arguments on the scope of Negev Highland viticulture call for synthesis and scrutiny. This is especially justified considering that neither of the two most recent studies on the topic (Fuks *et al*. 2020; Seligman 2020) addresses the other's arguments (due to near-simultaneous publication), while even more recent publications related to Byzantine Negev economic archaeology offer new data with which to better contextualise ancient Negev Highland viticulture (Bar-Oz *et al*. 2021; Blevis *et al*. 2021; Ktalav *et al*. 2021; Langgut *et al.* 2021). Addressing these gaps and possibilities, we seek here to present the debate, carry forward the discussion, synthesise current evidence for the Negev Highland wine economy and its Mediterranean connections, and propose goals for future research on Negev Highland viticulture. First, we briefly review the historiography of this topic up to 2020 as a background to the current debate. Second, we critically evaluate the main arguments of Seligman (2020), on their own terms, and vis-à-vis new research. Third, we bring the findings of Fuks *et al.* (2020) to bear on the question of the Negev Highlands' role in the Gaza wine trade. Fourth, we summarise other lines of evidence for the dynamics of Negev Highland wine production and trade, beyond the purview of Fuks *et al*. (2020). Finally, we present a synthesised narrative of Negev Highland wine production, pointing to directions for future research on matters still widely open to interpretation and debate.

The historiography of Negev viticulture

Previous research on Negev viticulture

The Negev Highlands preserve rich evidence of intensive ancient dryland farming, especially viticulture. Late 19th–early 20th century pioneering scholar-explorers initiated documentation of the vast agricultural lands surrounding the ancient sites, which has since been improved on by archaeological survey techniques. Edward H. Palmer was apparently the first modern scholar to write of ancient Negev Highland winepresses and vineyards (Palmer 1871: 367, 370, 373). He also reported on terraced (check-dammed) wadis for rainwater runoff collection, ancient wells, walled fields, vestiges of gardens, middens and stone heaps on the hill slopes known to local Bedouin as *tuleilat el-ʿanab* or *rujim el-kurfum* ('grape mounds' or 'vine heaps', *ibid*.: 361–385). According to Palmer (*ibid*.: 367), the latter "would allow vines to trail along them and would still keep the cluster off the ground". Variants of this interpretation,

including the idea that the mounds created microclimates suitable for grapevine cultivation via dew collection and were a form of lithic mulch (Calder 1958: 147–149; Lightfoot 1996, and references), were adopted by such scholars of the ancient Negev as Phillip Mayerson (1959; 1960). However, geomorphological studies have convincingly demonstrated that these were not vine trellises but a by-product of efforts to expose stone-covered slopes, thereby enhancing runoff directed to agricultural fields in wadi beds (Kedar 1957; Glueck 1958, 1959; Evenari *et al*. 1982: 135–147; Bruins *et al.* 2019). As for their grape-referencing Arabic name, it may be that the spatial patterning of the *tuleilat el-ʿanab* is reminiscent of vineyards (Mayerson 1959, 1960; Kedar 1964; Fig. 2), or that this name preserves a memory of their ultimate purpose. For the gathering of hillside stones was just one component of the ancient dryland farming system focused primarily on cultivation of vines and cereals. The material groundwork for this system also included massive construction of check dams in the wadis to collect floodwater and alluvium; stone walls enclosing agricultural fields; built and hewn installations, including water cisterns and pigeon towers for fertiliser production (Kedar 1957; Hirschfeld and Tepper 2006; Avni *et al*. 2019; Tepper *et al*. 2020).

The wide spread of ancient Negev Highland agriculture was demonstrated first by occasional surveys and mapping through aerial photography (e.g., Kedar 1967), and later through the systematic archaeological surveys conducted between 1979 and 1989 as part of the 'Negev Emergency Survey' (see Avni 2014: 260–261 for a summary). Approximately 1500 sq km were systematically surveyed, revealing hundreds of agricultural settlements from the Byzantine and Early Islamic periods. The vast agricultural systems around

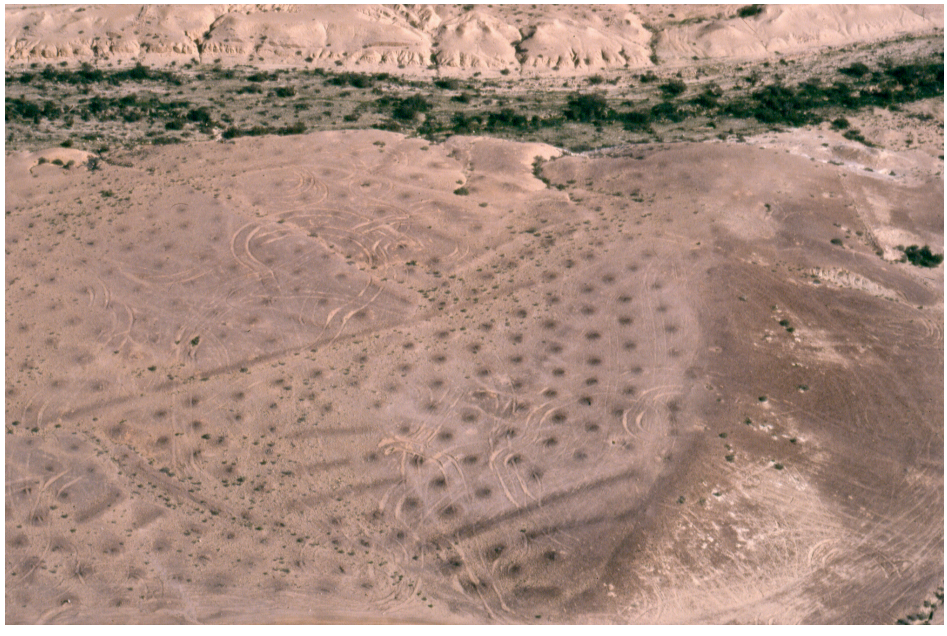

FIGURE 2 *Tuleilat el-ʿanab*, literally "grape hillocks", are stone mounds formed as a by-product of stone clearing on slopes to improve runoff. Their spatial distribution may resemble vineyards, but the actual vineyards of Late Antiquity would have been planted in the terraced wadi below, in this case, Nahal Lavan near Shivta (photo Gideon Avni).

them covered more than 30,000 ha of cultivated plots dammed with stone-built terraced check-dams (Avni 2014: 260–274, and references). In some areas, recent and meticulous re-surveying with the aid of drones has demonstrated that the agricultural regime was even larger than previously estimated through traditional survey methodologies (see for example Sion and Rubin 2020, compared to Rubin 1990: 76–82).

Excavations at Shivta and Nessana during the 1930s, conducted by H. Dunscombe Colt, provided additional clues as to what was grown in the terraced wadi beds. This includes further documentation at Shivta of Byzantine industrial winepresses, which were later found in Oboda, Elusa and additional sites in the Negev with similarities of planning and style (Mazor 1981; 2009; Seligman 2020: Fig. 3). The Colt excavations at Nessana (Colt 1962) revealed the now well-known collection of 6th–7th century CE literary and economic papyri, which attest to the existence of vineyards, as well as wheat, barley, olives, figs, dates and legumes (Kraemer 1958; Mayerson 1962). In the same excavation, grape pips figured among a serendipitous archaeobotanical assemblage preserved in a sealed deposit in the North Church complex (Mayerson 1962: 258). Grape pips were also among the most numerous plant-remain types found in later excavations of pigeon towers at Shivta and Saʿadon (Ramsay *et al.* 2016; Tepper *et al*. 2018a).

An additional indicator for ancient Negev crops has been extant fruit trees irrigated only by desert runoff, relicts of past cultivation associated with ancient wadi check-dams (Zohary 1954; Ashkenazi *et al*. 2015; 2020). By this measure, the most successful species are olive, fig, pomegranate, almond, date and grape (Ashkenazi *et al*. 2020). The oldest of these is a series of olive trees in Wadi Zeitan near Shivta, surmised as descendent from Byzantine-period plantings. The youngest relicts are trees planted in experimental farms during the mid-20th century to reconstruct ancient Negev farming (Evenari *et al*. 1982;

Figure 3 Negev Highland winepress. This Byzantine industrial winepress sits atop the acropolis of Oboda (photo Gideon Avni).

Fig. 4). These have been only minimally cared for in recent decades but demonstrate the viability of local viticulture, arboriculture and field cropping.

The recent NEGEVBYZ project focused on excavation of garbage dumps on the outskirts of Byzantine settlements at Elusa, Nessana, and Shivta (Tepper *et al*. 2018; Bar-Oz *et al*.

Figure 4 Reconstructed desert farm, Shivta. An experimental farm reconstructed by Michael Evenari and his team in the 1960s and 1970s, in aerial view (above) and from the ground today (below). The farm used ancient techniques of desert rainwater runoff harvesting which reached their greatest application in the Negev Highlands during the Byzantine 5th–6th centuries CE (photos Gideon Avni, Guy Bar-Oz).

2019), further confirming the presence of grapes as a significant component of the Byzantine Negev Highland crop basket (Fuks *et al*. 2016; Langgut *et al*. 2021). For the first time, these excavations also demonstrated the importance of grapes to the local economy, via the ubiquity and relative frequency of charred grape pips—second only to charred grains of barley and, in some cases, wheat—among the midden plant assemblages (Fuks *et al*. 2020).

Mayerson's Negev legacy

As far as we are aware, the first published suggestion that the Negev Highland settlements may have been suppliers of Gaza wine was by Mayerson (1985). The key component of Mayerson's argument, and of Seligman's recent rebuttal, is the presence and capacity of Negev Highland winepresses. Both rely on the survey published by Gabriel Mazor—originally in Hebrew in 1981 and in English in 2009—of nine winepresses associated with the Byzantine Negev Highland settlements, which Seligman (2020) updates to 12. Mayerson used additional sources of evidence, such as references to viticulture in the Nessana papyri and in hagiographic texts, as well as the aforementioned presence of grape pips in Nessana's North Church which he had published as part of a chapter in the Colt excavation report (Mayerson 1962). That chapter also attests to Mayerson's field-based appreciation of wadi cultivation, which made viticulture possible in this desert region. However, he clearly considered industrial winepresses to be the clinch in the argument. Following discussion of the hagiographic evidence, and in particular the fascinating letter from Procopius of Gaza to Jerome prophesying the day "when you will see Elusa again and you will weep at the sand being shifted by the wind stripping the vines naked to their roots", Mayerson writes:

> On the basis of this bit of literary evidence alone, we might not be justified in concluding that Elusa was a wine-producing center. However, a short distance from the site of the city, a wine press of substantial proportions and extraordinarily fine workmanship was uncovered (Mayerson 1985: 76).

Mayerson goes on to describe the other Negev winepresses, concluding that "the size of the wine presses currently known leaves no doubt th Roman-Byzantine at the farmers of the Negev were engaged in the large-scale production of wine". Taking this inference further, Mayerson makes a connection between the Negev winepresses and Gaza wine, likely mediated by the monastic economy:

> It is certainly possible to speak of these presses, if not as industrial operations, then as corporate or cooperative ventures, most likely undertaken by monastic communities distributed throughout the central Negev. It is equally reasonable to assume that part of their output satisfied the needs of local inhabitants, and that part—especially in years with harvests of high yields—was sold to wine merchants in Gaza (Mayerson 1985: 78).

Mayerson's enthusiasm for the Byzantine Negev winepresses is patent, and justifiably so. These winepresses provided the archaeological counterpoint to literary evidence for local viniculture, making tangible the near-fanciful concept of ancient wine production in the desert! Seligman (2020) makes the excitement even more accessible, with new color photos accompanying his description of the winepresses' workings. However, on the basis of this bit of archaeological evidence alone, to paraphrase Mayerson, we might

not be justified in concluding that the Negev Highlands were a wine-producing center (see below, 'Seligman 2020: contribution and controversy').

The implications of Mayerson's analysis of Negev Highland wine production are far-reaching. The very existence of a Mediterranean wine trade whose expanding influence brought about a greening of the desert would appear to support a market-oriented, modernist view of the ancient economy. Meanwhile, its previously assumed floundering in the mid-7th century CE concomitant with the rise of Islam, supports a Pirennean paradigm of Late Antiquity. Mayerson's claim that the Negev Highlands were suppliers of the Mediterranean trade in Gaza wine during the 5th and 6th centuries has been accepted by historians interested in the Holy Land and Mediterranean wine trade of Late Antiquity (Decker 2009: 138–139; 2013; McCormick 2012: 69–70; 2019). Seligman (2020) questions this accepted knowledge. Unfortunately, neither the evidence collected by Mayerson, nor that garnered by opponents, provides convincing evidence for the scale, intensity, economic role and chronological boundaries of Negev Highland viticulture. That gap was largely filled by Fuks *et al*. (2020) in demonstrating that this microregion was involved in commercial-scale viticulture and Mediterranean trade, while charting the phenomenon's chronological boundaries.

Seligman 2020: contribution and controversy

Seligman's critique

Seligman's (2020) article, 'Were the Central Negev Settlements Suppliers or Importers of Gaza Wines?', provides the basis for the first scholarly critique in print of Mayerson's 35-year-old hypothesis on the connection between Negev viticulture and Gaza wine. Yet this is not the only service this article provides to the Roman-Byzantine archaeology community and students of Negev history. First, it demonstrates the inadequacy of the scattered evidence originally collected by Mayerson (1985) to support the hypothesis that the Negev Highlands were a supply region for the famous *vinum Gazetum* in the 5th–6th century CE. Second, it offers an updated synthesis of Byzantine Negev Highland winepresses. Finally, it utilises an interdisciplinary array of sources to advance the argument that the region could not have been a supplier of Gaza wine, including demographic and economic calculations in a first attempt at modelling Byzantine Negev wine production and consumption. Seligman concludes that Negev Highland viticulture was likely insufficient for local demand, and that the Negev Highland settlements were importers rather than exporters of Gaza wines.

Seligman's argument for skepticism regarding the Negev Highlands as a source for Gaza wine involves two key components: the output capacity of Negev winepresses and the economic viability of transport. A close reading of the paper yields additional arguments, some explicit and involved, others implicit, which may be summarised as follows:

1. The winepresses and amphorae which have been and continue to be excavated in the vicinity of Gaza and Ashkelon provide sufficient evidence for locally sourced Byzantine Gaza wine, which would have obviated the need to source wine from the Negev Highlands.

2. It was not economical to transport wine ca. 100 km from the Negev Highlands to the coast, especially considering the prohibitive costs of overland transport (based on Diocletian's edict) and the weight of wine-filled amphorae.
3. If wine had indeed been transported this distance to Gaza, one would expect significant numbers of wine amphorae to be found in the Negev Highland settlements, particularly near winepresses. However, locally produced Halutza (Elusa) jars have not been discovered in association with Mediterranean trade. Meanwhile, the main amphora types associated with the Gaza wine trade (alternatively known as the *Gazition* and *Askalōnion*, 'Gaza [wine] jars' and 'Bag-shaped jars', or LR4 and LR5, respectively) were produced in the northwestern Negev and southern Coastal Plain closer to Gaza, as evidenced by archaeological kilns. According to Seligman, transporting empty amphorae from these regions to the Negev Highlands, to be filled with wine and returned, makes no economic sense. Therefore, these ceramics must reflect importation of wine to the Negev Highlands rather than export from them.
4. Comparison of the supply potential calculated from known Negev winepresses to the demand for Negev wine based on demographic estimates, demonstrates that the Byzantine Negev would have had a deficit rather than a surplus in wine production. Seligman estimates daily per capita wine consumption at 0.4–1 l for men and half that for women, or 109–274 l annually. His calculation of annual output from the 12 presses is 904,800 l or about 905 cu m, which would suffice for between 3,302 and 8,301 people. These figures are considerably less than conservative estimates of the Byzantine Negev Highland population at ca. 30,000. Such a population would require between 3,000–8,000 cu m annually ($109 \frac{l}{person*yr} \times 30{,}000$ people = $3{,}270{,}000 \frac{l}{yr}$ and $274 \frac{l}{person*yr} \times 30{,}000$ people = $8{,}220{,}000 \frac{l}{yr}$).

Although all these arguments are discernible in Seligman's paper, the crux of his case is (4), which includes estimates of both potential output and wine consumption in the Negev Highlands. Together, these suggest that Negev Highland viticulture could not have met internal demand for wine consumption, let alone external demand for export wine.

Scrutinising Seligman

We analyse each of Seligman's arguments in the order presented above:

Gravitational pull of coastal wine export

We do not doubt the involvement of Gaza's immediate hinterland in export wine trade. Indeed, the available archaeological evidence from the Gaza and Ashkelon region demonstrates that wine production in and around these cities was economically significant (Erickson-Gini 2021). Yet, the fact that Gaza wine was sourced close to Gaza does not preclude its derivation from more distant sites as well. The question is whether this industry was large enough to push the export wine supply chain into the desert, as far as 50 and up to 100 km from Gaza (see Fig. 1). This is an open question which can only be answered with positive evidence. We cannot prejudge the extent of cultivated land area needed to supply the Gaza wine trade without knowing the scale of

export. However, we can gauge the extent to which the Negev Highlands were involved in commercial-scale viticulture.

Cost-efficiency of transport

Similarly, we do not doubt that overland transport had its costs. The question is whether the product's value justified these costs. In the absence of hard data on the difference between the price of Gaza wine and the cost of its overland transport, a direct answer to this question is elusive. However, the textual evidence indicates that Gaza wine was a highly valued product (McCormick 2012; Lantos *et al*. 2020)—certainly considered worth shipping throughout the Mediterranean and beyond—so it is plausible, if unproven, that Gaza wine at the port was worth the cost of an extra day's camel driving. Moreover, once water, soil and fertiliser were harnessed, Negev viticulture could produce a high-quality product, as evidenced by recent proliferation of boutique wineries in the region. The combination of a radiant desert sun and mild soil salinity increases photosynthesis and sugar content (Keller 2015: 319), enabling production of a sweet, quality wine with high alcohol content, as described in the literary sources on Gaza wine (Lantos *et al.* 2020). The provision of sufficient cold weather during the dormancy period afforded by the Negev Highland climate also contributes to overall excellent conditions for quality viticulture. Thus, Negev Highland wines were likely of superior quality to those grown near the coast.

Sourcing ceramics

We agree that amphorae used in Gaza wine export were produced in the northwest Negev and southern Coastal Plain, not in the Negev Highlands. However, Seligman (2020: 266) states: "For the central Negev to be part of the trade in Gaza wines, significant numbers of *Gazition* or *Askalōnion* jars should be found there, especially close to the wine-presses. Unfortunately, little pottery has been published". In fact, these two pottery types *have* been found in significant quantities (>30,000 identified sherds) in the Negev Highland middens, identified by Tali Erickson-Gini and reported by Bar-Oz *et al*. (2019) and Fuks *et al.* (2020) as 'Gaza jars' and 'Bag-shaped jars'. The absence of quantitative data in previous reports makes it hard to interpret scattered finds of Gaza jars, which may be one factor leading to Seligman's inference that the Negev Highlands were importing wine. It is unfortunate that the pottery of earlier excavations at these sites was poorly published, especially pottery surrounding the excavated winepresses. One exception is Beʾer Shema, ca. 30 km from Gaza and just over halfway from Gaza to Elusa. Here, a Byzantine industrial winepress was excavated from which the main ceramic material retrieved was of Gaza jars and Bag-shaped jars (Erickson-Gini *et al.* 2015). In addition, scattered kiln wasters at the site attest to local pottery production, probably of the very same amphorae. To some extent, Beʾer Shema provides a missing link connecting Elusa and the Negev Highlands to Gaza. On one hand, Beʾer Shema contains all the components that Seligman demands as evidence for supplying Gaza wine. In addition to the winepress, associated wine amphorae pottery, and evidence for their production, a telling Church floor mosaic image juxtaposes a Gaza jar with a pigeon surrounded by grape vines, representing two ends of the production process (Fig. 5). The same mosaic also depicts a grapevine growing out of an amphora

Figure 5 Above: Excerpts from the Be'er Shema Byzantine church mosaic displaying several components of Negev viticulture: pigeons flanked by grape leaves, one of which roosts on an adapted Gaza wine jar (centre); a donkey (left), a camel (right) and their respective drivers, whose loads are covered but which appear on a background of grape clusters and leaves. Below: The mosaic (left) found at Kissufim, not far from Gaza, captures the overland transport of the products of viticulture in the region during Late Antiquity. Orbikon the camel driver appears to lead on a tired camel with a cluster of grapes. Strapped to the camel's back are Gaza wine jars of which an archaeological example is shown (right). Photos: Be'er Shema mosaic: Daniel Varga, Israel Antiquities Authority; Kissufim mosaic: Elie Posner, Israel Antiquities Authority Collection at the Israel Museum Jerusalem; Gaza jar: Davida Eisenberg-Degen, Israel Antiquities Authority.

as well as camel and donkey drivers on a background of grape clusters, grape leaves and more pigeons (Gazit and Lender 1993; Fig. 5). On the other hand, at some 30 km from the coast, Be'er Shema makes the extra stretch to Elusa not seem so far. Indeed, Be'er Shema (Birsama) is alluded to in the Nessana papyri, indicating that the two sites were part of the same regional economic network (Dolinka 2007).

Meanwhile, Seligman's (2020) assumption that wine amphorae production ought to necessarily occur near wine production sites should be questioned. Overland transportation of pottery vessels from production centres across large distances has been observed in the context of the alleged 'Oboda potter's workshop'; no pottery was produced at Oboda but rather transported from Petra by camels (Goren and Fabian 2008: 342). A similar situation may have existed in the transportation of empty wine amphorae from the kilns near Gaza and Ashkelon to wine production centres in the Negev Highlands. Transporting empty wine amphorae to the Negev Highlands makes economic sense especially when considering the availability of fuel needed for pottery kilns (see below, 'The environmental economics of amphorae production').

Estimating supply and demand

To assess the extent to which a local supply of wine could have met local demand, Seligman estimates regional wine consumption and regional wine production. We scrutinise each in turn, offering counter-estimates:

Estimating demand

How much wine did Negev Highland residents drink? Based on various textual sources, Seligman acknowledges a range of 0.4–1 litres daily wine consumption for men in the Roman-Byzantine empire, half that for women, and a negligible amount for children. Using these numbers to calculate local consumption makes far-reaching assumptions. It assumes, for instance, that indigenous wine consumption modelled the standards of Roman Italy (or medieval Gaul), and that the standards preserved in such texts reflect reality for the populace. It also assumes that the 0.4–1 l was undiluted (directly affecting the consumption demand estimate) and fully fermented (affecting production time and hence capacity, see below, 'Estimating supply').

One generous Roman consumption estimate is Cato's yearly allowance of seven amphorae for each of his slaves (Agr. 57), which seems to accord the high Roman wine consumption standards—accepting an estimate of ~50 l/amphorae (Purcell 1985). Yet this also demonstrates high seasonal variability – "11 litres being reserved for two major festivals, and three months being provided with grape-wash instead of wine" (*ibid.*: 13). In the same spirit, we may surmise that during the wine production season Negev residents drank a semi-fermented wine which took up only minimal time in winepress collection vats (see below, 'Estimating supply'), that following the winter rains they drank freshly collected rainwater without wine, and that most of the year they drank grape wash, reserving the valuable quality wine for export. Although we do not possess sufficient evidence to prove such a scenario, this heuristic exercise illustrates how seasonal dynamics and economic considerations could have significantly affected local consumption. Various factors, such as taxation, social hierarchies and export value surely affected consumption as well.

Cultural consumption practices may have similarly affected local demand. Prior to the growth of viticulture in the Byzantine period, Negev residents could not have relied on wine for regular drinking, and we simply do not know how rapidly or extensively that may have changed. Even at the height of the Byzantine period, it is possible that most Negev residents had not fully acculturated to Roman-Mediterranean culinary and wine-consumption practices. Among Jews in 2nd–4th century CE Palestine, wine "was considered a festive beverage, but not normal fare" (Safrai 1994: 131). The Mishna (Rabbinic legal text redacted in the 2nd century) stipulates that one who imbibed an amount equivalent to ca. 180 ml in one sitting was considered gluttonous (Sanhedrin 8:2), and 15 amphorae of wine was considered a maximum acceptable yearly quantity for a family (Sheviʿit 5:7). According to the Jerusalem Talmud (Rabbinic legal text redacted in the latter 4th century), "…wives of the poor do not drink wine" (Ketubbot 5:11).[3] Based on these sources, Safrai (*idem*) estimates an upper standard

[3] See Safrai 1994: 129–131, who estimates 20–25 l/amphora (contra Purcell 1985 above) and either 38–47 l or 75–94 l as a maximal annual per capita figure averaged among men, women and children.

of half a litre undiluted wine per man per week, or 28 l per year.[4] This estimate of nearly contemporaneous indigenous wine consumption in the southern Levant is considerably less than Seligman's low estimate of 104 l. Indeed, due to the mismatch between consumption and production estimates, Safrai (1994: 132) concludes that "the role of grape cultivation as an important part of the ancient Palestinian economy can be understood only if the export of wine was undertaken on a large scale". It is telling that other calculations using text-based Roman per capita consumption figures and demographic estimates in wine-producing regions yield anomalies when compared to production output estimates (Purcell 1985: 13).

Estimating supply

How much wine did the Negev Highlands produce? Seligman (2020: 269) acknowledges that wine "production capacity using traditional techniques is dependent on numerous variables, including length of harvest, pressing techniques, volume and number of collection vats, and the times required for primary fermentation and to empty the vat". Assuming a harvest period of 50 days, 3 to 4 days' time to primary fermentation and emptying the vat, and his calculated 75 cu m volume of the 12 Negev winepresses, Seligman arrives at a yearly output capacity of ca. 900 cu m of wine. However, Seligman's 50-day harvest period is based on Dar's (1986: 153–154) ethnographic observations in Samaria. It is widely acknowledged that this pre-modern viticulture was much less advanced than that of Roman-Byzantine Palestine. With the Romans' interest in, development of, and experimentation with wine-grape varieties,[5] it is likely that different varieties were cultivated which could extend the season significantly. Considering only the most common grape varieties known from pre-modern Palestine, and the possibilities afforded by timing of pruning, a 90-day harvest period (ca. July 1st–September 30th), if not longer, is highly plausible. In the summer heat of the Negev, vats could have feasibly been emptied every other day. If performed continuously over a 90-day harvest period that would yield 45 times filling and emptying each vat, rather than the 12 estimated by Seligman (2020: 269). This demonstrates how Seligman's calculations of output may be easily quadrupled, without including additional winepresses. Yet an even more significant variable, in our opinion, is the ratio of known winepresses in the region to actual winepresses in antiquity.

Seligman's assumption that the number of local winepresses known today represents a significant portion of those in use during Late Antiquity is a central shortcoming in his calculation of Negev Highland wine production capacity. Seligman (2020: 270) acknowledges but dismisses this issue: "One could properly claim that not all the wine-

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[4] This is based on the Mishna's stipulation that standard olive oil consumption is half a *log* per week (Ketubbot 5:8) and that wine consumption was three times that of oil (Shevi'it 5:7), yielding 1.5 *log* wine per week. At the conversion factor of 0.36 *log*/litre adopted by Safrai, this is equivalent to about 0.54 litres of wine per week or 28 litres per year. Safrai writes "1.5 *logs* per week or 28 *logs* per year per male"—a typo which affects subsequent calculations (Safrai 1994: 131), but his conclusion is that Jews in Roman Plaestine must have drunk significantly less wine than they produced.

[5] "Pliny claims that there were at least 80 ancient grape varieties known to produce outstanding wine, two thirds of them from Italy" (Kron 2012: 10, and references).

presses might have been found, but even if the number of large presses were doubled or tripled, no significant surplus could have been produced". This sentence is misleading. The number of ancient presses must have been much larger than the number discovered thus far.

Admittedly, the rate of additional winepress discoveries since the 1980s could be taken as a sign that most have been uncovered. The dozen Negev winepresses reported by Seligman are little more than the nine reported by Mazor nearly 40 years prior and, of the three "new" presses, one (Oboda IV) is a re-interpretation of a structure excavated in 1959–1960. However, the recently discovered presses at Ruheiba suggest a different story. These were found through an intensive survey using drone technology (Dahari and Sion 2017). Seligman (2020: 262) notes that the surveyors of Ruheiba mark four more winepresses in caves but that they have not been investigated and their identification as winepresses is unconfirmed. If confirmed, this would make Ruheiba the Negev Highland site with the most winepresses (six), together with Oboda. Yet none of these presses was known or published until the drone survey. Similarly, recent work at Elusa using geophysical and archaeological survey techniques complemented by excavation has yielded additional winepresses, although these have been identified as Early Islamic (Schöne *et al*. 2019). Recent salvage excavations at the Ramat Negev Regional Council have unearthed yet another large Byzantine winepress, which was perhaps part of a larger complex of buildings from the 4th–6th century (T. Erickson-Gini, personal communication). Both presses were covered by loess and not visible in previous surveys. These examples suggest that digital-age survey technology combined with renewed excavations in this region may uncover many more winepresses. It is also worth noting that most of the winepresses reported on so far are large industrial presses situated in prominent locations within or near settlements as at Shivta and Oboda (Fig. 3). However, such settlements make up a small fraction of the ca. 30,000–50,000 ha land area covered by Negev Highland agriculture (Kedar 1967; Rubin 1990; Sion and Rubin 2020). In reporting the results of his GPS mapping project, Haiman (2012) notes that farmhouses and topographic features designed to enhance rainwater runoff (*tuleilat el-ʿanab*) are "distributed up to 5 km from the Negev towns, and all are associated with huge industrial winepresses". In our opinion, the greatest number of winepresses is to be found in fields beyond the well-excavated settlements and in loess-covered valleys. It is here that the search for Negev winepresses should continue, using the latest survey technologies and excavation methods.

The problem of missing winepresses is well-known in other regions as well. Despite longstanding theories on the Phoenicians' role in transporting wine and diffusing viticulture from the 1st millennium BCE, the first Iron Age winepress in Lebanon was discovered only very recently at Tell el-Burak (Orsingher *et al*. 2020). Incidentally, it was complemented by storage amphorae and significant proportions of grape remains on site (Orendi and Deckers 2018). Similarly, despite extensive evidence for large-scale wine production and storage in the ancient kingdom of Urartu (9th–6th century BCE) in present-day Armenia deriving from inscriptions, storage vessels and archaeobotanical remains, no winepresses have been found to date (Newson forthcoming). The most likely explanation is the near absence of archaeological surveys and excavations in hinterland areas. Data on agricultural installations from Roman Italy and other regions suggest underrepresentation of olive presses

in landscape surveys on the order of 10% or less (Mattingly 1988: 41; Marzano 2013: 100). Hence, rather than doubling or tripling the number of identified winepresses, as Seligman allows, we would surely be justified in multiplying by a factor of five. When combining this with the multiplier for vat-emptying discussed above, a more accurate estimate of Negev Highland wine production is easily 20 times that offered by Seligman (2020), if not more. This does not include the Northern Negev and southern Coastal Plain, where survey evidence suggests a similarly intensive wine industry (Huster 2015; Haiman *et al*. 2020).

One way to evaluate estimates of overall winepress output is to compare them to estimates of agricultural carrying capacity. Survey data on check-dammed wadi beds offers an estimate of peak cultivation area, which can be compared to estimates of subsistence consumption to gauge the plausibility of surplus production. We calculate that 16,500 ha would have been sufficient to feed a population of 30,000 in the Byzantine Negev Highlands (see Supplement). Relying only on the low figure of 30,000 ha of dammed wadi beds from survey data (the high figure is 50,000 ha), the remaining 13,500 ha could have easily produced some 24,000 cu m of wine, most of it surplus,[6] and representing over 25 times that estimated by Seligman (2020). As noted, this discrepancy between the low production estimates from the installations' capacity and the high estimates from land use calculations is not unique to the Negev Highlands. Again, the most parsimonious solution appears to be a significant underrepresentation of presses in landscape surveys.

Fuks *et al.* 2020: new data, new understandings

Fuks *et al*. (2020) used ratios of archaeobotanical seed remains and ceramic amphorae sherds to chart the growth and decline of Negev Highland viticulture, suggesting vibrant export production in the mid-5th–mid-6th centuries CE. Although there had been little doubt that grapes were cultivated and pressed into wine at Negev Highland sites, as discussed above, this was additionally confirmed by the range of grape plant parts reported by Fuks *et al*. (2020), including pips, pedicels, grape skins, charcoal and pollen (see also Langgut *et al*. 2021). Different taphonomic processes conspire against the general preservation of grape skins, charcoal and pollen, such that their mere presence attests to the significance of local viticulture. The high relative quantities of grape pips—second only to barley and wheat kernels among domesticated plant seeds in the Negev Highland assemblages—cannot be explained by importation of wine. Grape pips are not only numerous but are also among the most ubiquitous plant remains, found in every midden context. These findings attest to the importance of local production. Indicating the rising intensity of local viticulture, grape pip proportions relative to cereal grains rose during the 4th–6th centuries from negligible proportions in the 1st–3rd centuries to a peak in the mid-6th century; they declined during the mid-late 6th century and early 7th century. The latter 7th century ratios diverged by site, making evasive a single narrative on either recovery or continued decline for that period. The combined results suggested that local

[6] If we use Safrai's (1994: 131) upper consumption estimate explained above, only 300 cu m or about 1% of this potential output would be needed for local consumption. Full calculations appear in the Online Supplement.

viticulture developed into a commercial-scale enterprise beginning in the 4th–mid-5th century, peaking in the mid-5th–mid-6th century and declining in the mid-late 6th century.

Just as grape-to-cereal ratios offered an index for the intensity of viticulture, ratios between the two main types of storage amphorae found, Gaza jars and Bag-shaped jars, were used as an index of the Negev Highlands' involvement in Mediterranean trade. Although both amphorae types were used to store wine, structural differences make Gaza jars more suited to camelback transport. This is vividly presented in the Kissufim church mosaic, which depicts a camel loaded with Gaza jars led by Orbikon, the camel driver (Fig. 5). Thus, relative ratios of Gaza jars and Bag-shaped jars provide a general indicator for the importance of trade in wine and other goods. They do not indicate the direction of that trade, but the grape pip ratios do. Although negligible at first (1st–3rd centuries), in the mid-5th–mid-6th century, Gaza jars were by far the most common pottery type in the middens, accounting for up to half of all identified sherds (including cooking ware, whose easily cracked but identifiable sherds are often overrepresented). This demonstrates that the Negev Highland sites were heavily involved in regional and Mediterranean trade. Toward the end of the local Byzantine period (mid-6th–mid-7th centuries), Gaza jars declined significantly. Thus, the same chronological trend for the rise and fall of grape-to-cereal ratios was observed in the ratio of Gaza jar sherds to the less-mobile Bag-shaped jars. This suggests that developments in local viticulture were linked to Mediterranean trade.

Integrating quantitative archaeobotanical and ceramic data obtained from the same contexts thus supported a previously unproven connection between Negev Highland viticulture and Mediterranean trade in the mid-5th–mid-6th century. Decline of Negev viticulture in the mid-6th century is corroborated by other evidence, including the end of dovecote maintenance (Hirschfeld and Tepper 2006; Tepper *et al*. 2018a) as well as patterns of settlement and trash disposal at Elusa (Tepper *et al.* 2018b; Bar-Oz *et al*. 2019). As they preceded the Islamic conquests by a century, the archaeological manifestations of this decline debunk Pirennean implications of Islam. Rather, the mid-6th century decline corresponds with a turbulent empire-wide period of pandemic in the form of Justinianic plague and climate change in the form of the Late Antique Little Ice Age, followed by socio-political turmoil associated with the end of the Justinianic Age (Büntgen *et al*. 2016; Sarris in press, and references). Each of these could have acted as triggers, exposing the vulnerability of the peripheral Negev economy to contracting markets across the Mediterranean.

In long-term historical perspective, unprecedented commercial florescence of the Late Antique Negev appears to have been relatively short-lived, reverting to an age-old pattern of smaller-scale settlement and survival-subsistence strategies within about two centuries. These findings enhance our understanding of ancient Mediterranean trade and markets, with relevance to sustainability in an ancient international economy and the vulnerability of peripheral regions to climatic/environmental disturbances. The success of agricultural intensification in an arid desert, as represented by Byzantine Negev commercial-scale viticulture, is a truly impressive feat. Yet its decline provides an early precedent for increased vulnerability to challenges like plague and climate change in a globalised economy. This rapid rise of viticulture in a hot, arid environment and its swift decline apparently due to dependence on the imperial market has much in common with

the even more extreme rise and fall of modern Algerian viticulture—which was the largest source of global export wine in 1960 (Meloni and Swinnen 2014).

Other lines of evidence for the dynamics of Negev Highland wine production and trade

Additional sources of evidence, including some very recently published data, provide further insight into the relationship between Negev Highland viticulture and Mediterranean trade. These further illuminate the economic rationale behind export of local wine within the Byzantine Negev Highlands' historical, geographic, and environmental context.

The environmental economics of amphorae production

One might be inclined to interpret the high proportions of Gaza jars in the 5th–mid-6th century Negev Highland middens not as proof of *export*, but as proof of wine *import* to the Negev, as proposed by Seligman (2020). This is challenged not only by the archaeobotanical evidence for local viticulture and its scale (Fuks *et al*. 2020), but also by anthracological (charcoal) evidence for the Negev Highlands' vulnerability to depletion of fuel resources (Langgut *et al.* 2021)—a key input for pottery production. An increase in tamarisk (*Tamarix* sp.) charcoal between the 4th–mid-5th century and the mid-5th–mid-6th century accompanied by a decrease in the superior boxthorn (*Lycium* spp.) fuel indicates a possible depletion of higher quality firewood over these periods (Bar-Oz *et al.* 2019; Langgut *et al*. 2021). Such depletion would have additionally limited the pottery production capacity of the Negev Highlands when local viticulture was at its peak. To achieve optimum kiln temperatures for Gaza jar production, Negev Highland residents would have needed to import high quality wood to the Negev. Alternatively, they could have imported pottery from areas where high quality wood fuel (and clay) was more abundant. The latter option makes better economic sense considering the weight of transport, as well as the quality of local clays. As shown above, the transportation of pottery vessels by camels over large distances was an accepted practice, and it is reasonable to assume that camel caravans transporting wine from the Negev Highlands to the seaport of Gaza returned carrying amphorae for refilling wine at local production centres.

Trade networks attested by aquatic goods

Amphorae were not the only goods transported to the Negev Highlands from the Coastal Plain, as attested to by a significant presence of sea products in local midden deposits. Numerous fish bones found in the Elusa, Shivta and Nessana middens were identified to Mediterranean, Red Sea and Nile fish taxa (Blevis *et al.* 2021). Many of the identified fish are common in both the Mediterranean and Red seas but finds of gilt-head bream (*Sparus aurata*) could have only originated in the Mediterranean Sea. This confers with Nessana papyrus 47, which recounts a shipment of fish from the Mediterranean (Kraemer 1958: 139–141). Edible shellfish deriving from each of these aquatic habitats were also found in the Negev Highland middens, yet here Mediterranean taxa clearly dominate (Ktalav *et al*. 2021). The Mediterranean seafood provides further support for the Negev Highland's connection to Mediterranean trade, concomitant with the rise of local viticulture, while also hinting at a two-way transfer of goods. Thus,

ancient camel caravans supplying Negev Highland wine to the Coastal Plain would have returned with amphorae and seafood. Nessana papyrus 85 suggests that fish were sold in Gaza jars (Kraemer 1958: 246), and a scenario of repeated reuse and recycling is possible (Peña in press). The evidence for aquatic products further contributes to the picture of a complex, connected, and commercial economy of which the Negev Highlands were a part. It is fair to say that wine and seafood represent the main transported goods in the Byzantine Negev Highland economy, the former exported and the latter imported. Moreover, these two products appear to be central to the economy of Roman-Byzantine Palestine more generally (Safrai 1994: 126–136, 163–165, 383–386, 394). To add one recent example, excavations in 2019 of Roman-Byzantine er-Rasm south of ancient Ashkelon revealed facilities for fish sauce (garum), wine production and related Byzantine-period Gaza jar production, as the main economic activities (Erickson-Gini 2021). The two-way exchange of fish and wine reflects the interlinking of hinterland, coastal and overseas trade, and is known from other historical contexts, including much more recent mercantile capitalism across the North Atlantic. Indeed, the economic rationale for the triangular exchange of fish and wine between 17th century Spain, England and Newfoundland was probably not much different from that of 5th–6th century Byzantine Mediterranean trade in the same (Pope 2004, esp. p. 80, 116–121).

Dovecotes as indicators of intensive viticulture

Pigeon towers, or dovecotes, were mentioned above as a component of the Negev Highland agricultural landscape and infrastructure. More than any other installation except winepresses, they are indicative of intensive viticulture. This is because pigeon manure is the ideal fertiliser for vineyards, as was well-appreciated by the Roman agriculturalists (Pliny the Elder 1940–1963: VII.6; Columella 1926: II.14; Varro 1870: III.7). Thus far several Roman–Byzantine pigeon towers in the Negev have been documented, including four in the immediate environs of Shivta, three near Saʿadon in the Negev Highlands, and nearly 20 in the Beer-sheba region (Tepper 2021). Recent studies have demonstrated that local farmers achieved sustainable soil improvement by raising pigeons and using their manure for fertiliser (Hirschfeld and Tepper 2006; Ramsay *et al.* 2016; Tepper *et al*. 2017; 2018a; Marom *et al.* 2018; Tepper 2021). It is quite evident that the investment in dovecote building and maintenance was not performed for the sake of cereal cultivation, which was successfully conducted without it by 20th century Bedouin (Zohary 1954). Calculation of manure production showed that a single pigeon-tower could produce up to 15 tons of manure per year (Hirschfeld and Tepper 2006). Based on information from Roman agronomists and traditional Middle Eastern agriculturalists, each dovecote could have sufficed for thousands of vines. As with the winepresses, remains of more dovecotes no doubt await discovery in the landscape further afield from the main settlements, or underneath the soil. This is especially likely considering that the higher number of known dovecotes in the Beer-sheba region is the result of greater excavation intensity there (Y. Tepper, personal communication). The image of two pigeons engraved on a lintel at the entrance to Shivta's North Church, not far from the winepress (Fig. 6), as well as pigeons and grapes in the Beʾer Shema mosaic, including one pigeon nesting in a Gaza Jar (Fig. 5), are vivid symbols of these birds' importance to the viticulture-based economy of the Byzantine Negev Highlands.

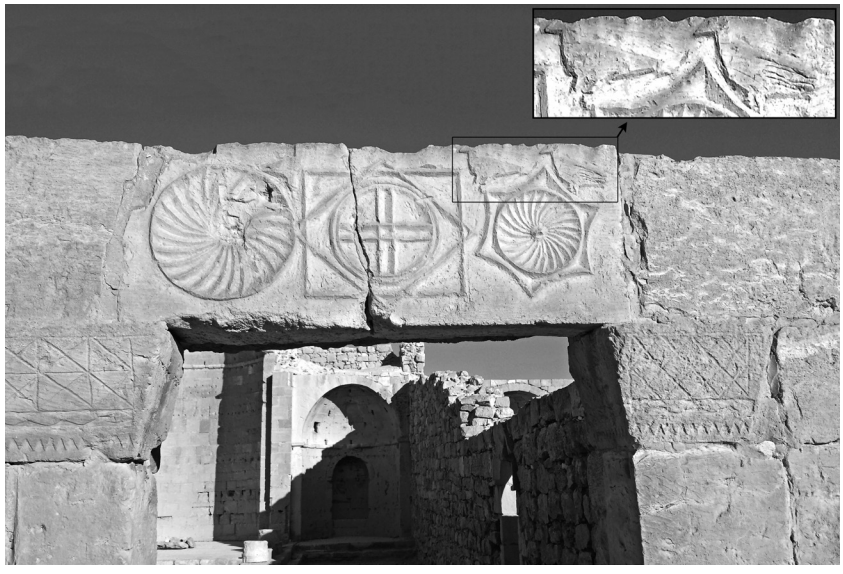

FIGURE 6 Negev pigeons. Two engraved pigeons roost in the top right corner of a lintel at the entrance to Shivta's northern church, reflecting the importance of pigeons to the local viticulture-based economy, and, probably, its connection to the church. Pigeons are still part of the landscape in Shivta today (photo Guy Bar-Oz).

Discussion and future research

The debate on Negev/Gaza wine in Late Antiquity: analysis and synthesis

Methodologically, estimates of production and consumption may be used to indicate the possibilities in an ancient economy, as we demonstrated for surplus vine cultivation in the Byzantine Negev Highlands. However, uncertainty surrounding initial assumptions in the calculations-based approach leads to wide divergence in final estimates such that multiple and conflicting results are attainable from equally legitimate (and problematic) assumptions. Given this problem of equifinality, the calculations-based approach should not be relied upon in the same way as hard evidence for actual production and consumption. We believe that the stalemate between Mayerson (1985) and Seligman (2020) is broken by the new data presented by Fuks *et al.* (2020). To explain why, and present a nuanced narrative of Negev Highland viticulture, it is helpful to break down the discussion into the following questions or inferential steps:

1. Did the Negev Highlands grow grapes in Late Antiquity?
2. Did the Negev Highlands produce wine?
3. What was the intensity of local grape cultivation?
4. Was local viticulture related to regional and Mediterranean trade?
5. Did the Negev Highland sites produce Gaza wine?

Numbers 1 and 2 above have been known for a long time, based on the presence of winepresses and textual evidence as reviewed above. Numbers 3 and 4 were demonstrated by Fuks *et al.* 2020. Number 5 is still unproven, although the answers to 3 and 4 above are suggestive. This is summarised in Table 1 below.

TABLE 1
Summary of inferential steps and evidence for Negev Highland viticulture

Claim	Evidence	References
Grape cultivation	Winepresses; Nessana papyri; relict and experimental vines	Palmer 1871; Mayerson 1962; 1985; Kedar 1967; Evenari *et al*. 1982
Wine production	Winepresses	Palmer 1871; Mazor 1981; 2009; Seligman 2020
Commercial scale	Grape pip relative frequencies	Fuks *et al*. 2020
Mediterranean trade	Gaza jar relative frequencies	Fuks *et al*. 2020
Negev wine = Gaza wine	Circumstantial	Suggested by Mayerson 1985; still unproven

The available evidence does not enable us to simply equate Negev viticulture with Gaza wine production. What we can say with confidence is that in the mid-5th–mid-6th centuries the Negev Highlands were involved in commercial-scale viticulture which was linked to a wider economy via Mediterranean and regional trade. In answer to Seligman's (2020) question, "were the central Negev settlements suppliers or importers of Gaza wines?", we have shown that as major producers they certainly had no need to import wine, and that at least some of the wine they produced probably went to Gaza whence it was shipped to destinations around the Mediterranean. Contextualising these conclusions further, we offer the following narrative:

During the Byzantine period, particularly in the 4th–5th centuries, all of Palestine witnessed major demographic and economic growth, including an increase in Mediterranean trade (Avi-Yonah 1958; Tsafrir 1996; Walmsley 1996). The zenith of public and private construction spans the 4th–mid-6th centuries, presenting an ongoing process of settlement intensification and population growth (di Segni 2017). Notwithstanding internal microregional diversity, Palestine had a regional comparative advantage in viticulture (Safrai 1994: 112–116, 126, 128, 132–133), complementing Egypt's position as the Empire's breadbasket, and industrial olive oil production in Libya, Tunisia, and southern Spain (Mattingly 1988; Safrai 1994: 394, 417–418). Thus, much of Palestine witnessed an expansion of viticulture, spurred by the growing export trade from the ports of Gaza and Ashkelon. The gravitational pull of wine exportation from Byzantine Palestine's southern coast encouraged expansion into marginal and desert regions, among them the Negev Highlands, and concomitant migration from crowded towns and villages to the less-densely populated desert. The desert attracted monks seeking spiritual peace and inspiration, and monasteries apparently played a major role in the financing and organisation of Negev economy and society, viticulture included. Holy Land monasticism may have fueled the allure of the wine itself. Desert runoff cultivation in terraced wadis was improved and perfected, and the three main crops were barley, wheat and grapes. Quality Negev Highland wine was bottled in Gaza jars, strapped to camels' backs and sold for a good price at Gaza. Wine exports funded more than seafood, and wealth acquisition is still visible in the residencies and churches of Negev Highland sites such as Shivta, Oboda and Mampsis. The rise of Negev Highland viticulture attests to complex mobilisation of productive resources in an ancient economy. Its fall appears to have been triggered by climate change, plague,

and/or socio-political instability which exposed inherent vulnerabilities of this system (Fuks *et al*. 2020).

For future research

The debate on Gaza wine and Negev viticulture presents a great opportunity to ponder and pursue connectivity, continuity and change in an ancient Mediterranean economy. The framework and narrative presented above may be valuable for generating predictions and focusing future research. Within the Negev Highlands, it will be interesting to see if future studies produce evidence for additional sources of local wealth aside from viticulture and the holiness industry. As regards viticulture, we predict that many more winepresses and dovecotes will be found in the region with advanced drone and ground-penetrating survey techniques, particularly in areas further away from the main settlements. Future archaeobotanical studies may shed light on whether local viticulture survived or perhaps even revived in the Early Islamic period and on its ultimate demise, with relevance to the question of continuity and change in the Byzantine–Islamic transition (Magness 2003; Avni 2014; Avni *et al.* 2019). Future research will also likely refine our understanding of consumption habits among the local population. With the advancement of different chemical and biomolecular techniques applied to residues on or in skeletal remains, it may be illuminating to discover direct evidence for consumption of wine and other products. The same goes for residues on pottery, which will continue to improve our understanding of the uses and reuses of different amphorae types, including Gaza jars and Bag-shaped jars.

Moving beyond the Negev Highlands, one question concerns the observable trends in wine production on the Coastal Plain, where a much larger density of winepresses has been found. Did the wine trade here also decline ca. 550 CE, as in the Negev Highlands, or did it continue strong into the 7th century? Ratios of grape pips and cereal grains, as well as Gaza jars and Bag-shaped jars, from middens at sites along or near the Coastal Plain will be particularly illuminating in this regard. Similar questions may be asked of other regions, such as the Northern Negev, claimed to be part of the same wine-producing system (Haiman *et al*. 2020). We also note that the Negev offers an important test-case for comparison with other regional production centres of the Late Antique Mediterranean, such as the Syrian limestone massif, the Tunisian Sahel, Tripolitania and the Nile delta, among many others (Mattingly 1996; Wickham 2005: 442–450; Zerbini 2013, 2015; Lavan 2015).

Meanwhile, the identity of Byzantine Negev Highland wine remains elusive. Was it one and the same as Gaza wine? Does it represent a case of powerful expansion of a single variety throughout southern Palestine, or was it a local boutique wine highly specific to Negev Highland *terroir*? Perhaps future biomolecular-archaeological studies will clarify these and related issues. At the sesquicentennial of Palmer's documentation of the evidence for ancient Negev Highland viticulture, we know so much more about the 'when', 'where' and 'how' of this ancient economic phenomenon. By the bicentennial of modern scholarship on ancient Negev viticulture we will surely know much more about the 'who' and the 'what' as well.

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