



Rural production and land use at Iron Age Clazomenae, Ionia

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Received: 15 August 2025 / Accepted: 11 January 2026 / Published online: 12 February 2026
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Abstract

We present new evidence for the nature of agricultural production and land use in the Iron Age Aegean through archaeobotanical remains recovered from the site of Clazomenae in Ionia, western Anatolia. The spectrum of crops and wild resources utilised at the site largely conforms to those recorded elsewhere in the Iron Age Aegean but includes rare finds of caper and sloe that support their status as likely foodstuffs in the region. High proportions of barley from the site prior to the Archaic period align with other assemblages in western Anatolia to reflect a crop signature distinct from neighbouring regions. We suggest that a shift towards free-threshing wheat in the Archaic period may result from an increase in rural settlement and more intensive cultivation of the landscape. Nut and fruit remains align with zooarchaeological evidence attesting to the importance of upland forests as a natural resource within the hinterlands of the site. This is harmonious with a localised model of farming and land use within the Iron Age Aegean, although some value-added products are likely to have been traded across maritime exchange networks.

Keywords Iron Age · Classical period · Aegean · Anatolia · Agriculture · Land use

Introduction

Models of farming in the ancient Aegean have been central to debates surrounding the nature and scale of the classical economy (Finley 1973; Halstead 1987; Osborne 1991;

Oliver 2006). The essentially rural nature of *poleis*, with most of the populace engaged in farming (Bintliff 2024 and references therein), also means that reconstructions of agropastoral production and land use are crucial to understanding the structure and rhythms of ancient society more broadly. This has fostered a strong tradition of research into the textual, archaeological and ethnographic evidence for farming systems that has done much to elucidate their general characteristics (e.g. Halstead 1987, 2014; Foxhall 1995, 2007; Bintliff 2008, 2023). There remain many questions, however, that can only be answered by close study of the remains of farming products themselves (i.e. archaeobotanical and zooarchaeological analysis) which has only recently started to grow within classical archaeology (Lodwick and Rowan 2022). This has left gaps in our understanding of key issues such as the extent to which crop and livestock production varied between regions, how systems of land use were adapted to feed growing populations and the ubiquity of interregional exchange in farming products. This is particularly the case for the eastern Aegean (the western Anatolian coast and its neighbouring islands), where archaeobotanical remains have been reported from just five sites across the Late Helladic (LH) IIIC and Classical periods: the sanctuary at Heraion (Kučan 1995), Miletus (Stika 1997), Troy (Riehl 1999) and, around the Sea of Marmara, Dascyleum (Oybak

Communicated by S.M. Valamoti.

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Fig. 1 Clazomenae and its environs (adapted from Google Earth)

Dönmez et al. 2017) and Ayazmaçukur (Willcox 2003).

Fig. 2 Excavated areas of Clazomenae and Liman Tepe



Despite important insights produced from excavations and survey (e.g. Koparal and Vaessen 2020), the nature of rural production this region remains poorly understood.

We begin to rectify this through archaeobotanical research conducted at the site of Clazomenae in Ionia, western Anatolia. We report an assemblage of plant remains spanning the 12th to late fourth centuries (c.) BC and recovered from both terrestrial and submerged contexts. In doing so, we shed important light on the nature of arable farming and land use around the site, with broader implications across the ancient Aegean.

Clazomenae and its environs

Clazomenae is situated on the northern coast of the Urla-Çeşme peninsula in the Izmir region of western Anatolia (Figs. 1, 2), within the ancient region of Ionia. The Urla and Mandalan plains spread to the south, formed of alluvial soils fed by water sources from limestone uplands enclosing them (Uzel et al. 2012, p 442). To the west, the Karaburun peninsula is dominated by uplands reaching up to 1,200 m a.s.l., dividing a small coastal plain along its eastern coast and broad alluvial valleys reaching the western shore. The natural vegetation of the area consists of pine (*Pinus brutia*, *P. nigra* and, on the Karaburun peninsula, *P. pinea*) and oak woodland (including the deciduous *Quercus cerris* and *Q. infectoria* and evergreen *Q. coccifera*) with

a shrubby understory including *Olea oleaster* (wild olive), *Myrtus communis* (myrtle) and the rock roses *Cistus creticus* and *C. salviifolius* (Atalay 1986; European Commission 1987). *Maquis* shrub communities including evergreen oak, *Erica arborea* (tree heather) and *Juniperus oxycedrus* (cade juniper) are formed with destruction of forest, followed by *phrygana* dwarf shrub, including *Euphorbia* spp. (spurges), *Teucrium* spp. (germanders) and *Cistus* spp., with further disturbance. Along the coast, dune scrub formations include *Vitex agnus castus* (chaste tree) and *Pistacia lentiscus* (mastic tree) (Ozturk et al. 2002). Pollen records elsewhere along the central western Anatolian coast paint a broadly similar picture for the Iron Age but suggest that deciduous oak woodlands were more widespread (Müllenhof et al. 2004; Knipping et al. 2008; Stock et al. 2020).

Evidence for occupation at the site of Clazomenae dates back to the Middle Chalcolithic period (Tuncel and Şahoğlu 2018). The prehistoric settlement (referred to as Liman Tepe) continued to be occupied throughout the Bronze Age, notably including a heavily fortified Early Bronze Age citadel and lower town spanning 15 ha (Erkanal and Şahoğlu 2016). The Late Bronze Age occupation was disturbed by recent development but seems to have been a modest settlement confined to the top of the mound (Erkanal 2008; Mangaloğlu-Votruba 2015). During this period, trade in the Gulf of Izmir was likely dominated by the wealthy site of Panaztepe to the north-east (Ersoy et al. 2024). Clazomenae appears to have asserted itself in interregional exchange networks in the Early Iron Age, forming strong links to northern Greece, Macedonia, Boeotia and Euboea visible in pottery (Ersoy 2004; Vaessen and Ersoy 2024). Between the late 12th and early 10th c. BC, it grew beyond the limits of the Early Bronze Age lower town, with a drop in the number of rural sites in its hinterland pointing to the nucleation of populations at Clazomenae (Koparal et al. 2017; Koparal and Vaessen 2020; Ersoy et al. 2024).

By the late 10th c. BC, the core of the settlement appears to have shifted south-west of the area of Liman Tepe, with a burial ground to the west of the new core pointing to the formalisation of settlement boundaries (Koparal 2017a; Koparal and Vaessen 2020; Ersoy 2022). From the late 8th c. BC, there is a significant increase in the number of sites in the hinterland of Clazomenae, predominantly established along the main overland routes in use throughout the Late Bronze and Early Iron Age (Ersoy et al. 2024).

Major developments took place in the settlement and its hinterland in the Archaic period. The late 8th to early 7th c. BC saw the construction of a large fortification wall and foundation of several necropoleis that continued to be used throughout the 6th c. BC (Hürmüzlü 2004; Ersoy and Cevizoğlu 2024). Distinct residential and industrial quarters appear to have been defined by the 6th c. BC with the

construction of a large olive press and an iron smelting complex to the west and southwest of the domestic area (Ersoy 2004; Koparal and İplikçi 2004). The status of Clazomenae as a major pottery production centre is supported by remains of at least four pottery kilns and abundant production waste on the outskirts of the settlement (Cevizoğlu and Ersoy 2016; Ersoy 2022). Underwater excavations and palaeoenvironmental research have revealed the construction of coastal breakwaters in the 7th–6th c. BC enclosing a harbour of around 5 ha (Erkanal 2014; Riddick et al. 2022). Abundant archaeological remains attest to intensive use of the harbour in the Archaic and Classical periods.

Settlement around Clazomenae expanded rapidly from the 7th c. BC, with new sites founded beyond the established road networks of earlier periods (Koparal and Vaessen 2020). A defensive network including border forts on the fringes of the Clazomenae territory alongside tumuli and rural sanctuaries likely acted as landmarks to demarcate boundaries with neighbouring *poleis* (Koparal 2017b). This points to the formalisation of the Clazomenae *chora* in which the site acted as the main regional civic and political centre (Koparal and Vaessen 2020). Much of the settlement was abandoned at the end of the 6th c. BC as occupation moved to the nearby Karantina island during the suppression of the Ionian Revolt by the Persians, although the mainland is likely to have been farmed to supply the island (Ersoy 2004; Güngör 2004). The Archaic settlement was re-occupied in the early 4th c. BC following major rebuilding before being abandoned again for Karantina island before the Hellenistic period (van Beek and Beelen 1991; Özbay 2004).

Material and methods

Archaeobotanical sampling and analysis

The archaeobotanical remains in this study derive from the Yaşar University excavations of the settlement of Clazomenae (led by Y. Ersoy) and the Ankara University excavations of the submerged harbour (led by V. Şahoğlu and I. Tuğcu). The assemblages from each excavation were subject to different recovery strategies, preservation conditions and taphonomics so will be reported separately before being considered together in the discussion.

Land excavations

Sampling for archaeobotanical remains followed a ‘judgemental’ strategy (see Maltas et al. 2023b) in which contexts were sampled if they were considered likely to contain remains. This centred on burnt contexts, the contents of

vessels and pits, and visible concentrations of archaeobotanical remains. Soil samples were processed by water flotation and remains that floated (the float) were collected in a 0.3 mm mesh and the rest (the heavy residue) were retained in a 1 mm mesh. The majority of the archaeobotanical material was collected in this way except from above four graves and within a well (see below), which were collected by hand.

The floats were briefly scanned and those that contained remains were selected for further analysis. Large floats were sieved into >1 mm and 0.3–1 mm fractions prior to sorting. The >1 mm fraction of one sample was estimated to contain over 1,000 crop grains and was therefore split into two subsamples using a riffle box sample splitter. One half of the sample was sorted and contained over 700 crop grains, beyond the minimum sample size found to reflect the relative proportions of taxa to a high degree of accuracy and reliability by van der Veen and Fieller (1982). Large 0.3–1 mm fractions were also divided into subsamples no smaller than 1/8. Subsamples of two litres were taken from heavy residues of four or more litres. The counts of items in all subsamples were multiplied up and the different fractions combined to produce counts for the whole sample.

Both the >1 mm and 0.3–1 mm fractions were sorted using a low-power stereomicroscope (7–45x) at the Clazomenae excavation house. Items were quantified to identify the minimum number of plant structures of each taxon using the embryo ends of cereals and the radicle ends of pulses as ‘diagnostic zones’ (cf. Jones 1991). The minimum number of structures of other taxa was estimated by visual inspection. For fig fruits, this was primarily based on the combined volume of fragments. Plant taxa were identified by comparison with relevant literature (e.g. Sabato and Peña-Chocarro 2021). Lists of species geographically relevant to the site were extracted from *Flora of Turkey* (Davis 1965–2000). Time restrictions and limited access to seed reference collections meant that we were only able to conduct very preliminary identifications of some arable weed/wild remains and therefore did not attempt to identify and fully quantify each taxon. Full analysis of these remains will be the focus of future research.

Underwater excavations

Plant remains were recovered by hand during excavation of the submerged harbour deposits. All of the samples of remains were briefly scanned to establish the type and approximate quantity within them. Shown in Table S1, this demonstrated that the assemblage was overwhelmingly dominated by remains of olive stones, hazelnut shells and wood fragments. Only samples thought to contain remains of other taxa were therefore selected for further analysis,

although the majority of these also contained remains of hazelnut and/or olive. Plant remains were analysed using a low-power stereomicroscope at the Ankara University Research Centre for Maritime Archaeology. In the absence of cereals and pulses from the harbour, the minimum number of structures was estimated by visual inspection. All plant structures were fully quantified except olive stones in quantities estimated to be over 100, which were grouped into approximate numerical categories. Plant taxa were identified as described above.

Results

Land excavations

Overview and diachronic trends

The archaeobotanical assemblage from the land excavations is reported in Table S2. A total of 6,922 plant remains were recovered from 66 archaeobotanical samples. Ninety-five percent (6,574 remains from 45 samples) derive from Archaic contexts, 0.1% from Geometric (six remains from three samples), 1.4% from Protogeometric (94 remains from 17 samples) and 3.6% from LH IIIC (248 remains from one sample).

Various potential crops and economic taxa were identified within the assemblage (Fig. 3): *Triticum turgidum/durum* (free-threshing wheat), *T. monococcum* L. ssp. *monococcum* (einkorn wheat), *T. cf. turgidum* L. ssp. *dicoccum* (Schrank) Thell. (cf. emmer), *Hordeum vulgare* L. (hulled barley), *Panicum miliaceum* L. (broomcorn millet), *Vicia ervilia* (L.) Willd. (bitter vetch), *Lens culinaris* Medik. ssp. *culinaris* (lentil), *Cicer arietinum* L. ssp. *arietinum* (chickpea), *Lathyrus sativus* L. (grass pea), *Vicia faba* L. (broad bean), *Olea europaea* L. (olive), *Vitis* sp. (grape), *Ficus carica* L. (fig), *Corylus avellana* L. (hazel), *Quercus coccifera* L. (kermes oak), *Amygdalus* sp. L. (almond), *Prunus spinosa* L. (sloe), *Capparis* sp. (caper), *Silybum marianum* L. (milk thistle) and *Calendula arvensis* L. (field marigold). Most of the taxa were recovered as seeds. Fig was attested by drupelets (seeds) and fruit fragments. Hazel and almond were present as nut shell fragments and kermes oak as a cupule.

The cereal and pulse assemblage was overwhelmingly dominated by *P. miliaceum*, making up 84% of remains from this category and recovered from 30% of samples. Barley and free-threshing wheat were present in lower quantities but were encountered comparably frequently across the samples, making up 6 and 2.5% of cereal and pulse remains and present in 39 and 26% of samples, respectively. Cereal chaff is notably absent from the assemblage, suggesting that crop processing waste was not a major source

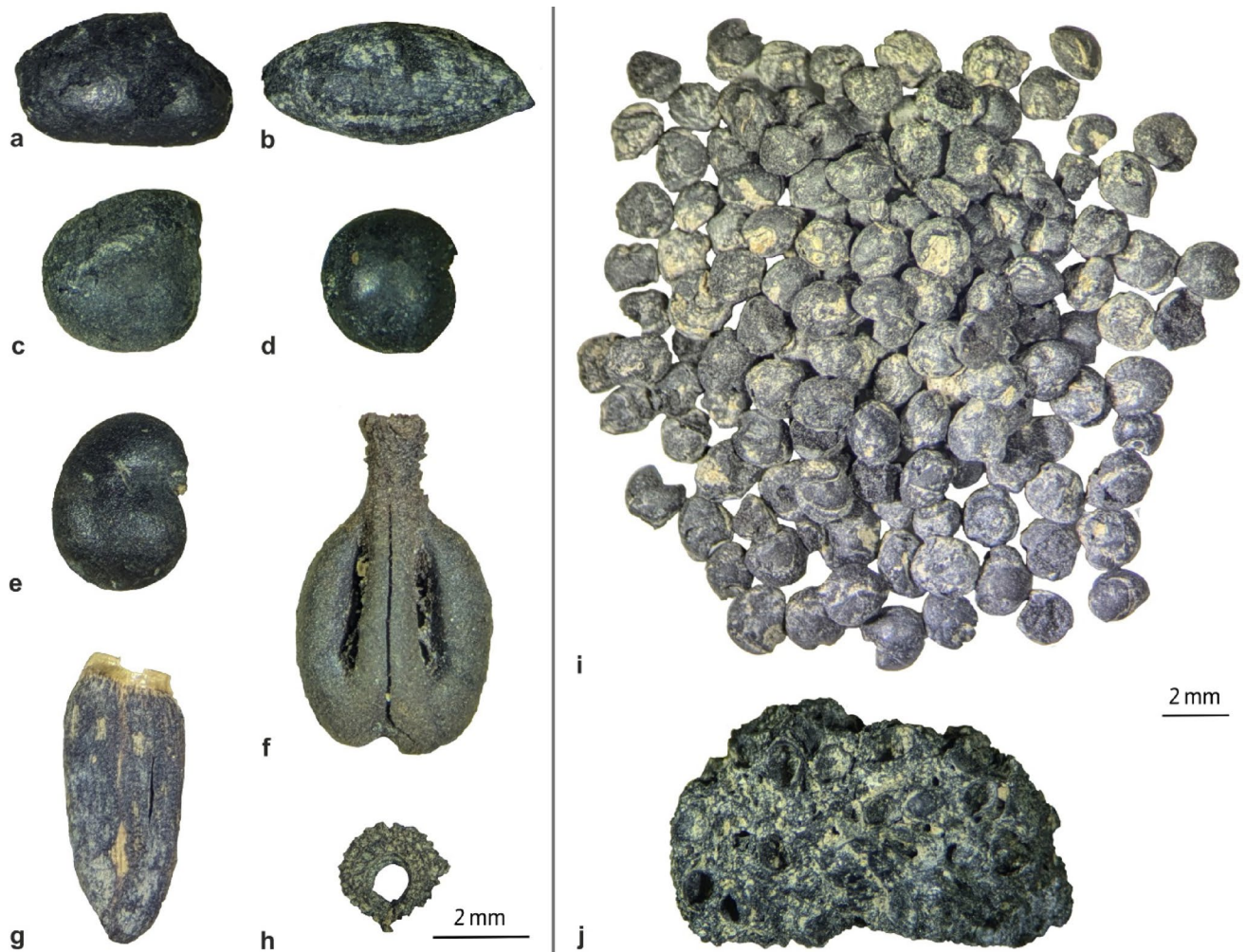


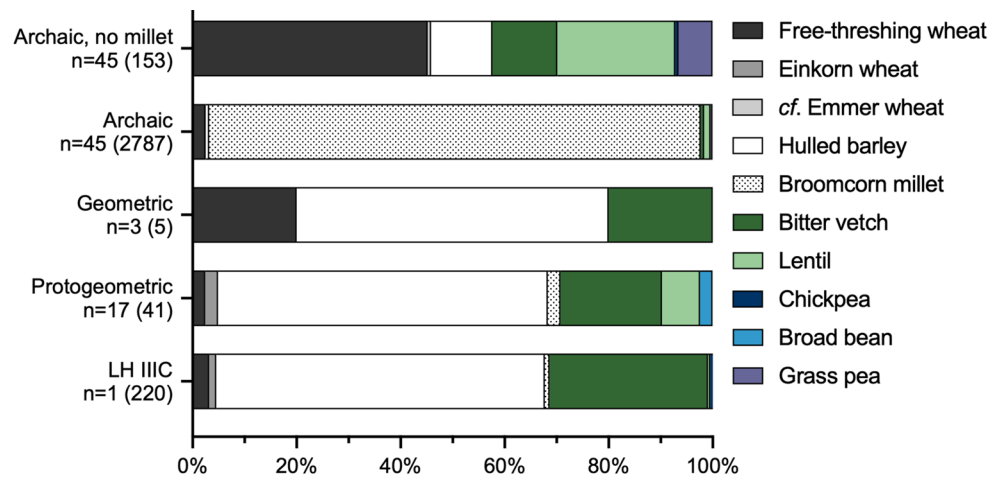
Fig. 3 Plant remains recovered from the land excavations of Clazomenae. **a:** free-threshing wheat, **b:** hulled barley, **c:** bitter vetch, **d:** lentil, **e:** caper, **f:** grape, **g:** milk thistle, **h:** field marigold, **i:** broomcorn millet, **j:** fig fruit

of plant remains within the recovered samples. Pulses were much more poorly represented, comprising just 5.5% of the assemblage combined. The fruit and nut assemblage was dominated by grape and olive, respectively making up 47% and 42% of remains from this category. The number of seeds of arable weed/wild taxa is small, making up 5.5% of the total assemblage of plant remains from the site (see Table S2). Of these, small-seeded species are particularly underrepresented, making up just over 10% of weed/wild seeds. This may be due in part to the size of the mesh used to recover the flot, creating a bias against the recovery of seeds smaller than 0.3 mm in size. It may also be explained by the limited presence of remains from early-stage crop processing waste and dung burning, both of which are associated with small-seeded species (Jones 1983; Charles 1998), and the overall limited size of the archaeobotanical assemblage.

Although the small size of the assemblage and limited number of samples from some periods warrant caution, some diachronic trends are visible in the proportions of

cereal and pulse crops within the samples. Shown in Fig. 4, samples from the LH IIIC and Protogeometric are very similar, both dominated by barley and bitter vetch alongside small quantities of free-threshing wheat, einkorn wheat and other pulses. Slightly higher proportions of free-threshing wheat in the Geometric (although, based on six remains, not representative) presage a major increase in this species at the expense of barley in the Archaic. An increase in lentil at the expense of bitter vetch further diverges from earlier crop spectra, but a much larger pulse assemblage is needed to evaluate this. Grains of *P. miliaceum* are also clearly much more abundant in the Archaic than earlier periods, although this is primarily due to a single deposit (see below). *Corylus*, *Quercus*, *Amygdalus*, *P. spinosa*, *Capparis*, *S. marianum* and *C. arvensis* are restricted to Archaic samples (Table S2).

Fig. 4 Proportions of cereal and pulse species for each occupation period at Clazomenae. n: number of samples (number of cereal and pulse seeds)



Compositional and contextual analysis

Following Dennell (1976), Halstead (1994) suggested that potential crops can be considered cultivated if they were found as a store/cache or comprise at least 50 seeds and make up over 30% of the seeds within a sample thought to represent a cleaned crop product. None of the remains from Clazomenae were found as a store/cache. The LH IIIC sample derives from the fill of a single roomed structure. It is primarily composed of *H. vulgare* and *V. ervilia* which make up 90% of the crop seeds within it. The arable weed/wild seeds are dominated by *Lolium temulentum* and *Galium*, both of which are common field weeds and are able to pass through processing and into storage alongside crop seeds (Defelice 2002; Thomas et al. 2011). This suggests that the sample represents a secondary deposit of remains deriving from crop stores and that *H. vulgare* and *V. ervilia* were therefore cultivated. The Protogeometric and Geometric samples do not contain enough remains to make this kind of inference but the continued dominance of *H. vulgare* and *V. ervilia* in these periods indicates that they were cultivated.

The Archaic samples derive from a range of archaeological contexts. Their contents are summarised in Table 1. Four were recovered from soil just above cremated human remains from a late 7th c. BC necropolis. Three contained small quantities of olive stones and one a single grape seed alongside 40 free-threshing wheat grains. Biases potentially introduced by collection by hand prevents further compositional analysis, but these seeds may have been deposited on top of the cremated remains as part of the burial process, continuing a practice known from the Bronze Age of the Izmir region (Şahoğlu 2016). Whatever the case, this cluster of grains attests to the distinct treatment of free-threshing wheat and its probable status as a cultivated crop.

Thirty samples were taken from four late 6th c. BC pithoi within a small building opening onto a stone-paved courtyard in the west of the settlement (Fig. 5). Pithos 2 is heavily

dominated by *P. miliaceum*, making up 98% of the cereal and pulse seeds in the vessel. There is no evidence for in situ burning, meaning that the deposit is unlikely to represent the original stored contents of the pithos. Despite the large number of seeds, the overall density of remains is also lower than expected for an in situ storage deposit of *Panicum* at ca. 190 seeds/litre for the two richest samples and 60 seeds/litre for the whole vessel. Significant quantities of fig seeds and fruit fragments within the vessel are also unlikely to have been stored alongside *P. miliaceum*. They are more likely to be the remains of domestic refuse that was discarded into fires and dumped within the pithos after it fell out of use. This is further suggested by nutlets of *Vitex agnus castus*, a shrub unlikely to have reached reproductive maturity within cultivated fields and therefore likely to have been deposited within animal dung burnt as fuel within domestic fires. Mixed remains of various cereals, pulses and fruits within the other pithoi are also more consistent with refuse than stored products. Despite this, the high proportion of *P. miliaceum* within the Archaic assemblage points to its status as a cultivated crop. The ubiquity of *H. vulgare*, *L. culinaris* and *V. ervilia* across the Archaic samples also suggests that they were cultivated.

Seven samples were recovered from waterlogged deposits dating to the late 6th c. BC within a well. These contained few cereals and pulses but the bulk of the fruit and nut remains within the assemblage. These were most likely discarded in the well as domestic/passing refuse following processing and/or consumption. The vast majority of the olive stones were intact and therefore consistent with fruits consumed whole rather than pressed for oil (cf. Margaritis and Jones 2008). Remains of wild plants were dominated by seed pods of various *Medicago* spp. (medick) and *Onobrychis caput-galli* (cockscorn sanfoin). *Medicago* spp. and *O. caput-galli* are found on rocky slopes and waste places (Davis 1970, pp 499, 507–508, 565) and may therefore have been growing on or around the well and deposited their

Table 1 Counts of select taxa from different contexts types of the Archaic period

| | Necropolis n=4 | Pithoi n=30 | Silo and room fills n=4 | Well n=7 |
|---|-------------------|----------------|-------------------------------|-------------|
| Cereals and pulses | | | | |
| <i>Triticum turgidum</i> ssp. <i>dicoccum</i> (cf. emmer wheat) | | 1 | | |
| <i>T. turgidum/durum</i> (free-threshing wheat) | 40 | 24 | 5 | |
| <i>Triticum</i> sp. (wheat) | | 5 | 1 | |
| <i>Hordeum vulgare</i> (hulled barley) | | 14 | 2 | 2 |
| <i>Panicum miliaceum</i> (broomcorn millet) | | 2,635 | | |
| <i>Vicia ervilia</i> (bitter vetch) | | 19 | | |
| <i>Lens culinaris</i> ssp. <i>culinaris</i> (lentil) | | 35 | | |
| <i>Cicer arietinum</i> subsp. <i>arietinum</i> (chickpea) | | | | 1 |
| <i>Lathyrus sativus</i> (grass pea) | | 10 | | |
| Fruits, nuts and potentially economic plants | | | | |
| <i>Ficus carica</i> (fig, seed/fruit) | | 335/23 | 1/1 | 1/ |
| <i>Vitis</i> sp. (grape, seed/pedicel) | 1/ | 16/3 | | 1,665/2 |
| <i>Olea europaea</i> (olive) | 9 | 33 | 1 | 1,470 |
| <i>Corylus avellana</i> (hazelnut) | | | | 15 |
| <i>Amygdalus</i> sp. (almond) | | | | 1 |
| <i>Quercus coccifera</i> (kermes oak, cupule) | | | | 1 |
| <i>Prunus spinosa</i> (sloe) | | | | 2 |
| <i>Capparis</i> sp. (caper) | | | | 1 |
| <i>Silybum marianum</i> (milk thistle) | | | | 4 |
| <i>Calendula arvensis</i> (field marigold) | | | | 5 |
| Arable weed/wild | | | | |
| <i>Onobrychis caput-galli</i> -type | | | | 7 |
| <i>Medicago</i> spp. | | | | 165 |
| <i>Chenopodium</i> -type | | | | 1 |
| <i>Lolium temulentum</i> -type | | x | | |
| <i>Phalaris</i> sp. | | x | x | |
| <i>Avena</i> sp. | | x | | 1 |
| <i>Galium</i> sp. | | x | | |
| <i>Vitex agnus-castus</i> | | x | | |
| Caryophyllaceae | | x | | |
| Small Fabaceae | | x | x | |
| Polygonaceae | | x | | |

n: number of samples. x: presence. The full data is reported in ESM Table S2

Pods within it. While *Capparis*, *S. marianum* and *C. arvensis* also grow wild in the Izmir region, they may also have been collected/cultivated as food or medicine and will be discussed further below. The single acorn cupule may have been deposited with many twigs that were found alongside the carpological remains. The remaining Archaic samples derived from the fills of a stone silo and various rooms but contained few remains.

Underwater excavations

The archaeobotanical assemblage from the harbour is reported in Tables S1 and S3. Over 750 samples of plant remains from the Archaic and Classical periods were briefly scanned. As noted above, olive stones heavily dominated the assemblage making up approximately half of the samples and present in quantities ranging from 5 to over 500.

Three hundred and eight samples were selected for further analysis.

The spectrum of plant remains resembles the well, containing olive stones, grape seeds, hazelnut shells, almond shells, a kermes oak cupule, a sloe stone and a medick seed pod (Fig. 6). A single cone of *Pinus brutia* Ten. (Turkish pine) was also recovered. Like the well, the vast majority of olive stones were unbroken, suggesting that they were discarded from olives consumed whole. The hazelnut shells tended to be split in half or fragmented. These are consistent with olives and hazelnuts consumed by people on boats or around the harbour and discarded into the water. This can also explain the presence of grape seeds, almond shells and the sloe stone, suggesting it is the primary depositional pathway for plant remains from the harbour. *Medicago* and *Q. coccifera* may have grown in its vicinity. *Pinus* cones were likely to have been collected for their nuts, although today

Fig. 5 Late 6th c. BC pithoi in the west of the settlement. Pithos 2 is indicated by the red arrow

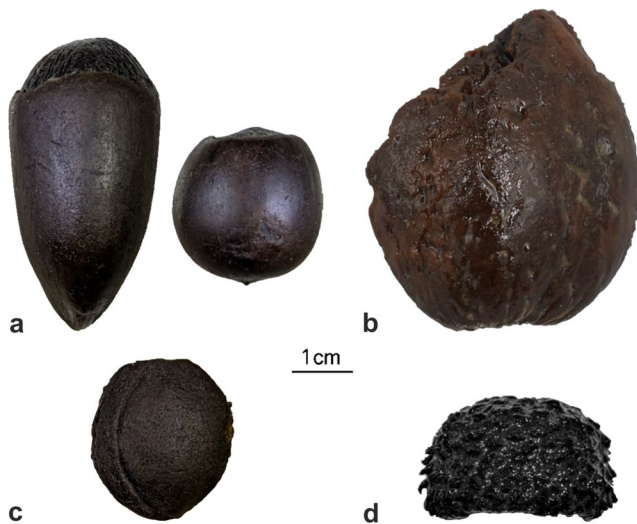


Fig. 6 Plant remains recovered from the underwater excavations of the Clazomenae harbour. **a:** hazelnut, **b:** almond, **c:** sloe, **d:** kermes oak

this is typically only *P. pinea* (stone pine), and charred pine nuts have been recovered from Classical Sikyon, southern Greece (Tsirtsi 2022). The *Pinus* cone from Clazomenae was closed and may have been discarded into the harbour as a result, but may also have fallen off a nearby tree or been stripped off twigs gathered for another use. *Pinus* cones have also been recovered alongside sheep and goat remains within submerged Punic pithoi from Sardinia, where they have been interpreted as flavourings or preservatives for meat (Del Vais and Sanna 2012). The *Pinus* cone and scale from Clazomenae were not found in vessels, however, and the Sardinian specimens may also rather derive from refuse dumped in pithoi rather than flavourings.

Discussion

Crops and economic plants in the ancient Aegean

All of the plants that are likely to have been cultivated at Clazomenae (*T. turgidum/durum*, *H. vulgare*, *P. miliaceum*, *L. culinaris*, *V. ervilia*, *Vitis* sp., *O. europaea* and *F. carica*) are well-attested at other Iron Age sites in the Aegean (see syntheses by Megaloudi 2004, 2006; Livarda 2012; Margaritis 2017; Valamoti et al. 2018; Douché et al. 2021). They are all also known as foodstuffs in the ancient Mediterranean (Flint-Hamilton 1999; Grivetti 2001; Valamoti et al. 2022) except for *V. ervilia*, the status of which is less clear. Valamoti et al. (2022) synthesised textual references to *V. ervilia* and found that it was predominantly considered animal fodder but also noted for its medicinal properties for humans. References to human consumption as food are primarily in times of famine, for example Demosthenes, writing in the 4th c. BC, stating that vetches were sold for food in Athens during shortages resulting from the Decelean War (*Against Androtion*, 15). Flexibility in the categorisation of food and fodder crops during periods of scarcity is also well documented in recent contexts and includes the addition of *V. ervilia* to bread flour (Jones and Halstead 1995; Halstead 2014, pp 164–166, 291–292). It is worth noting the elite audiences for which many ancient authors were writing, however, suggesting that more regular consumption of *V. ervilia* as a low status food cannot be ruled out. While it is not clear if they were cultivated at Clazomenae, hulled wheats (einkorn and emmer), chickpea and broad bean are also known to other Iron Age sites in the Aegean and recorded as foodstuffs within Archaic/Classical texts (Flint-Hamilton

1999; Grivetti 2001; Valamoti et al. 2022). A number of the fig fruit fragments recovered from the Archaic amphora are consistent in shape with dried fruits, a staple of the ancient Greek diet (Foxhall 1993) and reported as both seeds and whole fruits within archaeobotanical assemblages from the Neolithic onwards (e.g. Renfrew 1973; Sarpaki 1999; Valamoti 2023, pp 146–148). Other potential crops and economic plants found at Clazomenae are less well attested in the archaeobotanical record. Finds of hazelnuts are very rare in the prehistoric Aegean, although *Corylus* charcoal has been found in a few sites in northern Greece (Marinova and Ntinou 2018; Valamoti 2023, p 153). In the Iron Age, small quantities of charred hazelnut remains have been reported from Archaic Miletus, Ionia (Stika 1997) and Geometric Krania, central Macedonia (Margaritis 2006–2007). More abundant remains (of 302 nuts) were recovered from Archaic waterlogged deposits from the sanctuary at Heraion, Samos (Kučan 1995). In central Anatolia, an unspecified amount of remains were recovered from jars at Gordion dating to around 700 BC (Miller 2010). These are well outside the natural range of *Corylus* and were therefore imported, a practice also known to Middle Bronze Age central Anatolia from finds at Kültepe (Fairbairn et al. 2014). Today, *Corylus* is predominantly known to northern Anatolia and has only a scattered distribution in the west and adjacent islands (Davis 1982, p 686). Writing in the 4th c. BC, Theophrastus (*Enquiry into Plants* 3.15.1) states that the mountain of Tmolus, contemporary Bozdağ, in the Izmir region had hazel in abundance, however, suggesting that it was more widespread in the west in antiquity. The presence of hazel as part of the natural woodland of the Izmir region is also attested by nutshells within a core from Lake Belevi directly dated to the 6th millennium, 3rd–2nd millennia and 8–5th c. BC (Stock et al. 2020). Theophrastus (*Enquiry into Plants* 3.15.1) references several aspects of hazel management, confirming it as a managed/cultivated plant in the ancient Aegean as well as one utilised in its wild form. Alongside the consumption of nuts, stripped twigs were used to make baskets, a practice continued in western Türkiye today (Kültür 2008). Almonds also have a long history of exploitation in the Aegean, with small quantities of remains reported from the Epipalaeolithic/Mesolithic onwards (Valamoti 2023, pp 152–154). The domestic almond, *Amygdalus communis*, is not native to the region, having likely been domesticated in the Levant in the 4th–3rd millennia BC (Zohary et al. 2012), meaning that these earlier finds must be native wild species. *A. webbii* grows wild in the Izmir region (Davis 1972, p 21) and has endocarps morphologically very similar to *A. communis* that can also produce a sweet fruit (Nicolás-Almansa et al. 2021). *A. webbii* therefore cannot be ruled out for the remains from Clazomenae. Sporadic hybridisation can also occur between *A. communis* and *A. webbii* (Hanelt 1997),

meaning that cultivated stands could have included hybrid populations. Almond cultivation is well attested in the textual record of the 4th c. BC, with numerous aspects described by Theophrastus (*Enquiry into Plants*) and Aristotle advising to plant almond trees around beehives (*History of Animals*, 9.4.20). Xenophon describes an ointment made from pork fat, sesame, bitter almonds or turpentine in western Armenia under Persian rule (*Anabasis*, 4.4.13). Elsewhere in the Iron Age Aegean, small quantities of charred *A. communis* seeds are reported from Protogeometric Knossos, Crete (Livarda 2012), Geometric and Archaic contexts from the Sanctuary of Poseidon at Kalaureia, Poros (Sarpaki 2019) and Classical Sikyon, northeast Peloponnese (Douché et al. 2021), in addition to remains of *A. cf. communis* from Archaic Miletus (Stika 1997) and *cf. Amygdalus* from Archaic Perge, southwest Anatolia (Kroll 2017). A single *A. communis* stone contemporary to the hazelnut remains was also found at Gordion (Miller 2010). The seeds of sloe from Clazomenae are the first from the Archaic Aegean. The only other Iron Age finds are three charred seeds from Protogeometric and Geometric levels of Kastanas, central Macedonia (Kroll 1983). Evidence for exploitation in northern Greece dates back to the Early Neolithic (van Zeist and Bottema 1971). Elsewhere in the Iron Age Mediterranean, 53 seeds were recovered alongside 11 seeds of domestic plum from submerged Phoenician-Punic amphora dating to the 6th–2nd c. BC at Santa Giusta lagoon, Sardinia (Ucchesu et al. 2017). Charred remains of one stone and four whole fruits were recovered from 7th–6th c. BC deposits at Monte Polizzo, Sicily (Stika et al. 2008). In northern Italy, a seed fragment identified as *P. cf. spinosa* was reported from an 8th–7th c. BC pit from Monte Trabocchetto (Arobba et al. 2003) and 379 seeds found alongside other *Prunus* species from submerged contexts around 12th–11th c. BC pile dwellings at Stagno (Giachi et al. 2010). It is not clear if any of these remains derive from cultivated trees. Textual evidence is also ambiguous in this regard, with Virgil, writing in the 1st c. BC, describing elms planted alongside pears, blackthorn bearing sloes and plane trees (that were already offering shade (*Georgics* 4.103). The high tannin content of sloe makes them unappetising raw but they are processed into jams and liquor in various parts of Europe (Łuczaj and Pieroni 2016; Valdes et al. 2025). Sloe liquor is considered a digestive (Alarcón et al. 2015) and a decoction is consumed in Turkish Thrace as a treatment of cardiac disease (Kültür 2007).

Finds of *Capparis* in the Mediterranean have been synthesised by Rivera et al. (2002). They have been reported from just two other sites in the Iron Age Aegean. A single waterlogged seed was recovered from a 7th c. BC deposit at the edge of the sanctuary at Heraion, Samos, thought to derive from votive offerings and/or meal waste (Kučan

1995). At Corinth, in the north-eastern Peloponnese, a single charred seed dating to the Classical period was recovered from a fill above a floor within a dining room in the sanctuary of Demeter and Kore (Bookidis et al. 1999). The source of the remains is unclear. Earlier finds are known from both the Aegean and Anatolia, with individual seeds sporadically recovered from a few sites in each region (e.g. Helbaek 1970; van Zeist 1991; Asouti et al. 2001; Valamoti 2004, p 32). The only clear evidence for consumption in the eastern Mediterranean comes from Tell es-Sweyhat in north-west Syria, where a jar of charred flower buds and unripe fruits was found dating to the late 3rd millennium BC (van Zeist and Bakker Heeres 1985, pp 309–310). More recently, desiccated caper fruits were found in a jar alongside shoots, leaves and fruits of *Cannabis sativa* from an 8th c. BC tomb in north-west China, where they are thought to have possessed a medicinal function (Jiang et al. 2007). Caper is mentioned several times by Theophrastus, most notably with reference to its unwillingness to grow on cultivated land and preference for good soils near towns (*Enquiry into Plants*, 6.5.2). Later Greek and Roman authors describe its status as both a cultivated and wild plant food possibly also used in perfume (Miller 1995; Rivera et al. 2002; Gorzalczany et al. 2025). While clearly consumed in the ancient Mediterranean and beyond, current finds from the Aegean provide little insight into the extent and nature of its consumption.

There are no finds of *S. marianum* from the Aegean or Anatolia contemporary with those from Clazomenae. Finds from the Late Bronze Age are known only from Troy, including 12 seeds recovered from a deposit containing both crop grains and dung-derived remains (Riehl 1999, p 69; appendix 1). *S. marianum* is known to increase lactation in livestock (Tedesco and Guerrini 2023) and was therefore posited as supplements to animal feed at Troy because mature plants are generally avoided by grazing animals (Riehl 1999, p 69). *Silybum* heads may also have been used as tinder, however. *S. marianum* is also known to have potential in the treatment of liver disease in both humans and animals (Flora et al. 1998) and, in the Izmir region, its seeds and stem are consumed in various forms to treat the liver, rheumatism, anorexia and as a diuretic (Sargin et al. 2013). Writing in the 1st c. AD, Dioscorides refers to the medicinal properties of a plant called *Silubon* (*De Materia Medica*, 4.159), suggested to be *S. marianum* by John Goodyer, a botanist who translated the text in the mid 17th c. (Gunther 1933, p 554). The Latin name of the genus, *Silybum*, derives directly from the ancient Greek. Whether *S. marianum* was actively used by the occupants of Clazomenae, as a medicinal plant or otherwise, is unclear.

Textual evidence for the use of *Calendula* is scant. In the 1st c. AD, Pliny refers to the medicinal properties of a plant called *Clymenus*, interpreted as *C. arvensis* within

a 19th c. translation, but also possibly *Convolvulus sepium* (hedge bindweed) and *Lathyrus clymenum* (Spanish vetchling) (*Natural History*, Bostock and Riley 1855). No other finds are reported from the Archaic Aegean or Anatolia. One seed was recovered from Hellenistic levels of Kınık Höyük, central Anatolia (Castellano 2022). In the Late Bronze Age, small quantities of seeds are reported from Olynthus, northern Greece (Becker and Kroll 2008), Akrotiri on Thera (Sarpaki 1987) and Troy (Riehl 1999). The finds from Troy include four seeds from an unspecified fill alongside likely field weeds, dung-derived remains and a few cereal and fruit seeds, consistent with a refuse deposit. Those from Akrotiri include a few seeds within a semi-clean store of *Lathyrus sativus* and therefore likely to have been field weeds. Like *S. marianum*, therefore, ambiguities in both the textual and archaeobotanical records mean that there is no clear evidence for the use of *Calendula* in the Iron Age Aegean.

Beyond the species recorded here, textual evidence attests to a broad diversity of crops and economic plants that were utilised within the Iron Age Aegean (Grivetti 2001), only some of which are known to the archaeobotanical record (Megaloudi 2004, 2006; Livarda 2012; Margaritis 2017; Valamoti et al. 2018; Douché et al. 2021). In addition to the relatively low number of archaeobotanical assemblages recovered thus far, a major reason for this is the lack of a depositional pathway through which many remains would become preserved. The most common mode of preservation in the Mediterranean is charring which creates a bias towards the recovery of plant structures likely to survive burning and come into contact with fire either as discard or when crop stores are accidentally burned (typically the seeds and/or chaff of cereal and pulse crops). Waterlogged contexts generally offer a wider variety of fruit, nut and other taxa that are consumed fresh, exemplified at Clazomenae in the greater breadth and abundance of these taxa in the well and harbour than charred deposits, but are rare in the Mediterranean. A particularly rich assemblage of waterlogged remains derives from the Archaic deposit at the edge of the sanctuary at Heraion, including remains of *Vitis*, *Olea*, *Ficus*, *Amygdalus*, *Corylus*, *Quercus*, *Capparis*, *Punica granatum* L. (pomegranate), *Prunus persica* (L.) Batsch (peach), *Cucumis melo* L. (melon), *Citrullus lanatus* (Thunb.) Matsum. & Nakai (watermelon), *Morus nigra* L. (black mulberry), *Rubus fruticosus* agg. (blackberry), *Anethum graveolens* L. (dill), *Apium graveolens* L. (celery), *Coriandrum sativum* L. (coriander), *Papaver* (poppy) and *Pistacia terebinthus* L. (terebinth) alongside *T. turgidum/durum*, *H. vulgare* and *L. culinaris* (Kučan 1995).

The fragmentary nature of the archaeobotanical record makes it difficult to track variation in the choice of crops and economic plants across the Iron Age Aegean and neighbouring regions. Based on available data, variation in the

presence of fruit, nut and vegetable taxa is primarily dictated by the distribution of waterlogged deposits. Remains of cereal and pulse crops offer a more equitable means of comparison, but no trends are visible in their presence/absence across sites/regions between the LH IIIC and Classical periods. Comparing the proportions of remains of different cereal and pulse species may be more informative.

Comparing regional crop spectra

Figure 7 shows the proportions of different cereal and pulse seeds within site assemblages from the LH IIIC to Classical periods in Greece, western Anatolia, and central and southern Anatolia. An arbitrary minimum of 30 total cereal and/or pulse seeds was applied for assemblages to be included in the analysis. We compare proportions of seeds only in order to improve comparability between species with different taphonomic biases impacting the deposition of chaff, except for spelt wheat which is often only recognised by its glume bases. The free-threshing wheat grains recovered from above the Archaic graves at Clazomenae were also excluded from the analysis due to their unique depositional pathway. While the limited number and small size of some assemblages, particularly in western Anatolia, warrant caution, several trends can be tentatively highlighted. In Greece, there is a reduction in the frequency of glume wheats (einkorn and emmer) in the Archaic and Classical period, present in just one of four assemblages (emmer from Kalapodi) compared with 10 of 11 earlier assemblages. The replacement of glume wheats by free-threshing wheat in these periods has been previously discussed by Kroll (2000), Livarda (2012) and Valamoti et al. (2018), and has been linked to the greater ease with which the latter is processed and it being less bulky when stored and/or transported, making it a better suited to feed the rapidly growing populations of this time. Free-threshing wheat and barley are the most abundant cereals in all regions, but free-threshing wheat makes up a larger proportion of the cereal grains within assemblages from central and southern Anatolia than Greece and western Anatolia, although with a few exceptions including Archaic Clazomenae (Fig. 7b). The western Anatolian assemblages also tend to contain greater proportions of barley and fewer glume wheats than those from Greece. Shown in Fig. 7a, *P. miliaceum* tends to be present in small proportions save for a few notable exceptions (Kastanas, Perge and Clazomenai), but is more often found in Anatolian assemblages (13 of 17) than Greek ones (5 of 15). Trends are also visible amongst pulses (Fig. 7c), with Greek assemblages containing a greater diversity of species that are well-represented, contrasting with a stronger dominance of *V. ervilia* and *L. culinaris* in central and southern Anatolia. The western

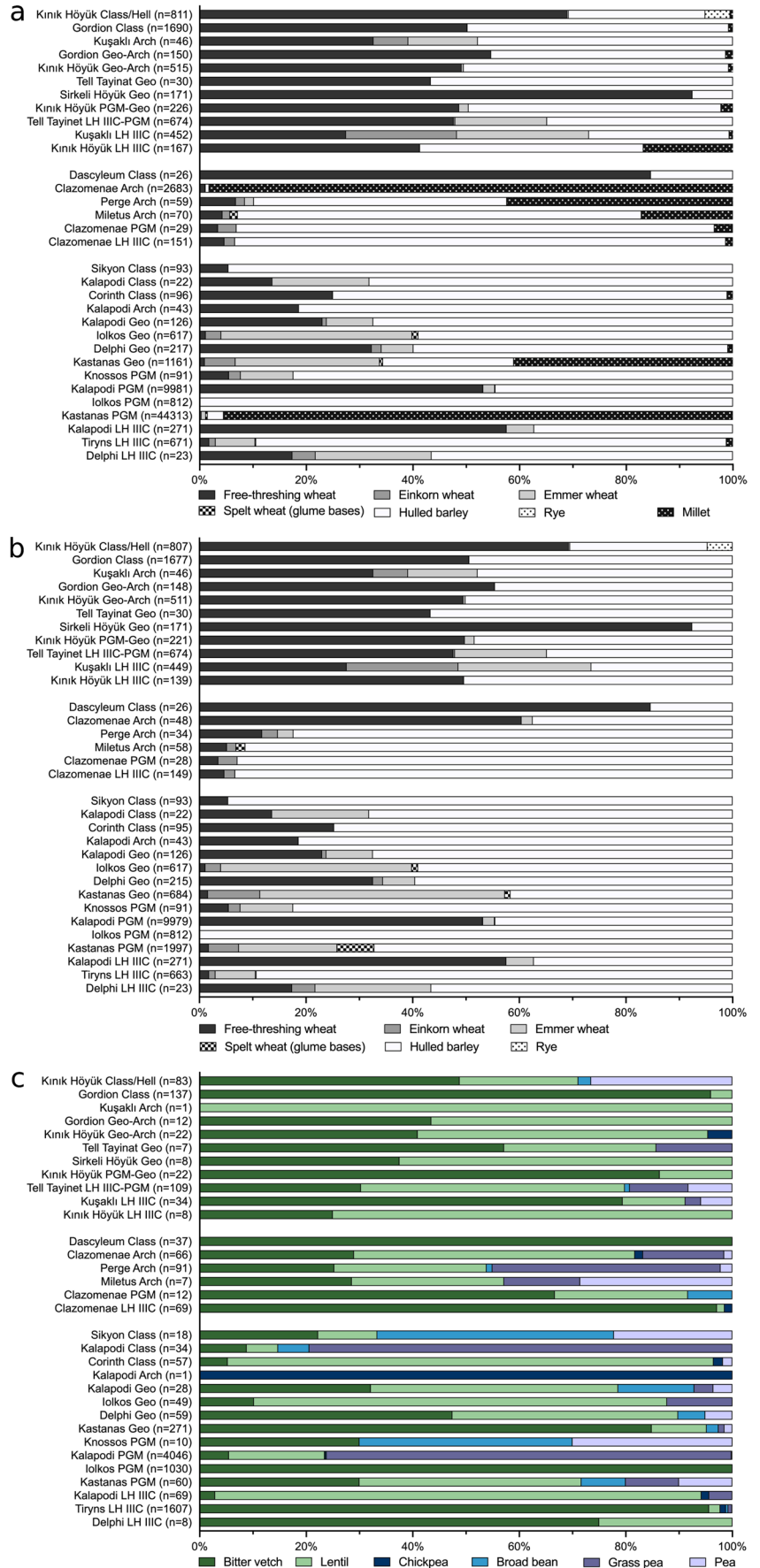
Anatolian assemblages tend to align with Greece rather than central and southern Anatolia.

The differences in crop spectra between Greece and central and southern Anatolia reaffirm a previously recognised trend (Riehl and Nesbitt 2003). Although based on a small dataset, this is the first time a distinct crop signature has been recognised for western Anatolia, aligning with artefactual evidence for cultural practices unique to the region (Ersoy et al. 2024). The greater overlap between the assemblages from coastal western Anatolia and Greece than those elsewhere in Anatolia continues a trend from the Bronze Age (Maltas and Günel 2024). The dominance of barley at Clazomenae during the LH IIIC and Protogeometric also directly continues a trend from the Middle (Maltas et al. 2023a) and Late (Maltas field notes) Bronze Age occupations of Liman Tepe.

The favouring of free-threshing wheat over barley by the Archaic period breaks with this tradition. Given the relatively small size of the assemblage, it is possible that this is due to differences in the contexts that were sampled from different periods. The LH IIIC and Protogeometric deposits come from a different part of the settlement than the Archaic pithoi from which most of the later remains derive. All of the samples included in the analysis contain mixed types and/or small quantities of remains consistent with secondary and/or refuse deposits, however, suggesting that similar depositional pathways shaped the compositions of the samples across different contexts. This suggests that they may well reflect a real change in the proportions of different crops grown at the site.

If this is the case, an explanation may lie in changes in the exploitation of the Clazomenian *chora*. Models of agropastoral production in the ancient Aegean suggest that the bulk of the population were engaged in farming, with daily journeys made between home and field (Bintliff 2024). The settlement formed a centre point in the landscape, surrounded by intensively managed ‘garden’ plots transitioning to less intensively managed fields as frictions of distance restricted the movement of people and applications of household waste/manure. This model is supported by ethnographic parallels of recent non-mechanised farmers in the Aegean (Jones et al. 1999; Halstead 2014, pp 216–217) as well as haloes of pottery sherds reflecting intensive applications of domestic waste to cultivated land in the immediate hinterland of Archaic/Classical settlements and tailing off further afield (Bintliff 2023 and references therein). Limited rural settlement around Clazomenae in the Bronze and Iron Age (Koparal and Vaessen 2020) suggests that the site predominantly relied on foodstuffs produced by its occupants. The bulk of cereals are therefore likely to have been produced on fields managed with limited anthropogenic inputs some distance from the settlement. These conditions align

Fig. 7 Proportions of **a** cereal taxa, **b** cereal taxa not including millet, **c** pulse species from LH IIC and Iron Age archaeobotanical assemblages from central and southern Anatolia (upper group), western Anatolia (middle group) and Greece (lower group). All counts are of grains/seeds unless stated otherwise. PGM: Pro-togeometric, Geo: Geometric, Arch: Archaic, Class: Classical, Hell: Hellenistic. n: number of grains/seeds. Citations ordered as shown: Kınık Höyük–Castellano 2022; Gordion–Marston 2017; Kuşaklı–Müller-Karpe et al. 1998; Tell Tayinat–Karakaya 2024; Sirkeli Höyük–Sollee et al. 2020; Dascyleum–Oybak Dönmez et al. 2017; Perge–Kroll 2017; Miletus–Stika 1997; Sikyon–Tsirtsis 2022; Kalapodi–Kroll 1993; Corinth–Bookidis et al. 1999; Iolkos–Jones 1982; Delphi–Luce and Marinval 2008; Kastanas–Kroll 1983; Tiryns–Kroll 1982



with the dominance of barley as a crop often utilised in the prehistoric Aegean for its ability to thrive in less productive growing conditions than wheat, including at Chalcolithic and Bronze Age Liman Tepe (Maltas et al. 2022, 2023a; see also Vaiglova et al. 2014 and Wallace et al. 2013 for similar examples, alongside Nitsch et al. 2017; Vaiglova et al. 2023 and Diffey et al. 2025 for more variable growing conditions relative to other crops).

The proliferation of rural settlement in the Archaic period is likely to have brought new patterns of rural production to the countryside. Forming their own centres from which farming radiated, new settlements will have reduced frictions of distance across the landscape and increased the area under intensive cultivation. At Clazomenae itself, an uptick in traction related pathologies in smaller cattle is consistent with increased use of cows for ploughing (Crabbé et al. 2025), favoured for intensively managed plots by recent non-mechanised farmers in the Aegean (Halstead 2014, pp 55–57) and pointing to efforts to further intensify production around the settlement. As a less hardy crop than barley but one that appears to have been considered higher status (Garnsey 1999, pp 199–200), wheat may have been favoured on more intensively managed plots. The more intensively cultivated land surrounding Clazomenae and the new centres of production in its hinterland may therefore have increased the production of wheat across the countryside, rendering its populace less reliant on extensively cultivated barley. The population growth represented by rural infilling may also explain the increased importance of millet in the Archaic. As a summer crop, millet would have provided an additional growing season through which to increase the productivity of the countryside and support growing populations. Further archaeobotanical evidence from Clazomenae and nearby sites is needed to assess this hypothesis further, but it is plausible that a busier, more intensively managed landscape offered new opportunities, and necessities, for production and consumption within the Clazomenian countryside.

Rural production and land use

The spectrum of crops and economic plants reported here can also shed light on broader patterns of land use around Clazomenae. The bulk of agropastoral activities are likely to have taken place on the plains spreading to the south of the settlement. Estimates of their carrying capacity far surpass maximum population estimates for the territory of Clazomenae (Koparal 2014). Like today, farmers also likely took advantage of the low slopes and valleys of the upland foothills surrounding the plain for the cultivation of grapes and olives. *Capparis* would have been found locally amongst *maquis* on sandy and gravelly soils (Davis 1965,

pp 504–507; Özdemir and Öztürk 1996). *Vitex agnus castus* also grows locally on sandy and dry alluvial soils as well as rocky areas near the sea (Dogan et al. 2011), suggesting that some livestock were grazed within the immediate hinterland of the settlement. In contrast, the majority of pigs from Protogeometric and Archaic deposits survived until two years old, suggesting that they were not intensively managed and may have roamed freely in the open forests of the uplands and their foothills (Çakırlar et al. 2016).

These woodlands appear to have been a major resource for the occupants of Clazomenae. Remains of hare, wild goat and fallow deer attest to their importance for hunting (Çakırlar et al. 2016). Hare and fallow deer may occupy forest edges and nearby fields (Oğurlu 1997; Ünal et al. 2022), but wild goats are predominantly found under the cover of red pine in mountainous areas (Gündoğdu and Oğurlu 2009) and will have necessitated trips into the upland interiors. Hazel may have been cultivated on the plain but is also found naturally within broad-leaved woodlands, open *Pinus nigra* woodlands and pseudo-*maquis* (Davis 1982, pp 686–688), all of which are likely to have characterised the Karaburun peninsula in the past. Almonds may also have been cultivated, but *A. communis* and *A. webbii* are also found on limestone slopes, oak woodland and scrub (Davis 1982, p 21) and therefore likely to have been found in the uplands and their foothills. Similarly, sloe is found amongst scrub and forest remnants up to 1,700 m a.s.l. (Davis 1972, p 9) and would therefore have been a resource of the uplands and their foothills. There is no archaeobotanical evidence for coastal resources but remains of sea bream (*Brama* sp.) and murex (*Murex* sp.) attest to the exploitation of tidal zones and waters close to the coast (Çakırlar et al. 2016).

The plant and animal remains from Clazomenae thus reflect the exploitation of rich natural resources that were available within the countryside immediately surrounding the settlement. This is harmonious with a general picture constructed from the archaeological and textual evidence for farming and land use as local in scale, aligning with the localised dynamics of the *polis* (Foxhall et al. 2007). This did not render agropastoral production free from the influences of interregional exchange and contact across the Mediterranean, however, as new economic opportunities and plants, animals and knowledge spread. The Archaic period saw the increased presence and/or introduction of species like pomegranate and the chicken across the Aegean (Pagnoux and Zurbach 2020; Best et al. 2022), while a change in the size and shape of pig remains from Archaic Clazomenae points to the introduction of new breeds or rearing practices (Slim and Çakırlar 2023).

Archaic Clazomenian amphorae found across the Mediterranean and Black Sea also attest to the export of some (as yet unknown) goods (Sezgin 2004). The production of

wine for maritime exchange networks is well-documented elsewhere in the Aegean and may have been a profitable investment for large landowners at Clazomenae (cf. Foxhall 2007, pp 80–82). Although there is no direct evidence for this, quantities of imported Clazomenian amphora across late Archaic phases at Berezan in the Crimean Peninsula were inversely proportional to those from Chios (Chistov et al. 2020, p 222), plausibly containing wine famously produced on the island and hinting at the same use for those from Clazomenae. The olive press, constructed in the first half of the 6th c. BC and rebuilt on a larger scale possessing greater efficiency in the last quarter of the 6th c. BC (Koparal and İplikçi 2004), also attests to the production of significant amounts of oil. Indeed, writing in the 4th c. BC, Aristotle states that the land of Clazomenae bore olive oil in abundance, such that the oil of citizens was loaned to the state at interest to be used as security to procure a loan of grain (*Economics*, 2.2.19). Specialised production of olive oil as a cash crop for export has been questioned by Foxhall (2007, pp 78–80), although oil from bumper harvests of the estates of large landowners was likely to have been sold. *Olea* DNA within 4th c. BC amphora recovered off the coast of Chios attests to some interregional exchange (Foley et al. 2012). Pollen records across the Aegean also show increased proportions of olive trees within rural landscapes of the Geometric and Archaic periods (e.g. Müllenhof et al. 2004; Bakker et al. 2012; Kouli 2012; Lazorova et al. 2012; Shumilovskikh et al. 2016), with maxima disproportionate to the other *maquis* taxa that grow naturally alongside them, pointing to increased scales of cultivation. While most of the olives produced at Clazomenae were probably consumed locally, with the remains from the harbour also highlighting the importance of olives consumed whole, it is therefore likely that some oil was exported.

Conclusions

Archaeobotanical remains from Clazomenae offer important insights into rural production and land use in Iron Age Ionia. The occupants of the site grew and/or consumed a variety of crops and potentially wild plants, most as foodstuffs but some that may have had medicinal uses. While these largely conform to those recorded elsewhere in the Iron Age Aegean, they include rare finds of caper and sloe, supporting their status as likely foodstuffs in the ancient Aegean. While the small size of the assemblage makes inferences both preliminary and tentative, high proportions of barley compared with other cereals in the LH IIIC and Protogeometric align with other western Anatolian assemblages to reflect a crop signature distinct from other regions of the Aegean and Anatolia. A shift in the proportions of barley and

free-threshing wheat in the Archaic period may be linked to a surge in rural settlement and more intensive cultivation of the landscape that plausibly increased the availability of wheat within the Clazomenae countryside. The increased importance of millet in the Archaic may also have been a response to a growing population. Continued archaeobotanical work at the site will seek to test these hypotheses. The spectrum of plant remains also aligns with the zooarchaeological record to highlight the importance of upland forests as a natural resource within the hinterlands of the site. More broadly, our findings support a model of farming and land use within the ancient Aegean as predominantly local in scale, although some farming products surely made their way across interregional exchange networks. More archaeobotanical assemblages from the Iron Age will help to contextualise these results and shed greater light on the nature of farming and land use within the ancient Aegean.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s00334-026-01088-5>.

Acknowledgements We are grateful to Naoise Mac Sweeney, two reviewers and the editor for their valuable comments on an earlier draft of this article. The land and underwater excavations at Liman Tepe continue as part of the Izmir Region Excavations and Research Project (IRERP) under the framework of the Ankara University Mustafa V. Koç Research Center for Maritime Archaeology (ANKÜSAM), with permits from the Turkish Ministry of Culture and Tourism. The excavations are generously supported by the Ministry of Culture and Tourism, Türkiye; Ankara University Rectorate; Ankara University Scientific Research Fund (BAP), Project Nos. 2006 – 0901024, 10Y6055002, 15A0759003, 18A0759002 and SBA-2022-2654; TÜBİTAK, Project Nos. 108K263; 114K266; 116Y107 and 124K036 Institute for Aegean Prehistory (INSTAP); Ankara University, Faculty of Languages, History – Geography (DTCF); INSTAP-SCEC; İzmir Metropolitan Municipality and Urla Municipality. For more information on ANKÜSAM and IRERP, see <http://ankusam.ankara.edu.tr>.

Declarations

Conflict of interest We have no competing interests to declare.

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