The contribution of palynology to the reconstruction of villa gardens at Roman Stabiae

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Keywords

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Abstract

Prestigious gardens known as *viridiaria* emerged in the first century BCE and gained popularity as the Roman horticultural revolution was promoted by the emperor Augustus. This paper aims to reconstruct early Roman elite gardens and compare their botanical components. The gardens were exposed at the Roman resort of Stabiae, which, like neighboring Pompeii, was buried in 79 CE under several meters of volcanic ash. Located on the lower slopes of the Verano and Latteri Hills, Stabiae comprised exceptionally fertile farmland and luxurious villas looking across the Bay of Naples. Beginning in the eighteenth century, several archaeological expeditions have conducted excavations at the site, all of which encountered gardens among the architectural remains. This paper discusses the palynological methods that were used to reveal the botanical composition of three gardens: the northern garden of the Panoramic Domus, the courtyard garden of Villa San Marco, and the Great Peristyle Garden of Villa Arianna, the best preserved and one of the largest ornamental gardens in the Roman world. The study compares between materials obtained using two different sampling strategies and palynological extraction techniques: pollen assemblages recovered in the plaster that coated garden structures and pollen assemblages extracted from the garden soils. Based on this comparison, we were able to reconstruct more accurately the ornamental and productive plants cultivated in the gardens. They included local plants and fruit trees—grapevine (*Vitis vinifera*), myrtle (*Myrtus communis*), Persian walnut (*Juglans regia*), chestnut (*Castanea*), elm (*Ulmus*), olive (*Olea europaea*), and rose (*Rosa*). Pollen of the exotic date palm (*Phoenix dactylifera*) and acacia (suggested as *Acacia nilotica*) is also present, proposing Egyptian influence on the gardens' design. Pruning and miniaturizing of the ornamental plants, common among horticultural trends of the period, are also suggested. The observations deepen our understanding of how these gardens relate to their local landscape and the broader cultural interplay of plants and art, early in the development of the Roman Empire.

Introduction

The Roman city of Stabiae was a luxurious seaside resort until its burial under several meters of tephra ash from the Vesuvius eruption in 79 CE. It stretched along a high cliff and overlooked the Bay of Naples, just south of Pompeii (Fig. 1). Profiting from agriculture and horticulture on the fertile soils of the lower slopes of the Verano and Latteri Hills, as well as pisciculture and maritime trade, a new class of wealthy Romans built lavish villas on former agricultural terraces (Howe, 2016, 2018). These villas claimed the finest panoramic views across the Bay of Naples in the west (Fig. 2) and toward Mount Vesuvius in the north. They also featured gardens expressing the Roman elite's interest not only in pleasant retreats from city life but also in horticultural and arboricultural innovations, and they did so at a time of the "Augustan horticultural revolution" (Marzano, 2022).

Figure 1. Location map of Stabiae (prepared by I. Ben Ezra).

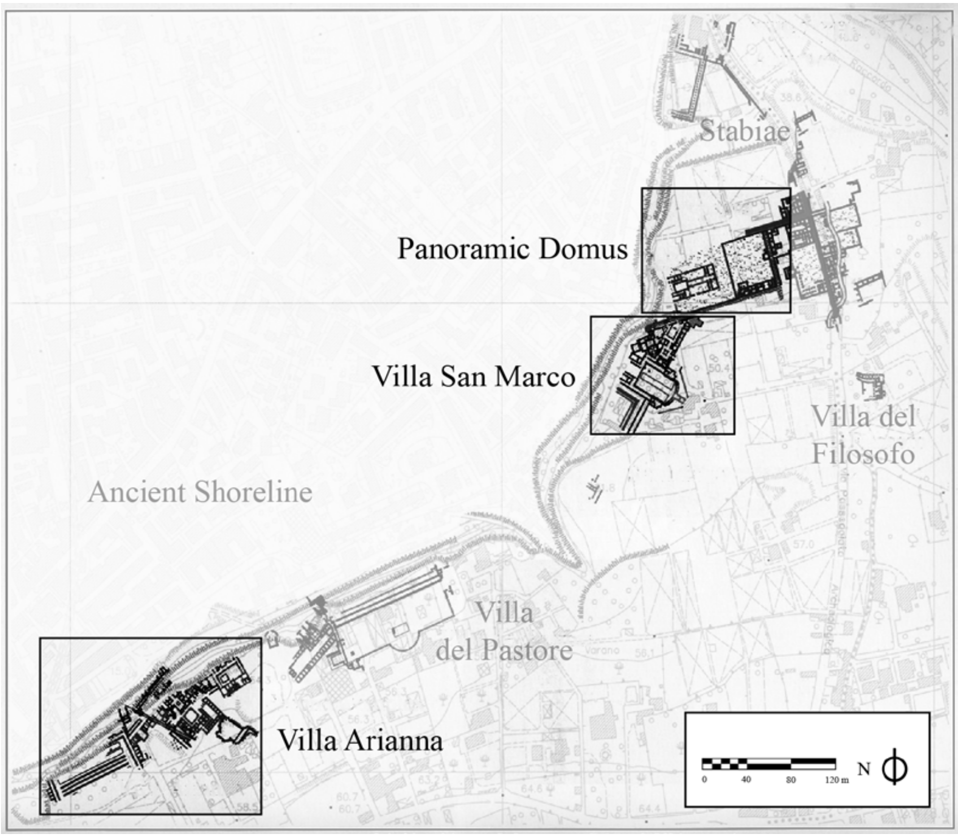

Figure 2. Location plan of the villas of ancient Stabiae (Howe, 2016: 12; courtesy of the Parco Archeologico di Pompei).

The first archaeological excavations at the site were conducted by the Bourbons in 1757–1762 under the direction of Swiss engineer Karl Jakob Weber. He employed tunnels to explore the villas and produced the first plan of the town, including some of the gardens, designated as *terra* (Pagano, 1997). These tunnels were then backfilled. In 1881, Ruggiero collected the eighteenth-century excavation records of Stabiae and published the early explorers' plans, diaries, and descriptions (Ruggiero, 1881; Jashemski, 1979: 328). In the 1950s and 1960s, Libero d'Orsi removed the volcanic ash from the main areas of the Villa San Marco and the Villa Arianna, revealing the sites with their gardens as seen today; however, other villas and their gardens remained buried. Some of the gardens were later surveyed by Jashemski (1979), but d'Orsi's records were not available to her and are currently still under study for their evidence of root cavities and other garden remains (Gleason and Langgut, in press).

Focused work on the gardens of the Villa San Marco and Villa Arianna has resumed in the past twenty years, notably the exposure of the Great Peristyle Garden of Villa Arianna, which was excavated from 2008 to 2013 (Howe et al., 2016). This vast garden, surrounded by covered walks on three sides and open to the Bay of Naples on the fourth, is the largest, most-densely planted garden exposed in the area in the twenty-first century. The garden's excavation only removed the volcanic ash (lapilli), exposing the ancient surface for careful documentation; no stratigraphic excavation was undertaken (Gleason and Sutherland, 2016). Its well-preserved, contoured planting beds feature about 525 root cavities, opening new avenues for analysis and interpretation from several disciplinary perspectives (Gleason, 2010; Howe, 2016). One of the most challenging is the identification of the specific plants these root cavities represent, as most plants cannot be identified by the shape of the roots without the presence of leaves or other diagnostic parts (Ciaraldi, 2007: 41). During the collection of finds from the surface of the garden, the archaeologists found no unusually well-preserved archaeobotanical evidence—such as nuts, seeds, or impressions—in the earth or volcanic debris that might facilitate the garden's botanical reconstruction (Gleason, 2010). Wood charcoal remains were interpreted as evidence of fuel material (Challinor, 2016). Nonetheless, a few carbonized remains have been suggested as related to meals and/or fertilizer (Gleason and Langgut, in press). An analysis of phytoliths produced evidence of one ornamental plant—date palm—and suggested that grasses may have been cut for areas of lawn, such as turf paths (Ryan, 2016). The spatial distribution of land mollusks was used to map the moisture and sun/shade conditions across the garden, as well as the relative heights of planted areas, as different mollusk species have specific habitat requirements (Pinto-Guillaume, 2016). Among these types of proxies, palynology has provided the most promising results when it comes to identifying which plants grew in this extraordinary garden. Pollen was recovered in the garden soil by Caprio (2008) and extracted from plaster installations facing the garden by Langgut (2022).

In this paper we show that palynological spectra cannot be used directly to identify what grew in the garden without careful consideration of the pollen-dispersal mechanisms involved for each taxon identified and of the assemblage's depositional constraints (Weinstein-Evron, 1994; Mariotti Lippi, 1998; Russo-Ermolli and Messager, 2014). Although gardens of the Vesuvian region have been preserved and extensively studied, reconstructing the botanical composition of ancient Vesuvian gardens has proved challenging for three major reasons: (1) the paucity of carefully executed and well-documented garden excavations like those performed at Villa Arianna (Gleason, 2010; Howe et al., 2016);[1] (2) lengthy exposure or destruction of garden soils, including the "contamination" of the ancient garden soils with recent flora and reworked remains (e.g., Mariotti Lippi, 1998); and (3) the scarcity of botanical remains and/or appropriate interpretations of these remains (e.g., Langgut, 2022).

Some of these obstacles can be overcome by extracting microbotanical remains, mainly plaster-bound fossil pollen grains (Weinstein-Evron and Chaim, 1999), preferably attached to structural elements facing the garden. We call this procedure the pollen-plaster technique. It involves the separation of the plaster (attached to structures in the gardens) into two different layers: outer and inner parts. This separation assists in evaluating how the pollen penetrates the plaster (more below). During the last decade, the floral compositions of several ancient

1 Classical archaeology traditionally devoted its energy and attention to architectural elements rather than attached gardens.

gardens throughout the Mediterranean have been reconstructed in this way (Langgut et al., 2013; Langgut et al., 2015; Barrett et al., 2020; Langgut, 2022; Gleason and Langgut, in press), demonstrating the benefits of this procedure: it does not require large-scale excavation, and microbotanical remains inside the plaster belong to a distinct time capsule, since it becomes sealed once dry.

This study has two main aims: (1) to employ the pollen-plaster technique to reconstruct the botanical composition of the Stabian gardens of Villa San Marco and the Panoramic Domus and (2) to assess the pollen-plaster technique's accuracy by comparing its results to those provided by pollen extracted from garden soil samples. The latter will focus on the gardens of Villa Arianna and Villa San Marco. It will draw on published data—soil-extracted palynological spectra (Caprio, 2008) and a plaster-extracted pollen assemblage from Villa Arianna (Langgut, 2022)—and will be augmented with the new results of this study for the Panoramic Domus and Villa San Marco of pollen recovered in plaster. Finally, we will capitalize on our results to discuss the importation of ornamental plants from across the Roman Empire, explore horticultural trends of the period, and look deeper into the interplay of plants, art, and the cultural landscape.

Material and Methods

The Panoramic Domus

This *domus* (urban house) (Figs. 2, 3) was first mapped by the Swiss engineer Karl Jakob Weber, who worked under the auspices of the Bourbon regime in Naples. Studying the site in 2009, Ruffo noted this building's remarkable nature, extending over a complete urban block perpendicular to the cliff (Ruffo, 2010; Howe, 2018: 103–104). Its unusual design incorporated earlier structures into a complex of rooms, pools, and gardens, many of which are still buried under Weber's backfill (Ruffo, 2010). The building may have been incorporated into the Villa San Marco (below) in the years prior to the eruption.

Recent excavations uncovered a garden peristyle, including rows of Ionic columns on three sides of the courtyard (Ruffo, 2010). Its unearthed remains frame the southeastern section of what is likely an extensive U-shaped garden, which enveloped a large dining hall. This hall also faced a fine interior garden on the villa's landward side, recorded by the Bourbon excavators. The dining hall offered a panoramic view of the bay, framed by large windows and irregularly spaced colonnades (Ruffo, 2009: 239; Howe, 2018: 103–104). While the proximity to the cliff's edge precluded further excavation of the U-shaped garden, two samples collected for this study from the plaster around the peristyle produced pollen assemblages indicating which plants populated the garden.

Villa San Marco

Built on cultivated soils dating back to the sixth century BCE, Villa San Marco (Figs. 2, 4) offers the broadest range of excavated gardens and is notable for the juxtaposition of real and painted landscapes (Zarmakoupi, 2014: 68–73; Zarmakoupi, 2021: 184), continuously choreographed throughout the complex along with sea views. Visitors coming from the landward side passed through a red-stuccoed porch into a lofty tetrastyle atrium (d'Orsi, 1996: 326, 340). Immediately to their right, a broad window in the tablinum—the main office and a traditional reception room for the owner of the house—framed a large tree in the courtyard. This courtyard, accessible by a door from the corridor to the right of the tablinum, has an unusual layout, featuring a planting bed surrounded by a low wall with piers and columns for covered walks. This spatial arrangement provided an attractive, shaded path to the street and the Panoramic Domus northeast of it (Fig. 2); it drew attention to the garden and minimized the conspicuousness of the latrine and service rooms (Howe, 2018: 107).

In the planting bed at the courtyard's center, a large ash-filled tree cavity was uncovered, along with smaller root cavities around it. Carbonized remains identified the tree as elm (*Ulmus*; Caprio, 2008; Ruffo, 2009), an identification supported by our palynological evidence. Garden soil samples (Caprio, 2008) and two plaster samples collected from the courtyard's northeastern corner (this study) enabled us to identify with certainty some of the ornamental plants that occupied this verdant courtyard. Although small, this garden made an important first impression on the visitor as the backdrop to the tablinum, within the symbolic space of the atrium (Vitr., *De arch*. 6.5.3–5).

Leaving the atrium from its western corner, visitors strolled down a narrow L-shaped hallway, painted black, with small seaside villa scenes on one side and two small gardens on the other. The eastern of these had several root cavities (Ruffo, 2009), but plaster samples could not be taken due to modern conservation of the paintings. The next small garden also faced the hallway but opened off rooms to the north. A single root cavity was noted here during the excavations (Jashemski, 1993), and a plaster sample for pollen analysis was taken from a drain that had not been conserved. Emerging from this narrow walk, the visitor arrived at a luxurious and expansive peristyle with a fine marble pool and nymphaeum, flanked by large root cavities identified as plane trees (*Platanus orientalis*), based on leaf impressions found in association with cast branches (Jashemski, 1979: 331). Here, too, plaster samples were not taken due to the conservation work on the architectural surfaces. Finally, the visitor climbed a gentle ramp up to a vast strolling garden, similar in size to that of the Villa Arianna (Fig. 5). Framed on three sides by a peristyle with a striking spiral-fluted colonnade, the garden has been exposed only at each end (Catoni and Rescigno, 2023; Gleason and Langgut, in press). On the fourth side, the terrace opened to a panoramic view of the bay and Mount Vesuvius. The garden included a sundial and large dolium, apparently used as a planter (Jashemski, 1979, 1993). Only two root cavities were documented in excavations of the area and the garden, which has yet to receive a close archaeological examination using modern techniques of garden archaeology. Three samples were taken from columns and water channels in this garden.

The pollen-plaster technique

Pollen grains can penetrate plaster in two ways: by air and by water. The first occurs mainly during bloom, when airborne pollen grains get trapped in the wet plaster surfaces. The second mechanism occurs when water from the garden (e.g., water channels, pools, reservoirs) is used to mix the plaster. The pollen within the water can originate in water plants and/or in pollen that travels in the air and sinks to the water structures via dust, for example (Langgut et al., 2013; Langgut et al. 2015). In order to distinguish archaeologically the two mechanisms (air and water), we separated the outer and inner portions of the plaster (for more on the pollen-plaster technique, see Langgut et al., 2013). After cleaning the sample with compressed air to remove recent pollen contaminations, we divided it into two subsamples, by scraping off the outer surface (< 0.1 mm thick) with a sharp razor blade.In this study we analyzed four plaster samples from the Panoramic Domus (Fig. 3: Nos. 1, 2) and six from Villa San Marco (Fig. 4: Nos. 3–8) and compared them with the six most successful plaster samples analyses by Langgut (2022) from Villa Ariana (Fig. 5: Nos. 9–11). Modern plaster prepared for conservation purposes at Villa Arianna was sampled for control.

Pollen extraction was executed as described by Langgut et al. (2013). A *Lycopodium* spore tablet was added to each sample as a tracer (Stockmarr, 1971; Bryant and Holloway, 1983). The unstained residues were homogenized and mounted onto microscopic slides using glycerin. A light microscope with magnifications of 200×, 400×, and 1,000× (immersion oil) was used to identify the pollen grains. The identification was based on a comparative reference collection of recent pollen of Tel Aviv University (deposited at the Steinhardt Natural History Museum) and pollen atlases (Reille, 1995, 1998, 1999; Beug, 2004; Niccolini and Bertini, 2023). For each sample all the pollen grains within the residue were counted and identified to the most detailed systematic level.

The plaster samples as a time capsule

All the gardens have a *terminus post quem* of 79 CE, when the eruption of Mount Vesuvius buried them under 3–4 m of lapilli. None of the gardens discussed here has been excavated stratigraphically, so dating of the gardens' soils is limited. The wall paintings from which the plaster samples were taken are all from the latest phase of the buildings. While often the paintings would be installed before the plants, earthquakes in the years before the eruption, and certainly after the massive earthquake of 62 CE, would place most of the decorative schemes between 62 and 79 CE. Similarly, samples taken from the mortar of garden features, such as the tank and water channels, are assumed to belong to the final phase of the garden.

Botanical comparison

We conducted two comparisons in this study: The first explored the botanical compositions of the three studied Stabian gardens (Villa Arianna, Villa San Marco, and the Panoramic Domus; Figs. 3–5) to deepen our understanding of the horticultural trends of the period. The second examined garden-soil pollen assemblages

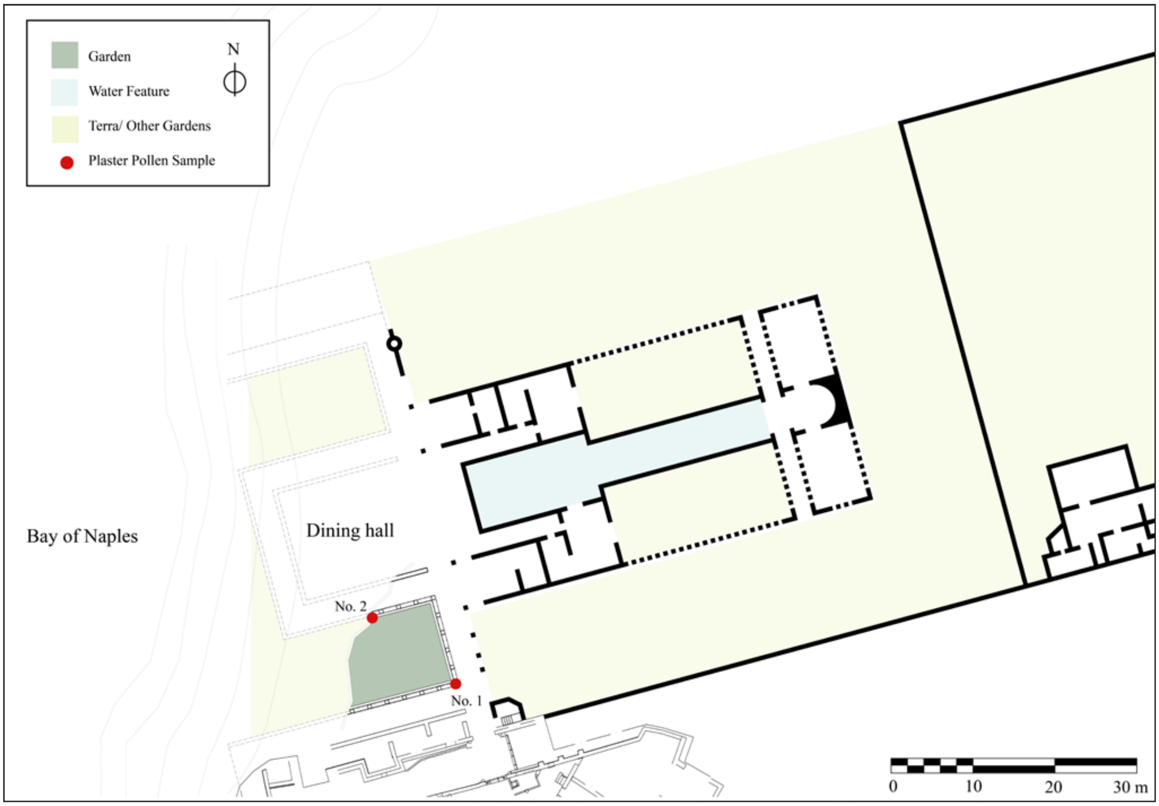

Figure 3. Plan of the Panoramic Domus with the pollen sampling locations (after Ruffo, 2010: fig. 33 and Weber in Ruggiero, 1881: pl. 1; courtesy of the Parco Archeologico di Pompei).

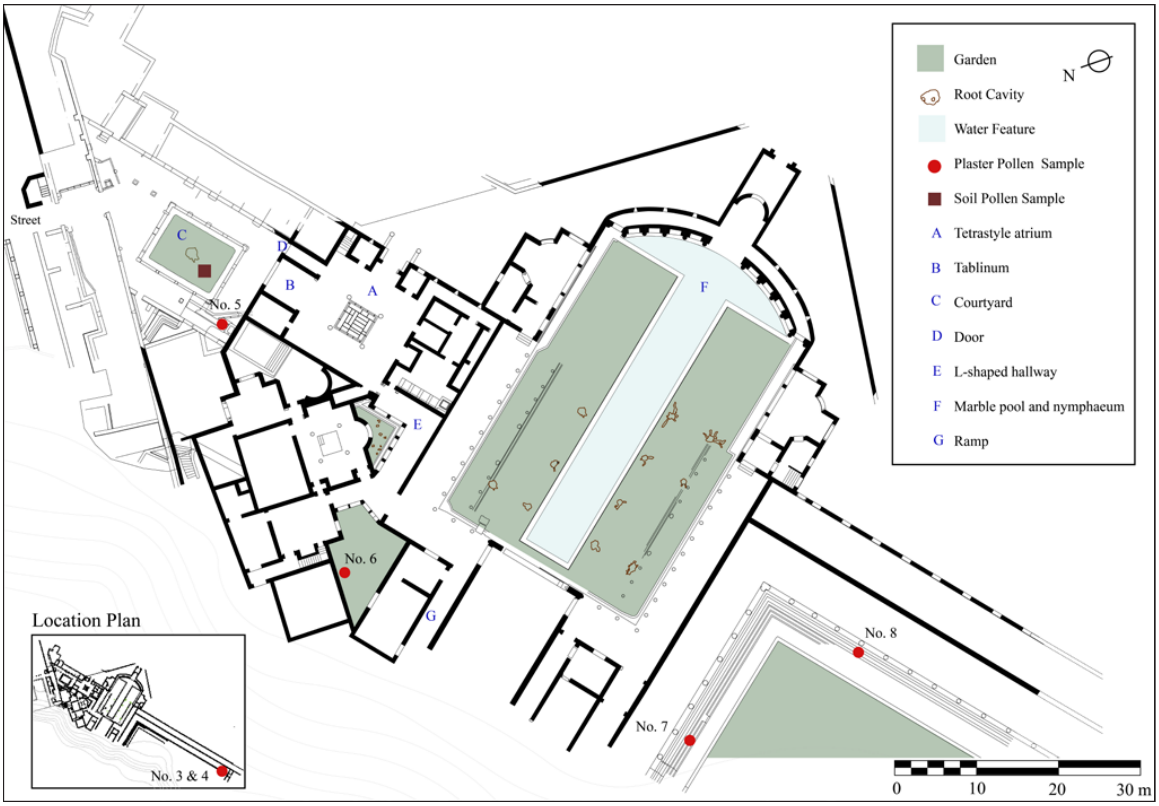

Figure 4. Plan of Villa San Marco showing area of the Peristyle Garden with pollen sampling locations (after Restoring Ancient Stabiae Survey Project; with the permission of the Parco Archeologico di Pompei).

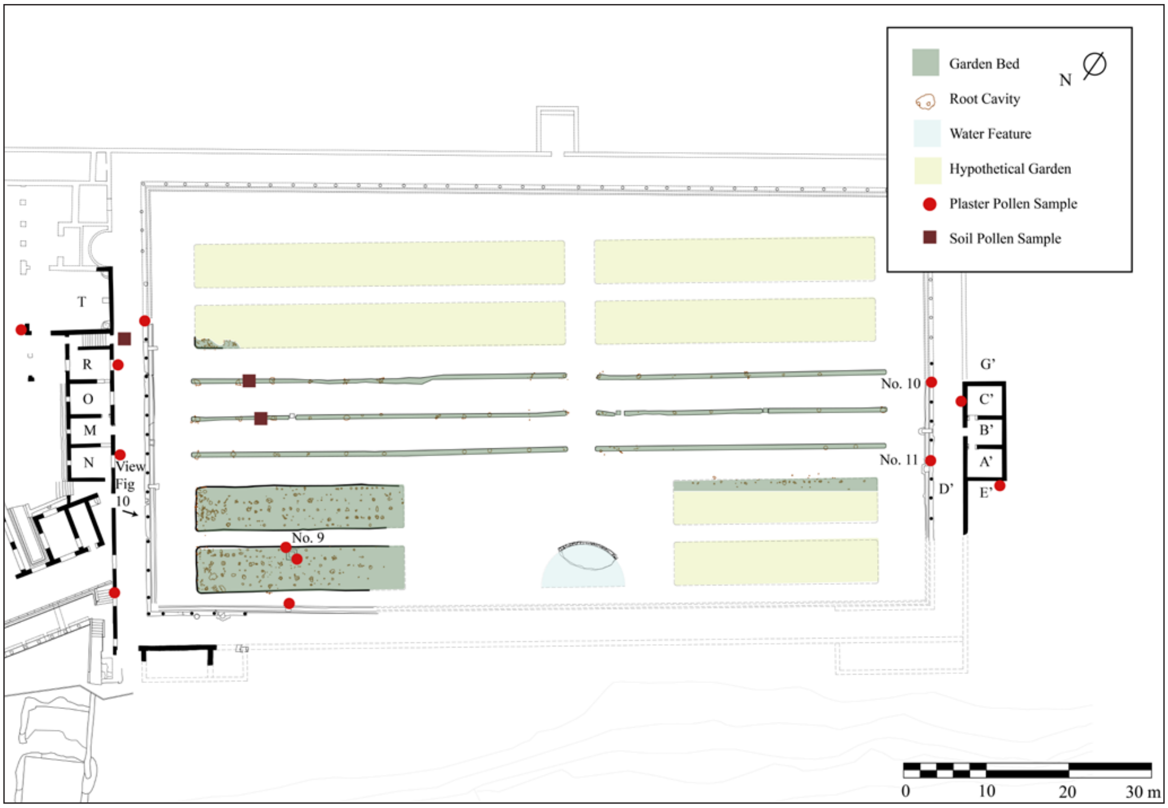

Figure 5. Plan of the Great Peristyle Garden of the Villa Arianna with garden beds and pollen sampling locations (after Restoring Ancient Stabiae Survey Project; with the permission of the Parco Archeologico di Pompei).

(Caprio, 2008) against pollen assemblages extracted from plaster (this study and Langgut, 2022). The aim of this comparison was to evaluate the benefits and drawbacks of each palynological method for ancient garden reconstruction.

Unlike paleoclimatic and paleoenvironmental palynological studies that employ quantitative measures and statistical analyses (e.g., Fægri and Iversen, 1989; Weinstein-Evron et al., 2015), we apply the qualitative approach to our comparison (the presence or absence of pollen taxa). Pollen concentrations in archaeological samples, which may differ from one site to another, can vary considerably also between several samples from the same site, depending on an intricate combination of multiple processes. Some of these processes pertain to the timing and season of pollen deposition, the archaeological context, wind direction, and particularities of the ecological niche in question (Langgut, 2022; Gattiglia et al., 2023), while others are taphonomic and occur after the site's abandonment, influencing pollen preservation (Bryant, 1989; Fægri and Iversen, 1989; Mercuri, 2014). In order to facilitate an interpretation that is as accurate as possible, we must analyze several samples from the same archaeological context alongside control samples (Bryant and Holloway, 1983; Russo-Ermolli and Messager, 2014; Mercuri et al., 2019; Langgut and Gleason, 2020).

Results

The pollen assemblages extracted from the plaster samples of the three villas are generally in a good state of preservation (Table 1). The subsamples of the plaster's outer surface are usually typified by higher numbers of pollen grains and a greater variety of pollen taxa (see summary in the Sum columns of Table 1). This is probably because both wind and water delivered pollen into the outer part of the plaster, whereas the pollen in the plaster's subsurface was usually conveyed by water alone, as suggested in most cases at Villa Arianna and the Panoramic Domus. Only a few samples of Villa Arianna produced converse results with more taxa variety documented in the plaster's subsurface.

Table 1. Palynological data of Stabian gardens (garden of Panoramic Domus, garden of Villa San Marco, and Great Peristyle Garden of Villa Arianna), based on the pollen-plaster technique.

	Panoramic Domus (this study)				Villa San Marco (this study)						Villa Arianna (Langgut, 2022)						Control		Sum	
Archaeological context	Piece of collapsed fluted column; side that would have faced the garden on the north side; two layers		Side of north drain; sample taken in broken area near cliff edge		Upper peristyle extension; southeastern side of engaged column; fine and rough plaster; 5 cm; a piece had fallen recently from the column	Upper peristyle extension; fluting from engaged column; this piece would be at the top of a column, yet unexcavated	Peristyle between atrium and Panoramic Domus; corner tank	Walled garden; drain sample; 1 layer	Upper peristyle, main area; piece of upper drain taken below the second column of the north colonnade	Upper peristyle, main area; sample from drain along east colonnade, 4 columns from the northern corner	Southeastern corner of water tank (Sample no. 3)		From column at west end of garden across from G and C (Sample no. 7)		Column outside room A; side facing garden (Sample no. 13)		Modern plaster		Panoramic Domus and Villa Arianna (not including control sample)	
Taxon / **Plaster sample ID**	Sample no. 1a (outer plaster)	Sample no. 1b (inner plaster)	Sample no. 2a (outer plaster)	Sample no. 2b (inner plaster)	Sample no. 3	Sample no. 4	Sample no. 5	Sample no. 6	Sample no. 7	Sample no. 8	Sample no. 9a (outer plaster)	Sample no. 9b (inner plaster)	Sample no. 10a (outer plaster)	Sample no. 10b (inner plaster)	Sample no. 11a (outer plaster)	Sample no. 11b (inner plaster)	Sample no. 12a (outer plaster)	Sample no. 12b (inner plaster)	Total pollen (outer part)	Total pollen (inner part)
Pinus (pine)	9		19	2	13	14	52	3	11		15	27	2	1	4	11		4	49	33
Cupressaceae (cypress/juniper)			20	3	3				7	3	8	1			2	4	9	5	30	7
Olea europaea (olive)	11	3	64	14	20	22	8	2	50	11	44	74	1	2	30	5	6	8	150	98
Platanus orientalis (Oriental plane)				1							1								1	1
Myrtus communis (true myrtle)							1				2				2			1	4	
Rosaceae (rose type)			2	2			1				7								7	2
Juglans regia (Persian walnut)			9	1	4	9	1		2	1	9	1			5		2	1	23	2
Vitis (grape)	1		1		1				1		6		3		3			1	11	3
Phoenix dactylifera (date palm)	1		2					1											3	3
Tilia (linden)			1				1												1	
Cedrus (cedar)			1								1							4	2	
Alnus (alder)	8	2	61	6	21	12	20	12	17	3	28	30	1	5	1	2	5	94	99	45
Corylus (hazel)	8	1	50	5	15	1	2	2	6	1	11	1			1	3	5	21	70	10
Castanea (chestnut)			51	8		3	3	1	2		9	1		1				16	60	10
Carpinus (hornbeams)			7	3				3	2									8	7	3
Populus (poplar)			1	1															1	1

	Panoramic Domus (this study)				Villa San Marco (this study)						Villa Arianna (Langgut, 2022)						Control		Sum	
Ulmus (elm)	6	1	31	12	3	1	1	1	9	4									39	37
Picea (spruce)			1								1	2							1	0
Abies (fir)			2	1							1	2						4	3	3
Betula (birch)	1		8			1	4		1		7	17						29	16	17
Ericaceae (heath)			1		2	1	4	1	1		2							6	3	
Salix (willow)	7		8		4		1	1	1		8	8						8	23	8
Quercus evergreen type	34	4	40	8		2	1	1	1		7	7		1		1	1	12	81	21
Quercus deciduous type																		19		
Acacia	4		2			1													7	
Asteraceae Asteroideae type (aster-like)	1		3		2	2	1		2	1	1	3		1				5	5	4
Asteraceae Cichorioideae type (dandelion-like)			3			7			2	1	2	3		17				3	5	20
Artemisia (sagebrush)			12	2										1				2	12	3
Ilex (holly)			1																	1
Poaceae (grasses)	1	1	4	1	2	4	6	1	6	1	5	11	1	1		7		11	11	21
Cerealia type			1	1		2	1		1	1	2							3	3	1
Caryophyllaceae (pink family)					1	1						3								3
Chenopodiaceae (goosefoot family)	3	1	38	5	6	3	4	3	3		7	17					1	15	48	23
Plantaginaceae (plantain family)	1	1	7	2		6	2	1	2	2	12	19		20		4	3	51	20	46
Ephedra (Mormon tea)							1						1					1	1	
Brassicaceae (cabbage family)	1		3			1	2		3		1	7						5	5	7
Urticaceae (nettle family)			3										1	6		4		267		
Malvaceae (mallows)					1															
Liliaceae (lily)									1											
Fabaceae (legumes)					1		1				4	5						4	4	5
Ranunculaceae (crowfoot family)												1						5		1
Cannabis/Humulus								1										9		
Apiaceae (umbellifers)	1		5						1		9	9	1					13	16	
Thymelaea (sparrow-worts)																		1		
Cyperaceae (sedges)											1							2	1	
Total counted	98	14	461	78	99	93	118	34	132	29	211	250	11	67	6	33	38	861		
Clump: *Olea europaea* (olive) (5–6 grains)					1							1								
Clump: *Castanea* (chestnut) (9–10 grains)	1											1								
Unidentified	25	3	59	12	6	17	15	9	12	2	21	2	30	24	5	6	1	21		

Unfortunately, at Villa San Marco we were unable to separate the two plaster layers and therefore analyzed the samples as undifferentiated units (Table 1). In several cases, pollen grains of olive or chestnut appeared in clumps (that is, several pollen grains remained still attached to each other, as in the flower source, indicating that the pollen did not travel from afar and most probably originated in the garden; Table 1). The control sample from Villa Arianna was dominated by a pollen spectrum deriving mainly from the natural environment. Due to Villa Arianna's proximity to the Panoramic Domus and Villa San Marco (Fig. 2), and because of the lack of modern plaster at the latter two sites, the modern plaster of Villa Arianna is used in this study as a representative of the recent vegetation in the area.

Discussion

Botanical reconstruction of the Panoramic Domus's garden

Although pollen was relatively well preserved in the four analyzed plaster samples (Table 1), the results of this study are difficult to interpret due to the challenges of ascertaining the exact source of the pollen grains. On the one hand, the palynological spectrum may represent what grew in the garden, but on the other hand, pollen grains could originate in the surrounding natural or cultivated environment. The samples may also include a mix of both sources (nearby vegetation and garden plants), especially regarding air-pollinated taxa (Mariotti Lippi, 2000; Dimbleby and Grüger, 2002: 183; Mariotti Lippi and Bellini, 2006; Vignola et al., 2022; Gattiglia et al., 2023). Some of this complexity may be solved by considering pollen-dispersal mechanisms. Pollen from insect-pollinated plants typically does not travel far from its source, so these taxa are more likely to have grown in the gardens. The Panoramic Domus plaster's pollen assemblages include pollen of grapevine[2] and rose type, and as both aretypified by low pollen dispersal mechanism, we suggest that these plants were cultivated in the garden, despite their appearance in low numbers. This is also the case with the Persian walnut: although it is a wind-pollinated species, it is characterized by a low pollen-dispersal efficiency due to its heavy, medium-sized grain (Bottema, 2000; Langgut, 2015; Stolze and Monecke, 2017).

The occurrence of chestnut pollen in a clump (Table 1) is another strong indicator of origination in the garden. Even for wind-pollinated species, pollen grains in clumps must have fallen close to the plant that formed them. Mariotti Lippi (1998) came up with the same interpretation while identifying clumps of stone pine from the hanging garden of the Casti Amanti Complex at Pompeii. In general, the chestnut is a wind- and insect-pollinated tree that produces small pollen grains (Krebs et al., 2022). Its pollen production is low to high depending on the environmental conditions (Lang, 1994; Astray et al., 2016; Larue et al., 2021). When the wind is transported over long distances in relatively dry weather, chestnut pollen may be occasionally overrepresented in pollen assemblages (Peeters and Zoller, 1988; Krebs et al., 2019). By contrast, in the case of humid weather conditions during the fluorescence, which highly reduces the anemophilous fraction of the pollination, chestnut may be underrepresented in palynological studies (Conedera et al., 2006). In any event, the total absence of chestnut pollen from the modern control plaster sample, together with its appearance in a clump within the ancient one, indicates that it most probably grew within the garden and did not originate in the natural/cultivated nearby environment.

One of the most interesting observations that emerged under the microscope is the presence of date palm and acacia pollen. These plants were doubtless part of the garden; both are characterized by relatively low pollen-dispersal mechanisms (Almehdi et al., 2005, and Millar et al., 2022, respectively) and date palm grains, specifically, do not travel farther than 200 m from their flower source (Almehdi et al., 2005). Moreover, the date palm's fruits do not ripen in the Mediterranean climate, implying that their function was primarily aesthetic and that they were imported from the eastern part of the empire for display as exotic specimens; this was probably also the case with the acacia (and see below).

Some of the herbs identified in the pollen assemblages (Table 1), such as members of the nettles and plantains, may represent ruderal plants that grew in the garden (Mercuri, Bandini-Mazzanti, et al., 2013). Notably,

2 Nearly all domesticated grapes are monoecious (they produce male and female flowers at different locations on the same plant) and self-pollinated, while wild grapes are dioecious plants (they have unisexual flowers). Therefore, wild grapes account for better pollen distribution than domesticated grapes (Turner and Brown, 2004; van Zeist et al., 2009; Fuks et al., 2020).

tracing herbaceous pollen to the genus/species level is usually difficult. For example, in Italy the cabbage family (Brassicaceae) is highly diverse, comprising numerous genera and species; some are used as crops (Vignola et al., 2022) and others as ornamentals, and yet others are merely common weeds (Langgut, 2022). The pollen of *Matthiola* (stock, a member of the cabbage family), which could be distinguished on morphological grounds (Caprio, 2008) and is a common ornamental plant, was not found. The Brassicaceae are entomophilous plants and therefore characterized by low pollen-dispersal efficiency (Vignola et al., 2022). Some regional palynological studies propose that the Brassicaceae pollen can be an indicator of the local presence of vegetable gardens. Cabbage cultivation was suggested based on several pollen studies from Campania (Mariotti Lippi and Bellini, 2006; Russo-Ermolli and Messager, 2014; Vignola et al., 2022). In general, many of the herb plants identified in the Panoramic Domus's pollen assemblages (such as members of the composite family, pink family, grasses, and umbellifers) appeared in relatively low values. They are all common in open habitats, such as those of riverbed vegetation, wet meadows, temperate pastures, and Mediterranean dry grasslands (Vignola et al., 2022). The relatively high values of sagebrush and members of the goosefoot family may indicate that they grew on the nearby Mediterranean coast (e.g., Kadosh et al., 2004).

The plaster-palynological spectrum of the Panoramic Domus also includes pollen of arboreal plants that may have originated in the nearby natural and cultural environment. The pollen of pine, cypress/juniper, spruce, fir, birch, evergreen oak, alder, hazel, heath, willow, and holly may have derived from the Verano and Latteri Hills (Grüger et al., 2022; Vignola et al., 2022). Quantitatively, the distribution of these wind-pollinated taxa leans heavily toward the plaster's outer layer (Table 1).[3] The cultivated landscape most probably featured olive orchards and some woodlands or groves of chestnut and walnut. Recent regional studies on fruit tree horticulture (Langgut et al., 2019; Krebs et al., 2022; Marzano, 2022) and nearby palynological records (Vignola et al., 2022) confirm these suggestions.

3 Yet, there is a possibility that some of the trees were grown in the garden; for example, the willow, which is an ornamental tree and is pollinated by both insects and wind.

The gardens of Villa Arianna and Villa San Marco: soil and plaster-extracted pollen comparison

The plaster-palynological assemblages at Stabiae were characterized by a relatively good state of pollen preservation and high taxa diversity (Tables 1, 2; Langgut, 2022). The pollen most probably reflects the vegetation present when the walls were plastered. Plastering is often done in the spring, when much of the garden is in bloom (since the cooler temperatures prevent plaster from cracking while it dries). In some cases, this may predate the installation of the garden; however, it appears that, whether due to the earthquake of 62 CE, which necessitated rebuilding/rehabilitation of the plastered walls/features, or changes in fashion, the walls of the Stabian gardens were plastered when garden plants were present. The samples of the outer part of the plaster are characterized, in most cases, by higher pollen concentrations and higher numbers of pollen taxa (see Sum columns in Table 1). These higher values may indicate that at least some of the plants originated in the gardens and were not blown from a distance by the wind. Among these taxa are cedar, Persian walnut, myrtle, hazelnut, grape, rose, and heath.[4] As explained above, the occurrence of both olive and chestnut in clumps trapped in the plaster is a robust indicator of origination in the garden (Table 1), yet some of the individual grains may have derived from the nearby natural and/or cultural environment. *Olea* is a wind-pollinated species that releases large amounts of pollen into the atmosphere and is well represented in pollen spectra (e.g., Bottema and Sarpaki, 2003). It was also found to be a reliable indicator for oleiculture (Baruch, 1990; Mercuri, Mazzanti, et al., 2013; Langgut et al., 2014).

The pollen assemblages that were extracted from the garden soil at Villa Arianna and Vila San Marco show great similarity to those derived from the plaster in these gardens (Tables 1, 2). Yet, the comparison between the two methods clearly indicates that by using the pollen-plaster technique, specifically by the separation of the plaster to inner and outer layers, it is easier to suggest what pollen represents plants that were grown in the garden and which pollen grains traveled from afar (Table 1). In addition, more suggested ornamental

4 Could be *Arbutus* spp. or *Rhododendron* spp.

plants were illuminated by the pollen-plaster technique (Table 2). At Villa Arianna grape pollen, usually typified by very low pollen-dispersal efficiency, was revealed by the plaster palynological spectrum. At Villa San Marco the plaster pollen assemblages also added the two taxa of Egyptian origin, date palm and acacia; these desert trees were palynologically recorded in the outer layer of plaster samples of Villa San Marco but were absent from the corresponding soil samples. Mariotti Lippi (1998) reported on the poor preservation of pollen grains extracted from the soil of a Pompeian garden, possibly due to chemical oxidation or microbial attack. Perhaps this can explain the lower taxa diversity and lower pollen concentrations in the soil samples of Villa Arianna and Villa San Marco in comparison to the plaster samples (Table 2).

Horticultural trends

Egyptian influences

The presence of date palm and acacia (most probably *Acacia nilotica*) pollen reflects the Egyptian influence on the Stabian gardens. Pollen from both these exotic trees was found at the Villa San Marco and the Panoramic Domus (Tables 1 and 2), while date palm was detected at the Villa Arianna through phytolith analysis (Ryan, 2016). Egyptian gardens and landscapes, which developed over the millennia of the Pharaonic period, captured the Roman imagination at the time of its conquest (Grimal, 1984: 84–86). At Pompeii paintings and mosaics portraying the Nile and statuary depicting Egyptian themes turned urban and villa gardens into miniature "Nilescapes," presenting visitors with Roman visions of Egypt (Barrett, 2019: 349–350).

The acacia was well known to Romans, reflecting the trade between Pompeii and Egypt (Jashemski et al., 2002: 85). Pliny the Elder (*NH* 13.63) reported that it grew near Thebes in a forest over 60 km from the Nile and was used for a variety of purposes, including garlands. The acacia was represented in garden paintings, such as the now-lost painting in the House of Adonis at Pompeii (Jashemski et al., 2002: 85). The date palm was also familiar and had considerable symbolic value in both the Egyptian and Roman worlds.[5] In the latter it was used in triumphal processions to symbolize pacification and victory (Fine, 1989; Jashemski et al., 2002), whereas in Egypt it symbolized fertility, abundance—which the Romans also admired—and perhaps also the regeneration of life (Ayalon, 1987). Notably, the palm featured prominently in the Judea Capta coinage, which was widely circulated at the time of the Vesuvius eruption (Brin, 1986).[6]

Contrary to early interpretations that attributed Roman *Aegyptiaca* to the worship of Egyptian gods or the problematic concept of "Egyptomania," Barrett's (2019) contextual analysis of Pompeian gardens suggests that the representations of Egyptian landscapes in domestic gardens at the hub of the empire allowed individuals to present themselves as sophisticated citizens of the empire. Concomitantly, household material culture was domesticating, familiarizing, and "Romanizing" foreign images and objects. That which was once considered alien and potentially dangerous was now part of the *domus*, ever more tightly interwoven with the cultural constructions of what it meant to be Roman. Ultimately, planting trees of Egyptian origin, such as acacia and date palm, helped render the Stabian gardens, particularly the Panoramic Domus, a microcosm of the empire.

Miniaturized plants

Miniaturization through propagation and pruning (*nemora tonsilia*) facilitated the display of a wide variety of trees, shrubs, and vines in large and small garden areas (Ciarallo, 2001: 42, n. 5; Landgren, 2013: 88–94). This art's development is attributed to Gaius Matius and is said to have been introduced in the time of Augustus (Plin., *NH* 12.6). The person responsible for the garden's design and overseeing its maintenance and plantings was the *topiarius* or *artifex* (Langren, 2013). During the first century of its introduction, *ars topiaria* appeared to have already included the art of miniaturization, which perhaps evolved into the plant shaping procedures

5 The date palm represented in Roman garden paintings differs from the tree's classic image with its tall trunks, arching crown, and drooping clusters of dates. Instead, only the young vertical pronds are depicted, and the dead and arching fronds, removed (Gleason, 2019: 319, fig. 9). Some paintings portray the date palm growing in a pot or a *dolium* (Jashemski et al., 2002: 140), suggesting that they were cultivated as dwarf trees, named *Chamaezēlos* in ancient Roman texts (Plin., *NH* 13.7.28). At present, date palms are still widely planted in private and public gardens for ornamental purposes in Italy, yet they are not over-pruned as suggested by the Roman paintings.

6 A very early Egyptian influence, though of a funeral garden outside an Egyptian territory, was suggested for Middle Bronze Age Judea (Kisilevitz et al., 2017).

Table 2. A pollen comparison (presence/absence) between the gardens of Stabiae (garden of Panoramic Domus, garden of Villa San Marco, and Great Peristyle Garden of Villa Arianna). In the latter two gardens two different archaeological contexts are compared (plaster vs. garden soil).

Reconstructed garden at Stabia		Garden of Villa San Marco		Garden of Panoramic Domus	Great Peristyle Garden of Villa Ariana	
Archaeological context		Plaster (this study)	Garden soil (Caprio, 2008: 29–30, 57–61)	Plaster (this study)	Plaster (Langgut, 2022)	Garden soil (Caprio, 2008: 29, 31, 58–61)
Likely to be garden plants	*Olea europaea* (olive)	+*	+	+	+*	+
	Myrtus communis (true myrtle)	+	+		+	+
	Rosaceae (rose type)	+	+	+		
	Vitis (grape)	+	+	+	+	
	Phoenix dactylifera (date palm)	+		+	**	
	Acacia	+		+		
	Castanea (chestnut)	+	+*	+*	+*	+
	Ulmus (elm)	+	+	+	+	
	Juglans regia (Persian walnut)	+	+	+	+	+
Possible garden plants	*Pinus* (pine)	+	+	+	+	+
	Cupressaceae (cypress/juniper)	+		+	+	
	Platanus orientalis (Oriental plane)		+	+	+	+
	Salix (willow)	+		+	+	+
	Corylus/Ostrya (hazel/ hophornbeam)	+	+	+	+	+
	Saxifragaceae (rockfoil)		+			+
	Papaver (poppy)		+			+
	Liliaceae (lily)	+	+			+
	Viburnum (black haw)		+			+
	Tilia (linden)	+		+	+	+
	Cedrus (cedar)			+	+	+
	Alnus (alder)	+	+	+	+	+
	Fraxinus (ash)		+			+
	Ericaceae (heath)	+		+		
	Hedera helix (ivy)		+	+		
	Buxus (box)		+			
	Prunus		+			
	Carpinus (hornbeam)	+		+	+	+

Reconstructed garden at Stabia		Garden of Villa San Marco		Garden of Panoramic Domus	Great Peristyle Garden of Villa Ariana	
Archaeological context		Plaster (this study)	Garden soil (Caprio, 2008: 29–30, 57–61)	Plaster (this study)	Plaster (Langgut, 2022)	Garden soil (Caprio, 2008: 29, 31, 58–61)
Possible plants of the natural environment	*Picea* (spruce)			+	+	
	Abies (fir)		+	+	+	
	Taxus (yew)		+			
	Betula (birch)	+	+	+	+	+
	Morus (mulberry)		+			
	Populus (poplar)		+			
	Phillyrea		+			
	Ilex (holly)			+		
	Fagus sylvatica (purple beech)		+			+
	Quercus evergreen type	+	+	+	+	+
	Quercus deciduous type		+		+	+
	Asteraceae Asteroideae type (aster-like)	+	+	+	+	+
	Asteraceae Cichorioideae type (dandelion-like)	+	+	+	+	+
	Poaceae (grasses)	+	+	+	+	+
	Cereal type	+	+	+	+	+
	Caryophyllaceae (pink family)	+	+		+	+
	Chenopodiaceae (goosefoot family)	+	+	+	+	+
	Plantaginaceae (plantain family)	+	+	+	+	+
	Ephedra (Mormon tea)	+			+	
	Brassicaceae (cabbage family)	+	+	+	+	+
	Urticaceae (nettle family)		+	+	+	
	Malvaceae (mallows)	+				
	Artemisia (sagebrush)		+	+	+	+
	Fabaceae (legumes)	+	+		+	+
	Ranunculaceae (crowfoot family)		+		+	
	Cannabis/Humulus	+	+		+	+
	Lamiaceae (mints)		+			
	Scrophulariaceae (figwort family)		+			
	Apiaceae (umbellifers)	+	+	+	+	+
	Typha (reedmace)		+			
	Cyperaceae (sedges)				+	

* Pollen grains appeared in clumps.
** Present based on phytolith investigation (Ryan, 2016).

described by Pliny the Elder (*NH* 16.76, 16.140) and Pliny the Younger (*Ep.* 5.6.16–17).

Miniaturization is clearly depicted in Roman garden paintings, such as the garden frescoes in the House of Livia at Prima Porta or the House of the Golden Bracelet at Pompeii, where the artists had carefully rendered the cut marks of the pruning (Fig. 6; Gleason, 2019). Furthermore, ancient texts often employ the prefix *chamae* to indicate dwarf plants for garden use (e.g., *Chamaeplatanus* [dwarf oriental plane], *Chamaezēlos* [dwarf date palm], and *Chamaedaphne* [suggested as dwarf laurel]; André, 1985; Gleason, 2019, and references

Figure 6. Detail of a painting from the House of the Golden Bracelet at Pompeii showing pruning marks (modified after Gleason, 2019: 10).

therein). Based on these lines of evidence and the close spacing and size of root cavities, Gleason (2019) recently suggested that dwarf trees were used in the garden of Villa Arianna. Notably, a palynological study of a small peristyle garden in the Herodian palace at Jericho provides independent support for Gleason's theory (Langgut and Gleason, 2020). This palace was built with the patronage of Marcus Agrippa and evidently employed a wide range of Roman artisans from builders to painters (Netzer, 2006: 57). Set in the Judean Desert, the garden's palynological analysis found a wide range of large Mediterranean trees popular in Rome. Crucially, these trees could not have survived outside the garden walls, but they also could not have grown to their full size within the garden's space. The only explanation for the observed patterns is that the trees in question were miniaturized by being cultivated inside ceramic planting pots (*ollae perforatae*) that were buried in the earth and arranged in neat rows (Langgut and Gleason, 2020).

Interestingly, despite the radically different environments involved, the Judean Desert pollen assemblage of the miniaturized garden at Jericho is remarkably similar to that of the Stabian gardens (e.g., olive, myrtle, and date palm). These patterns underscore the empire's far-reaching influence not only concerning the economy, long-distance trade, architectural trends, and art but also on gardening and horticultural fashions. Though no planting pots have been found in the Great Peristyle Garden of Villa Arianna, stacks of pots were noted by the early excavators in a room off the garden (Howe et al., 2016).

Reconstruction of the gardens based on a landscape approach

In painted *villae maritimae* scenes throughout the Vesuvian region, the distinctive silhouettes of umbrella pine, cypress, palm, and other trees signaled lush gardens (Fig. 7). Placed within the panels of Third Style wall paintings (20 BCE–20 CE), these miniaturized views, called "topia" (Vitr., *De arch.* 7.5.2; Plin., *HN* 35.116; Bergmann, 1992; Zarmakoupi, 2021), may be understood as a shorthand for the wide array of gardens found archaeologically in these maritime villas. Gardens, as we see in the plans of this article, ranged broadly in size and nature. Some were restricted spaces that allowed light and air into the building's center while providing the illusion of a larger garden view; others were ornate peristyle gardens associated with traditional atriums, expressing the owner's stature and wealth while creating a pleasant environment for strolling, dining, and other domestic activities; and finally, there were the large garden terraces of the Stabian villas (at San Marco, Pastore, and Arianna), where horticultural marvels were displayed for the pleasure of open-air walking, conversing, or dining, alone

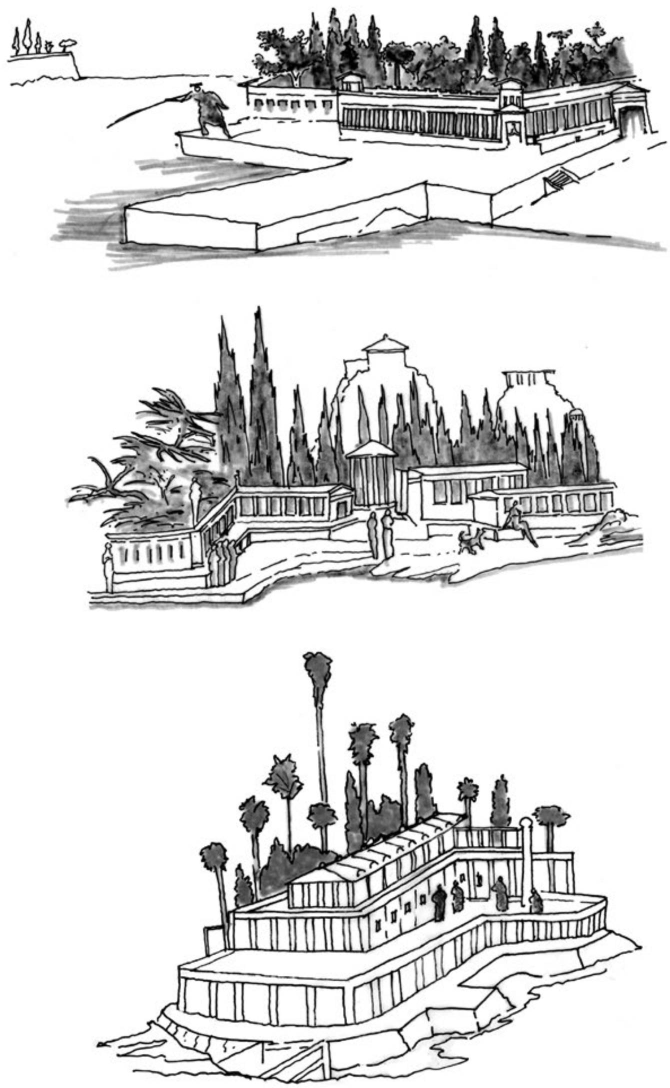

Figure 7. Three maritime villas (20 BCE–20 CE) with garden plantings highlighted (palms, pine, and cypress trees). Line drawn details from (top) Naples Museum Inv. no. 9482; (middle) Casa del Menandro, Pompeii, Inv. no. 10.4; and (bottom) Villa San Marco, Stabiae, Inv. no. 9409 (drawn by K. Gleason).

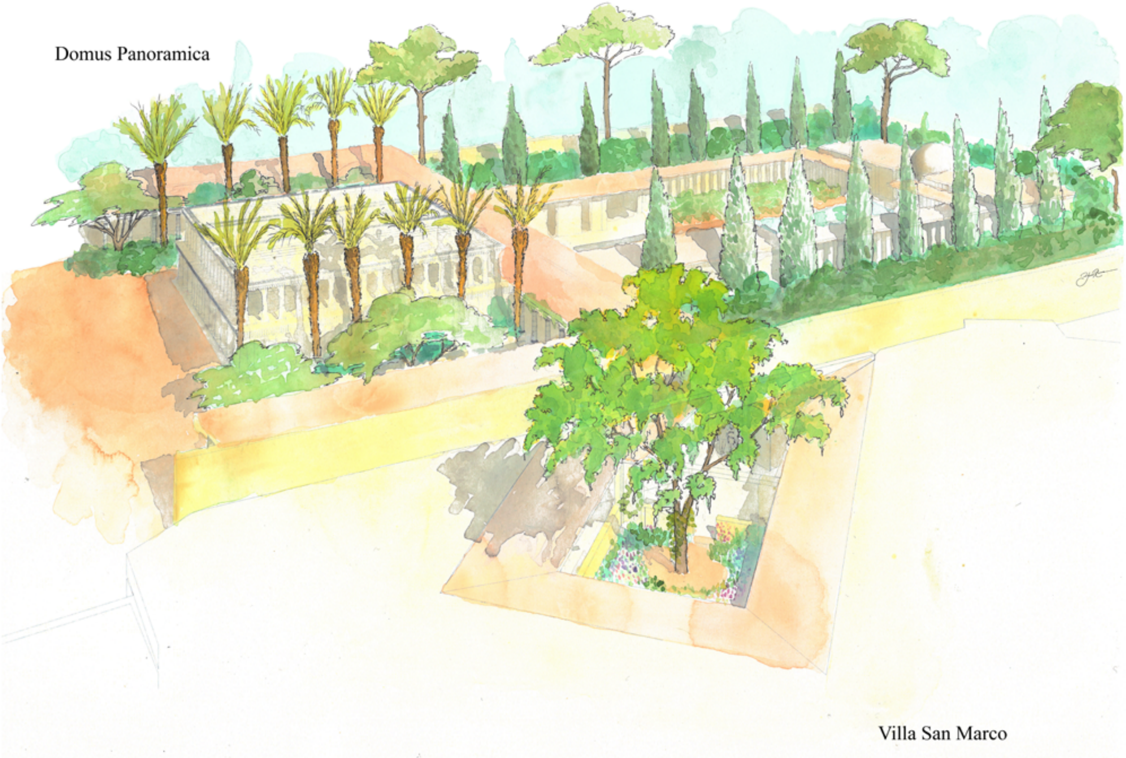

Figure 8. Reconstructed bird's eye view of the Panoramic Domus and the Peristyle Garden of Villa San Marco, looking northeast. The reconstruction is based on the pollen data together with other botanical evidence (e.g., root cavities) and garden paintings of the period (drawn by Y. Korman).

Figure 9. Reconstructed view from the tablinum into the courtyard garden of Villa San Marco. The reconstruction is based on the pollen data together with other botanical evidence (e.g., root cavities) and garden paintings of the period (drawn by Y. Korman).

Figure 10. Reconstructed view of the east end of the Great Peristyle Garden at the Villa Arianna. The reconstruction is based on the pollen data together with other botanical evidence (e.g., phytoliths, root cavities) and garden paintings of the period (drawn by Y. Korman).

or in large parties (Figs. 8–10; Howe, 2018; Gleason and Langgut, in press).

The palynological and archaeobotanical remains indicate the plants in each type of garden, and this evidence can then be assessed based on a variety of factors to reconstruct the appearance of the garden. Root cavities and planting pots suggest locations for different types of plants (large tree, small shrub, staked vine, etc.). The size of the garden suggests whether the plant was dwarfed or pruned to fit the space, either alone as a focal point or in a composition with other garden plants. Other environmental conditions are also critical: sun/shade, prevailing breezes and winds, and soil conditions, including evidence of fertilizers (Gleason and Palmer, 2018).

The Romans enjoyed visual illusions and allusions in their gardens, and at Stabiae this included the interplay of paintings and real garden features. As is vividly demonstrated slightly later in the letters of Pliny the Younger (*Ep.* 23.108), the interaction of architecture and gardens through views and movement is an essential aspect of the Roman garden (Kuttner, 1999; Zarmakoupi, 2021).

Garden paintings of this period from Rome and Pompeii offer a range of variations in pruning methods that may respond to these factors. With the exception of cypresses, these paintings show no shrubs or trees in a "natural" form—all were shaped to suit the aesthetic tastes of the time. The composition of these paintings also hints at some principles of designing real gardens: flowers in the foreground, rising to flowering shrubs such as roses; a middle ground of ornamental shrubs and trees such as oleander and *Viburnum*, alternating with fruit trees such as pomegranate, citrus species, strawberry tree, and *Prunus* species. These alternated with or were set off by a background of dark-green laurel or myrtle, with the distinctive silhouettes of cypress, pine, and palm (Fig. 11; Gleason, 2016). There is also a possibility that within the three different compositions (foreground, middle ground, and background) different varieties of the same plant were displayed (e.g., palm, laurel). In other scenes, the gardens are set against vivid sky-like blue or rich ochre backgrounds. The significance of these zones may be purely aesthetic, or, as proposed by Touwaide (2007), they may be an expression of the classification systems explored by scientists of the time. The positioning of many garden paintings suggests that the fruiting trees and flowering shrubs were set in the cone of vision of the viewer and thus pruned to keep the display at this height as the tree matured (Fig. 12; except cypresses, often set within the background). This focus on the height of the viewer differs from traditions in which the trees and shrubs are pruned in proportion to the architectural surroundings. The garden beds of the Villa Arianna appear to have been laid out with this kind of compositional system (Gleason, 2019), although more work is necessary to

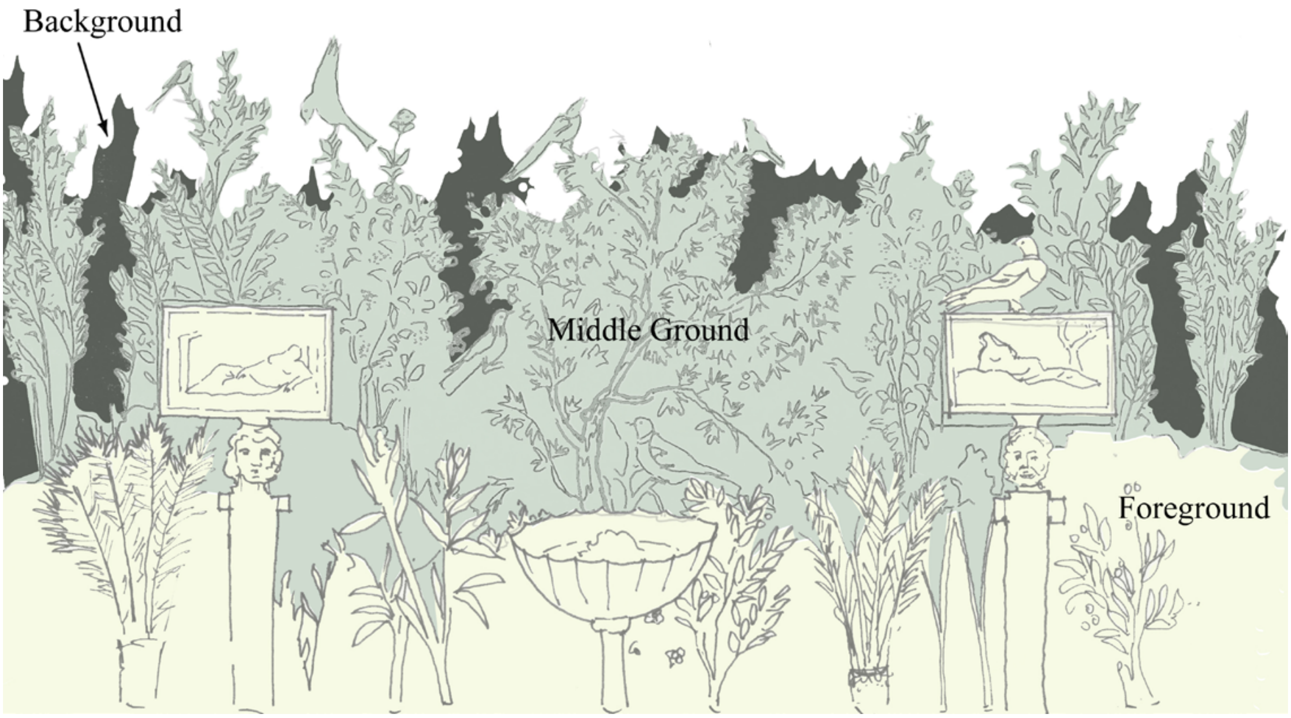

Figure 11. Garden painting from the House of the Golden Bracelet, Pompeii, shaded to indicate foreground, middle ground, and background (drawn by K. Gleason).

associate the palynological results with the evidence obtained from root cavities.

Gardens, especially those of the elite, are microcosms of the larger, broader landscape (Cook and Foulk, 2013). One significant contribution of our palynological study is the identification of plants that are not represented or yet unidentified in garden paintings.[7] The olive and nut trees such as walnut and hazelnut[8] are a case in point. They do not seem to have featured in the murals but have been common in the gardens of Stabiae; furthermore, the Vesuvian region was famed for the economic value of their produce (Marzano, 2022), underscoring the relationship between gardens and the surrounding agro-industrial landscape. Indeed, recent scholarship indicates that Roman elite and non-elite gardens operated as loci of horticultural experimentation throughout the empire at a time of imperial expansion and change. As Marzano (2022: 129) notes, "identifying the best varieties to be cultivated commercially in the specific environmental conditions present in the provincial territories must have been of as great interest to the farmer-colonists as it was for the Romanised local elites investing in cash crop cultivations." Gardens everywhere in the empire therefore played a role in developing and testing the cultivation and potential of various plant species, both local and imported. The identification of archaeobotanical remains of citron and lemon in elite Roman gardens confirms this notion (reviewed by Langgut, 2017). Citron remains dated to the third and second centuries BCE were recovered in affluent gardens in Rome and the Vesuvius area, while remains of lemon were revealed in the Forum Romanum (Rome) and are dated to the late first century BCE–early first century CE (Langgut, 2017).

7 It may be claimed that these two proxies used for garden reconstruction (palynology and garden paintings) complement each other.

8 The pollen evidence also exhibits that hazelnut was imported to the royal priestly garden of King Herod the Great in the Promontory Palace in Caesarea, most probably from the western part of the empire (Langgut et al., 2015).

Figure 12. Section through a garden bed at the Villa Arianna showing hypothetical zones and human scale of plantings as informed by garden paintings (drawn by Y. Korman).

Summary and conclusion

This paper employed palynological data to identify the botanical components and horticultural fashions of three prestigious gardens in Stabiae, near Pompeii: the northern garden of the Panoramic Domus, the courtyard garden of Villa San Marco, and the Great Peristyle Garden of Villa Arianna (Figs. 8–10). Buried by the eruption of Vesuvius in 79 CE, the villas and their lavish gardens have been only partly excavated, and much remains to be discovered. Based on our pollen results and comparison with previous studies, the following conclusions can be drawn:

(1) Various local ornamental plants and fruit trees were grown in the gardens, including grapevine, myrtle, Persian walnut, chestnut, elm, olive, and rose. Pollen grains of the exotic date palm and acacia were also identified, suggesting Egyptian influences on the gardens' design.

(2) Our palynological investigation suggests that the pollen-plaster technique is preferable over pollen extraction from garden soils, primarily on the grounds of preservation and contamination (from later periods, as well as reworked pollen). The pollen-plaster technique should be applied specifically in gardens that have already been excavated or are long exposed—preferably when an exact date of the garden or its last plaster appliance can be determined—since the pollen captured in the plaster serves as a time capsule.

(3) The evidence of Persian walnut and hazelnut suggests that nut trees were featured in luxurious gardens along with fruit trees, although they are not clearly portrayed in garden paintings of the time. We may anticipate that the trees were pruned or dwarfed like the other plants displayed in *viridiaria* of this period.

(4) Gardens speak to practices and meanings in the broader landscape. We suggest that the pollen record points to the Roman interest in arboricultural innovations, which began during Augustus's reign, normalized the import of plants, and developed local plant varieties and their products for export and other economic applications.

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