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RESEARCH

Analysing a botanical code: structure and augural value of nature in the corinthian and related capitals coming from the area of ancient Rome

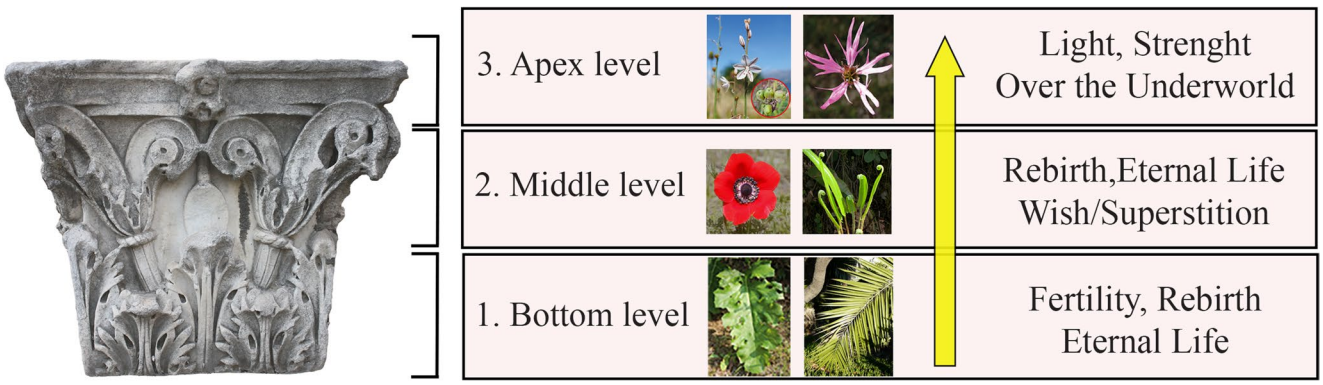
Alessandro Lazzara[1] · **Zohreh Hosseini**[1,2] · **Alma Kumbaric**[3,4] · **Chiara Giobbe**[5] · **Giulia Caneva**[1,2]

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Abstract

Several scholars and ancient sources highlight the communicative functions of images in the ancient Roman architecture, including plant-based motifs. Among them, Corinthian capitals, usually considered overall a stylistic character, are associated mostly with the *Acanthus* leaves. Indeed, further neglected plants still need a more precise identification. This paper aims to carry out a systematic analysis of their botanical composition and of the potential encoded symbolic messages. Through an analysis of 83 Roman capitals, overall Corinthian (52), Corinthianising (23), and Composite (8), dated between the II century BCE to the IV century CE from the territory of Rome, we recognised 40 different plant motifs (35 of them identified), resulting in 29 families, 30 genera and 27 species. Their bottom level is characterised by few variations of botanical species, where the recurrence of *Acanthus*, representing the idea of Rebirth, is the primary key to the style. The presence of emerging spikelets of *Triticum* sp., previously unmentioned, seems to have a recurrent and highly relevant augural role of fertility. We cannot neglect some zoomorphic associations, such as the Acanthus leaves that, at distance, show the apotropaic effect of lions' mouths. The middle level shows the main variability of species, often hosting the presence of *Asplenium scolopendrium*, having an augural value. The re-flowering flowers motif, with flowers that metamorphose into other plants, recurs in Corinthianising and Composite typologies, suggesting a never-ending life. The apical level, through the abacus plants and snakes, primarily conveys the ideas of strength, light, and salvation.

Graphic abstract



Keywords Roman archaeology · Corinthian capital · Plant iconology · Acanthus · Augural message · Not-written communication

Extended author information available on the last page of the article

1 Introduction

The close relationship between humans and nature led the early civilisations to carefully observe and interpret nature in both practical and religious ways (Frazer 1890; Bob et al. 2008). This connection is also evidenced by palaeobotanical studies, which revealed ancient plant uses and landscape organisation that were at the origin of cultural landscapes (Weiss and Kislev 2007; Mercuri et al. 2010; Day 2013; Masi et al. 2023). Natural elements were perceived as creations and processes governed by divine will and reflected in the creation of myths (Brosse 1991; Hart 2005; Dehbozorgi 2017). Several Latin authors, such as Ovid, Pliny the Elder, and Virgil, documented this profound relationship between culture and nature, demonstrating how plants, animals, and all natural phenomena were meticulously observed to uncover divine messages hidden within them (Dierbach 1833; De Cleene and Lejeune 2002; Caneva 2010). Plants gradually acquired symbolic values linked to their practical uses, such as medicinal properties or for their unique biological features, giving rise to specific associations with abstract ideas and beliefs (Knight 1892; Brosse 1989, 1991; Kandeler and Ullrich 2008; Day 2013).

As several scholars observed (Zanker 1990; Castriota 1995; Caneva 2010; Motti et al. 2022), in ancient cultures, images served as a language, acting as "carriers and catalysts for human reflections, communications, and actions" (Haug 2022) and contributing to the identity and memory of societies (Rowan 2021). Images were accessible to a broader audience, which was unable to understand written languages, thereby transcending elite classes through their visibility, repetition, and consistency (Kellum 1994; Caneva 2010). Depictions of a rich variety of plants, as whole entities or portions (fruits, flowers, or leaves), appear in a wide range of contexts, from natural landscape representations in private villas to singular motifs in public monuments (Kellum 1994; Jashemski et al. 2002; Caneva 2005; Bergmann 2017). Ancient buildings were not only functional spaces but also symbolic frameworks for expressing beliefs, values, and cultural identities of the societies and architectural structures. Moreover, the imagery they conveyed served as visual narratives, communicating the religious ideas and the ideology of power, such as the traditions of past societies (Carroll 2002; Psarra 2009; De Tullio and De Tullio 2019; Muktiono 2023). The integration of natural motifs, particularly plant-based, especially in funerary or religious buildings, such as temples, enhanced their symbolic and aesthetic significance (Kempt 1978; Castriota 1995).

Capitals, as the terminal part of columns, served not only structural purposes but also symbolised the connection between the terrestrial and celestial realms (Caneva 2005, 2010). Plant motifs in capitals are attested in several ancient cultures, such as in ancient Egypt and Persia, where the archaic capitals were characterised by stylised representations of palms, papyrus, and lotus symbolising regeneration and life (Kempt 1978; De Cleene and Lejeune 2002; Caneva et al. 2023). Furthermore, in Greek and Roman cultures, botanical elements were prominently featured in Corinthian capitals and their derivative forms, where the Acanthus represents the principal motif (Ebeling 1924; El Weshahy and Ellabban 2022). Vitruvius (*De Architectura*, Book IV, i, 9) recounts the myth behind the origin of the Corinthian order, which, although debated, underscores the ancients' attention to nature. According to tradition, the belongings of a young Corinthian girl were placed in a basket on her tomb, covered with a square tile. In spring, an *Acanthus* plant grew beneath the basket, curving around its edges and inspiring Callimachus to design the Corinthian capital (Vitruvius [15 BCE] 1997).

The Corinthian order first appeared in classical Greece during the IV century BCE, gradually replacing the already well-diffused Doric and Ionic orders. Early examples from Bassae, Tegea, Nemea, and Olympia reveal experimental designs with varying degrees of success, until the II century BCE, when the "normal" shape of the Corinthian capital became established in Attic. When introduced in Rome and the Italian Peninsula in the II century BCE, the Corinthian order became dominant, replacing the Italic capitals (von Hesberg 1981; Jones 1991). Variations in its design led to the development of Corinthianising forms, enriched with several additional vegetal motifs. In the Flavian Age, the Composite capital was characterised by *Acanthus* crowns, flowering tendrils in the *Kalathos*, and an Ionic *kyma*. Indeed, these capitals can be grouped into three distinct typologies: Corinthian (Type I), Corinthianising (Type II), and Composite (Type III). Despite the variability of the capitals structural composition in terms of motifs, according to chronology and typology, their structure can be separated into three main portions, as previously pointed out by Bernard (2012): Bottom level (which comprehends only the two leaf crowns of the *Kalathos*), Middle level (which includes all the structural elements between the two crowns and the Abacus flower) and finally the Apex level (including only the Abacus flower and the moulding, if present) (see Fig. 1).

Plants occur not only through the *Acanthus* leaves, but also in other elements, simply referred to as "abacus flower", "helices", "little calyx" and "flowering tendrils", without any detailed botanical identification. When limited to the "crown leaves", different species of the genus *Acanthus* have been carved in Corinthian capitals, such as *Acanthus mollis*, *A. spinosus* and *A. balcanicus* (Minissale et al. 2019). These species are respectively native of the western and eastern part of the Mediterranean basin and the Balkan peninsula up to Dalmatia; the relevance of *A. mollis* in the

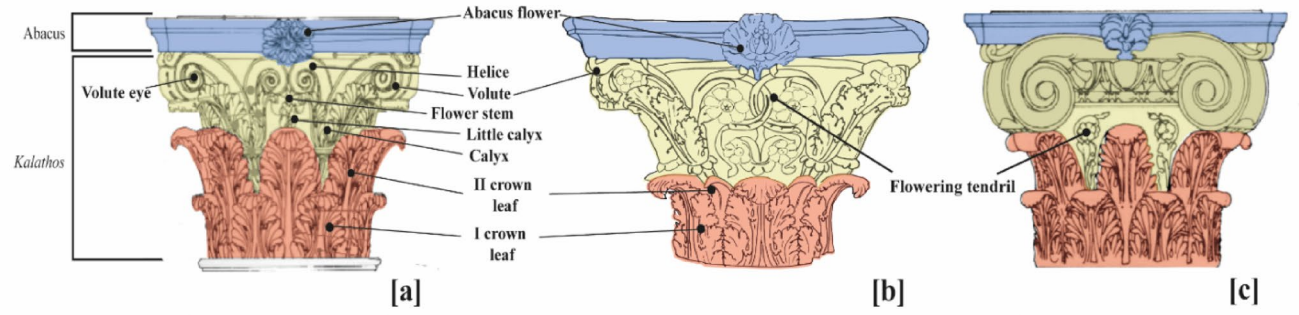


Fig. 1 Scheme of the Corinthian - Type I (**a**), Corinthianising –Type II (**b**) and Composite – Type III (**c**) capitals and all the compositive structural elements. The divisions of the three simplified levels are shown in three colours: Red (Bottom), Yellow (Middle), and Blue (Apex). Images were modified by the Authors after Boldrighini et al. (2007) and using as a model the capital from Palatine Museum (https://colosseo.it/opere/capitello-corinzieggiante/, accessed in March 2025) for image (**b**) (color figure online)

more recent representations can be explained considering the conquest by the Romans of the great cities of Magna Graecia and Sicily, which occurred at the end of the III century BC (Minissale et al. 2019). Its central role during the Augustan age, as documented by its use in the *Ara Pacis*, the most iconic monument of the Augustan peace and the beginning of the Roman Empire (Castriota 1995; Caneva 2010), explains its selection as a classical model in monuments and artworks (Vandi 2002). Furthermore, we recently observed (Caneva et al. 2024) that in the ancient capitals of the Apulian area, other plant species more recurrent in the dry Mediterranean area, such as *Verbascum sinuatum*, had a similar symbolic generative role. When examining the classical Corinthian capitals with attention, the evidence of other neglected plant species still requires a more precise identification. Data on proportions, construction techniques, and the organisation of Corinthian and derived capitals reveal a variability in the composition. However, a systematic analysis of their botanical composition and the potential symbolic messages encoded within them is still lacking.

This research aims to analyse the plant-based motifs of Corinthian, Corinthianising and Composite capitals from the area of ancient Rome, in order to identify the botanical species and their recurrence in the structural composition of capitals, and then to explore the hidden messages. Through a morphological analysis of the carved elements and a comparison with natural flora, we will enhance the surprising attention to natural details and the stylistic changes through chronology, which gave rise to a lost unwritten tool of communication, readable also by illiterate people.

2 Materials and methods

2.1 Data collection

Due to the variability of capitals across chronology and provenance, we limited the research to elements related to Roman culture dated between the II century BCE and the IV century CE, only coming from the territory of Rome. The data were mainly collected in the National Roman Museum of Rome (*Palazzo Massimo*, *Terme di Diocleziano*, *Palazzo Altemps* and *Crypta Balbi*). After considering a previous database on Roman phyto-iconography published by Kumbaric and Caneva (2014), we collected further data from the main archaeological museums and parks of Rome and closer area (Vatican and Capitoline Museums, Arch. Park of *Ostia Antica* and *Appia Antica*, Roman and Imperial *Fora*) and from isolated monuments (*Tempio Rotondo di Ercole Vincitore*, *S. Maria in Trastevere* and Temple of Hadrian). Finally, we created a new database (Supplementary Materials, S1) containing information on the selected capitals, associated with an ID, including: provenance, chronology, and the museum inventory number obtained by consulting bibliographic references (Giuliano 1981, 1982, 1984a, b, 1985a, b).

2.2 Structural composition analysis

We analysed the structural composition of the capitals and how plant motifs recur in them, as well as how they vary according to typology and chronology. Furthermore, we associated the identified botanical elements with the portion of the capitals where they are represented, according to the nomenclature suggested by Boldrighini et al. (2007) (Fig. 1).

2.3 Plant-based motifs identification

Following the methods proposed by Caneva (2005), Caneva et al. (2005) and Caneva (2010) and later applied in several works (Kumbaric et al. 2013; Kumbaric and Caneva 2014; Caneva et al. 2014, 2023, 2024; Motti et al. 2022; Lazzara et al. 2024) the identification process involved a detailed analysis of botanical motifs, carefully examining images of botanical elements in the capitals, highlighting the relevant diagnostic elements and comparing them with the morphological details of real plants occurring in a compatible biogeographical context. For the comparison, we mostly used the Italian Flora by Pignatti (2017) and other taxonomical databases, such as herbaria and Internet-based photographic collections (e.g., Kew Royal Botanical Garden (https://powo.science.kew.org accessed on 15 February 2025), Dryades Home (https://dryades.units.it accessed on 15 February 2025), The World Flora Online (https://www.worldfloraonline.org accessed 15 February 2025) and images from previous phyto-iconography studies in Roman art (Jashemski 1979; Jashemski et al. 2002; Caneva 2010; Kumbaric and Caneva 2014; Motti et al. 2022). The species names of the identified taxa followed the updated nomenclature of the World Flora Online Plant List (https://wfoplantlist.org/). For the identified taxa, we also associated the biological forms and the chorology, considering the frequencies of the different typologies. Finally, in the morphological elaboration of images, we also checked further connections with the biological world, such as possible zoomorphic suggestions, following previous analyses of similarity (Caneva 2010).

2.4 Statistical elaborations

The statistical and network analyses employed in this study aimed to uncover distribution patterns, co-occurrence relationships, and underlying associations among plant motifs represented in Roman capitals. These analyses explore variations across different typological (Corinthian, Corinthianising, and Composite) and spatial levels (bottom, middle, and apical) of the capitals' components. All analyses were conducted using RStudio (version 4.2.3) and relevant visualisation and statistical packages.

To illustrate the distribution of plant motifs across capital types and spatial levels, we constructed chord diagrams using the "circlize package" in R. Two matrices were created: one species-by-capital-type (I, II, and III) and the other species-by-level (bottom, middle, and apex), based on recorded occurrences.

A heatmap analysis (R's heatmap package) was conducted to visualise species occurrences across various chorological categories and highlight clusters of species with similar temporal distributions, using a species-chronology matrix and applying hierarchical clustering with Euclidean distance and complete linkage to identify groups with similar distributions. Rare species (those occurring only once or twice) were excluded to reduce noise and enhance pattern visibility.

2.5 Interpretation of the symbolic valence

Lastly, we sought to interpret the hidden symbolic messages behind the structural composition of the botanical motifs, consulting suitable archaeological and historical sources. We focused our attention on the texts of classical ancient Greek and Roman authors, like the *Naturalis Historia* of Pliny the Elder (23–79 CE), the Metamorphosis of Ovid (43 BCE − 17/18 CE) and the *De Materia Medica* of Dioscorides (40–90 CE) and other modern vocabularies regarding symbolisms and iconography (e.g. (Knight 1892; Chevalier and Gheerbrant 1992). However, when the ancient sources did not explicitly report the symbolic linkages of plants, we considered their morphological and eco-physiological characteristics (i.e., habit, structure, colours, or shapes), their disposition and linkages, in order to find possible connections, as proposed by (Caneva 2010).

3 Results

3.1 Plant-based motifs identification and their general recurrence in the capital's composition

The dataset comprises 83 capitals, the majority of which belong to Corinthian ($n=52$), followed by Corinthianising ($n=23$), and Composite ($n=8$). Among them, a total of 40 different plant motifs were recognised, of which 35 were identified (Tables 1 and 2). Based on the different diagnostic elements, we reached various taxonomic levels of identification, resulting in 29 families, 30 genera, and 27 species. When a *taxon* was not completely attributable, we used the abbreviation 'cfr.' (=compare). In two cases, we suggested only the family (Asteraceae and Malvaceae), and in 3 cases, only the genus (*Quercus* sp., *Lilium* sp., *Ephedra* sp.). Twice, we considered the same motif as referable to different genera of the same family (i.e. *Anthemis* sp. or *Leucanthemum* sp.) or very different taxa (i.e. fruits fitting with those of Araceae family and those of *Sorghum* cfr. *bicolor*).

Despite the fidelity with which plants were often carved, in most of the capitals (72%), their erosions or detachments left few elements unidentified (=IND). In other cases, although we could not attribute a particular *taxon*, we distinguished some motifs as botanical elements, in particular, flowering buds, which are only present in one capital (MPA_CAP), flowers distinguished only by the number of

Table 1 The botanical taxa occurring overall at the bottom and medium level of the Corinthian capitals and derivatives (excluding the unidentified elements)

Plant Taxa	B. forms	Chorology	Rep. El.	Diagnostic observable traits	Presence (%)	Position
Plants present mainly from the bottom to the middle level						
Acanthus mollis L. (Acanthaceae)	H scap	Steno-Medit.	L, I	Leaves with spatulate outline, pinnate with deeply incised lobes.		B, M, A*
Verbascum sinuatum L. - like (Scrophulariaceae)	H bienn	Euri-Medit.	L	Typical lobed-sinuous basal leaves		B; M; A*
Lilium sp. (Liliaceae)	G bulb	Medit.	F	Long trimerous tepals with a revolute apex		B; M*; A*
Phoenix dactylifera L. (Arecaceae)	P scap	Paleosubtrop	L	Long pinnate leaves with rigid segments. Basal leaves curved, with linear, rigid segments.		B; M; A*
Acanthus spinosus L. (Acanthaceae)	H scap	Steno-Medit.	L	Leaves with deep, acute, toothed, spiny divisions.		B; M
Botrychium lunaria (L.) Sw. (Ophioglossaceae)	G rhiz	Subcosmop.	L	Leaves divided into semilunar segments, lacking a central rib		B; M
Plants present only at the bottom level						
Triticum cfr *monococcum* (Poaceae)	T scap.	W-Asiatica	I	Spike with rachis and spikelets at alternate nodes. Possible confusion: Hordeum sp.		B
cfr *Ephedra* sp. (Ephedraceae)	NP	Paleotemp.	S	Cylindrical bundled branches	<5%	B
Anthemis sp. or *Leucanthemum* sp. (Asteraceae)	H	N/A	F	Capitulate flowers formed by central flowers and ligulate at the margin	<5%	B
Plants present only in the medium of the capital's structure						
Asplenium scolopendrium L. subsp. *scolopendrium* (Aspleniaceae)	H ros	Circumbor.	L	Leaf with entire toothed and wavy margin, with ± acute apex		M
Clematis vitalba L. (Ranunculaceae)	P lian	Europ.-Caucas.	S	Climbing, fascicled woody stem	<5%	M
Campanula cfr *persicifolia* L. (Campanulaceae)	H scap	Euroasiat.	F	Bell-shaped flowers with five-lobed petals in a fused, enlarged corolla. Lobes less longer than wide	<5%	M
cfr *Biarum tenuifolium* (L.) Schott (Araceae)	G bulb	Steno-Medit.	L	Linear and acute spathe	<5%	M
cfr *Dracunculus vulgaris* Schott. (Araceae)	G rhiz	Steno-Medit.	L	Large bract (spathe) with wavy margins	<5%	M
Laurus nobilis L. (Lauraceae)	P caesp; P scap	Steno-Medit.	L, FR	Elliptical or oblanceolate leaves, with undulating edges. Subsessile ovoid berries as fruits	<5%	M
cfr *Matthiola* sp. (Brassicaceae)	Ch suffr; NP	Steno-Medit.	F	tetramerous, actinomorphic, with obovate-orbiculate petals and with wavy margins	<5%	M
Hedera helix L. (Araliaceae)	P lian	Subatl. - Submedit.	L, FR	Ovate- rhomboidal leaves in flowering branches or palmate-lobate in the others. Fruits as globular ovoid berries	<5%	M
Heliotropium europaeum L. (Heliotropiaceae)	T scap	Medit. - Turan	F	Long-stalked scorpioid tops	<5%	M
Medicago sativa L. (Fabaceae)	H scap	Euroasiat.	FR	Spiral fruits with 2-3 coils	<5%	M
Vitis vinifera L. (Vitaceae)	P lian.	Euri-Medit/Caucas.	L, FR	Leaves heart-shaped, divided into 3–5 lobes with dented margins	<5%	M

Legend: (B. = biological L (Leaves), F (Flower), I (Inflorescence), B (Bulb), FR (Fruit) and S (Stem); For the position in which the species are attested in the capitals (B=Bottom, M=Middle, A=Apex).

If the species are present sporadically in other levels, they are indicated with (*) in the position column

Table 2 The botanical taxa occurring overall at the apical level of Corinthian capitals and derivatives (excluding the unidentified elements)

Plant Taxa	B. forms	Chorology	Rep. El.	Diagnostic observable Traits	Presence (%)	Position
Plants present from the middle to the apex level of the capital's structure						
Asphodelus cfr. *fistulosus* L. (Asphodelaceae)	H bienn; H scap	Paleosubtrop	F, FR	Flowers formed by six tepals, soldered at the base, with a rib in the centre. Tripartite roundish fruits.		B*; M; A
Anemone cfr *coronaria* L. (Ranuncolaceae)	G bulb	Steno-Medit.	F	Pentamerous flower with rayed symmetry, elliptic or rounded tepals, and a large floral disc.		M; A*
Malvaceae	N/A	N/A	F	Flowers with five petals. Stamens soldered to filaments forming a tube structure.		M*; A
Papaver cfr. *somniferum* L. (Papaveraceae)	T scap	Subcosmop.	F	Tetramerous flowers with lobed and wavy margins		M; A*
Quercus cfr. *cerris* L. (Fagaceae)	P scap	Euri-Medit.-Sett.	L	Shaped leaves, deeply lobed, almost touching the midrib, but also leaves with shallow, unequal, almost serrated and pointed lobes.	<5%	M; A
Lychnis flos-cuculi L. (Caryophyllaceae)	H scap	Eurosiber.	F	Short bell-shaped calyx and corolla with five fringed petals, deeply divided		A
Quercus cfr. *robur* L. (Fagaceae)	P scap	Europ.-Caucas.	L	Oblong–ovate leaves, rounded lobes, divided no further than halfway to the midrib	<5%	A
Quercus sp. (Fagaceae)	N/A	N/A	L, FR	Oblong–ovate leaves, rounded lobes	<5%	A
Allium sativum L. (Amaryllidaceae)	G bulb	Asia	B	Bulb splits into "cloves"	<5%	A
Asteraceae cfr.	N/A	N/A	F	Flower-head inflorescences with single tubular and/or ligulate flowers	<5%	A
cfr. *Crataegus monogyna* Jacq. (Rosaceae)	P caesp/P scap	Paleotemp	L	Oval-rhombic edged leaves, 1–4 incisions on each side, elongated lobes and a truncated base	<5%	A
Primula cfr. *auricula* L. (Primulaceae)	Ch suffr ; H ros.	Orof. S-Europ.	F	Flowers with ovate-rounded cauline bracts, bell-shaped calyx; corolla funnel-shaped, with entire or heart-shaped lobes.	<5%	A
Lupinus albus L. (Fabaceae)	T scap	E-Medit	FR	Inflorescences in terminal racemes, with alternate flowers arranged in spirals on the rachis.	<5%	A
Olea europaea L. (Oleaceae)	P caesp; P scap	Steno-Medit.	F	Flowers with a persistent 4-toothed calyx, funnel-shaped corolla with four petals welded at the base	<5%	A
Sorghum cfr. *bicolor* (L.) Moench (Poaceae) or Araceae	T or G	Africa and Indian subcontinent or N/A	I	panicle with round-shaped fruits or Compact spikelet	<5%	A

Legend: (B. = biological), L (Leaves), F (Flower), I (Inflorescence), B (Bulb), FR (Fruit) and S (Stem); For the position in which the species are attested in the capitals (B=Bottom, M=Middle, A=Apex).

If the species are present sporadically in other levels, they are indicated with (*) in the position column

petals (5-, 4-, and 3-petaled), or generic ferns, without further identification (IND_fern).

The identified taxa exhibited different recurrence among the analysed capitals, as well as their presence at different structural levels (see Fig. 2). They were mainly represented through their flowers and inflorescences (18 taxa), followed by leaves (14 taxa) and only few through their fruits (5 taxa), stems (*Clematis vitalba* and *Ephedra* sp.) and bulb (*Allium sativum*).

A certain variability is shown for biological forms, with the majority consisting of tree and woody plants, particularly Phanerophytes (29%), with the presence of lianose species (*Clematis vitalba*, *Hedera helix*, *Vitis vinifera*), followed by Herbaceous plants, like Hemicryptophytes (26%) and Therophytes (13%), with a prevalence of H scap form (*A. mollis*, *A. spinosus*, *Campanula cfr persicifolia*, *Medicago sativa*). Moreover, it is interesting to note the high number of geophyte plants (19%), particularly bulbous ones (*Lilium* sp., *Biarum tenuifolium*, *Anemone coronaria*, *Allium sativum*).

The identified species exhibit heterogeneous chorological distribution. Most belong to the Mediterranean Basin and the Euro-Mediterranean area (e.g., *Olea europaea*, *Laurus nobilis*, *Acanthus mollis*, *Verbascum sinuatum*), particularly Steno- and Euri-Mediterranean. Also represented are species from Western Asia (*Triticum monococcum*) and Euro-Asiatic elements (*Medicago sativa*, *Quercus robur*), as well as those with subtropical (*Phoenix dactylifera*) and sub-Mediterranean distribution (*Hedera helix*).



Fig. 2 Images of the most relevant and represented species identified in the capitals in each level, comparing the carved elements in capitals (1 A capital 44_TD, inv 12/00083575; 2 A capital 25_TD, inv. 12/00083571; 3 A capital 8_TD, inv 126362; 4 and 7 A capital 11TD, inv 128082; 5 A capital 38_TD, inv. 220; 6 and 8 A capital MC, inv. 1935; 9 A capital 10_TD, inv. 442319). All the photos of capitals by Authors, Courtesy of the Ministry of Culture, *Museo Nazionale Romano.* Images of fresh plants: 1B,2B,4 C,7B from Dryades (https://dryades.units.it/cercapiante/index.php); 3B, 4B, 6B, 8B-C, and 9B from GBIF (http://gbif.org/)

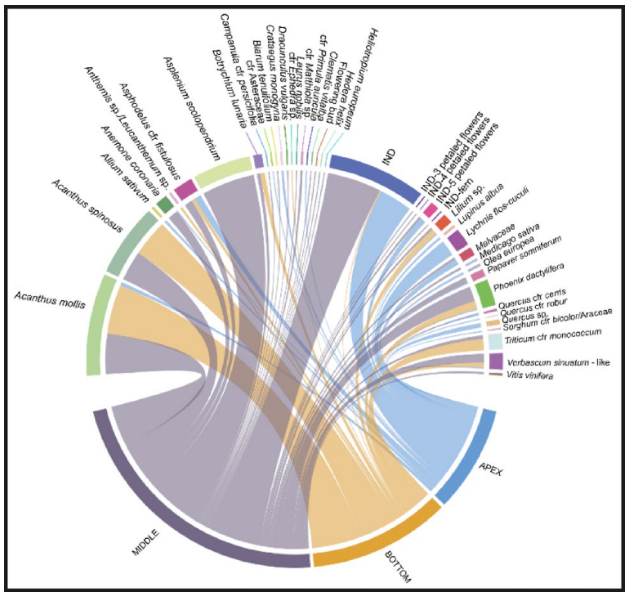


Fig. 3 Graph which shows the relations and recurrence of the species according and the three structural levels. The size of each segment indicates the frequency of a species in a given typology, while thicker chords imply higher levels of occurrence

Considering the previously cited nomenclature, at the bottom level, the "crown leaves" are mainly formed by *A. mollis* (52%) and *A. spinosus* (39%), even if other species, such as *Verbascum sinuatum*, can also be sometimes detected. Notably, we note the surprising emergence, even if sometimes cryptic, of *Triticum* cfr. *monococcum*, which appears exclusively in this level, and a few interesting species such as *Ephedra* sp. and *Bothychium lunaria* (Fig. 3).

The middle level exhibits the highest botanical diversity, with 24 identified species, but also a certain number of "IND" motifs, mostly related to the "flower stem", sometimes identified with petals of *Asphodelus fistulosus*. Here, the "helices" correspond to *Asplenium scolopendrium*, which appears as the most represented species (55%), except for capital TAS_1, in which they are represented by laurel leaves and fruits. *A. mollis* and *A. spinosus* (42% and 31%, respectively) are also very representative at this level, used to represent "calyxes" and "little calyxes" as well as in the "Flowering tendrils" in Typology II and III.

The apex level was often severely compromised or absent, which explains the high margin of unidentified motifs. Structurally, the "abacus flowers" can be represented as single elements or a combination of motifs with external and internal parts in a metamorphic composition, a form already observed in Roman monuments (Caneva et al. 2019), sometimes with other motifs in the architectural mouldings. For the external part, the most representative species is *Lychnis flos-cuculi*, while for the internal part, the fruit of *Asphodelus fistulosus* is the most recurrent, with few occurrences of *Allium sativum* bulb (Fig. 3). Moreover, its recurrent the zoomorphic motifs that could be identified as a snake in the apex as well as another zoomorphic structure generated by the profiles of acanthus leaves from the bottom level and the *A. scolopendrium* composing the "helices", which seem to form the mouths and eyes of felines (Fig. 4).

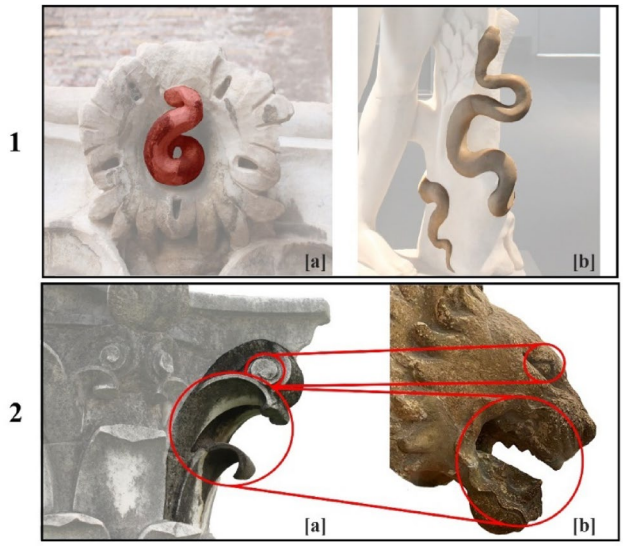


Fig. 4 Zoomorphic elements in capitals representing **(1a)** snake in the abacus flowers (capital 11_TD, inv 128082) and **(2a)** profiles of felines (capital 79_TD, inv. 362097) compared to the representation of corresponding animals in other artworks, in particular **(1b)** a snake from the statue "Apollo tipo Chigi" (Palazzo Massimo, inv. 75675) and **(2b)** the head of a lion (From the Archaeological Museum of *Valle dei Templi*, *Agrigento*). All images by Authors, Courtesy of the Ministry of Culture, Italy

3.2 Plant-based motifs and chronological and stylistic associations

When considering the chronology, most of the analysed capitals in all the considered typologies were dated between the II and III centuries CE ($n=26$) and between the I and II centuries CE ($n=21$) (Fig. 5a). For 12 of them, a chronological information was still missing and three of them were dated to a generic "Imperial Age" period. The heatmap (Fig. 5b) shows the most continuous presence of *Acanthus mollis*, *A. spinosus*, and *Asplenium scolopendrium*, which appear in nearly all periods (A–F), reaffirming their symbolic and decorative importance in Roman capitals. *Asplenium scolopendrium* and *Triticum* cfr. *monococcum* show an intense concentration in classes C and D (1st to 3rd centuries CE), suggesting a higher architectural production and diversification in vegetal decoration. Several species, such as *Lilium* sp., *Quercus* sp., and Malvaceae, showed a non-continuous use, being represented only in specific chronological periods, suggesting more targeted or context-dependent usage. Overall, classes C and D (1st–3rd centuries CE) emerged as the richest in botanical diversity, indicating a peak in typology and symbolic experimentation in Roman architectural ornamentation.

The botanical composition varied across the three typologies (Fig. 6). The results confirm not only that *Acanthus mollis* and *A. spinosus* are the most prominent species, recurring in all three typologies, with the latter being strongly related to the Corinthian ones, but also a previously neglected role of *Asplenium scolopendrium*. The Typology I shows the higher recurrence of *Acanthus* and *Asplenium*, whereas Typology II shows the higher biodiversity of taxa represented ($n=29$, excluding the "IND" categories), including specific motifs represented only in this typology.

3.3 Symbolical value of the botanical motifs

The identified species have different symbolic meanings (see Supplementary Materials, S2), as shown in Fig. 7, and some discussion seems necessary here.

At the *bottom level*, the Acanthus, as the main identified plant, appears symbolically associated with the concept of Rebirth or Eternal Life and considered a protection against evil spirits, as reported by Vitruvius and further scholars (Adam 1991; Vandi 2002; Caneva et al. 2014; Aamir and Malik 2020). Moreover, we cannot neglect some zoomorphic associations, such as the curved Acanthus leaves that seem to show the apotropaic illusion of lions' mouths.

The concept of the Earth's fertility and fecundity is expressed through the representation of wheat and lily. The first one was deeply connected to deities such as Demeter/Ceres (Murr 1890; Arrigoni 2018). In fact, cereals represented a key changer in the lives of civilisations, being one of the principal nutrients in their diets (Halperin 1936; Lintas and Mariani-Costantini 1991). Their importance is also evident in their symbolic association with the agricultural context and, therefore, with the fertility of the Earth. However, wheat was also associated to the funeral context: it was indeed sown in the tombs as sign of the good things sent by the dead' in a cultural practice very diffuse in Greece since the Archaic period (Burkert 2010; Arrigoni 2018) but also used as food offerings in funeral ceremonies by Etruscans as testified by some archaeobotanical evidences (Moricca et al. 2023). In this way, the presence of cereal spikes is consistent in the crown, recalling a prosperous life.

The lily was instead associated with the Great Mother and the related feminine goddess and used in their cults. In the mythological literature, the lily originated from the milk dripped from Hera's breast while she was feeding Heracles (De Cleene and Lejeune 2002). Finally, the mullein, which also recurs in the middle level, had numerous medicinal applications (Turker and Gurel 2005; Alipieva et al. 2014; Donn et al. 2023), but it was mainly associated with the symbol of light and flames, not only for its characteristic yellow flowers, but also because its stems were used as candles (*candela regia)* during funerals and ceremonies (Muenscher 1935; Caneva et al. 2024; Yılmaz and Ecevit Genç 2024).

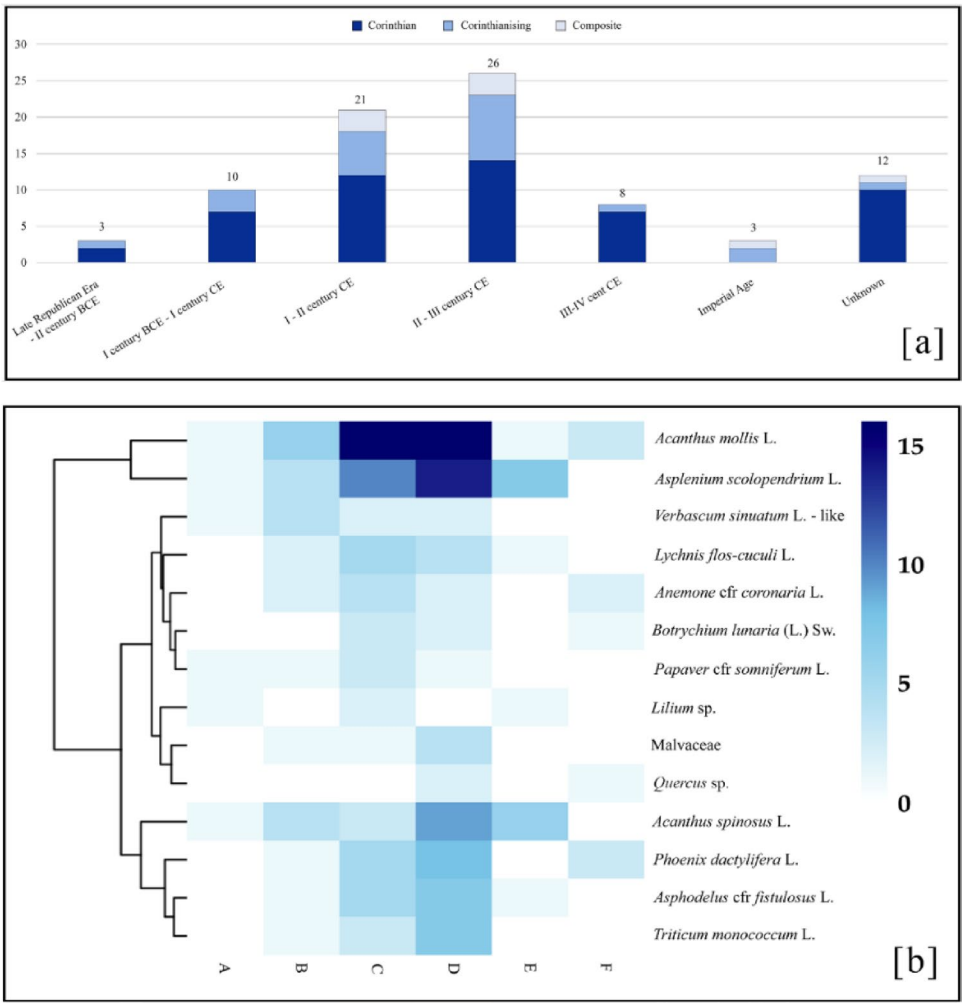


Fig. 5 **(a)** Chronological distribution of the analysed capitals and the typologies present in each period; **(b)** Heatmap showing the distribution of plant-based motifs according to different chronological periods divided in five main temporal groups: A (Late Republican Era and II cent. BCE), B (I cent. BCE and the passage I cent BCE – I century), C (I century and the passage I - II century), D (II century and the passage II - III century), E (III century, the passage III-IV century and the IV century), F (not defined Imperial Age). In the analyses, we included only the main recurrent species, excluding the "IND" motifs and the groups of capitals without a chronological attribution ("Unknown")

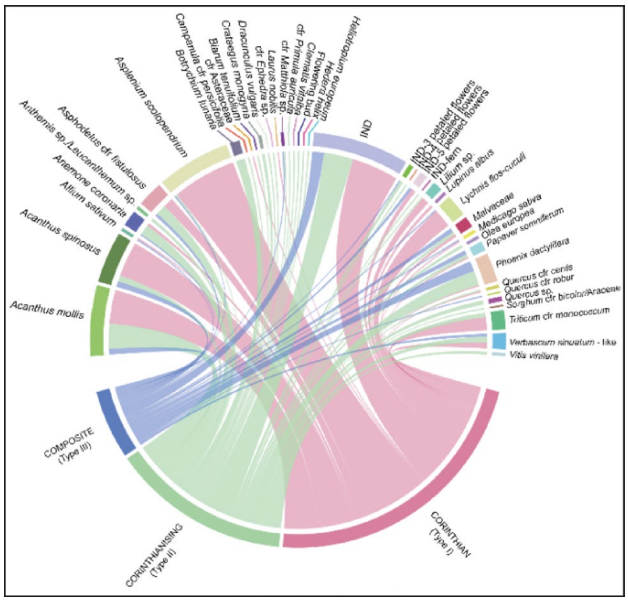


Fig. 6 Graph showing the relations and recurrence of the species according to the three different typologies of capitals. The size of each segment indicates the frequency of a species in a given typology, while thicker chords imply higher levels of occurrence

Despite the common denominator of *Acanthus*, the evaluation of the symbolic messages in the *middle level* is more variable in the capital's typology, due to the numerosity of represented species.

The *Asplenium scolopendrium* commonly recurs, forming the "volutes" and "helices", which at distance can also assume the shape of eyes. This plant had a salvific or warding-off value, as shown by Dioscorides, according to its medical purposes against numerous diseases, against snake bites and other 4-footed beasts (*De Mat. Med.*, III, 121) (Osbaldeston and Wood 2000). Some of these uses are still present in European folk medicine traditions (Glamoclija et al. 2014; Petkov et al. 2021). Their "volutes", which have analogies with the spatial organisation of the "pastoral" ferns, also show similarity with the spirals and the *lituus*, the arched stick used as a cult tool by the Etruscan and Latin people and by the *Auguri* to mark a ritual space in the sky (Caneva 2010).

Then, the asphodel (*Asphodelus fistulosus*), which recurs in ancient Greek and Roman culture, growing in arid pastured Mediterranean fields subject to fires, was a

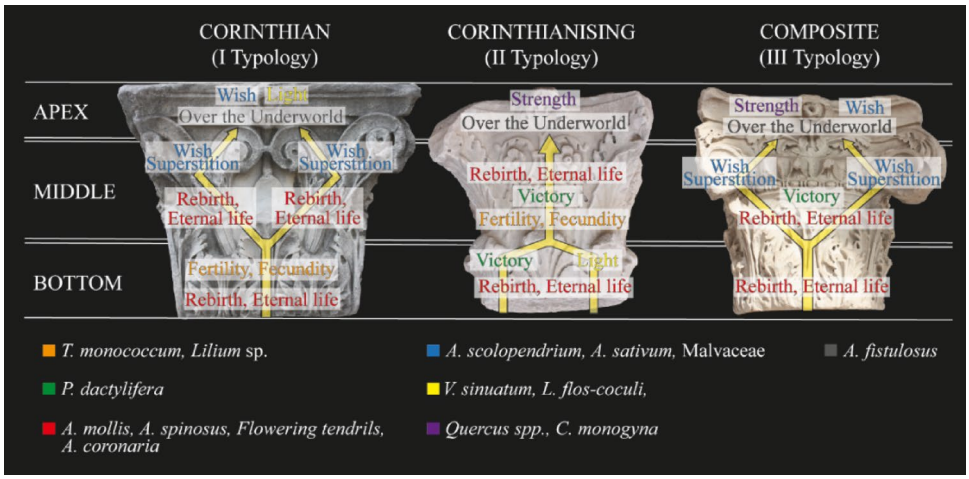


Fig. 7 Symbolism expressed by the plants represented in each structural level for the Corinthian (I), Corinthianising (II) and Composite (III) capitals. At the bottom, the concept of rebirth is mainly expressed with *Acanthus* and fertility by *Triticum* spikes. In the middle level, it is enriched by the apotropaic value of *Asplenium scolopendrium*, and by the flowers in tendril scrolls. Victory over death is expressed by *Phoenix dactylifera* and by Asphodel fruit, and Fertility by *Papaver somniferum*. The abacus plants express strength (*Quercus*), light (*Lychnis*) and salvation (Malvaceae and snakes). The selected capitals were courtesy sourced from the *Museo Nazionale Romano* (a – INV. 2000524; b – INV. 442319; c - no inv.). Photographs taken by the Authors

Pythagorean plant commonly used in primitive alimentation (Pliny, *NH*, XXI, 108) (Pliny the Elder [77–79 CE] 1855); Chirassi 1968; Baumann 1993; Amigues 2002; Fabbri 2018). It was related to the world of the dead, as shown in the Odyssey, being the plant composing the field in which Odysseus encounters his fallen comrade Ajax (Homer, Od. XI.539, 573; XXIV.13) (Homer [8 BCE] 1937; Fabbri 2018; Giesecke and Siede 2023), associated with the Goddess of the dead's Persephone/Kore (Hom., Od. XI, 627–635) and used as an offer to the dead's (Hom., Od., XI 627–635) (Homer [8 BCE] 1937; Fabbri 2018). These aspects explain its magic and apotropaic value, as it was planted in front of countryside houses to keep dangers away (Pliny the Elder [77–79 CE] 1855; Fabbri 2018).

The date palm (*Phoenix dactylifera)* represented one of the most widely used motifs from Mesopotamia to Egypt and later also in Greco-Roman culture (Michel-Dansac and Caubet 2013). This plant had multiple symbolic roles, representing fecundity and serving as a symbol of life. Later, in Greece and Rome, it also symbolised immortality and victory (Lehner and Lehner 2003; Nava et al. 2007; Michel-Dansac and Caubet 2013; Sharma et al. 2019), and its fruits assumed importance also as funerary offerings, as testified by some archaebotanical data (Preiss et al. 2005; Bosi et al. 2020).

In this level, especially in the composite capitals and Corinthianising capitals, we note the representation of some species only represented here (e.g., *Dracunculus vulgaris*, *Hedera helix*, *Ephedra* sp., *Vitis vinifera*), having magical attributes, related to the vegetative forces and fertility (Caneva 2010; Savo et al. 2016), as well as a significant representation of flowers. Flowers were considered the perfect expression of the blossoming of youth, beauty, sexual desire, and seductive power. These characteristics, together with their good smell, made them a perfect iconographical association with the Goddess of Love, Aphrodite/Venus. However, the symbolism of flowers is more complex, with variations associated with different species (De Cleene and Lejeune 2002; Kèi 2015; Lamburgo 2018). When considering the occurring species, the main representative flowers seem mostly associated with the transitory values of life and the earth's rebirth. *Anemone'*s flowers, with the rapid blossoming, were the symbol of Adonis (beloved of Aphrodite/Venus), from whose blood the flower was born (Frazer 1890; Lee 1999; De Cleene and Lejeune 2002; Lehner and Lehner 2003; Giesecke 2014). Papaver had connections with various deities, with principal associations with Hypnos (the God of sleep) and his son Morpheus (the God of dreams), derived from the somniferous or narcotic properties of the poppy, which was consumed through the milk extracted from the capsule. On the other hand, the poppy capsule is frequently attested as an iconographical element of Demeter/Ceres, as a symbol of fertility and abundance, due to its numerous seeds (Guillaume-Coirier 2001; De Cleene and Lejeune 2002; Nava et al. 2007; Fabbri 2009; Rosso 2010).

At the Apex level, mainly recur plants connected with the sky and the stars, such as *Lychnis*, that took its name from the Greek diminutive of *lýkhnos*, which means "lamp", due to use of its stems as wicks for lanterns (Maliński et al. 2014), or of plants having salvific value, as Malvaceae, that had a wide use in medicine and therapy (Dioscorides, *De Materia Medica*, II, 144; III, 163; III, 164) (Osbaldeston

and Wood 2000), and laid on the altar of Apollo, representing the food of divine men (Detienne 2009; Caneva 2010). Furthermore, snakes were associated with medicine, holding both positive and negative symbolisms, as evidenced by mythological creatures such as Medusa or the Hydra of Lerna (Manna 2025). On the other hand, snakes were overall associated with Fertility and Protection, considered guardians and protectors of the Underworld in Etruria and Egypt, or a symbol of Knowledge and Wisdom due to their association with the god of Medicine, Asklepios, in Greek Mythology. Moreover, the iconography of the snake also recalls the already well-expressed concept of Rebirth and Immortality, as suggested by its ability to shed its skin (Pieraccini 2016; Rodríguez Pérez 2020; Manna 2025). A superstitious value is also highlighted by garlic (Hand 1980; Caneva 2010; Yaniv Bachrach 2025) while a connection with the Underworld is attested by the fruits of asphodel (Baumann 1993; Fabbri 2018; Giesecke and Siede 2023).

At this level, we also found oak leaves (*Quercus*, with several species), a tree sacred to Zeus/Jupiter, that were used to make the famous Roman *corona civica* as a symbol of victory and power. Oaks symbolised longevity, strength, and power, while the concepts of immortality and fertility were instead associated with their acorns (Brosse 1991; Lehner and Lehner 2003; Giesecke 2014; Leroy et al. 2020). The idea of strength is also relatable to *Crataegus* sp. Finally, the white lupin, which was used rarely, played the role of a "visionary" plant, with its seeds considered sacred food used to communicate with the dead at the Oracle of Acheron (Baumann 1993; Camilla and Ruck 2017).

4 Discussion

This study enhanced that the Roman Corinthian capitals were formed not only by *Acanthus* leaves, but they also contain a richer botanical structure, with some motifs represented more frequently than others. Among the 35 identified taxa, besides the dominant recurrence of *Acanthus mollis* and *A. spinosus*, other species, such as *Asplenium scolopendrium*, especially in Corinthian typology, confirm the persistence of core vegetal codes across time.

Following the structural division and composition of the capitals, the results also showed that the presence of changes in plant selection, particularly at different levels, resulted in higher botanical diversity at the middle level. Meanwhile, at the bottom and partially at the apex, certain species seem to be preferred, probably as standardised motifs.

The bottom level is characterised by few variations of botanical species, where the recurrence of *Acanthus* is the primary key of the style, with some species being recurrent. The first typology (Corinthian) is the "simplest" in terms of botanical motifs, showing the lowest number of species, whereas the Corinthianising style showed the highest variability, with specific taxa identified only in it. This result can be related to their later chronology. In fact, this increase in the capitals of the I–III centuries CE can be related to several reasons, such as a period of great architectural innovation or political changes in Rome, that could reflect broader imperial cultural dynamics.

Giving a historical perspective, we can observe that during the Augustan age, the Corinthian capital underwent a transformation in a plastic and naturalistic sense (Heilmeyer 1970; Pensabene 1973; Freyberger 1990).

In the capitals of the Flavian age, the plastic Augustan model was transformed into a succession of plant elements and to shorten the working times, all the surfaces not visible from below were left without decoration: the lower half of the second crown of leaves was smooth, while the distinction into lobes by means of deep grooves occurred only in the upper half of the leaf (Pensabene and Caprioli 2009). At the same age, the composite capital, characterised by two crowns of leaves and flowering tendrils in the *Kalathos*, and by an Ionic *kyma* with ovules and arrows, which originates from a festoon between the echinus shells, was definitively codified, as exemplified by the Arch of Titus. In the Severan age, an eclectic style was established, ranging from a rather sober decoration, as (e.g. the Arch of Septimius Severus), to the ornamental exuberance of the Baths of Caracalla, where the capitals were not only characterized by the vegetal overabundance, accompanied by the use of strong chiaroscuro, but also by the addition of figures of divinities (Pensabene 1986; Pensabene et al. 2007; Milella 2019).

Throughout the III century AD, capitals of the so-called "Asiatic Corinthian" type, produced in the quarries of Proconnesus (*Docimium*) in Asia Minor, were imported. They arrived in Rome and Italy in either a completely finished or semi-finished state (Pensabene 1986; Pensabene et al. 2007). Finally, from the Constantinian age onwards, the reuse of capitals from monuments of the previous era dominated, but there was also the imitation of older decorations, translated into the new late antique language (Pralong 1993, 2000; Kramer 1997; Violante 2011).

When considering the iconographic interpretation, this study also confirmed that such more or less complex plant-based motifs had not only ornamental functions, but were also overall tools of communication (Heilmeyer 1970; Caneva 2005, 2010; Camilla and Ruck 2017; Leroy et al. 2020). As capitals, far from being mere structural terminations, they were dynamic carriers of symbolic botanical language. Plant identifications obtained from the analyses and compared with archaeobotanical data from archaeological sites related to the Roman culture (Palmer and Van der Veen 2002; Zach 2002; Preiss et al. 2005; Rottoli and Castiglioni

2011; Vaz et al. 2021) confirmed that in ancient cultures, plants played a central role in daily life activities, including funerary and celebratory rituals, which also defined their possible symbolic value.

We uncover how spatial hierarchy, typological experimentation, and visual repetition encode messages of fertility, death, rebirth, and immortality, structurally represented through motifs with a shared "Botanical Code" (Caneva 2010). The presence of flowers is not surprising as they held an important role in ancient societies, being frequently used to build garlands and wreaths used in celebrations to honour gods, but also the dead ones in funerary scenarios, as testified by archaeological findings (Jashemski 1979; Hamdy 2007; Rogers 2020; Bowe 2021; Hristova et al. 2024). The representation of flowering tendrils was distinctive of the Greek settlements in Magna Graecia and Sicily, spreading later to the rest of the Italian peninsula (Heuer 2019). This motif is consistently represented in Apulian vases, often in conjunction with the depiction of deities, where tendrils serve not only a decorative purpose but also facilitate correct narrative comprehension, or in monumental artworks such as the *Ara Pacis* (Caneva 2010; Caneva et al. 2014). This motif is primarily based on the concept of plant metamorphosis, conveying a continuous idea of rebirth and endless life, as well as concepts of fecundity and prosperity (Caneva et al. 2014).

Zoomorphic elements animate the capital's structure, and reading the capital composition by the natural motifs, the spatial layering suggests a conscious design logic in which symbolic depth increases toward the apex. Considering the location assumed by capitals at the upper parts of the columns, in the sacral spaces of temples or palaces, the message should assume even greater importance to the (ancient) people who watched it.

5 Conclusion

The study of Roman Corinthian capitals and their variations revealed, for the first time, their surprisingly rich botanical composition, which was not limited to Acanthus leaves, showing significant variability of elements, particularly in the Corinthianising typology.

The distribution of the species varied according to the three main structural divisions (bottom, middle, and apex) that compose the capitals. The iconographical analysis of these botanical motifs highlights some symbolic messages that may be conveyed through their use. Acanthus suggests the concept of Rebirth and Fertility through its combination with *Triticum*. The presence of various flowers and plant elements, along with the recurring motif of metamorphic flowering tendrils, suggests augural messages and superstitions related to fertility, eternal life, and Abundance, also associated with the Underworld.

This research highlights the importance of analysing botanical motifs, interpreting them not only as decorative elements but also as a tool of communication. It also reinforces the perspective on analysing ancient architectural structures through an unwritten language, which could provide new cultural and social insights into ancient cultures. Future research will enrich the collection, providing wider evidence of shared or changing stylistic tools.

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Data availability No datasets were generated or analysed during the current study.

Declarations

Conflict of interest Authors have no financial or proprietary interests in any material discussed in this article.

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Authors and Affiliations

Alessandro Lazzara[1] · Zohreh Hosseini[1,2] · Alma Kumbaric[3,4] · Chiara Giobbe[5] · Giulia Caneva[1,2]

✉ Alessandro Lazzara
alessandro.lazzara@uniroma3.it

[1] Science Department, University of Roma Tre, Viale Marconi 446, Rome 00146, Italy

[2] NBFC, National Biodiversity Future Center, Piazza Marina 61, Palermo 90133, Italy

[3] Biology Laboratory, Istituto Centrale per il Restauro (ICR), Via di San Michele 25, Roma 00153, Italy

[4] Department of Environmental Biology, Sapienza University of Rome, Piazzale Aldo Moro 5, Rome 00185, Italy

[5] Museo Nazionale Romano, Piazza di S. Apollinare, 8, Palazzo Altemps, Rome 00186, Italy