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The process of nucleation amongst the early cities of central Italy in the first millennium BC

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This article assesses the process of nucleation amongst the early cities of Tyrrhenian central Italy in the first millennium BC. The article examines the advantages, disadvantages and causes of nucleation. A multi-proxy and multi scalar perspective is implemented drawing on the available evidence for ancient DNA, isotopes, pedology/geoarchaeology, animal and plant remains, contextualized within the settlement archaeology. The article contains original data for settlement distribution, plant remains and stable isotopic analysis of plants.

KEYWORDS

nucleation, central Italy, ancient DNA, isotopes, first millennium BC, Etruria, plant agriculture, animal husbandry

1 Introduction

People make places nucleated (cf. Fox and Wolf, 2024). Nucleation, defined simply as the aggregation of substantial numbers of individuals in one relatively closely defined place on a long-term basis, has biography (Figure 1). It goes through a series of stages, passing from the vulnerable stage of experimental foundation to subsequent stages of transformation, resilience, potentially expansion and ultimately dissolution, sometimes after a considerable period. This is not a unilineal model, since such development can comprise substantial variation (Stoddart, 2020a; Zeviani 2023), indeed this is a characteristic of our case study. The model allows us to measure the variability of these changes through the understanding of the development of settlement, coupled with evidence for subsistence (by modelling food records onto the landscape) and political processes from the study of the internal trajectories of cities and their impact on their territory. In certain circumstances, we can identify the institutions that sustained these changes, and their transformation through time. We can now begin to add the missing element of the agency and dynamism of the actual people increasing in number and moving through the landscape by means of the evidence of a combination of ancient DNA (aDNA) and stable and radiogenic isotopes at the foundational, transformative and resilient stages.

Recent work has examined the underlying causes of stability and delicacy/fragility of urban societies (Stoddart, 2017a; Yoffee, 2019). These results show the tension between social resilience/fragmentation and the underlying biological and ecological forces that control demography and sustain/weaken the new nucleated experiments, which led to urbanism when they endured. The resilience of the original nucleation depended on the durability of the

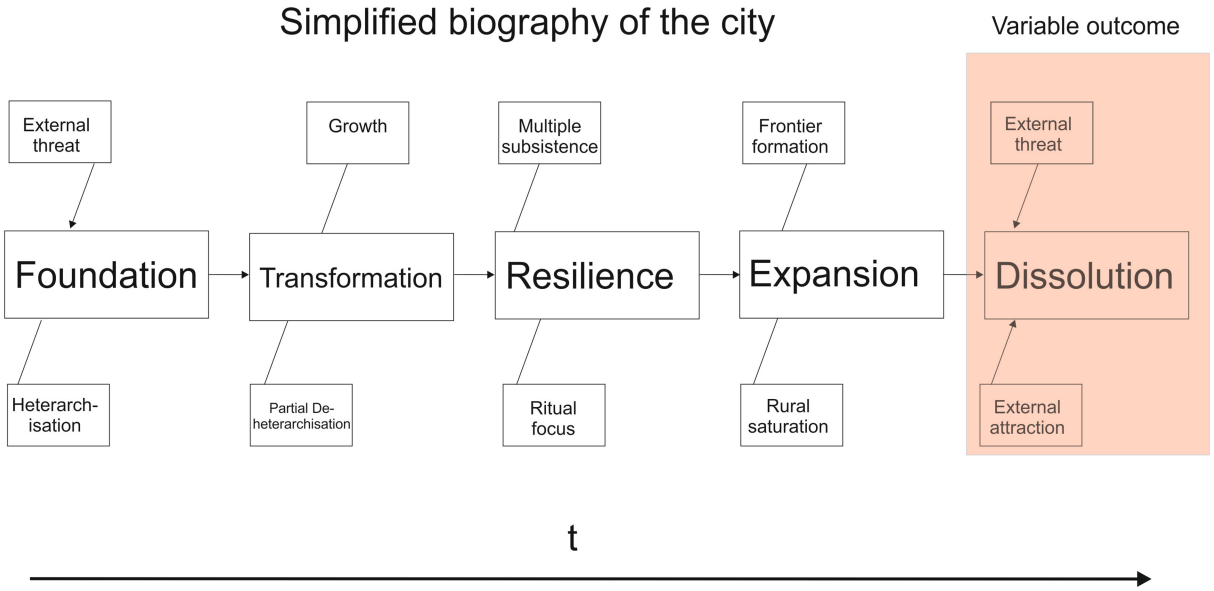

FIGURE 1
The nucleation biography. A theoretical model of the nucleation of the city, passing from foundation to transformation to expanded resilience to expansion and the ultimately dissolution. The development of individual nucleations deviates from this idealised model (Stoddart, 2020a) depending largely on the geopolitical position in the landscape. Source: Simon Stoddart.

collective social action that brought smaller communities together. For this purpose, the human landscape needs to be modelled, enhanced by the insertion of rural settlement and ground-truthed by the re-examination of original survey data (Stoddart, 2017b; Zeviani 2023). In tandem, we can seek to investigate mobility, diversity and the range of the city in controlling the mobility of humans and animals, over the course of time. Humans tend to accompany and guard their flocks and thus register their range of territorial access. In this way, we can test the social model of urbanism by examining the ebb and flow of individuals to and from the center.

Work on the nucleation in central Italy in the first millennium BC has focused on institutions inferred from cultural achievements, notably the built environment, rich material culture and ritual, especially burial. These approaches are the intellectual heritage of concentrated expertise over many centuries of archeological research. While summarizing some of this long-standing research, which is too extensive to cover here in anything like its entirety, this article primarily takes a complementary and integrative approach that examines the tempo and sequence of nucleation and accompanying institutions alongside its supportive infrastructure in central Italy during the first millennium BC. For this purpose, we focus on the available data on the biological side of the city (aDNA, isotopes, animal remains and the physical environment) and how these interface with the built environment.

Recent anthropological scholarship (summarized in Holland-Lulewicz et al. (2020) and applied to urbanism (Thompson, 2023)) has stressed the importance of institutions that structured nucleated society. Tantalizing textual accounts of the Etruscans point to leaders, often identified as Kings in a number of the urban communities (Tagliamonte, 2017). A major moment of transition is indicated within the sequence of Tarquinia at the early seventh century BC level where symbols of authority, the trumpet, axe and shield, were found, but these do not by themselves indicate the nature of the institutional authority behind them. From the fourth century BC onwards, the term *zilath* (usually translated as magistrate) appeared, indicating figures of accepted institutional authority. This term seems to be part of a spatially nested and overlapping set of terms, community (*spura*), city (*methlum*), village (*tuthina*), citadel (*cilth*) and people (*rasna*).

The Etruscan evidence from cemeteries and settlements suggests that durable descent groups provided the main institutional focus, which, over time, were encased but never superseded by overarching ritual and incipient political institutions, made visible by offices such as the magistracies. These ritual institutions provided long-term, specialized knowledge, and from the evidence of inscriptional display in later tombs (Figure 2), the tenure of magistracies offered considerable prestige. This perspective is also supported by the *elogia* of Tarquinia where such personal histories are celebrated (Cornell, 1976, pp. 425–426).

The resilience (primarily measured in terms of duration; Smith et al., 2021) of the city has its own biography. There is a process of foundation, often considered, in the case of our example of Etruria, to be caused by a context of political uncertainty, by a requirement of defense, headed by a military elite, even though this elite is not easily visible in the archeological record. There was subsequently a maintenance of the city's attractive qualities by means of collective ritual, by the pooling of resources to create a built environment and a reservoir of expertise, most notably visible archeologically in the production of material culture, which attracted an ever-larger community and maintained the demographic profile through cultural and social resilience. These processes have been deeply studied by the cultural engineers of the ancient world. Similarly, surface survey has also now demonstrated the transition from village to nucleated life, giving one dimension of the probable mobility of descent groups into the metropole (as defined in Kopytoff, 1989), an increasingly popular destination that created a resilience embedded in numbers.

New dimensions of resilience are, moreover, currently emerging through the application of archeological science, particularly life sciences: namely population growth accompanied by high levels of mobility and diversity of the communities' inhabitants recovered from their very bodies rather than inferred from their settlements or the richness of their material culture. The body, therefore, becomes as central as material culture to interpret past population dynamics (Blake, 2025). Sample sizes are still low, but they are beginning to converge on meaningful patterns (e.g., Scheeres et al., 2013; Trentacoste et al., 2020; Esposito et al., 2023; Bagnasco et al., 2024; Riccomi et al., 2024). Furthermore, we can now model the potential agricultural support in the landscape by assessing soils against the distribution of urban centers and rural settlement, with the advent of relatively big data models and modelling (Zeviani, 2023; Zeviani et al., 2025; Zeviani, 2025). Whilst the metropole was attractive, it still depended on its countryside to survive, and, to understand that survival, we need to model its foundations. Finally, new studies of human remains have registered a presence of selective violence, most probably implemented only when other modes of resilience failed. Simultaneously, the human body has been shown to be a receptacle of stress and disease. This reminds us that the process of nucleation was not entirely a pacific and gentle process, but one accompanied by severe stresses of interpersonal disagreement and conflict and difficult health developments during the life course.

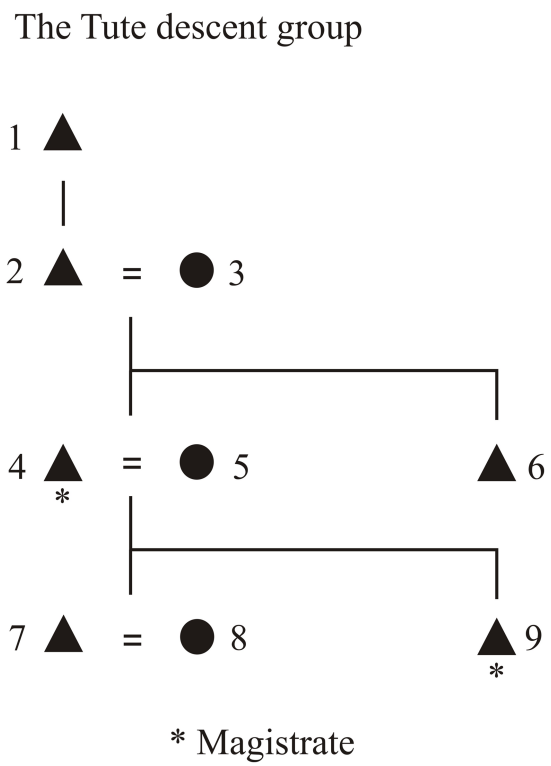

FIGURE 2
An inscriptional biography of the Tute descent group of Vulci, showing the emphasis on institutional display of the office of magistrate. (After Marchesini, 2007). Source: Simon Stoddart.

The result is a fuller biography (Figure 3) of nucleation and accompanying institutions from the time of foundation through periods of maintenance, including acts of repression, as well as expansion. We can begin to understand the underlying social processes, employing the powerful African model of Kopytoff, as applied by Stoddart (2020a) and Zeviani (2023) for Etruria, who ultimately established that cities (metropoles) live or die by the application of political manipulation of descent groups. Under this social model and demographic availability, the adventurous and the deviant seek to move from their home metropole and set up new nucleations which sometimes succeed and sometimes fail. A successful nucleation has not only to attract new members, maintaining population levels sometimes competing with a high death rate, but also compete with other nucleated communities for its members. We can see this phenomenon during the full Etruscan period, when the main Etruscan cities ultimately won the competition against

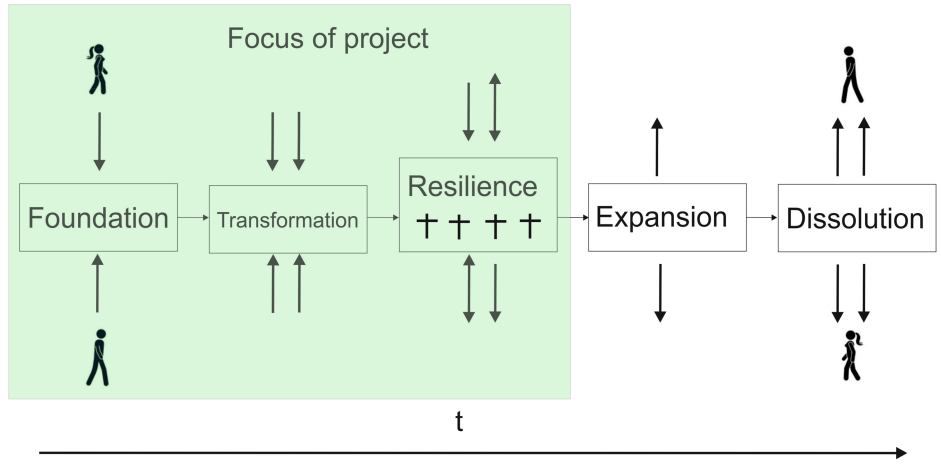

FIGURE 3
The nucleation demography. A theoretical model of the nucleation of the city, passing from influx of population, to demographic influx attracted by the nucleation, to equilibrium between input/output and mortality, to expansion and ultimately dissolution. The development of individual nucleations (Stoddart, 2020a) deviates from this idealised model depending largely on the geopolitical position in the landscape. Source: Simon Stoddart.

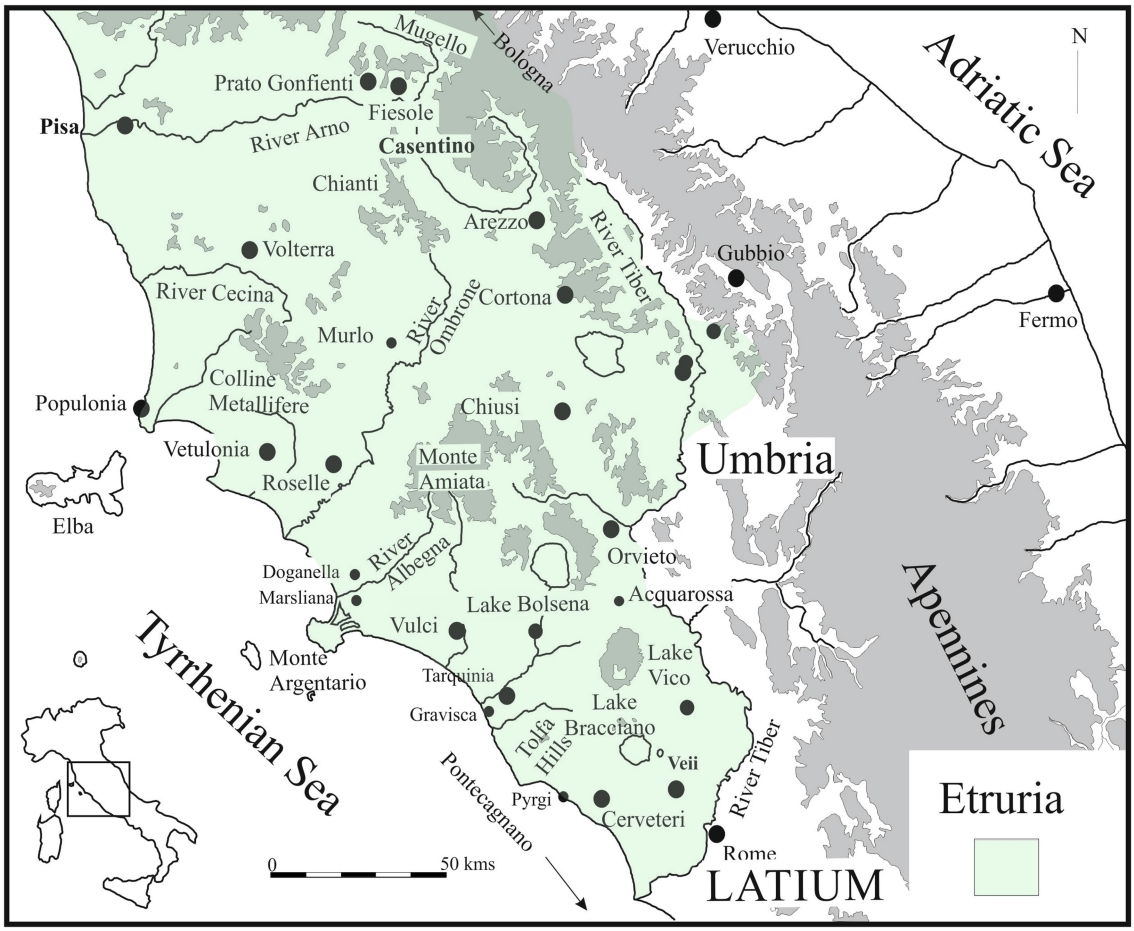

FIGURE 4
Map of Etruria, showing major sites. Source: Simon Stoddart.

nascent nucleations on their peripheries, be they centers of broadly Etruscan identity or those in more dispersed mountainous areas attributed to other cultural entities such as the Umbrians. Moreover, the Latins (transformed into Romans) later persuaded many of these same Etruscan communities to transfer their allegiance, not only by the famous Roman coercion, but also by offering a "better" political and cultural deal to their central institutions, leading to a relatively rapid transition from one locus of nucleation to another. We can thus conclude that social resilience is as important as ecological resilience in the maintenance of these highly successful communities.

In the context of Etruria (Figure 4), we are dealing with a nesting of the micro (implemented in historical times by Ginzburg, 1993) within the macro, the classical detail within the wide-ranging sample of archeological science, with agency as a part of the process. One approach is to build up a set of microhistories, even if these can be profoundly influenced by pre-suppositions of cultural context, ultimately drawn from ancient authors (Bagnasco et al., 2024). Others are based on a combination of archeological science and carefully constructed cultural information without the impact of peri-textual sources (Esposito et al., 2023). It is vital to situate these microhistories within a broader macro context, including rates of general population growth, and that is the approach taken here. In many ways, this is no different from the varied schools of landscape archeology (Stoddart, 2000), stretching from David Clarke (1972) to Chris Tilley (1994) and into the current millennium (DeMarrais and Earle, 2017, pp. 195–196), or settlement archeology as expressed many years ago by Flannery (1976), where nested scales of analysis are critical to understanding how society, and, in this particular instance, nucleation operated. It is also an expression of current understandings of globalization where the local should also be articulated with the global (Stoddart, 2022a). It is no accident that nucleation in the central Mediterranean took place at the same time as processes of globalization. One needs to be nested within the other to have a full and comprehensive effect.

International scholars have been generally aware of what the classical world can offer archeology by way of rich examples (cf. Flannery and Marcus, 1983) for a broader intellectual understanding and how that world has influenced our understanding of other worlds in spite of their differences (MacCormack, 2007). However, if one examines comparative examples of archeology, it is notable, dare we say notorious, that the study of one of the major European urban civilizations, namely the Etruscans, has largely escaped the gaze of anthropological archeology. This is not for want of instructive data. It is for want of exposure of the substantial data to a world outside broadly classical archeology, whereas the *giant* civilizations of classical archeology, Greece and Rome, because of their varied legacies

(cultural and political) to the Western world have been examined with much greater thoroughness. One new contribution from archeological science in Etruria is that we now have the data to begin to understand demography and the movement of individuals through these scales, and Etruria is now beginning to yield this cutting-edge evidence. This will enable a proper comparative flavor to the research.

2 Theoretical approaches

2.1 Robust and delicate nucleation

Nucleation provides both advantages and challenges. The advantages of collective action (Blanton and Fargher, 2008; DeMarrais, 2016; DeMarrais and Earle, 2017) are well defined. We can identify as especially cogent the factors that depend on weight in numbers: collective identity, differentiated responsibilities (including roles for ambitious individuals) and pooled resources. The subsequent challenges for the nucleated community, and its long-term resilience, rest on how to provide the resources to support and maintain such large numbers and how to prevent social dissension and disease. New data are beginning to assess the central issue of quantifying the level of flow of people into and out of the city from an integrated social anthropological and biological perspective.

In some cases, the political endeavor of nucleation was successful and enduring. Collective identity was supported by ideology and religion, often manifested securely by shared burial customs and ritual authority. Numbers counted in securing the collective against opposing forces. Responsibilities, including power, were successfully differentiated. Resources were carefully balanced both within the city itself and necessarily from the surrounding countryside. In other cases, the endeavor was faltering and ultimately short-lived. This may have been because of a lack of collective identity, or a failed ability to pass on the sense of collective identity between generations. Furthermore, collective identity may have been vested at a micro-level, namely the descent group and thus have provided an alternative focus of solidarity (Helms, 2007) to the nucleated community. Numbers may ultimately have proved to be insufficient, particularly in competition with other nucleated centers. Responsibilities may have been ineffectively distributed such as to create conditions of dissension. Resources may have been difficult to procure satisfactorily, particularly if factors of ecological resilience were not built into the equation. Resilience is measured by solving these issues.

In the European theatre of nucleation in the first millennium BC, there was an apparent account of two contrasting trends, broadly placed north and south of the Alps. In this reading, south of the Alps, there were numerous examples of apparently stable "eternal" nucleation. The Latins and the Greeks, epitomized by Rome and Athens, had long materialized sequences, apparently without interruption. Textual sources inform on some elements of dissension, but the built environment shows continuity. North of the Alps, prior to Roman political incorporation of some of the same landscapes, the contrasting pattern is that nucleation appears to have been difficult to maintain over more than a few generations (Stoddart, 2017a). Nucleation reverted to dispersal. Etruria drew on both these trends. Metropoles (the term coined by Kopytoff) provided a focus of continuity, that is successful resilience. However, at the frontiers between these great centers, there were much shorter-lived nucleations that were ultimately not tolerated by the great metropoles themselves (Stoddart, 2000; Zeviani, 2023), showing insufficient resilience in terms of population numbers, social institutions and resources to resist more powerful neighbors. In this way, Etruria offers many empirical data for the study of nucleation that many other European examples did not achieve. It offers an understanding of how robust and delicate nucleation can co-exist. On the one hand, force of numbers, accompanied by ecological and political resilience prevailed, that is, until a more effective political force, that of the Romans replaced the Etruscan equilibrium. On the other hand, in the interstices, smaller population numbers confined in space were unable to develop the resilience faced by larger surrounding metropoles.

2.2 The experiment of nucleation

As projected by Henry Wright (2006), nucleation (for him state formation) was an experimentation taking place between closely spaced intensely competing centers, showing signs of conflict. Nucleation was also an experiment in Europe at this time. Other instances of nucleation had taken place millennia earlier, notably in what is now the Ukraine (Chapman et al., 2014), and in the second millennium in the Aegean (Parkinson and Galaty, 2007), but for the most part nucleation was a new way of living which required new ecological, material and social technologies to achieve success. Central Italy engaged in that experimentation in broadly the same way as envisaged by Henry Wright in Madagascar. Many of the Etruscan centers were closely spaced (Stoddart, 2020a) and there is emerging evidence of conflict (Bagnasco et al., 2024). However, whereas some regions maintained nucleation, others failed to sustain this process in the competitive arena in which they existed, and still others chose strategies which continued to avoid nucleation, most notably in the more remote valleys and mountainous areas surrounding Etruria and Latium, denominated by the written sources as Sanniti and Vestini. These communities had a different form of resilience that was often born out of independence of action founded on mobility and proximity to resources which may have been differently shared in a more dispersed human landscape. Nucleation was not the only strategy, and populations in the age of experimentation would have had memories of these alternatives.

2.3 Concepts of resilience

The robustness of nucleation requires a social technology to replace these potentially attractive memories both to overcome the advantages of dispersal and to enhance the advantages of concentrated resources. Understanding the social city is fundamental, since it is closely related to strategies of social resilience by the formation of enduring institutions. Boissevain (1964, 1979, 2011, 2013) drawing ultimately on his studies of the intimate interactions in the small scale nucleations of village life in Malta, by implication points to the difficulties of maintaining cohesion as nucleation increases in size. The solution in small scale Malta was to maintain a heterarchical structure of competing smaller scale elements. This can be a successful strategy, provided these heterarchical elements are not tempted to move toward other allegiances, based on kin or other forms of association. Success is tempered by vulnerability, especially to external forces. Kopytoff

(1989) and Terrenato (2019) in their substantially different ethnohistorical contexts, Africa and early Rome, point to the need for an enduring attraction of nucleation to avoid fission. Dismantling of the component parts (aka descent groups) of nucleated centers may often have been particularly to the advantage of other nucleated centers, both incipient and already formed, which may have appeared to offer more to descent groups who found themselves at odds with any emerging dominant authority. Kopytoff (1989) envisaged a meteorological power map in the African continent, of highs and lows, where there was always the temptation to move toward the political low of the internal frontier where opportunity beckoned, but to move back if this solution was unsustainable. Terrenato (2019), more recently in the context of Roman central Italy employing ethnohistorical data, has envisaged a competitive political landscape where descent groups were the main power brokers, seeking to recruit to their own nucleated centers. This would ultimately reduce the need for military action by external polities such as Rome, since employing modes of political persuasion is much more effective than the heavy weight of coercion.

The resilience of a given nucleation can be shown to be related to the form of socio-political strategy deployed to maintain cohesion, and that a collective strategy was generally more enduring (Feinman and Carballo, 2018). Many nucleations had a tension between the institutional coherence of the whole community and the social networks that constituted that community (Min, 2019). The ability of the social networks to mitigate these tensions led to the overall resilience of the nucleation. The Etruscan case had a particular fit within this scenario, since the material remains and more particularly their historiographical analysis seem to suggest great dependence on long distance trade, great disparities of wealth at least displayed in death, and a great emphasis on exclusive monumental architecture once again most visible in death, all categories suggested to be part of a less collective strategy (Feinman and Carballo, 2018, Table 1). An important fact of mitigation of the tensions is that these resources were distributed heterarchically along lines of descent groups and less centrally, thus potentially promoting an alternative equilibrated stability, a form of intra-community peer polity interaction. At a scalar level we can see this in fractal terms. The peer polity interaction of descent groups within the communities mirrored the peer polity interaction of communities within the Etruscan human landscape. This heterarchical pattern may had an intimate component, closely related to the modern concept of the 15 min and the Third Place. In these smaller quarters of the city, the heterarchical elements of the city could have maintained their cohesion. Unfortunately, only a few Etruscan cities, such as the late Etruscan city of Marzabotto (Figure 5), have had sufficient open area excavation undertaken to examine the material evidence of this interpretation. The combination of stabilizing heterarchy focused on ancestral descent groups and strong international trade appears to have a broad similarity with the nucleations of the Swahili of East Africa which endured for many hundreds of years (Robertshaw, 2019, p. 152). We further suggest that this emphasis on the material form has to be complemented by study of the human (including direct biological) evidence to achieve a more complete picture of the balance of social power, most notably in the interpretation of diet, mobility and kinship from isotopes and the relationship to the rural territory and the frontier.

Archeology can add an extra dimension to this ethnohistoric view from the nucleated center. Social resilience also relates to how the nucleation relates to its hinterland. This is partly a demographic equation, namely where people are located, but logically extends to a relationship of identity and administration over territory, and the degree to which a recognizable frontier forms to the territory of the neighboring nucleation. The structure of the countryside also gives a measure of the varied flexible strategies that might be adopted to support nucleation, and the Etruscan case, in common with the Harappan case (so different in other ways) (Petrie, 2019), gives many examples of this in practice.

The Etruscan case study thus gives many opportunities to explore multiple dimensions and practices of nucleation that can then be integrated into one variegated account, drawing on both cultural achievements and scientific data. A city was hungry for people and consequently food, and thus its ecology was critical to provide sufficient support. A city was potentially very diverse, since the local area was unlikely to provide the full required demographic profile. When consensus and the collective failed, the city also had the potential for violence. The sheer numbers of individuals may also have created conditions of reduced health, the so-called graveyard effect. Decline in stature, a possible indicator of health, amongst related populations (Sparacello et al., 2017) is a pattern confirmed by Parkinson et al. (2023) on the basis of a larger, but still less powerful, sample for the Iron Age. Ritual was a prominent feature and does seem to have provided a counterweight to tendencies to fragment. In this way, a balanced perspective of Etruscan nucleation can be achieved.

3 Biography. The tempo and sequence of nucleation in central Italy during the first millennium BC

3.1 Foundation

There is much discussion about the process of Etruscan nucleation which has been covered elsewhere (Stoddart, 2022b). Curiously the term nucleation is not favored, but the discussion is couched in terms of changing cultural entities such as a transition from proto-urban to urban. Early accounts have suggested a Norman model for Etruscan society where a small immigrant military class subjugated an indigenous peasantry (Ward-Perkins, 1959, p. 15). More recent research has criticized this approach (Amann, 2024), since both settlement evidence and a reading of the incoming biological evidence suggest a substantially local development. We can, nevertheless detect that the key traditional scholarly debates of Etruscan urbanism are about the degree of influence from more "*culturally advanced*" (terminology used by the practitioners but not shared by the present authors) civilizations such as the Greeks (Pallottino, 1975), the degree to which key figures drove the nucleation (Torelli, 1981), and whether these key figures were part of a male military elite (di Gennaro, 2000; Pacciarelli, 2000). In previous work, one of us has compared this debate to the situation in the Valley of Oaxaca (Stoddart, 2010, 2020a). In other words, this is a debate between individual and collective action. It is a debate that permeates the discussion of modern historians in periods much closer to our own, with direct effects on our current and personal lives (Garton Ash, 2023). In reality, the scales of individual agency and collective authority may have ultimately worked together, as illustrated clearly in the modern world.

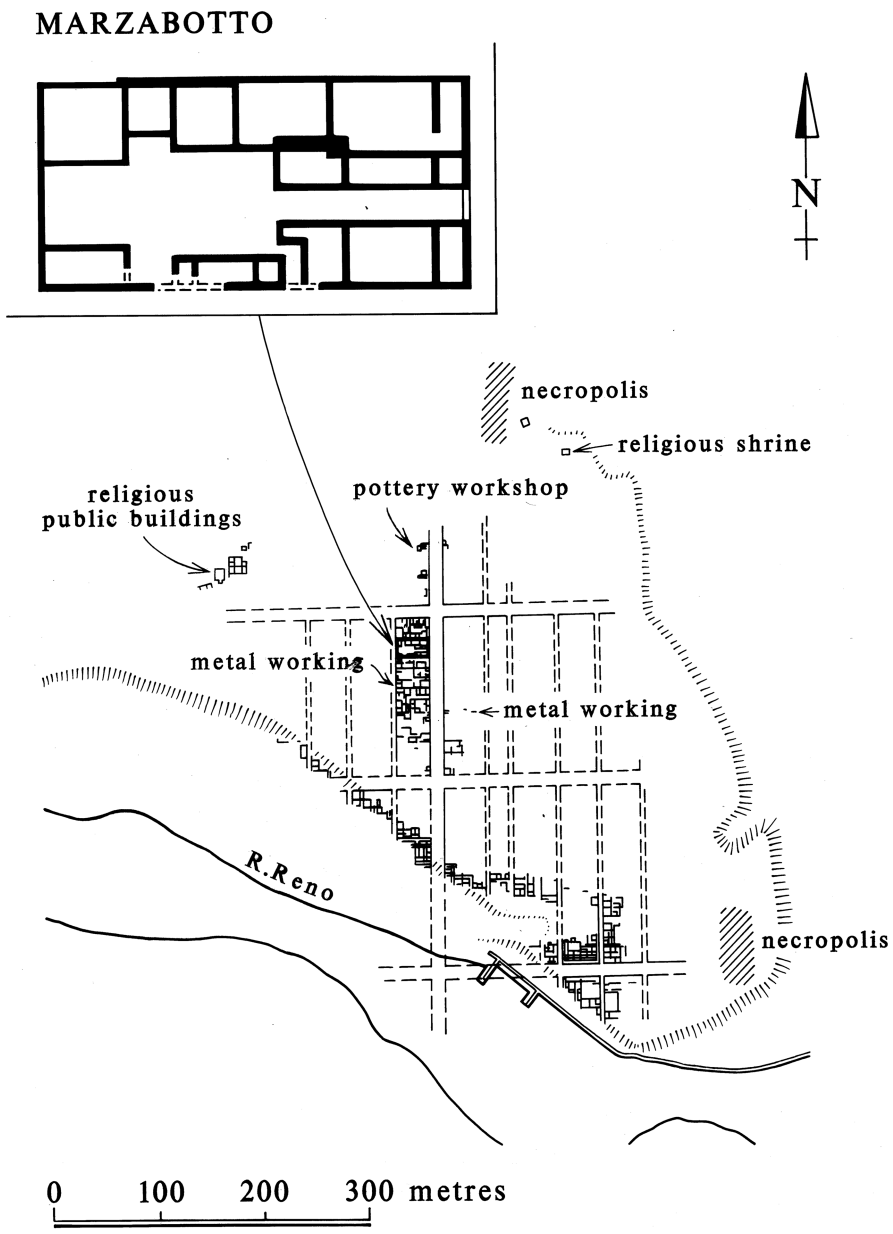

FIGURE 5
Plan of Marzabotto. Source: Simon Stoddart.

Recent work in Etruria has shown the transition from villages to plateau had an intermediate stage where clusters of smaller villages gathered around larger villages before the definitive transfer to the larger plateau (Barbaro, 2010; Stoddart, 2020b, Figure 7.4) (Figure 6). Once this transfer took place, there is the further discussion about the nature of the new political entities that formed on the larger plateau of Etruria (di Gennaro, 1986; Pacciarelli, 2000, 2017; Vanzetti, 2002, 2004; Stoddart, 2020b). Was the occupation of the plateaux multi-focal and thus visibly heterarchical (Ward-Perkins, 1961; Rendeli, 1991) or was the occupation immediately gathered together under one unitary political authority (Guidi, 1989; di Gennaro et al., 2004)? In spite of the substantial consensus by protohistorians studying the Villanovan material culture, it is highly probable that a tension remained between the need for cooperation in the plateau and the constituent institutions that made up that community. This was a tension that continued to be present in the later Etruscan communities, where the central institutions of the descent groups competed for political attention with the requirement to act together as one supra community. Distinct neighborhoods in urban entities are a common phenomenon cross culturally (Smith, 2010), but recognizing them from what remains largely surface scatters of material in the case of central Italy is a first problem, even before defining what they represent in social and political terms. Given the formation process of Etruscan nucleation combined with the available evidence, it is highly probable that clustered neighborhoods were retained long into the formation of the city. The evidence from the two cities,

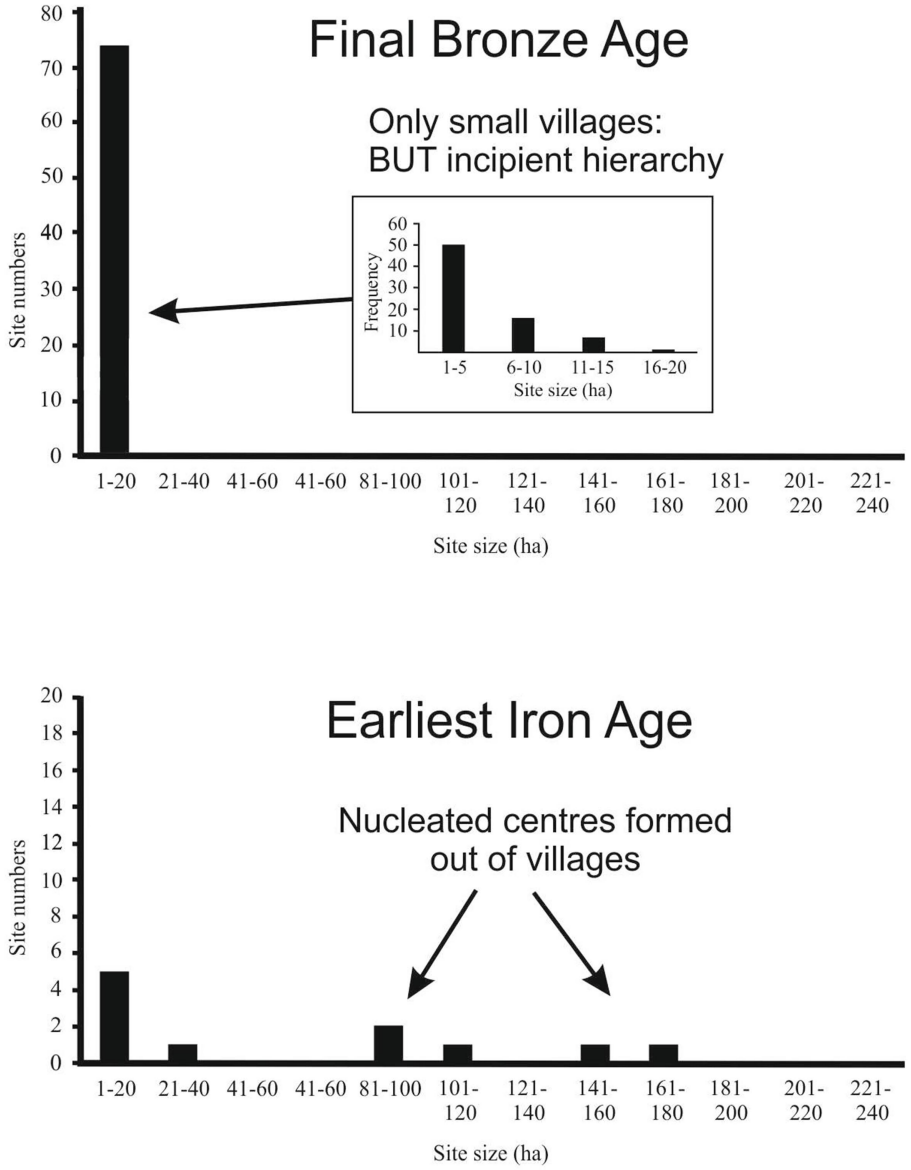

FIGURE 6
Change in distribution of settlement size between village and nucleated phase. (Data from Barbaro, 2010). Source: Simon Stoddart.

Tarquinia and Veii, which have been systematically studied both by geophysics and surface survey do seem to confirm the idea of the enduring neighborhood, with open spaces (Smith, 2008), born out of the very nature of the nucleation process from a series of separate villages (cf. Samuels et al., 2021). At a later stage, both were subjected to an attempt to formalize the structure of the city around a series of monumental ritual structures.

In our view, the Etruscan nucleation retained a strong element of social fractality, repeating similar structures both at a higher and lower order. This relates directly to the formation process from a series of villages, composed themselves of a series of descent groups. These villages can still be detected in the surface surveys of the nucleated centers. Each overarching nucleation in turn appeared to have had a putative ancestor. Some names, such as Tarchon in Tarquinia have come down to us (Nielson, 1984; Muse, 2007; Bagnasco et al., 2013). At a higher order scale, the nucleated centers themselves collectively formed a competing network generally designated as Etruscan, perhaps centered around collective ritual (see below), contrasting with other collective identities, most particularly the Latins to the South.

To this we can add the view that the period of change was a phase of uncertainty in the Mediterranean which required special measures of ensuring security (Briquel, 2000), an opinion shared by Zanini (2012). This uncertainty may have been episodic in the early phases of nucleation, since modelling radiocarbon suggests a drop in demography at about 800 BC, well into the development of nucleation (Parkinson et al., 2021). Another dimension is the scale at which the context of nucleation needs to be considered. One wider scale relates to the Mediterranean. Another is the scale of the Italian peninsula. In this respect, we may be dealing with substantial shifts in population density from the Po Plain to

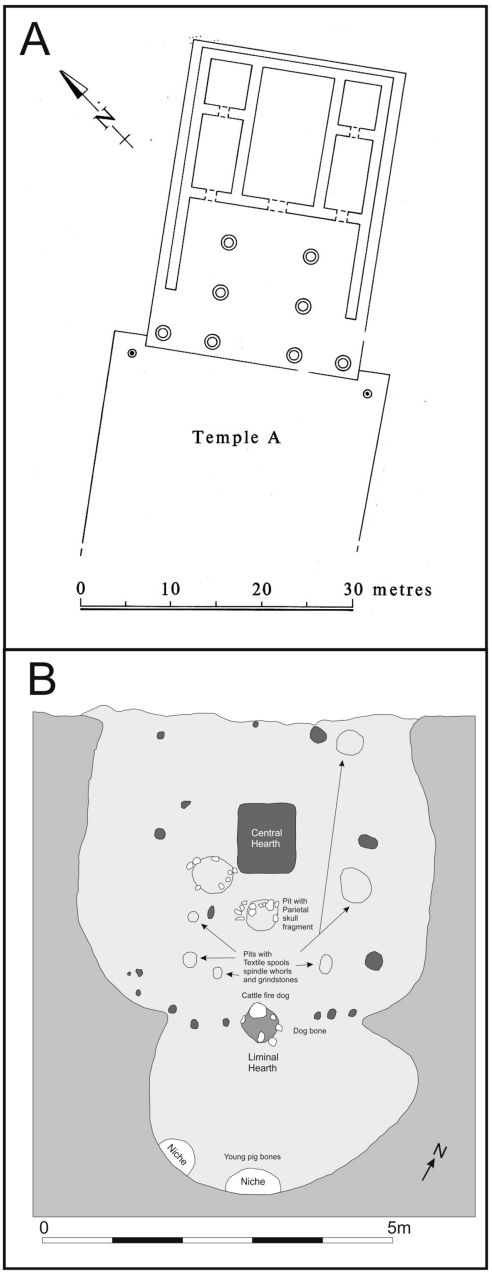

FIGURE 7
(A) Temple A at Pyrgi, a port of trade from the period of nucleation. **(B)** Embedded ritual at Sorgenti della Nova, a village site dating to the period before nucleation. **(B)** After Cardosa and Pitoni (2012). Source: Simon Stoddart.

central Italy (Zanini, 2012) although these shifts may have primarily affected the inland areas, as explored in more detail of material culture by Cardarelli (2009). An implementation of this argument to ensure the safety of people and resources has been applied as an agent-based model to explain nucleation (Cecconi et al., 2015), but notably this has been applied to Tyrrhenian Southern Etruria, an area where communities may have been aware of the demographic instability to the north, and responded accordingly with a repeated nucleated response. Rites of foundation are more easily found in the smaller nucleated villages of Etruria, since they were abandoned when the larger nucleations took place at the very end of the Bronze Age and the very beginning of the Iron Age. This has allowed extensive excavation in a way that will be never be achieved in the primate cities of the Iron Age. The prime example is that of Sorgenti della Nova (Figure 7B), which has been excavated for some 30 years like the more southerly city of Tarquinia by the University of Milan. The excavators have also deliberately undertaken an open area strategy of the relatively shallow stratigraphy and revealed what they quite reasonably suggest are embedded domestic rituals, focused ritual activity and foundation rituals. The focused ritual activity relates to two artificial caves with a hearth associated with a high quantity of piglet bones (unusual for the period) (Cardosa and Pitone, 2012). Another less well-defined example within a settlement is at Poggio Buco (Setti and Zanini, 1998). This form of ritual was contemporary with the deposit of metal hoards and structured middens, often full of feasting deposits and even with metal work. The deposit of hoards continued into the period of more substantial nucleation.

Rites of foundation have also been identified in the later nucleated cities (Michetti, 2013) while the deposits of hoards appear to have ceased. The most remarkable case is that of the *complesso monumentale* on the Civita of Tarquinia, where deliberate deposits were found in the early seventh century BC of an axe, a trumpet and a shield (Bonghi Jovino, 2010). These are very redolent symbols of offence/punishment, defense and alarm, which require little translation, particularly when found in deliberate association. The sequence from the Bronze Age to the Roman in Tarquinia is interpreted by the excavators as memorialized sequence that runs from a *mundus* cavity in the tenth century, accompanied by continuous memorialization of structures, offerings and human remains, with an increasing formalization through time. The presence of inhumed human remains within the community both at Tarquinia and on a smaller scale in Veii, is particularly telling since the habitual rite of burial of the time was cremation, in large cemeteries placed on the boundary of the city. The material remains of these rites have been closely linked to written sources at Tarquinia, which report sacred books, and the layout of the city mirroring the interpretation of the celestial sky. On the ground the most elaborate schemes have been detected in later cities such as Marzabotto (Figure 5) where an initial rite of foundation was crystalized in the layout of the city and temples along rectilinear lines.

3.2 Transformation, resilience and expansion

The Etruscan city typically underwent a process of transformation (Figure 8), increased resilience and expansion over the period 800 to 500 BC. The transformation had a considerable internal impact on the internal organization of the city. As far as the limited open area excavations allow us to interpret, the heterarchical village structure mirrored by oval huts in clusters across the settlement plateau was gradually formalized into a more rectilinear format (Figure 9) (Brandt and Karlsson, 2001; Miller, 2017; Bruder, 2022). This process appears to have been anticipated by the internal organization of the city, and

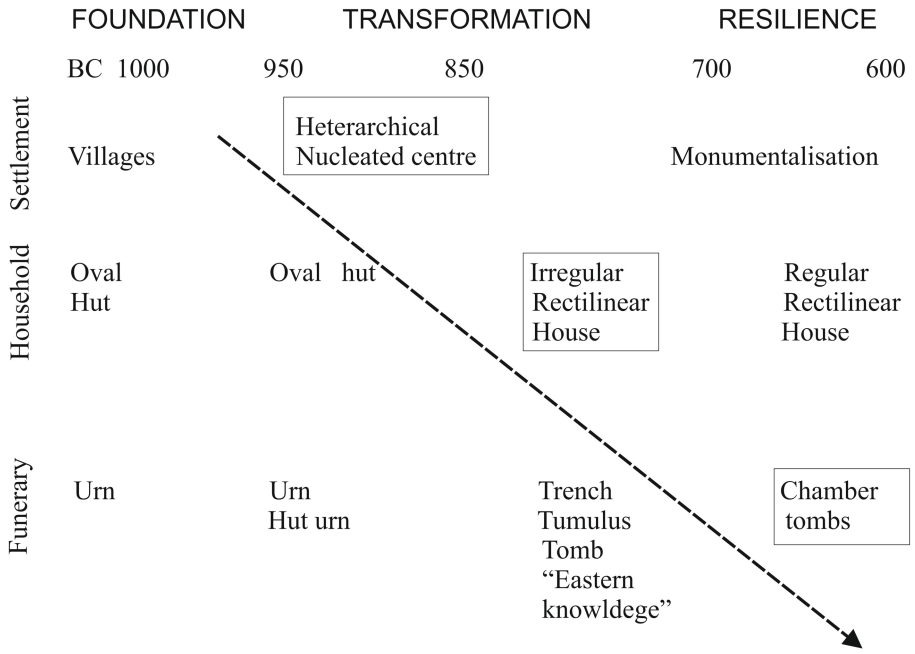

FIGURE 8
Internal transformation of the nucleated center, giving a setting according to the theoretical model of Figure 1. Source: Simon Stoddart.

then followed in sequence by the individual component parts (the household buildings) and finally the places of burial, which alluded to earlier memories. The layout of rural buildings subsequently followed the same trends (Malone et al., 2014).

Further excavation is needed in the domestic areas of the city, as opposed to the ritual zones, to substantiate this model of development. Additionally, the limited application of archeological soil and sediment micromorphology, along with other micro-analytical techniques (e.g., μFTIR and μXRF) (e.g., Brönnimann et al., 2020; Karkanas and Van de Moortel, 2014; Nicosia et al., 2022), hinders the precise reconstruction of changing human behaviours and spatial usage within settlement areas. The nature of the foundation and transformation processes, particularly in terms of continuity and change within the archeological sedimentary record, largely remains to be investigated. At present, we only have a detailed understanding the transformation of the places of burial into formalized structures that increasingly represented the descent group through time, supported by social genealogies of inscriptions (Figure 2), which occur in most of the cities, but perhaps have been most clearly illustrated by the urban cemetery of the Crocefisso del Tufo at Orvieto. Here the urban layout is very clear, and each tomb of a descent group is clearly indicated by the family inscription over the door (Bizzarri, 1962, 1966).

The transformation of the countryside was equally evident (Figure 10). Whereas the foundation of the nucleation had led to substantial clearance of the countryside, the period's transformation and resilience led to a reoccupation of the countryside with rural settlement. The most dramatic effects can be registered in the coastal southern cities, particularly where these coincide with substantial survey activity. The prime example is that of Cerveteri whose eastern territory has been extensively surveyed (Cerveteri, 1993; Enei, 2001) and subsequently assessed in a systematic comparative manner (Zeviani, 2023). The peak of occupation appears generally to have occurred in the sixth century BC, substantially adding to the resilience of the city by establishing a network of smaller productive agricultural sites in its territory, and then retracted in the following period, before expanding again in the period (not illustrated here) before Roman incorporation. This contrasts with Chiusi (Figure 11) where a more distributed organization of the landscape was achieved. The outcome was generally a strikingly primate organization of the landscape, where the largest center dominated its surrounding countryside (Figure 12).

3.3 Dissolution

The level of dissolution of the Etruscan was highly variable. Some cities such as Veii were subjected to much discussion in the Roman sources (especially Livy) as subject to a veritable dismantling by military means. Others such as Tarquinia definitely had a decline, but can be defined by a much gentler transition. Furthermore, northern cities such as Arezzo were incorporated into the Roman system, become part of major ceramic production that is very visible in the archeological record. Terrenato (2019)'s argument is very telling that the Roman strategy was as much persuasion as coercion, operating crucially within the institution of the descent group, that residual heterarchy, which could be peeled off from any centralizing forces of the nucleation. The Roman strategy depended on many factors, including the degree of centralized nucleation by each center.

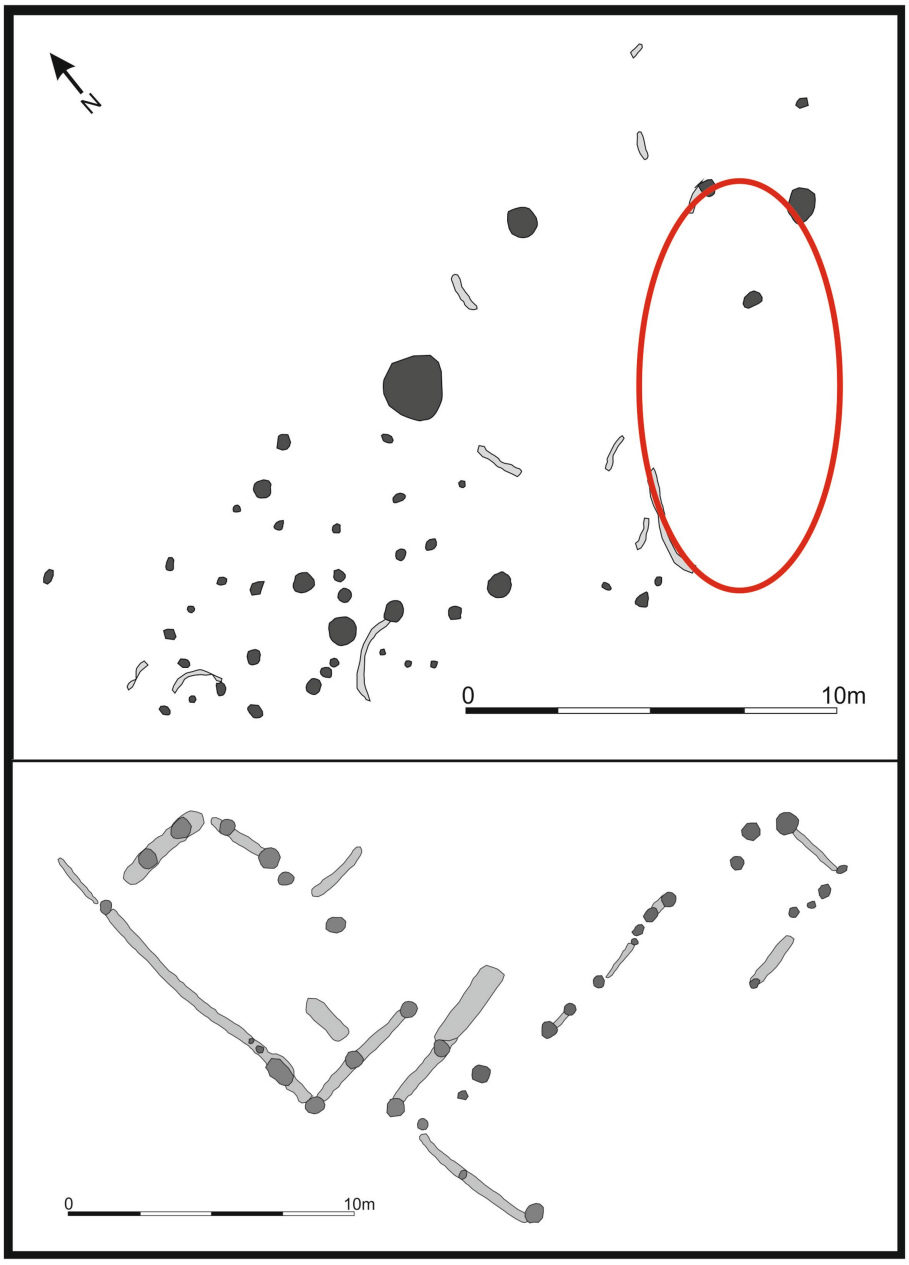

FIGURE 9
Structural transformation within the nucleated center of Veii. Above: Nucleation. Below Consolidation. After Tabolli and Cerasuolo (2019). Source: Simon Stoddart.

4 Resilience

4.1 Ritual

The historiographical traditions of Etruscan research have uncovered ritual structures in almost all the major Etruscan cities. The cities of Tarquinia (already discussed) and Veii provide the paramount examples. However, all the major Etruscan cities have ritual deposits that became more formalized and ritualized in the course of time. Orvieto is an interesting example because the well-defined plateau has a substantial number of temples, that suggest a continued point of reference to the original constituent parts of the original nucleation. Perugia on the eastern frontier has rather later deposits that only in the course of time became more formalized and focal to the community. These relatively well understood data suggest that the process of ritualization had a degree of spatial differentiation, ranging from early developments in the "glocalized" coastal cities to the later more heterarchical patterns within the inland nucleations, mirroring the patterns of territorial control by the same nucleations.

Sanctuaries (and the temples contained within them; Figure 7A) are traditionally considered the key institutions in the Etruscan community, "a social nexus … a place for meeting and social competition" (Becker, 2008, p. 87) and redistribution (Becker, 2008,

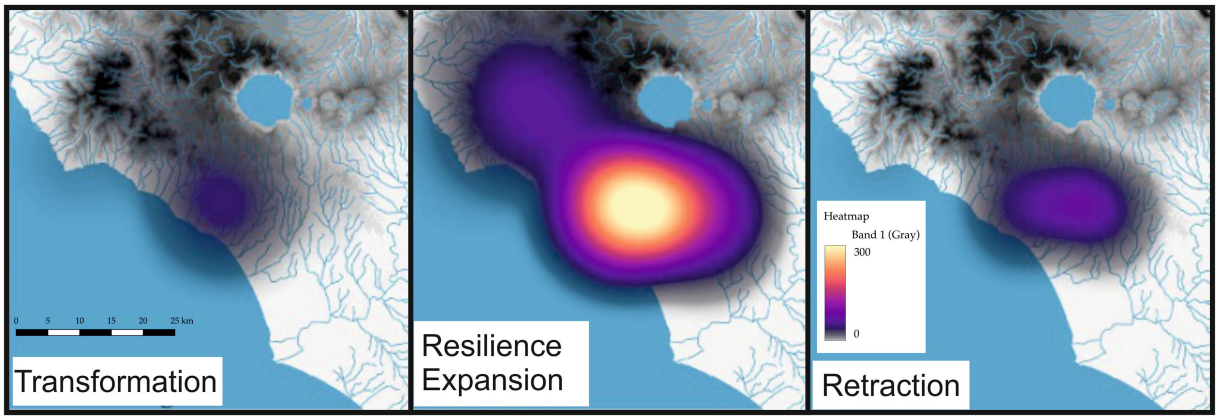

FIGURE 10
Changes in the countryside around Cerveteri (Zeviani, 2023), giving a setting according to the theoretical model of Figure 1.

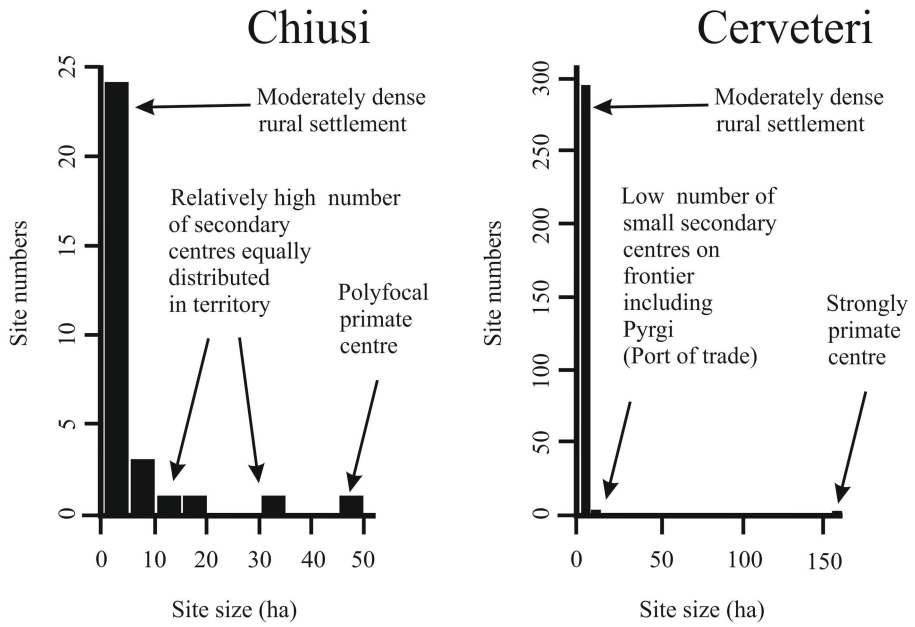

FIGURE 11
The contrasting distribution of settlement size between Chiusi and Cerveteri. Stoddart (2020a) interprets the size of Chiusi from its polyfocal format, reducing some estimates of the nucleated center's size.

p. 97). Study of these reveals the prominence of leading members of descent groups (particularly men) in making dedications, thus emphasizing the continuing heterarchical nature of decision making (cf. Jannot, 2005, p. 82), within an institutional framework. Dedications by the community itself are more difficult to establish although they have been inferred by drawing on Greek parallels, a dangerous comparison within a different cultural milieu. In the later periods, it is very probable that there was an over-arching ritual institutional framework (Tagliamonte, 2017, pp. 134–136), plausibly coordinated from the Fanum Voltumnae, that has been located (and excavated (Stopponi, 2011)) near Orvieto, in a geopolitically rational point in Etruria.

4.2 Subsistence

A major precondition for the nucleation processes is resilient farming systems endowed with the capacity to support not only the growing demographics, but also the emerging sector of non-agricultural specialists (trade, seafaring, metallurgy, pottery, architecture, etc.) that became a defining factor for Etruscan urbanism.

In spite of the largely later iconographic and material evidence from Etruscan tombs, which intimate high levels of meat consumption, isotopic investigations are beginning to outline a more nuanced picture of past domestic consumption. The isotopic

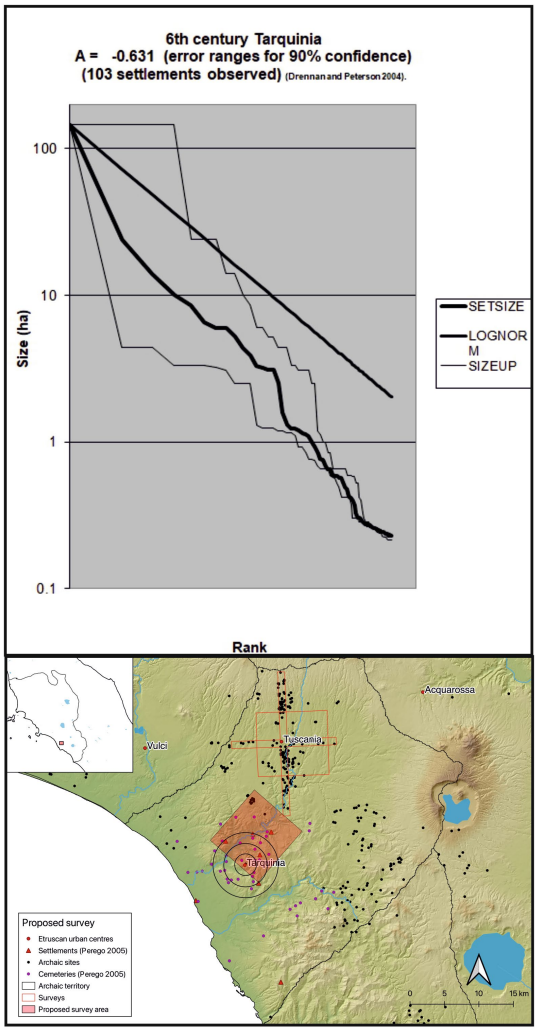

FIGURE 12
Tarquinia. Rank size distribution and spatial distribution. Above: Rank size of sites where size can be calculated drawing on Stoddart (2020a) and Zeviani (2023). Below: Rural data from Zeviani (2023).

data at Fermo (Esposito et al., 2023) and Pontecagnano (Riccomi et al., 2024) – two Villanovan/Etruscan sites located outside the main Etruscan territory of central Italy – revealed that individuals had a relatively homogenous diet, consuming C3 plants, with limited intake of animal proteins and no, or negligible, marine food consumption. At Pontecagnano, millet was contributing to the maternal diet and breastfeeding, as well as supplementing infants and children's diets. By contrast, six individuals from Tarquinia (Bagnasco et al., 2024) – despite the very small sample number and allowing for their likely deviant status – had a wide range of diets from terrestrial to marine, often with a predominance of plant-based foods contributing to the terrestrial portion.

As in most agrarian societies, crop husbandry was the principal provider of human sustenance, but, despite its fundamental role, the direct archaeobotanical evidence for farming is still underrepresented in discussions of Etruscan urban formation and systematic recovery of plant remains is not commonly applied in fieldwork (Shriver-Rice and Schmidt, 2022). The study of late second millennium and early first millennium BC animal husbandry has been more developed (De Grossi Mazzorin, 2001; Minniti, 2012; Trentacoste and Lodwick, 2023; Stoddart, 2024). For this reason, we can perhaps give a greater statement of trends in animal as compared with crop husbandry. Evidence for the nature of marine resource exploitation is sparse as a consequence of a lack of systematic flotation, but where present, fish exploitation appears largely locally orientated, with fish consumption also conditioned by local food traditions (Russ and Trentacoste, 2021).

Animal rearing appears to transition to an economy more focused on secondary products, pig rearing and later chicken, as urban forms of production took hold (Trentacoste, 2020), and emphasis on pig production greatly intensified in the Roman period (De Grossi Mazzorin and Minniti, 2023). This process, however, was not linear or wholesale (e.g., Moses, 2020). In terms of the ecology of animal grazing, pilot isotopic work demonstrated inter-site differences in livestock herding strategies, which were argued to reflect the impact of distinct socio-economic contexts on land use and mobility (Trentacoste et al., 2020). Such work raises questions on the organization of late pre- and proto-historic animal herding patterns and mobility and how they intersect with collective action through the use and management of common grazing areas (Kanne et al., 2024; Haughton and Løvschal, 2023). Common grazing lands have been suggested for prehistoric northern Europe (Haughton and Løvschal, 2023), and the existence of such areas is to be inferred in the traditional view of the central Italian Bronze Age as a predominantly 'pastoral' society, in which the economy and community interaction were centered on seasonal transhumance (Puglisi, 1959). Bronze Age transhumance remains accepted in the literature, based on similarities between ceramic styles been suggested summer and winter zones (e.g., Barker, 1981; Cavazzuti and Putzolo, 2015). In this interpretation, the role of peripheral heathlands in northern Europe may be analogue to Apennine and Sub-Apennine uplands, with the funerary barrows of northern Europe functioning similarly to 'Opferplätze' (e.g., Malone and Stoddart, 1994), matching the large cultural zones of inland Chiusi-Umbria area on the one hand and the Tolfa Allumiere zone on the other (Zanini, 2012).

Nucleation, and the more geopolitical and territorial approach that accompanied it, would be expected to have significant impacts on rights-of-way and access to natural resources that underpin herding systems. Assuming relatively free movement in the later Bronze Age, as proposed in traditional models, the capacity to achieve relatively long-distance mobility would potentially be interrupted by the political concerns of competing nucleated centers. Recent work, however, has begun to challenge the ubiquity of long-distance Apennine transhumance, and instead had emphasized more locally and regionally focused forms of management (Trentacoste et al., 2020; Trentacoste et al., 2023). If fairly locally constrained, nucleation and control over a larger territory may have allowed larger centers to negotiate more distant upland grazing, or at least draw animal capital from a wider radius (Trentacoste et al., 2021). In the subsequent Roman period, this negotiation would have become much more achievable, if political and economic frictions on mobility were eased (Trentacoste et al., 2021).

Macrobotanical remains have so far been collected from over twenty Etruscan sites, although with strong variation in the quality of recovery and consequently also the interpretative strength of the data. Figure 13 summarizes the occurrence of cereals and pulses on sites that have produced relevant evidence.

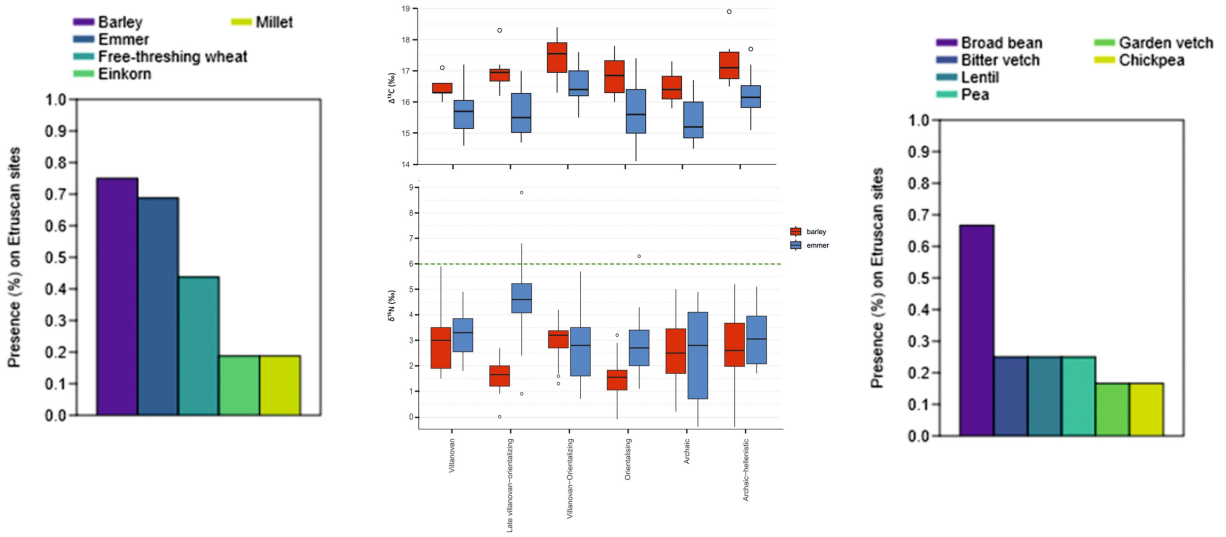

FIGURE 13
The evidence for plant agriculture in Etruria. From left to right: Percentage presence of cereals on sampled Etruscan sites; isotope values in cereals from Tarquinia (carbon (above) and nitrogen (below)); and percentage presence of legumes on sampled Etruscan sites. Source: Carbonised plant remains - Schmidt (2025); isotopes- Fanny Gaveriaux.

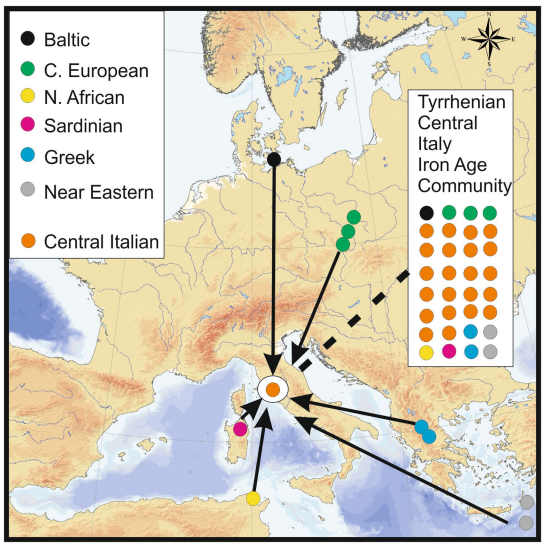

FIGURE 14
aDNA evidence for nucleation, showing the principally Italian genetics of the central Italian population After Moots et al. (2023) with additions. Source: Simon Stoddart.

The choice of staple crops seems to have drawn on long experiences of the local landscape, minimizing risk and seeking resilience. A consistent focus on emmer, barley, and broad bean is discernible, which broadly continues a trend observable on the Italian peninsula at least since the Bronze Age (Motta and Beydler, 2021). These three staples are supplemented by a diverse range of secondary domesticates, which collectively do not, though, seem to have had a major impact on subsistence.

At Tarquinia the recent application of systematic sampling for the retrieval of archaeobotanical material and of isotopic analysis on cereal grains has been crucial to test the resilience of the nucleation process. Tens of thousands of crop remains have allowed, for the first time, more delicate insights into the organization of cereal farming between the ninth and sixth century BC. The isotopic work in combination with functional ecology of the weedy flora shows that the input from manuring, irrigation, and other forms of intensive management practices on cultivation remained low-key throughout these centuries. Nitrogen and carbon isotopic analysis on emmer and barley indicates that they were likely cultivated in similar environmental conditions. Furthermore, the data do not show any notable variation over time, suggesting that cultivation practices and environmental factors remained relatively consistent throughout the period of initial nucleation and its maintenance (Figure 13). It is remarkable that similar low input agricultural practices during the nucleation phase have been identified also at Gabii, a Latin settlement east of Rome and the only other site in the region where systematic sampling and isotopic analysis are an integral part of the research design (Gavériaux et al., 2024).

This cumulative evidence translates into a farming system in which the necessary yields and consequent resilience of the nucleated community were achieved via the extensification of agricultural land. Farming systems relying on extensification are observed across Eurasia as a key component in urbanization processes since they allow an increase in production with low labor input, once political protection of expanding arable land is in place (Bogaard et al., 2018; Styring et al., 2017).

The edaphic signal of the weeds from Tarquinia reveals a primary focus on the nearby floodplain of the Marta River during the period in question. Beyond providing a secure and sustainable environment, the landform has a spatially limited extent around the immediate site catchment and would further have fueled the need to reinforce influences on the wider landscape under periods of demographic growth.

From the fifth century BC and onwards, when the formation of the city consolidated with more centralized institutions, archaeobotanical evidence becomes diffuse, but isotopic signals from cereals imply that farming regimes based on low input continued to remain the modus operandi, most likely coupled with more intertwined supply networks from rural production that is mediated through subsidiary centers in the hinterlands of Tarquinia's territory (Zeviani et al., 2025).

Arboriculture became another important aspect of Etruscan farming economies, especially regarding the Mediterranean staples vines, olives, and perhaps figs. Intensity and practices are less visible in the archaeobotanical record, but, at least in the case of vine, dispersal rates of Etruscan amphora show that by the sixth century BC productional scales were reached that facilitated systematic export outside Etruria (Perkins, 2012; Dodd, 2022). Additionally, by this time, a range of native wild trees may have become subject to more formal management, possibly even cultivation, and including taxa such as hazel, pines, and cornelian cherry.

Beyond diversifying farming systems and enabling the exploitation of new landscapes, intensive arboriculture has shown to be closely linked to urbanization processes, as resilient territoriality and its political protection is required for these long-living and immobile crops, that in turn provide resources with high return rates when integrated into exchange networks (Fuller and Stevens, 2019; Gilman, 1981). More centralized institutions, beyond the descent group, may have been required to achieve these ends.

The combined data highlight how the provision of the consolidating cities became increasingly dependent on renegotiating the wider landscape. Whereas village societies of the Bronze Age principally managed to be sustained by their immediate surroundings and were considerably more mobile because of their focus on annual crops, the nucleated sites were not only gradually exceeding their local capacity, but also increasingly invested in perennials whose productivity required transgenerational stability. The outcome is a hierarchized and politicized landscape in which the nucleus remains the stable seat of power, with the accompanying institution. Tarquinia is a prime example of such a nucleus where we can now more closely reproduce the agricultural forces behind expansion. Here influences follow the Marta River which provided both arable land and communication routes, and in the further hinterlands power eventually was fanned out along the dendritic river catchment where subsidiary centers on fertile volcanic soils likely became crucial agents in supplies of the city.

4.3 Impact on the landscape

The nucleated centers occupied a varied natural landscape, although some suggest that central Italy was favored by wetter conditions within a more broadly dry landscape in the Mediterranean at c. 1000 BC (Finné et al., 2019). The southern and larger nucleated cities of the south generally occupied a volcanic landscape, with rich potential for agricultural production, perennial access to water, good sources of clays for ceramics and architectural enhancement, woodland for fuel and mineral extraction. The northern and inland cities were often situated in zones of more easily eroded sedimentary deposits, bordered by substantial tectonic valleys. Combined with distance from the "glocalized" Mediterranean, these factors had a profound effect on the background and even intensity of nucleation.

The level of understanding of the impact on the landscape is relatively limited at this stage after a strong start in the 1960s (Judson, 1963, 1968; Alvarez, 1972; Cherkauer, 1976; Shriver-Rice et al., 2025). The high level of erosion from Roman times onwards has tended to shroud the earlier alluvial deposits (Brown and Ellis, 1995; Stoddart and Malone, 2022; Barker et al., 2023). The deposits are also rather difficult to date, since many of the ceramics and even radiocarbon can be substantially residual and therefore not precisely linked to the processes under study. These are long-standing challenges in the context of alluvial valleys across the Italian Peninsula (e.g., Hunt, 1995) that have led to preliminary assessments indicating that the destabilization of the landscape was not as serious as in later periods. However, no explicit project has trenched sufficiently deeply to reach any possible deep alluvial deposits, except possibly in some of the river valleys, or focused on different kinds of sedimentary archives. Such alternatives include the understanding of the soil evolution across the nucleated plateau as influenced by the aggregation and disaggregation episodes, linked with localized evidence of landscape transformation as indicated by slope deposits. These local archives could also curb the difficulties of assessing the level of damage to the landscape by the level of agriculture already outlined and disentangling anthropic influence from that of climate and base-level adjustments in fluvial records (Butzer, 2005; Fuchs, 2007; Wolf and Faust, 2015).

However, dynamic systems like soils, buried or not, and slope materials present important dating challenges, although the use of Optically Stimulated Luminescence (OSL) techniques can overcome the mobility, residuality, and calibration issues of radiocarbon dating. While this has only been used to a very limited extent in central Italy (Barker et al., 2023), recent work is pointing to landscape impacts as early as the late sixth century BC in both the Tiber delta and low-lying parts of Rome (Brock et al., 2021; Brock et al., 2025; D'Orefice et al., 2022). Furthermore, in the lower reaches of the Albegna valley, OSL dating and pollen analysis have been combined to produce greater detail of potential human impact on the lower reaches of the riverine systems that were clearly so important for Etruscan agricultural systems (D'Orefice et al., 2022).

The broader understanding is supported by the generalized studies of vegetational change for the central Italian area (Stoddart et al., 2019). This multi-proxy evidence, but mainly based on pollen, once again indicates no clear correlation between the presence of rural settlement and the removal of vegetation beyond what had already been removed in earlier periods. However, once again, the evidence is relatively tenuous, because only one pollen core at Lago dell'Accesa is placed in the near proximity of a settlement (Drescher-Schneider et al., 2007). Pollen samples taken from two farms at Val Petraia and Pian d'Alma, from furnaces for iron ore reduction at Rondelli, from a necropolis at Populonia (Lippi et al., 2000; Sadori et al., 2010) when combined with Late Etruscan evidence of charcoal and seeds/fruits (Di Pasquale, 2003; Buonincontri et al., 2013) showed that, during the Etruscan period, the immediate environs of sites had some clearance. The recent analysis of a well in the Chianti area suggests clearance of the oak forest on a substantial basis only in the late Etruscan period (Mariotti Lippi et al., 2020). The study of a *domus* of similar late Etruscan date from Vetulonia shows the exploitation of a wide range

of woods, both local and more distant from Monte Amiata, but it is difficult to assess the impact on local vegetation (Coradeschi et al., 2021).

The Roman expansion brought a much more intense utilization of the landscape that can be measured along a wide range of dimensions (Stoddart et al., 2019). These include the drainage and reorganization of the landscape (de Haas, 2017), even if this approach had started in selective regions such as around Veii at an earlier stage in the Etruscan period (Judson and Kahane, 1963; Bergamini, 1991).

5 Interaction from a material and biological perspective

The material evidence of the interaction of Etruscan communities has been studied in very great detail, filling many of the museums of the Western world. It is a piece of evidence closely linked to the production, consumption and display of pottery and metalwork in tombs and sanctuaries. It would be a disservice to this great cultural tradition to try to summarize the evidence here. By contrast, the bioarcheology of urbanism (Betsinger and DeWitte, 2020) is a developing field which is beginning to have its impact on our understanding of Etruscan nucleated centers in two principal areas: mobility and diversity.

5.1 Mobility

It is generally accepted from studies of more modern times (Wrigley, 1967; Stoddart et al. in preparation) that nucleation (and indeed urbanism) required a constant supply of population, not only to provide the original concentration of population, but also to retain population numbers, in the face of low fertility, disease and even emigration. In spite of major differences in the characterization of urban life in the classical past, and amongst the Etruscans in particular, similar factors are assumed to have operated. Through the application of isotope and aDNA analysis, even if plagued by small sample size, difficulties of chronology and the complications of differential funerary practice (notably cremation vs. inhumation), it is beginning to be possible to differentiate between different scales of mobility. The employment of multi proxy approaches on larger sample sizes is the way forward, providing not only an ancestral "stratigraphy," but also movement in different stages of the life course.

5.2 The genetics of diversity

Recent research on the genetics of nucleation has made major strides at both a macro and micro level. The work has moved on from the study of modern populations of humans (Achilli et al., 2007) and animals (Pellecchia et al., 2007) in the pursuit of *Ancient Origins*, without chronological control, toward a more detailed and precise analysis of ancient DNA. A half-way house is provided by the comparison of ancient mitochondrial DNA from human remains and that of modern populations, implemented in this way because of the early state of the art and the lack of large sample sizes (Vernesi et al., 2004; Ghirotto et al., 2013). The first study engaged with 17 samples from the core Etruscan area between the Arno and the Tiber, and was able to define, within the limits of the available date, that the samples studied were a coherent biological population, showing a characteristic mitochondrial diversity for the region over time. The same data were employed for a more detailed study of the relationship between ancient and modern populations (Malyarchuk and Rogozin, 2004). The second study which shows a mixed picture where the Casentino, a well-defined mountain tectonic valley, illustrates the best case for continuity of female descent, even if this valley had a less distinct Etruscan identity in the past. Other areas of Tuscany presenting increasing degrees of later mobility which led to population replacement. A third mitochondrial study investigated the Umbrian area, displaying the high degree of variation (Modi et al., 2020), that one might expect from an area that was less distinctive both culturally and in terms of the processes of nucleation, contra the textual sources which emphasize the ancient character of the Umbrians as a distinct entity rather than a residual category (Stoddart and Redhouse, 2014). Larger scale aDNA studies carried out over the last decade have shown that mitochondrial haplogroups are diverse within Iron Age Italy, and within populations from different regions and material cultures. Mitochondrial haplogroup profiles do not seem to distinguish between individuals from different Italic archeological contexts, nor to rule out continuity between Iron Age populations and modern populations (Posth et al., 2021; Ravasini et al., 2024; Antonio et al., 2019; Bagnasco et al., 2024).

In these early studies, and indeed in many later studies, the full collaboration between archeologists and geneticists appears to be largely missing. There is a preoccupation with the issue of origins, drawn from early archeological literature and debates in the written sources, which does not have such a sound characterization for anthropological archeology. The Vernesi study contained just one bioarchaeologist accustomed to studying archeological material, and cited relatively generic archeological sources. The Ghirotto team contained no archeologists and cited generic archeological sources. It is essential that the archeological and genetic context are considered in equal measure and that questions are posed from both disciplinary perspectives. More recent analyses tend to have many more details of the archeological context (especially in the supplementary materials where individual samples can usually be identified alongside chronological and cultural data) supported by a wider archeological authorship, which allows a much deeper interpretation at multiple scales of analysis (e.g., Posth et al., 2021).

In a number of aDNA studies from mainland Italy and Sicily the presence of Bronze Age Steppe-related ancestry has been confirmed by the end of the third millennium BC, though the proportion of this ancestry is very heterogenous between individuals (Fernandes et al., 2020; Saupe et al., 2021; Moots et al., 2023). These newly sequenced individuals also demonstrate a shift in Y-chromosome lineages, with the appearance of R1b-M269 derived haplogroups, though the Y-chromosome haplogroups more common in the Neolithic do not disappear entirely. Beginning with the first large-scale aDNA study of Italy in Antonio et al., 2019, a marked increase in genetic heterogeneity in populations is noted, starting in the Iron Age. A number of Iron Age individuals have been found across a range of archeological contexts who carry ancestry similar to individuals from regions outside Italy, including the Baltic Sea region, Central Europe, North Africa, and the east Mediterranean (Bagnasco et al., 2024; Antonio et al., 2019; Antonio et al., 2024; Posth et al., 2021), as would be consistent with the increased biological interaction of urban societies (Nalls et al., 2009), engaged in the process of nucleation

(Antonio et al., 2019, Supplementary Figure S6). Larger, that is nucleated, populations have fewer, shorter runs of homozygosity (ROH), whereas isolated or bottlenecked populations have more, somewhat longer ROH (Ceballos et al., 2018), although this needs to be thoroughly checked with larger sample sizes. The Posth et al., 2021 study from a small sample of 14 individuals securely dated to before 500 BC, nevertheless suggests the essential coherence of the genetic group at this time, with a broadly Italian ancestry, with the exception of one individual with a central European ancestry.

Micro-analysis has shown the coherence of descent groups demonstrating the biological reinforcement of family identity through time. An analysis of one of the tomb groups in the Monterozzi cemetery at Tarquinia demonstrated, as expected, that some members were related through the female line (Cappellini et al., 2003, 2004) using mitochondrial DNA. The Posth et al., 2021 work is a longitudinal population study across 2000 years of history. It is mainly a population study, but at the late Etruscan site of Casenovole recent, but disturbed, excavations uncovered family groups within family tombs, composed of four individuals with first- or second-degree relationships, where one had central European ancestry. A collection of skulls from the nineteenth century preserved in Leipzig from Tarquinia (most probably Monterozzi) equally demonstrated two clusters of three skulls with first and second degree family relationships between the out of context cranial fragments, dating to the Late Etruscan period. Unsurprisingly, the different sampling strategy of Antonio et al., 2019, which was more substantially a population study, discovered no close kin relations between the small numbers of individuals sampled from each site. The work of Moots et al., 2023, Antonio et al., 2024, combined with more recent contributions (Bagnasco et al., 2024; Ravasini et al., 2024), has established that the first millennium BC was a period of relative genetic stability, where the majority of sequenced individuals have a broad Italian genetic affinity (Figure 14), whereas the remaining 10 have a wide range of genetic affinities from the Baltic, central Europe, Sardinia, North Africa, Greece and the Middle East. It would be dangerous extrapolate from these 32 the proportion of individuals with a more distant ancestry, but it does indicate that as many as c. 30% may have been more mobile ancestrally than the majority of the nucleated community.

Our recent work brought six of these individuals into consideration (Bagnasco et al., 2024), and we suggest that our detailed approach focused on precise archeological contexts is the way forward. Ghirotto et al. (2013, p. 1) claim that early Iron Age burials were entirely cremated. Even if most early Iron Age burials were indeed cremated, this is, in fact, not always the case and our recent study has taken advantage of this fact. These, unlike most of the other samples investigated have a very precise stratigraphic provenance, excavated under good modern conditions. Most importantly, they are inhumations with the precious petrous bone present, allowing multi-facetted approach. We need to remain cautious about the implications of these results, because they formed part of a special place for burial that so far only consists of 20 inhumations from the main Etruscan phase of the city stretched over most of its chronological range, but concentrated in its early part, and thus may not be representative of the full nucleated community.

The six skeletons studied by our team have nevertheless permitted both a micro study and a macro study, with an interdependence between the two, assisted not just by ancient DNA on five but also by a range of other studies including palaeopathology, isotopes and radiocarbon dating on all six. The micro study shows that these are not closely related individuals, while the macro study indicates that at least one had a distant ancestral origin from the Baltic and the isotopes seem to confirm a probable mobile life course for the same individual and a second. At a population level, all the new individuals, but? one with a broadly Baltic ancestry, cluster with other first millennium BC individuals of central Italy, suggesting a coherent interacting nucleated population, that fits neatly into the broader patterns established by Moots et al. (2023) and Antonio et al. (2024), and included in the generalized pattern.

5.3 From genetics and isotopes to levels of mobility

Isotope analysis on human remains, for reconstructing diet and mobility, have involved various Villanovan and Etruscan sites within and outside the main Etruscan territory of central Italy (e.g., Cangemi, 2016; Esposito et al., 2023; Bagnasco et al., 2024; Riccomi et al., 2024) and many other contexts are under analysis[1].

Strontium isotope ratio $^{87}Sr/^{86}Sr$ analysis of individuals from the necropolis of Quattro Fontanili of Veii (Cangemi, 2016) – one of the largest Etruscan settlements located on a plateau of 175 hectares – showed that between 15 and 20% of the analyzed individuals were non-local (Cangemi, 2016, p. 134). The site of Fermo (ninth-fifth century BC, Miranda and Esposito, 2021) exemplifies well the Villanovan expansion within the Italian peninsula (Miranda and Esposito, 2021; Miranda, 2022; Esposito, 2022; Pacciarelli, 2022). The site, located in the Marche region, is surrounded by typical Picene sites, characterized by different material cultures and funerary rituals (Naso, 2000; von Eles and Baldelli, 2017). $^{87}Sr/^{86}Sr$ isotope analysis by Esposito et al. (2023) showed the presence of 22.2% of non-local individuals. Archeological studies (Miranda, 2018; Esposito, 2022; Miranda, 2022; Miranda and Esposito, 2021) associated with osteological and isotope data (Esposito et al., 2023; Esposito, 2021; Esposito, 2023) have given more nuanced insight into patterns of human mobility at Fermo, limiting the idea of a cultural embodiment of Fermo by Picene groups. The presence of isotopically non-local individuals is indicated in the earliest phases of the necropolis (ninth-eighth century BC), whilst showing only isotopically local individuals in the latter phases (seventh-sixth century BC). The study of the six individuals buried in the sacred heart of Tarquinia demonstrated that two out of the six were isotopically non-local, a slightly higher percentage compared with the other sites. The general character of these specially buried individuals will be further clarified when comparing them with the other 14 inhumed skeletons buried at the monumental complex and the individuals from the vast majority of the community buried within the cemeteries surrounding the settlement.

By combining the current evidence from isotope analysis and aDNA, we can estimate a range of individual mobility from about 15/20% in some episodes of more distant communities to roughly 20% for the main body of a well-connected community, to levels of about 30% for more special individuals within a well-connected community. The term episode is key to this characterization, because future research needs not only to address larger samples, but also to

1 https://cordis.europa.eu/project/id/101065320

provide greater archeological insight and chronological control within the biography of the city in order to be able to compare the different realities that contributed to the urbanization of the Etruscan world. The use of multiple proxies such as archeological context (i.e., funerary data, grave goods, chronology), osteological data, multi-isotope (e.g., $\delta^{15}N$, $\delta^{13}C$, $\delta^{34}S$, $\delta^{18}O$, $^{87}Sr/^{86}Sr$) multi-tissues (e.g., tooth enamel sampling, incremental dentine sampling, bone sampling) analyses and aDNA for the reconstruction of the osteobiography and past identity (Blake, 2025) of ancient individuals will contribute increasing level of scalar and contextual sophistication. These approaches have the potential to reveal detailed information on the life-history of the individual analyzed and possible shift in lifestyle, while giving back a broader dataset for comparison. The combination of all these data will produce a more nuanced understanding of the human past, analyzing past dynamics from the perspective of the single individual, the community and, more broadly, on the Etruscan group, providing past narratives of great interest.

6 Political control

Early accounts of Etruscan nucleation suggested a series of equally spaced peer polities (Renfrew, 1975; Figure 5), and indeed the notionally 12 major nucleated centers did share similar characteristics of highly nucleated primate organization. However, more recent detailed research has uncovered the fact that Etruscan cities varied in their political control of their countryside. This has been extensively reported elsewhere (Stoddart, 2020a; Zeviani, 2023) and so we only give some indicative examples here. This variation was partly geopolitical and partly environmental. The coastal territory of the city of Tarquinia had both a dendritic structure and a stepped hierarchy. On the coast, a ritualized port of trade mediated with the Mediterranean. In turn, the primate city of Tarquinia mediated with the secondary centers in the hinterland. The immediate environs of Tarquinia were the lower courses of the Marta river, and contained largely calcareous outcrops, whereas the secondary centers, such as Tuscania, were set in a volcanic terrain. Frontiers of such a territory were not absolute, but do seem to have some meaning, often marked by natural features or cultural markers such as sanctuaries. To the north the territory was indicated by the Arrone river and to the south by the very substantial Tolfa hills, also marked by ritual sites such as the Punta della Vipera sanctuary. The city territory of Cerveteri, immediately to the south, was almost entirely volcanic and substantially hedged in by Tarquinia to the north and the expansive city territory of Veii to the East. This city territory of Veii was perhaps the most expansive nucleated center, most probably incorporating the smaller centers of the culturally differentiated Faliscan territory to the north, until it was itself the first Etruscan city to be incorporated in the axis of Rome.

Strategies of nucleation according to the geopolitical location and environmental context were not always sufficient to sustain control and there is some evidence that violence was another approach. The 20 skeletons discovered in the *complesso monumentale* of the Civita of Tarquinia seem all to have suffered some form of maltreatment close to, or at, the time of death. The fact that material symbols of power (axe, trumpet and shield) were deliberately buried in the same location suggests that sanctions of violence were also applied, corroborated by Latin textual and Etruscan visual evidence.

7 Conclusion

In this review article we have sought to assess critically the current trends and opportunities of the study of nucleation in central Italy, focusing principally on the Etruscan Tyrrhenian flank of the peninsula, but necessarily setting the pattern within a wider context. It is potentially an exciting moment, when a comprehensive approach will bring these neglected data sets into wider exposure. For some time, scholars have achieved a powerful cultural history, one that has often been a concealed proxy for the Greek world, seen through the museum cases of the western world. We now potentially have more powerful proxies of the very people whose life courses created nucleation and whose bodily remains were placed in the cemeteries that mainly surrounded their nucleated habitations. We propose an approach that combines the stimulation of comparative ethnography with the bedrock of the life and earth sciences to take the field forward. The use of ethnography is rarely employed in the context of classical archeology, because the ancient writers provide their own ethnohistories. However, we think it useful here that in the spirit illustrated by Henry Wright (2006) and Flannery and Marcus (2012), we can stimulate the sense of difference of the Etruscan ethnography, guided away from exotic narratives by multi-facetted scientific data.

The current article seeks to provide some of the data that allow comparison with other societies in terms of how institutions are formed and developed over the course of time (cf. Carballo and Feinman, 2023, pp. 65–69). The approach emphasizes the variability of the experiment of nucleation within the constraints of interacting centers. The practice of territorial management was varied, determined by the geopolitical location, the level of interaction, the size of the managed territory and the ecology of the surrounding landscape. The general pattern was longevity and sustainability (cf. Feinman et al., 2023) that has been compared elsewhere to Monte Alban in the Valley of Oaxaca as a product of collective action (Stoddart, 2010), but this was not an absolutely consistent pattern. In contrast to many Mesoamerican examples outside the Maya area, the overall landscape took the form of competing peer polities that survived together, until the system was interrupted by Rome. The seventh century BC was most probably a tipping point when the descent group, the institutional strategies of the first stages of nucleation, were replaced by more community-based strategies, albeit still tempered by the enduring importance of the self-same descent groups.

Author contributions

SS: Conceptualization, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing. EB: Investigation, Writing – review & editing. CE: Investigation, Writing – original draft, Writing – review & editing. GM: Investigation, Writing – original draft. FG: Investigation, Writing – review & editing. RM: Investigation, Writing – review & editing. LM: Investigation, Supervision, Writing – review & editing. OP: Investigation, Writing – review & editing. FS: Investigation, Writing – review & editing. CZ: Investigation, Writing – original draft.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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