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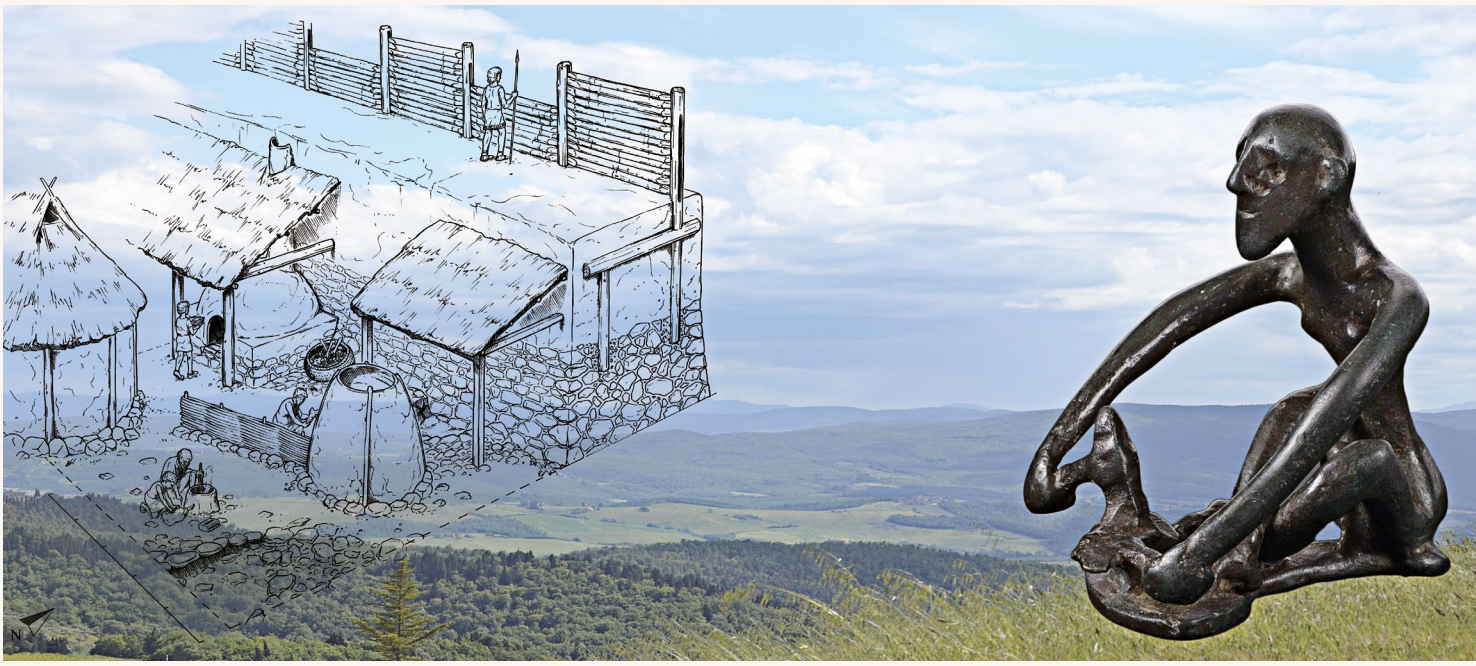

11

Organizations of Production and Crafts in Pre-Roman Italy

Panel 3.7

Nadin Burkhardt
Robinson Peter Krämer (Eds.)

Propylaeum
SPECIALIZED INFORMATION SERVICE CLASSICS

Proceedings of the
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PREFACE

On behalf of the 'Associazione Internazionale di Archeologia Classica (AIAC)' the 19th International Congress for Classical Archaeology took place in Cologne and Bonn from 22 to 26 May 2018. It was jointly organized by the two Archaeological Institutes of the Universities of Cologne and Bonn, and the primary theme of the congress was 'Archaeology and Economy in the Ancient World'. In fact, economic aspects permeate all areas of public and private life in ancient societies, whether in urban development, religion, art, housing, or in death.

Research on ancient economies has long played a significant role in ancient history. Increasingly in the last decades, awareness has grown in archaeology that the material culture of ancient societies offers excellent opportunities for studying the structure, performance, and dynamics of ancient economic systems and economic processes. Therefore, the main objective of this congress was to understand economy as a central element of classical societies and to analyze its interaction with ecological, political, social, religious, and cultural factors. The theme of the congress was addressed to all disciplines that deal with the Greco-Roman civilization and their neighbouring cultures from the Aegean Bronze Age to the end of Late Antiquity.

The participation of more than 1.200 scholars from more than 40 countries demonstrates the great response to the topic of the congress. Altogether, more than 900 papers in 128 panels were presented, as were more than 110 posters. The publication of the congress is in two stages: larger panels are initially presented as independent volumes, such as this publication. Finally, at the end of the editing process, all contributions will be published in a joint conference volume.

We would like to take this opportunity to thank all participants and helpers of the congress who made it such a great success. Its realization would not have been possible without the generous support of many institutions, whom we would like to thank once again: the Universities of Bonn and Cologne, the Archaeological Society of Cologne, the Archaeology Foundation of Cologne, the Gerda Henkel Foundation, the Fritz Thyssen Foundation, the Sal. Oppenheim Foundation, the German Research Foundation (DFG), the German Academic Exchange Service (DAAD), the Romano-Germanic Museum Cologne and the LVR-LandesMuseum Bonn. Finally, our thanks go to all colleagues and panel organizers who were involved in the editing and printing process.

Bonn/Cologne, in August 2019

Martin Bentz & Michael Heinzelmann

Organizations of Production and Crafts in Pre-Roman Italy: An Introduction

Nadin Burkhardt – Robinson Peter Krämer

Ancient economies and economic systems of the Mediterranean basin – ranging from small households to entire world systems – have been studied quite profoundly by classical archaeologists, ancient historians and prehistorians. The 19th International Congress of Classical Archaeology of the AIAC in Cologne and Bonn has shown the importance of the economy in current research and the broad range of topics and approaches involved in reconstructing ancient economies.

While economic approaches are generally becoming more important and even mainstream topics, this is not the case in research on pre-Roman Italy. Here, the term pre-Roman Italy refers to the area of the Italian Peninsula, Sicily and Sardinia during the Iron Age (from ca. 1000 BC onwards) before the 'Romanization' (the installation of a Roman territorial administration) and includes Etruscans, Italic cultures, as well as the 'Magna Graecia' (in the sense of indigenous populations and their colonial encounters with the Greeks). Until now, research on pre-Roman Italy has not focused a lot on economy and if so, mostly in very specific contexts:

- the specialization of crafts and production as well as the division of labor in this context and as an indicator of urbanization processes,[1]
- specific forms of production, such as agriculture,[2] metal processing,[3] and salt production,[4]
- Greek Colonies and Greek Colonial encounters with Indigenous populations,[5]
- and consumption patterns, often the consumption of Greek pottery.[6]

However, some (mostly recently published) general investigations and overviews exist and may lead to a rise in attention to economies in pre-Roman Italy.[7] Due to this situation, four members of the study community 'Etruscans and Italic Cultures' of the 'German Association of Archaeologists' (Arbeitsgemeinschaft 'Etrusker und Italiker' des Deutschen Archäologenverbandes)[8] formed this panel to discuss aspects of the economy of pre-Roman Italy on the basis of their projects and work.

We chose our topic, because recent excavations and investigations in the field of workshop structures, such as at Gabii,[9] Pithekoussai,[10] Kroton,[11] Lokroi Epizephyrioi,[12] Naxos,[13] Selinunt[14] and Kyme-Cumae,[15] have provided a range of new data that is stimulating a fruitful discussion on the organization of production and crafts in pre-Roman Italy. The publication of our panel therefore focuses on this particularly interesting and topical research topic.[16]

The aim of the following four articles is to contribute to an intensified debate on geographical, chronological and functional patterns in the organization of crafts and productions by discussing current case studies and methods:

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Robinson Peter Krämer analyzes the possibility of an Etruscan 'ritual economy' based on the archaeological evidence for organizations of production and crafts in Etruscan sanctuaries between the 8th and the 5th centuries BC. Ancient sanctuaries were important economic nexuses because of their storage function and religious services, contributions to the production of goods and function as market places and centres of knowledge and communication. Krämer discusses three economic activities: (1) metal processing, (2) textile production; and (3) trade and the standardization of weights. There is only scarce evidence of sacred embedded metalworking. In Satricum, Tarquinia and Gravisca clear traces of metal processing have been found. Krämer postulates a strong connection between the organization of metal processing in the city-state of Tarquinia and in the city-kingdoms of Cyprus. According to him, the ore of the Tolfa Mountains was worked and stored under sacred protection in the sanctuaries of the city-state of Tarquinia.

Context, spatial analyses and quantifications of typical tools for textile production may help to distinguish textile tool finds as parts of a sacred embedded production or as votive offerings. On this basis, textile production is very likely in the Etruscan sanctuaries of Caere, Ortaglia (Peccioli), Tarquinia, Veii and Poggio Colla (Vicchio) with a clear connection to female deities. Etruscan sanctuaries may have controlled specialist textile workshops. These workshops were attached to the sanctuaries and produced high quality textiles for ritual garments for statues and cult personnel, as well as for Etrusco-Italic linen books.

Scales and weights are rare finds in Etruscan sanctuaries, though a few have been excavated in Caere, Fucoli, Satricum and Tarquinia. Perhaps the weights functioned as a reference system in the city-states. Krämer postulates that these Archaic sanctuaries may have had a key function regarding the calibration, standardization and internationalization of weight systems. The Fanum Foltumnae near Orvieto and the sanctuary of Sant'Omobono next to the Forum Boarium in Rome may have functioned as market places for local and regional trade.

Based on these case studies, Krämer reconstructs Etruscan sanctuaries of the 8th–5th centuries BC in the sense of a ritual economy as retainer workshops, which exhibited a high degree of organisation, embedding and centralisation, and were strongly controlled by sacred institutions.

Raffaella Da Vela focuses on ancient ergonomics. She considers the possibility of reconstructing the spatial analysis of ancient pottery productions within the methodical framework of ergonomics, the study of the design of physical work, especially components of the tangible workplace environment that comprise the working conditions of the labourer. Da Vela compiles parameters of ergonomic research in order to make the methods useful for comparative analyses of pre-Roman workshops. The parameters are tested in a case study of an Etruscan Archaic pottery workshop in Florence in the area of the Cinema Apollo in the Via Nazionale.

She analyzes the dimensions, the inner spatial organization, and the embedding of the workshop in its surroundings. A single kiln allows for the analysis of the coordination between design, size, service level, ventilation option and orientation of the kiln mouth and the minimisation of the immediate risk of injury and long-term health risk. The archaeological evidence from a workshop area grants insights into the workflow, the distances and the visibility of different working spaces and the ventilation options. The known surroundings of a workshop offer the possibility to prove the position in or in relation to the settlement, the distance to houses or other structures, to the raw material, and to the space of the distribution of the products, which Da Vela refers to as 'community ergonomics'.

Ergonomic approaches offer new potential for the study of production contexts. The ergonomic analysis provides a way of separating local peculiarities and common necessary conditions, and of observing the transfer of know-how in the pre-Roman world as well as in the Mediterranean basin.

Nadin Burkhardt argues that we cannot simply assume the existence of production quarters in the early period from the 8th to the 7th century BC. For the purpose of the argument, she presents the known archaeological remains and finds of the so-called metal working quarter of Mezzavia of Pithekoussai, the first Greek settlement in the west. Afterwards, Burkhardt compares these structures to similar and contemporary early production places in mainland Greece, such as Oropos, and in other western Greek settlements, such as Locroi Epizephyrioi, Megara Hyblaia, Naxos and Selinus. The article includes several different questions: How was such an early area of metal production constructed, and which functions were included? What can we learn about the structure of the working areas and about the use of space there? With what kind of urban structures and functions were such working places combined? Do the analysed settlements show a discernible development trend from the 7th to the 6th century BC?

The production sites of the 8th and 7th century were not permanent installations with their own building structure. In a way similar to the production of ceramic, the production of metals was part of the *oikos*. The position of the *oikos* with metal production indicates a specialisation of selected *oikoi*. The relatively small installations with up to three kilns were located inside the settlements as part of the habitation area or in direct connection to a dwelling. There were no metal production quarters as in later periods. In parallel to this model of production in familial workshop, larger specialized factories or a kind of workshop consortium developed in some Greek colonies during the 7th century BC.

Sophie Helas analyzes and reconstructs the location, the working conditions and the techniques used at a recently excavated early Iron Age metal workshop at Gabii, twenty kilometers east of Rome. This workshop has been excavated in the eastern part of the settlement, on the arx and directly behind the fortification wall of Gabii. The lack of slags and melting structures or traces of iron working lead Helas to interpret this workshop as a bronze foundry with two construction phases. The younger structures

can be dated by pottery sherds found in the collapsed remains of its superstructure to Latial period IIB–III, so the workshop was used in the 9th and in the early 8th century BC.

A circular kiln, set on a platform made of stone slaps, was installed in the first phase. In the 9th century BC, the fortification wall was erected and the kiln was now positioned directly against the rampart. In its second phase, the kiln was formed into a rectangular base with a dome, a tunnel-like stoking chamber and an air flue opposite it. It was a horizontal kiln with combustion channel and stoking chamber arranged in a row (downdraft kiln). Because of the high operating temperature of over 600° degrees Celsius and the lack of specific small finds attesting the production of ceramic vessels, Helas interprets the kiln having been used in the manufacture of casting models for metal production.

A casting pit in the shape of a semi-circular structure was installed to the east of the kiln, thus forming a kind of basin-like pit filled with fine sandy layer. It was set against the city wall and must have been part of the second phase of the workshop. A third installation was found directly to the south of the casting pit and has been interpreted as a drying chamber: A circular substructure formed a low platform of 2.5 m diameter; two long rows of stones were added at the western side. These parallel walls formed a kind of ventilation corridor and made the structure useable as a drying cabinet. She assumes that the freshly shaped terracotta moulds for the lost-wax technique of the casting may have been slowly and carefully dried there. That raw metals were melted here is indicated by a piece of fired clay with a hole for the nozzle of bellows. In the upper layers of the workshop, a fragment of a sandstone casting mould was found, originally made for five different objects. This shows that non-expendable mould casting and the so-called lost-wax casting technique were practiced in this workshop.

The four papers share the topic of the economy in pre-Roman Italy and show that a changed focus with its own framework of questions and methods might help to generate new results and perspectives. The close look at materials and structures of the archaeological remains, against the background of economic conditions, allow new interpretations. Our four case studies hopefully provide new insights that might stimulate a new discussion and new perspectives about economic systems in pre-Roman Italy.

Votive offerings and findings in ancient sanctuaries should not only be interpreted as components of rituals and cult actions, but may also be analyzed to answer broad economic and socio-political questions. A pottery workshop with kilns might represent ancient ergonomics and workplace environments. Early contexts of production and metal processing could be interpreted in the sense of urbanization developments and household/*oikos* organizations, rather than as anachronistic, specialized working quarters.

In this sense, it might be possible to generate guidelines or to show at least flexible patterns by means of examples and case studies. We hope that our examples lead to an intensified discussion about the economy in pre-Roman Italy and that the transfer of known patterns facilitates the analysis of hitherto less known or difficult to interpret contexts.

Notes

[1] Damgaard Andersen 1997; Nijboer 1997; Nijboer 1998; Nijboer 2004; Fulminante 2014.

[2] Cifani 2009

[3] Zifferero 2017; Nijboer 2018.

[4] Attema – Alessandri 2012.

[5] Donnellan et al. 2016; Zuchtriegel 2018.

[6] Reusser 2002; Bentz – Reusser 2004; Kistler 2014; Bonomi – Guggisberg 2015; Kistler et al. 2015.

[7] See for example: Nijboer 1998; Viglietti 2011; Cifani 2016; Becker 2017a; Becker 2017b; Becker 2017c; Nijboer 2017a; Nijboer 2017b.

[8] <https://darv.de/arbeits-gemeinschaften/etrusker-und-italiker/> (17.08.2019).

[9] Helas in this volume with further references.

[10] Burkhardt in this volume with further references.

[11] Marino et al. 2012; Marino et al. 2013.

[12] Meirano 2012.

[13] Lentini 2012.

[14] Bentz et al. 2016.

[15] D'Acunto 2009.

[16] For a general, current view at the topic, see: Bentz – Helms 2018.

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Was there an Etruscan Ritual Economy? Tracing the Organization of Production and Crafts in Etruscan Sanctuaries (8th–5th Centuries BC)[1]

Robinson Peter Krämer

In Classical Antiquity, sanctuaries and cult places were important economic nexuses and covered important economic fields, such as: (1) storage of commodities and resources, objects of value or money (*thesauroi*, in some cases even proper temple banks);[2] (2) religious services, e.g. healing, oracles, and sale of priesthoods; (3) land property and livestock;[3] (4) market places and harbors for long distance trade, especially as *emporia* or 'ports of trade');[4] (5) production of goods and crafts.

The terms 'ritual economy' or 'temple economy' (in analogy to the term 'palace economy') have been coined to describe these religious-economic functions, and have been studied quite profoundly in the context of the Ancient Greek world.[5] However, there is a still a lack of analyses for ritual economies in Etruscan sanctuaries, and the Etruscan religion.[6] This paper shall tackle important aspects of production and crafts, and offer a reconstruction regarding the organization of possible Etruscan ritual economies. I am going to discuss three economic activities before outlining some principles of the Etruscan ritual economy: (1) metal processing; (2) textile production; and (3) trade and the standardization of weights in sanctuaries.

Metal Processing

Metal processing is a significant craft to be discussed here since metal in itself had a high economic value and was frequently dedicated or hoarded in cult places. There are many sanctuaries in Greece known to have attested places for metal processing (e.g. Samos, Delphi, Olympia, Nemea, Kalapodi, Eretria and in Athens at the Hephaisteion and south of the Acropolis)[7]. However, there is only scarce evidence of sacred, embedded metalworking in the sanctuaries of Etruria and *Latium vetus*.

In Satricum, almost no metal finds are known from the settlement, while on the other hand a noticeable number of metal finds are attested for the northwestern necropolis and the sanctuary. The Archaic votive deposit I in the sanctuary contains so many metal objects among the numerous findings that it has been interpreted as a ceremonial metal hoard.[8] Slag finds on the Acropolis of Satricum are mainly concentrated in three locations in direct proximity to the sanctuary: thus it may be assumed that during the 8th–7th century BC high-quality objects of bronze and iron were processed under the supervision of a *princeps* or an exclusive elite in the sacred context. These objects were probably used in representative banquets, in the regional and Mediterranean gift exchange, as dedications in sanctuaries, and as burial gifts in rich tombs.[9]

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Very few cases of metalworking are known for cult places in Etruria during the 8th–5th centuries BC. Two of these examples can be found in the territory of Tarquinia: in the 'Monumental Complex' on the settlement plateau and in the *emporion* Gravisca. In the 'Monumental Complex' of Tarquinia, immediately north of the building β, the remains of a furnace that probably facilitated metallurgical activities are attested. 48 clay finds were made in the area, containing mostly gray internal colorations due to the high heat and contact with metal to which they had been subjected. These clay finds were identified by the excavators as parts of matrices. In a few cases, traces of bronze have also been found, so that the furnace of the 'Monumental Complex' can be interpreted as the remains of a bronze foundry. Some clay elements and 'matrices' seem to belong to the furnace itself, others to tools for bronze casting and further processing.[10]

Many furnaces, water basins, tools, slags, and traces of reddish colored earth indicate the performance of metallurgical activities on a large scale in the *emporion* of Gravisca between the first and third building phase around 580–480 BC. Metal and slag findings suggest the processing of iron, copper, bronze and lead, and at least partial reuse and smelting of metal objects, such as sheets, bars, fibulae, and even twelve iron ploughshares. Most furnaces were distributed in the eastern part of the sanctuary, right around the shrine of Aphrodite, the oldest temple in Gravisca. The connection between Aphrodite, the *Aphrodision*, and metal processing at Gravisca has existed since the foundation of this cult place, and is very noticeable: it reminds us directly of parallels with metalworking in Cyprus, the mythical birthplace of Aphrodite.[11] The *emporion* of Gravisca played an important role in the Archaic period not only in Mediterranean long distance-trade, but especially in the production and distribution of metal.[12]

Both Etruscan examples of metalworking in sacred contexts are from the city-state of Tarquinia. It seems plausible to assume that the ore came from the Tolfa Mountains in the hinterland of Tarquinia and was a crucial commodity under the control of the socio-political elites of the Orientalizing and Archaic period (similar to Satricum, see above). The many indications for metal processing in the *emporion* of Gravisca suggest that metal was an important main export good and economic factor for Tarquinia in the 6th century BC. The ore was mined in the Tolfa Mountains, possibly worked and stored under sacred protection in the sanctuary, and then sold to Ionian Greeks in the *emporion*. At the same time (from ca. 630 BC onwards), the Ionian *naukleroi* (traders) accessed the rich metal deposits in Tartessos on the southern Iberian Peninsula, and imported many kinds of resources from the entire Mediterranean to the Ionian city-states via a vast trading network.[13]

A very close parallel to this type of organization applied to metallurgical activities may be found in Cyprus, where large quantities of copper were mined and traded in ports to the Mediterranean. There is an intense debate concerning the scale and function of possible metal manufacture in Cypriot sanctuaries, but scholars tend to reconstruct the organization of at least some metallurgical activities from the late Bronze Age (at least since the 12th century BC) until the end of the city-kingdoms as "the 'triptych'

par excellence of the Cypriot politico-economic activity":[14] the copper was mined in the Troodos Mountains, processed in metal workshops within urban sanctuaries under divine protection (especially in Kition and Palaipaphos), and exported via the harbors.[15] Here, I propose a very similar model for the metalworking in the city-state of Tarquinia and suggest that the similarities in the organization of metalworking are not random. Besides the organizational patterns of Cypriot and Tarquinian metallurgical activities, some aspects indicate close contacts between the city-kingdoms (*basileia*) in Cyprus (mainly Kition and Palaipaphos) and Tarquinia in the late 7th/6th century BC that may help to explain the similar organization of metallurgical activities in both regions:

(1) Aphrodite/Astarte/the 'Ingot Goddess'/the 'Cypriot Goddess' served as a main deity and divine protector of metal workshops in Cyprus and in Tarquinia.[16]

(2) The building techniques and architecture of building β in the 'Monumental Complex' of Tarquinia share so many characteristics to the architecture of the eastern Mediterranean, and especially of the Levant, that the excavator Maria Bonghi Jovino suggests building β might have been built by a Levantine architect.[17]

(3) At the back wall of building β was an altar, which is not attested anywhere else in Etruria. According to Sophie Helas, it could instead be interpreted as a Phoenician sacrificial podium. Helas believes the sacrificial pits at the entrance may be compared to those of the sanctuary in Kition. She also assumes the presence of visitors from the eastern Mediterranean, probably from the Levant, in the 'Monumental Complex', and proposes that these visitors were intentionally addressed with this unique building.[18]

(4) Around the middle of the 6th century BC an anchor with the Cypro-Syllabic inscription *a-sa-ta* entered the 'Monumental Complex' of Tarquinia. According to the analysis of Giulio Mauro Facchetti, this inscription could mean either *ánstā* – 'rise up!', or (less likely) *As(e)tártāi* – 'for Astarte'.[19]

(5) The monumental tumuli of Tarquinia, with their wide, theatrical spaces ('piazzaletti') and stairways in the entrance area, share a specific – and for Etruria unique – architecture, that can otherwise only be found in Cyprus (especially in Salamis).[20]

In my opinion, the abovementioned archaeological data suggests a strong and special connection between Cyprus and Tarquinia. Cypriot and Phoenician specialists (the famous term 'Cypro-Phoenician' may apply here) could have had helped to organize metalworking in the city-state of Tarquinia as part of intense cultural contacts.

Textile Production

Textiles provide crucial information on the 'ritual economy' of Etruscan sanctuaries. There are already some fruitful studies on the role of textiles in Etruscan sanctuaries, and the research of Margarita Gleba, Sanna Lipkin and Gretchen Meyers is especially important in this context.[21] Loom weights, bobbins, spindle whorls and *epinetra* are typical tools for textile production that can frequently be found in sacred contexts

from classical antiquity. A fundamental and general problem is deciding whether the function of such textile tools was (1) as a votive offering from a dedicant, or (2) as part of textile production in sanctuaries. In general, both possibilities are equally plausible and evidenced in the archaeological record.[22]

Examining the distribution of textile tools within a sanctuary is a strategy for identifying the possible existence and sites of textile production within that sanctuary. If a large amount of textile tools cluster in one room or a single location within a sanctuary, this might indicate the existence of a loom or similar installations for the production of textiles. Unfortunately, there is little data to support such identifications. However, the cult place of Poggio Colla in Vicchio is an exceptional example of a spatial cluster of textile tools in just a few areas of a sanctuary.[23] Another strategy is the quantification of textile tools found at a site in order to identify at least the possible, or even probable, places of textile production. If a sanctuary contains many textile tools, textile production is probable, even though some of the textile tools might also have been dedications. Some scholars have collected quantitative data for textile tools in Etruscan sanctuaries and identified certain cult places as possible places of textile productions. These include Poggio Colla (Vicchio), the Portonaccio sanctuary of Veii, Vigna Parrocchiale in Caere, the 'Monumental Complex' of Veii, and Cetamura in Chianti.[24] I collected quantitative data for textile tools found in 23 Etruscan and seven Latial cult places (see table 1 below).[25] The Etruscan sanctuaries can be divided into three groups: 20 or less findings

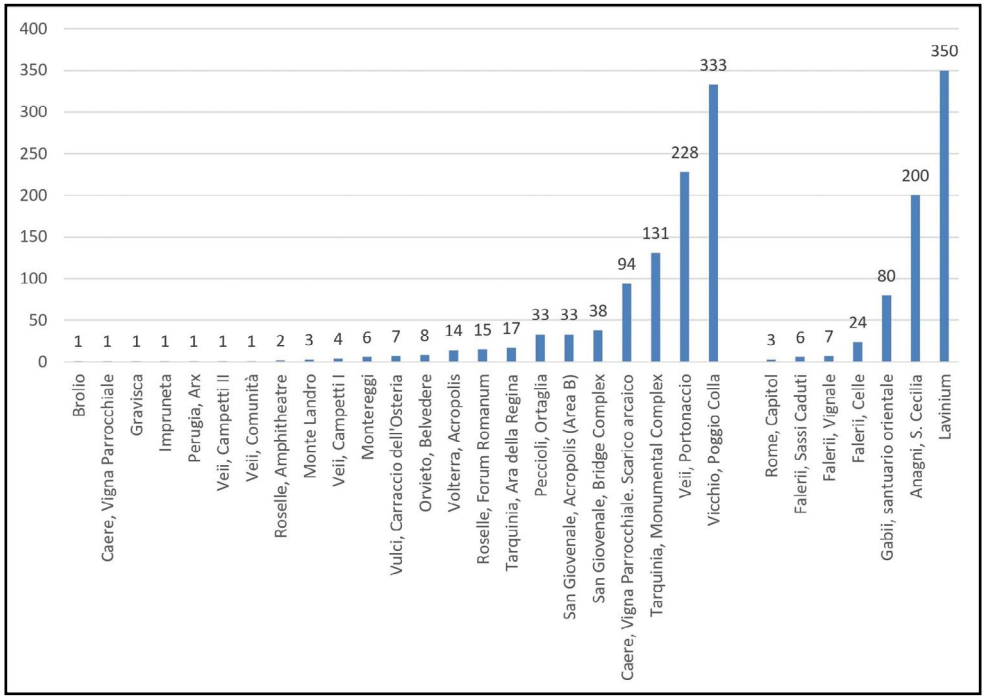

Table 1: Number of textile tool findings in Etruscan (left) and Latial (right) sacred contexts.

are attested for 16 of the 23 sites, 30–40 findings are attested for three sites, while only four contexts contain more than 90 findings of textile tools. On the basis of data from Etruscan sanctuaries, textile production is very likely to have taken place in Vigna Parrocchiale in Caere, the monumental complex of Tarquinia, Portonaccio in Veii, and Poggio Colla (Vicchio). There is also a limited possibility that textile manufacture took place in Ortaglia (Peccioli), and area B of the acropolis of San Giovenale.

Now that some possible textile production sites have been identified, a central question emerges: which cult recipients were venerated in these sanctuaries? Table 2 below shows the few deities attested for these cult places. All of them are female, which should not come as a surprise nor be treated as a coincidence, since the deities of Greek sanctuaries with attested textile productions were almost exclusively female, and textiles as well as textile tools were often considered as part of the 'female sphere' (*mundus muliebris*). In addition, Margarita Gleba and Gabriel Zuchtriegel's lists of Italic sanctuaries with textile tool finds contain almost exclusively female deities.[26]

Archaeological and anthropological studies have shown that textile production in pre-modern times was extremely labor-intensive and time-consuming, and could take

Site, context	**loom weights**	**spindle whorls**	**bobbins**	**total no. of textile tools**	**attested deities**
ETRURIA					
Caere, Vigna Parrocchiale. Scarico arcaico (*)	77	2	15	94	– (Vei)
Murlo, Poggio Civitate (*)	113	581	875	1569	–
Tarquinia, Monumental Complex	62	34	35	131	Artumes, Uni, Thesan, Turan, potnia theron?
Veii, Portonaccio	26	197	5	228	Menerva, Aritimi/ Artumes, Turan, Vena(i), Rath
Vicchio, Poggio Colla	97 (hellen.?)	153 (hellen.?)	83 (hellen.?)	333	Uni
LATIUM VETUS					
Anagni, S. Cecilia	attested	more than 200	0	more than 200	?
Gabii, santuario orientale	3	71	6	80	?
Lavinium, 13 Altars	350	many	0	min. 350	?

Table 2: Etruscan and Latial contexts with a probable textile production (* = probably not a sanctuary).

up even more hours of labor than food production and all other trades combined.[27] The study of the organization of such a demanding craft – especially in sanctuaries – is therefore as important as it is interesting. Eva Andersson Strand and Karina Grömer have defined four contexts for textile production: (1) Household production, (2) Household industry, (3) Attached specialist production, and (4) Workshop production for trade.[28] A textile production integrated into a sanctuary and the cult practice corresponds to the third type of 'attached specialist production'. Characteristic for this form of textile production is the manufacture of remarkably high quality products by specialists with particular craftsmanship skills. These craftspeople, and their training, would have been under the control of a patron.[29] If Etruscan sanctuaries display attached textile workshops, we should expect similar characteristics to those defined by Eva Andersson Strand and Karina Grömer.

We can only speculate as to which products were manufactured in Etruscan sanctuaries. In analogy to Greek sanctuaries, cult garments for deities ('ἱερά ἱμάτια') are the most likely products of textile production. Ancient authors mention two examples of productions of cult garments for statues in Rome as well.[30] In general, scholars propose ritual garments for priests, cult staff and participants, wall decorations, and ritual clothing for cult statues as typical textile products manufactured in Etruscan and Latial sanctuaries.[31] Linen books (*libri lintei*), in which rituals and sacrifices, but also chronicles and magistrate lists were recorded, are mentioned less frequently as a possible manufactured textile product. Such books, made from folded linen strips and inscribed using ink, are exclusively attested for Italic cultures, and are especially well-evidenced for the Etruscans, Romans and Samnites from at least the second half of the 5th century BC on.[32]

The only preserved example of a *liber linteus* is the 'mummy bandage of Zagreb' (*'liber linteus zagrabiensis*'), a ritual text probably written around 200–150 BC near Perugia. In this case, ritual instructions were written down with black ink in 12 columns on a fine rectangular linen cloth (originally ca. 340 × 45 cm). The mummy bandage is the longest preserved Etruscan text with ca. 1330 words (about 60% of the original text).[33]

Since the approximate dimensions and structure of the 'mummy bandage of Zagreb' are known, it can be used as a representative example of the construction of *libri lintei*, so that it is possible to calculate the invested labor for the production of these ritual texts and to postulate an organizational structure for the production process.[34] In total, the production of the Zagreb mummy bandage, without the procurement of the raw material (cultivation and harvest of the flax, and production of the ink), from spinning the yarn to weaving the linen cloth and inscribing it with the ritual text, probably took between 183-499 working hours. In my opinion, due to the quality of this example, about 400-500 working hours are probable, which with great caution could also be regarded as a general guideline for the production of *libri lintei*.

The work invested in the production of *libri lintei* within the Etruscan economy is enormous compared to other activities. The high quality of the products, as well as

the specialization of the craftspeople in particular skills, testifies to production in the context of the sanctuary, and in my opinion manifests the sense of an 'attached specialist production' as defined by Eva Andersson Strand and Karina Grömer. A *liber linteus* was a high-quality product requiring a high degree of specialization, not only for the manufacture of the fine linen fabric, but also in terms of the reading and writing skills required for the inscription, and the ritual knowledge, to which only the priesthoods in their sanctuaries would have had access. Due to the control of knowledge exercised by the priests, the labor-intensive production, and the necessary crafts specializations, it may be assumed that *libri lintei* were produced directly and exclusively in shrines. The thesis of textile production in Etruscan shrines in the sense of an 'attached specialist production' can therefore be considered as highly probable.

Sanctuaries, Trade and the Standardization of Weights

Markets can be defined as an evident economic function of sanctuaries. Here, I do not discuss the role of sanctuaries as *emporia* for long-distance trade,[35] but instead their role as *agorai* for local and regional trade. In general, markets and trading activities can be assumed to be an integral part of the 'ritual economy' for Etruscan sanctuaries of supra-regional importance, which drew numerous visitors in the context of regular festivals and meetings.

Two sanctuaries might help to determine the function of sanctuaries as regional markets. Armando Cherici discussed the *Fanum Foltumnae* and its possible function as a market place for Volsinii and its hinterland (especially in the sense of a regular fair for farmers and herdsmen).[36] Similarly, the Forum Boarium and its sanctuary of Sant'Omobono certainly served as an important supra-regional market place with one key function: cattle were bred by herdsmen under seasonal transhumance in the Latin and Sabine mountains, and then brought by the *via salaria* ('salt road') to the Forum Boarium ('cattle market'). There, the cattle were traded along with cheese and milk. The salt extracted from the saltworks at the Tiber mouth and on the Tyrrhenian coast was also brought via the Tiber to the Forum Boarium and sold there.[37] Salt was certainly not only interesting for the inhabitants of Rome, but above all for the cattle herdsmen, who needed it not only for the preservation of meat, but also as a nutritional supplement for their cattle.[38] The Forum Boarium attached to the sanctuary of Sant'Omobono was therefore used as a platform for business to exchange salt from the coast and the Tiber, as well as cattle, meat, and milk products from the mountains.[39]

Additionally, Dionysius of Halicarnassus and Livy name markets with merchants, farmers, artists and craftsmen, as well as ceremonial games, at the *Lucus Feroniae* under Servius Tullius (672–640 BC)[40], and at the *Fanum Voltumnae* in 403 BC.[41] In Etruscan and Latin sanctuaries, therefore, regular theater performances and *ludi sacri* with fairs and markets may also have been common.[42] However, it is extremely difficult to identify

such market and fair events, since they may have taken place outside the sanctuary in temporary stands and tents.

In Olympia, the accommodation and provision for visitors to the sanctuary (possibly in a dedicated festive and dining house) could be demonstrated by archaeological findings of locally produced pottery and fountains,[43] while trade between traders and visitors may be traced by the discovery of official, standardized and calibrated bronze weights. The merchants in Olympia probably had to pay a fee to the sanctuary for the use of the official weights, similar to the fee documented in other Greek sanctuaries.[44] Scales and weights are attested for sanctuaries in Etruria and central Italy as well, but they seem to have had an entirely different function from those found in Greek sanctuaries. Three Etruscan sanctuaries are known to have contained weights:[45] Caere, Sant'Antonio with two weights from the 6th and 4th centuries BC,[46] Fucoli near Chianciano Terme with two weights from the 4th century BC,[47] and Tarquinia, Ara della Regina with 15 weights of undetermined period.[48]

Since only few weights are attested for each Etruscan sanctuary, it cannot be assumed that they served as official weights for the use of visitors and traders as in Greek sanctuaries. Instead, Etruscan sanctuaries could have stored a single set of one or more standardized and calibrated weight systems for the city-state and its surroundings. The weights would then take on similar functions as reference systems as the International Prototype of the Kilogram ('kilogramme des Archives') and the International Prototype Meter ('mètre des Archives') in modern times. Such a location, which functioned as storage and control center for calibrated measures and weights, was called a *ponderarium* in the Roman society[49], and the existence of such a facility in the sanctuary of Sant'Antonio in Caere during the 6th century BC has already been postulated by Adriano Maggiani.[50]

The sanctuary of Satricum, where two weights and two scales from the 7th/6th century BC were found, might have similarly served as an early *ponderarium*, as is argued by Albert Nijboer. One weight can be dated to the second half of the 7th century BC and, according to Albert Nijboer, probably corresponds in its strongly corroded state of 267 grams to a Roman-Oscan pound (273 grams). The second weight from the Archaic votive depot 1, under temple 1 (late 9th – middle of the 6th century BC), corresponds in its corroded state of 340 grams almost exactly to a Campanian pound (341 grams). The Archaic votive depot 1 also contains the remains of two scales dating from before the middle of the 6th century BC.[51] As Satricum featured a striking amount of findings and features related to metal processing, the two different weight standards (Campanian and Roman-Oscan) in this sanctuary may also be related to the mining, distribution, and trade of metal. There is a known parallel in Pithekoussai, where ore was mined and an Euboian weight from the early 7th century BC was found.[52]

Against this background it seems plausible to postulate that some sanctuaries in Etruria and *Latium vetus* probably served key functions regarding the calibration,

standardization and internationalization of weight systems in the sense of *ponderaria* from the late 7th/6th century BC on. Sanctuaries with such weight standards might have functioned not only as markets, but also as institutions that offered unification and reliability of scales, measures, and prices, as well as economic safety and a 'sacred security' for visitors and traders alike.

In terms of the New Institutional Economics (NIE), trade is expensive and the determination of products, amounts, and prices, as well as the definition and enforcement of exchange agreements, all cost resources: these are the 'transaction costs'.[53] With more technologies, increasing specialization and division of labor, as well as longer trade distances, larger market sizes and networks of consumers and trading partners, transaction costs rise and more resources must be invested to measure and enforce exchange agreements. At this point, 'institutions' help to lower transaction costs, determine prices, and enforce exchange agreements.[54] New Institutional Economics helps to determine the central role that sanctuaries in Etruria and *Latium vetus* might have played since the late 7th and 6th centuries BC not only in long-distance trade, but also for regional markets and the economies of city-states and their hinterlands. Sanctuaries seem to have been important depositories for weight standards and could have operated as *ponderaria* and markets, thus providing socio-economic safety and lowering transaction costs for trade.[55]

Conclusion: A Reconstruction of the Etruscan Ritual Economy (8th–5th centuries BC)

The analysis of metal processing, textile production, and the standardization of weights may provide evidence that economic activities actually took place in Etruscan sanctuaries. But can this then be defined as a ritual economy? How were production and trade integrated into sacred contexts?

Cathy Lynne Costin intensively analyzed the general organizational forms and characteristics of production sites.[56] In a central contribution from 1991, she defined organizational forms for the various production locations on the basis of four parameters, each defined by two opposing characteristics. The parameters are the following: (1) Context (independent – attached); (2) Concentration (dispersed – nucleated); (3) Scale (small, kin-based – factory); (4) Intensity (part-time – full-time).[57]

Based on the composition of these parameters and properties, Costin postulated eight basic types of organizational forms and specializations for production sites: "(1) *Individual specialization*: autonomous individuals or households producing for unrestricted local consumption; (2) *Dispersed workshop*: larger workshops producing for unrestricted local consumption; (3) *Community specialization*: autonomous individual or household-based production units, aggregated within a single community, producing for unrestricted regional consumption; (4) *Nucleated workshops*: larger workshops aggregated within

a single community, producing for unrestricted regional consumption; (5) *Dispersed corvée*: part-time labor producing for elite or government institutions within a household or local community setting; (6) *Individual retainers*: individual artisans, usually working full-time, producing for elite patrons or government institutions within an elite (e. g., a palace) or administered setting; (7) *Nucleated corvée*: part-time labor recruited by a government institution, working in a special-purpose, elite, or administered setting or facility; (8) *Retainer workshop*: large-scale operation with full-time artisans working for an elite patron or government institution within a segregated, highly specialized setting or facility"[58].

If one classifies the productions and crafts in Etruscan sanctuaries into this system, one can observe strongly embedded and dependent structures ('attached specialists'). These are generally typical for the temple and palace economy, as well as for the production of luxury goods and weapons. In particular, the workshops for metal processing and textile productions point to crafts that were embedded in sanctuaries. At the same time, these embedded workshops were often 'nucleated' and located in the immediate proximity of sacred contexts.[59]

The exact scale of production can hardly be determined (especially for textile production), but seems to have been rather small. Some skills, such as the processing of metal and precious materials, as well as literacy, and assets such as ritual knowledge, were certainly strongly controlled and regulated, so that they were only available to a limited group of people. Likewise, the intensity of commercial production fluctuated strongly between part-time and full-time production. Cult garments and *libri lintei* may have been produced less frequently, while metal processing may, in at least some places, have been a full-time (or seasonal) occupation.

Based on these parameters of organizational forms and specializations, I reconstruct productions and trades in Etruscan sanctuaries of the 8th–5th century BC according to Cathy Lynne Costin as 'Nucleated corvée' or 'Retainer workshops', which exhibit a high level of organization, embedding, and centralization, and were strongly controlled by the sacred institutions for the manufacture of at least some products. The intensity of production is difficult to determine, and must remain partly open. In summary, production and crafts in Etruscan sanctuaries therefore tended to be highly centralized and embedded economic structures, some of which were highly specialized.

Notes

[1] This contribution is a small excerpt from one chapter of my PhD thesis (Krämer in press), which was funded by the German Academic Exchange Service (DAAD; 2013) and the DFG Research Training Group 1878 'Archaeology of Pre-Modern Economies' (2013–2016).

[2] Silver 1995, 23–25; Davies 2001a; Shaya 2005; Sassu 2010; Sassu 2014; Hamilton 2015.

[3] Horster 2004. Papazarkadas 2011.

[4] For the extensively studied phenomenon of emporia or 'ports of trade', see for example Silver 1995, 18–23; Möller 2000; Möller 2001; Möller 2005; Schweizer 2007; Fantalkin 2014; Ulf 2014; Krämer 2016 (with a New Institutional Economics approach and further bibliography on this matter). The above-mentioned studies share a main economy-trade-perspective, partly based on a Polanyian tradition. More recently, other scholars favor a shift towards a multiethnic polis or settlement community perspective; e.g. Demetriou 2011; Demetriou 2012; Daniels 2018. Of course, these two research perspectives (or priorities) are not mutually exclusive.

[5] See for example: Linders – Alroth 1992; Silver 1995, 3–38 chapter 1; Sinn 1996; Davies 2001; Davies 2001a; Sassu 2010; Sassu 2014.

[6] For initial preliminary studies on this matter by the author of this paper, see: Krämer 2016; Krämer 2017; Krämer 2020; Krämer in press.

[7] Heilmeyer 1969; Zimmer 1990; Risberg 1992; Völling – Zimmer 1995.

[8] Bouma 1996, esp. 54–65. 81–83; Nijboer 1998, 168–184; Nijboer 2001; Waarsenburg – Maas 2001.

[9] Nijboer 1998, 180–184; Nijboer 2001; Waarsenburg – Maas 2001. Stattdessen: See chapter ‚Sanctuaries, Trade and the Standardization of Weights' below on the implications of metal processing for the standardization of weights in Satricum.

[10] Chiaramonte Treré 1997; Geroli 2001.

[11] Fiorini – Torelli 2007, 91–97.

[12] On metal processing in Gravisca, see: Fiorini 2002, esp. 157 f.; Fiorini 2005, 181–185; Fiorini – Torelli 2007; Fiorini – Torelli 2010, 29–32; Fiorini 2014.

[13] Krämer 2016.

[14] Papantoniou 2012, 94.

[15] Kassianidou 2005 (skeptical with an emphasis on the history of the debate); Iacovou 2012; Papantoniou 2012, 94 with notes 120–121 and further reference.

[16] Fiorini – Torelli 2007, 91–97; but see also Kassianidou 2005, 132–135 critical on the 'Ingot deities'. Papantoniou 2016, especially 82–84. 88–97 on the identification of the 'Cypriot Goddess' with Aphrodite, the context of social changes and Mediterranean commerce, and rightly against 'Phoenicianizations' or other colonial interpretations.

[17] Bonghi Jovino 1999.

[18] Helas 2019. I would like to thank Sophie Helas for sharing her unpublished article with me. In my opinion, the architects and cult participants of building β could also have been visitors from Cyprus, since Phoenician elements are also represented in Cyprus. This opinion is also based on the other references I mention here and I find this position convincing, even if there is only limited archaeological evidence to support it.

[19] On the anchor, see: Bagnasco Gianni 2015, passim (for the linguistic analysis: G. M. Facchetti, L'àncora di Tarquinia. L'iscrizione, in: Bagnasco Gianni 2015, 57–64); Bagnasco Gianni et al. 2016, esp. 43 f.

[20] Mandolesi 2012, especially 36–38 with fig. 5–6; Mandolesi – Lucidi 2015/2016, 95 with note 41. Alessandro Mandolesi and Maria Rosa Lucidi consider the idea of craftsmen who were trained by teachers from the Levant ("La manodopera del "piazzaletto", educata agli insegnamenti levantini …"). However, their comparisons for tumuli come exclusively from Cyprus.

[21] Gleba 2008; Gleba 2009; Lipkin 2012; Lipkin 2012a; Meyers 2013; Gleba 2015.

[22] Gleba 2009; Meyers 2013.

[23] Meyers 2013, 253–263 with fig. 4.
[24] Gleba 2008, 183–187; Gleba 2009, 76–80; Lipkin 2012, 98 f.; Lipkin 2012a, 124–126; Meyers 2013, 263–269; Gleba 2015, 376–379.
[25] A more in-depth analysis of the data with numbers and references will be published in my PhD thesis (Krämer in press).
[26] Gleba 2009, 71 f. Tab. 1; Zuchtriegel 2012, 272–275.
[27] Costin 2013, 181 with further references: "Yet perishables made up the overwhelming bulk of ancient material culture and pre-industrial cloth production likely required more hours of labor than food preparation and other crafting combined."
[28] Andersson 2003; Grömer 2016, 241–261.
[29] Grömer 2016, 252 with reference to Eva Andersson Strand: "The work of the specialist is done on a fulltime basis, and technical skills and knowledge are extended in order to create higher quality products. The persons involved in specialist production are often dependent on a patron, who feeds and supplies them. Goods produced in this way can now also serve as precious gifts for exchange. A further feature of this production level is the complete control and authority over the craftsmen the patron exercises, including their expertise and the training of further specialists working for him."
[30] The Statue of Hercules Triumphalis on the Forum Romanum was wrapped in special robes in the case of a Triumph (Plin. nat. 34, 33). According to Silius Italicus, during the Second Punic War Roman matrons formed a procession and consecrated a Palla with woven-in golden threads to Juno. They made the Palla with their own hands, and it was apparently intended for the cult image (Sil. 7, 74–85).
[31] Bonfante 2009; Gleba 2009, 80 f.; Lipkin 2012a, 126 f.; Gleba 2015, 376–381.
[32] According to Livy, the Romans used linen books (*libri lintei*) during the period of 444–434 BC for chronicles and lists of magistrates, which were archived in the temple of Iuno Moneta on the Aventine (Liv. 4, 7, 12; 4, 13, 7; 4, 20, 8; 4, 23, 2–3.). In the year 293 B.C. the old Samnite priest Ovius Paccius carried out sacrifices in Aquilonia according to the instructions of an ancient linen book. The ritual would go back to an ancient ceremony of the Samnites, who used it when they conquered Capua from the Etruscans in 423 BC (Liv. 10, 38, 5–6). Thus the venerable *liber linteus* of the priest Ovius Paccius would have been in use for at least 130 years.
[33] Roncalli 1980; Van der Meer 2007; Belfiore 2010.
[34] The exact steps of the calculation and analysis will be published in my PhD thesis (Krämer in press).
[35] See above footnote 4.
[36] Cherici 2012.
[37] Saltworks are not only attested by literary sources for the early Roman period (Liv. 1, 33, 9; Plin. nat. 31, 89; Plut. Romulus 25, 4), but also by archaeological finds and contexts from the Villanova period (Mandolesi 2014).
[38] Plin. nat. 31, 88: "Quin et pecudes armentaque et iumenta sale maxime sollicitantur ad pastus, multo tum largiore lacte multoque gratiore etiam in caseo dote.". See also Cifani 2016, 166.
[39] Viglietti 2011, 231–233. On Archaic and early Republican salt trade in Rome, *Latium vetus*, and Etruria, see Cifani 2016, 166–169.
[40] Dion. Hal. ant. 3, 32, 1–3; Liv. 1, 30, 4–7.
[41] Liv. 5, 1, 1–7.

[42] On the few indications of *ludi sacri* and theatre performances in Etruscan sanctuaries, see Colonna 1993, 343–347; Camporeale 2010; Thuillier 2011.

[43] Bentz 2012; Bentz 2012a; Gauer 2012; Bentz 2013.

[44] Hitzl 1996, especially 101–104.

[45] On weight systems and the standardization of weights in Etruria and *Latium vetus*, see: Nijboer 1994; Nijboer 1998, 207–237 chapter 4; Maggiani 2002; Maggiani 2007; Maggiani 2012.

[46] Maggiani 2002, 167–169 Nr. 5. 7; Pl. 28 c. e; Maras 2009, 277–279 Cr do.7; Maggiani 2012, 403–405; L. Haumesser in: Maggiani 2014, 280 Nr. 332.

[47] Maggiani 2002, 165 f. Nr. 2–3; Pl. 27 b–d.

[48] Romanelli 1948, 266 Nr. 82; 270; Maggiani 2012, 394 with note 11.

[49] Schneider 1952. Schulzki 2001. Sanctuaries in Ancient Israel and the Iron Age Levant could have had similar functions as is attested by the Old Testament (Exodus 30, 13; Numbers 3, 47; see also Silver 1995, 25).

[50] Maggiani 2012, 403–405.

[51] Nijboer 1994, 1–12; Nijboer 1998, 168–184 chapter 3.6.2; 210–223.

[52] On Pithekoussai see: Nijboer 1994, 12–15; Nijboer 1998, 165–168 chapter 3.6.1; 220 f. On metal processing in Satricum, see also above chapter 'Textile Production'.

[53] North 1985, 558: "Transaction costs here are defined as the costs of specifying and enforcing the contracts that underlie all exchange (…). They are the costs involved in capturing the gains from trade. They include a specification of what is exchanged or of the performance of agents and an analysis of the costs of enforcement. The costs of contracting are in general those of searching out who has rights with respect to what is being traded, what rights they have, and what are the attributes of the rights; those of searching for prices associated with the transaction and the predictability of those prices; and those of stipulating contracts and contract performance."

[54] North 1991, 97. 99: "Institutions are the humanly devised constraints that structure political, economic and social interaction. They consist of both informal constraints (sanctions, taboos, customs, traditions, and codes of conduct), and formal rules (constitutions, laws, property rights). Throughout history, institutions have been devised by human beings to create order and reduce uncertainty in exchange. Together with the standard constraints of economics they define the choice set and therefore determine transaction and production costs and hence the profitability and feasibility of engaging in economic activity. […] In the absence of a state that enforced contracts, religious precepts usually imposed standards of conduct on the players". See also Silver 1995, 18–23 on sanctuaries as guarantors and protectors of Mediterranean trade.

[55] On the concepts of New Institutional Economics mentioned extremely briefly here, see the works of Douglass C. North: North 1977; North 1984; North 1985; North 1987; North 1991. On the application of NIE in Classical Antiquity, see for example: Frier – Kehoe 2007; Bang 2009; von Reden 2015, 102–104 with further references; on Archaic long-distance trade and 'ports of trade' in a NIE perspective, see Krämer 2016.

[56] Costin 1991; see also: Costin 1998; Costin 2005.

[57] Costin 1991, 3–18 with fig. 1.4 and plate 1.1.

[58] Costin 1991, 8 f. with plate 1.1.

[59] See Costin 1991, 11–15.

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For the Pottery and for the Potters: an Ergonomic Approach to Pottery Production in Italy (8th–1st Century BC)

Raffaella Da Vela

Spatial analysis has been applied in different forms to pre-Roman pottery production in Italy as well as in the whole Mediterranean for the same period (8th–2nd century BC).[1] The dynamics of interaction between craftsmen and productive structures can only be partially detected in the archaeological record, which has hence often been supplemented with ethnological parallels.[2]

The present contribution provides a methodological focus and discusses the possibility to reshape the spatial analysis of pottery production within the methodological frame of ergonomics, the discipline studying the relationships between worker and working space in the dynamic of workflow.[3]

Ergonomics offers a suitable set of methodological tools to understand the impact of social and political systems on the balance between workers' needs and the workshops' productivity and to build a general model to compare different workshops and production systems. In approaching ancient pottery production contexts, we are dealing with paraergonomics or intuitive protoergonomics.[4]

Ergonomic categories have already been intuitively applied by archaeologists to pre-Roman production: e.g. Ninina Cuomo di Caprio has pointed out that the variations within a standard range in the dimensions of *praefurnia* of the Hellenistic kilns of Morgantina are a compromise between functional needs, the space available for their construction and the expertise and knowledge of the potters.[5]

In this article, I will establish some parameters to rationalize an ergonomic approach to the archaeological dataset and make it suitable for comparative analyses. Ergonomics has an evaluative function, which analyzes the human factor in the spatial organization of the workflow, and a proactive function, which aims to improve the efficiency of the production system and the workers' quality of life. The analytic function will be tested here in a case study of an Archaic Etruscan pottery workshop in Florence, while the proactive function will be presented as a potential of the archaeological modelling.

Ergonomic Analysis

An ergonomic evaluation in pre-Roman pottery production can be conducted on three levels[6] of the workflow[7]:

a. Spatial and dimensional relationships within a single task of production;
b. Spatial organization of work and workshop-layout;
c. Community ergonomics of a workshop embedded in a production and social system.[8]

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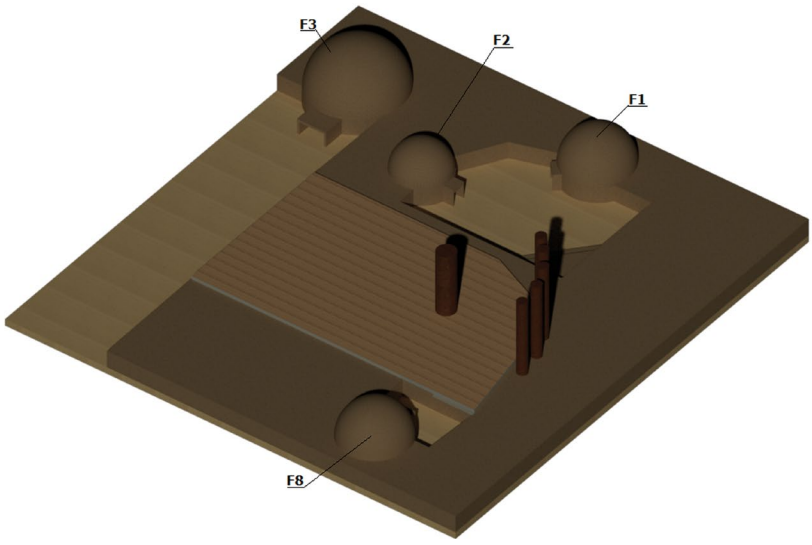
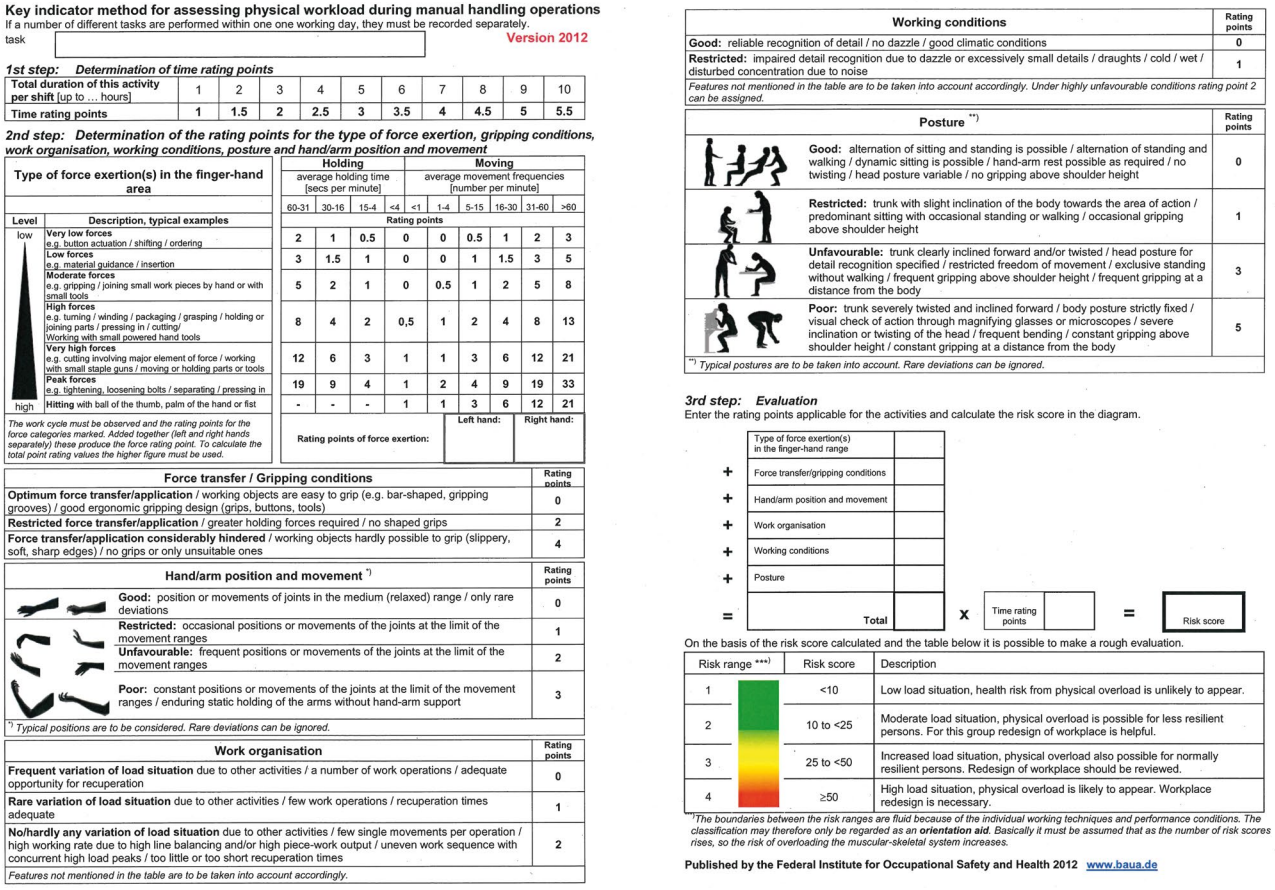


Fig. 1: Pottery Workshop of Florence, via Nazionale, cinema Apollo: reconstruction of the last phase in AutoDesk AutoCAD-Architecture.

The possibility of applying complex ergonomic analyses depends on the conditions of preservation of the ancient contexts. The available sources for the first level of ergonomic analysis in pre-Roman Italy are mostly kilns and more seldom working areas for the potters' work and basins for clay preparation (attestation level 1). The sources for the second level are workshops with attestations of many phases of production (Attestation level 2). The sources for the third level are workshops, which can be plausibly linked to an urban context or a commodity chain (Attestation level 3). The dataset of pre-Roman workshops presents an unbalanced distribution of the attestation layers, with many isolated or single kilns, few workshops with at least partial operational sequences and very few cases of topographic entanglement of the workshops, most of them located in Magna Graecia and in Etruria.[9] As a pilot test, an ergonomic evaluation of the Archaic pottery workshop of Florence, via Nazionale, Cinema Apollo[10] (fig. 1) has been conducted through a Hierarchical Task Analysis (HTA)[11]. A structured heuristic Ergonomic Evaluation of the complex tasks of pottery production has been indicated with a multi-aspect physical load assessment method, the KIM (Key Indicator Method for manual handling operations), which takes into account posture-based and bio-mechanics analysis, allowing the evaluation of static and dynamic ergonomics (fig. 2).[12]

Ergonomics of the Firing Process (fig. 3–4)

The ergonomic evaluation of the firing process is suitable for all layers of attestation, since single kilns can be isolated or be part of a workshop, and deals with immediate risk of injury, as well as long-term health risks.



Key indicator method for assessing physical workload during manual handling operations
If a number of different tasks are performed within one one working day, they must be recorded separately.
task
Version 2012

1st step: Determination of time rating points

Total duration of this activity per shift [up to … hours]	1	2	3	4	5	6	7	8	9	10
Time rating points	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5

2nd step: Determination of the rating points for the type of force exertion, gripping conditions, work organisation, working conditions, posture and hand/arm position and movement

Type of force exertion(s) in the finger-hand area

Level	Description, typical examples	Holding: 60-31	30-16	15-4	<4	Moving: <1	1-4	5-15	16-30	31-60	>60
		Rating points									
low	**Very low forces** e.g. button actuation / shifting / ordering	2	1	0.5	0	0	0.5	1	2	3	
	Low forces e.g. material guidance / insertion	3	1.5	1	0	0	1	1.5	3	5	
	Moderate forces e.g. gripping / joining small work pieces by hand or with small tools	5	2	1	0	0.5	1	2	5	8	
	High forces e.g. turning / winding / packaging / grasping / holding or joining parts / pressing in / cutting/ Working with small powered hand tools	8	4	2	0,5	1	2	4	8	13	
	Very high forces e.g. cutting involving major element of force / working with small staple guns / moving or holding parts or tools	12	6	3	1	1	3	6	12	21	
	Peak forces e.g. tightening, loosening bolts / separating / pressing in	19	9	4	1	2	4	9	19	33	
high	**Hitting** with ball of the thumb, palm of the hand or fist	-	-	-	1	1	3	6	12	21	

The work cycle must be observed and the rating points for the force categories marked. Added together (left and right hands separately) these produce the force rating point. To calculate the total point rating values the higher figure must be used.

Rating points of force exertion: Left hand: Right hand:

Force transfer / Gripping conditions	Rating points
Optimum force transfer/application / working objects are easy to grip (e.g. bar-shaped, gripping grooves) / good ergonomic gripping design (grips, buttons, tools)	0
Restricted force transfer/application / greater holding forces required / no shaped grips	2
Force transfer/application considerably hindered / working objects hardly possible to grip (slippery, soft, sharp edges) / no grips or only unsuitable ones	4

Hand/arm position and movement *)	Rating points
Good: position or movements of joints in the medium (relaxed) range / only rare deviations	0
Restricted: occasional positions or movements of the joints at the limit of the movement ranges	1
Unfavourable: frequent positions or movements of the joints at the limit of the movement ranges	2
Poor: constant positions or movements of the joints at the limit of the movement ranges / enduring static holding of the arms without hand-arm support	3

*) *Typical positions are to be considered. Rare deviations can be ignored.*

Work organisation	Rating points
Frequent variation of load situation due to other activities / a number of work operations / adequate opportunity for recuperation	0
Rare variation of load situation due to other activities / few work operations / recuperation times adequate	1
No/hardly any variation of load situation due to other activities / few single movements per operation / high working rate due to high line balancing and/or high piece-work output / uneven work sequence with concurrent high load peaks / too little or too short recuperation times	2

Features not mentioned in the table are to be taken into account accordingly.

Working conditions	Rating points
Good: reliable recognition of detail / no dazzle / good climatic conditions	0
Restricted: impaired detail recognition due to dazzle or excessively small details / draughts / cold / wet / disturbed concentration due to noise	1

Features not mentioned in the table are to be taken into account accordingly. Under highly unfavourable conditions rating point 2 can be assigned.

Posture **)	Rating points
Good: alternation of sitting and standing is possible / alternation of standing and walking / dynamic sitting is possible / hand-arm rest possible as required / no twisting / head posture variable / no gripping above shoulder height	0
Restricted: trunk with slight inclination of the body towards the area of action / predominant sitting with occasional standing or walking / occasional gripping above shoulder height	1
Unfavourable: trunk clearly inclined forward and/or twisted / head posture for detail recognition specified / restricted freedom of movement / exclusive standing without walking / frequent gripping above shoulder height / frequent gripping at a distance from the body	3
Poor: trunk severely twisted and inclined forward / body posture strictly fixed / visual check of action through magnifying glasses or microscopes / severe inclination or twisting of the head / frequent bending / constant gripping above shoulder height / constant gripping at a distance from the body	5

**) *Typical postures are to be taken into account. Rare deviations can be ignored.*

3rd step: Evaluation
Enter the rating points applicable for the activities and calculate the risk score in the diagram.

	Type of force exertion(s) in the finger-hand range	
+	Force transfer/gripping conditions	
+	Hand/arm position and movement	
+	Work organisation	
+	Working conditions	
+	Posture	
=	Total	x Time rating points = Risk score

On the basis of the risk score calculated and the table below it is possible to make a rough evaluation.

Risk range ***)	Risk score	Description
1	<10	Low load situation, health risk from physical overload is unlikely to appear.
2	10 to <25	Moderate load situation, physical overload is possible for less resilient persons. For this group redesign of workplace is helpful.
3	25 to <50	Increased load situation, physical overload also possible for normally resilient persons. Redesign of workplace should be reviewed.
4	≥50	High load situation, physical overload is likely to appear. Workplace redesign is necessary.

***) *The boundaries between the risk ranges are fluid because of the individual working techniques and performance conditions. The classification may therefore only be regarded as an **orientation aid**. Basically it must be assumed that as the number of risk scores rises, so the risk of overloading the muscular-skeletal system increases.*

Published by the Federal Institute for Occupational Safety and Health 2012 www.baua.de

Fig. 2: Interactive Worksheet for KIM calculation (version 2012).

The immediate risk depends on different factors: the possibility of crushing injuries caused by a kiln collapsing due to defective construction; the inhalation of toxic products, due to the materials used or an imperfect firing process; the risks of serious flash burns and consequent infections. The archaeological sources for an analysis of these parameters are the following: dimension of kilns, dimensions and position of their mouths (regulation of fire); rapport mouth/*praefurnium* (regulation of air circulation); numbers and positions of the aeration holes (aeration system) and in some cases destruction layers caused by the spontaneous collapse of the kiln.

In the case study (fig. 4), the kilns have a diameter of about 1 m, the mouths are c. 0,40 m large and 0,50 m high, giving access to short *praefurnia* (about 0,30 m deep). Information about the regulation of aeration on the vault is lost. The risks linked to collapse of the kilns were very low, since combustion chambers were quickly completely dug into the ground and the vaulted firing chamber in clay was both light and stable, presenting more risks of implosion than of explosion.

Long-term health hazards depend on a variety of factors: muscular and joint damage due to carrying and moving loads, repetition of unhealthy or un-ergonomic movements,

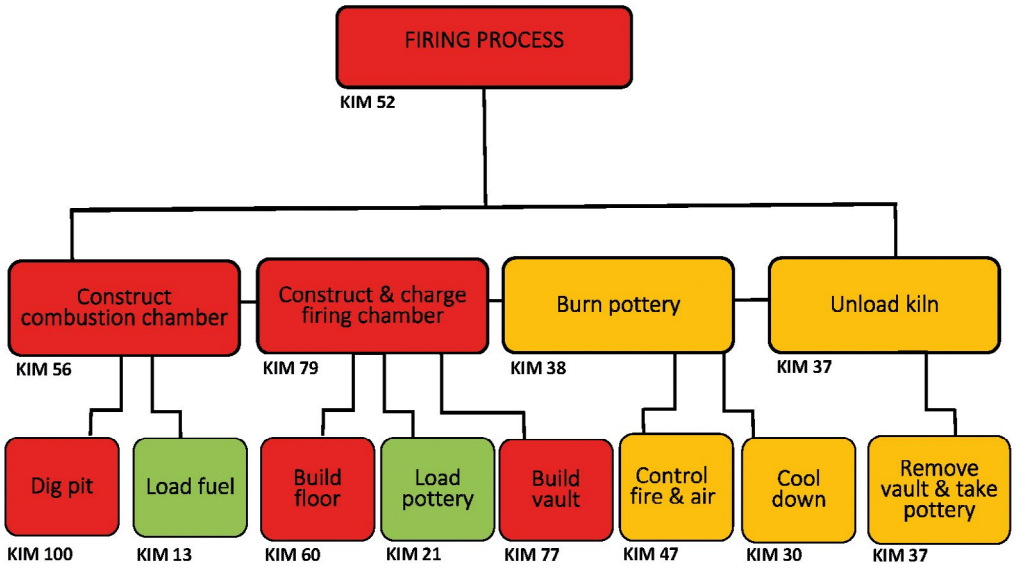


Fig. 3: HTA of firing task for the Pottery Workshop of Florence, via Nazionale, cinema Apollo, with KIM-Number calculation.

such as bending down and straightening up or twisting the back by carrying heavy loads; skin being exposed to dangerous materials or elements; the respiratory system being exposed to particulates. The archaeological sources permit only the ergonomic numeric evaluation of mechanical risks: height/diameter of the combustion chamber (need of fuel alimentation); height/diameter of the kiln floor (charging/discharging); position of the kiln-mouth relative to the ground level of the workshop (possibility to sit or stand while controlling the fire). In the case study, the application of this first level of ergonomic evaluation on the kilns shows different KIM values in the tasks related to the firing process (fig. 3), higher for the construction of the kiln and of the floor of the firing chamber, built by leaning clay bars on a central mobile pedestal[13] and in the delicate phase of charging and discharging. Handling of heavy objects was sporadic, e.g. when positioning the about 20 kg heavy stone to close the kiln's mouth to cool it down slowly, and consequently has a lower impact.

Ergonomics of the Workshop-Layout and of the Workflow (fig. 5–7)

The workshop-layout is structured to economize movements within the workflow and to complete them rapidly to increase the efficiency of production. In the analysis of the workflow, the possibility of multifunctional spaces, especially open-air spaces, calls for the combination of space analysis with an analysis of the operational sequences.[14] Workflow analysis further requires a dataset of a complete workshop or at least of a consistent part of it.[15]

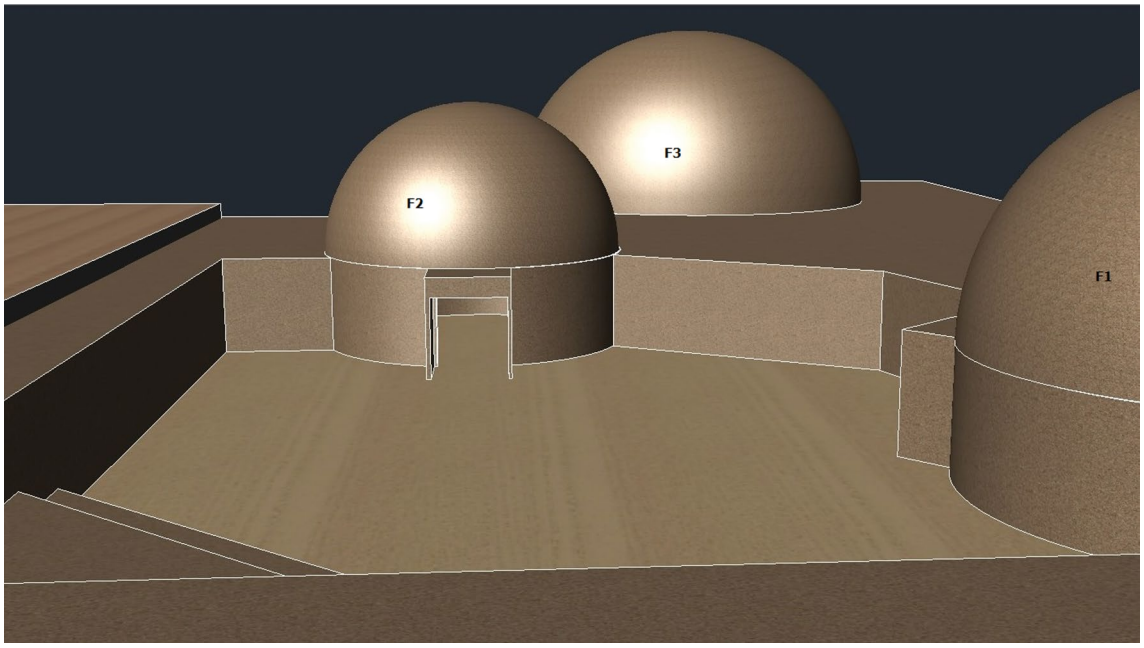


Fig. 4: View of kilns F1 and F2 as a 1,65 m high person, reconstructed in AutoDesk AutoCAD-Architecture.

Given the available sources, the ergonomic parameters of the workflow are the following: path from storage/preparation of raw materials to working place; path from working place to drying/decorating place; path between drying place and firing place; path between firing place and storage. The paths are evaluated based on frequency of use, distance, angles of movement within the working-path; differences in ground level, resolved with inclines or steps. Parameters linked to light and visibility are for the most part inaccessible, because the original height of the buildings is lost.

These parameters are based on the following archaeological data: workshop surface (sqm); access path analysis for different working stations and working-path reconstruction based on the phases of the operational sequence; position of the kilns.

In our case study, the workshop produced different materials: tiles, small pots (*ollae*) and large food containers (*pithoi*, jars). Technique, form and weight of different products affect especially ergonomics of forming, drying, decorating and stocking. Even if the workshop was not specialized, some kilns show a trend towards specialization, e.g. the kiln F8, where only fragments of tiles have been found. This kiln is also the one nearest to the working and drying area. The position is probably linked to the delicate phase of charging and stocking these materials, which are the heaviest and most likely to be deformed and crushed in transport (fig. 7). The paths, described as weighted ties in the HTA, do not present particular high values in the ergonomic evaluation, since the differences in ground level are very small (30–50 cm). The proximity of two kilns (F1-F2) with a common working area is a way to save energy in the production process (fig. 4).

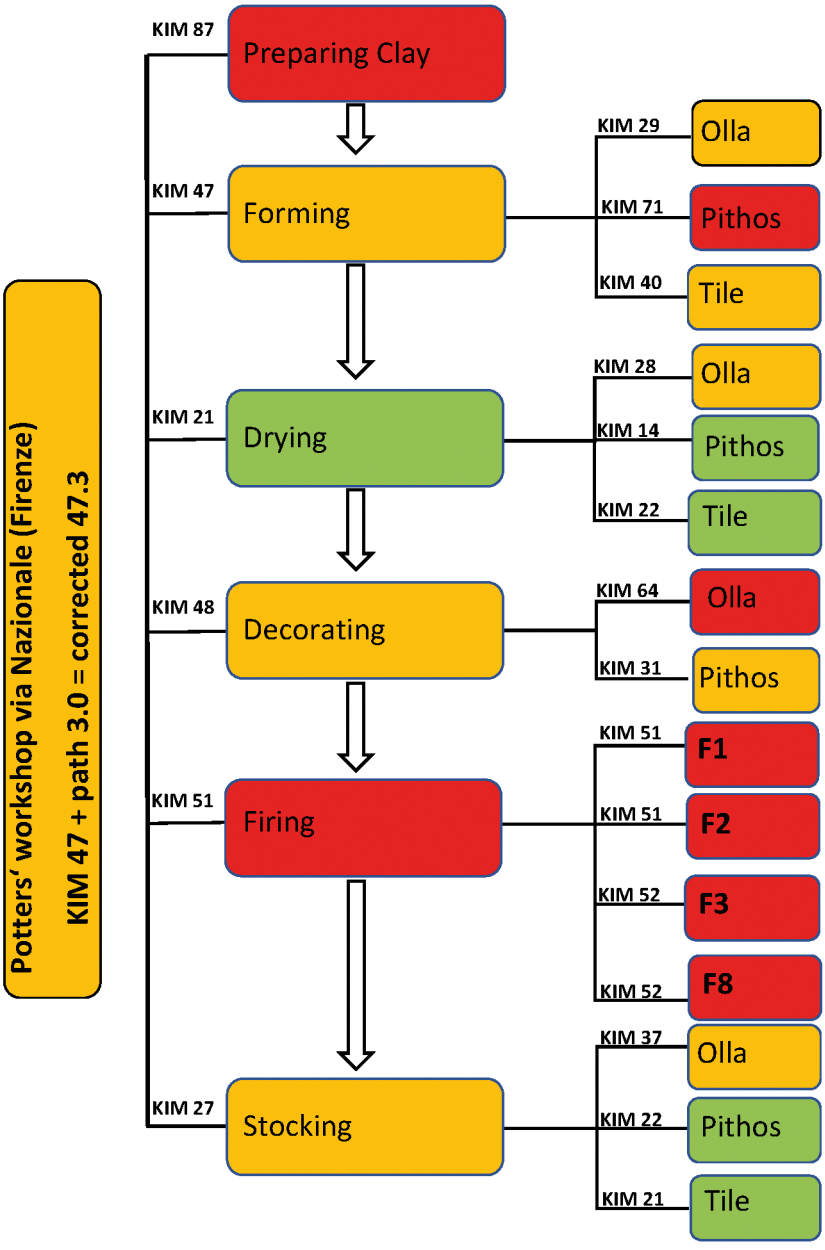


Fig. 5: HTA of the operational sequence of Pottery Workshop of Florence, via Nazionale, cinema Apollo, with KIM-Number calculation.

Since the borders of the working area are only partially preserved, it is not possible to prove how kiln F3 was accessed, though it was probably also accessible from the central working-area, as were all other kilns (fig. 6). The ergonomic evaluation of the path within the operational chain is very low and does not affect the general KIM number (fig. 5).[16]

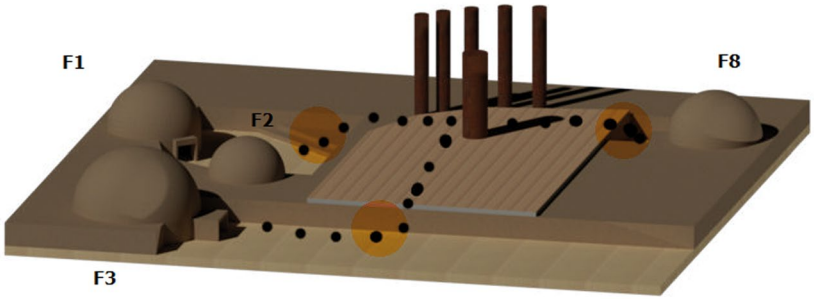


Fig. 6: Pottery Workshop of Florence, via Nazionale, cinema Apollo: reconstruction of the working path in AutoDesk AutoCAD-Architecture, inclines and steps are indicated with orange circles.

Community Ergonomics

There are very few documented examples of workshops in pre-Roman Italy, which can be integrated into a social and environmental structure, as well as in a complex commodity chain. The workshop location gives some indication as to its role within the commodity chain as well as in the human and urban landscape,[17] but nevertheless a broader dataset is necessary to frame it correctly and permit us to understand the workshop within a conceptual framework of 'intersubjective and embodied habitus'[18] of production and consumption.

This conceptual framework of chaînes opératoire is the object of analysis in community ergonomics.[19] The main parameters that have to be taken into consideration for community ergonomics are the time required to reach the workshop from the residential area, the supply of raw materials, the facility's access to a redistribution system, its access to common services,[20] as well as the position of the workshop in the commodity chain, in particular its connections to the sources or distribution hubs of raw materials and re-distribution routes or structures (marketplaces, harbors and docks).[21] The required large-scale analysis shows a high degree of complexity (fig. 8). A dataset complete enough for this level of analysis is still unknown, though there are already some good cases, which could be suitable for community ergonomics evaluation, as e.g. in Lokri Epizephyrioi, Naxos, Selinunte and Veio Campetti.[22] For the case study of the kilns of Cinema Apollo, this level of ergonomic evaluation is yet missing.[23]

Toward a Construction of an Ergonomic Index for Pottery Production in Pre-Roman Italy

The proactive function of ergonomics can be adapted as useful tool for the archaeological modelling of human behavior. It is possible to empirically develop an ergonomic index in pre-Roman pottery workshops and study cultural or contextual

Fig. 7: Reconstruction of the section of F8, view standing from South-East.

reasons for deviations from the standard. Since Vladimir Stissi's analysis of the layout of potteries in Greece and Magna Graecia revealed evidence for a lower impact of geo-cultural variability on the workshop-layout,[24] the use of ergonomics can help to highlight subtle differences.

The workflow for an ergonomic evaluation can be generalized, parametrizing the application to empiric data, in a way to realize an ergonomic model for each level of analysis, progressively including the models of the sub-levels (s. ergonomics of firing process in fig. 1 and in fig. 5). This model can also be calibrated on the base of the source material preserved by introducing a correction parameter to weight the number and the importance of the available parameters.

To create an ergonomic index starting from the ergonomic model, we need to be able to quantify and qualitatively compare the ergonomics values collected by applying the model to a larger dataset, which could be archaeological as well as ethnological.[25]

The ergonomic index should include static and dynamic measurements calibrated on the anthropometric data of inhumations unearthed in local necropoleis.[26] Using the same dataset, it should in the future be possible to integrate 3D-CAD reconstructions of the working space of ancient workshops with Human Digital Modelling based on anthropological observations of the inhumations found in the same geographic area.[27]

Ergonomics – do we really need that?

Ergonomics shares some research questions with the studies on contextualized chaînes opératoires, such as spatial insertion and access pattern analysis.[28] The ergonomic evaluation is based on the observation of material remains, in terms of productions structures, production organization and economic space. Therefore, ergonomic evaluation of pottery workshops differs from spatial analysis by focusing on human factors and introducing the human body as a dimension of the working space.

The individuation of ergonomic patterns can be useful to detect differences in the social organization and in the exploitation of labor in workshops with different modes of production, from individual household production to nucleated workshops industries for mass production.[29] Ergonomics can thus be harnessed to study the

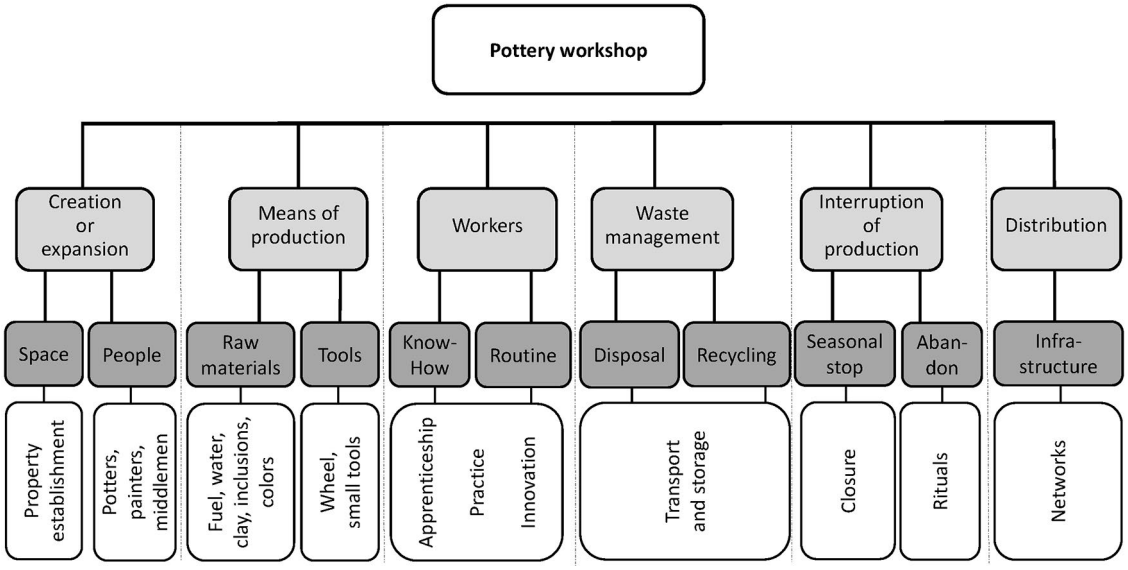


Fig. 8: Proposal of HTA for Community Ergonomics of Pre-Roman Workshops.

impact of production systems and their structural needs on the healthy and life quality of potters.

Moreover, despite the lacunary documentation of many contexts, an ergonomic evaluation of pottery workshop, modulated on three attestation levels, can detect cultural patterns while remaining sensitive to chronology and cultural geography: this 'ergonomic footprint' can then be considered an indicator of specific ceramic traditions or communities of practices as well as technological boundaries.[30]

A research focus on human work and work organization, proper to social archaeology, finds in ergonomics a means of bridging the gap between the reconstruction of structure and social interaction in ancient societies and the functionality of teleological acts in the production process.[31]

Acknowledgments

My gratefulness gives to the organizers of the Convention and in particular to the organizers and editors of the session, Nadin Burkhardt and Robinson Peter Krämer. A special acknowledgment is given to Albert Nijboer and Eleni Hasaki, who were discussing the topic with me during and after the presentation in Bonn and gave me very useful bibliographic indication on their works on the integration of ethnographic studies.

I also wish to warmly thank Henry Heitmann-Gordon for the stylistic editing of the paper.

Notes

[1] In ancient Greek pottery workshops in particular by Heleni Hasaki (Hasaki 2011, for further bibliography s. note 5. 13). An application of spatial analysis to ancient production contexts, to analyze the social implications of work has been e.g. presented by Monteix 2016, 171–173 and Monteix 2018, 133–150 for Pompeian bakeries.
[2] For a review of the ethnographic approaches to pottery production: Nijboer 1998, 18. 50–78; David – Kramer 2001; for an application to pottery workshops in Tunisia: Hasaki 2011, where the ethnographic parallels are applied "to extrapolate the spatial requirements and configurations for ancient workshops": Hasaki 2011, 13.
[3] The formalized definition of ergonomics is: "the theoretical and fundamental understanding of human behavior and performance in purposeful interacting socio-technical systems, and the application of that understanding to design of interactions in the context of real settings": Wilson 2000, 560. The term was coined in 1949 by a group of scientists working in the fields of Psychology and Engineering (Murrel 1958, 602). In the 1960s, the progressive digitalization of the work extended the semantic field of the terms and the potentiality of the scientific application of ergonomics, in the branch of cognitive ergonomics (Green – Hoc 1991). Up to the 1980s, ergonomics focused on sociotechnical systems (Macroergonomics: Berlin – Adams 2017, 5) and cognitive ergonomics on large-scale logical systems (Yoon 2001).
[4] Many studies on ergonomics in modern production contexts allude to ergonomics in historical and archaeological contexts: Taveira – Smith 2012, 275. A definition of protoergonomics is given by Jerezy Charytonowicz: "From prehistory, man has always taken care of their comfort and convenience by making the first tools and successively transforming the material environment, in order to adjust them to their own needs and thus subconsciously initializing paraergonomic activities. The time from prehistory to the second half of the 19th cent. can be described as a period of intuitive ergonomics or subconscious ergonomics." (Charytonowicz 2009, 450).
[5] Cuomo di Caprio 1992, 50. 51.
[6] The three levels are an adaptation of the levels of ergonomic interaction formulated by Livy 1974, 89.
[7] Defined as a teleological motion towards the goal of pottery production.
[8] Community Ergonomics (CE) is a part of (macro-)ergonomics, dealing with the global ergonomics within communities and their social organization: Newman – Carayon 1994, 738–741; Bayeh – Smith 2001, 1201. In the case of pottery production, community ergonomics takes into account how workshops were embedded in the local social structures and the regional and supra-regional commodity chain, including topographical and structural information (Yoon 2001, 254).
[9] The workshops attested by sporadic markers of production, such as traces of firing, misfired pottery or production tools, are not suitable for ergonomic evaluation. In pre-Roman pottery workshops, the firing phase, individuated by kilns, is best attested, while the other phases are badly underrepresented: of the 511 sites of production in middle and south Italy collected by Gloria Olcese (Olcese 2012), only 43 are suitable for the application of criterium A. For criterium B, only 10 sites are available. The same lack of documentation has been mentioned by Eleni Hasaki and by Vladimir Stissi for Greek pottery workshops (Hasaki 2006, 225; Hasaki 2011, 14–17; Stissi 2012, 205).
[10] The workshop, dated on the basis of stratified ceramic fragments to the end of the 7th – first half of the 6th cent. BC, presents many phases of frequentation/use. The last one was attested by four kilns (F1–F3.

F8) type I of Cuomo di Caprio 1985, 140–142) and a working area with chopper-pavements: Cianferoni – Da Vela 2015; Da Vela 2019.

[11] HTA consists in the individuation of tasks directed towards a goal (in our case the production of pottery), in the analysis of their interactions and in breaking them down into sequential chunks: Berlin – Adams 2007, 132. 133.

[12] The KIM evaluation number derivates of derives from a calculation in an interactive sheet, where different movements and postures required by the working tasks are associated to a numeric scale. The interpretation of the ergonomic number is established in the KIM-Method as follows: n<25 absence of risk (color green in the HTA); 25<n<50: minor risk (yellow in the HTA); 50> high risk (red in the HTA): BAuA 2012.

[13] For its shape: s. Cuomo di Caprio 2007, 543–545. For the control of the fire and the cooling down in the case study: Da Vela 2019, 36. 37.

[14] For the differences in the operational chain of household and industrial workshops, referring as well to the implications of specializations: Nijboer 1998, 30. 31. 52–54. For the standardization of the operational space in pottery workshops: Hasaki 2011, 24.

[15] The operational sequences of the workflow of pottery production are based on the possibility to individuate spatially organized structures for each station of the working process: Nijboer 1998, 50–73; Orton–Huges 2013, 121. 122; Santacreu 2014, 60–108.

[16] The present paper presents a modification of the HTA diagram, evaluating the ergonomics of the paths represented as linking edges within the traditional tasks sequence.

[17] This aspect in particular has been analyzed by Vladimir Stissi for the location of Greek pottery workshops: Stissi 2002, 38–48.

[18] Dobres 2010, 52.

[19] Community Ergonomics aims to study the ergonomics of the whole production system (Taveira – Smith 2006, 286).

[20] For potters' residential areas and shared infrastructures in potters' quarters: Stissi 2002, 52–54.

[21] For the impact of the human factor, resources and viability on the choice of the workshops location: Stissi 2002, 38–48.

[22] Lokri Epizephyrioi: Stissi 2012, 201–205; Naxos: Stissi 2012, 207–209; Selinunte: Bentz et al. 2013; Veio, Campetti: Belelli Marchesini 2017, 111–115.

[23] Camporeale 2015, 42. 43.

[24] Stissi 2002, 55.

[25] An ergonomic model of the pottery production in particular could be developed based on ethnographic comparisons. s Nijboer 1998, 18 with preview literature.

[26] Ergonomic models are based on the normal distribution of anthropometric measurements for men and women: Berlin – Adams 2017, 65–82.

[27] Digital human models are male and female manikins with different anthropometric measurements and weight, which are used to reproduce the three-dimensional movement of people at work: Berlin – Adams 2017, 162–173. There is some specific software which allows for the modelling of production ergonomics, such as Tecnomatix® Process Simulate Human and the JackTM Software of Human Simulation by Siemens.

[28] Taveira – Smith 2012, 275–277 present ergonomics as embedded in the sociotechnical system, since the balance between improvement of the production and conditions of the workers is strongly affected by the political and social views of the societies in which the production takes place.
[29] For the definitions of these different scales of production: Nijboer 1998, 50–54.
[30] Technological skills and related cognitive patterns result from apprenticeship processes in communities of practices: Roux 2011, 81. 82; Hasaki 2012, 194–196. In particular on the impact of the social structure in cognitive processes of apprenticeship: David – Kramer 2001, 311–316; Santacreu 2014, 56. 212–216; for the concept of persistence of traditional patterns of production as technological boundaries: Roux et al. 2017.
[31] The relationship between variation of the ergonomic parameters and social and cultural changes is studied e.g. by Rubio 1991, 85, who pointed out how social differentiation and change in work organization can change the ergonomics of a workshop. The possibility to integrate space syntax analysis, studies on the chaîne opératoire and cognitive studies permits us to overcome the traditional separation between specific functionalist, cognitive and sociopolitical explanatory approaches to the organization of pottery production (s. Costin 2005, 1043. 1044). For the impact of cognitive patterns in the workflow: Green – Hoc 1991, 294. 295 "mental aspects, even in a very repetitive physical action must be carefully considered. The increasing interest in cognitive aspects of work is determined by the development of tasks which have important cognitive features as well as the theoretical progress of several sciences in dealing with these features."

Image Credits

Fig. 1. 3–8: by author. – Fig. 2: from Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, <https://www.baua.de/DE/Themen/Arbeitsgestaltung-im-Betrieb/Physische-Belastung/Leitmerkmalmethode/pdf/KIM-manual-handling.pdf?__blob=publicationFile&v=2> (17.08.2019).

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Spezialisierungsfolgen: Struktur und Befunde der metallverarbeitenden Werkstätten in frühgriechischen Siedlungen

Nadin Burkhardt

Abstract: Consequences of Specialization: Structures and Patterns of Bronze Workshops in Early Greek Settlements in the West

There is always a map of the so-called metal working quarter of Mezzavia in the rich literature about early Greek metal production. These structures are part of Pithekoussai, the first Greek settlement in the West. The structures of Mezzavia were built on three terraces, with houses and open areas, and they were in use from the 8th to the 6th century BC. Here were found bronze objects, semi-finished products, technical equipment, tools and traces of the production process.

The author follows the thesis that we cannot speak simply of production quarters in these early times. For the purpose of the argumentation, the archaeological remains and finds of Pithekoussai will be compared to similar findings in other Western Greek settlements like Locroi Epizephyrioi, Megara Hyblaia, Naxos and Selinus and also with early productions places in the Mainland.

The article includes several different questions: How was such an early area of metal production organized and which functions were included? What can we learn about the structure of the working areas and about the use of space there? With which kind of urban structures and functions were such working places combined? Which parallels existed to the Eubean production places, especially in Eretria, the origin cities of the Greek settlers, and in Oropos? Was there a comprehensible development trend from the 7th to the 6th century BC?

Im folgenden werden frühgriechische Werkstattspuren im Siedlungskontext im Focus der Betrachtung stehen. Ein topographischer Schwerpunkt liegt auf den westgriechischen Befunden, die ausgewählten Befunden auf Euböa und aus Oropos gegenübergestellt werden (Abb. 1).

Frühgriechischer Handwerksplätze lassen sich auf eine mögliche Differenzierung von Werkplatz und Wohnort analysieren, sowie in Hinblick auf mögliche Vorstufen eigenständiger Werkstattbauten und auf eine Entwicklung zu Handwerkervierteln, wie sie für die archaische Zeit bekannt sind. Nicht Kostenfaktoren, Rationalisierung oder Serienproduktion stehen im folgenden im Focus, sondern Arbeitsteilung, Spezialisierung und Raumgestaltung.

Frühgriechische Werkplätze und Produktionsstätten sind für verschiedene Landschaftsräume näher betrachtet worden;[1] hier ist besonders auf die Arbeiten von Nijboer hinzuweisen.[2] Speziell antike Werkstattstrukturen und die Ausbildung eines

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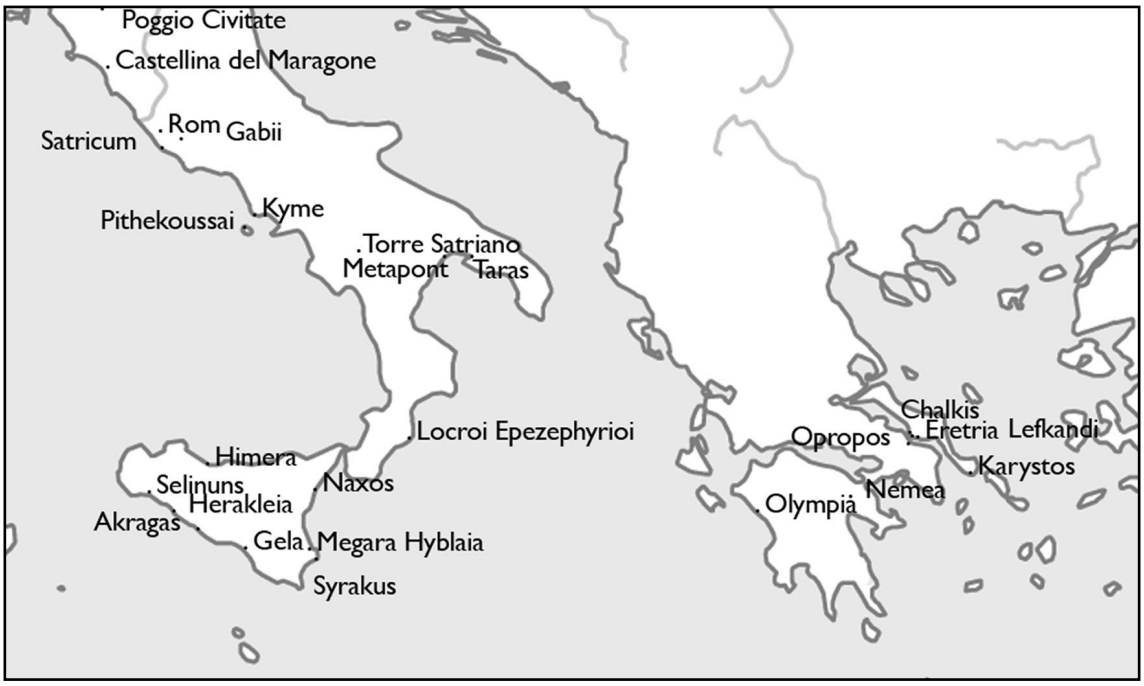

Abb. 1: Kartierung der im Text näher behandelten Orte.

Handwerkerquartiers standen 2009 im Focus der Tagung „‚Quartiers' artisanaux en Grèce ancienne" in Lille, wo auch frühgriechische Befunde analysiert wurden.[3] Bronzewerkstattbefunde im hier betrachteten Raum, oftmals in Verbindung mit Töpfereien, wurden im Jahr 2000 von Fischer-Hansen zusammengestellt.[4] Töpfereien wurden für den Raum der Magna Graecia von Barra Bagnaso und Pisani veröffentlicht.[5] Zu ergänzen sind die phönizischen Produktionsstätten, zuletzt besprochen von Miß.[6] Befunde und Einzelfunde, die eine lokale Metallverarbeitung in der Magna Graecia belegen, sind bisher aus Akragas[7], Selinus, Megara Hyblaia[8], Metapont[9], Herakleia, Himera, Lokroi und Gabii[10], und aus indigenen süditalischen Orten bekannt. In bezug auf die griechischen Kolonien stammen nur die Befunde aus Megara Hyblaia, Selinus und Pithekoussai aus dem 8. und 7. Jahrhundert v. Chr., die anderen sind in der Regel aus spätarchaischer und klassischer Zeit. Für eine Metallverarbeitungsstätte sind an Befunden und Funden neben Schmelzöfen und Schmiedeherden/Essen auch Amboss, Düsen, Brunnen oder andere Wasserinstallationen – z. B. zum Abschrecken, ein Hofareal, Lager- und Arbeitsbereiche, Werkzeuge, Tiegel, Gußformen, Abfälle, Verarbeitungsschlacken, Halbfabrikate und Rohstoffe zu erwarten.[11] Die Öfen für die Metallherstellung wurden in einer leicht eingetieften Mulde von geringem Durchmesser 0,70–1,00 m mit zylindrischem Mantel errichtet; um höhere Temperaturen zu erreichen, wurden Blasebälge eingesetzt, deren Luftzufuhr über Düsen und Düsenöffnungen in der Offenwandung ins Innere geleitet wurde. Das geschmolzene Metall sammelte sich am Boden des Ofens und konnte als Gußkuchen entnommen werden. Bereits gewonnenes

Metall oder Metallabfälle konnten in Tontiegeln über einem Feuer geschmolzen werden. Die bisher bekannten Werkstätten zeigen, dass es keinen standardisierten Aufbau gab; selbst ein architektonischer Rahmen war nicht immer gegeben, da für die Installationen lediglich ein freier Platz notwendig ist. Oft sind nur Öfen, Werkplätze, Produktionsabfälle oder Werkzeuge erfasst worden. Gebäudestrukturen sind dem Befund nach für die frühe Zeit selten. Eine Werkstatt, hier verstanden als ein Raum, eine Raumgruppe oder ein Gebäude, das hauptsächlich der handwerklichen Produktion dient, bezeugt in ihrer Errichtung neben entsprechender Organisation auch eine stärkere Kontinuität. Wir können jedoch hinsichtlich der Größe, des Spezialisierungsgrades und der Lage im Verhältnis zu Haus und Stadt differenzieren. Die räumliche Organisation und eine mögliche Entwicklung derselben sind im Zuge früher griechischer Siedlungsaktivitäten von besonderem Interesse, denn eine lokale Produktion und die dazugehörigen Werkstätten gehören bereits zur zweiten Phase der westgriechischen Siedlung. Im Folgenden steht der Befund in Pithekoussai im Focus, im Vergleich mit euböischen Bronzewerkstätten aus der Mutterstadt, geometrisch-früharchaischen griechischen Werkplätzen und süditalischen archaischen Töpfereien.

Produktionsstätten in Pithekoussai

Pithekoussai wird auf der Insel Ischia der Überlieferung nach durch Siedler aus Chalkis und Eretria gerundet.[12] Die Insel Ischia umfasst etwa 45 qkm und liegt im Westen des Golfes von Neapel, 33 km gegenüber dem Festland mit den Campi Flegrei. Eine griechische Ansiedlung, die mit dem antiken Pithekoussai gleichgesetzt wird, befindet sich im Nordwesten der Insel an der Küste beim heutigen Ort Lacco Ameno mit Blick auf die kampanische Küste. Sie entstand den Keramikfunden gemäß kurz vor oder um die Mitte des 8. Jahrhunderts v. Chr.[13] Von der See her kommend erblickte man als erstes den Akropolishügel, den heutigen Monte Vico. Dieser steile, gut zu verteidigende Sporn wird von zwei Buchten umschlossen, die gute Hafenmöglichkeiten bieten. Der antike Ort wurde von den Hängen her hoch verschüttet und ist zudem modern überbaut, dennoch wurden bisher zwei Votivdepots (loc. Pastola und Scarico Gossetti auf dem Monte Vico), ein Töpferareal (S. Restituta), ein sog. Metal Working Quarter (Mezzavia) und ein Teil der Nekropole (San Montano) ergraben (Abb. 2). Die jüngsten Grabungen erfolgen seit 2016 nordöstlich des Mezzaviaquartiers auf dem Gelände der Villa Arbusto: Mehrere Terrassenmauern und weitere Mauern unklarer Zuordnung wurden aufgedeckt; die Keramik bezeugt eine Nutzung von spätgeometrischer Zeit (LG I) bis in archaische Zeit.[14] Den Funden nach ist noch keine eindeutige Interpretation der Befunde möglich; sie lassen sich in den häuslichen und in den sakralen Kontext einordnen. Metallfunde sind jedoch anders als im Nachbarquartier selten, und Produktionsspuren fehlen bisher. Reine Wohnhäuser außerhalb der sogenannten Werkstattareale wurden bisher nicht aufgedeckt; sie werden südöstlich der Akropolis unter dem modernen Ort vermutet.

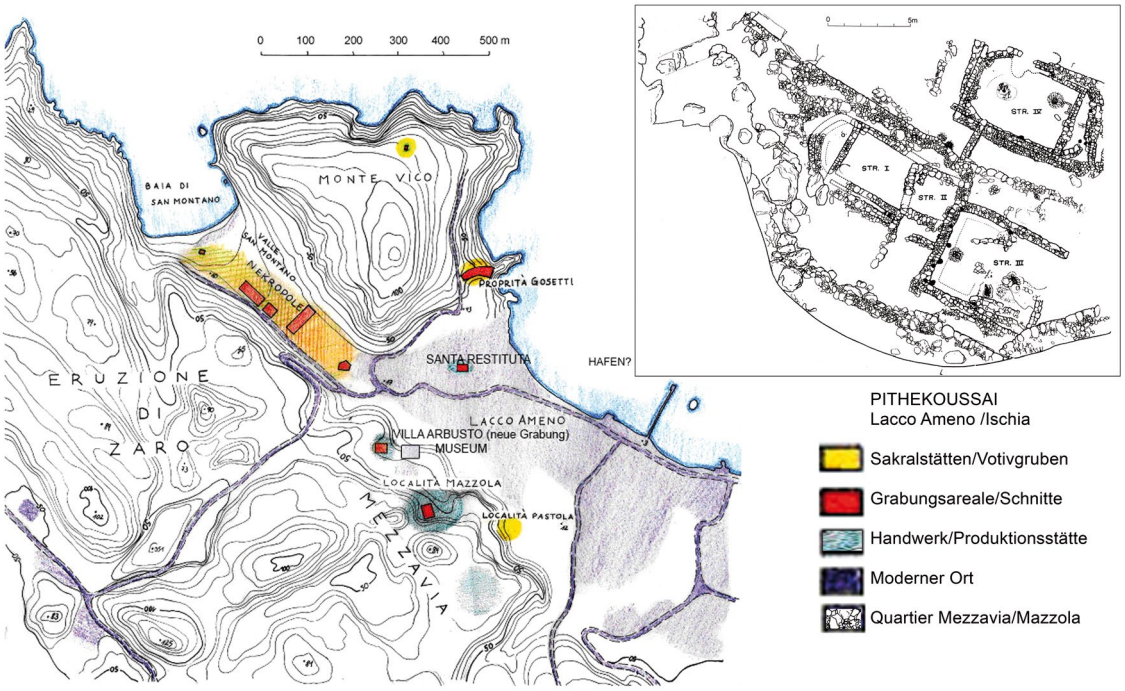

Abb. 2: Lacco Ameno/Pithekoussai mit Kartierung der Fundorte und Grundrissplan des Quartiers in der località Mezzavia.

Entweder gab es eine Hauptsiedlung und die Fundorte località Pastola und Mezzavia stellen suburbane Siedlungspunkte dar oder die Besiedlung erfolgte in einzelnen *nuclei,* wie es auch Buchner schon für Mezzavia vorschlägt.[15]

Bisher konnte man zwei Areale mit Produktionsspuren erfassen; im Tal bei St. Restituta und am Hang des Zaro-Plateaus in der località Mezzavia (Abb. 2). Unter der Kirche Santa Restituta im Tal in Küstennähe sind es Töpferöfen der spätgeometrisch-früharchaischen und der hellenistischen Zeit.[16] Auf 1500 qm wurden hier sieben Töpferöfen mit unterschiedlichen Nutzungszeiten aufgedeckt; das ursprüngliche Töpfereiareal wird von Olcese jedoch größer, mit einer Ausdehnung Richtung Osten, rekonstruiert.[17] Die lokale Produktion ist über die zahlreichen geometrischen Aryballoi, Skyphoi, Kotylen, Kratere, Amphoren und Krüge aus lokalem Ton, die in hoher Anzahl aus den Gräbern stammen, belegt.[18] Töpferöfen des 8. Jahrhunderts v. Chr. fehlen auf Ischia bisher weitgehend;[19] unter Santa Restituta ist lediglich einer erfaßt worden, der in spätgeometrisch-früharchaische Zeit (LG II) datiert wird.[20] Die Lage der Töpferöfen resultiert aus der Nachbarschaft von Tonvorkommen, Quellwasser und Hafen.[21] Da sich unter dem Fundmaterial unter Santa Restituta auch eine ‚tuyère', eine Düse für die Belüftung von Schmelzöfen (Abb. 3), Feuerungsschlacken und ein Kristall Bleiglanz (Blei-II-Sulfit), wie man es zur Blei- und Silbergewinnung verwendete, gefunden wurden, kann man zusätzlich eine Metallverarbeitung im Umfeld der Öfen postulieren,[22] zumal sich außerdem einige hier gefundene Buchstücke von Mühlen und Mortaria mit

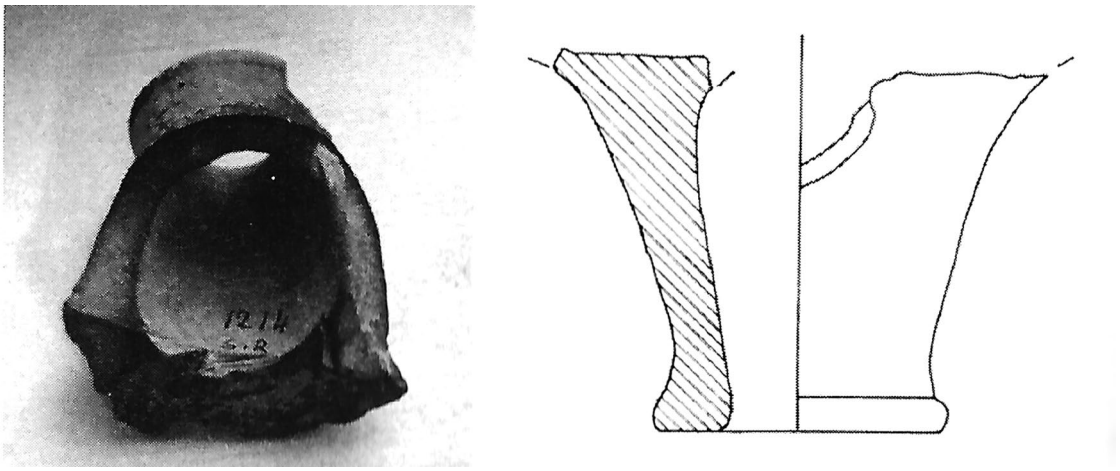

Abb. 3: Belüftungsdüse aus dem Töpferöfenareal unter Santa Restituta (Inv.Nr. SR 1214).

dem Erzzerkleinerungsinventar der Erzwaschereien in Laurion vergleichen lassen.[23] Ob im Umkreis der Produktionsplätze gewohnt wurde, ist weitgehend ungeklärt, da die Spuren von als Räume oder Höfe zu deutenden Strukturen spärlich sind und es keine Abfallgruben gibt.[24]

Ein zweites Areal mit handwerklichen Produktionsspuren wurde auf der Collina Mezzavia, gegenüber dem Monte Vico auf mehreren hoch am Hang gelegenen Terrassen erfasst.[25] Hier wurden in einem Areal von 5000–6000 qm mit Häusern und Höfen Metallobjekte hergestellt. Auf drei Terrassen, die sich am Hang von Südosten nach Nordwesten erstrecken, wurden mehrere Strukturen aufgedeckt, die von der Mitte des 8. Jahrhunderts bis in archaische Zeit datiert wurden (Abb. 2). Drei Phasen ließen sich scheiden: 1.) Mitte bis Ende 8. Jahrhundert (720) v. Chr.; 2.) um 700 bis Ende 1. V. 7. Jahrhundert v. Chr. und 3.) Ende 7. Jahrhundert bis Mitte 6. Jahrhundert v. Chr. – letztere jedoch nur auf der untersten Terrasse im Randbereich.[26] Auf der obersten Terrasse fand man ein bereits stark gestörtes nicht erhaltenes Gebäude. Auf der mittleren Terrasse liegen hintereinander ein Apsidengebäude, ein kleines Mauergeviert und ein rechteckiger Bau (strutture I–III). Auf der untersten Terrasse lag ein mehrphasiger Bau mit vorgelagertem Hof. Die Mauern bestehen aus unbearbeiteten Lavabrocken und lokalem Trachytgestein; nur die der letzten Nutzungsphase aus dem grünlichen Tuff des Epomeo.[27] Teils wurden die Mauern zweischalig mit Bruchstein-Erde-Füllung hochgezogen. Der Oberbau könnte aus Lehmziegeln ausgeführt worden sein, denn die Mauern werden nach oben kleinsteiniger und dienten wohl als Sockel. Die Bruchsteinmauern wurden teils durch vertikale vorgesetzte Balken stabilisiert, die auch als Dachstütze dienten.

Zur ersten Phase gehört das Ovalhaus Struktur IV von 8 × 4 m; um 700 wird es überlagert von einem rechteckigen Haus.[28] Die Pfostenstellungen im Ovalhaus könnten für eine Teilüberdachung sprechen; vor dem Zugang im Osten befindet sich ein rechteckiger Hof, in dem in der 2. Phase, zeitgleich zum Rechteckbau, eine rechteckiger

Ofen aus Ziegeln eingetieft wurde.[29] Benachbart liegen zwei als Amboss dienende schwere Steine. Die Arbeitsspuren in der Struktur IV deuten auf eine Schmiede hin: Außer den Ambosssteinen wurden in einer Grube neben dem Gebäude Bronzeabfälle, Bleibrocken, Metallabfälle, Bronzedraht, grünliche Schlacken, ein kleiner Bronze- oder Kupferbarren und Halbfabrikate, darunter eine Fibel, deponiert.[30] Die Fibel zeigt noch die Naht, die aus der zweischaligen Form resultiert. Der Fibeltyp ist in Kampanien verbreitet,[31] findet sich aber auch in Griechenland, z. B. in Olympia.[32] Außerdem fanden sich mehrere schwach gebrannte kleinere Tonbrocken, die von Wachsformen für kleinformatige Bronzeobjekte stammen könnten.[33]

Der Bereich der Struktur III von 7.50 × 6.00 m stammt auch aus der ersten Phase mit einer Weiternutzung um 700 v. Chr. und war, wie die Pfostenstellungen zeigen, nur im Westen überdacht. Im hartgebrannten Lehmboden befand sich eine Feuerstelle mit zahlreichen Holzkohleresten. Eisenstücke, Schlacken und Hammerschlagabfälle belegen die Metallproduktion, zumindest die Eisenverarbeitung. Überdachte Arbeitsbereiche wie sie auch in Eretria und Oropos in dieser Zeit in Benutzung waren, sind typisch für Bronzewerkstätten, um die Rohformen aus Ton oder Wachs zu schützen und eine störungsfreie Arbeitsumgebung zu schaffen.[34]

Das Apsidengebäude auf der mittleren Terrasse (struttura I) ist das einzige, das nach einer Zerstörung nicht wie die anderen um 700 wieder aufgebaut wurde; seine Ostecke wird von einem neuen Arbeitsbereich überlagert. Es war wohl bei einem Erdbeben zerstört worden, denn auf dem Boden lagen noch ganze zerschmetterte Gefäße. Interessanterweise weist es keine Arbeitsspuren oder Halbfabrikate auf und diente insofern wohl allein zu Wohnzwecken.[35] Im Inneren fanden sich mehrere Gefäße, Fragmente eines großen Kraters – eine Imitation euböischer Kratere des Cesnola-Malers[36] – und mehrerer Skyphoi (Aetos 666-Imitationen) sowie ein Teil einer SOS-Amphora aus dem letzten Viertel des 8. Jahrhunderts v. Chr.[37]

Die Funde aus dem Mezzavia-Areal wurden bis auf Einzelstücke noch nicht publiziert.[38] Es sind Fibeln, eiserne Messer, Rinde, kleine Figuren, wohl Fibelaufsätze, und ein kleines Gewicht. Für die Fibelformen und Ringe gibt es Parallelen aus der Nekropole,[39] auch ein Angelhaken[40] und Messerklingen wurden in den Gräbern gefunden. Das kleine Gewicht war in der Nähe, außerhalb des Gebäudes IV, geborgen worden und hat die Form eines bleiverfüllten Bronzerings (17 × 6 mm); mit 8,79 g entspricht es etwa dem Standardgewicht von 8,72 g des euböisch-attischen Staters.[41] Aufgrund seines Fundorts (Sturzlage) ist die Datierung nicht gesichert; es wird zwischen dem 1. V. 7. Jahrhundert und dem späten 7. Jahrhundert /1. H. 6. Jahrhundert v. Chr. eingeordnet.[42] Es kann als Feingewicht in der Schmuckproduktion zur Abmessung für Edelmetalle gedient haben. Die Befunde und Funde weisen nach dem bisherigen Publikationsstand auf die Metallverarbeitung; Verhüttungsspuren wurden nicht explizit als solche ausgewiesen, bei den Schlacken kann es sich um Schmiedeschlacken handeln.

Schon Greco interpretierte die Befunde in Mezzavia und unter Santa Restituta als funktional spezialisierte Areale: Mezzavia mit einer Spezialisierung auf

Metallverarbeitung am Hang und „ateliers di ceramisti“ im Tal in Hafennähe, beide als räumlich von den Wohngebieten abgesonderte Produktionsgebiete.[43] Heilmeyer sah in der Koloniegründung erst die Voraussetzung erfüllt „sich in Handel und Handwerk […] arbeitsteilig sesshaft zu machen“,[44] wobei ihm Pithekoussai als Vorzeigebeispiel dient. Im folgenden soll anhand weiterer Metallhandwerksstätten auch diese These eigenständiger spezialisierter Produktionsbetriebe in spätgeometrisch-früharchaischer Zeit überprüft und in Frage gestellt werden.

Von welcher Bedeutung das Metallhandwerk für die Pithekoussaner war, lässt sich vielleicht aus den Votivgaben mit Bezug auf die Metallproduktion ablesen. In der loc. Scarico Gosetti wurde eine größere Grube untersucht, die wohl von oberhalb abgerutschtes und entsorgtes Material aus einem Akropolisheiligtum enthielt.[45] Die Grube enthielt archaische Dachterrakotten, Rohstoffbrocken, Geräte, Produktionsabfälle, und Keramikgefäße von italischen bronzezeitlichen Stücken (Appenninkultur) bis zu kampanisch-schwarzgefirnißter Ware.[46] Sie umfasst also Fundmaterial von der Gründungsphase bis in hellenistische Zeit. Unter den Votiven befanden sich auch Objekte der Metallverarbeitung: Luppen, Eisenschlacke in der Tellerform, wie sie beim Schmelzen entsteht, Belüftungsdüsen für die Öfen (tyères)[47] und ein Eisenmineralbrocken von der Insel Elba[48] aus der Mine Rio Marina.[49] Die Funde vom Akropolishang sind nicht stratifiziert, aber ein Stück Eisenschlacke gleicher Art wurde auch bei den Gräbern des 8. Jahrhunderts v. Chr. gefunden.[50] Der Rohstoff, das Erz, wurde wohl aus Elba und Etrurien importiert.[51] Pithekoussai befand sich an einer günstigen Position, um an den Handelswegen der Phöniker und Etrusker entlang der italischen Westküste zu partizipieren und gefragte Bodenschätze einzuhandeln.[52] Weitere Funde verweisen auf Metallbearbeitung: Zwei dickwandige Gefäßböden stammen wohl von Wasserbehältern zum Abschrecken; sie enthalten eine braune Masse, die sich unter dem Elektronenmikroskop als mit Kalk verbackener Hammerschlag erwies, wie er bei der Eisenverarbeitung anfällt.[53] Die Fundstücke müssen nicht alle Votive sein, auch eine Metallproduktion unter dem Schutz des Heiligtums wäre denkbar. In der Heimat der Siedler, in Eretria auf Euböa, sind Bronzewerkplätze, Öfen und Halbfabrikate sowie Produktionsabfälle im Apollonheiligtum gefunden worden.[54] Und auch in Nemea[55] und Olympia lassen Werkstücke, Verworfenes, Gußmantelfragmente, abgeschlagene Eingußtrichter unter den fertigen Votiven auf Metallverarbeitung vor Ort schließen.[56] In der griechischen Kolonie Gela an der Südküste Siziliens wurde im extraurbanen Heiligtum in der località Bitalemi unter den um die Mitte des 6. Jahrhundert v. Chr. im Boden deponierten Votiven auch Barren, Gußabfälle, Gußformen und Gußtiegel notiert.[57] Und aus der Tochterkolonie Gelas, dem westlich benachbarten Akragas, stammt aus dem extraurbanen Heiligtum in der località S. Anna ein großes Votivgefäß, ein Pithos, in dem auch Brucherz, Gußkuchen und Rohmetall deponiert worden war.[58] Aus Italien haben wir spätere Befunde wie den spätarchaischen in Himera,[59] wo im urbanen Tempeltemenos der Oberstadt nahe Tempel D an der Peribolosmauer Schlacken und Luppen gefunden wurden, des weiteren auch im extraurbanen Tempelareal auf dem Piano

di Tamburino, und Befunde aus frühklassischer Zeit in Locroi Epizephyrioi,[60] wo direkt neben dem Tempel in der località Marasà Verhüttung und Verarbeitung von Metallen bis ins 4. Jahrhundert v. Chr. belegt ist. Diese Verbindung von Metallverarbeitung und Heiligtum ist ab dem 7. Jahrhundert v. Chr. auch in italischen Siedlungen wie etwa in Satricum anzutreffen.[61] Möglicherweise gab es also neben Mezzavia Metallverarbeitung anderenorts in Pithekoussai.

Die Fundareale Mezzavia und St. Restituta erlauben nach dem jetzigen Forschungsstand auch Rückschlüsse auf die Produktion. Da keine größeren Gußgruben und Gußmantelfragmente angetroffen worden, sind hier keine größeren Schutzwaffen oder Statuen gefertigt worden;[62] eher Kleinteiliges wie Geräte, Werkzeug, vielleicht Angriffswaffen und eben Schmuckstücke.[63]

Metallverarbeitung in Chalkis, Erteria und Oropos

Schon die Heimat der Pithekoussaner, Chalkis und Eretria, sowie die Insel Euböa überhaupt sind schriftlich und im Befund für Metallverarbeitung und Kupferherstellung in früher Zeit bekannt. Auf Südeuböa bei Karystos sind Minen, Stollen und Schlackehalden aufgedeckt worden.[64] Auch in Lefkandi, zwischen Chalkis und Eretria, wurde neben einem Ovalhaus eine große Grube mit einen Fragment eines großen Gußtiegels (30 cm Dm) und 350 Gußmantelfragmenten für Bronzestangen und -bänder von Dreifußbeinen aufgedeckt.[65] Hier wurden also im 9. Jahrhundert v. Chr. in sicherer Handhabung größere Mengen für den Vollguß geschmolzen und in vorbereite Formen gegossen.

In Eretria wurde im Zentrum der späteren Stadt eine Oikosgruppe mit Metallverarbeitung ergraben (Abb. 4). In der ersten Phase entstanden in der 1. H. des 8. Jahrhunderts vier schlichte Ovalbauten, in denen Öfen, Tiegel und Schlacken sowie Halbfabrikate auf Bronzeverarbeitung verweisen, die Heilmeyer nach Verdan mit einer temporären Produktion verbindet, beispielsweise anlässlich von Festen, Renovierungen und ähnlichem, wie sie auch für Olympia angenommen wird.[66] Die Temporalität, die bedarfsbezogene Installation einer Bronzeverarbeitungsstätte, ist auch für die klassische Zeit gut fassbar[67] und gut abgrenzbar von dauerhaft genutzten Anlagen.[68] Die ebenfalls in den Bauten gefundene Feinkeramik kann auf eine Mischnutzung verweisen.[69] Die südlichen Bauten Ed 1 und Ed 150 zeigen keine Produktionspuren. Ende des 8. Jahrhunderts v. Chr. wurde direkt zwischen ihnen ein Langhaus errichtet, das als Sakralbau Daphnephoreion bekannt ist und dem späteren Apollontempel vorausgeht. Es ersetzt den Apsisbau ohne Produktionsspuren. Zu der Bronzeverarbeitung in den anderen Gebäuden kommen Eisen- und Goldbearbeitung. In einer dritten Phase an der Wende zum 7. Jahrhundert werden auch die anderen Bauten niedergelegt, und der Pre-Tempel steht allein im Peribolos.[70] Auch in einem anderen Haus in Eretria wurden Rohmetalle, speziell Goldnuggets, gefunden. Wenn wir die Oikosgruppe als Sitz einer gut situierten Familie ansehen, können wir die Errichtung des Heiligtums als

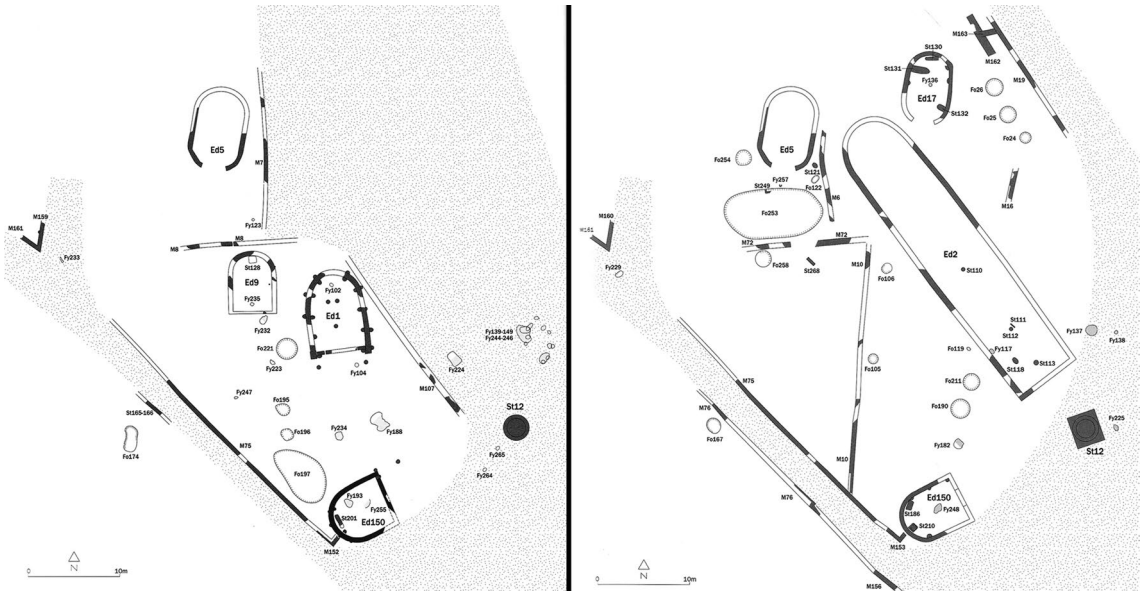

Abb. 4: Oikosgruppe im Areal des späteren Heiligtums des Apollon in Eretria (Euböa).

neue Machtpräsentation und -ausrichtung verstehen,[71] in Konkurrenz zu den anderen einflussreichen eretrischen Eliten. In dem Heiligtum wurden vor allem Bronze- und andere Metallvotive geweiht.

Oropos, gegenüber von Eretria in der Oropaia gelegen und wohl im 1. Jtd. v. Chr. von Lefkandi aus gegründet, weist eine dem pithekoussanischen Mezzaviaquartier ähnlichen Befund auf. Im östlichen Randbereich der geometrischen Siedlung waren jeweils zwei Ovalhäuser in einem Peribolos nebst mehreren Anbauten errichtet worden (Abb. 5). Es sind Oval- und Rundbauten mit Bruchsteinsockel und Lehmziegelaufbau; um die Ovalbauten deutet ein Ring von Pfostenlöchern auf eine umlaufende Portikus oder ein weiten Dachüberstand.[72] In den Häusern und im Hofbereich wurden Eisenmineralienbrocken,[73] Schlacken in größeren Mengen, Holzkohlereste, Aschedepots, Metallabfälle, Schmelzzubehör, Belüftungsdüsen (tuyère), Ambossteine, Ofenfragmente und Ofeninstallationen gefunden. Der Ofenbefund in Oval A bezeugt den Betrieb der Schmiedeöfen in geschütztem Raum; in Eingangsnähe lagen mehrere Bottiche für den Reduktionsprozeß (einer noch mit Schlacke), ein Podest aus Stein scheint als Werkbank gedient zu haben. Bronze und Eisen waren hier parallel verarbeitet worden; erst nach dem 7. Jahrhundert ist eine Trennung und Spezialisierung anzusetzen.[74] Das Haus A(lpha) datiert in spätgeometrische Zeit (LGIIb). Benachbart existierte zeitgleich das Ovalhaus B(eta)(-Γ); nach Mazarakis-Ainian diente es in der ersten Phase als Wohnstätte oder zumindest nicht als Werkstatt, besitzt einen Plattenboden und eine Herdstelle. Erst später, im Laufe des 6. Jahrhunderts v. Chr., wurde hier eine Keramikwerkstatt mit Ofen eingerichtet, während Haus A verfiel.[75] Auch das südlich außerhalb liegende Ovalhaus Iota-Sigma-Tau, das zur benachbarten Ovalhausgruppe Iota und Theta gehört, ist eine Metallwerkstatt, zeitgleich zu Phase 2 des Ovalhauses Iota (A). Nördlich angrenzend

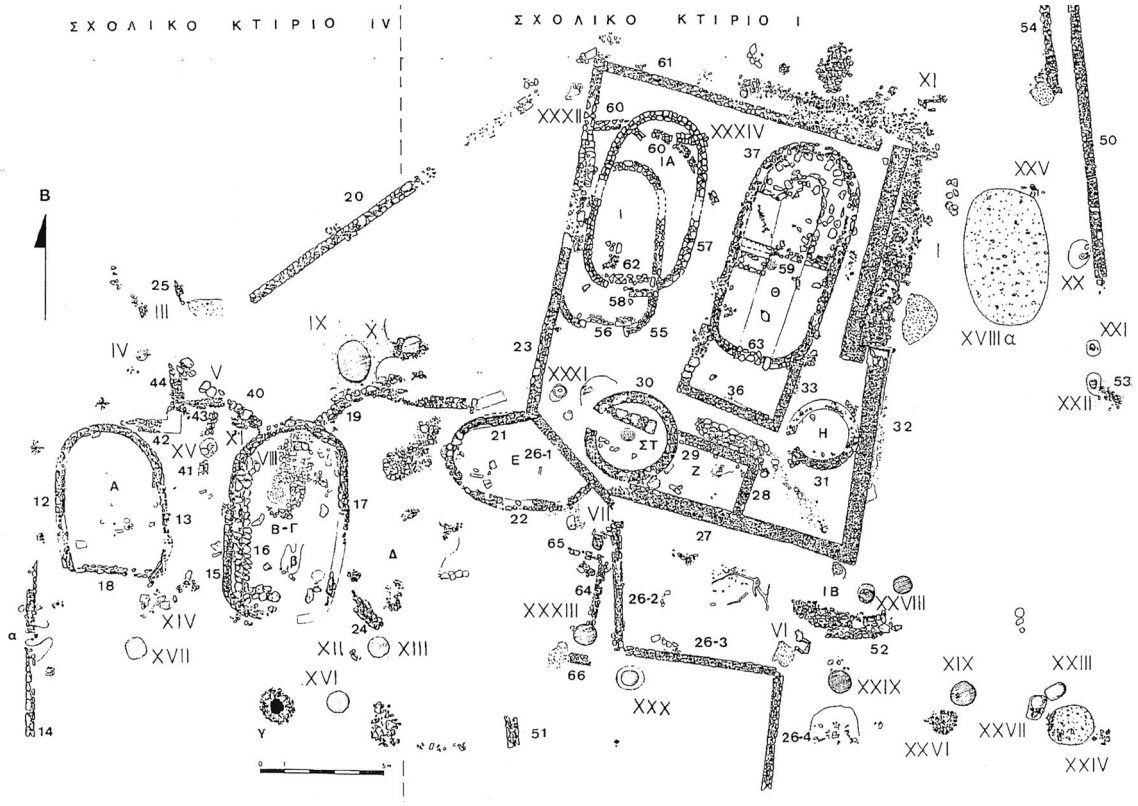

Abb. 5: Oikosgruppe mit Metallverarbeitungsspuren in Oropos.

wurden siebzig Eisenwerkzeuge, einige Schlacken und Metallabfälle gefunden.[76] Das Ovalhaus Iota diente in beiden Phasen den Befunden und Funden nach durchaus als Werkplatz, wenn auch vielleicht nur temporär.[77] Nahebei innerhalb des Peribolos wurden zudem zwei Töpferöfen (ST und H) erfasst, die zeitgleich zu allen Phasen der Gebäude bestehen. Einen solchen Töpferofen gibt es auch in der Ovalhausgruppe im Westsektor der Stadt. Dort wurde wiederum kein Hinweis auf Metallverarbeitung gefunden.

Aus der Abfolge der Bauten lässt sich des weiteren erschließen, dass es zuerst Oval- und Apsidenbauten gab, die als Werkplätze und wohl auch für andere Zwecke genutzt wurden, worauf das Geschirr und die Webgewichte und Spinnwirtel hinweisen. Ende des 8. Jahrhunderts (Phase 3) wurden neben diesen Bauten größere Ovalbauten errichtet, die offenbar nicht als Werkplatz dienten, zugleich wurde der Produktionsbetrieb in den anderen Bauten intensiviert. Im frühen 7. Jahrhundert wurden die Areale durch Anbauten erweitert, die Raumstruktur demnach differenziert und die Produktion fortgesetzt.

Als Zwischenergebnis ist festzuhalten, dass Ovalhäuser mit Metallverarbeitung und die Ovalhäuser ohne solche Spuren und Funde in Oropos sich in Aufbau und Technik kaum unterscheiden. Die Lage der Funde in den Hofflächen spricht für die Existenz großer Regale oder anderer Installationen in Leichtbauweise, etwa in Holz.

Metallverarbeitung und Töpferhandwerk existieren benachbart. Die Abfälle werden in direktem Umfeld entsorgt und planiert.

Die Häuser mit Werkplätzen liegen sowohl zentral als auch peripher im Peribolos. Sie liegen nicht in der Peripherie der Siedlung. Es wurden offenbar keine speziell für die Metallverarbeitung gedachten Häuser errichtet; die Ovalbauten des 8. Jahrhunderts v. Chr. waren multifunktional – wie es Verdan auch schon für die frühen Ovalbauten in Eretria postuliert hat. Die Größe der Periboloi spricht für kleinere Familienbetriebe. Sie bilden jedoch kein auf einen Handwerkerstatus beschränktes Viertel, denn das Ovalhaus Theta, im gleichen Peribolos mit Ovalhaus Iota diente den Funden nach wohl als Sitz eines führenden Gemeinschaftsmitglieds.[78] Es ist in der ersten Phase mit 9,80 × 4,70 m sehr groß, wurde in zwei Bereiche unterteilt und besitzt rückwärtig eine aufgemauerte Bank und eine Herdstelle. Zu den Funden gehören große Kratere, kleinere Krüge und Lekythen, Trinkgefäße, auch Vorratsgefäße, Kochgeschirr und zwei Tonlampen sowie Bronzenadeln und ein Glöckchenanhänger.[79]

Eine reine Subsistenzwirtschaft ist unwahrscheinlich, da z. B. im nahen Westquartier keine Metallproduktionspuren entdeckt wurden. Man kann andenken, dass nur einige Oikosverbände die Metallproduktion unter ihrer Aufsicht hatten. Der hohen Ausstattungsstandard der Nebenbauten lässt auf eine führende gut vernetzte Position dieser Oikoi schließen.

Vom spezialisierten Oikos zum Handwerksbetrieb

Die Differenzierung handwerklicher Produktionsstätten war Teil der frühen griechischen Kolonisierung; sie geschah im Zuge der zunehmenden Spezialisierung der Handwerker und der Produktionssteigerung, die der Kolonisierung vorausging.[80] Die Differenzierung bringt jedoch eine allmähliche Veränderung mit sich, deren Konsequenzen erst in den Koloniestrukturen des 7. und vor allem des 6. Jahrhunderts v. Chr. sichtbar werden.

In den frühen Werkplätzen wurden Eisen und Bronze verarbeitet; die Technik ist auf den Massivguß beschränkt. Hohlformen und großformatige Figuren sind im 8. und 7. Jahrhundert noch nicht nachweisbar. Wohn- und Produktionsstätten sind in den hier gezeigten Beispielen anfangs in gemeinsamen Räumlichkeiten untergebracht, Ende des 8. Jahrhunderts werden Arbeitsort und Wohnort getrennt, bleiben aber unmittelbar benachbart. Dabei ist diese „Enge“ nicht auf einen niedrigen Stand des Besitzers zurückzuführen. Während im Falle Pithekoussais die Lage weiterer Wohnhäuser unbekannt ist und die Nähe zu einem Heiligtum nur postuliert werden kann, liegen die Produktionsstätten in Eretria und Oropos trotz Feuergefahr und Lärmbelästigung zentral; sie sind jedoch mit einer Einfassungsmauer von der Umgebung abgegrenzt. Die wenigen Werkplätze in Etrurien, Mittel- und Süditalien, die nicht allein der Verhüttung, sondern auch der Verarbeitung dienen, datieren vom späten 7. bis ins 4. Jahrhundert v. Chr. und sind bis auf drei Fälle (Santorso in der Provinz Vicenza, S. Giorgio nahe Verona

und Populonia in der Provinz Livorno)[81] ebenfalls in Wohnbauten und im Inneren der Siedlungen eingerichtet worden, so z. B. in Etrurien in San Giovenale (Prov. Viterbo) und Castellina del Marangone.[82]

In Pithekoussai wurden im Mezzaviaviertel keine Töpferöfen erfasst, während zwischen den Töpferöfen unter S. Restituta Metallproduktionsspuren zu beobachten sind. Auch in Eretria liegt keine Kombination von Metall- und Töpferhandwerk vor, während in Oropos diese Produktionsstätten zusammengeführt wurden, besonders im frühen 7. Jahrhundert v. Chr.

Töpfer- und Metallproduktion in der Magna Graecia

Erst im Laufe des 7. Jahrhunderts v. Chr. werden Produktionsort und Wohnort sowie die einzelnen Handwerkszweige getrennt: Für Italien ist dies gut für die Töpfereien belegt. Besser untersucht und publiziert sind jene in Naxos[83], Megara, Selinus und Lokroi. Naxos und Selinus sind klare Beispiele für eine Zentralisierung der Werkplätze, im Fall der Töpferöfen Mitte/Ende des 6. Jahrhunderts v. Chr. In Naxos, einer euböisch-chalkischen Gründung in der 2. H. des 8. Jahrhunderts v. Chr. (735/34) an der Ostküste Siziliens, ist die Produktion von Gefäßen und Terrakotten ab dem frühen 7. Jahrhundert v. Chr. zu fassen.[84] Die Töpferöfen liegen im Bereich der Oikoi und auch im Areal der Heiligtümer sowie im suburbanen nordwestlichen Stadtareal. Die beiden Öfen im Aphroditeheiligtum vom Ende des 7. Jahrhunderts dienten der Gefäß- und der Ziegelproduktion.[85] Aus dem 6. Jahrhundert v. Chr. stammen die im Heiligtum gefundenen Negativformen für die Terrakottenproduktion. Ein Ofen des späten 7. Jahrhunderts im Hof eines Hauses an der Straße Se produzierte Gefäße wie Schalen, Lekanen, Deinoi, Krüge und Hydrien.[86]

Ab der Mitte des 6. Jahrhunderts v. Chr. werden die Produktionsplätze in die nordwestlichen suburbanen Bereiche verlegt, eben dorthin, wo im frühen 6. Jahrhundert in drei benachbarten Öfen bereits Ziegel und großformatige Gefäße wie tönerne Becken produziert wurden. Hier, auf dem Salluzzo-Laruncho-Hügel, entsteht ein Töpferquartier auf 1000 qm. Es löst, soweit die Befunde zeigen, die Gefäßproduktion die Oikosproduktion ab.[87]

In Selinus (Abb. 6), einer Tochterstadt des sizilischen Megara aus der 2. Hälfte des 7. Jahrhunderts v. Chr., wurde am Ostrand der Stadt im 5. Jahrhundert v. Chr. eine viele Öfen umfassende Großtöpferei ausgebaut. Sie liegt innerhalb der Mauern, aber räumlich separiert von den Wohninsulae. Hier haben mehrere Töpfer in einer Kooperative oder einem Großbetrieb verschiedenste Ware, vom Trinkgefäß bis zum Pithos, hergestellt.[88] Die Töpferei besitzt ältere Vorläufer vor Ort, darunter auch Rundöfen und Matritzen einer Terrakottenproduktion in der 2. Hälfte des 6. Jahrhunderts v. Chr.[89] Metallverarbeitung wurde hier nicht beobachtet. Kurz nach der Gründung 628 v. Chr., im späten 7. und 6. Jahrhundert v. Chr., wurde in Selinus im Oikosbereich produziert: In einer Insula nahe der Akropolis sind vier archaische und teils später

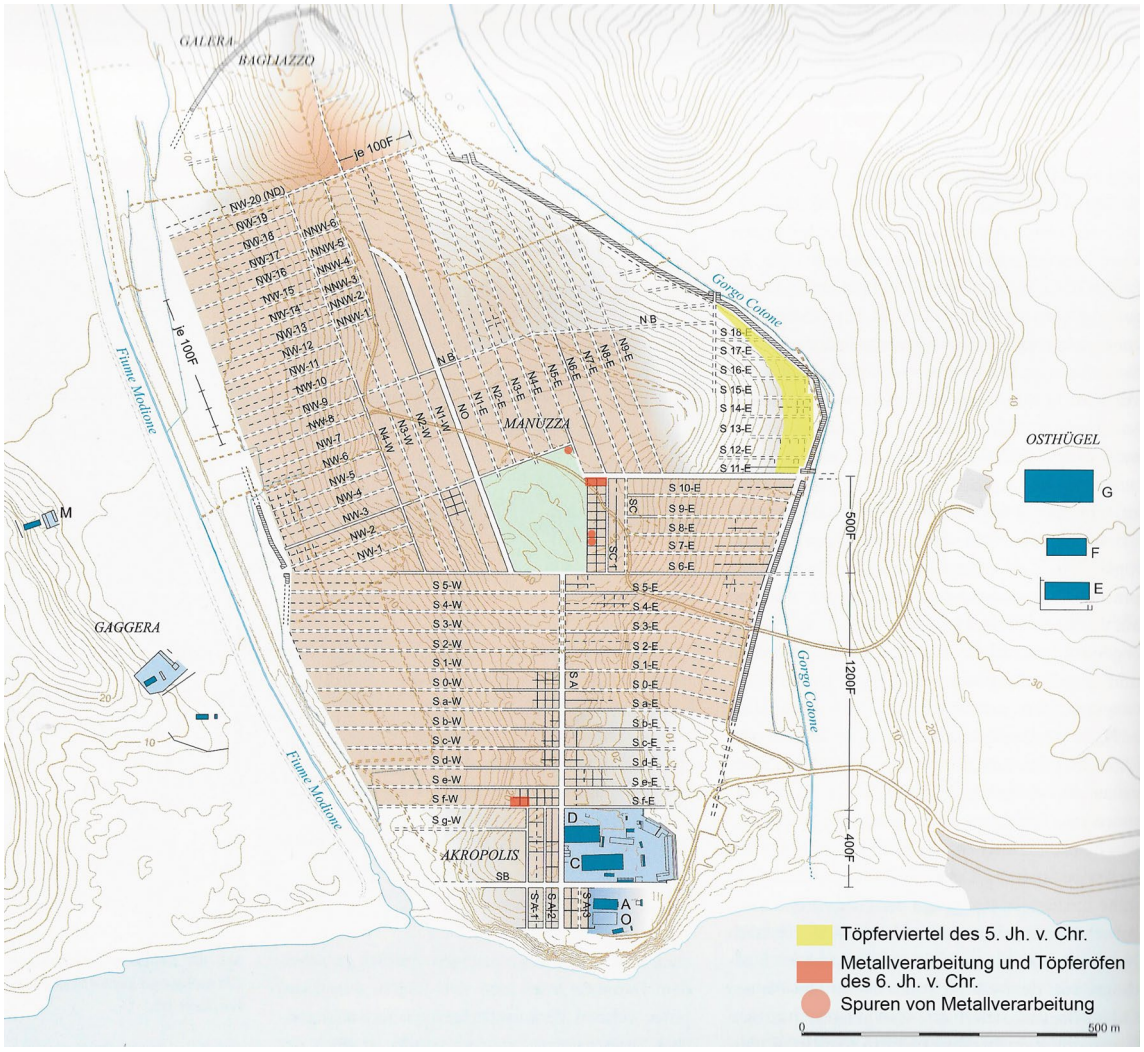

Abb. 6: Stadtplan von Selinus mit Kartierung der Metall- und Tonverarbeitungsstätten.

wiederverwendete Öfen aufgedeckt worden;[90] nahe den Öfen in einigen Metern Abstand wurden die Spuren von Metallverarbeitung erfasst.[91] In einem Ofen des letzten Viertels des 7. Jahrhunderts v. Chr. sind nicht nur Gefäße gebrannt sondern auch Metallobjekte hergestellt worden.[92] In der Agorarandbebauung wurden im Areal zweier Häuser auch große Eisenschlacken in Schichten aus der Mitte des 6. Jahrhunderts v. Chr. gefunden, die auf Metallverarbeitung im Umfeld schließen lassen.[93] In den benachbarten Läden traten Hinweise auf die Verarbeitung und Weiterverarbeitung von Metallobjekten auf.[94] Auch die Pfeilspitzenrohlinge und die Fragmente von zugehörigen Eingußtrichtern aus dem Bereich der Nordhalle sprechen für eine buntmetallverarbeitende Werkstatt.[95] Überhaupt wurden auf und im Umkreis der Agora ungewöhnlich viele Metallobjekte gefunden, besonders im Ostrandbereich. Sie datieren ab 600 v. Chr. und setzen sich neben vollständigen Stücken auch aus Halbfabrikaten, Fehlgüssen, Gußabfällen und

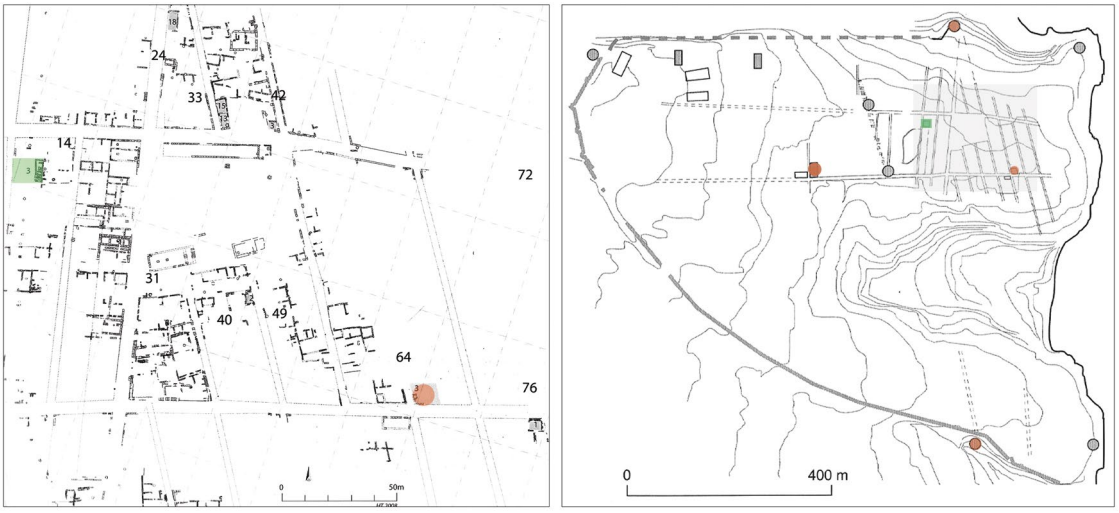

Abb. 7: Stadtplan von Megara Hyblaia mit Kartierung der Metallverarbeitungsspuren.

für die Thesaurierung zerkleinertem Material zusammen.[96] Auch im Agorabereich bestand ein früharchaischer Töpferofen für die Ziegel- und Gefäßproduktion.[97] Erst ab der Mitte des 6. Jahrhunderts v. Chr. entwickelt sich ein Töpferquartier am Ostrand der Stadt.[98]

In Megara Hyblaia und Lokroi Epeziphyrioi verlaufen die Entwicklungen anders. In Megara wurden zwei archaische Befunde der Bronze- und Eisenverarbeitung erfasst; sie befinden sich im Umkreis der Agora und waren, sofern räumliche Werkstätten erkennbar sind, ordentlich ins Insulasystem eingepaßt und den Wohnbauten benachbart (Abb. 7). Eine Bronzewerkstatt des 7. Jahrhunderts v. Chr. wurde westlich der Agora aufgedeckt, sie lag am nördlich Kopfende einer Häuserreihe.[99] Eine weitere archaische Stätte, speziell der Eisenverarbeitung lag an der Kreuzung von C 1 und D 4 nördlich der Agora, bereits im Stadtrandbereich.[100] Töpferöfen für die Gefäß- und Terrakottenproduktion lagen in archaischer Zeit sowohl im Stadtinneren zwischen den Wohnbauten, als auch direkt vor der Stadtmauer im Süden.[101] In den anschließenden Zeiten entstehen zahlreiche kleine Töpfereien und eine weitere Metallwerkstatt, teils innerhalb, teils außerhalb der neuen Stadtmauer;[102] ein isoliertes zusammenhängendes Handwerksgebiet entwickelt sich nicht.

In Lokroi sind ca. 20 Öfen auf den Höfen der Häuser gefunden worden, jeweils in unterschiedlichen Formen: größere für Keramikgefäße und kleinere runde für figürliche Terrakotten. Die Öfen stehen in einem durch Insulae geprägten innerurbanen spätarchaischen Bezirk am Stadtrand, der Ende des 6. / Anfang des 5. Jahrhunderts v. Chr. angelegt wurde; in mehrräumigen schlichten Häuser von ca. 120–220 qm Größe[103] (Abb. 8). Anders als in Selinus bleiben Produktionsstätten und Wohnorte in Verbindung. Feinkeramik und Terrakotten wurden vom letzten Drittel des 5. Jahrhunderts bis kurz vor der Mitte des 4. Jahrhunderts v. Chr. vor

Abb. 8: Quartier „Centocamere" in Locroi Epizephyrioi mit Töpferöfen (rot markiert).

Ort produziert; eine Vorläuferproduktion wäre möglich.[104] Dicht an dicht liegen hier Töpfer- und Koroplastenwerkstätten ab archaischer Zeit.[105] Eine Verbindung von Metallhandwerk und Töpferei wurde auch hier beobachtet: Gießereiabfälle und die Reste von Großbronzen sprechen für eine lokale Produktion.[106] Speziell Koroplastiker waren wohl auch mit der Metallverarbeitung vertraut, da dort ähnliche Techniken zum Einsatz kamen.[107] Züchner merkt an, dass es auch denkbar wäre, dass Bronzegießer ihre Tonformen beim benachbarten Terrakottentöpfer brennen ließen.[108] Hier können wir Familienbetriebe und einen geringen Produktionsumfang annehmen; die Verbindung von Haus und Arbeitsplatz bleibt bestehen. Ähnlich sind die Befunde in der Unterstadt von Himera. Die Verbindung von Töpferei und Metallverarbeitung, wie sie in Oropos besonders deutlich wird und auch für Pithekoussai (St. Restituta), Selinus (nur im 7.–6. Jahrhundert v. Chr.) und Lokroi anzunehmen ist, war so auch anderenorts nicht ungewöhnlich. Etwa in Korinth[109] oder Kroton[110] und auch außerhalb griechischer Poleis, wie im 7. Jahrhundert v. Chr. in Poggio Civitate in Etruria und im 6. Jahrhundert v. Chr. in Torre Satriano und

Braida di Vaglio in Süditalien.[111] Segbers ordnet die Kombination der Produktion für den alltäglichen Bedarf zu, ausgeführt durch den gleichen Handwerker oder einen Zusammenschluss von metallverarbeitenden Handwerkern und Töpfern in einer Werkstatt.[112]

Für die geometrische und spätgeometrische Zeit lässt sich aus der späteren Entwicklung festhalten, dass die Metallproduktion und -verarbeitung eine wichtige Rolle in der frühen Polis spielte und möglicherweise für die euböische Kolonisation einen wichtigen Auslöser darstellte. Die Produktionsstätten sind keine permanenten Anlagen mit eigenen Bauten und Installationen; die Metallverarbeitung ist wie die Keramikherstellung Teil der Oikosproduktion.[113] Dabei lässt die Verteilung innerhalb der Siedlung auf eine Spezialisierung ausgewählter Oikoi schließen, deren Wohnstandard und Ausstattung für eine gehobene Position sprechen.[114] Zu derartigen Ergebnissen kommt auch Miß für die phönizisch-punischen Metallwerkstätten: Die relativ kleinen Anlagen spätgeometrischer bis früharchaischer Zeit[115] mit ein bis drei Öfen liegen tendenziell innerhalb der Siedlungen,[116] angegliedert an Wohnhausareale oder in direkter Verbindung mit einem Wohnbereich.[117] Aufgrund des gegenüber der Keramikproduktion höheren Spezialisierungsgrades und der komplexen Arbeitsschritte, der überschaubaren Produktionsmenge und der Angliederung an Wohnbauten wird es sich hier wie dort um durch den Oikos verwaltete Betriebe mit geringem Personalaufwand handeln. Zudem ist die Metallverarbeitung in geometrischer Zeit auch ohne größere Spezialisierung, wie sie beispielsweise der Bronzehohlguß erfordert, möglich. Natürlich sind dennoch Spezialisten beispielsweise für die Edelmetallschmuckproduktion anzunehmen, auch temporäre Wanderarbeiter, etwa zu besonderen Anlässen wie bei sakralen Festen oder Weihungen, sind denkbar. Wir wissen nichts über die personale Struktur, können aber in den westgriechischen Kolonien eine Entwicklung im Laufe des 7. Jahrhunderts fassen, nach der parallel zur Oikosproduktion nun auch größere spezialisierte Werkstätten entstehen, die von der Haus- und Wohnstruktur abgelöst wurden. Im homerischen Epos werden dann schon spezialisierte Berufsfelder wie der Schmied und speziell der Goldschmied angeführt,[118] die über einen festen Werkplatz – die Schmiede – verfügen, die Treffpunkt und Aufenthaltsort für verschiedenstes Volk sind.[119] Die Ansprache als ‚Metal working quarter' des Mezzavia-Areal in Pithekoussai entspricht nicht den Voraussetzungen für ein Handwerkerviertel, indem mehrere Produzenten nahe beieinander, aber in eigenen räumlichen Einheiten zur gleichen Zeit ihrem Handwerk nachgehen wie etwa im archaischen Töpferviertel in Selinus.[120] Die Bezeichnungen ‚Handwerkerquartier' oder ‚Handwerksviertel' sind für geometrische Bauten bis Ende des 8. Jahrhunderts v. Chr. meines Erachtens anachronistisch und aus späteren Zeiten abgeleitet. In geometrischer Zeit muss stärker von den Möglichkeiten und der Spezialisierung einzelner Oikoi ausgegangen werden.

Notes

[1] Zimmer 1990; Costin 1991; Blondé – Muller 1998; Monaco 2000; Hasaki 2002; Carandini – Greco 2005; Sanidas 2013 und Sanidas 2016.
[2] Nijboer 1995, 33–42; Nijboer 1998; Nijboer 2004, 303–321; Nijboer 2006, 109–143.
[3] Esposito – Sanidas 2012: speziell die Beiträge von Gros, Zurbach, Mazarakis-Ainian, Monaco, Denti, Meirano und Lentini.
[4] Fischer-Hansen 2000, 91–120.
[5] Barra Bagnasco 1996, 27–34; Pisani 2012a, 311–332; Pisani 2012b, 15–37.
[6] Miß 2015, 5–38; Miß 2018, 85: 13 Werkstätten in vier Siedlungen auf Sizilien, 12 auf Sardinien (zumeist Metallwerkstätten), der Großteil jedoch in Spanien und Nordafrika. Es handelt sich zumeist um Öfen, nur in 18 Fällen konnte ein zugehöriges (Werkstatt)-Gebäude dokumentiert werden.
[7] Fischer-Hansen 2000, 110: 5. Jh. v. Chr. außerhalb der Stadt am Heiligtum.
[8] Fischer-Hansen 2000, 111: 8.–7. Jh. v. Chr., innerhalb der Stadt.
[9] Fischer-Hansen 2000, 111: 6.–3. Jh. v. Chr., Töpferei und Metallverarbeitung.
[10] Helas 2014, 145–166.
[11] Nijboer 1998, 197–235; Giardino 1998, 56–70.
[12] Plin. nat. 3, 82; Strab. 5, 4, 9; Liv. 8, 22, 5.
[13] Buchner 1975, 66. 67; Coldstream 2008, 98; Dunbabin 1948, 6 .7; Ridgway 1981, 45–56; Ridgway 2000, 237; De Vries 2003, 146–154.
[14] Giallanella – de Caro 1998, 337. 338 Abb.1; Olcese 2017, 24 Nr.3; Burkhardt – Faust 2016, 4; vorangegangene Notgrabung 1995: Gialanella 1996, 149.
[15] Buchner 1975, 64.
[16] Buchner – Rittmann 1948, 22. 45; Monti 1980, 65; Olcese u. a. 1996; Heilmeyer 2014/2015, 181–182; Olcese 2017, passim (die Öfen sind archäometrisch und über die Keramikfunde datiert worden), vgl. Buchner 1975, 66.
[17] Olcese 2017, 15.
[18] Monti 1980, 61–65 Abb. 20–23; Buchner 1982, 103–105; Nizzo 2007, 36. 37; Neeft 1987, z. B. 59–65. 306. 309. 312: aus der Zeit 725/715–680/670 v. Chr.
[19] Kritisch Ridgway 1990, 67; Buchner – Ridgway 1993, 33.
[20] Olcese 2017, 17 (fornace I: datiert nach der Termolumineszenzmethode).
[21] Olcese 2017, 18.
[22] Olcese 2017, 18 Abb.I.5 (tuyère), 32 Abb.II.18 galena mit 40 cm Dm.
[23] Olcese 2017, 33 Abb.II.19–20.
[24] Heilmeyer 2004, 410; Olcese 2017, 18.
[25] 1969–1970 erfolgten die Grabungen durch Giorgio Buchner, mit den Grabungsassistenten Jeremy Rutter (1969) und Jeffrey J. Klein (1970), unterstützt durch das Museum der Universität Pennsylvania (Klein 1972, 35; Buchner 1970/71, 63. 64).
[26] Buchner 1972, 364.
[27] Gialanella 1996, 147.

[28] Ridgway 1992, 92. 93 Abb. 25; Klein 1972, 36; Buchner 1970/1971, 63–67 Abb. 5.
[29] Zimmer 1990, 17 Abb. 1; Gialanella 1996, 147.
[30] Klein 1972, 37 Abb. 5–6; Buchner 1975, 65.
[31] Buchner 1972, Taf. 91.3: fibula con arco a piccola sanguisuga piena; cf. Fibeln aus Grab 581 und 283: Buchner 1993, Taf. 169 und 109; Nizzo 2007, 91 Nr. A10A2b1: Bsp. aus Grab 5,6 cm L, LG I; Verweis auf Bartoloni – Nizzo 2005, 416. 417, cf. Fibel aus Grab 81 (Slg. S. Paolo), Paribeni 1906, 388 Abb. 11.
[32] Zimmer 1990, 18; Philipp 1981, 286–288.; D'Agostino 1973, 214.
[33] Zimmer 1990, 18: eigene Anschauung mit G. Buchner.
[34] Zimmer 1990, 158–159.
[35] Klein 1972, 36; Buchner 1972, 365.
[36] Gialanella 1996, 147.
[37] Buchner 1972, 366.
[38] Die Publikationsrechte liegen bei Costanza Gialanella und Pietro Guzzo.
[39] Guzzo 2004, 77: 192 Schmuckstücke in 74 Bestattungen, von TGI bis MPC/C.
[40] Nizzo 2007, Taf. 2 Nr. A370A.
[41] Buchner 1975, 80.
[42] Buchner 1970/1971, 64.
[43] Greco 1994, 17; vgl. Greco 2005, 15–20.
[44] Heilmeyer 1982, 108.
[45] Di Sandro 1986, 9; Buchner 1975, 64; Coldstream 1995, 251. 266. 267.
[46] Nur wenige eisenzeitliche Keramikscherben aus der Zeit vor der Gründung Pithekoussais sind darunter. Spätgeometrisches Material ist reichlich vorhanden und dominiert den Befund, Keramik des 7. bis 5. Jhs. v. Chr. ist dagegen seltener vertreten, während der Anteil der Ware hellenistischer Zeit bis zur späten schwarzgefirnißten kampanischen Ware deutlich höher liegt. Aus klassischer Zeit stammen figürliche Terrakotten (Scatozza Höricht 2007); aus hellenistischer Zeit Tonvotive in Früchteformen und figürliche Protomen (Monti 1980, 98 Abb. 43). Römische Keramik fehlt (Di Sandro 1986, 9. 10). Zu den frühesten Stücken gehören Skyphoi a chevron mittelgeometrischer Zeit (Ridgway 1981, 45–56; Ridgway 1984, 98 Abb. 21).
[47] Ridgway 1992, 90. 91 Abb. 24; Buchner 1970/1971, 66; Buchner 1969, 97. 98 Abb. 10 a–d; Zimmer 1990, 19 sieht darin jedoch Kesselstützen, also Haushaltsgerät.
[48] Der Metallabbau auf der Insel wurde durch die Etrusker in großem Stil betrieben; die Verhüttung erfolgte vor allem gegenüber an der Festlandsküste in Populonia. Giardino 1998, 195; Diod. 5, 13, 1–2.
[49] Snodgrass 1980, 339. 367 (aus über 400 km Entfernung importiert); Buchner 1966, 12; Buchner 1969, 97. 98; Buchner 1975, 68. 69. Das Ergebnis der Metallanalyse durch das Universitätsmuseum Pennsylvania ergab: Fe 63,4%, Si 21,2% und Spuren von Cu, Ca, Mg. Die Analyse weiterer Metallabfälle durch Giorgio Marinelli, Instituto di Mineralogia e Petrografia dell'Universitá di Pisa, ergab ebenfalls eine Provenienz von Elba (Monti 1980, 68 Anm. 30: Fe/2 O/3).
[50] Buchner 1966, 12.
[51] Monti 1980, 67; vgl. Markoe 1992, 71 Abb. 8. Auch ein Erzbrocken aus Pithekoussai, Mezzavia, stammt aus Elba. Ridgway 1992, 99.
[52] De Juliis 1996, 45–50; Ridgway 1994, 35–46; Morris 1992, 143; Lane Fox 2008, 140; Camporeale 2000, 89–91; Aubet 1993, 240, 264; Markoe 1992, 61–84; Hartmann 1985, 285–294; La Rocca 1974, 86–103.

[53] Zimmer 1990, 19; Buchner 1969, 97 Abb. 27a–d; Proben in Berlin am Antikenmuseum untersucht; Überlassung durch Buchner. Tiegel können es nicht gewesen sein, da sie nicht verbacken oder verschlackt sind.

[54] Huber 1991; Huber 1997; Verdan 2007; Verdan 2012 Kap. 6. 8.

[55] Zimmer 1990, 7: Gußanlagenbefunde aus Nemea und Olympia erwähnt.

[56] Bol 1985, 22. 27 Abb. 8–9. Sie lagen mit fertigen Votiven unter einer Planierschichte um 600 v. Chr., können also spätgeometrisch bis früharchaisch sein. Bol führt sie auf temporär zum Fest angereiste Handwerker zurück, die in provisorischen Werkstätten arbeiteten. Sie brauchen nur Werkzeug und Blasebalg mitbringen, Wachs, Holz, Braunkohle und Formerde gab es vor Ort. Schlacken oder Tiegelfragmente fanden sich bisher nicht. Nach Zimmer 1990, 161 Anm. 612 waren in den Heiligtümern in Olympia und Samos auch Bronzebarren unter den Votiven. Heilmeyer 1981, 443 Abb. 2.3; Rhoden – Weisgerber 1988, 196–204 Abb. 1 Düsen aus Olympia.

[57] Baitinger 2016, 168 mit Anm. 1217 (Depot 7, 8 und 19).

[58] Fiorentini 1969, 72; Baitinger 2016, 175 insges. 149,8 kg Bronze waren im Pithos.

[59] Edel – Mango 2017, 117.

[60] Rubinich 2010, 390–392, Weger 2013, 58. 74.

[61] Maaskant-Kleibrink 1992, 106–107; Weger 2013, 47. Schlacken, Hüttenreste (VII) und eine hohe Anzahl Metallvotive.

[62] Zimmer 1982: vgl. die Auswertung der Vasenbilder: Gerüst und große Öfen; Werkzeug: Schaber, Meißel, Stichel, Feilen, Bimsstein, Schulp des Tintenfisches, Hammer, Setzhammer, Zangen.

[63] Wohl auch keine Toreutik: Treibarbeit, aber Füße und Henkel wurden teils gegossen, sind aber nicht im Fundmaterial.

[64] Bol 1985, 9.

[65] Zimmer 1991, 19–20 Abb. 15 Formmantelfrg., Mus. Eretria; Zimmer 1990, 19–20; Bol 1985, 21 mit Anm. (verwechselt mit Eretria); Popham – Sackett 1968, 28–30. Abb. 67.

[66] Heilmeyer 1982, 105.

[67] Heilmeyer 2004, 408; Zimmer 1990, 156.

[68] Zimmer 2018, 126–129: Die Bronzegießerwerkstatt am Syntagmaplatz in Athen wurde ab dem 5. Jh. v. Chr. bis in spätklassische Zeit genutzt und zeigt im Befund eine andere Gießgrubenform und eine höhere Anzahl an technischen Funden wie Trichterfragmenten.

[69] Verdan 2007, 315: LG-Feinkeramik in Ed 17 und in Gruben vor Ed 5.

[70] Verdan 2007, 345–359.

[71] Hall 2013, 18.

[72] Mazarakis-Ainian 1998, 194.

[73] Mazarakis-Ainian 1998, 203: „iron minerals in their natural state" im Peribolos von Ovalhaus A.

[74] Pleiner 1969, 35: „Smithies (of iron work) of the 7th century B. C. served as foundries of bronze as well."

[75] Mazarakis-Ainian 1998, 195 Abb. 13: er erwähnt Schlacken, ein Knochenwerkzeug mit Bleiresten, Spinnwirtel, Webgewichte, eine Bronzescheibe mit zwei Löchern, eine erste und eine spätere Herdstelle, einen Töpferofen (letzte Phase). Eine genaue Zuordnung zu den Phasen erfolgt nicht. 8.50 x 4.60 m – größer als Ovalhaus A.

[76] Mazarakis-Ainian 2012, 130 Abb. 5: wohl der Versturz aus einem Holzregal.

[77] Laut Mazarakis-Ainian 2012, 128 diente auch der Herd des Hauses Iota-Sigma-Tau nicht für die Metallproduktion, und der Nachfolgebau (Iota-Sigma-Tau) im Peribolos, rund, 120 m Dm, mit Ofenbefund sei in der Funktion rätselhaft.
[78] Mazarakis-Ainian 1998, 201: allerdings mit Bezug auf das Ovalhaus in Pithekoussai und eine Apsishaus im Apollonheiligtum in Eretria.
[79] Mazarakis-Ainian 1998, 196. 198: drei Phasen, spätes 8.–7. Jh. v. Chr., 2. Phase: verlängert auf 12 m, Mauern immer weiterverwendet.
[80] Z. B. bei der griechischen Fibelherstellung und bei der Produktion von Kleinbronzen (Votive,) Anfang des 8. Jh. v. Chr., mit technischen Neuerungen im 2. V. des 8. Jh. v. Chr. Heilmeyer 1982, 61–66. 104–105.
[81] Weger 2013, 76–77.
[82] Weger 2013, 78.
[83] Naxos: Lentini 2012, 281–300.
[84] Lentini 2012, 281–282.
[85] Lentini 2012, 287 Abb. 5 zwei Öfen des 7.–6. Jh. v. Chr. im Aphroditeheiligtum. Ein archaischer Ziegelofen wie Ofen B wurde auch in einem Heiligtum Scala Portazza in Leontinoi, einer Tochterkolonie von Naxos, gefunden. Auch im Apollonheiligtum von Metapont sind zwei Öfen für die Dachziegelproduktion aufgedeckt worden: Cuomo di Caprio 1992, 76.
[86] Lentini 2012, 287. 288 Abb. 10–13.
[87] Lentini 2012, 284. 294: Lediglich eine Ansammlung Terrakottennegativformen nahe der Agora (Insula C5, stenopos 6) könnte auf eine Koroplastenwerkstatt des späten 5.–4. Jh. v. Chr. zurückzuführen sein.
[88] Selinus: Bentz 2018, 101–112, bes.105–108; Bentz u. a. 2013, 69–98; Bentz 2015, 62–66. Auf 1200 qm wurden auf drei Terrassen, Höfe, Arbeits-, Lagerräume, kleine Votivnischen, zwei Öfen ab Mitte 6. Jh., weitere Öfen/neuer Kerameikos ab 5. Jh. v. Chr., Ziegel, Vorratsgefäße, Sarkophage, Louteria, Terrakotten, Feinkeramik, nur wenige Knochen und Metallobjekte gefunden. Das Areal gehört zu einem großen Töpferareal mit 83 Öfen, am Fluss am Ostrand der Stadt, innerhalb der Mauern, aber durch unbebauten Streifen von der Stadt getrennt. Hausähnliche Strukturen aber ohne „Wohninventar“ – wohl Arbeitsbereich mit Wasser. Metallfunde – die meisten aus Bronze, einige aus Eisen und nur vereinzelte aus Blei – sind selten. Unter den wenigen identifizierbaren Stücken sind Nägel und Nadeln sowie vereinzelt Fragmente von Gefäßen, Reiben, Angelhaken und Pfeilspitzen.
[89] Bentz u. a. 2016, 63. 64 Abb. 4; 70. 71 Abb. 13 a–b.
[90] Fourmont 1992, 57–68, bes. 60–61 (Insula FF 1, südwestlich der Akropolis auf dem Manuzza-Plateau, Keramikproduktion und Koroplastik ab Ende 7./Anfang 6. Jh. v. Chr.).
[91] Fourmont 1992, 61 (les artisans métallurgistes). Nach Baitinger 2016, 178 waren es Schlacken, Barren, Brandstellen und eine Gußform für ein Pferd, spätes 7.– fr. 6. Jh. v. Chr.
[92] Vorbericht: Fourmont 1991, 7–41; Fourmont 1992, 61; Albers u. a. 2011, 45.
[93] Baitinger 2016, 177. 178; Adorno u. a. 2016, 74: das nördliche Ende der Ostrand-Insula an der Agora, Schnitt A, Hausgrundstücken 11 und 22 (Schlehofer/Franceschini).
[94] Baitinger 2016, 178: Grundstück 3 b,c; Grundstück 4, Phase Ib.
[95] Baitinger 2016, 177: sie stammt wohl aus dem 5. Jh. v. Chr., aus der Spätzeit der Stadt.
[96] Baitinger 2016, 165. 166. 176.

[97] Bentz u. a. 2013, 69–98; Jonasch 2009, 6: spätarchaische Dachziegelproduktion im Agorabereich.
[98] Nach der Zerstörung 409 v. Chr. durch die Punier sind Töpferofen im späten 5. und 4. Jh. v. Chr. wieder im Stadtgebiet zu finden: an der Straße EE 2 und FF 1. Fourmont 1992, 57.
[99] Gras – Tréziny 2009, 88 Abb. 1 Nr.1, 89 Abb. 2 Nr.3 (Insula 14); Gras u. a. 2004, 45 Abb. 39; und 481. 482; Vallet u. a. 1976, 342 (14,3 und 64,3). 410.
[100] Gras – Tréziny 2009, 90; Gras u. a. 2004, 483.
[101] Gras – Tréziny 2009, 88–90 Abb. 1 Nr.3 und 4, Abb. 2 Nr.3 (Insula 64).
[102] Gras – Tréziny 2009, 91–97 Abb. 3 Die hellenistischen suburbanen Öfen liegen in den Hausruinen vorangegangener Epochen.
[103] Barra Bagnasco 1996, 27–34; Meirano 2012, 257–279. Von größeren und besser ausgestatteten Häusern ist aber erst eines, zudem 4./3. Jh. v. Chr. datierendes Haus im südlichen suburbanen Gebiet gefunden worden. http://www.treccani.it/enciclopedia/locri-epizefiri_%28Enciclopedia-Italiana%29/ (14.04.2020).
[104] Spigo 1977, 127.
[105] Muller 2014, 63–82.
[106] Fischer-Hansen 2000, 96 nach Barra Bagnasco 1989, 37–42. 45–47.
[107] Burr Thompson 1990, 31–36 in bezug auf klassisch-hellenistische Toreuten und Koroplasten; Segbers 2018, 114–115; vgl. Athen: Uhlenbrock 1990, 15.
[108] Züchner 1950/1951, 203; Hasaki 2002, 287 bringt weitere derart begründete Nachbarschaften von Töpferöfen und Metallhandwerkern (Pella, Petres/Florina, beide hellenistisch).
[109] Segbers 2018, 115; Stilwell 1948, 114–118.
[110] Segbers 2018, 114; Spadea 1993, 27; Verbicaro 2010, 231.
[111] Segbers 2018, 114. 115.
[112] Segbers 2018, 116.
[113] vgl. Pleiner 1969, 35.
[114] Vergleichbar den für die Keramikproduktion geprägten Begriffen wie „communal specialization“ (Costin 1991) und „household industry“ (van der Leeuw 1977; Peacock 1982).
[115] Die ältesten der bisher erfassten phönizischen Werkstätten zur Metallbearbeitung im Mittelmeerraum datieren in die 2. H. des 8. Jh. und ins 7. Jh. v. Chr.: Miß 2015, Kat.Nr. 34 (Iberien, La Fonteta); 39 (Morro de Mequitilla); 41 (Sa Caleta); 42 (Toscanos); 49 (Karthago); 60 (Lixus); 70 (Sulky/Sant'Antioco).
[116] Miß 2018, 97; Miß 2015, 14 sowie Kat.20 (Cádiz); 25 (Cerro del Villar), 34 (La Fonteta, Metallverarbeitung am Siedlungsrand); 41 (Sa Caleta); 70 (Sulky). Diese Lage und Struktur bestätigt Nijboer auch für Marzabotto: Nijboer 1998, 288.
[117] Miß 2015, 14 bes. Kat.34 (La Fonteta, Metallverarbeitung am Siedlungsrand); 41 (Sa Caleta); 62 (Monte Sirai).
[118] Canciani 1984, N 76, 98–99 mythische Spezialisten der Metallverarbeitung im Epos, N 99–100, 112, 118–122 homerische Bezeichnungen der Spezialisten im Metallhandwerk.
[119] Hom. Od. 3, 432–439; 8, 273; 18, 328; Eckstein 1974, L 28, 42. Drerup verbindet eine besondere Wertschätzung der Schmiedekunst und des Erzes mit der Repräsentation des Oikos in geometrischer Zeit. Drerup 1969, O 132.
[120] Costin 1991 zu den Kriterien seiner „nucleated workshops“; vgl. Hasaki 2002, 266.

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Abb. 1: Autorin. – Abb. 2: Autorin, nach Mertens 2006, 37 Abb. 40. – Abb. 3: Olcese 2017, 18 Abb. I. 5. – Abb. 4: Verdan 2007, Taf. 7–8. – Abb. 5: Mazarakis-Ainian 1998, 189 Abb. 10. – Abb. 6: nach Fourmont 1992, 57–61; Baitinger 2016, 177–178; Bentz u. a. 2016, Abb. 4. 13 a–b. – Abb. 7: Gras – Tréziny 2009, 88–89 Abb. 1–2. – Abb. 8: nach Meirano 2012, 262 Abb. 2 und Barra Bagnasco 1996, 28.

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An Iron Age Metal Workshop at Gabii, Latium

Sophie Helas

To Stefano Musco (†), with my gratitude

Topography

The ancient site of Gabii was a settlement of the Latins, who formed a part of the larger group of the Italic peoples. It is located in the immediate vicinity of Rome on a coastal plain in central Italy which extends from the Tyrrhenian Sea in the west to the Apennine Mountains in the east. The earliest archaeological evidence of the Latin culture (civilità laziale) dates back to the turn of the 1st millennium BC.[1] Amongst researchers, Gabii is most well-known for its Iron Age necropolis which is located at today's Osteria dell'Osa. The finds of the necropolis have been analysed and published by A. M. Bietti Sestieri and A. De Santis.[2]

The Evolution of the Settlement

The main source of every urban study of Gabii has to be the work of M. Guaitoli, for which he analysed aerial photographs and the general topography as well as known stray and surface finds.[3] His results are now to be substantiated or possibly corrected by the ongoing research projects.[4] According to Guaitoli's studies, the rim of the crater lake was already populated during the middle Bronze Age. The analysis of the tombs at Osteria dell'Osa suggests that Gabii had become an important location by the 9th century BC (according to traditional chronology).[5] Little is known about this settlement. The concentration and distribution of the surface pottery paint a picture of several pre-urban nuclei spread irregularly over the tuff plateau, the slopes and the edge of the lake (fig. 1). In the early Iron Age, the inhabitants of the area retreated to the southern part of the plateau where a proto-urban settlement was established over the course of the 8th century BC. During the 7th and 6th century BC, the site evolved into an urban centre with sanctuaries[6] and governmental institutions.[7] The city prospered during the Archaic period, but ultimately began to decline in importance, power and inhabitants with the onset of the mid-Republican period (4th/3rd century BC).[8]

Location of the Workshop

The fortifications of Gabii and their historical context were the main objectives of our archaeological explorations.[9] During our excavations, conducted between 2008 and

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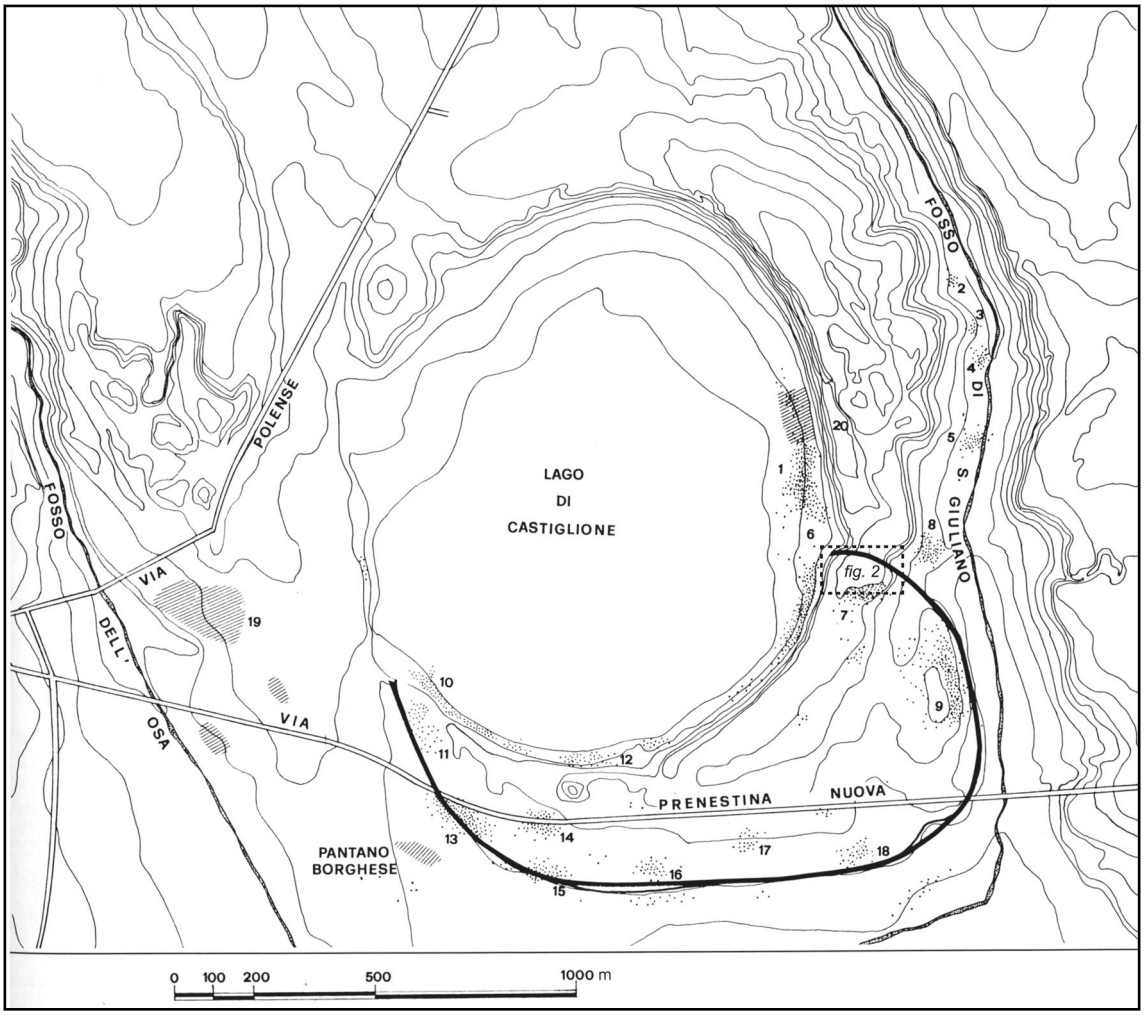

Fig. 1: Gabii in the Early Iron Age, with the later city wall (black), pre-urban nuclei (dotted) and necropoleis (hatched). The dotted line marks our excavation areas A and B.

2014, a group of structures was discovered in the eastern part of the ancient *arx*, which we interpret as a metal workshop and copper-alloy foundry. At present, the *arx* of Gabii is less prominent than it was in ancient times, mostly due to extensive quarrying of tuff stone to its south that began in the mid-Republican period. Very obvious even today is the depression to the north of the northern edge of the *arx* (fig. 2). Originally most likely a natural landform, its defensive properties were reinforced by further chiselling away the sides, most likely during the Archaic period. To the south of this moat, up on the northern edge of the settled *arx*, our two main trenches A and B are located. In area B, the workshop that is to be the subject of this paper was excavated between 2010 and 2014.[10]

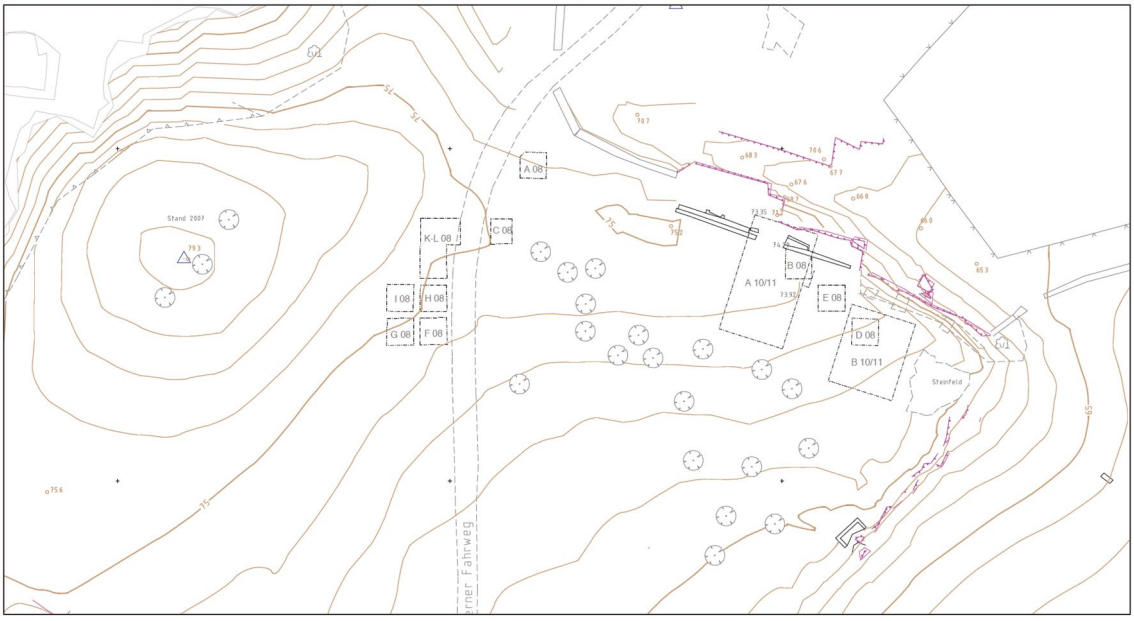

Fig. 2: The northern arx of Gabii with the areas excavated by the German Archaeological Institute (2008) and the University of Bonn (2010–14).

The Structures

Structure 1: The Kiln Used to Manufacture Terracotta Casting Moulds

Structure 1, of which only the foundations remain, is located directly below the crest of the slope. After discovering and identifying the light-red soil as the fill of a kiln and determining its extents, we[11] decided to cut it lengthwise from east to west and excavate only its southern part (figs. 3. 5. 6). We were able to distinguish two building phases. In this paper, only the main phase (Phase 2) shall be discussed in detail.[12]

Phase 1: The Circular Kiln – Latial Period IIB or earlier

The first kiln consists of a platform made of roughly set stones, forming a circular structure with an external diameter of 3,40 m. This was most likely a substructure for a dome-shaped kiln made of clay and wattle and daub, of which no traces remain.

Phase 2: The Kiln on a Rectangular Platform – Latial Period IIB

After the fortifications had been built up against the northern side of the kiln, it received a new frame. For this purpose a short wall was constructed on its eastern side, connecting the platform and the city wall (figs. 3–5). On its northern side, the narrow gap between the fortification and the circular platform was also filled in, and the southern side was similarly closed off. With this frame, the kiln received a new, rectangular form.

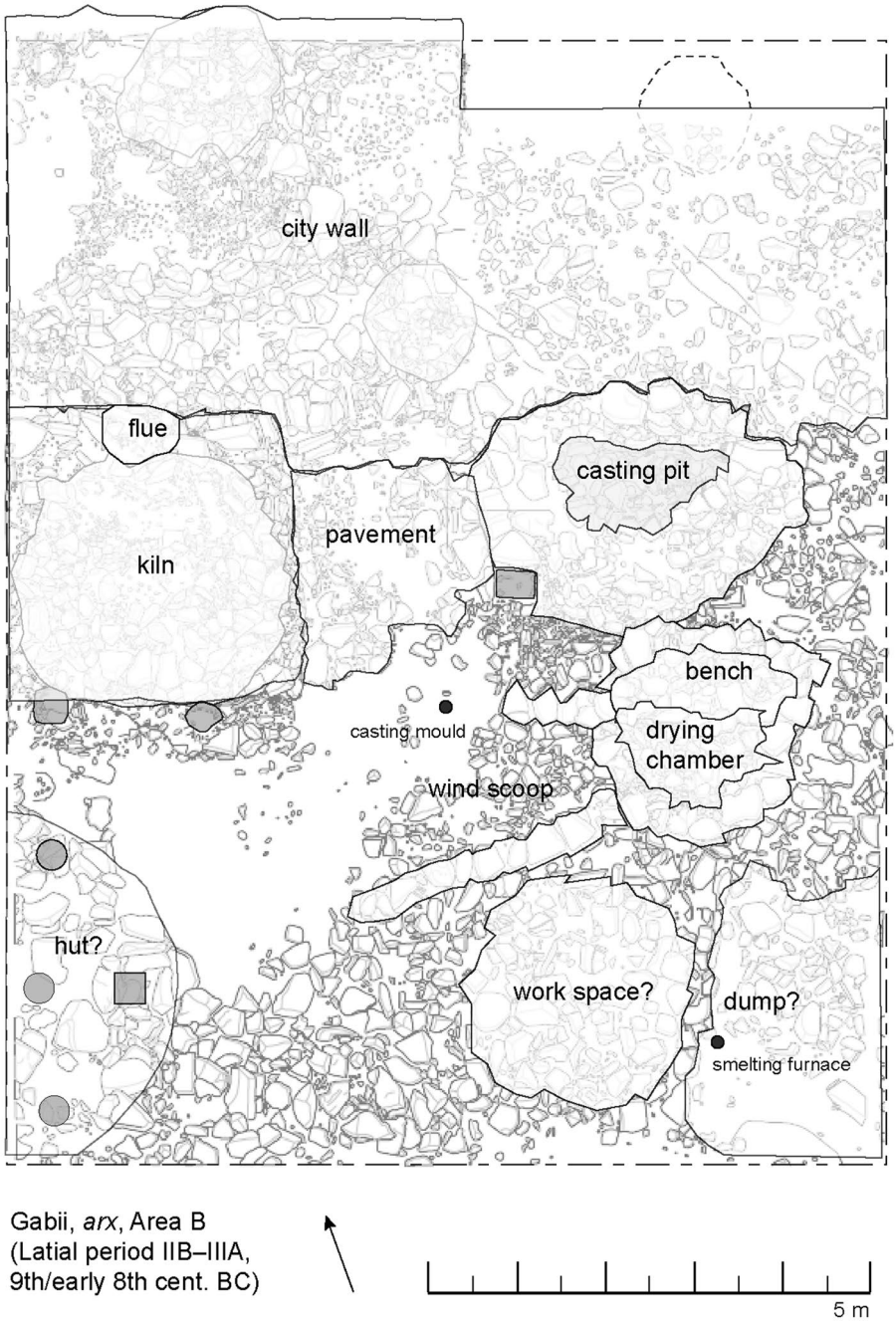

Fig. 3: Drawing of area B with Structures 1–3 (structure 1: kiln, structure 2: casting pit, structure 3: drying chamber).

Two post-holes and remains of loamy material point to the existence of a dome-shaped structure made of clay and wood. The centre of the kiln's platform was now hollowed out, creating a shallow pit lined with small stones. The opening forming the entrance to the kiln reached far into the dome, leading us to reconstruct a tunnel-like stoking chamber.

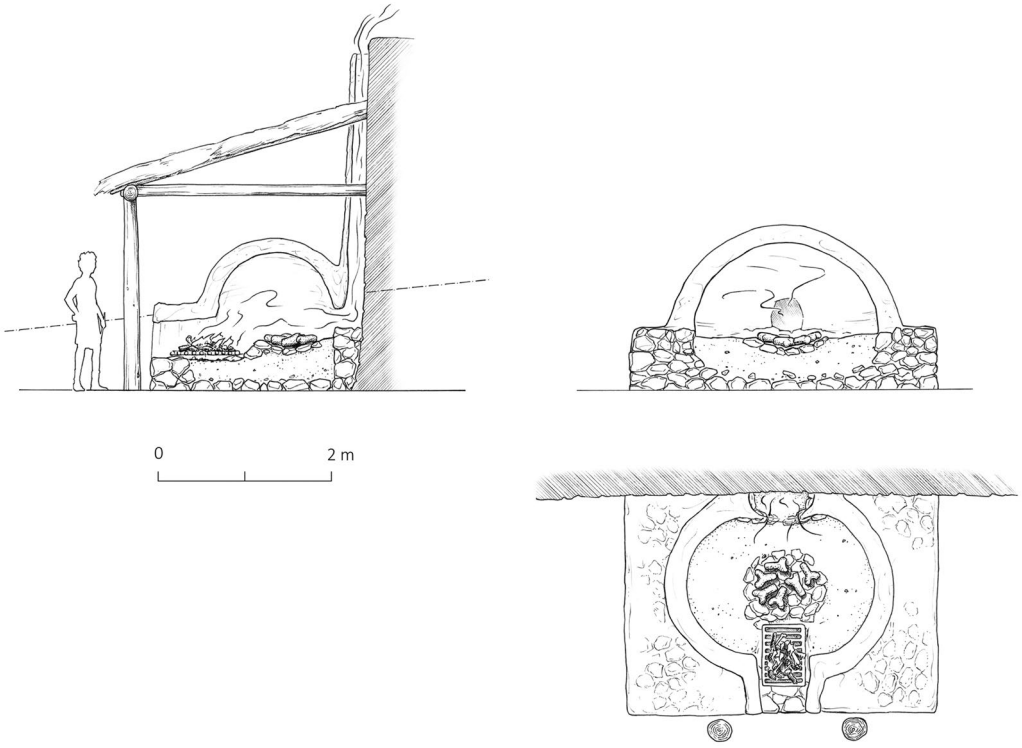

Fig. 4: Isometric reconstruction of the kiln used to manufacture terracotta moulds (the dotted line marks the surface level of 2010).

The specific arrangement of a number of stones directly opposite of the stoking chamber leads us to assume that there might have been a chimney or air flue in this spot. The kiln was protected by a roof, as evidenced by the two post-holes flanking the stoking chamber. The other side of this roof was most likely supported by the city wall built up against the kiln, with the wooden beams inserted into the fortification proper.

Interpretation as a Kiln used for the Manufacture of Casting Moulds

Fundamental for the interpretation of the structure as a ceramic kiln are a number of factors that point to the fact that the interior of the kiln was exposed to very high temperatures. Even during the excavation of the structure, the difference between the surrounding soil and the light, reddish material inside the kiln was evident at first glance. The material recovered from this fill also featured many pieces of charcoal and fragments of calcified bones. Small, burnt, dark-grey pieces of travertine and limestone were also frequently encountered.

Vital clues were provided by our colleagues of the University of Basel. The archaeobotanical and archaeozoological analysis of the material, conducted by Ö. Akeret and S. Deschler-Erb respectively, as well as geological information provided by Ch. Pümpin led us to the unambiguous conclusion that the inside of the domed chamber must have seen temperatures of over 600° Celsius.

Fig. 5: Overview of area B, view to east, with prevailing wind directions (Rome, annual average).

This precludes the interpretation of the structure as an oven used for culinary purposes. The reconstruction as a kiln was not immediately apparent, however, since it lacks the perforated floor characteristically found in ancient ceramic kilns encountered in the wider Mediterranean region. Also not found were specific small finds often associated with the production of ceramics, like wasters and misfired material, test-pieces, kiln props and other kiln furniture and significant amounts of ceramics. An important role in identifying the structure in area B as a kiln used for manufacturing ceramic moulds played the recently-published study of Nepalese foundries and metal workshops by A. Furger.[13] His description of the traditional procedures and working processes utilised for casting metal figurines underlines the central importance of a kiln that could produce the necessary terracotta moulds.[14] Theorising that our structure was not used to manufacture ceramics, but rather ceramic moulds used for metalwork would account for all the different observations made during its excavation and during

the analysis of the materials found. It therefore seems that structure 1 was designed as a horizontal kiln (see below).

A brief Typology of Ancient Ceramic Kilns

Ancient ceramic kilns known from archaeological research are usually divided by their specific form and design into two broad categories. These kilns evolved from more simple methods of manufacturing ceramics,[15] which used open fires[16] or covered pits[17] to fire pottery. The use of open fires or fire pits was generally discontinued with the development of more complex, permanent structures that could be used more than once. One major improvement was the separation of the to-be-fired pottery from the fuel, which led to improved control over the firing process. Generally speaking, pottery and fuel could be arranged in two ways: Either vertically, by placing the ceramics above the fuel, or horizontally, by placing the ceramics behind the fuel. This influenced the layout of the kiln and the way in which the airflow and heat of the flames were directed inside of it. The vertical or updraught kiln[18] consists of two chambers arranged on top of each other, separated by a perforated floor. The heated air travels vertically, from the lower combustion chamber through the pierced floor, past the load and out of the kiln through the chimney placed at its highest point. In a horizontal or downdraught kiln,[19] on the other hand, the firing chamber is placed in front of the pottery chamber, with the latter eventually being located slightly higher than the furnace. Here, the hot gases move through the kiln in a horizontal direction until they escape through a flue or exit at the back of the pottery chamber, generally[20] located at about its floor level.[21]

Interpretation as Horizontal Kiln

We would therefore argue that this structure discovered in area B (fig. 3) was a horizontal kiln, since combustion and pottery chamber are arranged in a row and not on top of each other. In addition, no hints of the existence of a perforated floor could be found, which is a prerequisite for an updraught or vertical kiln. The furnace was therefore located in the tunnel-like installation in the south, a hypothesis supported by the fact that a noticeably higher amount of ash, calcified bone fragments and charcoal was found here compared to the rest of the structure. The pottery chamber was equipped with a shallow pit that must have held the load of the kiln, as can also be theorised by the fact that we found more ash surrounding the depression than within it. In the back of the dome, in the area where the kiln meets the city wall, there was probably a flue through which the hot gases could escape, which is characteristic for and the most practical solution in a horizontal kiln.

Chronology

Only a few finds can be clearly attributed to the first phase of the structure (e.g. Cat. 1, 2).[22] The remains of the collapsed, rectangular kiln, on the other hand, yielded far

more material (e.g. Cat. 3–6).[23] These ceramic finds (fig. 8, Cat. 1–6) allow us to conclude that this kiln was in use until Latial period IIB–III and point to a construction date in Latial period IIB. Latial period IIB is traditionally dated to 830–770 BC. In light of the 14C-derived date ranges proposed by A. Njiboer,[24] Latial period IIB should receive a slightly ›higher‹ date of about 900–850/825 BC. This matches our own 14C results, for which we analysed two charcoal samples taken from the within the post-holes of the kiln's small porch. They, too, date the structure to the 9th century BC.[25]

Structure 2: The Casting Pit

Remains of this structure were found east of structure 1 adjacent to the city wall. Only 30 cm below the topsoil the first elements of this installation began to emerge, consisting of the fill of the casting pit and its stone-lined walls (figs. 3. 5–6).

The Remains

The semicircular structure was built up directly against the city wall using quarry and fieldstones, thus forming a kind of vat- or basin-like pit. The walls of this basin are made up of the straight segment of the city wall in the north and the rounded southern part set against it. The stones of the surface of the inner wall and the floor of this structure were noticeably discoloured, turning the originally light-grey material a light yellow-red. The pit, 65 cm deep at its lowest point, was filled with a fine, sandy layer of soil that contained a large number of bone fragments and ash, which were disproportionately found directly at the surface.

Interpretation as a Casting Pit

Three factors point to the interpretation of structure 2 as a casting pit. Firstly, the discolouration of the stones making up the walls of the basin and which points to them having been exposed to intense heat could only be found on the interior walls and the floor and not the exterior walls of the structure. Secondly, calcified bones were found mainly in the upper layers of the reddish filling and were clearly concentrated in the western part of the pit. This leads us to theorise that, for one, the entire pit must have been exposed to high temperatures. Also, the concentration of the bones – many of them heavily charred –, ash and charcoal in this area of the pit could be evidence of a fireplace located in this upper western part of the installation. Thirdly, the calcified bones strewn throughout the fill point to them having come into contact with a fire burning over a temperature of 600° Celsius.[26]

If this structure is interpreted as a casting pit used for the manufacture of metal objects,[27] all three factors can be traced back to the same source. When casting objects using the lost-wax or lost-mould technique, hot metal is poured into terracotta moulds. During that process, the molten metal displaces the air inside the moulds, very rapidly

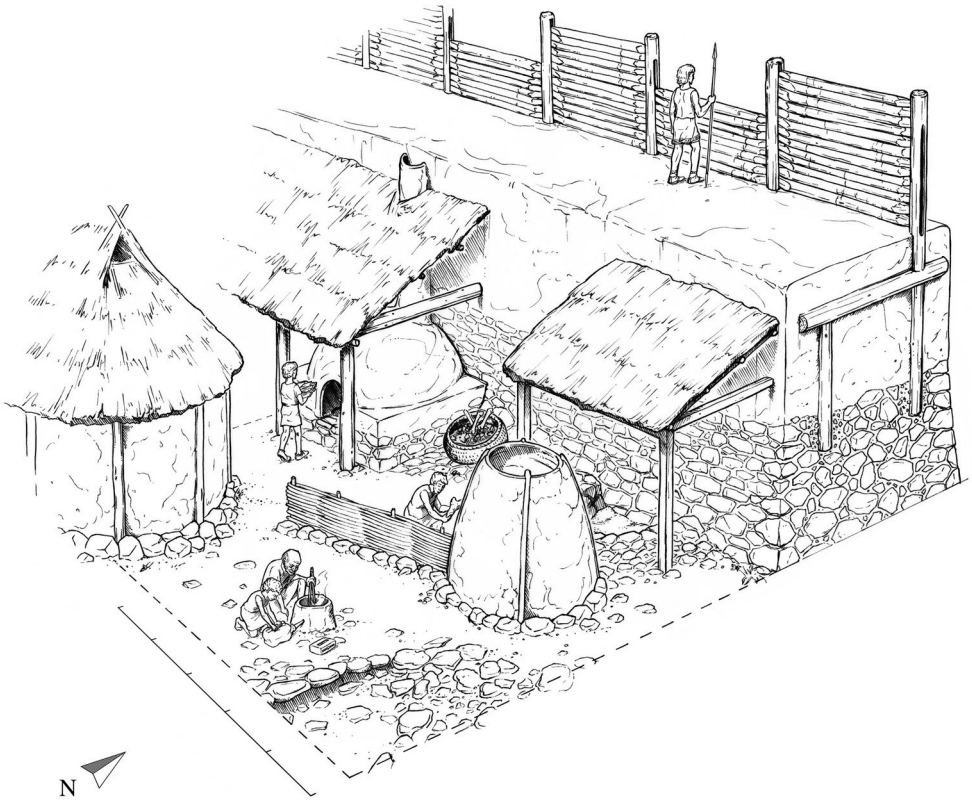

Fig. 6: Isometric reconstruction of the workshop and its surroundings.

cools off and begins to set.[28] This transition from a liquid to a solid state is accompanied by very high temperature levels, also known as heat of crystallisation or enthalpy. This thermal process is most likely responsible for the discolouration detected on the interior walls of the pit, where terracotta moulds would have been placed directly in the soft fill. Before the casting process could begin, both the metal and the moulds had to reach specific temperatures in order to guarantee the successful outcome of the casting and to protect the terracotta moulds, which would otherwise have shattered due to the temperature difference.[29] This would explain why only the interior of the pit seems to have been exposed to high temperatures.

We would therefore like to suggest that the moulds were heated in another part of the workshop[30] and then transferred to the casting pit with the feeder tubes pointing up. The gaps between the moulds were filled in with the sandy soil. They were thus surrounded on all sides by sand, a material, which could serve as a conductor that distributed the heat evenly throughout the pit. By interpreting the structure as a casting pit, the discolouration found on the inner walls and floor of the structure, the powdery fill containing very few finds and inclusions as well as the existence of a top layer consisting of ash and calcified bones could therefore all be explained in a satisfying manner.

Chronology

The casting pit was built up against the city wall, which in this period took the form of a wall made of rammed earth and wood, placed on a massive foundation of field and quarry stones.[31] This wall therefore predates both structure 2 and the reconstruction of the kiln (Structure 1, second phase), which seem to have been constructed contemporaneously.

As was the case with structure 1 (the kiln), no useful material for establishing a date of construction for this structure could be found. Some clearly dated sherds (e.g. Cat. 7–9) can be attributed to its last phase, however, dating its abandonment phase rather generally to Latial period IIB–III (fig. 8, Cat. 7–9). This allows us to conclude that the pit was constructed in Latial period IIB and therefore in the 9th or early 8th century BC (revised chronology).[32]

Structure 3: The drying chamber

Already during the spring campaign of 2011 we discovered a cluster of large stones in the eastern part of area B, directly to the south of structure 2. Only two years later we were able to identify it as the remains of a single structure, which was subsequently excavated and documented.

The Remains

The installation consists of two separate elements (figs. 3. 5): First, a roughly circular substructure taking the form of a low platform, and second, two long rows of stones set against its western side. Together with the western face of the platform, these two roughly parallel walls form a corner at a slightly obtuse angle. We suggest that an opening might have existed in the western wall of the structure built on top of the platform.

Interpretation as a Drying Chamber

The interpretation of the poorly preserved structure as a kind of drying cabinet (see below) can neither be substantiated by specific finds nor by parallels with similar constructions found at comparable sites. While we therefore move in a distinct grey area, our hypothesis is supported by a detailed analysis of the workshop's contexts. Within the circular part of the structure, we could detect no traces of fire or the presence of high temperatures, which precludes the use as an oven or kiln. This was therefore a small, circular room, possibly with a low bench on its northern side, which was accessible from the west. It can hardly be interpreted as a living space or small hut, possessing an external diameter of only 2,5 m.

The two stone walls built up against the western part of the circular platform and reaching into the open space between structure 1–3 and the city wall do not seem to belong to any other structure and are clearly connected to structure 3. The length

of the southern wall, which exceeds that of its northern counterpart and might have been even more substantial in antiquity, led us to interpret these walls as a means to channel air into the small circular room and therefore as a kind of ventilation channel or scoop. Then as today, the Latin plains generally experience westerly winds during the summer months, as modern computer programs used by sailors and aviators to determine wind direction and wind speed confirm (fig. 5). If the walls were meant to channel naturally occurring breezes, the layout with a shorter northern and longer southern wall, arranged in a slight V-form and oriented towards southwest, would have served that purpose perfectly.

If the walls of the superstructure on the circular platform – our so-called drying chamber – were slightly inclined inwards and the roof featured an opening, the air could have travelled from the entranceway to the west, though the interior of the chamber and up and out through the opening in the roof (fig. 6). Because the (generally thin) walls of drying structures – as for example in oast houses used to dry cereals[33] – are designed to be easily heated by the sun, the temperance difference between the outside and the inside of the structure would have caused convection and therefore facilitated the movement of air from colder, low-pressure areas to warmer, high-pressure areas. Because of this phenomenon we reconstruct the installation with a centrally placed upper opening,[34] which of course is pure conjecture. This thermal effect, however, would have been intensified by the walls constructed to the west of the room, which channelled the southwesterly winds into the structure.

The combination of these two architectural elements – the circular platform and the two walls built up against its western outer wall – lead us to propose the interpretation as a kind of small drying cabinet or chamber. This interpretation is made more likely by the structure's proximity to the metal workshop. When using terracotta moulds in the lost-wax technique, it is imperative that the freshly shaped moulds are dried very slowly and carefully. It is inadvisable to lay them out in the direct sunlight and storing them in the shade is much to be preferred, lest the moisture trapped in the clay evaporates too quickly, thus leading to cracks within the structure of the mould and/or deformation during the burnout or firing process.

The inside of our drying cabinet would have been shady, and the wind flow would have helped to slowly dry out the clay shells waiting to be fired. The low bench or platform found along the northern wall could have served as a shelf or pedestal on which the moulds could have been placed.[35]

Chronology

The northern wall of the scoop used to channel air into the direction of the small drying chamber is built into its western wall, meaning that the two structures must have been built at the same time. Additionally, the northern part of the drying chamber (structure 3) overlaps the southern wall of the casting pit (structure 2), which again points to a contemporary or very slightly later date of construction (fig. 5). This allows

us to interpret the wind scoop, drying chamber and casting pit as a single architectural and functional unit.

Ceramic material useful for establishing a more precise date for structure 3 could once again only be found in the collapsed remains of its substructure. The few datable sherds (e.g. Cat. 10) date the last period of utilisation to Latial period IIB–III, according to R. P. Krämer's analysis (fig. 8, Cat. 10). Consequently, this structure – just like structure 1 (second phase) and 2 – was constructed and used in the 9th and early 8th century BC.

Finds

Object 1: Fragment of a Melting Furnace (Cat. 12)
This terracotta object made of grit-tempered clay was found south of structure 3, the so-called drying chamber (fig. 3). It is fractured on at least three sides (fig. 7). The sherd, about 3 cm thick, is curved in both directions. The original diameter of the terracotta object can unfortunately no longer be reconstructed. Said object was hand-formed out of clay and its surface then sealed by direct contact with fire, meaning it was placed in the flames directly as opposed to properly fired in a kiln. This is documented by the specific, differently patterned colouring found on the in- and outside of the sherd. It also features a hole (diameter: 1,5 cm) with a raised, irregular edge surrounding it on the fragment's inner side. The area around this hole is of a reddish colour, which points to the fact that here a higher level of oxygen came into contact and reacted with the iron particles in the clay. It therefore seems possible that the nozzle of a bellows may have been inserted into the object through this hole.

The precise delivery of additional air to the fuel via a bellows is especially important during the melting process of crude metals or metal scraps, since it raises the rate of combustion and therefore the heat output of the furnace and thus helps reach the necessary melting temperatures.[36] Similar crucible furnaces, in which the fuel was placed and heated inside the installations and refractory crucibles were employed to heat the metal charge, are known from a multitude of Iron Age sites, for example from Heuneburg, a fortified hillside settlement by the upper Danube.[37] We believe that the fragment found at Gabii belonged to a low, circular furnace used to melt metals (fig. 6). This crucible furnace would have taken the form of a round clay structure at least 10 cm tall, with one wall featuring a hole through which the nozzle of a bellows could be inserted in order to add additional air to the fuel inside of it.

Object 2: The Casting Mould (Cat. 11)
This object (fig. 7) was found in the top layers southeast of structure 1 (the kiln) (fig. 3). It is made of porous sandstone, and only three of the six outer surfaces are preserved.

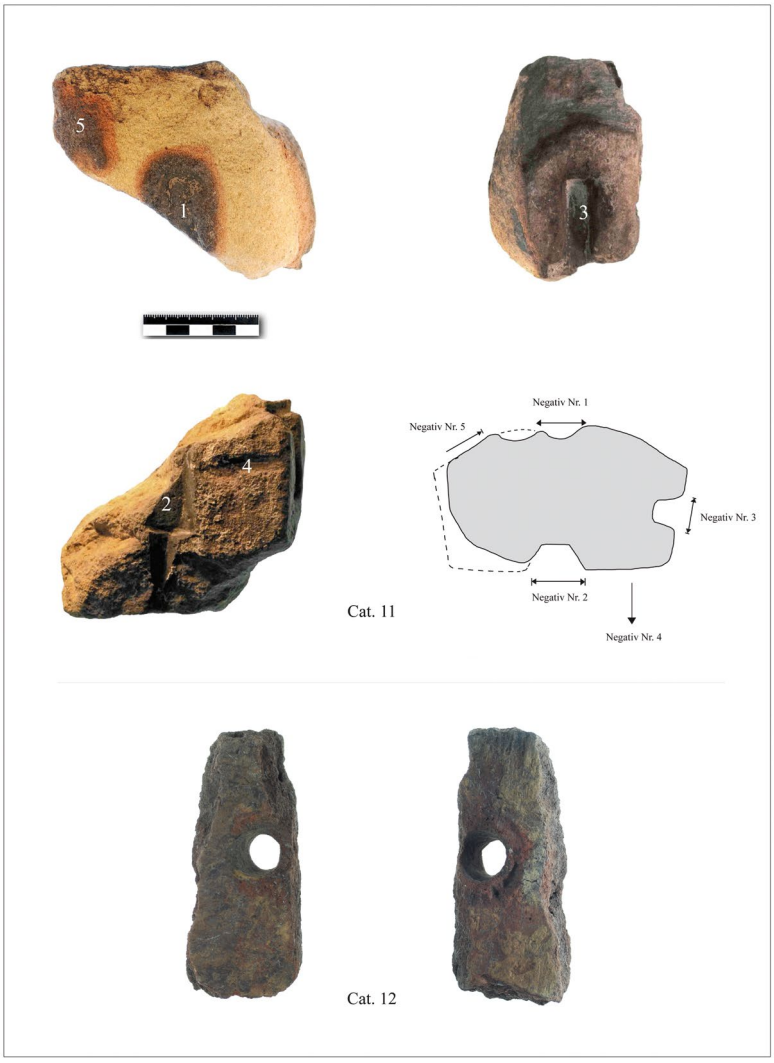

Fig. 7: A fragmentary sandstone casting mould (Cat. 11) and a fragment of a melting furnace with opening for bellows (Cat. 12).

The stone object features casting moulds for four, perhaps five different objects. Right next to the main fracture the object's surface is damaged, with the upper part having chipped off. It seems logical to assume that this surface, with the moulds for objects 1 and 5, was originally as regular and smooth as the reverse surface with the moulds for objects 2 and 4. The (restored) dimensions of the roughly rectangular stone object are about 10,5 cm (width) by 6,5 cm (height) by at least 12 cm (length).

The object exhibits clear, reddish-yellow traces attributable to the application of great heat, especially in and around the individual moulds. This leads us to propose an interpretation as a stone mould for different non-ferrous metal objects (cfr. fig. 6).

Since at least four different moulds can be counted, the object was used over a longer period of time. The individual shapes show differing stages of wear, which suggests that they weren't carved at the same time but rather subsequently, and were each used more than once.

It is unclear if our object formed an open mould, in which the molten metal was simply poured in the hollows and left to cool, or a closed mould, which contained a delivery system for the metal to reach the mould cavity and usually took the form of a covered open mould or two halves forming a single unit. The deliberately smoothed surface on the side containing the mould for object 2 could strengthen the interpretation as a closed mould. In this case, mould 4 would have formed the sprue leading towards the cast for object 2. Below that sprue could have been a venting channel.[38] The mould might therefore have been covered with a smooth, flat stone that left the channels accessible. The cast objects were all of an elongated form. The sides of the moulds for objects 2 and 3 taper off slightly, so that these resemble small metal bars, which could more easily be released from the moulds. Similar casting moulds have been found at the late Bronze Age settlement of Sabucina (Sicily). They each feature multiple moulds on three sides.[39]

Interpretation of the Archaeological Contexts

A Site for Secondary Metal Production

The three structures and two finds presented here lead us to propose that, in this area of the *arx* of Gabii, there was a workshop of a metalworker using mainly non-ferrous metals. Ores do not occur naturally in the immediate vicinity of the city,[40] and we did not find any indicators that metals had been smelted on-site, e.g. in the form of slag, pieces of ore or remains of fires in which the broken-up ore would have been roasted prior to the smelting process in order to remove any moisture still remaining within (so-called primary metal production). Instead, crude metals seem to have been processed here, i.e. melted, cast and forged (so-called secondary metal production).[41]

Non-Expendable Mould Casting

After the analysis of the archaeological contexts and finds we conclude that two separate casting methods were used for processing the crude metals. On the one hand, non-expendable mould casting was practised, using reusable moulds. This is suggested by the discovery of the stone mould, which produced several kinds of small, thin metal ingots. It is probable that these unwrought pieces of metal were then turned into small tools, objects or pieces of jewellery, which were forged somewhere close-by or in another part of the city. An indicator for the production of fibulae on-site or at least in

the closer vicinity could be the discovery of several copper-alloy pins, needles and rings in different parts of area B. The possible use of the small thin ingots as a kind of proto-money must not be discounted either.

Expendable Mould Casting

On the other hand, non-ferrous metal objects were produced using the so-called lost-wax casting technique. Since no remains of shattered terracotta moulds or spoiled castings were found, we have no information as to what kinds of objects were produced in this manner.[42] The depth of the casting pit (structure 2) would have allowed for the production of metal objects up to about 50 cm in height. As would be expected, no traces of the wax models have been preserved. Structure 3 seems to possess the most important elements of a drying cabinet or drying chamber, where the models, covered in a mantle of clay slurry, could be dried slowly and carefully. Where these shells were then heated to allow the wax to melt and run out is unknown. Instead of a simple fire, small and portable terracotta ovens (so-called cooking pot stands) could also have been used for this purpose, since the remains of several have been found in area B.

We suggest that the burned-out shells – now no longer containing their wax models – were then fired in the kiln discovered in the western part of area B (structure 1). Once that was done, the finished terracotta moulds were placed either directly in the casting pit or, if stored for a period of time, reheated and then placed within this basin-like structure (structure 2). They were surrounded with soft, sandy soil well suited to conducting the necessary heat. In the upper western part of the pit a furnace was then lit, the crude metal melted in a crucible and, once it had reached the melting point, poured into the prepared terracotta moulds. Based on the large number of calcified bone fragments found in the area, we assume that here as well as in the kiln animal bones served as the main source of fuel.[43] After the moulds had cooled off, they were uncovered and the rough castings released by shattering the shells. The cast objects would then have been further processed (sprues cut off, surface polished etc.), most likely somewhere close-by. We have found no trace of these next steps.[44]

A. M. Bietti Sestieri had already hypothesised in 1980 – during her exploration of the necropolis at Osteria dell'Osa[45] – that metal workshops producing copper-alloy objects existed at Gabii as early as the early Iron Age. Amongst the grave goods she found a substantial number of such objects, e.g. jewellery (especially in women's tombs), tools and other instruments that seem to have been locally manufactured. The discovery of the metal workshop on Gabii's *arx* has, as we would like to suggest, corroborated this hypothesis.[46]

Translation: Eva-Maria Träder

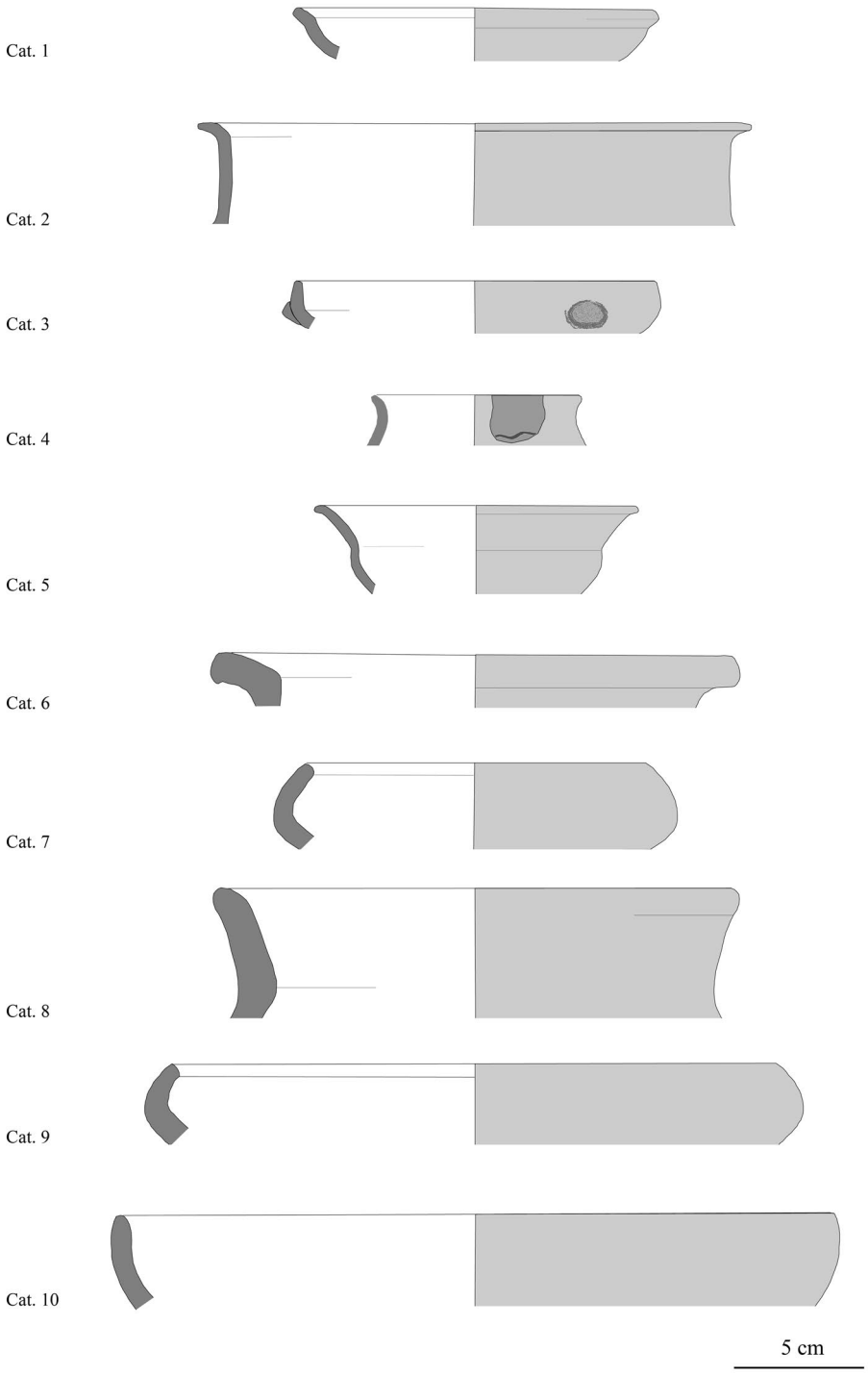

Fig. 8: Area B, ceramics selection (Cat. 1–10).

Appendix: Catalogue of Selected Finds from the Iron Age Metal Workshop at Gabii, Latium

R. P. Krämer

Structure 1:	First phase of round kiln: Cat. 1–2.
	Abandonment phase of rectangular kiln: Cat. 3–6.
Structure 2:	Last phase: Cat. 7–9.
Structure 3:	Last phase: Cat. 10.

Cat. 1 (inv. no. GB12MNB49I-1)
Rim fragment of a cup in impasto bruno
Hard-fired, dark-grey clay with some fine inclusions. Exterior black and polished.
H 2,6 cm; W 1,8 cm; wall Dm 0,5–0,6 cm; Dm 14 cm.
Maaskant-Kleibrink 1987, nos. 390. 392. 393. 674. 675; Bietti Sestieri 1992a, nos. 19a. 19c; 20a–20d. 22a–20c; Attema et al. 2001/2002, 343 no. VII-2.
Latial period IIB–IVA

Cat. 2 (inv. no. GB13MNB143I-2)
Rim fragment of an amphora in impasto bruno
Hard-fired dark-grey to black clay with a few very fine inclusions. Exterior black and very polished.
H 3,8 cm; W 6,2 cm; wall Dm 0,4 cm; Dm 20 cm.
Bietti Sestieri 1992a, nos. 7b. 7d (Latial period II).
Latial period II

Cat. 3 (inv. no. GB12MNB40I-2 – GeF156)
Rim fragment of a bowl in impasto with knob on shoulder
Medium-hard-fired reddish-brown clay (2,5 YR 4/4) with many very fine inclusions. Exterior reddish-brown (2,5 YR 4/4) and polished.
H 1,7 cm; W 4 cm; wall Dm 0,6 cm; Dm 14 cm.
Maaskant-Kleibrink 1987, nos. 364. 365. 367–369. 606–610; Bietti Sestieri 1992a, nos. 26c. 26d. 26h. 26m; Attema et al. 2001/2002, 337–340 no. V-3.
Latial period II–III, perhaps more likely Latial period IIB

Cat. 4 (inv. no. GB11MNB68I-1)
Rim fragment of an amphora in impasto bruno
Medium-hard-fired reddish clay (2,5 YR 4/8) with few fine inclusions. Exterior dark to black (2,5 YR 4/8) and polished.
H 1,8 cm; W 2,1 cm; wall Dm 0,4 cm; Dm 8 cm.
Maaskant-Kleibrink 1987, nos. 1086. 1214; Bietti Sestieri 1992a, nos. 11i. 11k. 11m. 13a. 13b var. III.
Latial period II–III, more likely Latial period II

Cat. 5 (inv. no. GB12MNB68I-1)
Rim fragment of a bowl in impasto bruno
Hard-fired clay with many very fine inclusions. Exterior almost black and polished.
H 4,2 cm; W 2,8 cm; wall Dm 0,4 cm; Dm 12,2 cm.
Maaskant-Kleibrink 1987, no. 1035; Bietti Sestieri 1992a, no. 24c; Attema et al. 2001/2002, 340 no. V-7.
Latial period III, perhaps Latial period IVA

Cat. 6 (inv. no. GB12MNB68I-4)
Rim fragment of an olla in impasto bruno
Medium-hard-fired reddish-brown clay (2,5 YR 4/4) with few fine inclusions. Exterior black and polished.
H 1,7 cm; W 2,9 cm; wall Dm 1,3 cm; Dm 20,4 cm.
Maaskant-Kleibrink 1987, no. 586; Bietti Sestieri 1992a, no. 11a; Attema et al. 2001/2002, 332 no. III-2.
Latial period IIB–III

Cat. 7 (inv. no. GB11MNB28II-1)
Rim fragment of a bowl in impasto bruno
Medium-fired brown clay (2,5 YR 4/4) with few fine inclusions. Exterior brown (2,5 YR 4/4) and coarsely smoothed.
H 3 cm; W 2,8 cm; wall Dm 0,7–0,9 cm; Dm 13 cm.
Maaskant-Kleibrink 1987, nos. 364. 365. 367–369. 606–610; Bietti Sestieri 1992a, nos. 26c. 26d. 26h. 26m; Attema et al. 2001/2002, 337–340 no. V-3; di Gennaro 2002, no. VIII.7.
Latial period II–III, perhaps more likely Latial period IIB

Cat. 8 (inv. no. GB11MNB28II-2)
Rim fragment of an olla in impasto
Medium-fired reddish-brown clay (10 R 4/4) with few fine inclusions and quartz. Exterior reddish and polished.
H 5 cm; W 5 cm; wall Dm 1,2–1,6 cm; Dm 20 cm
Maaskant-Kleibrink 1987, nos. 352. 585–588. 591. 592; Bietti Sestieri 1992a, nos. 11a. 11a var. II; Attema et al. 2001/2002, 332 no. III-2.
Late Latial period IIB–III

Cat. 9 (inv. no. GB13MNB35II-1)
Rim fragment of a bowl in impasto bruno
Hard-fired black clay with many fine inclusions. Exterior black and polished.
H 2,3 cm; W 4,5 cm; wall Dm 1 cm; Dm ca. 22 cm.
Maaskant-Kleibrink 1987, nos. 364. 365. 367–369. 606–610; Bietti Sestieri 1992a, nos. 26c. 26d. 26h. 26m; Attema et al. 2001/2002, 337–340 no. V-3; di Gennaro 2002, no. VIII.7.
Latial period II–III, perhaps more likely IIB

Cat. 10 (inv. no. GB13MNB137IV-1)
Rim fragment of a bowl in impasto bruno
Hard-fired grey clay with few fine inclusions and quartz. Exterior dark-brown to black and polished.
H 3,3 cm; W 4,8 cm; wall Dm 0,9 cm; Dm 26 cm.
Maaskant-Kleibrink 1987, nos. 625. 626; Bietti Sestieri 1992a, nos. 26a. 26f. 26i; Attema et al. 2001/2002, 337 no. V-2; di Gennaro – Schiappelli 2013, 87–89 no. 3; 89 no. 5.
Latial period II–III

Cat. 11 (inv. no. GB11MNB81III-5)
Fragment of a casting mould in porous sandstone. The surface features at least four moulds and yellow-reddish discolourations that may be attributed to intense heat.
H 6,5 cm; W 10,5 cm; L 12 cm.

Cat. 12 (inv. no. GB12MNB122IV-5)
Wall fragment of a melting furnace
Reddish Impasto (10 R 4/6) with many coarse and fine inclusions, exterior brown (7,5 YR 6/6). Curved wall fragment, fractured on three sides, featuring a round hole (Dm 1,5 cm).
H 4,8 cm; W 10,9 cm; wall Dm 2,8–3 cm.

Notes

[1] Bietti Sestieri 1979, 11–13; Bietti Sestieri 1992a; Bietti Sestieri 1992b; Bietti Sestieri 2014, 267–284; Zuchtriegel 2015.
[2] Bietti Sestieri 1992a.
[3] Guaitoli 1977, 17–20; Guaitoli 1981a, 157–161; Guaitoli 1981b; Guaitoli 1984; Guaitoli 2003.
[4] Terrenato et al. 2010; Terrenato et al. 2018.
[5] cf. Njiboer 2004; Nijboer – van der Plicht 2008.
[6] Zuchtriegel 2012.
[7] Fabbri 2010; Fabbri et al. 2012; Fabbri – Musco 2016.
[8] Guaitoli 2003.
[9] DFG Project No. 162143724: Gabii, Latium: The fortifications from the Archaic to the mid-Republican period. See also Helas 2018.
[10] Due to the particularly time-consuming documentation process necessarily applied in this area and the fact that our main focus was the study and excavation of the fortifications, the structures could unfortunately only be partially explored.
[11] I very consciously say ›we‹, since while I may have directed the project and authored this paper, the results presented here are the fruits and culmination of an intensive, lengthy discussion with all members of my team.
[12] For a more in-depth discussion I refer to the forthcoming main publication.

[13] Furger 2017.
[14] Furger 2017, 77 with figs. 90. 124.
[15] Cattani 1997, 508.
[16] Duhamel 1978/1979: "cuisson en meule"; Cuomo di Caprio 1985: "focolare all'aperto"; Köpke – Graf 1988: "Feldbrandanlagen"; Saracino 2005: "fornace a cielo aperto"; Heege 2007: "offener Feldbrand"; Rice 2015: "open firing".
[17] Duhamel 1978/1979: "cuisson en fosse"; Köpke – Graf 1988: "Brenngruben"; Saracino 2005: "fornace in conca"; Heege 2007: "Grubenbrand"; Rice 2015: "pit/trench firing".
[18] Köpke – Graf 1988: "stehender Ofen"; Saracino 2005: "struttura verticale"; Rice 2015: "updraft kiln".
[19] Köpke – Graf 1988: "liegender Ofen"; Saracino 2005: "struttura orizzontale"; Rice 2015: "downdraft kiln"; Cuomo di Caprio 2007: "fornace orizzontale/forno a fiamma rovesciata".
[20] Duhamel 1978/1979, 72 with fig. 42. Horizontal kilns can also be equipped with a chimney placed in the upper part of the kiln; a low-lying flue is therefore not always part of the design, cf. Heege 2005, 114.
[21] Cuomo di Caprio 1985, fig. 17b; Köpke – Graf 1988, fig. 9.
[22] The small number of datable sherds recovered do not contradict the date proposed below, but they are of particularly long-lived types that make a more detailed chronology impossible.
[23] A selection of the ceramics used for this chronology is presented by R. P. Krämer in the catalogue included in the appendix.
[24] Nijboer et al. 1999/2000, 163–176; Nijboer 2004, 527–556; Nijboer – van der Plicht 2008, 103–118.
[25] A charred wood sample (oak) gave an absolute date of 1125–912 calBC. The analysis of charred seed pointed to a slightly lower date (1071–843 calBC). The analysis was performed by our colleagues at the University of Cologne (CologneAMS, J. Rethemeyer).
[26] As pointed out by S. Deschler-Erb in her report. Ö. Akeret could not detect any carbonised floral material in the soil samples, since the high temperatures would have consumed such material without leaving perceptible traces. We refer the reader to the upcoming publication for details.
[27] This interpretation was suggested by S. Deschler-Erb, to whom I would like to extend my sincere gratitude for her generous help and advice.
[28] A brief summary can be found in Armbruster 2012, 308. 309 with fig. 421; see also Giardino 2010, chapter 5, esp. 66–70. Once again very helpful in general is Furger 2017.
[29] Ratka 1998, fig. 7.67.
[30] It seems unlikely that the moulds were heated in the pit itself, since no larger amount of charcoal was found in the soil filling its lower part.
[31] This phase of the city wall was erected in Latial period IIB. For more information we refer the reader to the forthcoming final publication (in preparation).
[32] cf. note 24 above.
[33] In our reconstruction we assume that the structure only possessed thin walls, maybe even made of ephemeral materials like leather, textile or wood.
[34] If the superstructure was tent-like, as we hypothesise, such an opening could have been covered up in the case of rain or very high temperatures.
[35] Following our proposed reconstruction, the entranceway and the upper exhaust opening could have been closed and opened at will in order to control the temperature, and wet cloths could have

been employed to control the humidity. This would have allowed the artisans to influence the drying process.

[36] Furger 2017, 77. 78.

[37] Drescher 2000, fig. 12. These kinds of crucible furnaces differ only slightly from the bloomeries used to smelt crude metals from ores, cf. Giardino 2010, 58–63, fig. 5. The fact that no slag has been found in Area B points to the interpretation as a crucible furnace, however.

[38] I thank A. Murgan for sharing his expertise on this subject.

[39] Albanese Procelli 2000, 75–90, cf. inv. no. 2637, fig. 4.1 and inv. no. 2647, fig. 4.2.

[40] Bietti Sestieri 1980, 111.

[41] Metallurgy is broadly divided into primary and secondary metal production operations, i.e. into the smelting of metals from ore and the further processing of melting the extracted, crude metals.

[42] We assume that all metal scraps were reused and melted down and that a hypothetical dump for material that was no longer usable is located somewhere in the wider area.

[43] Furger 2018, 234–237.

[44] The furnace used to heat the metal (Cat. 12) could comprehensively also have been used as a forge.

[45] Bietti Sestieri 1980, 110.

[46] I would like to thank many people for their generous help and their suggestions. Only a few of them can be mentioned here. First I would like to thank Area B supervisor A. von Helden and his assistants S. Holzem and A. Weirich. M. Zingaretti and R. Krämer analysed and documented the finds. Critical suggestions leading to a breakthrough in the study of the complex were offered by S. Deschler-Erb, Ö. Akeret and Ch. Pümpin from the Institute for Integrative Prehistory and Archaeological Science (IPAS) of the University of Basel. A. R. Furger conducted experiments to determine the suitability of animal bones as a fuel source. P. Fleischer and P. Thomas gave helpful (literary) references, and M. Jansen and D. Kirchner from the Bergbau-Museum in Bochum analysed numerous samples. I discussed many details of the interpretation with A. Murgan and A. Segbers, and S. Kiel (Magdeburg-Stendal University of Applied Sciences) took excellent aerial photographs and was a fount of meteorological information. I thank T. Scheffler as well as his colleagues M. Jakobi and J. Hoffmann for their various mapping and surveying services. O. Bruderer drew the reconstruction drawing and helped further the general discussion. E. Träder translated this text into English and had a few helpful suggestions. Last but not least I would like to thank the German Research Foundation (DFG), who financed this research project, and the Department of Classical Archaeology of the University of Bonn, which provided me with a workspace. Special thanks is also due to S. Musco of the Office for the Protection of the Archaeological Heritage in Rome, who invited us to Gabii and supported us on-site.

Image Credits

Fig. 1: Bietti Sestieri 1992a, fig. 4-1. After Guaitoli 1981a, fig. 1. – Fig. 2: M. Jakobi, Magdeburg. – Fig. 3: A. von Helden – P. Fleischer – S. Helas, Bonn. – Fig. 4: O. Bruderer, Zürich. – Fig. 5: S. Kiel, Magdeburg – Fig. 6: O. Bruderer, Zürich. – Fig. 7: S. Helas – S. Holzem – P. Fleischer (sketch), Bonn. – Fig. 8: S. Helas, Bonn, after original drawings by R. Da Vela, R. P. Krämer, E. Lunardon and M. Zingaretti.

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While economic approaches are becoming generally more important and even mainstream topics, this is not necessarily the case for research into Pre-Roman Italy, defined as the area of the Italian Peninsula, Sicily and Sardinia during the Iron Age. Until recently, there was almost no research into Pre-Roman Italy focused on economic studies, and the existing research has been mostly dedicated to very specific contexts:
(1) specialization of crafts and production in the context of urbanization processes; (2) specific production areas, such as agriculture, metal processing, and salt production; (3) studies focusing on Greek Colonies and Greek Colonial encounters with indigenous populations; (4) analyses of consumption patterns, mainly in the case of Greek pottery consumption.
Recent excavations and investigations devoted to the study of workshop structures, such as those at Gabii, Pithekoussai, Kroton, Lokroi Epizephyrioi, Naxos, Selinunt and Kyme/Cumae, have provided a range of new data that is stimulating a valuable and highly constructive discussion on the organization of production and crafts in Pre-Roman Italy.
Against this background, four members of the study group 'Etruscans and Italic Cultures' from the 'German Association of Archaeologists' *(Arbeitsgemeinschaft Etrusker und Italiker des DArV e.V.)* formed a panel to discuss the economic aspects of Pre-Roman Italy on the basis of their ongoing research projects: all of these focus on the field of production and crafts. The aim is to contribute to an intensified debate on geographical, chronological and functional patterns in the organization of crafts and productions by discussing current case studies and methods.

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