Athenische Mitteilungen

Abteilung des Deutschen Archäologischen Instituts

Band 135 · 2020

MITTEILUNGEN
DES DEUTSCHEN ARCHÄOLOGISCHEN INSTITUTS
ATHENISCHE ABTEILUNG

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DES DEUTSCHEN ARCHÄOLOGISCHEN INSTITUTS

ATHENISCHE ABTEILUNG

BAND 135 · 2020

GEBR. MANN VERLAG · BERLIN

VIII, 322 Seiten mit 324 Abbildungen

ISSN: 0342-1295

ISBN: 978-3-7861-2923-3

Umschlagbild: Statuenkopf, Neapel, Museo Archeologico Nazionale inv. no. 153654. Courtesy, Ministero per i Beni e le Attività Culturali e per il Turismo – Museo Archeologico Nazionale di Napoli (Hans R. Goette)

Einbandgestaltung: U. Thaler, S. Hoffmann

Satz: www.wisa-print.de

Druck und Verarbeitung: druckhaus köthen GmbH & Co. KG · Köthen

Printed in Germany

Printed on fade resistant and archival quality paper (PH 7 neutral) · tcf

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Votivwaffen im panhellenischen Heiligtum von Olympia (10.–5. Jh. v. Chr.): Eine diachrone Analyse

ZUSAMMENFASSUNG In diesem Beitrag werden die ersten Ergebnisse einer quantitativen Analyse von Metallobjekten vorgestellt, die im Zeusheiligtum von Olympia gefunden wurden und aus der protogeometrischen bis klassischen Zeit stammen. Wir konzentrieren uns auf Waffen als eine der am umfassendsten untersuchten Kategorien von Votivgaben, untersuchen ihre räumlichen und zeitlichen Deponierungsmuster mit diachroner Datenvisualisierung und rekonstruieren ein konkretes Veränderungsmuster am Beispiel griechischer Hoplitenrüstungen. Aufgrund der langen Nutzungs- und Ausgrabungsgeschichte ist die Anzahl der in Olympia dokumentierten Artefakte hoch, der räumliche und zeitliche Detailgrad der relevanten Kontextinformationen jedoch sehr gering. Die zeitliche Zuordnung der Objekte beruht fast ausschließlich auf der typenchronologischen Klassifizierung. Trotz dieser Einschränkung können die vorliegenden Daten zum Verständnis von Moden von Waffenweihungen im Heiligtum beitragen, die sich nicht zuletzt als Ergebnis sich verändernder religiös-kultureller Wahrnehmungen, religiöser Vorschriften, politischer Interessen und bewusster Verwaltung des Heiligtumsbereichs herausbildeten.

Schlagwörter Votivgaben; Panoplien; Hoplit; Quantifizierung; diachrone Analyse.

ABSTRACT This paper presents the first results of a quantitative analysis of metal objects found in the Zeus sanctuary of Olympia, dating from the Protogeometric to the Classical period. We focus on weapons as one of the most comprehensively studied category of votive offerings, explore their spatial and temporal deposition patterns with diachronic data visualization and reconstruct a concrete pattern of change on the example of Greek hoplite panoplies. Due to its long occupation and then excavation history, the amount of artefacts documented in Olympia is high, but the spatiotemporal resolution of relevant context information very low. The temporal attribution of artefacts relies almost exclusively on typochronological classification. Despite this limitation, the dataset can contribute to an understanding of fashions of weapon offerings in the sanctuary which emerged not least as an outcome of changing religio-cultural perceptions, religious regulations, political interests and conscious management of the sanctuary space.

Keywords votive offerings; panoply; hoplite; quantification; diachronic analysis.

Αναθηματικά όπλα στο πανελλήνιο ιερό της Ολυμπίας (10ος–5ος αι. π. Χ.): Διαχρονική εξέλιξη

ΠΕΡΙΛΗΨΗ Σε αυτό το άρθρο παρουσιάζονται τα πρώτα πορίσματα μιας ποσοτικής ανάλυσης μεταλλικών αντικειμένων, τα οποία βρέθηκαν στο ιερό του Διός στην Ολυμπία και χρονολογούνται από την πρωτογεωμετρική έως την κλασική περίοδο. Εστιάζουμε στα όπλα, δεδομένου ότι πρόκειται για μία από τις κατηγορίες αναθημάτων που έχουν διερευνηθεί στον μέγιστο δυνατό βαθμό, εξετάζουμε τα χωρικά και χρονικά μοτίβα απόθεσής τους με διαχρονική οπτικοποίηση δεδομένων και ανασυνθέτουμε ένα συγκεκριμένο μοτίβο αλλαγών λαμβάνοντας ως παράδειγμα ελληνικές πανοπλίες οπλιτών. Εξαιτίας της μακράς ιστορίας χρήσης και ανασκαφών στον χώρο, ο αριθμός των τέχνεργων που έχουν καταγραφεί στην Ολυμπία είναι μεγάλος, όμως ο βαθμός λεπτομέρειας των σχετικών πληροφοριών που τα εγγράφουν σε ένα χωροχρονικό πλαίσιο παραμένει περιορισμένος. Η χρονική απόδοση των αντικειμένων βασίζεται σχεδόν αποκλειστικά στην τυπολογική και χρονολογική ταξινόμηση. Παρά τον περιορισμό αυτό, τα διαθέσιμα δεδομένα έχουν τη δυνατότητα να συμβάλουν στην κατανόηση τάσεων στα αναθήματα όπλων στον χώρο του ιερού, όπως διαμορφώθηκαν ως αποτέλεσμα αλλαγών στις θρησκευτικές / πολιτισμικές αντιλήψεις, τις θρησκευτικές επιταγές, τα πολιτικά συμφέροντα και τη συνειδητή διαχείριση του χώρου του ιερού.

Λέξεις-κλειδιά Αναθήματα. Πανοπλίες. Οπλίτες. Ποσοτικός προσδιορισμός. Διαχρονική εξέλιξη.

INTRODUCTION

Among all ancient Greek sanctuaries Olympia stands out for many reasons, of which two will be of primary interest to this investigation: the number of votive offerings and their continuity from the 10th to the 5th century B.C. Regrettably we cannot assess this entire period in detail, nor can we explore the specific features of exhibition of the individual artefact categories[1]. Instead, our aim is to provide a high-level analysis of weapon artefacts and the rhythms of their offering.

Nearly a quarter of the 25000 votive offerings recovered in excavations at the sanctuary are weapons[2]. The huge amount of material evidence recovered from Olympia compelled archaeologists from an early stage to focus on distinct material categories. This act of typological classification enables efficient research management and allows archaeological specialists to acquire high expertise on distinct functional artefact types. But sometimes it can also narrow the focus of their interest to these types alone, hindering their broader understanding of the behaviour associated with the offerings in the sanctuary, its general evolution and related diachronic changes. We suggest a new interpretation of the material record from Olympia, offering a more global perspective that is vitally needed to understand how, why and when Ancient Greeks and (perhaps) visiting foreigners offered votive objects in the sanctuary[3].

There is a general consensus among scholars that material culture is a key component in understanding the development of ritual practices in the Greco-Roman world. Archaeological remains fossilize, concentrate and preserve the history of individual sanctuaries[4]. Moreover, they offer the only remaining evidence available for the reconstruction of life and ritual, which is not – or only poorly – represented in written sources. This holds especially true for the background and incentives of pilgrims visiting a sanctuary or smaller cults devoted to minor deities. Votive objects record the memory of a sanctuary and allow insights into the evolution of the actual procedures for offering artefacts at the shrine. This complex activity underwent continuous changes in the types and amounts of artefacts offered, the way they were prepared and deposited (complete, broken, drilled, bent, engraved or fragmented), and how and which objects from different (spatial or social) domains were introduced[5]. All these clues provide a key to understanding the biography of a sanctuary and the surrounding cult's progression towards greater religious complexity.

This research was developed in collaboration with the Römisch-Germanisches Zentralmuseum (RGZM) and the Deutsches Archäologisches Institut in Athens (Athens Department of the DAI), with the financial support of the Deutsche Forschungsgemeinschaft (DFG) under the Project title ›Olympia – Diachrone Entwicklung der Votivgaben vom 10. bis 5. Jahrhundert v. Chr.‹ [Olympia – Diachronic Development of the Votive Gifts from the 10th to the 5th Centuries B.C.] (BA 3197/1-1).
We are much indebted to Holger Baitinger and Reinhard Senff. We would also like to thank the following colleagues for their assistance with the project: J. Bonnes, M. Egg, G. Heinz, N. Kallas, A. Mees, A. Scarci. Finally, we would like to thank the anonymous reviewers for their comments, which have improved various aspects of the paper.

[1] Frielinghaus 2006; Graells i Fabregat 2017b; Graells i Fabregat 2017c.

[2] Offerings of weapons in sanctuaries are described in a large body of literature: Greenwell 1881; Kunze 1967a; Pritchett 1979; Jackson 1983; Jackson 1991; Jacquemin 1999; Baitinger 1999; Gabaldón 2005; Frielinghaus 2006; Baitinger 2011; Frielinghaus 2011; Baitinger 2012; Frielinghaus 2012; Baitinger 2016a; Baitinger 2016b; Graells i Fabregat 2016; Graells i Fabregat 2017a; Graells i Fabregat 2017b; Graells i Fabregat et al. 2017; Baitinger 2018; Graells i Fabregat – Longo 2018; Graells i Fabregat 2019b; Graells i Fabregat 2020; Scarci 2020.

[3] Previous attempts in Felten 1982; Kilian-Dirlmeier 1985; Philipp 1992; Philipp 1994; Baitinger 2016b.

[4] Luce 2010.

[5] Graells i Fabregat 2017b.

Only a few published attempts have been made to apply explicitly quantitative and statistical analysis to the study of votive offerings in Greek sanctuaries. The works of S. Hodkinson[6] and J. Larson[7], who focused mostly on bronze objects, are a rare example of such an approach: they highlight the significant potential which is offered by metal offerings, as well as the rich diversity in forms and functions of ancient offering practices. Hodkinson[8] maintained that, although bronze survives in greater quantities than more expensive metals, the archaeological record of bronze votive offerings is compromised and depleted by several post-depositional factors, such as melting down, plundering and the conservation problems connected to the metal itself. This led him to suggest that the numbers of each type of offering should be considered individually, according to the differential effect of these factors upon each type (objects made of sheets of bronze versus casts, size, etc.). A reliable, parametrized algorithm to calculate this suggested weighting is a desideratum, though, and remains a challenge for future scholarly research.

A first attempt to survey the votive offerings from Olympia comprehensively was the pioneering work of F. Felten[9], who tried to compare the offering activities there with those in Delphi. Some years later, I. Kilian-Dirlmeier[10] delved into the study of the origins of votive gifts in multiple Greek sanctuaries, including Olympia. In 1995, E. Jarva presented a quantitative analysis of weapons from Olympia – with a focus on body armour[11] – but the published results were severely called into question by H. van Wees[12]. Van Wees criticized the inconsistency of Jarva's proposals based on his own preconceived image of the Greek archaic panoply and army. Beyond Felten, Kilian-Dirlmeier and Jarva, other studies have examined the votive offerings from different points of view: some have attempted to summarise the chronological information on all votive offerings, mostly concentrating on the early phases of the sanctuary[13], while others have investigated a specific group of artefacts, frequently weapons, from a diachronic point of view[14].

Here we offer a new attempt in charting the development of votive offerings at the Zeus sanctuary of Olympia from the beginning of the archaeological record to the Classical period. The main goal of this project was to develop research ideas based on statistical analysis of the data recorded in the official database of the Olympia excavation project: iDAI.field.

The presented results are built upon three main pillars:

1. We only work with published material that has already been uniformly compiled in a dedicated database.
2. We thus work with a partially incomplete catalogue. We agree that complete publication and analysis of the finds is a fundamental requirement for a thorough study[15] and only a complete database of the finds will allow a conclusive quantification of the absolute number of dedications through types and periods. For the time being, however, we expect the large subset of published weapon artefacts to provide a meaningful statistical sample.
3. We limit the analysis to a time window from the 10th century – which corresponds to the first advent of votive offerings in the sanctuary – to the 5th century B.C.

In the following sections we will explain how we analysed the diachronic development of weapon artefacts by means of archaeological and statistical methods. We focus on the evolution of types, artefact numbers and associations of weapons. The results, which should be compared with observations from other sanctuaries in the future, are hoped to contribute

6 Hodkinson 1998.
7 Larson 2009.
8 Hodkinson 1998, 56.
9 Felten 1982.
10 Kilian-Dirlmeier 1985.
11 Jarva 1995.
12 van Wees 1997, 154 f.
13 Kyrieleis 2006.
14 Baitinger 2001; Bartels 1967; Bol 1989; Philipp 2004; Philipp 2014; Frielinghaus 2011; Kunze 1967b; Kunze 1991; Graells i Fabregat 2019b.
15 Hodkinson 1998, 56.

to the reconstruction of the history of Olympia and also to provide new insights into Ancient Greek warfare.

MATERIALS AND METHODS

The database constructed and compiled for this project contains (as of May 2019) more than 13000 individual artefacts, of which ca. 4000 are published, and boasts an extensive amount of contextual and object-specific information in German. Its structure was devised by the IT-Team of the German Archaeological Institute at Berlin, supervised by R. Förtsch, and follows the general layout of the iDAI.field database Version 1[16]. It is implemented with the proprietary database development software FileMaker Pro Advanced Version 17. In the future, this database will be reimplemented in a PostgreSQL based environment provided by the iDAI.field database Version 2[17].

All spatial data preparation for this paper was carried out with the GIS software QGIS version 3.4. All further data analysis was performed with the statistical data analysis environment R version 4.1.0[18]. We relied on the following ›R packages‹: cowplot, dplyr, forcats, ggplot2, ggrepel, ggridges, ggspatial, janitor, magick, magrittr, pbapply, purrr, raster, readr, rsvg, sf, tibble, tidyr, tidyselect and wesanderson[19]. The code is reproducible[20] and available in a public repository on GitHub (https://github.com/nevrome/olympia.votive weapons.article2021), as well as with a permanent digital object identifier (DOI) on the Open Science Framework Platform (http://dx.doi.org/10.17605/OSF.IO/RV2ZF).

For this paper, not all data were used, but only a specially prepared subset detailing weapon artefacts and relevant variables. While the raw source database cannot be published at present, the relevant subset is openly available in the repository. The supplementary Table 1 contains an overview of the variables in the subset table and their meaning *(table 1)*. Each individual artefact has a unique object identifier, typological dating information based on published dates in the relevant material-focused studies, rough information about the documented excavation location and a hierarchical typological attribution. The supplementary Table 2 lists the literature used for the typological dating of each artefact type *(table 2)*.

This dataset contains 3673 metal weapon artefacts documented and published during the complete excavation history of Olympia, as far as we have been able to reconstruct it. *Figure 1* is based on this dataset, but for all other figures a more strict filtering process had to be applied. They are computed from a selection of 3059 weapon artefacts that fulfil the following requirements:

1. The artefact must be typologically analysed and dated.
2. Its dating must fall between 1000 and 400 B.C.
3. The artefact must be spatially attributed to one of the site's macro areas (e.g. Temple of Zeus, Stadium, etc.).

Figure 1 visualizes the material distribution by category and describes the precision of the available artefact dating information. The categories are deliberately broad to give a general overview. Each individually documented and published artefact is counted as one observa-

[16] Schäfer 2011.
[17] Cuy et al. 2017.
[18] R Core Team 2021.
[19] In the order of the packages: Wilke 2020; Wickham et al. 2021; Wickham 2021a; Wickham 2016; Slowikowski 2021; Wilke 2021; Dunnington 2021; Firke 2021; Ooms 2021a; Bache – Wickham 2020; Solymos – Zawadzki 2020; Henry – Wickham 2020; Hijmans 2021; Wickham – Hester 2021; Ooms 2021b; Pebesma 2018; Müller – Wickham 2021; Wickham 2021b; Henry – Wickham 2021; Ram – Wickham 2018.
[20] Marwick et al. 2018.

Variable	R Data type	Description
general_id	Character	Unique object identifier.
dating_typology_start	Integer	Start of typological dating time window. All temporal information is based on typological attribution and the dating suggested in the respective literature. Negative numbers denote years BC, e.g. -674 = 674 BC.
dating_typology_end	Integer	End of dating time window.
find_area	Factor	Site macroregion, where the object was found.
typology_class_1	Factor	General typological attribution: *Waffe* (weapon), *Schmuck* (jewellery), *Pferdeausstattung* (horse tack), etc. Here only *Waffe*.
typology_class_2	Factor	More fine-grained artefact distinction: *Pfeilspitze* (Arrow head), *Helm* (Helmet), *Bronzene Speerspitze* (Spear head [bronze]), etc.
typology_class_3	Factor	Even more fine-grained attribution with partially chronologically relevant classes: *Korinthischer Helm* (Corinthian Helmet), *Illyrischer Helm* (Illyrian Helmet), *Thrakische Mitra* (Thracian mitre), etc. This column was not translated to English.
typology_class_4	Factor	Specific type attribution as proposed in the literature: IIA3d, D Stufe IId, IIIF, etc. This column was not translated to English.
orientation	Factor	Only used to distinguish greaves: left, right.

Table 1 Variables in the subset table and their meaning

Artefact type (typology_class_2)	Literature used for typochronological dating information
Arrowheads	Baitinger 2001
Spearheads	Baitinger 2001
Lances (Heads and sauroters)	Baitinger 2001
Shields	Bol 1989
Episemata (Shield emblems)	Philipp 2004; Philipp 2014
Helmets: Crested (A), Kegel (B), Illyrian (C), Corinthian (D), Multipart (E), Cretan (F), Chalcidian (G), Classical (H and J), Assyrian (K), Negau (L), Conical (M), Decoration Elements (N)	Frielinghaus 2011
Greaves	Kunze 1991; Jarva 1995
Foot guards	Kunze 1967; Jarva 1995; Graells i Fabregat 2019
Ankle guards	Jarva 1995
Thigh guards	Jarva 1995
Arm guards	Graells i Fabregat 2019a
Cuirasses	Graells i Fabregat in press
Mitres	Bartels 1967; Jarva 1995

Table 2 Literature used for typological dating

tion, so multiple artefacts – especially in the domain ›Shield and accessories‹– might have belonged to the same original weapon. On the other hand, we can only count preserved artefacts, so weapon and armour categories that are usually made from organic material are most likely severely undercounted due to preservation issues. These and other effects skew the representativity of the artefact counts both in this and all other analyses and will be a recurring topic below.

For *Figure 2*, a map of the spatial origin of weapon artefacts, it was necessary to define the major areas of the archaeological site of Olympia. Most artefacts found during the early

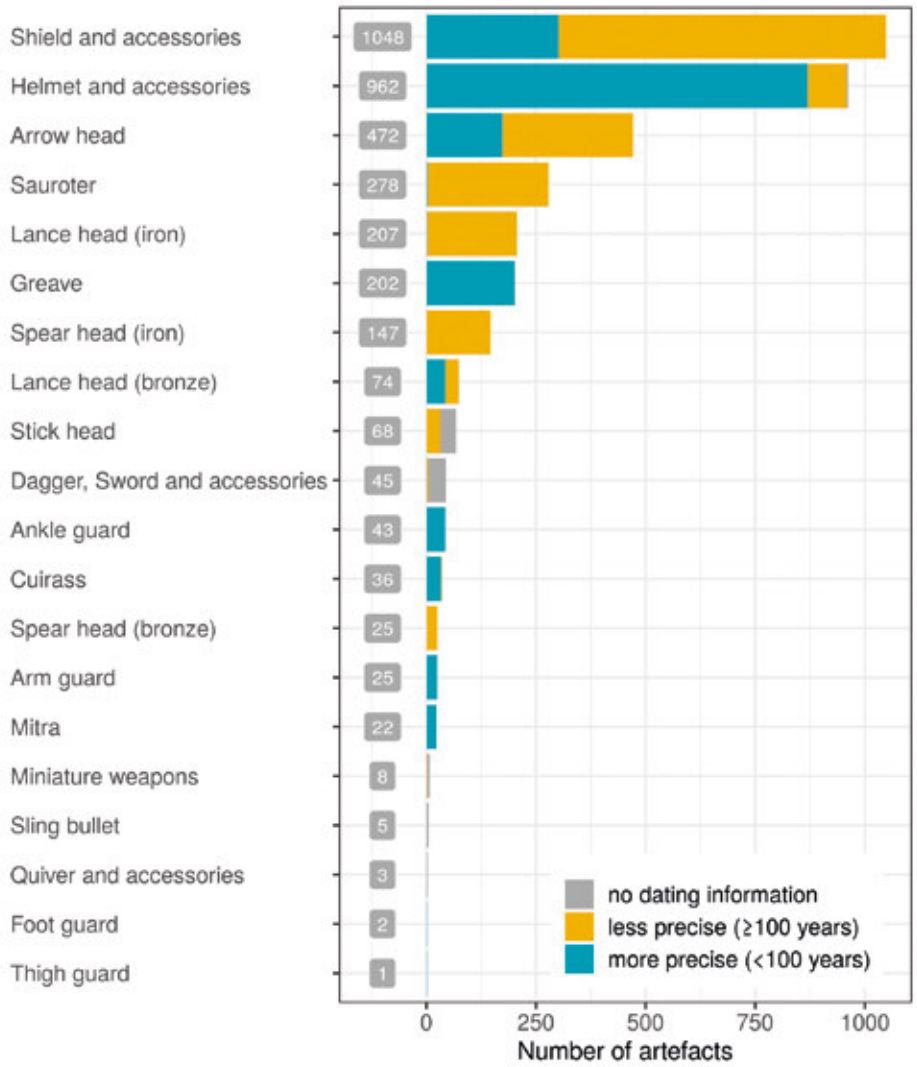

Fig. 1 Artefact category distribution in the Olympia weapon dataset. The labels show the total number of artefacts counted for the respective category. The fill colour of the bars indicates the proportion of the artefacts with dating information.

excavations in the second half of the 19th century were recorded, albeit with very imprecise information on their spatial context. The approximate area separation proposed here is based on preparatory work of the DAI Athens team and attempts to respect the geomorphological changes brought to Olympia in the post-antiquity period by the rivers Alpheios and Kladeos. However, the low degree of spatial precision for most of the old excavations renders this spatial attribution fuzzy. Also, the documented find position during the excavation does not necessarily represent the position at which an artefact was exhibited or even deposited, given the complex (building) history of the sanctuary. If significant amounts of earth were moved from one part of the sanctuary to another, then this earth might already contain votive offering fragments, and thus skew the archaeologically observed spatial distribution.

One of the most important features of the presented dataset is the widespread availability of (approximate) temporal information. The assigned time windows for each artefact are based solely on published domain expert knowledge: typological analysis and material comparison with finds from all over the Mediterranean world. This includes, firstly, data from Olympia, but also from other sanctuaries and cemeteries in Greece and Southern Italy.

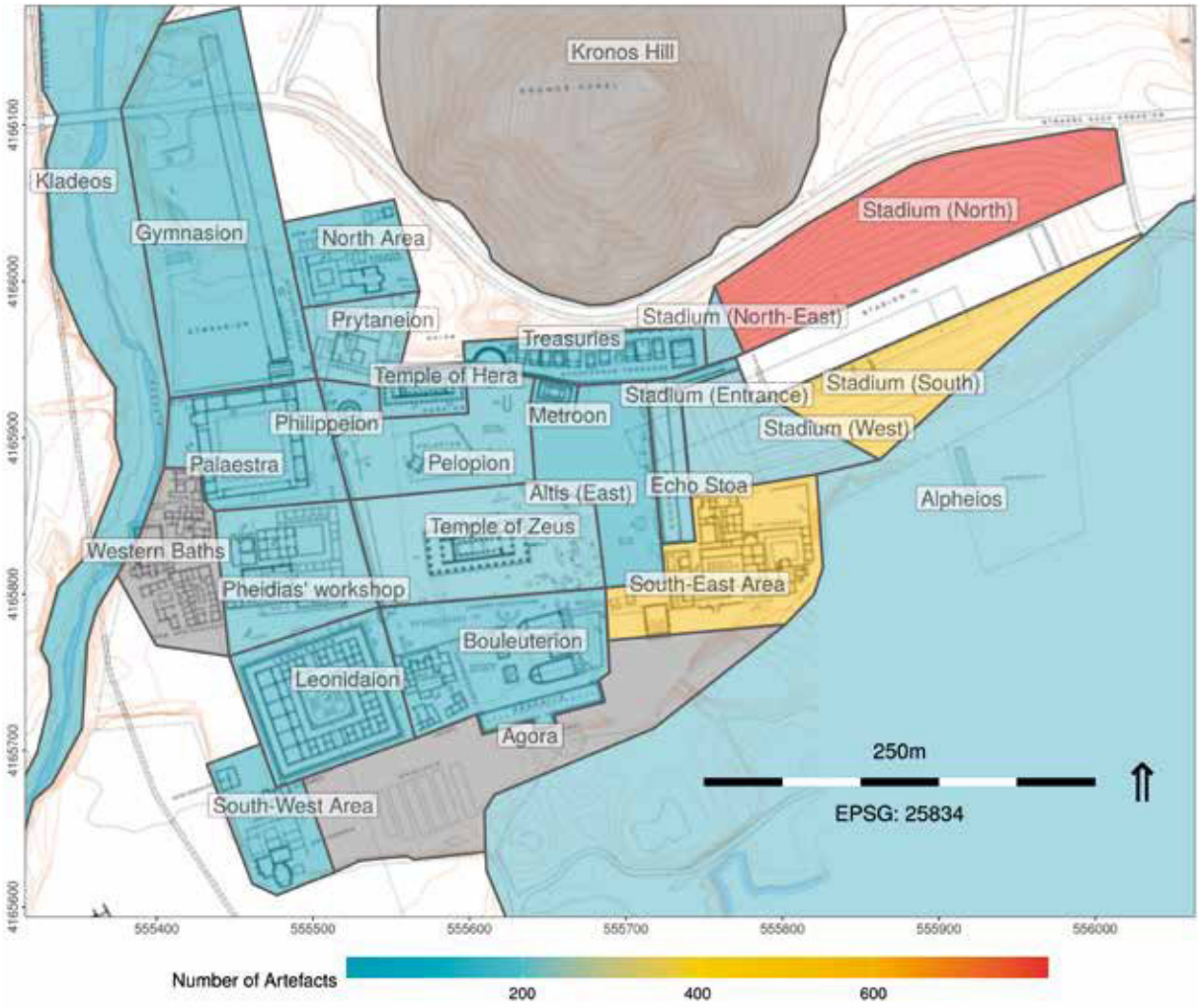

Fig. 2 Macro areas of the archaeological site of Olympia. The fill colour indicates the total number of weapon artefacts documented per area.

The datings are therefore often coarse and unreliable. Nevertheless, these data generally allow us to reconstruct the history of the votive offerings from an overarching, comparative perspective beyond the limitations imposed by individual material categories.

One major challenge in summarizing the temporal information quantitatively is the significant fluctuations in precision. For some artefacts, e.g. certain helmet types, very precise dating (< 25 years) is available; for others, e.g. spearheads, only broad time windows (> 100 years) have been reconstructed typologically. These windows irregularly overlap. To overcome these issues and create structurally uniform and continuous time series of relative abundance, we employed the aoristic method. This method was initially developed in forensics to reconstruct the incidents of a crime. It works by explicitly spreading the probability of an event across a time window, within which the event could have taken place[21], and allows for the calculation of a weight-corrected, year-wise measure of type occurrence. We used the R package aoristAAR to calculate these time series and (for some applications) the simpler, uncorrected per-year-count time series[22].

With this time series construction method, the static map in *figure 2* can be split up to display the temporal development of votive offering depositions in the different areas of

[21] Johnson 2004; Mischka 2004.

[22] Hinz et al. 2019.

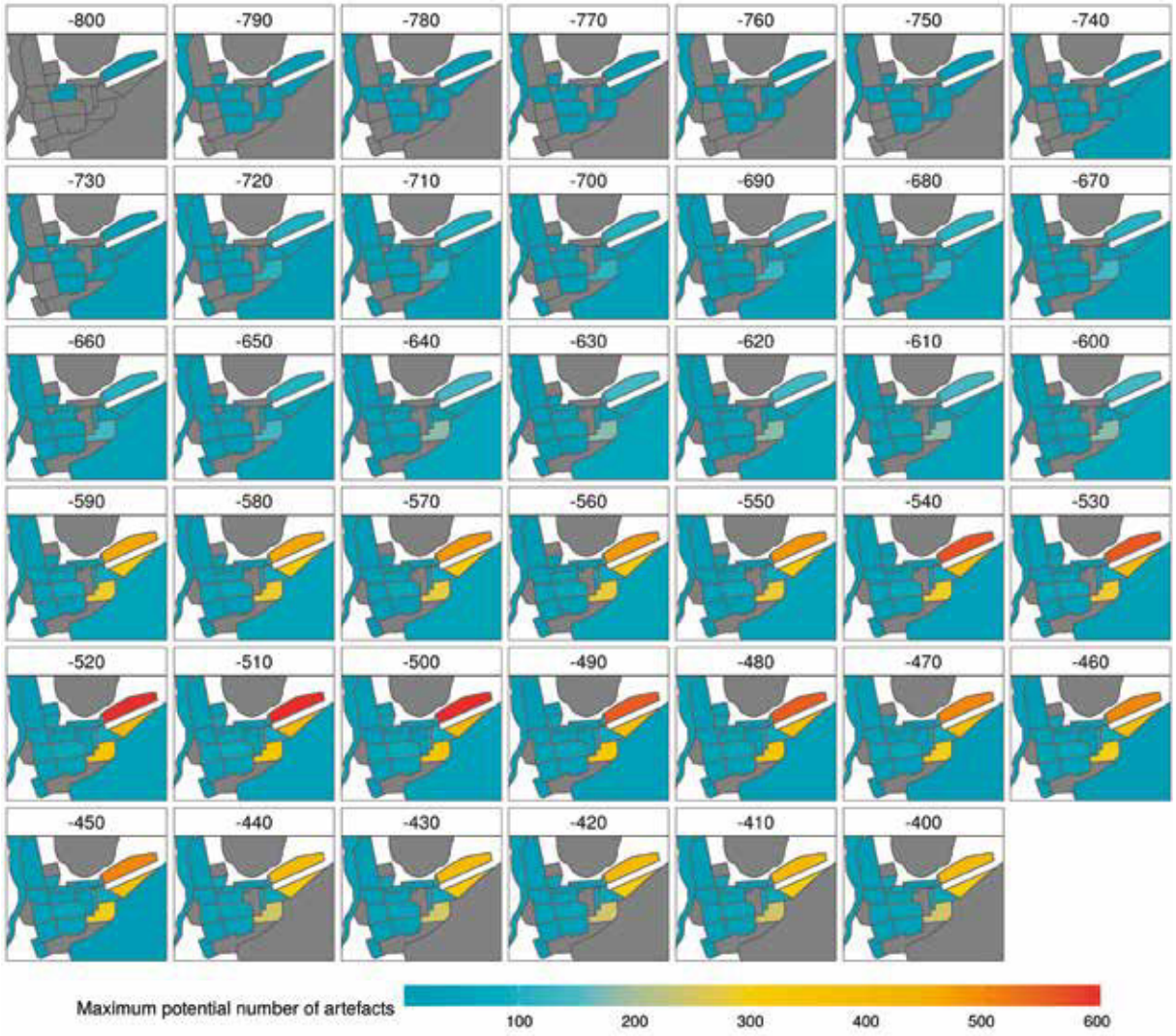

Fig. 3 Diachronic development of the weapon artefact distribution in steps of 10 years from 800 to 400 B.C.

Olympia. *Figure 3* expresses this result as a map plot matrix with one map for every 10-year step between 800 and 400 B.C.[23] For each time step, we plotted the maximum potential number of artefacts. This means that the map matrix cannot be read in the sense of »exactly between 490–480 B.C., around 300 artefacts were deposited in the South-East Area«, but rather »it is probable that around 480 B.C. a comparatively high number of artefacts was deposited in the South-East Area«. The imprecise input information necessarily translates to imprecise results.

Beyond the spatial extent of the votive offering ritual, the aoristic data transformation also allows us to conceptualize a notion of the changes in the kind of material deposited. *Figure 4* and *figure 5* present the aoristically corrected abundance time series for different material categories with typologically more and less fine-grained characterization. Plotting

[23] The time slot between 1000 and 800 B.C. is not plotted because of the very small amount of weapon artefacts from this period (cf. *fig. 6*). For the calculation of the underlying time series, the aoristic weight correction was not applied. Instead, each artefact was counted into each timestep overlapping with the dating range of the artefact in question. The number of displayed artefacts therefore exceeds the actual amount of artefacts due to multiple counting.

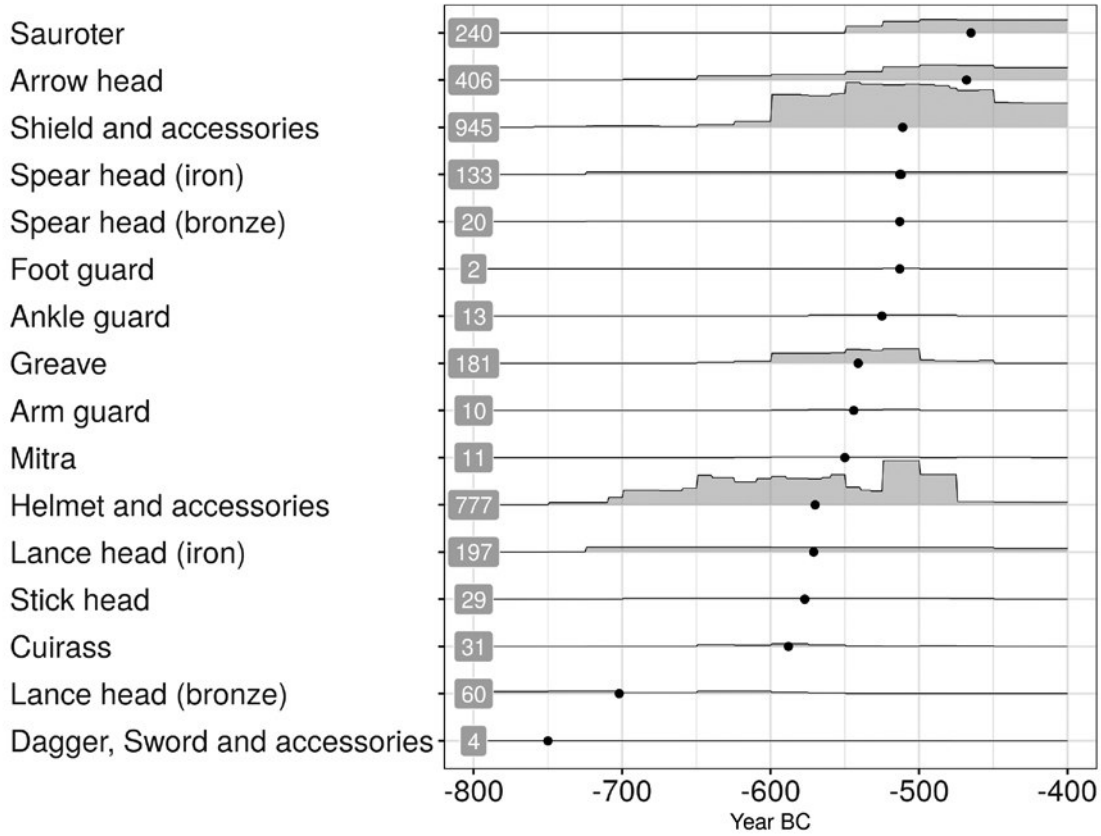

Fig. 4 Temporal distribution of the main artefact categories. The labels on the left give the total number of artefacts. The dot under each ridge shows the centre point of the distribution and the vertical order of categories from bottom to top follows the order of the center points in time.

the corrected artefact weight instead of the artefact count is especially useful here, so that we can visually adjust for the differences in artefact dating precision. The classification attempted for *figure 4* gives a general overview, but might be misleading in some respects: the overcounting (e.g. shield fragmentation) and undercounting (e.g. due to preservation) issues introduced above affect all results of this analysis.

Figure 6 is an attempt to zoom out further and summarise all available data in a general votive offering time series. *Figure 6 A* presents two different kinds of time series with the amount of weapon-offering artefacts per year: both the uncorrected artefact count (as employed for example in *figure 3*) as well as the year-wise artefact weight calculated with the aoristic method (as calculated for *figure 4* and *5*). *Figure 6 B* counts the maximum potential number of documented artefact categories per year (as fine-grained as in *figure 5*) to visualize the variability of the votive offering ›fashion‹ between 800 and 500 B.C. Of course the typological classification used for this diachronic tally depends to a large degree on the analysis of individual specialists. Typology does not directly represent how an ancient observer might have perceived objects, and it is an assumption on our part that differences among subtypes can be meaningfully compared across artefact categories.

Figures 6 C and *6 D* were introduced to visually highlight patterns of temporal change in the pace and direction of fashion diversity development. *Figure 6 C* simply shows the derivative of the spline fit to *fig. 6 B*, but *fig. 6 D* introduces a set of even bolder assumptions: if one assumes the *decade* to be a sensible unit of cultural change in stylistic transformation,

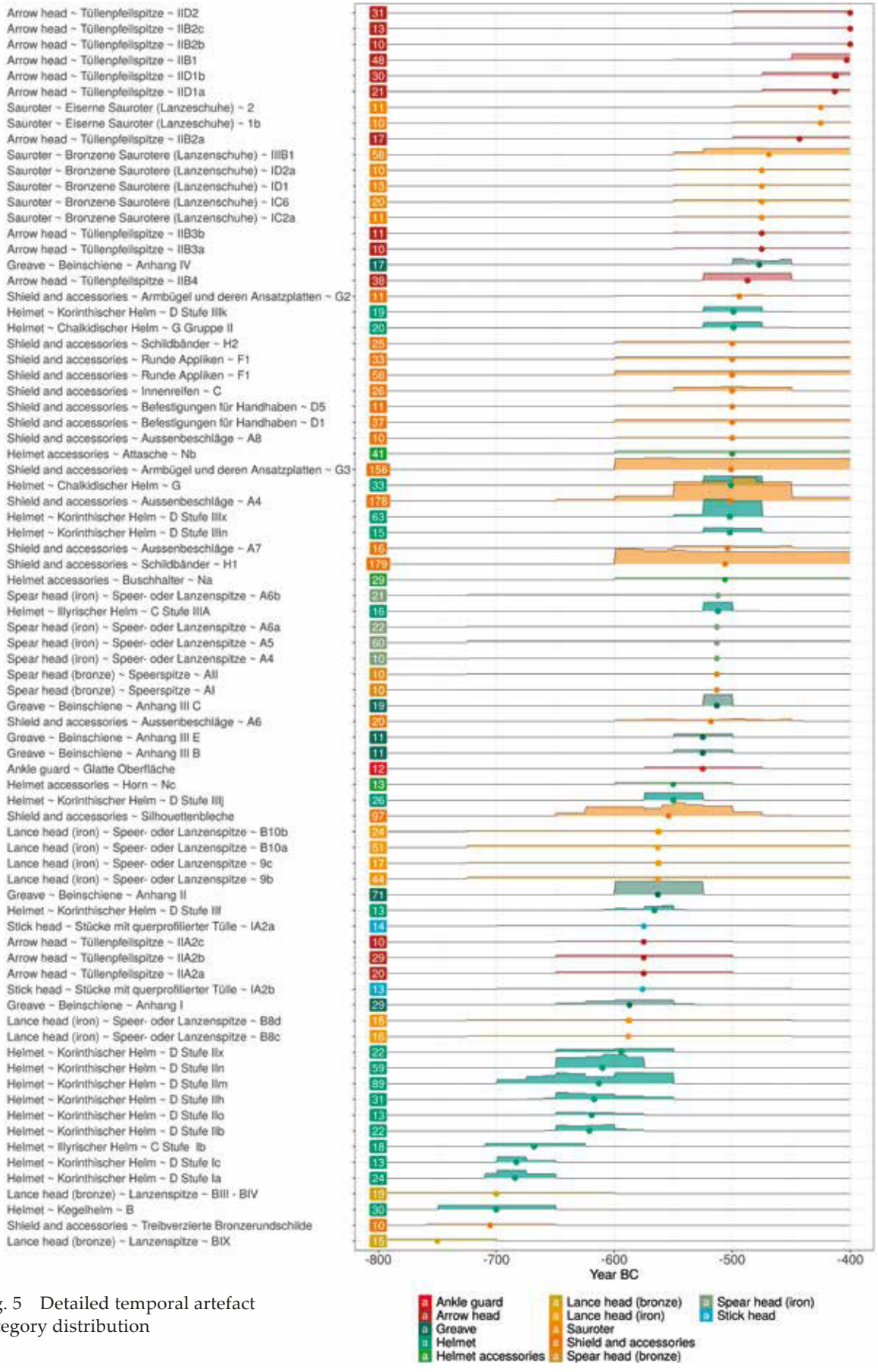

Fig. 5 Detailed temporal artefact category distribution

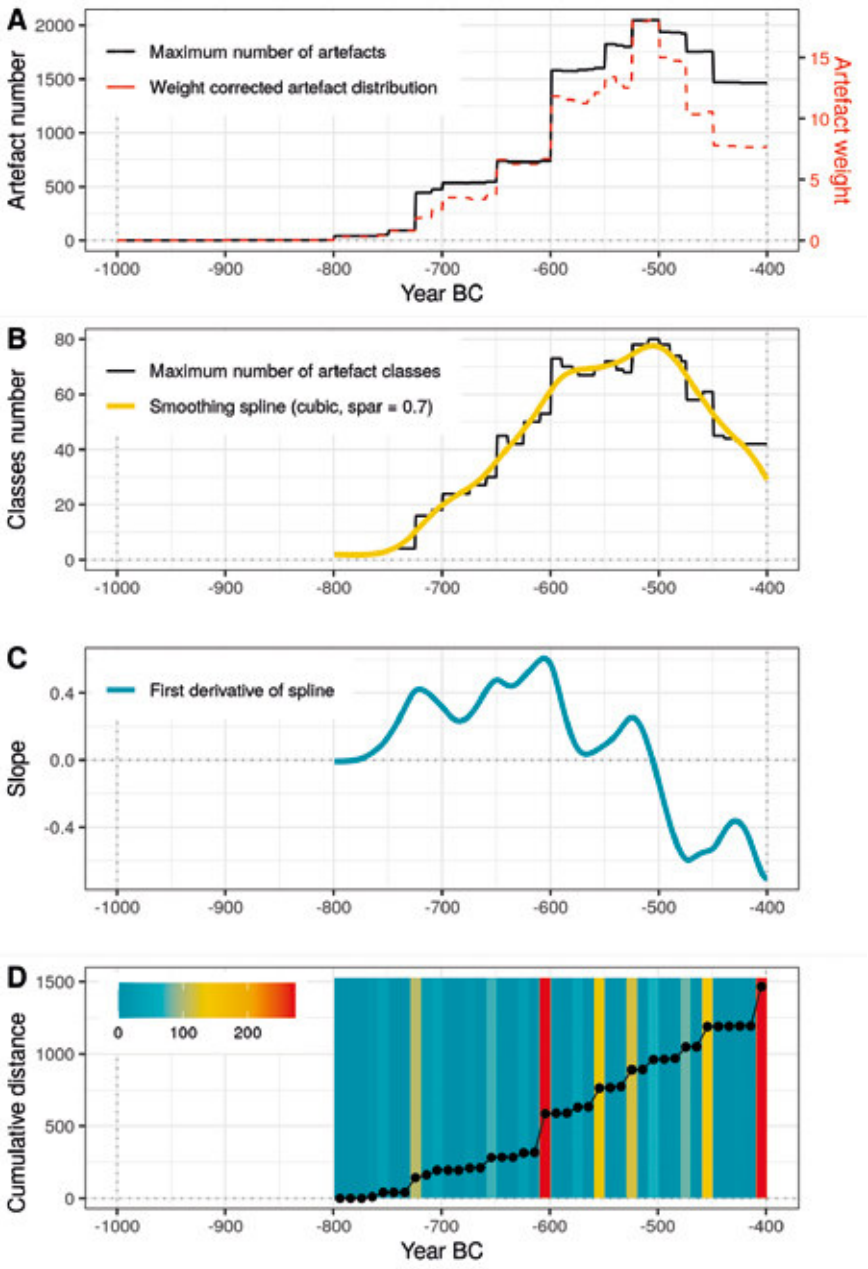

Fig. 6 A. Time series of all weapon artefacts between 1000 and 400 B.C. – B. Time series based on the temporal attribution of the artefact categories selected for *fig. 5*. – C. First derivative of the spline from B. – D. Sequence of decade-wise Euclidean distances based on the absolute number of artefacts for the categories in *fig. 5*. Each decade-decade distance is represented by a colour coded stripe. Points and line show the cumulative sum of the distance values.

one can calculate Euclidean distances between the typologically categorized inventory of one decade in relation to one of the succeeding decade. *Figure 6 D* renders the sequence of these Euclidean distances and their cumulative sum. The latter could help to identify phases of strong cultural (fashion) change and, conversely, phases of relative stability. However, the imprecise dating of most artefact categories (cf. *fig. 5*) relativizes the significance of this exploratory plot.

Artefact type-based time series finally allow one to take a temporally explicit look at special questions. In yet another highly experimental approach we wanted to investigate whether the quantitative evidence is consistent with a particular focus of the votive offering practice on the deposition of complete suits of armour (panoplies, see *figure 7 B*). *Figure 7 A* visualizes the counts of certain panoply-related artefact categories. This is not just a subset of *figure 1*: the counts are based on a stricter data selection (see above) and the categories are regrouped according to the research question. Helmets are counted without accessories and

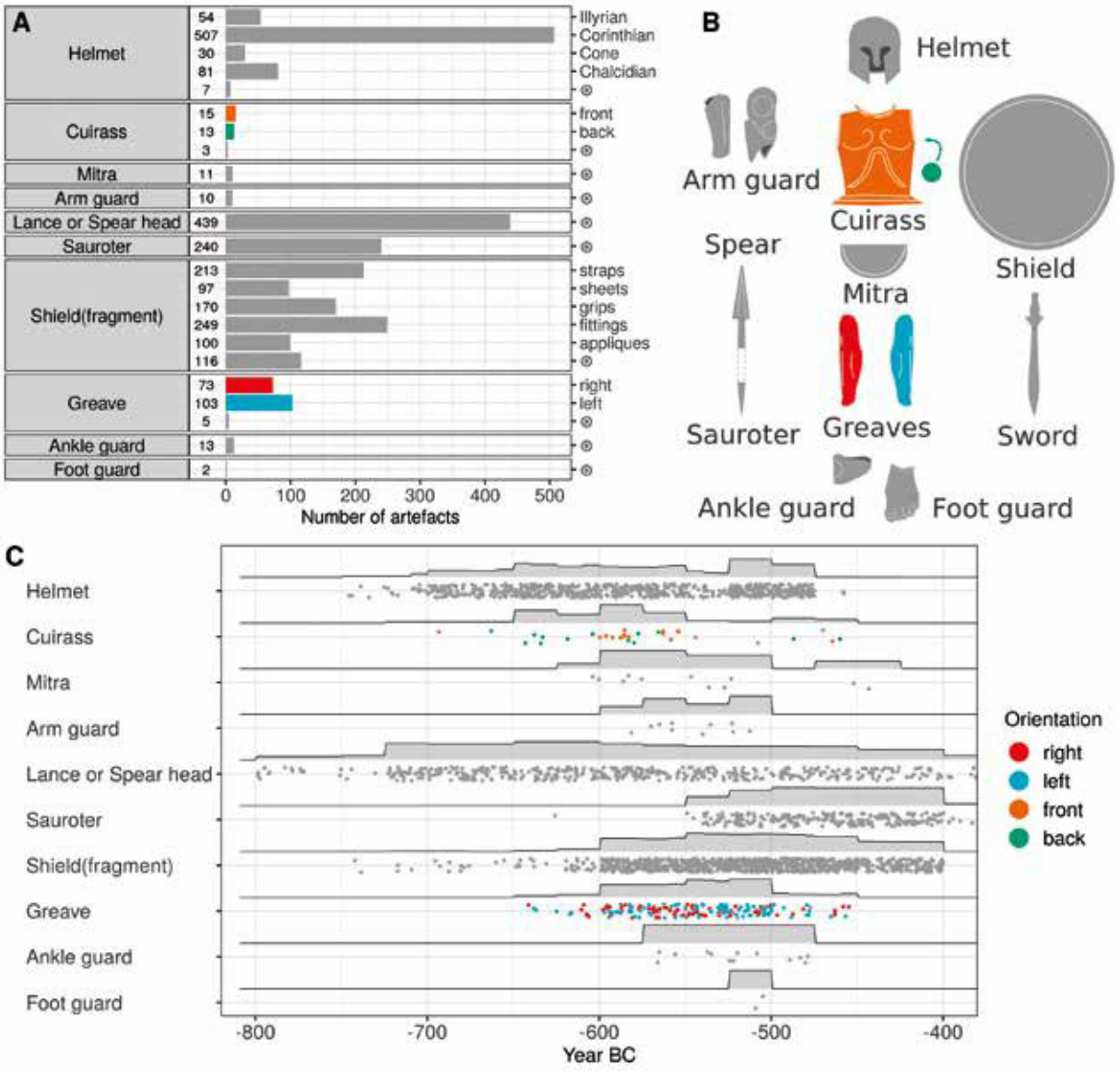

Fig. 7 A. Dated and typologically classified weapon artefact categories that are part of the Greek panoply. Shield related artefacts are split up into meaningful subcategories. – B. Schematic drawing of the ancient Greek panoply. – C. Normalized ridge plot of the diachronic aoristic weight for the panoply related artefacts

lances, spear, and stick heads are merged. For the artefact category which was probably the most difficult to count, i.e. shields, we split the data into functional subcategories. For some of these we can assume only one artefact per shield (e.g. ›straps‹ – ›Schildbänder‹), thus giving a better indication of the true number of shields deposited in Olympia. *Figure 7 C* shows the diachronic development of these panoply-related artefact categories, with one iteration of a possible chronological deposition model randomly sampled from the per-artefact age ranges. In this case we once more ignored the fact that the actual offering of a given artefact might have happened long after it fell out of fashion.

RESULTS

Currently there are at least 3673 documented and published metal weapon artefact fragments from the archaeological site of Olympia. More than 3059 of them are most likely from a time period between 1000 and 400 B.C. Weapon artefact depositions in Olympia seem to start at around 800 B.C. and slowly become more commonplace until they peak at the end of the 6th century B.C. *(fig. 6 A)*[24]. From 500 B.C. onwards, the number of weapons deposited per year seems to decrease. However, at 400 B.C., the end of the observation period analysed in this paper, the amount of weapon depositions is still relatively high.

Most of these artefacts are fragments of shields[25], helmets[26], arrow heads[27], spears (bronze[28] and iron[29] heads as well as bronze[30] and iron[31] sauroteres), and greaves[32] *(fig. 1)*. The proportions of these categories are not well-balanced: helmets are abundant, and so are – albeit to a lesser degree – remains from pole weapons (lance, spear and stick), shields and greaves. Other body armour, such as breastplates[33], mitras or limb guards[34], are rare. From these results alone it is not clear whether the intentional deposition of weapon artefacts as complete suits of armour[35] was the more common form of votive offering *(fig. 7)*; this issue will be discussed further below.

Most weapon artefacts were found in the southeast area and the southern, and especially the northern, stadium walls *(fig. 2)*[36]. The other areas yielded markedly fewer weapon finds. This trend becomes more visible from 600 B.C. onwards, although there are no strong shifts in the spatial distribution of weapon artefacts over time *(fig. 3)*. Regarding the temporal distribution of artefact types, helmets and spears seem to be the categories that initiate the weapon offering practice, whereas shields and limb armour only really become relevant from 600 B.C. onwards. Sauroters appear from the middle of the sixth century, and then last until the end of our observation window around 400 B.C., together with (accompanying) dory heads and fragments of shields. Other artefact types, especially limb armour, but also helmets, fade out at an earlier period. This result limits some artefact types to the height of the weapon votive offering tradition in Olympia between the end of the 7th and the beginning of the 5th century *(fig. 4. 5. 6. 7 C)*[37].

The number and range of weapon artefacts in Olympia rises gradually from 800 B.C. onwards and peaks at the end of the 6th century B.C. *(fig. 6 A. B)*. The change in trend that occurs around 500 B.C. *(fig. 6 C)*, namely towards less numerous and less diverse weapon depositions, is remarkable. Beyond this, notable shifts in the cultural preferences of certain artefact categories occurred in the second half of the 8th, the end of the 7th, the middle of the 6th, and the middle of the 5th centuries *(fig. 6 D)*. However, these signals might be strongly influenced by the artificial shifts induced by low-resolution typological dating: many artefact categories share starting and end dates *(fig. 5)*[38].

[24] Baitinger 2018, with previous literature.
[25] Bol 1989.
[26] Frielinghaus 2011.
[27] Baitinger 2001, 5–30 Kat. Nr. 1–489.
[28] Baitinger 2001, 33–74 Kat. Nr. 500–599.
[29] Baitinger 2001, 33–74 Kat. Nr. 600–952.
[30] Baitinger 2001, 33–74 Kat. Nr. 953–1193. 1232–1299.
[31] Baitinger 2001, 33–74 Kat. Nr. 1194–1231.
[32] Kunze 1991.
[33] Jarva 1995, 17–61; Graells i Fabregat 2019a, 248–251; Graells i Fabregat in preparation.
[34] Jarva 1995, 100–105 (ankle guards), 105–106 (foot guards), 79–84 (thigh guards); Graells i Fabregat 2019a, 275–286.
[35] Frielinghaus 2011; Gauer 2012.
[36] Frielinghaus 2012; Baitinger 2016b.
[37] Compared to *fig. 1*, the data was filtered more thoroughly and therefore the total numbers are smaller.
[38] cf. *fig. 4*. The plot is based on the variables typology_class_2, typology_class_3, and typology_class_4 (cf. *table 1*). Only categories represented by ≥ 10 artefacts are shown.

Each individual weapon offered as a votive gift in the sanctuary of Olympia has a complex and unique biography, beginning with its recovery from a battlefield (or after long personal use in combat) and ending with its deposition[39]. The process in between these two phases involved many intermediate stages, which were mainly linked to the ritual practices of offering at the sanctuary (such as ritual destruction, engraving of inscriptions, public exhibition, storage in the shrine treasuries or in any other storerooms)[40], but were also connected to maintenance (including the restoration of objects in order to display them longer, or the removal of old offerings which were melted down and the metal reused)[41] and plundering activities in post-classical times. Unfortunately, the written sources do not allow us to obtain detailed insights into the ceremonies accompanying the votive offering process[42] and we cannot ascertain the exact rules determining the ›votive lives‹ of weapons in Olympia[43]. Our analysis is hence limited to the material record acquired through archaeological excavations and the *longue durée* question that are not undetermined by it.

For example, previous publications on Olympia tend to concur that weapons were offered from the beginning of cult activity in the sanctuary until the middle of the 5th century B.C.[44] Our work now gives a quantitative overview with a less clear ending period in the middle of the 5th century *(fig. 6)*. It suggests that, based on the typological information alone, the practice could well have extended longer. This discrepancy is not least an effect of the imprecise chronological information available, with the absence of stratigraphic information in the sanctuary.

Most of the weapon artefacts considered here were buried in the layers of the stadium walls or deposited in wells *(fig. 2)*. The diachronic evolution of the spatial distribution of these weapons shows how the stadium area gained importance from the end of the 7th century B.C. *(fig. 3)*. By far the most weapons were found there, and it is at least plausible that many were exhibited and deposited there as well. Regarding the distribution within the stadium area, the northern wall contains the highest density of findings. In the area south and south-east of the stadium, significantly fewer weapons were documented. This observation must, however, be put into perspective, given the repeated swelling of the Alpheios River, which destroyed parts of this area by erosion. Many weapons were recovered only in the translocated sediments and under water[45].

By contrast, in the core of the sanctuary, the density of weapon finds is much lower than that of the stadium. Most of the weapons found in this area are also highly fragmented, while the very few complete pieces come from wells. Many fragments were especially collected in the surroundings of the Zeus temple and the Pelopion mound. There are at least two different interpretations of this observation: either this artefact scatter is an outcome of ancient cult offerings in this central area of the sanctuary including ritual destruction, or it is related to the systematic melting down of ancient votive offerings during the Byzantine period, when Olympia and its shrines suffered intensive plundering[46]. These contradictory hypotheses highlight the complexity of the votive offering taphonomy and the equifinality of possible effects causing the spatial artefact distribution we see today: some votive offerings may have

[39] Some, exceptionally, had much more complex biographies as is indicated by written sources or some inscriptions.

[40] Graells i Fabregat 2016.

[41] Graells i Fabregat 2017b.

[42] Pritchett 1979.

[43] On breastplates see Graells i Fabregat 2016: »[…] beyond the difficulty of getting any idea of the particular ritual(s), it is rather hard to find an explanation for why only some of the votives had been damaged. At least, no system underlying the choice of pieces that were damaged can be detected in Olympia« (Frielinghaus 2006, 38).

[44] Linders 1989/1990; Snodgrass 1989/1990, 289; Naso 2011, 41; Baitinger 2011; Baitinger 2012; Baitinger 2016a; Baitinger 2016b.

[45] »Besonders viele Waffen, darunter auch die erwähnten Helme aus der Hieronweihung, sind im Laufe der Zeit vom Alpheios augespült worden, was zu der Vermutung Anlass gibt, dass auch im Hippodrom solche Waffenmäler aufgestellt waren« (Kyrieleis 2011, 85).

[46] Völling 2019.

been intentionally selected to be deposited in wells, while others may just have been discarded in pits or dropped by chance after looting, and others still may have been translocated by earth movement for building activities long after their initial deposition. Artefact categories other than weapons could help in the future to distinguish different hypotheses here, and broaden our knowledge of the spatial foci of votive offering rituals in the sanctuary.

Nevertheless, the observed spatiotemporal distribution is in our view plausible within a broader historical context: the increasing concentration of weapons near the stadium walls can be understood as a consequence of Olympia's expansion and its growing political importance[47]. The mass arrival of pilgrims from all over the Oecumene to the Olympic Games required new infrastructure and the incorporation of new areas not previously used. The artefact distribution thus arose from socially and politically relevant representational behaviour rather than solely from religious factors[48]. Areas with a high concentration of pilgrims, or where pilgrims spent more time during the Games, were selected and appropriated to exhibit (collective and private) military successes.

Beyond the general spatial and temporal development of weapon votive offerings, the high volume of data in our study also allows a diachronic reconstruction of the weapon categories deposited. The basic results of this analysis are described above, so here we will focus on their meaning in light of the question whether weapons may have been offered more frequently as complete panoplies or as part of large series of similar objects. This has tangible implications, given that written sources of the 5th century B.C. and later actually describe the offering of large series of shields instead of panoplies. In particular, multiple ancient sources present long lists of shields that were apparently brought to the Greek sanctuaries[49]. These votive offerings might even have been part of a regulated fee after battle, in Ancient Greece usually named *dekáte* (δεκάτη), being equivalent to a tenth portion of the booty[50].

Shield-related artefacts are the most common category in our dataset *(fig. 1)*. To some degree this is an effect of their large size, their status as composite weapons and their pre- and post-depositional fragmentation. It is difficult to determine the true number of originally deposited shields represented by the individual fragments. However, if we assume that straps (Schildbänder) occur only once per shield, then a number of at least 200 specimens is likely *(fig. 7 A)*. This figure might be significantly higher, if more of the other individual artefacts are in fact from different shields as well (with a potential maximum at more than 900 shields), and even higher if we consider fully organic shields, that did not yield any archaeological evidence.

Most authors dealing with this topic agree that shields were present in every kind of Greek panoply[51]. An exemplary list includes greaves, breastplate, helmet, spear, sword and shield[52], another has a Corinthian helmet, breastplate, spears and shield[53], the panoply mentioned by Tyrtaeus[54] also lists helmet, shield, spear or sword. The quantity of shields may thus serve to postdict a minimum number of panoplies deposited in Olympia. If this underlying assumption is correct and panoplies were indeed the typical mode of votive offering[55], then the absolute number of shields should be nearly the same as the number of helmets. Due to the uncertainties in the shield count, we can not reliably confirm or deny this. At the

47 Barringer 2009; Scott 2010; Kyrieleis 2011.

48 Graells i Fabregat 2019b.

49 See Graells i Fabregat 2017a for a summary and previous literature.

50 Pritchett 1974; Jacquemin 1999, 123–145; Ober 1996; Krentz 2002, Baitinger 2011; Baitinger 2016b; Graells i Fabregat 2017a; Baitinger 2018.

51 Lorimer 1947; Snodgrass 1964; Anderson 1991; Hanson 1991; van Wees 1992; Lazenby – Whitehead 1996; van Wees 2000; van Wees 2004; Echeverría 2012; Krentz 2013; Schwartz 2013; Graells i Fabregat 2021 (with discussion).

52 Donlan – Thompson 1976, 341; Hanson 1991, 88 f.; Krentz 2013, 135

53 Echeverría 2012, 292.

54 Tyrt. 8, 31–34.

55 Echeverría 2012, 292.

very least, both category counts fall in the same order of magnitude. This makes it less likely that depositions of large series of shields were a frequent practice, though not impossible.

Beyond shields, the regular deposition of panoplies should also yield similar numbers of spears compared to helmets[56]. Here iron and bronze lances appear to be underrepresented[57]. Even more complicated is the case of greaves, cuirasses and arm guards. Greaves and cuirasses are complex armour composed of two parts (right and left for the greaves; front and back plates for the cuirasses) and date between the middle of the 7th and 5th centuries B.C. Both categories are rare *(fig. 1)*. Beyond the fact that they are less common, one could possibly point to the bad preservation of metal (especially iron) or a dedicated mode of deposition, that made them more vulnerable to plundering and melting down in the post-classical period, to explain their relative scarcity. In any case, it is not clear how and why these effects might have affected body armour and limb guards, but not so much helmets, spear heads and shield elements.

A closer look at some specific items gives further indication of where this signal might be coming from. Arm guards are single protective elements intended only for the right shoulder and upper arm. In contrast to other armour categories, they are dated only between the second quarter of the 6th century B.C. and the beginning of the 5th century B.C.[58] Sauroteres, the metal reinforcement of the bottom part of the spear or lance, are dated from the end of the 6th century onwards[59]. It is impossible to compare the scarce number of both categories with the rest of weapons as we did previously, because they were only used in a very specific period. The data must be examined from a diachronic perspective *(fig. 7 C)*.

Without this temporally explicit view on the data, it is hard to understand the role of very short-lived weapons such as limb guards. Ignoring the chronology means ignoring the evolution of the Greek panoply with its adjustment of types in reaction to changes in combat tactics. Panoplies developed over time, adding new weapons and discarding obsolete ones in order to improve their effectiveness and satisfy the demands of fashion and social interaction. For the development of the panoply, as documented in votive offerings in Olympia, we propose the following three-step model:

1. The first step (from 800 to 650 B.C.) is dominated by lances which become more frequently accompanied by helmets and metallic shields. Fully organic shields might have been more common in this period.

2. The second step (from 650 to 500 B.C.) adds different pieces of body armour to the previous combination (shield + helmet + lance): first, cuirasses and greaves, then arm guards and ankle guards. This composition may have been a reaction to rising social competition, because it supports different ways of emphasising the public identity of individual prominent warriors (especially those equipped with cuirasses and limb guards). The high number of types documented during this period *(fig. 6 B)* may be attributed to the not yet standardized panoplies, permitting local variations and short-lived fashions[60].

3. The third step (from 500 B.C. onwards) contains a more homogeneous repertoire, deprived of body armour. The decrease in the number of types could be an expression of the truly hoplite world and democratic idiosyncrasy of 5th century B.C. Greece.

[56] Schwartz 2013, 157.
[57] Based on the catalogue of Baitinger 2001.
[58] Graells i Fabregat 2019a, 275–286.
[59] Baitinger 2001, 63 f.
[60] Graells i Fabregat 2019a, passim.
Sources of illustrations: *Fig. 1–7:* Clemens Schmid.

CONCLUSION

In this analysis, we attempted to derive relevant qualitative information about the practice of votive offering in Olympia from quantitative data recorded in an artefact database. Despite the promising results, we are aware of their fragility. New discoveries, both in the form of excavated material and theoretical advances in the typological dating of artefacts, can render them obsolete or subject to modification. Even in the process of writing this paper, uncertainties in the attribution of certain types of dedications made an iterative adjustment of the data necessary. Any numerical analysis is influenced by the method of recording, especially if it is based on counts of fragmented materials. Although we are now confident about the validity of the presented interpretations, we also wish to emphasize the need to review them systematically.

Future analysis could be based on the following avenues of research: first, increasing spatial resolution of the material find's location attribution, in order to obtain a more detailed picture of the uses and organization of individual areas in Olympia; second, the incorporation of more items from other artefact categories into the database, in order to compare results from the social domain warfare – as analysed here with weapon artefacts – with other aspects of society (religiosity, feasting, athletics, pilgrimage, etc.); and third, once the method has been established, comparing Olympia with other cult sites in Ancient Greece and beyond.

Archaeological contexts with such density and variety of materials cannot be handled only with traditional, qualitative methods, but require thorough quantification and a variety of research techniques. Obtaining diachronic panoramas or spatial distribution maps requires careful management of information to ensure that it is organized, replicable and verifiable. The case of the Olympia sanctuary is, to our knowledge, exceptional not only for the number of votive objects recovered and for the state of publication, but also for the exceptional find database that ought to become an indispensable instrument of work for statistical studies and quantitative research.

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