CRAFTING BONE – SKELETAL TECHNOLOGIES THROUGH TIME AND SPACE

Proceedings of the 2nd meeting of the (ICAZ) Worked Bone Research Group

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Special Assemblages

Participants in the WBRG 1999 Budapest conference (left to right): Ülle Tamla, Elisabeth Brynja, Tina Tuohy, Liina Maldre, Karlheinz Steppan, Heidi Luik, Gitte Jensen, John Chapman, Alice Choyke, Janet Griffitts, Andreas Northe, Noëlle Provenzano, Jörg Schibler, Nerissa Russell, Colleen Batey, Lyuba Smirnova, László Daróczi-Szabó, Daniella Ciugudean, Mária Bíró, Kordula Gostenčnik, Eszter Kovács, Christopher Morris, Sabine Deschler-Erb, Ans Nieuwenberg-Bron, Katalin Simán, Isabelle Sidéra, Mickle Zhilin

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Introduction

Archaeologists and Archeozoologists, both study worked osseous materials (bone, antler and tooth, including ivory, in short all referred to as "bone"). Such reports, however, are often buried at the very back of faunal analyses appended to site reports. Furthermore, the two groups of specialists have had little chance to interact, even within Europe since they tend to attend different conferences and write for different fora.

At the root of this problem lay the arbitrary, largely institutional division between pre- and proto-historians, often imposed on bone manufacturing experts by nothing but formalism in research tradition. The most exemplary series of studies n this field is entitled: "*Industrie de l'os neolithique et de l'age de metaux*" (Bone industry *from the Neolithic and Metal Ages*). Another classic, a book, is sub-titled "The Technology of Skeletal Materials *since the Roman Period*". In very early prehistoric assemblages, attention is often focused on the question of whether a particular piece of bone was worked or not. In later assemblages, it is the intensity of manufacturing that often renders objects zoologically non-identifiable, so that important aspects of raw material procurement, including long distance trade, remain intangible.

The history of raw material use, however, is continuous and many of the constraints and possibilities inherent in skeletal materials are the same whether one is dealing with Paleolithic or Medieval artifacts. Indubitably, the organization of manufacture, the function and value of bone artifacts (as well as some technological innovations such as the regular use of metal tools or lathes), differ substantially between simple and complex societies through time. On the other hand, fundamental questions of tensile characteristics, procurement strategies, style and certain technological requirements are not only similar diachronically, but also open up new vistas when apparently unrelated periods are compared. The function of these objects as social markers, for example, remains remarkably constant through time, even if details vary. The papers in this volume reflect these conceptual similarities and differences as did the papers delivered at the conference itself.

The first meeting of what was to become the Worked Bone Research Group (WBRG) was organized by Dr. Ian Riddler in the **British Museum, London, in January 1997**. The committment and enthusiasm of that first workshop has greatly inspired subsequent efforts in recruiting a wide range of bone specialists, capable of contributing to discussions concerning bone manufacturing.

In keeping with the aims of the Worked Bone Research Group, since 2000 an official working group of the International Council for Archaeozoology (ICAZ), an effort was made to present these papers on the basis of what *connects* them rather than segregating them by archaeological period or region. Contributions mostly include articles based on papers delivered in September 1999 at the second Worked Bone Research Group meeting in Budapest, organized by the editors with the unfailing support of the Aquincum Museum (Budapest) and its staff. Several people who were unable to be present at this conference were also asked to contribute papers. Finally, five of the studies in this volume, originally delivered at a symposium on bone tools organized by Dr. Kitty Emery and Dr. Tom Wake, entitled "*Technology of Skeletal Materials: Considerations of Production, Method and Scale*", at the 64th Annual Meeting of the Society for American Archaeology (Chicago 1999), were added thereby expanding the academic spectrum both in terms of research tradition and geographic scope.

There are a total of 36 papers in this volume. Research was carried out on materials from Central and North America to various regions of Europe and Southwest Asia. The authors represent scientific traditons from Estonia, Hungary, Romania, and Russia, European countries in which, until recently, ideas developed in relative isolation. Other European countries represented include Austria, Denmark, France, Germany, Great Britain, Greece, and Switzerland. Last but not least, the North American scholarly approach is also represented here.

Schools of thought may be said to be exemplified by what used to be Soviet research, well known for pioneering works on taphonomy, experimentation and traceology. Bone manufacturing was first brought to the attention of Western scholars by the publication in 1964 of the translation of S. A. Semenov's *Prehistoric Technology*, published originally in 1957. Scholars in France have also carried out decades of co-ordinated work on operational chains in the manufacturing process from the selection of raw materials to finished products, with special emphasis on prehistoric modified bone. An entire working group, "Unspecialized Bone Industries/Bone Modification", is directed by Marylene Patou-Mathis. This working group itself is part of a larger research program on bone industry "*La Commission de Nomenclature sure l'Indistrie de l'Os Prëhistorique*" headed my Mme. H. Camps-Fabrer. Several specialists such as Jörg Schibler in Switzerland, have created laboratories where ground laying work has been carried out for years on worked osseous materials, especially from Swiss Neolithic Lake Dwellings and Roman Period sites. Language barriers have often prevented these important bodies of work from being as widely disseminated as they deserve. Arthur MacGregor in England, writing in English, has had a decisive influence on specialists working on more recent Roman and Medieval worked bone assemblages in Europe.

The work of all of these groups as well as certain individual scholars is well known within limited circles. Otherwise, however, the overwhelming experience of most researchers on worked bone have been feelings of isolation and alienation from most archaeological or archaeozoological work related, most importantly, to the absence of an international forum where their often specialized work can be presented and problems discussed.

In spite of the fact that there have been many practical obstacles to information flow between specialists in this field, there are really remarkable similarities of approach which should ultimately lead to the development of more compatible paradigms in research. Agreement on methodologies will have a positive feedback on communications, helping the field to grow and develop properly.

It seems that, at last, archaeologists and archaeozoologists and other specialists are talking to each other and sharing methodologicial points of view. One striking example of this can be seen in the the emphasis on raw materials studied in parallel to types found in the majority of papers in this volume. Previously studies often concentrated on typo-chronological questions, ignoring the questions of raw material morphology and availability. The series published by the *Centre National de la Recherche Scientifique*, edited by Mme. Henriette Camps-Fabrer in France is largely to be credited for beginning this new trend. It contains many papers concentrating on understanding manufacturing sequences and, indeed, from Europe to North America there are papers which explicitly deal with manufacturing sequences in individual assemblages.

There is also a consistent emphasis on experiment and manufacturing techniques present in much of the work in this volume. The related but fraught question of function continues to tantalize and frustrate most specialists. A number of articles attempt to apply techniques of hard science, such as scanning electron microscopy or light microscopy, together with experiment to get objective, "processual" answers to this important group of questions. Other researchers rely deductively on analogy, archaeological context, gross morphology, and textual sources as they try understanding how these objects were used.

When editing the volume, we tried to concentate on the underlying main concepts represented by each paper rather than grouping them diachronically or by geographical region. As a result, contributions follow a line from the theoretical through the problems of raw material selection, manufacturing techniques, experimental work, technical function and socio-cultural interpretations. Obviously many of these papers deal with several of these aspects simultaneously. Finally, analyses of assemblages are grouped to show the current state of general application of these principles as illustrated in papers in the rest of the volume. Reports on bone tool types will ultimately benefit from more unified typologies and also provide researchers with comparitive databases from regions beyond their own.

Finally, a word on the organization of papers in this volume. Although the editors have tried to group these papers by what they see as the main theoretical and methodological thrust of the authors it should be understood that most papers, to a greater or lesser extent, overlap between these artificial sub-titles. Happily, almost all these works include considerations of raw material exploitation, manufacturing and functional analyses and all make some attempt to consider the social context from which these artifacts emerged. It is exactly this cross-cutting of boundaries which allows us to hope that the study of worked osseous materials is well on the way to developing into a discipline in its own right.

In addition to the generous support given by our sponsors and technical editors for this volume, organizing the conference would not have been possible without the active help of numerous colleagues. Special thanks are due to Paula Zsidy, Director of the Aquincum Museum, Katalin Simán, archaeologist and two students from the Institute of Archaeological Sciences (ELTE, Budapest): László Daróczi-Szabó and András Markó. The Hotel Wien, Budapest and its efficient manager provided a comfortable setting for our discussions at a reasonable price. Last but not least, help with abstract translations by Cornelia Becker, Noelle Provenzano as well as Marjan Mashkour and Turit Wilroy should also be acknowledged here.

THE ECONOMICS OF BONE ARTIFACT PRODUCTION IN THE ANCIENT MAYA LOWLANDS

Kitty F. Emery

Abstract: Bone artifacts are typically sparsely distributed through Mesoamerican archaeological deposits, and their analysis has characteristically been limited to description and type classification. How should we analyse and compare small, diverse bone artifact assemblages, and are we able to glean socioeconomic data from these collections? The detailed examination of an unusual Maya bone working locus from the Guatemalan site of Dos Pilas allows me to discuss ancient manufacturing techniques, and the methodological questions inherent in their analysis. Comparison with smaller collections from other Classic Maya households in the Petexbatun and neighbouring areas provides insights into the changing techniques and scales of ancient bone artifact production, and the role of bone working in the Maya economy. These data can be applied to broader models of economic disruption during the period of Maya "collapse" at 800 AD in the Petexbatun region.

Keywords: Maya, economy, bone working, Petexbatun, collapse-period

Résumé: Les artefacts osseux sont en général peu abondants dans les gisements mésoaméricains et leur analyse s'est presque toujours limitée à une description et une identification typologique. Comment analyser et comparer des assemblages osseux réduits et diversifiés et sommes-nous en mesure de glaner des données socio-économiques dans ces collections? L'examen détaillé d'un exceptionnel locus de travail de l'os du site guatémaltèque de période Maya de Dos Pilas donne la possibilité d'étudier les anciennes techniques de fabrication et de poser les questions méthodologiques que suscite leur analyse. La comparaison avec des séries plus réduites d'autres habitats de la période Maya classique dans la région de Petexbatun et de ses environs fournit un bon aperçu des modifications des techniques et de l'importance de la production d'outils en os ainsi que de son rôle dans l'économie maya. Ces données peuvent être ensuite intégrées aux modèles plus larges de bouleversement économique au cours de la période de "l'effondrement" Maya vers 800 de notre ère dans la région de Petexbatun.

Mots-clés: économie, Maya, travail de l'os, Petexbatun, période d'effondrement Maya

Zusammenfassung: Knochenartefakte sind im allgemeinen in archäologischen Fundplätzen aus Mesoamerika selten belegt. Bezeichnenderweise beschränkt sich ihre Analyse zumeist auf eine Beschreibung und Klassifizierung der Typen. Wie nun soll eine Untersuchung kleiner und ganz verschiedenartiger Artefaktkomplexe vorgenommen werden? Sind wir in der Lage, hieraus sozioökonomische Daten abzuleiten? Die gründliche Überprüfung eines ungewöhnlichen Locus mit Knochenbearbeitung aus dem Mayafundplatz Dos Pilas in Guatemala gestattet mir, längst vergangene Verarbeitungstechniken sowie hier relevante methodische Fragen zu diskutieren. Im Vergleich zu kleineren Fundkomplexen aus Haushalten der klassischen Maya Periode, lokalisiert in Petexbatun und dessen Umgebung, kann die veränderliche Rolle und das Ausmaß der Knochenverarbeitung im Rahmen der Maya-Ökonomie beleuchtet werden. Diese Daten lassen sich in die Vorstellung eines wirtschaftlichen Wandels während der Phase eines allgemeinen Zusammenbruchs bei den Maya etwa um 800 n.Chr. in der Petexbatun Region einfügen.

Schlüsselworte: Maya, Ökonomie, Knochenverarbeitung, Petexbatun, Phase des Zusammenbruchs

Introduction

Artifact production and the social implications of manufacturing are of paramount interest in today's archaeological and anthropological literature. Despite the fact that worked archaeological skeletal materials can provide us with important information for the reconstruction of social, political, and economic variability, this resource has so far been underutilized in many areas of the world. The problem is particularly evident in the Maya area where collections of worked archaeological skeletal materials are consistently small and dispersed. However, as more sites are excavated in this region and methods of bone recovery improve, it is becoming clear that skeletal remains are ubiquitous across Central American sites even where preservational conditions are poor. This paper argues that comparative analysis of even these small Mesoamerican faunal assemblages can provide detailed information on patterns in bone manufacturing that allow us to evaluate theoretical issues of broad social importance.

My research[1] on modified bone remains from the southern lowlands of the Guatemalan Peten (fig. 1), uses a comparative analysis of changing bone modification techniques to address an economic model of the apparent collapse of Classic period Maya social and political systems in AD 800 in the Petexbatun region (Demarest 1997; Emery 1997). Although the status of the Late Classic Maya transition as a "collapse" has been much debated, there is little doubt that the period was one of social, political, and economic disruption that resulted in massive restructuring of all three systems. Its cause remains a mystery. One model suggests that the root of these changes was economic – a rejection of the Late Classic elite-focused, status-reinforcing system of exotic exchange, in favour of mass-production and trade of utilitarian goods focused on the middle class (Chase 1992; Freidel 1992; McAnany 1995; Palka 1997; Rathje, Gregory and Wiseman 1978; Rice 1987; Sabloff 1992).

The recovery of a fascinating assemblage of over 10,000 modified bone remains at the site of Dos Pilas in the Petexbatun has allowed me to evaluate this economic collapse model. The bone remains in this collection appear to represent the debitage created during the production of massive quantities of utilitarian bone needles and pins. Intriguingly the assemblage was recovered from a small housemound group (fig. 2) occupied after the collapse of the political elite at the site of Dos Pilas. The residence is unusual in many respects, and its use as a locus of bone tool production on an apparently massive scale into the Terminal Classic period provides a unique perspective on this much-debated period of social, political, and economic upheaval (Emery 1995; Foias and Brandon 1992; Johnston 1989; Palka 1997; Wright 1990).

This collection has allowed me to use a three-step process of analysis. First I have defined the nature of the bone working deposit. Second, I have used this deposit to recreate a linear reduction model for bone working in the Maya lowlands that can be compared with assemblages from neighbouring sites to define variability in bone working economies across both time and space. Third and most importantly, I have used the combined evidence to suggest the utility of bone working as an economic variable in discussions of the deterioration of Classic Maya social and political systems at around AD 800 in the Maya lowlands. It is the goal of this paper to focus on the methods of analysis of this assemblage as a precursor to suggesting its effectiveness for evaluation of the broader societal model.

Modeling ancient Maya bone working technologies

Defining the Nature of the L4-3 Bone Assemblage: The unusual characteristics of the L4-3 assemblage forces me to define the nature of the collection carefully as a locus of bone working and not a simple dump of subsistence detritus (Moholy-Nagy 1994). Despite poor preservational conditions in this part of the site, fully 10 times the number of bone fragments came to light here than were found in all excavations of the rest of the site. The majority of these were recovered from a single midden measuring only six square meters where the density of recovery was almost 3,000 bone fragments per square meter of soil. Even more intriguing is the fact that over 40% of these remains are worked (fig. 3). The percentage of altered remains recovered from other non-mortuary deposits at Dos Pilas is less than 10%.

While the debitage here is concentrated in a single midden, it is not exclusive to that midden and is actually scattered (in smaller proportions) across the entire housemound group. As well, there is no evidence of any such remains found outside the confines of this group indicating that this represents deposition from an in-situ locus of production, not midden debitage from other areas. Furthermore, the worked debitage found here can be classified into a series of manufacturing stages that cannot have resulted from random butchering or other activities. This defines the assemblage as the remains of an in-situ bone workshop.

Reconstructing a Bone Working Model: As workshop debitage, the assemblage is invaluable for reconstructing bone working methods in the lowland Maya region. I have created a descriptive taxonomy of alterations that combines information on the modification type and its location on the skeletal element to reconstruct the stage in the production sequence at which the modification would have been produced (fig. 4). This alteration sequence is then combined with a species taxonomy to create a model of the sequence of activities involved in the reduction of each bony element into the several artifact varieties, in effect, a linear reduction hierarchy similar to those used by lithic analysts. All the altered remains are then subjected to a detailed osteometric analysis to allow a further quantification of the production techniques.

The basic reduction model includes four stages: First, debitage removal of epiphyseal ends and surfacial irregularities; second, preparation of a diaphyseal shaft core[2]; third, longitudinal scoring and cutting into wide blanks or preforms; and finally reduction and finishing of preforms into perforators[3].

The primary reduction stage of bone modification was the removal of bone debitage, generally in a two-step process discarding first the epiphyses and second, any surface irregularities (fig. 5). While the first-stage epiphyseal removal was characteristically a simple horizontal ring cut at the epiphysis/metaphysis joint, the second debitage discard process was more complex and included cuts around the irregularity to remove it. This debitage removal stage was typically followed by the preparation of a bone shaft or cortical "core" by secondary trimming and preliminary smoothing of horizontal cuts made during the debitage removal (fig. 6). The first stage of final artifact production began at this stage as a variety of possible options. The bone core was occasionally immediately finished to create a bone tube or ring, or sections were removed (particularly from flat bones) to create disks or adornos.

However, since most of the L4-3 remains were destined to become perforators, the most common next stage was the longitudinal (vertical) scoring (fig. 7) and cutting of the cortical core into wide preforms or blanks (fig. 8). These were secondarily reduced to thinner blanks both before and after cortical and edge smoothing (figs. 9 and 10), and in a tertiary reduction stage these secondary blanks were further shaped into perforators of various widths and profiles (fig. 11). They were polished and occasionally decorated as finished artifacts. At a variety of stages within this sequence, a butt or handle was snapped off to leave the final artifact base (fig. 12).

Within each of these generalized reduction stages, more specific alterations can also be described. The retention of identifiable element segments well into the final reduction stages allows a more detailed understanding of skeletally specific reduction trajectories. In every case these manufacturing trajectories represent the efficient reduction of a specific element from a specific species.

Deer femurs for example, were cut both distally and proximally to remove the epiphyseal ends (fig. 13). The most common alteration was the initial removal of the epiphyseal ends below the level of the lesser trochanter and the fossa plantaris scar as well as the secondary removal of these surficial irregularities during the vertical cutting process. This pattern efficiently removes the debitage from the bone shaft while retaining the greatest length of bone shaft with the least wastage.

Alteration of the deer tibia was very different and yet equally efficient. The proximal end was cut dorsally, laterally, and medially to remove the crest and two sides, and these three sections were shaped into sturdy awls (fig. 14). The distal end was left unmodified and longitudinal sections were cut through the bone shaft leaving the distal epiphyseal sections as basal ends for the artifact then manufactured.

Comparative analysis of bone working in the Southern Lowlands

These remains provide a new avenue for the discussion of ancient manufacturing behaviour and production technology. However, on a broader scale we must evaluate the extent to which they can be used to indicate patterning in both social and economic arenas. Does the Dos Pilas assemblage represent a significantly different bone working economy from other time periods and regions, and can these remains shed light on other sociopolitical changes seen in the Terminal Classic period?

To answer this question a comparative analysis of remains from other sites and periods is essential. I have compared remains dating from the Preclassic to Postclassic periods from the other four sites within the Petexbatun region (Arroyo de Piedra, Tamarindito, Aguateca, and Punta de Chimino), and from the neighbouring and politically allied sites of Tikal[4] and Uaxactun[5].

My methods again included descriptive analysis of taxonomic, element, and modification information, this time within the framework provided by the L4-3 assemblage. I also analysed the density of artifactual remains, artifact diversity, and production remains from the various production stages relative to finished artifacts. These additional measures provided evidence for locations of bone working as opposed to locations of bone tool use. More importantly, these combined measures allowed me to test the intensity of bone tool production at working loci.

Despite extensive comparative analysis, no assemblage matches the L4-3 assemblage in terms of the spatial density of remains or apparent standardization of production. Interestingly, the closest equivalents lie in two incomplete Terminal Classic assemblages from the sites of Tikal and Uaxactun contemporaneous with the L4-3 group. In the Petexbatun, comparative analysis of bone working debitage suggests both a continuity in methods of manufacture dating back to the Preclassic period, and an increase in both production intensity and standardization during the final periods of occupation[6]. Similarities between the three Terminal Classic assemblages from the sites of Dos Pilas, Tikal, and Uaxactun and the differences between these assemblages and any earlier ones suggest that bone working changed significantly during this post-collapse period in the region.

Evaluating the social and economic significances of change

It is the nature of this change that allows me to examine the economic basis of the collapse model for the Petexbatun and surrounding region. If the hypothesis is correct, evidence for an economic cause for the collapse of social and political systems would have to lie in a change in scale and intensity of production, not a simple change in methods. My focus is therefore on evidence of increasing craft specialization or standardization of production.

In general, three critical variables are traditionally used to measure craft specialization (Brumfiel and Earle 1987; Costin 1991; Peacock 1981; Rice 1991): the degree of specialization in raw material choice; the extent to which production volume is in excess of household consumption needs (which indicates the use of manufactured goods away from the center of production); and the degree of standardization of production methods, artifact forms, and artifact sizes as a result of production specialization. These variables can be used as quantifiable measures of changing economic patterns in the Petexbatun and southern Maya lowlands as a whole.

The first variable suggests a shift from the expedient use of readily available raw materials to the specialized gathering and importation of species and elements specific to the production necessities of the craftspeople. The L4-3 assemblage is indeed characterized by a very low species and skeletal element diversity, particularly in comparison to subsistence deposits, but also in comparison to other modified bone assemblages from other periods at other sites. Species diversity measured with the Shannon-Weaver index was far lower in the L4-3 assemblage than it was in any of the other Petexbatun sites, and the vast majority of the remains were from artiodactyls including white tailed and brocket (*Mazama americana*) deer and two peccary species (*Tayassnuidae*) (fig. 15). Of these remains, over 95% were femur, metapodial, and tibia remains (fig. 16). In contrast, these represent less than 50% of the modified bone remains from any other site or period. That the Tikal Terminal Classic worked bone assemblage is also derived almost exclusively from artiodactyls, and of those bones, close to 70% were hindlimb and metapodial elements, suggests a similar source for this debitage.

The second measure of craft specialization is a multifaceted change in production standardization. This includes a shift from the production of a diversity of artifact types to a concentration on a small range of specific artifact forms (fig. 16). The evidence for this shift at L4-3 is very clear. While other Petexbatun sites and periods are characterized by a high diversity of artifact types, 98% of the L4-3 assemblage of finished artifacts are perforators, and a similarly high proportion of the debitage is characteristic of perforator manufacture and not of the manufacture of any other artifact. A comparison of the Petexbatun sites over time (excluding the L4-3 deposit) indicates a coincident drop in overall artifact diversity into the Terminal Classic period. Despite a similarity in trend, the diversity at other Petexbatun sites remains fully double that found in the L4-3 assemblage.

This standardization of form requires a concomitant standardization of production methods that rely on standardized and efficient techniques to provide the greatest product output for the energy input. The earlier description illustrated the efficiency and element- and species-directed nature of the production methods. Interestingly the comparative analysis indicates that bone working methods do not differ widely between sites and that most of the techniques used are in fact conserved from earlier periods indicating a continuity of production methods. However, it is interesting that some specific reduction stages, such as the "butt removal" as a final stage in blank production, the vertical thinning of blanks leaving ?stepped debitage, and the ?ring debitage (fig. 18) removed during secondary core finishing, are found only in the L4-3 and Terminal Classic Tikal assemblages. This may indicate an increased sophistication of the reduction techniques during the Terminal Classic at both of these sites. They may also however, simply highlight a recovery divergence between large and small assemblages.

Finally, the model suggests that the combination of a narrower range of artifact forms and more highly standardized production methods would result in an increase in the standardization of artifact sizes within any category of form. Detailed osteometrics show that artifact sizes are also much less variable in the L4-3 assemblage. Comparison of the coefficient of variation of artifact maximum width for finished artifacts showed that the L4-3 assemblage was significantly less variable in size than any other collection (fig. 19). Finished artifacts from an Early Classic assemblage at Tikal were much more variable in size, but bone working debitage from Terminal Classic Tikal was much closer to that found at L4-3 than in any earlier collection reinforcing the concept of the development of standardized production of tools and tool blanks at Tikal.

A third readily quantifiable measure of craft specialization is the change in volume of artifact production. Increasing specialization implies a shift from occasional production for domestic use, to a volume of production that is in excess of local consumption needs. And this third measure implies the fourth. If goods are produced in excess of local needs, their use shifts away from domestic or local consumption toward a wider dispersion and use of the resulting goods away from the center of production.

Our initial discussion of spatial bone density and the comparative analysis of worked bone densities across the site makes clear the enormous volume of production at the L4-3 locus. More important however is the distribution of reduction stages. The majority of the debitage is the result of early manufacturing stages, stages that are rarely found in other deposits (fig. 20). Despite the predominance of first stage debitage, the L4-3 assemblage includes fragments of 686 finished perforators, a density of seven per unit excavated, 10 or 15 times that found in other deposits. It is unlikely indeed that this volume is the result of domestic production. As well, despite the enormous quantity of finished remains, none of the bone perforators at the L4-3 site show evidence of use-wear even when preservation has been good enough to leave intact surface. There is also little evidence of the re-tipping that is common debitage at other sites and in other periods. Most important is the fact that in comparison with assemblages from other areas, a definite increase can be seen in the Terminal Classic proportion of working debitage from all stages, and a corresponding decrease in the proportion of finished artifacts.

The collapse and bone working evidence

The evidence from the L4-3 assemblage clearly suggests a Terminal Classic bone working system that is substantially different from earlier systems. The results may well provide evidence to support a model of economic change and a shift to mass-production of utilitarian remains for use by a burgeoning middle-class. Regardless, the impact of the comparative analysis is clear. Bone manufacturing techniques are neither limited nor of limited utility for examinations of social patterning. This assemblage and others can be used to suggest wider social and political trends.

As well, the fact that the basic L4-3 reduction hierarchy is applicable to a broader model of bone working for the southern lowlands as a whole indicates that the difficulties of small comparative sample sizes can be overcome by their incorporation into a broader model of bone working technology, and that their combined strength lies in revealing regional and chronological patterning.

Notes

[1]. This research was conducted during my dissertation research and is presented in greater detail both in that work (Emery 1997), and in a forthcoming monograph through Vanderbilt Press. My research was conducted as part of the Vanderbilt University Petexbatun Regional Archaeology Project directed by Dr. Arthur Demarest. Bone working analyses were financially supported by the Social Sciences and Humanities

Council of Canada, the Wenner Gren Research Foundation, Sigma Xi, and Cornell University. Permission for these analyses was generously provided in Guatemala by the Instituto de Antropología e Historia, the Museo de Arqueología y Etnología, Dr. Juan Pedro Laporte, the Parque Nacional de Tikal, and in the United States by the Peabody Museum of Harvard University.

2. While the longitudinal modifications are clearly done with lithic tools, research by (Wake 1999) suggests that the horizontal cuts are created using string and grit.

3 An intriguing outcome of the 1999 Chicago SAA symposium was the evidence that this basic reduction model is common to sites around the world, and is dictated in large part by the parameters of the bones themselves. It is the details of bone manufacturing within this basic system that differ between culture areas.

4 Various Tikal samples were examined. The majority of the Preclassic Early Classic assemblages were excavated by Juan Pedro Laporte as part of the Proyecto Nacional Tikal (Laporte and Fialko 1985). The Late and Terminal Classic zooarchaeological samples were excavated by the Pennsylvania State Tikal Project (Coe 1990), and were identified by Mary Pohl (1990) and Hattula Moholy-Nagy (1994) who first described the bone modifications analysed here.

5 Only one Uaxactun bone sample was examined, remains from the final occupation of Structure A-V. This structure was excavated by Carnegie researchers (Smith 1950; Ricketson 1937) in the 1930s, and Ricketson (1947) was the first to note the unusual distribution of modified remains in the assemblage. The bones were later described in greater detail by Lane Beck in an analysis of human bone working (Beck, pers. comm. 1994).

6 Details of this investigation can be found in Emery 1997: Chapter 8.

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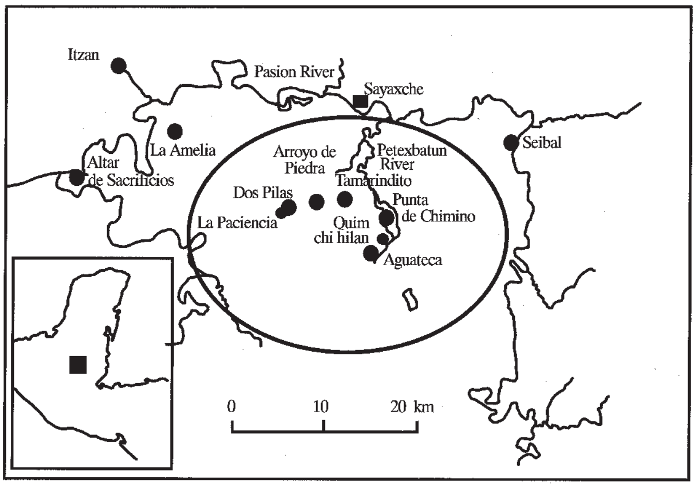

Fig. 1 Map of the Petexbatun region of the Maya lowlands, Guatemala

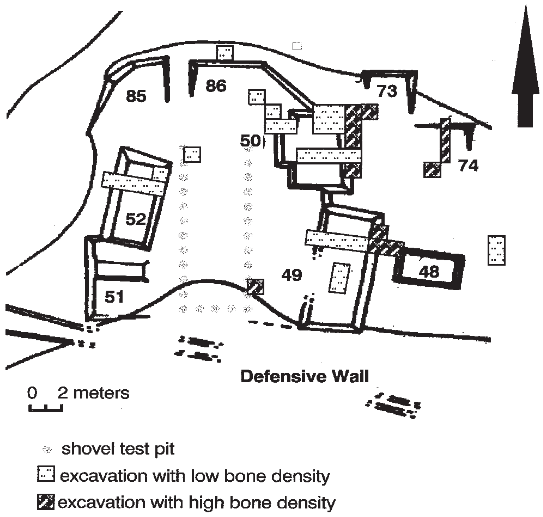

Fig. 2 Map of residential group L4-3, Dos Pilas, Petexbatun

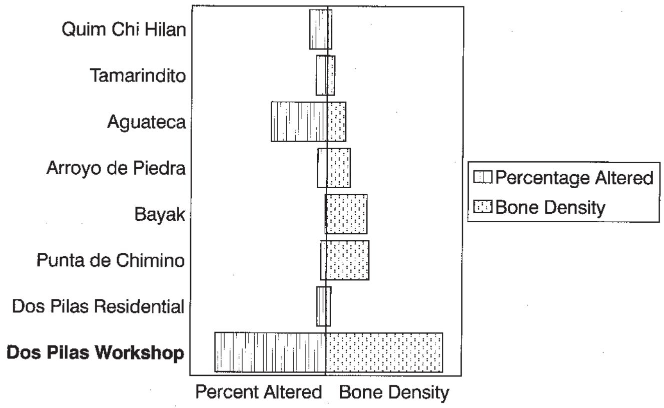

Fig. 3 Spatial density and percent alteration of bone remains in the Dos Pilas L4-3 assemblage

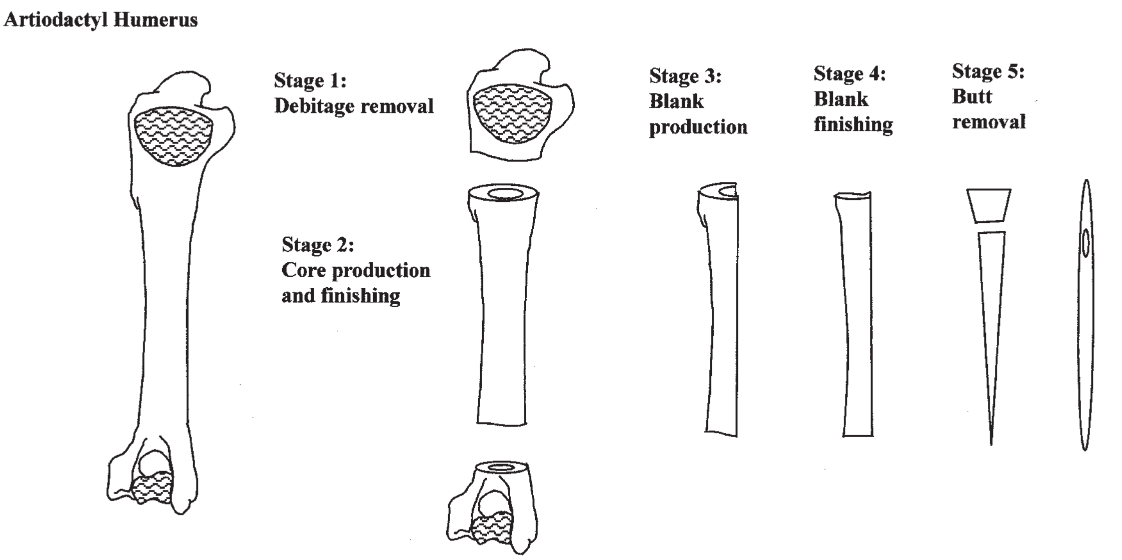

Fig. 4 Reduction hierarchy of bone working at the Dos Pilas L4-3 workshop

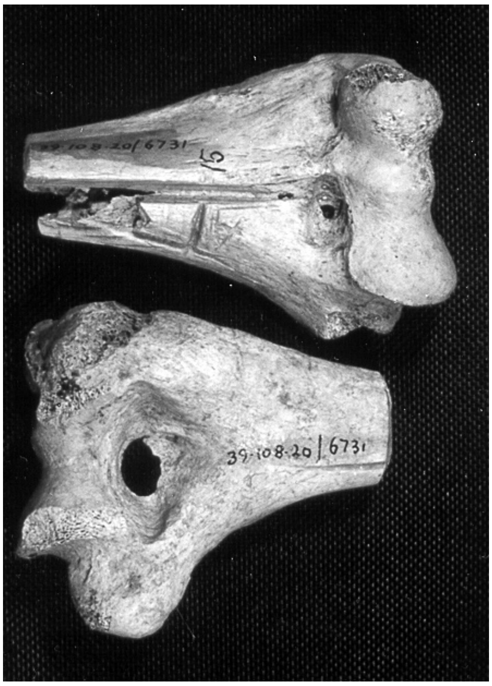

Fig. 5 Debitage removal: human humeri, Uaxactun

Fig. 6 Cortical cores with longitudinal scoring to mark first blank removal, Uaxactun

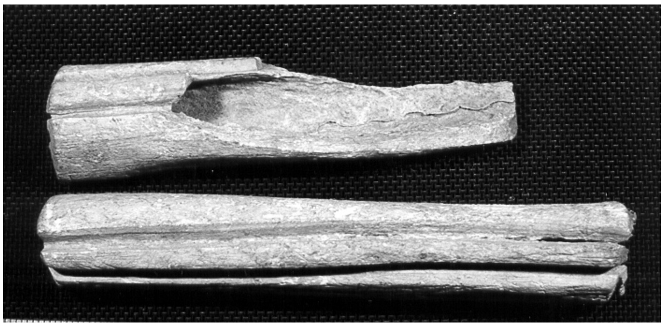

Fig. 7 Cortical cores with primary longitudinal cutting visible, Uaxactun

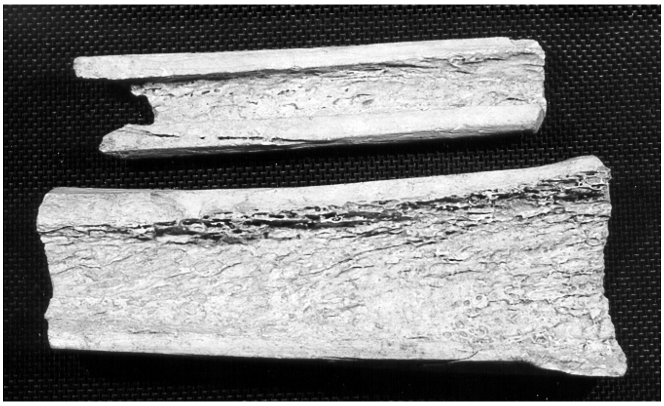

Fig. 8 Wide primary blanks, Uaxactun

Fig. 9 Secondary blank reduction to thin blank, Dos Pilas

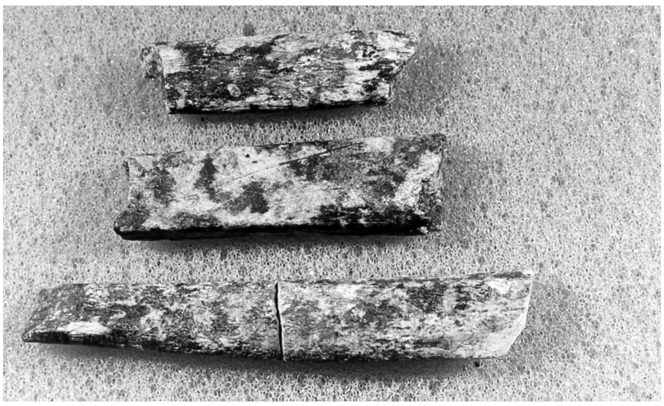

Fig. 10 Secondarily thinned blanks, Dos Pilas

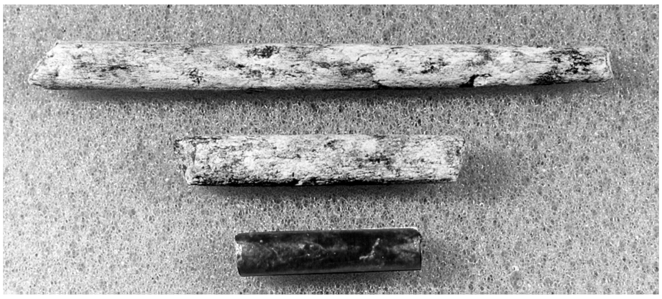

Fig. 11 Perforator shafts, Dos Pilas

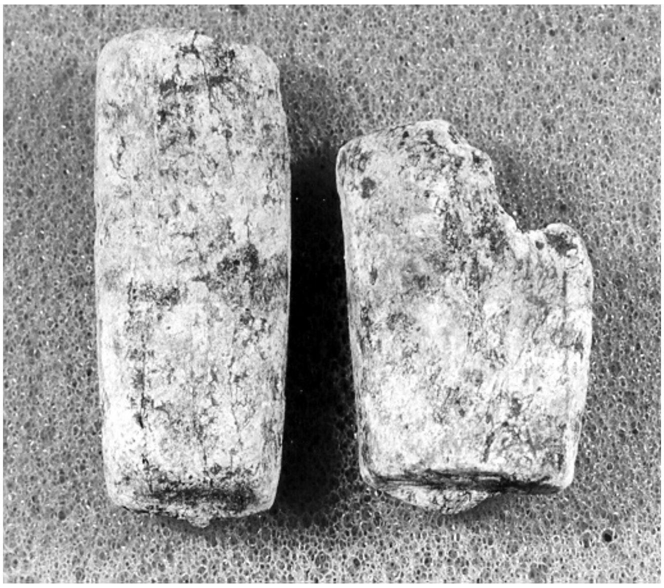

Fig. 12 Detached blank "butts", Dos Pilas

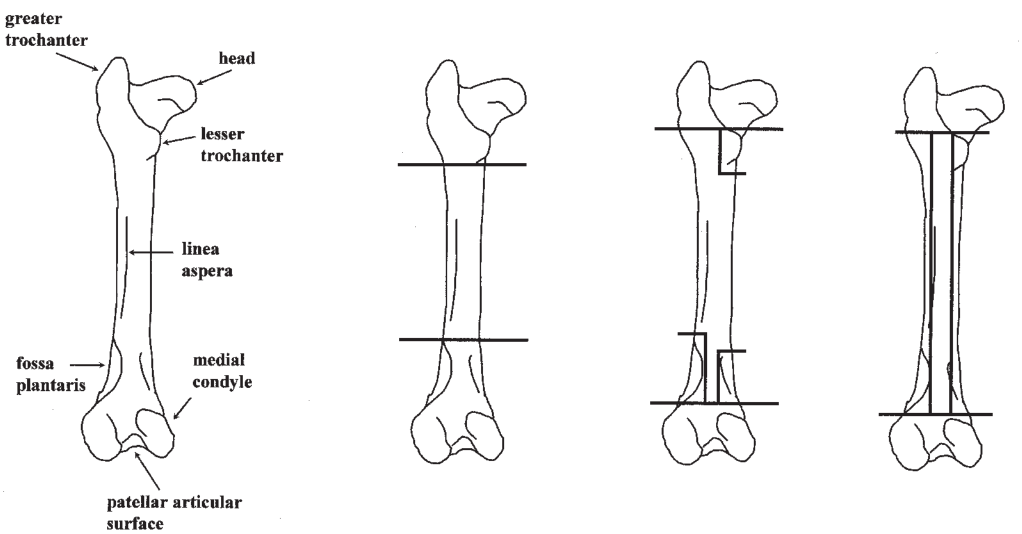

Fig. 13 Specific reduction strategies for Dos Pilas artiodactyl femur

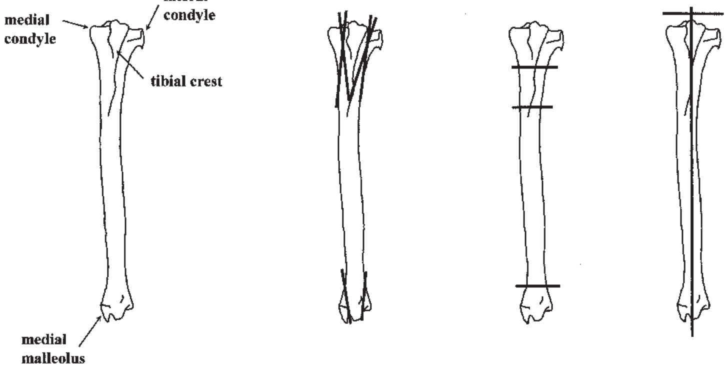

Fig. 14 Specific reduction strategies for Dos Pilas artiodactyl tibia

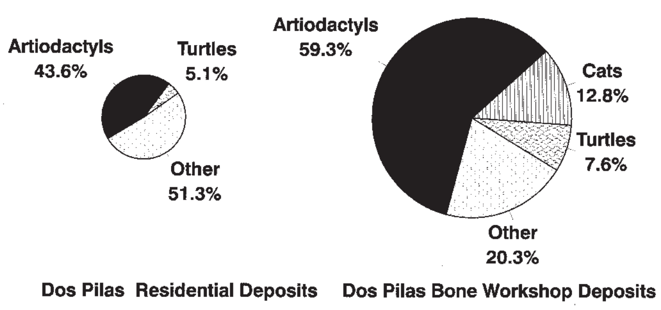

Fig. 15 Diversity of species in the Dos Pilas workshop and residential assemblages

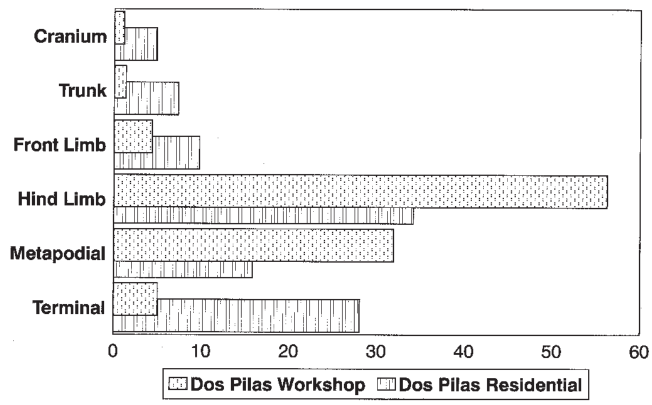

Fig. 16 Diversity of skeletal elements among artiodactyls at Dos Pilas

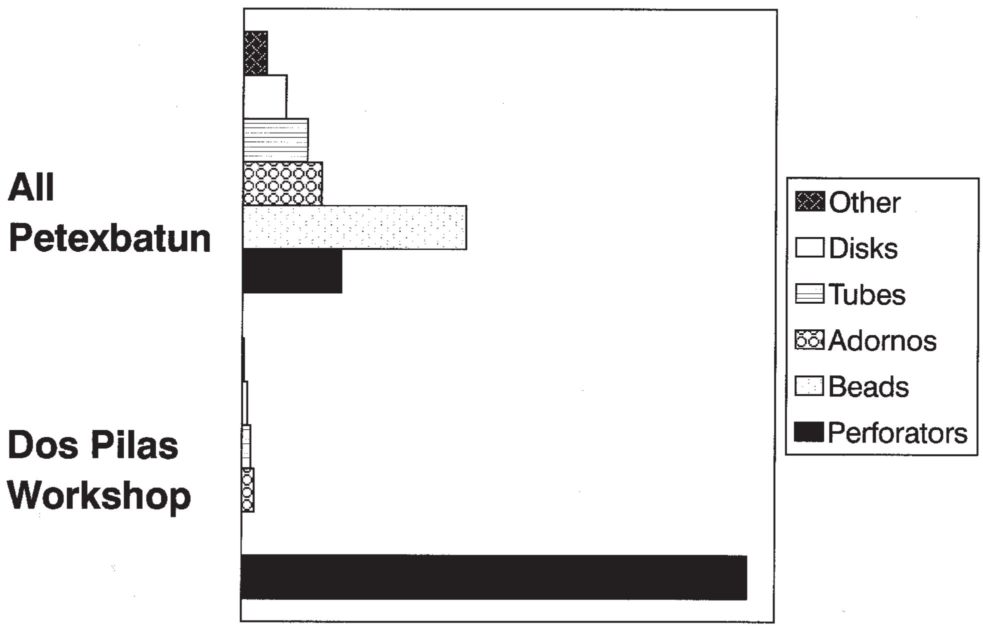

Fig. 17 Comparative artifact diversity at the Petexbatun sites

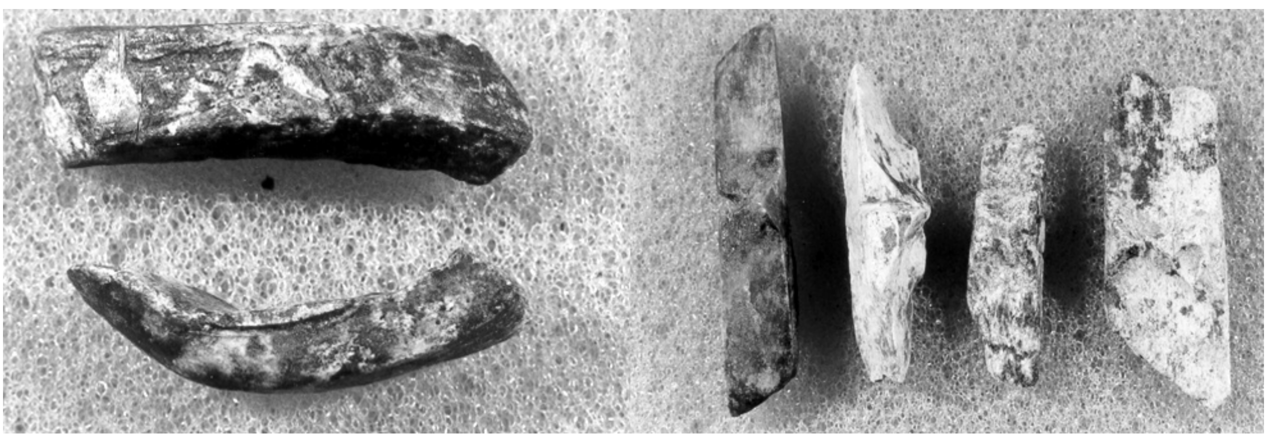

Fig. 18 Stepped and ring debitage, Dos Pilas

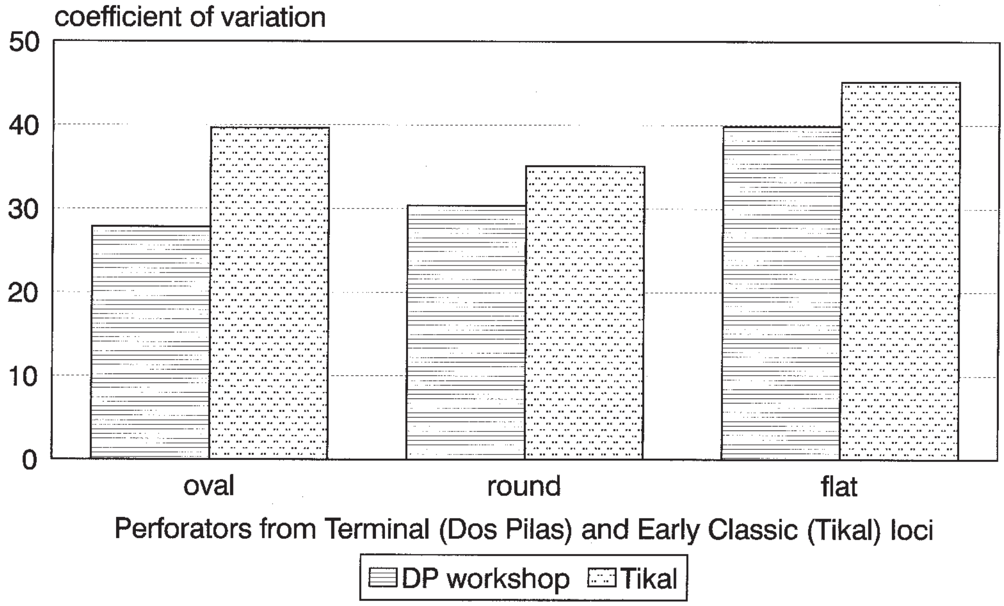

Fig. 19 Coefficients of variation (tool width) of finished perforators by classes of tip cross-section in Terminal and Early Classic periods (Dos Pilas and Tikal)

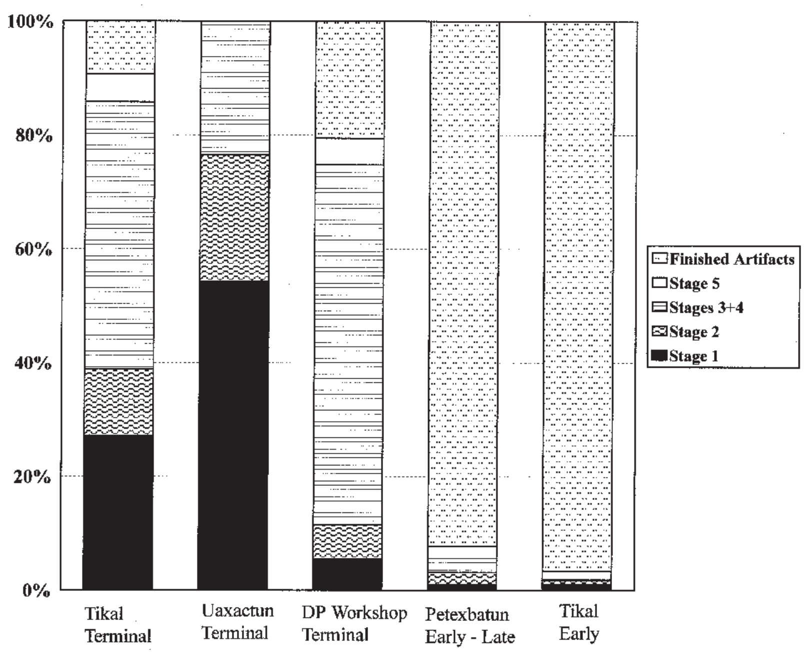

Fig. 20 Distribution of manufacturing stages in assemblages from the southern Maya lowlands