The ghost in the corridor … Some remarks on "Animal Secondary Products", edited by Haskel J. Greenfield[1]

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A considerable proportion of archaeological finds brought to light during the course of excavations is represented by animal remains. Archaeozoology (also known as zooarchaeology) is the discipline devoted to the identification, analysis and interpretation of this often voluminous material. The value of these finds usually lies in their sheer quantity and repeated occurrence that yield patterns reflecting particular kinds of valuable information about the societies that produced them. Given these disciplinary characteristics, it is appropriate to repeat one of my favourite quotes as an introduction to this review: "Sampling is a ghost which has come to haunt the corridors of archaeology" (Ammerman et al. 1978, 123). Fashionable research into herd management strategies, intimately connected to secondary product exploitation, is particularly dependent on sufficiently large sample sizes and multidisciplinary approaches in order to reach reliable conclusions.

Beyond the conscientious documentation of animal remains, the archaeological application of animal studies is of utmost importance. An entire volume written by an international group of scholars on a special aspect of ancient animal exploitation is a promising contribution to this subject. The papers in this volume approach the topic of secondary product exploitation in a variety of ways, some of which are more successful than others depending on discipline-related methods often dependent on statistically viable sample sizes.

What are Secondary Products?

Aside from the rare archaeological evidence of ancient animal rituals or pet keeping, the overwhelming majority of animal bones recovered from ancient settlements represent ordinary food remains and refuse from a variety of activities such as butchery, food-processing or bone manufacturing, originally the *primary* evidence of meat and raw material consumption. On the other hand, the technical term "secondary products" represents a range of renewable animal resources coming from live animals. I find "renewable" (a term also suggested by Shipman in this volume: Shipman 2014, 48), a conventionally understood contemporary concept, easier to use than the "*ante mortem*" or "life time" products proposed by Vigne and Helmer (2007, 36). "Renewable" should therefore replace the expression "secondary product" as a more tangible term.

These forms of exploitation most typically include dairy products, draught work, wool, hair, and manure for fertilizer and fuel. High status mounts, pets or honey bees fall into the same category. Not only can blood be used as a primary product (Greenfield 2014, 12 tab. 1.1) but it may also be drained periodically from large livestock as practised by cattle herders in East Africa and is also mentioned in relation to camels in "The Secret History of the Mongols" (Ligeti 1971). This

[1] Haskel J. Greenfield (ed.), Animal Secondary Products: Domestic Animal Exploitation in Prehistoric Europe, the Near East and the Far East. Oxbow Books, Oxford 2014. £ 65.00. ISBN 9781782974017. 256 pages with b/w illustrations and one CD. – This paper was originally commissioned as a book review but due to its scope and methodological detail it was considered in this section.

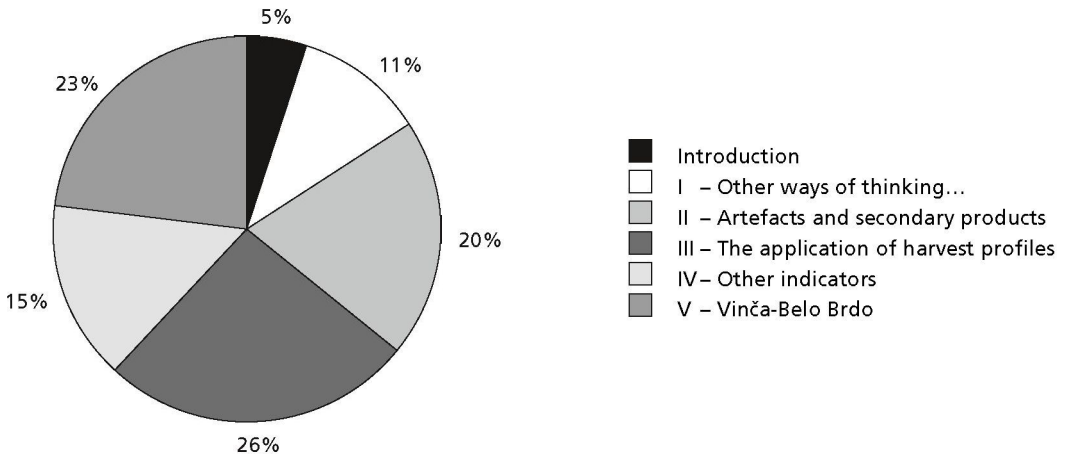

Fig. 1. Proportions between the main parts of the book (based on 256 printed pages).

would by definition classify as use of a secondary product. Even portions of meat may be harvested from the rump of live cattle in parts of Africa (Shipman 2014, 50).

Eggs represent the proverbial borderline case: they are non-renewable primary products from the viewpoint of the un-hatched chicken, but renewable as secondary products of the living hen. The concept of secondary products is rooted in domestication. One of the few, commonly encountered exceptions strengthening this rule in archaeology is shed deer antler, a wild animal product that – in addition to hunting – can be acquired by gathering for the purpose of manufacturing without killing the stag.

The attractive hard cover book under discussion here is based on five papers delivered in the session entitled "New approaches to the Secondary Product Revolution" organised by the editor at the 11th Conference of International Council for Archaeozoology in Paris in 2010. The editor himself wrote three of the 14 papers included in the final version of the book (Introduction, Parts I / a and V / a) and co-authored another three (Parts III / a, III / c, V / b) totalling almost half of all contributions. He also solicited papers from experts not represented in the conference programme. The core of the book consists largely of Greenfield's work in former Yugoslavia, especially on the Late Neolithic, Eneolithic and Middle Bronze Age levels at the eponymous site of Vinča-Belo Brdo in Serbia. The data inventories from this site (bone measurements, working photographs etc.) are usefully featured in a digital appendix on the CD that accompanies the volume.

Papers in this book are grouped into five major "Sections", in a sequence also followed in the rest of my review. *Fig. 1* shows the proportions between the Introduction and five parts of the book on the basis of their respective lengths.

Introduction

The term Secondary Products Revolution was coined by Andrew Sherratt (1981). He hypothesised that a largely contemporaneous set of innovations took place in animal husbandry in many parts of the Old World in the wake of the Neolithic when a package of new subsistence techniques swept across much of Eurasia. Haskel J. Greenfield has published extensively on the subject of

secondary products since the late 1980s and his introduction to the volume is an excellent review of previous research providing a clear critical account of its evolution. He has witnessed what he calls in this book "the age of innocence" at the beginning, as well as the "golden age" of the 1990s and early 2000s. Following 2005 he speaks of the "age of disillusionment" and in addition to his own analysis, much of this volume illustrates the tensions between the theory and methodologies that have generated much debate about the reconstruction of usually intangible secondary products from the coarse-grained osteological evidence of dead animals in excavated assemblages. During the last three decades, questions arose continuously regarding the first occurrence of various secondary products and the intensity of exploitation. In addition, diverse laboratory analyses have contributed to fine-tuning the model contributing primary evidence of such products such as milk residue.

Personally, I have long felt uncomfortable even with the idea of human demographic reconstructions using cemeteries as the related jargon sometimes conflates the fundamental concepts of live (*biocoenosis*) and dead community (*taphocoenosis*), as first defined by the aquatic ecologist Erich Wasmund (1926). The situation is even more complicated in the case of disparate animal remains recovered from middens, decimated by a host of human-induced and natural taphonomic processes often mentioned but rarely considered in the reconstruction of animal exploitation. Depending on preservation and precision of recovery, the remains of young domesticates may be particularly badly hit by taphonomic loss, biasing age profiles aimed at identifying the relative importance of meat vs dairy production as well as other forms of secondary exploitation.

Part I: Other ways of thinking about secondary products

The editor devotes a tenth of this volume to reflections on the origins and intensification of dairying in the archaeological record in combination with an innovative theoretical overview of the topic by Pat Shipman.

Diagnostic protocols established on extant animal populations are of great value in archaeozoology. Modern reference assemblages of known biological parameters (age, sex, breed, live weight) and documented forms of exploitation are invaluable tools in modelling past modes of animal use. Since the key to successfully exploiting animals for secondary products is the longevity of domesticates, ageing animal remains lies at the heart of reconstructing mortality patterns in excavated animal bone assemblages. Pre-dating Sherratt's 1981 proposition regarding secondary products by almost a decade, Sebastian Payne (1973) published his ground-breaking ethnographic study on extant goat herding in Anatolia documenting dental age profiles in relation to producing meat, milk and wool respectively. Differences in the ages when livestock are slaughtered are indeed related to the way a herd is being managed. Unfortunately, while Payne himself warned against the uncritical archaeological application of his meticulously constructed and tested models of secondary exploitation, the method spread like wildfire among zooarchaeologists, often hard pressed by excavating archaeologists to produce "meaningful" *archaeological* interpretations of meagre faunal materials. All too frequently, these results have been calculated using a few, scant handfuls of ageable teeth and long bone articular ends recovered from middens accumulated during time periods of unknown lengths, inflating the significance of such finds as valid descriptors of herd structure. In fact, what is seen in archaeological assemblages is nothing more than the age distribution of surviving individual finds. To the credit of the editor of this book, a thorough critical overview of these nagging problems was provided at the beginning of the volume in the introduction. These reservations are counter-balanced by incorporating cur-

rent zooarchaeological theory and cutting-edge methodological developments in laboratory techniques[2].

At the time Andrew Sherratt tried to conceptualise the critical changes in livestock that took place between the Neolithic and Bronze Age. The inclusion of the Palaeolithic in this volume through the example of dog domestication by Pat Shipman is an eye-opener. It expands the time frame in order to better illustrate the general concept. She points out that the original tenet of domestication having been "motivated by a desire or need for greater food security – is completely undermined by analyses of the first domesticate and its properties". While dogs would indeed be hard to consider typical livestock in a modern sense, the possibility that meat acquisition was not the only motivating force behind domestication and animal keeping in general, is a recurring theme in this book. This very important point is somewhat confused by listing animal skins under "wool and fur" (Shipman 2014, 49), which contradicts the renewable nature of secondary products: animals had to be killed for skinning and it cannot be assumed that their meat was not at least opportunistically consumed on such occasions.

Part II: Zooarchaeology, artefacts and secondary products

Traditionally, sheep and goat have been at the focus of studies of secondary products with some discussion of cattle, too. Direct and convincing archaeological evidence for secondary exploitation, on the other hand, is still far and few between. Such finds include rarely preserved wooden wheels, ploughs and yokes, wool remains as well as scarce iconographic sources from rock art in Europe.

Chapters in the rest of the book represent a time span between the Neolithic and the Iron Age in Southwest Asia and Europe with a characteristic emphasis on the Late Neolithic and Early Bronze Age. This traditional scope has been broadened geographically by including relevant research from what is termed the heartland of ancient China by Zhipeng Li and co-authors. Their work represents a welcome addition, as very little information on the exploitation for secondary products in this important area has been available in Western languages. Like all of us working with such data, the authors face the difficulty of small assemblage sizes where the combined sheep / goat dental ageing data based on NISP values is taken as "individuals" (Li et al. 2014, 64 tab. 3.4) although the overall trends seen in the better represented epiphyseal fusion data outline tendencies based on more convincing numbers. One wonders whether the possible lack of dairy exploitation supported by the absence of relevant written references to milk may have to do with the history of lactose intolerance, widely studied in modern-day populations in Asia but not yet well understood in its historical depth.

Synthesising multiple lines of evidence to demonstrate the particular herd management strategies is indispensable, the authors' multidisciplinary approach is warmly welcome. Archaeological evidence for wool exploitation during the Neolithic of Poland is presented by a paper by Marie-Lorraine Pipes, Janusz Kruk and Sarunas Milisauskas. Artefactual evidence for wool production in the form of spindle whorls and spools from the middle to late Neolithic settlement of Bronocice (Poland) reviewed by Pipes et al. (2014) importantly complements trends seen in the archaeozoological record based on the assumption that sheep played a far greater role in Neolithic

[2] Among these methods, identifying milk residues has not only pushed back the earliest direct evidence for bovid milking into the Early Neolithic as discussed here; it also provided the first ever tangible evidence of horse domestication in Kazakhstan (Outram et al. 2009), since it seems highly unlikely that wild mares could have been milked.

economies than goats. An upsurge in textile production was thus assessed by increases in tools used in fibre and textile production. A word of warning should be sounded, however. On the one hand, at this point it is far from clear whether these spindle whorls and loom weights were used exclusively for the large-scale processing of wool rather than plant fibre (hemp / flax / nettles) widely available at that time in Neolithic Europe. On the other hand, without high magnification use-wear examination of the 'beaters' presented there is no way of demonstrating that these objects were actually used as beaters. Tool form cannot always be automatically equated with function. Comparisons between age groups are based on the Minimum Number of Individuals (MNI). This is a logical solution which, on the other hand, seems a rather unreliable parameter in inter-site comparisons when taphonomic factors and the actual time span of deposition cannot be considered in detail. However, the synthetic nature of this multidisciplinary paper buffers these potential biases, represents a welcome call for better cooperation between archaeologists and zooarchaeologists.

As mentioned before, most typically, excavated bone assemblages represent primary products such as perishable meat, fat and hide through the bones that are preserved. Galindo-Pellicena et al. (2014), who studied caprine remains from the Chalcolithic and Bronze Age settlement layers at Portalón, also face the difficulty of not being always able to distinguish between sheep and goat, although Payne (1973, 284) already argued that "sheep and goat have to be considered together despite possible differences between man's use of the two animals at the same site. (The same problem exists if data on epiphysial fusion are used, as in most cases unfused sheep and goat bones cannot be reliably separated)". This situation is made even more difficult when metadata representing a broad literary base (such as the figures in Galindo-Pellicena et al. 2014, 108 Table 3.24) are considered: species level identifications were available from only 27 of the 43 assemblages reviewed in this paper. Hence the promising subtitle of this contribution, "The nature of Capra and Ovis exploitation", is somewhat misleading as most of the analysis concerns pooled caprine remains.

Regardless, it is this particular literature-based contribution – which inevitably carries with it the shortcomings of previous work – that contains important, recent literature on the morphometric distinction between sheep and goat. Aside from the seminal work by Boessneck et al. (1964), references to key papers recently published by Melinda Zeder and her co-authors on this topic (Zeder / Lapham 2010; Zeder / Pilaar 2010) are missing from all of the other papers in the volume.

Part III: Methodological issues in the application of zooarchaeological harvest profiles and other methods connected to the study of secondary products

The three chapters in this section make up over one quarter of the entire volume, dominated by the paper entitled "'Crying over spilt milk': An evaluation of recent models, methods, and techniques on the origins of milking during the Neolithic of the Old World" (Greenfield / Arnold 2014; cf. Greenfield 1988). This almost 60 pages long contribution is admittedly structured to counter critical arguments by Vigne and Helmer (2007) who had called for the thorough revision of Sherratt's concept of the Secondary Products Revolution and pointed out several weaknesses not only of the underlying theory but also the imprecision of the methods used including the all too frequent absence of statistical testing. Some of the points revisited here can be defended, others cannot. While concern has long been expressed over ternary diagrams used to compare age cohorts leading to a significant loss of information, I see a far greater problem with the percentage-based methods used in this paper (and many others): the direct effect of sample size on diversity often

remains completely unaccounted for. This is a problem clearly recognised by Greenfield (2008) as well. In the literature, however, sometimes handfuls of animal remains are compared to even fewer pieces of data, or at the other extreme, several thousands of data while the impact of this dramatic difference in numbers on interpretation is ignored. As may be seen in several papers in this volume as well, gradually reducing the ageable sheep / goat remains into several age cohorts usually results in tiny sub-groups that make little sense interpreting in terms of "herd management strategies". This contradiction in methodology becomes a vicious circle: professionally carried out identifications of species, sex and age, indispensable for testing hypotheses concerning production, whittle away statistically viable sample sizes. On the other hand, when less than maximum precision is accepted by the analyst, the resulting low-resolution picture hides essential questions such as sexual selection in culling or the striking functional differences (habitat preference, behaviour, diet) between sheep and goat.

The resulting small numbers of finds are not the analyst's fault: we need to document and study what is left. It is, however, the responsibility of the researcher to find the correct concentration of detail and interpretation that reflects the shortcomings as well as the potentials of each find material.

Some difficulties can be remedied by detailed publication of high-precision original data, guaranteeing that scarce details from individual sites will one day build up to form a clear, inductive picture of, for example, herd management strategies. Even then, many such data will never be fit for deductively testing the complex and sometimes grandiose hypotheses that lie at the heart of the particular research problem of secondary products.

This technical contradiction is very clearly shown by the review of 76 Levantine sites by Sasson and Greenfield (2014, 212 tab. 4.14). When the proportion between adult and young sheep / goat (i. e. caprinae combined) is broken down by geographic region, site type and archaeological period respectively, in the tabulated summary of site numbers individual cells often remain empty or contain only 1–2 cases. With such small numbers, key interactions between the three factors cannot be meaningfully studied (e. g. by using multiple variance analysis). This is an objective fact that should encourage the long term, focused collection of masses of data. Until that happens, however, I would argue that far more prudent language be used; the statement that "burial sites, a large [sic!] number of which contained a high proportion of young caprines" (Sasson / Greenfield 2014, 213) is based on the incredibly small number of three sites found in different geographic regions and inhabited in different time periods. Such small numbers (actually less than one hundred) should never be presented as percentages (33 % = 1 burial). Simply stating that young individuals were preferred (or better preserved / more carefully excavated?) in human burials would say everything that can be legitimately stated in a synthetic paper. To my mind, contextualising such small numbers in a "herding" narrative is linguistically inaccurate. Statements such as "cattle remains [...] around 15 % (of the total caprines and cattle herd)" (Sasson / Greenfield 2014, 213) have always reflected a common and disturbing semantic bias in the analysis of "mortality profiles", regardless of the reliability of underlying data sets.

The critical review of reconstructing secondary production in archaeology by Marciniak (2014, 193) adds a new, rarely discussed element to the host of criticisms levelled at these methods. He directs attention to the fundamental difference between living and dead populations, noting that the latter could be used in reconstructing "herds" only in cases of catastrophic mortality. This level-headed approach resonates with the aforementioned definitions by Wasmund (1926). Mortality profiles from archaeological remains should be treated as such and not be mistaken for past realities in actual animal herds. This evident difference between mortality profiles and herds is hardly ever mentioned in treatises discussing overarching models of secondary pro-

duction. Thanks to its thorough, critical edge, Marciniak's chapter is one of the most forward-looking papers in this volume. His recognition of the fact that "rejection of a popular method is potentially very troublesome if it is not replaced by something that improves the situation" (Marciniak 2014, 196) inspired him to look beyond traditional age-structure models and review a range of alternative, non-mortality based methods offering direct evidence and greater precision. These methods range from genetic studies to human lactose intolerance through food residue studies to animal palaeopathology (skeletal anomalies caused by over-milking in dams or enthesopathies in working animals).

Part IV: Other indicators of secondary products exploitation

Modelling the emergence of secondary products has been widely seen as a "prehistoric" subject. Although relevant throughout the history of human civilisation, in the usual absence of written records, archaeologists investigating earlier time periods have always been more attracted to the analysis of animal remains. However, animal bones offer only limited and often misleading information in themselves. Prehistorians tend to disregard Guilday's revealing work at Fort Ligonier in Pennsylvania (1758–1766). He demonstrated that the approximately 1800 kg meat estimated from the animal bones recovered "would have sustained only two men for the length of time of the known occupancy, or the entire garrison at full strength for just one day!" (Guilday 1977, 131). It must be emphasised that this observation was made on the basis of consumption refuse alone, disregarding the hazy aspects of meat production let alone the reconstruction of herd management strategies. Leftovers of meat consumption represent scrap to begin with, and taphonomic factors have a further detrimental effect on this primary evidence, emphatically, the animal remains studied by zooarchaeologists.

This part of the book therefore represents a very elucidating approach to the question. Through investigating "other indicators of secondary products", its authors breathe some fresh air into the stale atmosphere of reiterated polemics regarding harvest profiles. A particularly lucid paper by Trudy S. Kawami (2014) presents iconographic evidence of milk exploitation in Mesopotamian art. One of the attractive admissions in this paper is that its topic post-dates the putative "Revolution". By the 3rd millennium BC, dairying was a known fact, amply documented in written sources and images in Mesopotamia. While cattle representations abound in this well-illustrated paper, even showing various forms, pictorial documentation of milking is relatively scarce. The question of images showing cows being milked from behind "caprine" style has long attracted the attention of scholars (Zeuner 1963) and is interpreted here as a sign that cow milking would have been a rare sight in ancient Mesopotamia[3].

Importantly, the sound critical evaluation of iconographic (and documentary) evidence for secondary products exploitation is elegantly contextualised within the dynamically changing social and religious scenarios of the times. Such secondary product exploitation would be impossible to reconstruct at ordinary prehistoric sites where this valuable form of complementary information is lacking.

Related to this contribution is the study by Levent Atici (2014), who reviews coeval textual sources on the topic of secondary products from the Middle Bronze Age (late 2nd millennium BC)

[3] However, a cow milked in this fashion from the rear is also shown from mid-14th century Bologna in Justinian's *Digesta* (Morrison 2007, 24).

urban site of Kültepe / Kanesh, a settlement located in the "Mesopotamian outback" in Central Turkey. The activity of Assyrian-Anatolian trade networks was documented in cuneiform writing on tablets with considerable details about livestock. Personally, I always find critical comparisons between the written record and excavation data interesting. It is noteworthy for example that goats are rarely mentioned in these texts. Ample documentation of sheep breeds and wool trading, on the other hand, show the key importance of this latter species. Discussions on pack donkeys in these texts show how important certain working animals actually were, even if they tend to be consistently underrepresented in the archaeological record due to the differential disposal of their carcasses when not exploited for their meat. The inverse of such selective textual representation may be seen in the case of dairy products which are not even mentioned in the written sources concerned with Assyrian long-distance trade but probably played a role in local diets. Most importantly, the author directs attention to livestock as capital or commodity for exchange. Since archaeozoologists work with the remains of dead animals this key function remains intangible using osteoarchaeological methods alone. The emergence of complex societies and the likewise complex invention of secondary products cannot be understood without looking for supporting evidence in iconographic and documentary sources.

The last paper in this interesting section is not concerned with historical data but employs strontium isotope analysis of Neolithic and Copper Age samples from eastern Hungary. The aim of this research was to reconstruct possible herd mobility in relation to secondary product exploitation (Giblin 2014). This research is all the more important as analyses of demonstrably shaky age profiles often give rise to spurious assumptions concerning transhumance, an extremely complex socio-economic phenomenon, requiring an identifiable home base and temporary satellite settlements used by specialised pastoralists. While archaeological evidence of the latter is typically difficult to find, mortality curves reconstructed at permanent-looking settlements are of no use in answering the question of cyclical pastoral movements. In this paper, the analysis of 42 samples from a total of 11 teeth representing three different archaeological sites suggests that there were no increases in pastoral movements during the Late Neolithic and Copper Age in eastern Hungary (Giblin 2014, 267). Although sample size could be brought into question in this case as well, all results consistently point in the same direction: localised herding. Also, these measurements are used to pinpoint the state of individual animals, not reconstructing age ranges. X-Ray fluorescence strontium isotope measurements of Neolithic sheep from Poland also suggested that most animals were of likewise local origin (Pipes et al. 2014, 90). The gradual exploitation of various secondary products did not seem to stimulate herd mobility.

Part V: Zooarchaeological analysis of remains from Vinča-Belo Brdo

As part of this book review an important technicality must be pointed out: this site-based topic consumes over one fifth of the book. The voluminous first chapter in this section is a cuckoo's egg among the previous scholarly treatises on the Secondary Product Revolution. It contains detailed zooarchaeological information from the 1982 excavations at the type site of the Vinča culture on sixty printed pages and the CD added to the volume. The significance of the paper is evident as primary documentation. The genre of this text, however, is that of a largely unedited site report and represents neither analytical nor synthesising research work. "Statistics" appear in the use of percentages often calculated on meagre data sets and the results are not compared to significant tell sites in the Danubian region excavated over the last three decades (e. g. Feudvar, Hârsova and Pietrele).

Its title, "The origins of secondary product exploitation and the zooarchaeology of the Late Neolithic, Eneolithic and Middle Bronze Age at Vinča-Belo Brdo, Serbia: the 1982 excavations", is simply misleading. This lengthy paper remains isolated in a volume originally devoted to secondary products: a single table (Greenfield / Arnold 2014, 309 tab. 6.23) shows the distribution of ageable bones by species and period, and two paragraphs in the conclusions mention secondary products (ibid. 326). In spite of the minute presentation of results, the conclusions barely reach beyond the results provided by Bökönyi (1990, fig. 1): cattle was the most important species while pig and caprines, even when combined, were represented by far fewer bones. Hunting played a negligible role.

While most of the book appears carefully edited, this text seems to have been lifted from some old archive. The vernacular English names of animals are not provided in the tables and caption subtitles. This is potentially disorienting for readers with no training in Linnaean nomenclature, including archaeologists. In contrast to this highly technical format, the order in which species are listed in various tables is neither taxonomic nor archaeological (by tentative economic importance). For example, dog is inserted between two ungulate species and ruminants are separated from each other by horse. Among the game animals, beaver occurs between two cervid species. The possibility that the sequence follows the alphabetic order of Linnaean names is confused by the fact that Felis (cat) follows Ursus (bear). The genus *Apodemus* is erroneously listed under the avian family name Apodidae (swifts) instead of Muridae (true mice and rats).

The core information in tables 6.18–6.20 (Greenfield / Arnold 2014, 302–304) is redundant: the raw figures are identical number by number, differences being represented only by the inclusion (or not) of non-mammalian taxa when accompanying percentages are calculated. These tables take up three pages.

Fortunately, the associated short research paper on harvest profiles and thin-sectioning of teeth from domesticates from the same site offers some thoughts on changes in subsistence and seasonality. It directs attention to a method used successfully in studying the taphonomy and seasonality of Neolithic caprine remains in the region (Pike-Tay et al. 2004; Pike-Tay 2007). Although in the study under discussion here, only four of the ten sectioned samples (two sheep, a goat and a tooth identified on the caprine subfamily level) provided readable results (Greenfield / Arnold 2014, 345 tab. 6.42), the method could certainly be usefully added to the arsenal of research tools used in fine-tuning investigations of animal exploitation for secondary products.

In the absence of more high-precision ageing data, the rest of the paper is also built on interpretation of the much discussed traditional mortality curves. The harvest profile for pig mandibular teeth construction looks convincing. In the case of pooled sheep / goat teeth, however, it is impossible to tell how much of the similarity between the Late Neolithic and Middle Bronze Age trends is caused by the absence of species-level identification. Random-looking oscillations in the harvest profile of cattle may easily be the product of insufficient sample size (raw counts: Late Neolithic = 5, Middle Bronze Age = 9 specimens).

Actually, this second paper could have been profitably added to Part IV as directly relevant to the topic of the volume while – following careful edition – the long Vinča-Belo Brdo site report (from which it was evidently extracted) could have been saved on the CD as supporting information.

Concluding remarks

In summary, this volume is an important contribution to research on secondary animal production in spite of its heterogeneous and sometimes contradictory composition. Indubitably, exploiting various domesticates for a broad range of secondary i. e. renewable products has fundamentally transformed the nature of not only animal exploitation, but also impacted land cultivation practices, settlement types as well as socio-economic development in ancient Eurasia. Archaeological science has recently generated many types of new data, methods and techniques, highlighting previously hidden aspects of this important issue.

The holistic approach to Sherratt's original concept represented by this book is a welcome development as the uncritical interpretation of superficially drafted age profiles no longer represents sufficient argument for tentatively reconstructing herd management strategies. Our understanding of the origins of dairy and wool production as well as of animal traction and transport will greatly benefit from the use of increasingly sophisticated methods complementing valuable osteological documentation.

To some extent, methodological problems and issues rooted in sampling may also be remedied by systematically studying unusually large assemblages (hundreds, if not thousands of ageable remains of the same species) in which the law of large numbers potentially compensates for the sample size shortcomings singled out here. While the precise recording of relevant morphological data on species, age and sex is an imperative part of scholarly documentation, a more prudent and responsible language needs to be developed to avoid over-interpreting the meaning of results. Special attention also needs to be paid to always stating assemblage sizes (as has been done throughout this volume) and, if at all possible, the statistical significance of the numerical analyses of age distributions. Simple Chi square tests carried out on raw data would at least help researchers decide whether the patterns we see in numbers are really statistically significant. This simple method would also mean cells containing cases fewer than five would be automatically excluded from numerical comparisons. It must be emphasised that formal statistical significance is only a first step, it does not necessarily guarantee archaeological "significance" given the complexities of sampling. Even small numbers of animal remains can contain valuable information, but they are unsuitable for studying questions that need to be answered on the basis of consistent trends shown by large series of data. This was certainly one of the most important conclusions drawn from the targeted study of draught cattle (Bartosiewicz et al. 1997), representing a form of secondary exploitation directly reflected in the skeleton.

The strength of this book is that by thoroughly reviewing archaeological, iconographic, textual, and sophisticated scientific evidence, it offers an important complement to the analysis of scarce osteological data. It is worth mentioning that in a previous review of zooarchaeological research in the central Balkans, Greenfield (2008) himself warned that the quality of the information from Neolithic sites in the region is extremely variable. He discussed in-depth the effects of topography, sample size and taphonomic factors, offering a critical overview of recovery, quantification and curation techniques, concluding that the overwhelming majority of animal bone assemblages from the region have only limited potential in the understanding of past animal exploitation strategies. Over-harvesting the existing modest information by using bombastic, theory-driven language is no longer a viable option: turning a blind eye to the statistical inadequacy of sporadic food scraps in order to reconstruct complex systems of production in animal husbandry is edging on pseudo-science, using methods formally rooted in natural sciences on data that fall short of the basic criteria required by these same methods. In most caprine studies, the absence of species-level taxonomic identification and the impossibility of detecting sexual dimorphism in the young by just looking at

bone morphology further exacerbate the chronic problem of inadequate samples. While the paucity of data can be remedied by targeted long-term, meticulous inductive research, the language in this topic area needs to be toned down to a far more matter-of-factly presentation of the actual results.

Last but not least, the publisher, Oxbow Books, should be commended for this latest nicely laid out, hard cover book presenting an important animal topic in archaeology. Since the publication of the 14 edited volumes which present the proceedings from various symposia at the 9th Conference of the International Council for Archaeozoology in Durham (2002), Oxbow has steadfastly supported this discipline through a variety of important works in zooarchaeology fostering communication and helping to maintain a dynamic professional discourse between archaeozoologists and a broader community of interested scholars and laypeople.

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Reference of Figure:
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