# Quantitative Paleozoology

R. Lee Lyman. 2008. Cambridge University Press, Cambridge. Pp. 348, black-and-white illustrations. $29.34 (paper). ISBN 9780521715362.

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The literature on quantification of skeletal animal remains from archaeological and paleontological contexts is chaotic. Despite several attempts (e.g., Grayson 1984; Lyman 1994a) there has been little to no systemization. Lyman's book lends order to the chaos that starts with fundamental definitions and the most basic aspect of quantification, tallying of specimens (bones/shells or fragments thereof). This basic start to the book is a key element to its palatability because nearly any reader with a broadly scientific mind can pick it up, start with Chapter 1, and proceed with a spiraling crescendo into increasingly detailed chapters that follow. The first chapter addresses several important topics from the historical development of tallying (how it has been done and is done) to the statistical nature of paleozoological data, to an introduction of the zooarchaeological samples Lyman uses in examples throughout the book. Lyman repeatedly echoes and reinforces Grayson's (1984) conclusion that paleozoological data are "at best" ordinal scale. This is the case for at least a couple of reasons: paleozoologists do not sample directly from animal populations, thus analysts cannot control representativeness by design; and paleozoological remains pass through taphonomic histories that might modify what was/is represented. The statistical nature of paleozoological data is patently ignored by zooarchaeologists who pretend that their data are 'ratio scale at least.'

Lyman moves into basic units of quantification, number of identified specimens (NISP) and minimum number of individuals (MNI) in Chapter 2, covering the historical development of each unit. He opens with a brief but important discussion that relates to validity by defining target and measured variables. One must know what one hopes to count (target) in order to quantify appropriately (measure). There is a lengthy and tedious debate within zooarchaeology as to which unit is best for quantification of taxonomic abundances determined from faunal assemblages. Lyman covers problematic hurdles associated with each unit. NISP might be prone to the 'problem of interdependence' or multi-counting in that fragmentation may lead to specimens from the same individual being counted more than once. On the other hand, MNI might differ according to how faunal data are aggregated into sub-assemblages from a site. That is, additive MNI from multiple sub-assemblages might be different than that determined from the faunal sample considered as a single large assemblage (non-additive). Each problem is considered to be 'the classic problem' with each unit; Lyman shows (as did Grayson) that MNI and NISP correlate to one another in terms of representing taxonomic abundance in most cases. This is logical since MNI is derived from (based on) NISP. NISP represents a maximum and MNI represents a minimum; if the two measures correlate to one another in an assemblage then aggregation and interdependence are overcome. Lyman concludes that the paleozoologist should simply use NISP at ordinal scale to measure taxonomic abundance.

Despite that paleozoological data are at best ordinal scale and that NISP and MNI correlate to one another, a few zooarchaeologists extend quantification beyond basic units to derive meat weights, biomass estimates, skeletal mass allometry, and other derived units. In Chapter 3 Lyman demonstrates the fallacy of such extension. Lyman's reconsideration of a case study on the use of meat weights by renowned paleobiologist John Guilday is illustrative of this fallacy (p. 113). Guilday (1970) concluded that meat weights are "patently ridiculous," a sentiment that Lyman clearly agrees with for meat weights and similar quantitative methods. The issue with these kinds of derived units can be summarized as follows: if paleozoological abundance data are at best ordinal scale, meaning that it might only be possible to determine that taxon A was more or less abundant in the assemblage than taxon B, and if that resolution is clearly portrayed through the use of NISP, then why would the analyst *derive* a ratio-level variable of tissue weight *from* NISP? Lyman's answer is that the paleozoologist should not do so. Other methods that are introduced in Chapter 3 include taxonomic ubiquity, which is simply commonness of particular taxa in multiple assemblages, and a variety of methods for matching paired skeletal elements, the pitfalls and advantages of which Lyman considers in detail.

The first three chapters are an important prelude to Chapter 4, which is (in my opinion) the most important part of the book. Other sections represent organized and updated consideration of topics that have been covered in detail in the paleozoological literature, but determining the quality of paleozoological samples has not been covered in as concise and clear of a manner as by Lyman in this chapter. Lyman demonstrates that sampling to redundancy determined through the use of species-area curves and analysis of nestedness can aid the paleozoologist in terms of knowing how well the taxonomic composition of a faunal assemblage represents past ecological communities. Within a single assemblage if taxonomic richness asymptotes with substantial increases in samples size (NISP), then most of the rare taxa have been encountered. When assessing multiple assemblages, if smaller assemblages nest within larger ones in terms of represented taxa, then the community taxonomic composition is likely representative. Chapter 4, by necessity, also covers the influence of field recovery methods on paleozoological samples leaving the reader with a complete suite of tools for assessing the quality of paleozoological data on a sample-by-sample basis.

Chapter 5 organizes and discusses in detail the quantitative methods that paleozoologists use to analyze similarities and differences in taxonomic abundance over time and across space, such as NTAXA for richness and a variety of indices for examining taxonomic diversity and evenness. Updates from previous syntheses on quantitative methods include consideration of abundance indices popularized by Broughton and others (summary in Broughton 1999) in the 1990s and related statistical approaches (Cannon 2000). Chapter 5 concludes the discussion of taxonomic abundances, and Lyman turns to quantitative analysis of skeletal parts (elements) in Chapter 6. He begins by discussing another quantitative unit, the minimum number of elements (MNE), which is designed for assessment of skeletal element abundance. As he did with NISP and MNI, Lyman covers the historical development of MNE and shows that this unit is also ordinal scale at best and that it tends to correlate with NISP (also shown by Grayson and Frey 2004). No discussion of skeletal part frequencies would be complete without a detailed consideration of Lewis Binford's minimum animals units. Chapter 6, however, also expands into discussion of NISP to MNE ratios and other measures of extent and intensity of fragmentation. NISP:MNE was discussed in detail by Lyman (1994b), but it has received very little use as a quantitative measure of fragment size (cf. Nagaoka 2005; Wolverton 2006).

Chapter 7 rounds out the book through discussion of quantification and taphonomy. Another quantitative measure of fragmentation is introduced early in the chapter, the ratio of NISP to NSP, where NSP is the number of unidentifiable and identifiable specimens. As the ratio increases, a higher proportion of bone is identifiable, hence less fragmented. Lyman is incorrect on page 266 when he states, "because the relationship of the NISP/NSP ratio to preservational condition has never been empirically or critically examined, the NISP/NSP ratio is seldom used analytically" (see Wolverton et al. 2008:15). However, such empirical consideration may have been published just as *Quantitative Paleozoology* was going into press. Various kinds of taphonomic signatures that relate to one or another process such as weathering, abrasion, butchering, and/or burning are discussed. Lyman critically examines several approaches for tallying cutmarks; he is unimpressed with surface-area approaches that attempt to 'predict' where cutmarks should be based on estimations of missing portions of bones, which is tantamount to creating cutmarks out of thin air. A recent advance in butchery studies is Egeland's (2003) research on butchery-stroke frequency and cutmark frequency in which he found no relationship between the number of strokes and the number of butchery marks on bone. There is no greater disjunction between target and measured variables in zooarchaeology than there is in analysis of cutmarks. Ethnicity, procurement strategies, butchering intensity might all be targets, but they are rarely validly represented by the measured variable of cutmarks on bone.

In summary, Lyman's book is not a litany of techniques for paleozoological quantification. Instead it is a detail exposé of a variety of methods that discusses—through use of examples—technical application, rigor, and validity. The reader is left with clear reasoning as to when and why particular approaches can be appropriately applied in a variety of research contexts. It is both interesting and troubling to me that there is no unified framework or system for quantification in paleozoology. Archaeology, in general, often compromises methodological rigor for aggrandizing claims. If one is looking for a conservative approach that can be applied with defensible reasoning, Lyman's book is a good foundation for a systematic approach to paleontological and zooarchaeological quantification.

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