

INTRODUCTION



What is taphonomy and What is not?

Anna K. Behrensmeyer^a, Christiane Denys^b and Jean-Philip Brugal^c

^aDepartment of Paleobiology, MRC 121, National Museum of Natural History, Smithsonian Institution, Washington, DC, USA; ^bInstitut de Systématique et Evolution de la Biodiversité, UMR CNRS 7205, Muséum National d'Histoire Naturelle – Sorbonne Universités – UPMC – EPHE, Paris, France;

^cAix-Marseille Université, CNRS, MCC, UMR7269 LAMPEA, Aix en Provence, France

Efremov's original definition (1940, p. 85) – 'the study of the transition (in all its details) of animal remains from the biosphere into the lithosphere' – set the boundaries of Taphonomy at natural processes affecting remains between death and preservation in the rock record. Since its origins, the field of taphonomy has expanded to include all types of organic remains and traces, changes that occur after burial (diagenesis) and during exposure on outcrop surfaces, and even changes caused by collecting, museum storage, preparation and analysis (e.g. Fernandez-Jalvo and Marin-Monfort 2008). For some researchers, taphonomy covers the transition of organic remains from biosphere to lithosphere to laboratory, ending only when the taphonomic data and analyses appear in the printed pages of a scientific journal. In archeology, taphonomy also includes cultural artifacts and the changes that affect them during accumulation and burial ('site formation processes') (e.g. Lyman 2010; Dominguez-Rodrigo et al. 2011; Denys and Patou-Mathis 2014; Brugal 2017). An even broader viewpoint could extend taphonomy to the study of all types of changes in dead biological AND physical materials over time – transformations in biomolecules, iron particles, building materials, fermented food and drink, human garbage – both in the past and into the future.

Since the time of Efremov, taphonomy's conceptual territory has expanded in two directions, one extending the sequence of processes affecting individual specimens, the other encompassing many more kinds of materials and objects than originally specified. If Taphonomy is so broadly defined, does this dilute its original and important focus on processes and biases that affect organic remains and traces between death and preservation in the lithosphere? Should we propose a new term for the degradation and preservation of cultural materials that are not strictly 'biological'? Where should we draw the line between what is, and is not, 'Taphonomy'?

On one side of this debate is the important concept of natural change over time, which taphonomy has championed since its beginning. Understanding that dead remains have an active 'life after death' that affects information preserved in the fossil record was one of Efremov's most important contributions. Extending this idea to all types of non-living materials, organic or inorganic, makes sense from a conceptual standpoint. It also focuses

attention on the fact that virtually everything on Earth's surface is changing. The same processes that control what becomes a fossil, such as animal activity, climate, water flow and sedimentation, also affect non-biological materials. Everything 'dead' around us is subject to alteration over time. Is it useful to extend the meaning of taphonomy to include all biological, physical, and chemical processes that interact with non-living substances?

On the other side of the argument is a more pragmatic and empirical approach to 'What is Taphonomy?' Taphonomy as a field of science consists of the sum of investigations that have expanded understanding of the 'biosphere to lithosphere' transition for all types of organic remains. There is now a huge body of published and unpublished research across the globe, representing marine and terrestrial environments from the beginning of life to the present day. The papers in this special issue of Historical Biology represent the most recent part of the geological time column, with a wide range of innovative taphonomic research on archeological sites, faunal accumulations, and biological processes in Europe, Africa, and South America. Many of these papers focus on evidence that helps us distinguish non-human from human processes of bone accumulation and modification. It is clear from this research and other presentations at the 2016 ICAZ Taphonomy Working Group meeting that archeo-biological taphonomy is in a growth phase, inspiring new insights and methods for understanding the past, especially the human past. Those who see taphonomy as a field of study that is key to understanding preservation and bias in paleontology and archeology have a solid foundation of evidence and interpretations to answer the question, 'What is Taphonomy?'

Another view of 'What is Taphonomy?' involves bias in the fossil record. Many workers think of taphonomy as the study of bias, a scientific investigation of the long-standing realization that the fossil record is an 'unfaithful' recorder of life and death in the past. In latter part of the twentieth century, understanding and correcting for taphonomic biases was regarded as a necessary but rather negative ('wet-blanket') issue in paleontology, particularly as the field expanded into the realms of big databases and macro-evolutionary analyses. More recently, there has been a shift to 'positive' taphonomy, in which the study of live-dead bias reveals important ecological changes relating

to human impact in both marine and terrestrial environments (Western and Behrensmeyer 2009; Miller 2011; Kidwell 2013). Taphonomy has become an essential component of the new sub-field of Conservation Paleobiology (Dietl and Flessa 2011). The focus on bias has extended taphonomy into the post-fossilization realms of disintegration on outcrop surfaces, the impact of different collecting protocols, and preparation methods. All of these can introduce bias into the study of past organisms. But while the study of bias may be a central issue in taphonomy, it should not be used to define the field, because what is a 'bias' always depends on the question being asked. For example, a paleoecologist who wants to reconstruct community structure would regard a fossil assemblage that did not preserve small animals as seriously biased, but this would not worry a paleontologist who is interested only in studying the functional ecology of the megafauna. The foundation of taphonomy lies in understanding processes of preservation and their material results, and this in turn allows study of biases that may affect any given research question.

Participants in the 2016 ICAZ workshop debated what is and is not Taphonomy, and such discussions are a healthy indicator of a still-evolving field. The debate need not be resolved here, nor should any of the different viewpoints – from pragmatic and restricted to conceptual and inclusive – be discouraged. In its purest form, taphonomy focuses on what happens to organic remains up to the point where they are preserved in rock. But many scientists believe that modern taphonomy should include the study of changes resulting from post-interment processes as well as changes in non-biological cultural materials, shifting the overall focus to whatever can affect (and potentially bias) information in a fossil or archeological assemblage.

Extending taphonomy even further, to include changes that affect everything from stone artifacts to fermenting grapes to plastic bottles, can stimulate new thinking about the interactions of the living and non-living. It can raise novel questions about the evolution of the relationships between the Biosphere and the 'Anthroposphere,' as well as the future integration of our human material legacy into the Lithosphere. During the Quaternary, evidence of human activities was incorporated into the lithosphere via archaeological site formation processes. But a transition occurred in the Historical period, and now humans seek to intervene between Biosphere and Anthroposphere as we spend time and money protecting our material creations (as well as natural objects) from degradation. In other words, we seek to understand and control taphonomic processes in order to preserve our cultural heritage. This goes from embalming the dead in Ancient Egypt to modern conservation science, a relatively new field aimed at arresting, or even reversing, material change. It is reasonable to suggest that we need a new term for the study of processes in this cultural extension of taphonomy, i.e. the

science of the transition between the anthroposphere and the 'patrisphere' (i.e. museums).

Extending the conceptual territory of taphonomy leads to interesting questions such as, 'What will be the future fossils of our age, and how will they be preserved?' We imagine that Efremov himself would have been very intrigued by this evolution of his ideas. Taphonomy, at its core, continues as a vibrant field of archeo-bio-geological science, following the path set by its original definition and cumulative research. This is a direct and appropriate answer to the question, What is Taphonomy? But taphonomy also provides a perspective that extends the power of Efremov's ideas to all non-living materials, offering unique insights on micro- to macroscopic material transformations that are occurring all around us. Rather than finding a new term for this, I think that Taphonomy can serve both purposes – as a name for a pragmatic, evidence-based approach to understanding fossil and archeological preservation and also as a conceptual gateway into a much broader quest for knowledge about processes of change that are ever-present in the natural and material world.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

- Brugal JP. 2017. Des TaphonomieS. Une introduction. In *Taphonomie S*, Brugal JP, éditeurs. Paris: Edition des Archives Contemporaines, Coll Sciences Archéologiques; p. 1-20p. [ouvrage du GDR 'Taphonomie, Environnement et Archéologie', CNRS-INEE]
- Denys C, Patou-Mathis M. 2014. Manuel de Taphonomie, Editions Errance, collection Archéologiques; p. 1-284.
- Dietl GP, Flessa KW. 2011. Conservation paleobiology: putting the dead to work. *Trends Ecol Evolut.* 26:30-37.
- Dominguez-Rodrigo M, Fernandez-Lopez S, Alcalá L. 2011. How can taphonomy be defined in the XXI Century? *J Taphon.* 9:1-13.
- Efremov IA. 1940. Taphonomy: new branch of paleontology. *Pan-Am Geol.* 74:81-93.
- Fernandez-Jalvo Y, Marin-Monfort MD. 2008. Experimental taphonomy in museums: preparation protocols for skeletons and fossil vertebrates under the scanning electron microscopy. *Geobios.* 41:157-181.
- Kidwell SM. 2013. Time-averaging and fidelity of modern death assemblages: building a taphonomic foundation for conservation palaeobiology. *Palaeontology.* 56(3):487-522.
- Lyman RL. 2010. What Taphonomy is, what it isn't, and why taphonomists should care about the difference. *J Taphon.* 8:1-16.
- Miller JH. 2011. Ghosts of yellowstone: multi-decadal histories of wildlife populations captured by bones on a modern landscape. *PLoS One.* doi:10.1371/journal.pone.0018057.
- Western D, Behrensmeyer AK. 2009. Bone assemblages track animal community structure over 40 years in an African savanna ecosystem. *Science.* 324:1061-1064.

Copyright of Historical Biology is the property of Taylor & Francis Ltd and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.