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SPOTLIGHT

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Is Selling Vertebrate Fossils Bad For Science?

Fossil sales are big business. Major auction houses such as Sotheby's and Bonhams & Butterfields proudly feature fossils, including vertebrate fossils, in their catalogues. On-line auction sites such as eBay, fossil dealers offer museum-quality specimens for private ownership at prices ranging from around a dollar to several thousands of dollars. For example, searches conducted on eBay during the writing of this manuscript, using the key words "dinosaur fossil," gave results consistently showing around 200 items; items priced in U.S. dollars fetched a cumulative price tag consistently in excess of \$21,000. Clearly, there's money to be made in selling vertebrate fossils for profit.

Given this, it might come as a surprise to the general public that many people consider fossils to be resources worth protecting, rather than commodities to be sold. For example, a bill unanimously passed by the U.S. Senate in July 2005, and currently under consideration by the U.S. House of Representatives (before the Committees of Resources and Agriculture as of this writing), the "Paleontological Resources Preservation Act" (S.263), considers fossils to be nonrenewable and scientifically important resources requiring protection and conservation. A report published in May of 2000 by then-Secretary of the Interior Bruce Babbitt recognized fossils as part of our natural heritage, further emphasizing that vertebrate fossils are rare, and that significant fossils found on public lands should be conserved for scientific and educational purposes. The Society of Vertebrate Paleontology (SVP), a professional international organization of vertebrate paleontologists, asks its members to adhere to an ethics statement specifically rejecting the idea of significant vertebrate fossils as items that can be bought, sold or bartered, save where such activities bring those fossils into the public trust.

Why is there such a difference of opinion? Is it better to sell vertebrate fossils, or to preserve them in perpetuity? The answer lies in how one views science, and whether or not one appreciates the many benefits that science conveys.

Vertebrate paleontology is a scientific discipline that studies the fossil remains of ancient animals with backbones. As a science, vertebrate paleontology follows standard scientific protocols: making observations, advancing hypotheses, acquiring additional data, testing and refining hypotheses, and so forth. Yet, in the public purview, the nuts-and-bolts scientific process of paleontology is often de-emphasized. Books, magazines, and television programs frequently depict paleontology as proceeding from discovery and excavation, with occasional side trips through laboratory preparation, to full-blown and often visually stunning reconstructions of the extinct animal in question, replete with ecological and behavioral interpretations. Particular attention is paid to the importance of fossils that represent superlatives—the first, or the biggest, or the oldest, or perhaps the most complete.

This widespread misperception of how paleontology works contributes powerfully to the growing popular cachet of commercial fossil collecting, the practice of collecting fossils for sale. Indeed, many people view commercial fossil hunters as paleontologists in their own right, which is understandable given the apparent similarities. But this perception is wrong. In the majority of cases, commercial fossil collecting is not paleontology. It is not science. Those points of overlap between actual paleontology and commercial fossil hunting—fieldwork, lab work, and restoration—are the beginnings of the scientific process, representing the data-acquisition stage of an investigation. But they do not constitute a complete scientific program.



Eric Scott is Curator of Paleontology for the San Bernardino County Museum in Redlands, California, where he has worked since 1991. He studies the evolution and extinction of Plio-Pleistocene large mammals in western North America, with a particular emphasis on horses (such as the skull of Equus "occidentalis" shown here) and bison. Eric's studies include both field and museum work throughout the western United States as well as Mexico. Prior to his present position, Eric was Chief Excavator at the Rancho La Brea "tar pits" in Los Angeles. He graduated from the University of California, Los Angeles in 1990. Eric presently lives in Bloomington, California with his wife, Kim, who is also a paleontologist.

Some individuals may question such a rigid interpretation. Don't for-profit fossil finders often discover important fossils? Don't fossil dealers sometimes sell or even donate important fossils to museums? Isn't it true that some commercial collectors even publish scientific papers? The answer to each of these questions is, of course, "yes," for in some cases commercial collecting can and does contribute to paleontological science. The renowned Charles Sternberg and his descendants exemplified collecting of this nature. From the 1860s through to the 1960s, the Sternberg family collected literally thousands of vertebrate fossils from throughout the Americas, including innumerable spectacular finds, which they then sold for profit. But this example is a holdover from an earlier, simpler time: the Sternbergs sold their fossils to museums and academic institutions, rather than into the relative oblivion of private ownership. Museums interested in Sternberg fossils were not forced to compete with wealthy private individuals—or eBay, for that matter—to acquire them. Today, however, the economic situation has changed markedly, and most commercial fossil collecting constitutes paleontology no more than watching apples fall out of trees makes one a physicist.

A key difference lies in the long-term disposition of the fossils, as the Sternberg family story so aptly demonstrates. Vertebrate fossils provide baseline data for scientific investigations. In order for these data to be verifiable, and hypotheses built upon them to be falsifiable, the fossils need to be conserved in perpetuity. Paleontologists, therefore, discover, collect, and restore fossils in order to conserve them, with an eye towards long-term preservation, perceiving these fossils as both a part of our natural heritage and as singular, irreplaceable focal points of scientific data. Through such active conservation, the fossils, the data they contain, and their associated contextual information are held in the public trust. Scientific interpretations gleaned from these fossils can be tested and tested again. As new hypotheses are advanced, and as new investigative techniques are brought to bear, these fossils continue to provide a concrete framework of data upon which science can build. And, since the fossils are publicly held, the data they yield are likewise part of the public trust—a philosophy very much in keeping with the intent of the Paleontological Resources Preservation Act.

The attitude of professional vertebrate paleontologists is well characterized by the ethics statement of the aforementioned SVP: "the barter, sale, or purchase of scientifically significant vertebrate fossils is not condoned unless it brings them into, or keeps them within, a public trust" (see http://www.vertpaleo.org/policy/policy-statement_saleoffossils.html). Note that this ethics policy is aimed at scientists wishing to be members in a scientific organization. As such, it is not a condemnation of the actions of private individuals, an attempted repudiation of anyone's constitutional rights, or a defamation of the free-enterprise system. It is simply a policy emphasizing that scientists should put science first. Further, this ethics statement does not denote blanket repudiation of all commercial fossil practices, only those practices that remove significant vertebrate fossils from the public trust. Nor does the SVP policy reject the important efforts of amateur and avocational collectors.

In sharp contrast, commercial fossil hunters recover and prepare fossils in order to sell them. Precision in such practices is geared towards enhancing the monetary value of the fossils. These specimens are then sold, usually into private hands, and are no longer available for further analysis. Data gleaned from these fossils cannot be verified. Hypotheses advanced from these fossils cannot be tested. New investigative techniques cannot be applied. Long-term preservation is not assured. This is not science, and the public trust does not benefit.

What about fossils sold or donated to museums and universities by commercial collectors? Such activities do take place, and, in fact, are often encouraged. For example, the Association of Applied Paleontological Sciences (AAPS; previously the more aptly named American Association of Paleontological Suppliers) has its own ethics policy, which states in part that members should agree to "[r]eport to proper local authorities any significant discoveries of scientific or public interest" and must "[s]trive to place specimens

of unique scientific interest into responsible hands for study, research, and preservation" (see <http://www.aaps.net/ethics.htm>). Unfortunately, the AAPS policy provides no definition of what constitutes a significant discovery, a specimen of unique scientific interest, or responsible hands. How is a collector to know whether or not a fossil is significant?

Again, paleontology is a science. In science, the coin of the realm is precision—precision of data, precision in framing and testing hypotheses, precision in presenting conclusions. In paleontology as in other sciences, precision is demonstrated by repeatability. But, because paleontology is a historical science, dependent upon data left behind in ages past, repeatability can be difficult to achieve. Chemists may run the same experiment countless times to verify consistent results; paleontologists (and especially vertebrate paleontologists) cannot expect each and every fossil to yield identical data, or anticipate returning to an outcrop and being guaranteed of finding fossils or contextual data similar or identical to previous finds. Further, the organisms that are the focus of paleontologic investigations are themselves variable, and so understanding them necessitates understanding their variability.

For this reason, paleontologists achieve precision, not only by means of repeatability, but also by increasing sample size. A single fossil establishes a concrete starting point for scientific investigations; multiple fossils provide focus. Species, both living and extinct, are best understood when scientists have sufficient fossils to elucidate the extent of potential variation—morphological, ontogenetic, sexual, geographic, temporal, and so forth. To make this possible, paleontologists need multiple fossils, from multiple localities, and those fossils require long-term conservation so that future paleontologists can both verify earlier studies and apply new techniques by which to assess earlier conclusions.

Viewed in this light, it can be seen that the common perception that only "specimens of unique scientific interest" are important is just plain wrong. Such thinking is a holdover from 19th-century paleontology, when the science was young, and each new find had a fair chance to be something never before seen by human eyes. Paleontology today is not about rarity or uniqueness; it is about relationships—systematic, evolutionary, ecological, and stratigraphic. Significant fossils are those that provide data that help to clarify these relationships. Since no biota is made up of only unique plants or animals, and evolution is not restricted to unique organisms, any emphasis on uniqueness is misplaced, and belies the advances made by paleontology over the past century. Common fossils can be, and often are, extremely significant.

From a scientific standpoint, significant fossils or assemblages are those that provide data on systematics and phylogeny, on dating and stratigraphy, on evolution of organisms or biological communities, on unusual or spectacular circumstances in the history of life, and/or are rare or in danger of destruction. Using these criteria, virtually any diagnostic vertebrate fossil would have scientific significance, whether the fossil was common or not. In fact, the very commonness of fossils may, in some cases, provide revolutionary data, as the development of the theory of punctuated equilibrium using large samples of common invertebrates clearly demonstrates.

Partial or broken fossils also can be significant, depending upon the questions being asked. Taphonomic studies, for example, are based upon just such incomplete remains in reconstructing the formation of fossil deposits. Broken fossils also can be uniquely informative; the holotype of the recently named giant teratorn genus *Aiolornis*, for example, is a cracked, worn, and generally beat-up proximal humerus from Pliocene deposits in Riverside County, California, that my colleague Kathleen Springer and I studied with avian paleontologist Ken Campbell (Campbell et al., 1999). Had we lost our focus on significant fossils, and instead been interested in only glory finds, this battered but priceless fossil—holotype of the largest flying bird genus ever known from North America—likely never would have been noticed or appreciated.

Returning to the subject of commercial fossil collecting, one might ask, "What about fossils in the field that would otherwise be lost to erosion?" True, there are more vertebrate fossils presently

eroding out in the field than there are paleontologists to collect them. That means we need more vertebrate paleontologists, not that we need to sell some fossils and preserve others. From a scientific standpoint, a fossil sold out of the public trust is essentially the same as a fossil lost to the elements. Worse, selling significant fossils into private hands fosters a hunger for more such items on the market, and paleontology is forced through economics to take a back seat to commerce. This is unfortunate. Imagine—an animal dies in just the right area, a bone or a tooth beats the odds and becomes a fossil, and then thousands or millions of years later that fossil amazingly erodes out of the ground at the precise moment when someone is there to collect it. Then, rather than adding to humanity's store of knowledge, it becomes. . . a knick knack, a trinket, a veritable tchotchke. It's a sad waste.

Of course, most repositories are already home to large numbers of fossils, and many cannot simply accept all incoming fossils indiscriminately. Further, most paleontologists have full research programs already in play, so initiating new research projects doesn't usually happen at the drop of a fossil tooth. Paleontologists therefore have to assess which fossils have the potential to tell us the most, and spend time and effort on those. It doesn't then follow that, because some vertebrate fossils have less significance, then they have *no* significance. And it certainly doesn't follow that, if researchers aren't presently interested in a given fossil, then it will never have any significance in the future and the best treatment for that fossil, therefore, is to sell it to the highest bidder.

In addition, concerns arise about potential conflicts of interest. How does one determine whether or not a fossil has scientific significance if one is directly affected financially by that decision? If it's a choice between donating an important find to a museum or feeding one's family, how can one make an objective, dispassionate assessment? The only way to achieve such objectivity is to have no direct financial stake, to assess the significance of the fossil solely as an object of scientific interest and not as a marketable commodity.

Does this mean that vertebrate paleontologists are selfless martyrs, working for free? Hardly. Paleontologists have jobs, and are paid for their jobs. When they incur expenses as part of their jobs, they are reimbursed for those expenses. Trading or bartering fossils for cash is clearly different—it is selling, not reimbursement. Further, selling in our society usually involves maximizing profit—minimizing costs (likely at the expense of “common” fossils and contextual data) and then selling to the highest bidder. It's the American way, it's legal, and it's free enterprise, but it's also putting the monetary value of a fossil above its scientific value. Significance is unlikely to be assessed accurately and reliably with such a mindset.

Unfortunately, making statements such as these often gets paleontologists lambasted as having ivory-tower attitudes. In the 2000 book “*Tyrannosaurus Sue*” by Steve Fiffer, for example, commercial collector Peter Larson chalked up paleontologists' concerns as being due to “inadequacy” and “envy”: “[professional paleontologists] have a frustration at not making any significant advances on their own. . . A lot of armchair paleontologists have never grasped the fact that you have to work to discover something” (Larson, cited in Fiffer, 2000, p. 85). In the same book, paleontologist Robert Bakker opined that “[b]ecause these [academic paleontologists] have their PhDs, they think they have some God-given duty to protect antiquities and fossils. They're like self-appointed guardians of the faith; they want to make fossils off-limits to anyone without a doctorate. It's especially tragic because it threatens good amateurs—who've done more for the science than anyone” (Bakker, cited in Fiffer, 2000, p. 84–85).

These small-minded *ad-hominem* attacks entirely miss the point. Paleontology is more than just finding fossils, and significant scientific advances involve more than just digging bones out of the ground. Most vertebrate paleontologists I know are emphatically interested in furthering the science of paleontology. They share their data and results. They spend evenings and weekends working on their research programs. They spend weeks in the field, in harsh conditions. They provide constant outreach for the general public. Museums present displays of spectacular finds for public consumption, encourage the general public to take behind-the-scenes tours to see how repositories work, teach volunteers about past ages, identify those priceless finds that visitors bring in for viewing, and make fossils available to local schools and universities for educational purposes. How is any of this remotely an ivory-tower attitude?

Most repositories put the preservation of fossils first, not to restrict accessibility to just other degreed scientists, but to ensure that the fossils and their data remain available for future as well as present generations. Unfortunately, this can mean that not everyone gets to see or touch or hold every fossil. The long-term benefits in scientific knowledge gained for all humanity outweigh the shorter-term benefits enjoyed by a few. It is therefore with a sense of irony that one can contrast this attitude with claims that some significant fossils do not now, nor ever will, have sufficient scientific importance to outweigh their cash value. Which approach is more presumptuous?

As far as the importance of amateurs is concerned, paleontology is blessed by many such avocational and volunteer collectors whose essential efforts help fill museums. Most amateurs I know appreciate the value of the science, and are truly and deeply interested in preserving fossils in the best condition possible, with the best data possible, for as many people as possible, for as long as possible. That's why they work in the field and in museums with paleontologists—because they wonder they feel about the ancient world translates into a willingness to pass that wonder along to others. It is unfortunate that their feelings are not shared more widely.

Vertebrate paleontology is a science. Moreover, it is one of the most high-profile sciences there is in the general public perception. At a time when science and science education are facing increasing challenges, and in some cases outright hostility, it is essential that paleontologists convey a clear and consistent message about what constitutes science and how science works, as well as the benefits humanity consistently has accrued from science. Commercial fossil collecting bears many of the hallmarks of paleontological science, and is often perceived to be a scientific endeavor in its own right. When significant (as opposed to simply unique or rare) fossils are sold out of the public trust, however, it is commerce masquerading as science, nothing more

—ERIC SCOTT

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