



The benefits of commercial fossil sales to 21st century paleontology

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The luckiest people on this planet are the ones that have also made their passion their career. This is equally true for vertebrate paleontologists and commercial fossil dealers. We have other things in common as well. We all agree that fossils are important. We agree that it is our responsibility to educate the public about fossils. And we agree that scientifically important specimens should be in museums.

Fossils have been collected, bartered, bought and sold for thousands of years (Mayor 2000). Commercialism has remained a crucial and functionally key element of paleontology throughout its history. Although all facets of paleontology are permeated with continuing scientific contributions by commercial entities (Manning 2001), this essay will only reference a few of the more notable.

In Europe, much of what we know about the Jurassic marine faunas and environments of the Posidonia Shale Lagerstätten of Holzmaden (Germany), and the Blue Lias of Lyme Regis, Dorset (England) are based upon collections made by people who sold fossils. Mary Anning, an iconic person in the field of paleontology, is one of the more famous commercial collectors. Academics and curators at British institutions accepted Anning as a colleague, despite her lack of a formal degree or position at a university (McGowan 2001, Emling 2009). A congenial and civilized working relationship still exists today in England between commercial “professional” collectors and museum and university academics (Manning 2001).

In Germany the government actively buys important specimens from private collectors (Rupert Wild, personal communication). The production of fossils from the Messel Lagerstätten was increased more than a thousand-fold by the work and ingenuity of commercial and private collectors. Most of the specimens that have been saved from these Eocene lake deposits are the result of a preparation transfer of the fossil to a resin matrix, a technique first pioneered by commercial collectors (Thomas Perner and Jurgen Henzel, personal communication). This new method permitted the recovery of articulated vertebrate remains with skin, feathers and stomach contents (Schaal and Ziegler 1992). One commercially collected specimen, a complete primate described

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Tyrannosaurus rex BHI-3033 [Stan], The Museum @ Black Hills Institute. The privately collected, prepared and exhibited BHI-3033 is referenced in scores of scientific publications and is the only original mounted *T. rex* skeleton on display in a US state where *Tyrannosaurus rex* is found. Casts of this skeleton may be seen in more than 40 public and private museums and science centers around the world.

and named *Darwinius masillae*, was suggested to be a pivotal “link” in the phylogenetic tree of our own species (Tudge 2009).

The Solnhofen area is one of the most important fossil sites in Germany and is still collected almost exclusively by people who sell the fossils they collect. This site has been operated commercially since the advent of the lithographic printing process in 1798 (Barthel et al. 1990). The Solnhofen Limestone has produced some of the most important fossils in the study of evolution, including the iconic early bird *Archaeopteryx* (Bergmann et al 2010). Every single specimen of *Archaeopteryx* known to science has been bought and sold (Ostrom 1985, Barthel et al. 1990).

Interestingly, the specimen of *Archaeopteryx* that is today one of the most accessible to the scientific community and the public is the Thermopolis specimen, in the private Wyoming Dinosaur Center, in Thermopolis (Wyoming, USA). This specimen has been displayed in Canada, China, Europe, Japan, and the US. It has been molded, photographed, Micro-CT scanned, laser-scanned and XRF scanned, and has generated multiple high-impact publications (Mayer et al. 2005, Bergmann et al. 2010). Despite this excellent academic work, some paleontologists have raised concerns on the ethics of publishing such material. For example, an academic paleontologist interviewed by the Los Angeles Times on 19 March 2006, stated “*Ethically, in our profession, if a specimen is not in the public domain, its scientific worth is about zero.*”

One particular site that has shed vital clues on the evolution of birds from dinosaurs was discovered in the 1990’s near Liaoning, China. Here farmers, turned commercial fossil collectors, have been excavating Lower Cretaceous lake deposits since the 1930’s. Then as today, these collectors sell their discoveries to scientists and the public alike. Virtually every fossil of scientific importance from these deposits has been bought and sold. These include thousands of fossil birds, some with exquisitely pre-

served plumage whose chemistry has been resolved and the pigmentation of feathers constrained (Wogelius et al. 2011). Perhaps the greatest scientific advancement derived from these commercially collected fossils is the irrefutable evidence that theropods had feathers and indeed extant birds are derived theropods (Currie and Chen 2001, Norell and Xu 2005, and Xu et al. 2010, etc.).

Morocco has, perhaps, the largest per-capita population of commercial fossil collectors of any country, with an estimated 50,000 collectors and annual fossil sales totaling \$40,000,000.00 (Sicree 2009). These collectors and their activities are protected by law and the Ministère de l'Énergie des Mines. Fossils are legally exported, but foreigners may not collect fossils unless it benefits the local commercial collectors (Sicree 2009, Bardet et al. 2010, Frommers 2014). Thus publications of Moroccan fossils must include discussions of fossils that were purchased (Bardet et al. 2010, Murray and Wilson 2014). In the open pit mines, huge machines excavate the Maestrichtian and Palaeogene aged phosphate deposits. Commercial collectors extract any fossils exposed by the latest pass of the machines and are responsible for most of what we know about this rich, but otherwise inaccessible fauna (Bardet et al. 2010, Bardet et al. 2013).

In the United States, the buying and selling of fossils has always been a part of paleontology. Marsh and Cope competed to purchase the latest discovery, whether it was a single bone, or a train car full of them, there was a desire to beat the other scientist to publication (Jaffe 2000). At the end of the 19th century, the Sternberg family began hunting fossils in the western United States and selling them throughout the world. Beginning with Charles H. and ending with George, the Sternbergs collected and sold anything from titanotheres to dinosaur mummies (Manning 2008). The dynasty even had one of its members, Charles M. Sternberg, accepted into the academic community (Rogers 1999).

If not for commercial fossil collecting in the lacustrine Green River Formation, little would be known beyond the five most common fish. It is only because of commercial quarries, that we have a more complete picture of the life in and around "Fossil Lake." Without 100-plus commercial collectors over the last 100 years splitting limestone to collect fish after fish, science would never have seen the articulated mammals, lizards, snakes, and rarer fish, nor the feathered birds and all the plants and invertebrates that these diggers have produced (Grande 1984, Grande 2013).

Today, in the United States, commercial fossil collectors are barred from collecting fossils on Federal Land, but the rights of private landowners and the private ownership of fossils is maintained (The Paleontological Resources Preservation Act of 2009). Commercial collectors work legally on private land, and the landowners benefit financially from this activity, and thus are interested in the fossils on their land. The best of these collectors also work hand in hand with academics at both universities and museums. They employ scientists to help with data retrieval, restoration, mounting and finding the appropriate researchers to contact (Black Hills Institute, Siber & Siber, Triebold Paleontology, etc.).

New and important dinosaur specimens from the Morrison Formation (McIntosh et al. 1996, Redelstorff and Sander 2009, etc.), the Two Medicine Formation (Burnham et al. 2000, Evans and Larson 2003, etc.), and the Judith River Formation (Stein and Triebold 2013, Ott and Larson in press, etc.) have been recently discovered by commercial paleontologists and placed in museums, following the codes of ethics of the Association of Applied Paleontological Sciences, the Paleontological Society and the Society of Vertebrate Paleontology.

Some of the greatest contributions by commercial collectors have come from the Terminal Cretaceous Lance and Hell Creek Formations. These rocks have been reluctant to yield complete specimens because of a slow depositional environment and fragile, friable fossils that are difficult to collect. Commercial collectors applied their innovative techniques to the problem and discovered and collected vertebrates that

would have otherwise never been seen by academic paleontologists, or the public. The most significant of these discoveries have ended up in museums. These include some of the most complete skeletons of *Tyrannosaurus rex* (Larson and Donnan 2002, Brochu 2003, N. Larson 2008, P. Larson 2008), *Edmontosaurus* (Christians 1992), *Triceratops* (The Childrens Museum in Indianapolis; Houston Museum of Natural Science; National Science Museum, Tokyo), a new Ceratopsian (Ott and Larson 2010) and a brand new oviraptorosaurian theropod (Lamanna et al. 2014).

This is by no means a comprehensive list of recent contributions by commercial collectors to the science of vertebrate paleontology, but it should provide a sense of the scope and scale of those significant contributions. Shimada et al. (2014), in contrast, suggest that recent developments in commercial collecting are actually damaging to the science and cite three examples. These examples are worthy of additional discussion and we thank Shimada et al. (2014) for raising these particular cases.

The first case is that of a skeleton of *Tarbosaurus* that was illegally collected, smuggled out of Mongolia and appeared at an auction in 2012. This is indeed a clear example of illegal activity that was thwarted by paleontologists working with law enforcement agencies. Commercial collectors applauded these actions because any illegal specimens that appear on the market unfairly compete with legal fossils. No fossil enthusiast approves of the destruction of sites or the theft and damage of specimens by those who work outside the law.

The second example was a 2013 bill ("HB 392") that proposed allowing sales of fossils from Makoshika State Park in Glendive, Montana. This bill was passed by the Montana House for consideration by the State Senate. Although this might have been a naive move by a state representative or a park official, there is simply no evidence that the bill was the brainchild of commercial fossil collectors. In this case, the bill never made it out of the Senate.

The third and final case that Shimada et al. (2014) raise relates to the San Diego Museum of Natural History contracting with Bonhams to auction specimens originally purchased from C.H. Sternberg. Although the specimens had historical significance, they were of well-known and often duplicated taxa. "The Museum intended to use the money generated by the sale to purchase an important local fossil collection" (www.sdnhm.org/blog_details/fossils-withdrawn-from-auction/9/). Because of the public outcry from academic paleontologists (Perlman 2013) the specimens were withdrawn from the auction.

Shimada et al. (2014) stated: "We therefore consider the battle against heightened commercialization of fossils to be the greatest challenge to paleontology of the 21st century." We believe, on the other hand, that the demonization and marginalization of a specific portion of the paleontological community is the result of misunderstanding, misplaced entitlement and simple intolerance. Such attitudes endanger the future of the very science of paleontology and paleontological collections on which it is based. Through collaboration, education and constructive alliances, the fossil fuel that drives our discipline could be better managed and made more easily accessible to the scientists who work in both commercial and/or academic institutions, but more importantly, made equally accessible to the public.

A recent Gallup poll (gallup.com/poll/21814/evolution-creationism-intelligent-design.aspx) shows that 46% of Americans believe that God created humans in their present form. The same poll revealed that 66% of Americans believe that the Earth is less than 10,000 years old. Fifty-four percent believe that creationism should be taught in schools. The challenges that our discipline faces are grave and we need a united front so that we might work together to make fossils more available to the general public, in museums and private collections, so that more people can touch, learn and understand the beautiful story that is the evolutionary history of life on Earth.

We must not forget that many of today's public museums started out as private collections (Carnall 2013). Instead of castigating private collectors for their scientific

curiosity and desire to collect, purchase or sell fossils, scientists would do far better by welcoming them into the fold. This would go a long way in helping to solve two real problems recognized by Shimada et al. (2014): a shrinking job market and diminishing funding sources.

Private collections also have a legitimate role in the preservation and study of our planetary heritage. Most private collectors gladly open their doors to any interested scientist and many readily donate specimens or money to research programs. The historical value of well-curated collections often end as bequests to museums. It is fair to say that this does necessitate patience on behalf of paleontologists wishing to house such collections, but this is the perfect reason to work with collectors to ensure a partnership that will help in the curation, conservation and preparation of samples and ultimately in its accession to a collection. To castigate such dedicated passion for our past can only be detrimental to the future of the science.

Although Shimada et al. (2014) are not alone in their beliefs, most paleontologists do not share their views; “[W]orking with private and amateur collectors can very realistically improve our knowledge about the natural world” (Carnall 2013). The Paleontological Society’s code of ethics states: “*The principal importance of fossils is for scientific, scholarly, and educational use of both professionals and amateurs*” (www.paleosoc.org/pscode.htm). They further state: “*To leave fossils uncollected assures their degradation and ultimate loss to the scientific and educational world through natural processes of weathering and erosion.*” In the National Academy of Sciences report on Paleontological Collecting (Raup et al. 1986), the committee not only recognize the contributions to paleontology by commercial and amateur collectors as are their rights on private lands, but also recommended that regulated amateur and commercial collecting be allowed on public lands.

People collect fossils because of scientific curiosity. They come from all walks of life. A very lucky few are able to find work as paleontologists in universities or museums. Others create companies that collect, buy and sell fossils. Some satiate their passion as volunteers or by maintaining fossil collections that are often eventually donated to their local museum. Working in partnership we can all help to solve the contracting job market and diminishing public funds for paleontological research and exhibits. However, if we remain divided we may not fall, but simply fail the science at a time when we should be celebrating advances in the remarkable techniques and technology available to us in the 21st Century.

It is our humble opinion that the real “Greatest Challenge to Paleontology of the 21st Century”, is finding a way for amateurs, commercial fossil dealers and academic paleontologists to work together and do what is best for the public and the fossils. It’s the only way the science will thrive.

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