

"What commercial fossil dealers contribute to the science of paleontology"

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Recently Shimada et al. (2014) stated that there were "three interconnected, troubling challenges confronting paleontologists". These included a reduced job market, reduced funding and the commercialization of fossils. The cause and effect of commercialization to job and funding loss is claimed but not substantiated by example or evidence, and we conclude the claim of interconnectedness to be hyperbole. As for the sale of fossils, Shimada et al. (2014) argue that scientific data are lost through such sales, and that the exorbitant price that some specimens have fetched sends the wrong message to the public. Although Shimada et al (2014) condemn the sale of any fossil, it is clear from their article that their most significant concern is really in regards to vertebrate fossils. Regardless, we have come to realize that the mischaracterizations of commercial collectors made by Shimada et al (2014) is due in part to the failure of commercial collectors to adequately inform people about who they are and what they do. As a result, many of the criticisms leveled against commercial collectors are based on assumptions and not necessarily on fact.

There is a common misconception among many academic paleontologists (Shimada et al. included) that commercial collectors are not professionals, nor true paleontologists. The Oxford English Dictionary defines a "palaeontologist" simply as "An expert in or student of palaeontology." The Encarta World English Dictionary offers a more detailed definition: "one who studies life from prehistoric times by using fossil evidence." The term professional is described as: "1) engaged in an occupation as a paid job rather than as a hobby 2) very competent, showing a high degree of skill or competence and 3) somebody whose occupation requires extensive education or specialized training."

As independent commercial paleontologists and members of the Association of Applied Paleontological Sciences (AAPS), many of us make our living in paleontology mostly in collection, preparation and display. While only a few independent paleontologists have a degreed education in the field, many have extensive training, especially in collection and preparation of fossils. The commercial pursuit of fossils often requires detailed research and study in the field. When not collecting or preparing fossils, many of us are researching paleontology and geology as well as giving presentations at schools, clubs, organizations and professional meetings. Some independent paleontologists have published, working both alone and in conjunction with academic paleontologists to report discoveries, describe new species, and publish on the taxonomy, taphonomy, biostratigraphy, biology and geology of the fossils and rocks we work with.

Animosity directed toward commercial collecting is relatively new, but the sale of fossils is not. Commercial collecting predates the relatively young science of paleontology and has been intertwined in modern paleontology since at least the late 1700's with Mary Anning and her father, Richard. Mary Anning was an entrepreneur who needed to make discoveries in order to make a living. As a result, she discovered the first ichthyosaur, the first English pterosaur, the first two plesiosaur skeletons, and many other significant vertebrate and invertebrate fossils. Her firsthand knowledge enabled her to identify ink sacs associated with fossil belemnites and she recognized that feces fossilized and preserved important information regarding the diet of vertebrate fossils (Emling, 2009).

The commercial fossil business has led to an abundance of paleontological discoveries and has resulted in that industry becoming a leader in museum fossil preparation, restoration and mounts. This, in turn, has motivated many museum directors and trustees to turn to the fossil industry to acquire noteworthy and exciting specimens. This is often frugal and necessary especially when many museums do not have the staff or ability to mount collecting expeditions, create and house a preparation facility or hire a fully trained and educated staff.

The Late Jurassic lithographic limestones in Southern Germany, north of Munich, have been mined for centuries for use as building stone, slate, tiles, and lithographic plates. The miners commonly encountered fossils and sold them to supplement their income. Acquiring these fossils soon became popular with some of the locals, and pieces consistently brought ever-higher prices as collectors added to their collections (Barthell et al. 1990). Many of these collections were sold or donated to form the nuclei of a number of museums throughout Europe. In 1861, the first link between birds and dinosaurs, *Archaeopteryx*, was found and sold to the British Museum for a sum of £ 700 (Barthell et al. 1990), equivalent to a bargain price of \$74,400.00 in 2011 dollars (<http://www.measuringworth.com/exchange/>). Every single *Archaeopteryx* specimen known today has been discovered by industry and acquired by museums through purchase.

Fossils from the Posidonia Shale of Holzmaden, Germany were sold as early as 1668. By the 1890's, Bernard Hauff, miner and preparator, started marketing incredibly prepared slabs of these Early Jurassic marine vertebrate and invertebrate fossils to museums and collectors worldwide. His preparation laboratory and gallery was stocked with reptiles, pterosaurs, fishes, crinoids, and ammonites for sale to the public (Hauff and Hauff, 1981). These specimens were also purchased by museums and universities for display and research and still form the nucleus of scientific studies such as by Martill (1993), Maisch (1998), Arratia et al. (2001) and Grossman (2007).

In the United States, the oldest existing fossil supplier is Ward's Natural Science. Since 1862 (see Ward archives undated) they have been providing fossils and minerals for teaching and exhibit to schools and museums. Since 1945, Geological Enterprises has sold fossils to high schools, universities and museums while donating hundreds of specimens to teaching and reference collections, many of which have been classified as type specimens (Larson, 2001). The Sternberg dynasty of the late 1800's to early 1900's, is responsible for providing many of the world's top museums (American Museum of Natural History, Canadian National Museum in Ottawa, Ontario; Carnegie Museum, Smithsonian, Senckenberg Museum in Frankfurt, etc.) with specimens for a price (Rogers, 1999). Nearly all natural history museums have acquired specimens for their paleontological exhibits from the professional commercial community. Noteworthy

among these are the Royal Tyrrell Museum of Palaeontology, the National Museum of Natural History, the Houston Museum of Natural Sciences, the Royal Ontario Museum and the Natural History Museum of London. See the online supplement of donations and sales to museums and universities for a more detailed list: <http://aaps-journal.org/Commercial-Contributions-to-Paleontology.html>

Today, as a result of the commercial pursuit of fossils, there are now almost 60 specimens, many of which are over 50% complete. Very few of these Tyrannosaurus specimens were discovered by academic paleontologists. Several new dinosaur taxa described in recent years were found, excavated, and prepared by independent commercial collectors. These include the dromaeosaur *Acheroraptor* Evans et al. (2013), the giant oviraptorosaurian *Anzu wyliei* Lammana et al. (2014), *Avaceratops* Dodson et al. (1996), *Tatankaceratops* Ott and Larson (2010), *Gargoyleosaurus* Carpenter et al. (1998), *Gastonia* Kirkland, (1998), among others. Many new dinosaur specimens, discovered by independent collectors, have long been awaiting description and publication (Some examples are: *Gorgosaurus* sp., *Hypacrosaurus* sp., and Baby Louie at The Children's Museum of Indianapolis).

In the US and much of the world it is legal, ethical, beneficial and our right to pursue the commercial fossil trade and that should not be reversed. According to the 8th US Circuit Court of Appeals, fossils are considered "land...an ingredient comprising part of the "solid material of the earth"...a component...just like the soil, the rocks and whatever other naturally occurring materials make up the earth" (Fiffer, 2000, p. 151). Since fossils on private land are private property, they may be bought, sold and traded as such. Many professional paleontological collectors work with landowners to lease fossil-producing land or pay for specimens collected from their land, providing them with a secondary income that is often greatly needed.

Recently, Carr (2013) suggested that the best way to preserve paleontology would be to use Eminent Domain laws to confiscate specimens that may be deemed significant. Should this occur we believe it would have a devastating impact on landowner relationships, and access to most private land would most certainly be denied to commercial and academic paleontologists alike.

The fossil business is a positive economic force that creates jobs and pays taxes that support schools, museums, and federal jobs. Commercial paleontologists also provide specimens for public education, display and scientific research. Most primary and secondary teachers buy fossils for their classrooms, and many members of AAPS have generously donated specimens to them as well. Jobs are created for preparation, field collecting, molding/casting and mounting of skeletons, and even high-tech skills involving scanning and prototyping. Professional collecting adds to the number of jobs in paleontology, not at the expense of academic positions, but independent of them.

We note that concerns about fossil commerce are predominantly a North American attitude. In the United Kingdom, regulations or codes allow all to collect fossils on public lands. The Scottish Fossil Code states, "The Code encourages fossil collectors: amateur, academic, institutional and commercial, to collect responsibly and to manage collections in such a way that they will be useful to future generations. The Code also aims to enhance public interest in the fossil heritage of Scotland and promote this resource for scientific, educational and recreational purposes." (foreword in Trewin, et al. 2004). It is noted by Nield (2011, p.5) that the code in the UK has, "for the most part, been a model of balance and pragmatism, recognizing that collecting bans only make rare fossils even rarer, and may lead to irrevocable loss, denying

equally the right of local people to make livings, and for scientists from all over the world to study what, in the end, is the property of everyone". British palaeontologist David Martill (2011) argues for more, not less, commercial collecting so as to make more specimens available for study. He also emphasizes that fossil collecting should be allowed for everyone in all countries or the specimens will be lost forever and the science will die.

The European attitude can be best summed up in a recent online letter from David Ward to Shimada (VRTPALEO@usc.edu on 3-25-2014). "In contrast, in Europe we rarely have the funding to mount large collecting expeditions. We rely on a healthy relationship with commercial dealers that contains a degree of mutual respect. Without them, the bulk of newly exposed or discovered material would be lost to mankind, not just to science. As a result, new material is constantly appearing on the free market that, so long as it was legally obtained, is available for study. In most cases, there is no significant loss of data because most commercial dealers appreciate that the provenance and associated data is a valuable part of the package. I have had no problems in visiting the collection sites and gathering further biostratigraphic information where it is needed. This is icing on the cake as I love geological fieldwork. I personally, have been able to obtain, for our university and museum system, vastly more material than I could publish in a lifetime. In my opinion, the problem is not commercial collectors, it is a poorly-funded state sector and short-sighted researchers." (Reprinted with permission from David Ward)

Globally, many museums without an active paleontology program or collections accept that it is far more economical to obtain specimens for exhibition from commercial dealers than to establish their own programs. These include the Children's Museum of Indianapolis; Houston Museum of Natural Sciences; The National Museum of Tokyo, The Fukui Prefectoral Museum in Japan, Korea Institute of Geoscience and Mineral Resources in South Korea, museum in the Dubai Mall, etc. In addition, even museums with active paleontology programs have found it more economical to purchase rare paleontological specimens than to undertake fieldwork to find their own. Commercial collectors do make available the more common fossils to private individuals because of their lower price and commonality. These fossils include ammonites, trilobites, crinoids, shark teeth, Green River fishes, Oligocene turtles and common mammals. Nearly everything that the commercial fossil industry offers would never be found otherwise. This material comes from private property and without the efforts of commercial collectors, most would likely never have been collected.

Academic invertebrate paleontologists frequently work hand in hand with professional collectors. Invertebrate collectors see many more specimens and from different localities than their academic colleagues. As a result, they often bring new discoveries to the attention of academic paleontologists. Commercial, or independent, collectors are usually willing to share, donate and work with researchers in their important studies. This more open-minded attitude towards commercial collectors is reflected in the Paleontological Society Code of Fossil Collecting (www.paleosoc.org).

Many other sciences not only accept private enterprise, they encourage and look to it for help, research and advice to make their science better and stronger. Mineralogists engage closely with collectors and dealers to obtain the finest specimens and to publish on new discoveries with them. Astronomy relies on a global network of amateurs to track comets and asteroids. Biology, zoology, chemistry, geology and

medicine all utilize the private (commercial) sector to assist and contribute in all aspects of their respective sciences and welcome them into their ranks.

Like our academic colleagues, we love the field of paleontology and the pursuit of the unknown. Most of us are driven by our passion and not by profits. Most commercial paleontologists and collectors would be pleased to have closer relationships with academic paleontologists. We want our work to be researched. We enjoy having our contributions acknowledged and on display for the world to share. Our work does not undermine collections based scientific research; clearly, our efforts enhance and supplement academic endeavors. We believe that both academic and commercial collectors should work closely together, interacting and collaborating on their discoveries.

The Association of Applied Paleontological Sciences (AAPS), formerly the "American Association of Paleontological Suppliers", was organized in 1978 to create a professional association of commercial fossil and mineral collectors and preparators, for the purpose of promoting ethical collecting practices and cooperative partnerships with researchers, instructors, curators and exhibit managers in the academic and museum based paleontological community. The International Association of Paleontological Suppliers (IAPS) was created in the early 1990's to help foreign businesses organize and become aware of legislation in various countries regarding the import and export of fossils. The IAPS joined AAPS in 2002.

AAPS emphasizes ethical standards in the conduct of those engaged in all aspects of commercial collecting as described in its Code of Ethics. Each member must agree in writing to support this Code. The code states:

1. Strive to stay informed and comply with International, National, State and Local regulations pertaining to collecting activities and general business practices.
2. Obtain permission from landowners or governmental authorities to gain access to collecting sites.
3. Assure that all lands, properties, flora and fauna are left without damage to property or ecology as a result of the collecting activities.
4. Require that fossil materials received from outside collectors are obtained in compliance with the above collecting guidelines set forth by the Association.
5. Report to the proper local authorities any significant discoveries of scientific or public interest.
6. Strive to place specimens of unique scientific interest into responsible hands for study, research and preservation.
7. Make no misrepresentation as to identity, locality, age, formation, repairs or restoration of paleontological specimens.
8. Conform to professional business practices when obtaining and disposing of specimens.

9. Maintain a good credit standing among fellow suppliers of earth science materials.

10. Encourage good relations and cooperation with agencies, institutions, and organizations actively involved in paleontological pursuits.

We acknowledge that commercial paleontology is not without its troublemakers. Like the Society of Vertebrate Paleontology, AAPS has had illegal and unethical behavior demonstrated by some of its members. However, AAPS makes every attempt to weed out those who are not doing things honestly or legally and strives to educate its members and the public in proper methods of collection and documentation. AAPS is currently amassing the laws and regulations regarding fossil collection and exportation of every country so that we can better inform our members as to how to legally conduct their business.

Obtaining information on any country's laws and regulations regarding fossil collecting, sales and export, has been a frustrating endeavor. Often, no single agency representing the country, has all the correct information available. Acquiring a complete list of regulations involves contacting foreign museums, customs, multiple ministry offices, and local officials. Their answers and the information received are often conflicting; with one entity claiming something is legal and another stating just the opposite. Most of the foreign agencies our organization has contacted cannot quote their current laws, or supply the actual documentation defining them. Matters are made worse when corrupt customs agents gladly sign export forms for a fee, giving the false impression that it is legal to transport specimens out of a country where it is not.

Obviously, fossil laws and regulations affect students and researchers as well as anyone else interested in fossil collecting. As embarrassing as it would be for a public museum to hold a specimen in their collections that came from a country where such removal is illegal, it could also be financially devastating to the museum, a dealer or a private collector if that specimen were to be confiscated by a government authority, let alone the possibility of facing criminal charges. In the United States, documentation of land ownership and the laws are much easier to locate with a little research. Still, many fossil enthusiasts are uninformed regarding what is legal to collect, where it is legal to collect, and if it is legal to sell what is collected. Clearly, academics and commercial paleontologists should work together on compiling information on every country's laws and regulations regarding fossil collecting, sales and export.

There is an unfortunate misperception raised by Shimada et al. (2014) that commercial collectors are only out for the money and have little interest in the science. Shimada et al mention the high prices for a few fossil sales that they perceive as representative of monstrous profits that may potentially take away their incomes or funding. Contrary to what Shimada et al, implied, high price fossil sales are the exception, not the rule. In reality, the fossil market is driven by supply, demand and the quality of the specimen. Commercial collecting is a small business and sales prices reflect a combination of labor costs, collecting costs (which may be high, especially when heavy equipment is needed or the specimen requires months of excavation) and preparation costs (specialized tools, equipment, material and labor). There are also restoration costs (purchase of cast replicas to replace missing parts or paying a sculptor to make the missing parts), mounting costs (specialized steel, fittings, equipment and material), crating (materials), shipping, marketing, insurance (property, liability, health, auto, unemployment, and workman's

compensation), and taxes. Rental or mortgage costs for shop/lab space, and utility costs, including electricity and heating/cooling are additional costs. These expenses are generally not aspects of a business considered by those condemning the prices of fossils. Income received from the sale of large priced items must last months or sometimes years because operation expenses do not go away. Any hope for profit may be reduced or negotiated away. It is not uncommon to spend between 10,000 to 30,000 hours or more in the collection and preparation of a single dinosaur skeleton. Labor costs at a modest \$12.50 hour would be \$125,000 - \$375,000. When added to the additional costs listed above, it becomes apparent that many collectors are lucky to break even, let alone make sizeable profits. How effective, in their careers, would academic paleontologists be if they had to pay out of pocket for office, lab space, storage, tools, equipment, utilities, insurance, taxes and salaries to students for help?

There are untold numbers of fossils lost to the elements, construction projects, and neglect, every year and far too few interested humans to ever collect a single percentage of them. Dinosaurs have been eroding out of the ground for more than 150 million years and a billion years from now they will still be eroding out. Any fossil saved from nature is a fossil saved for future generations.

In Brazil, China and many places elsewhere in the world, fossils are not allowed to be collected without fines, imprisonment or worse. This has not stopped the local population from excavating fossils. In many cases these laws have simply driven fossil trade underground to the black market where no one benefits. As Martil (2011, p. 17) so eloquently put it, "Protecting fossils' criminalises palaeontologists. Laws banning fossil collecting and private fossil collections deter amateur palaeontologists, drive them underground and stifle curiosity. Fossils left in the ground weather away and are lost. Banning commercial collecting loses tax revenue." Many governments (USA included) seem to spend more money each year on regulating, patrolling, law enforcement, and prosecution of fossil collectors than they do, collecting and preserving the fossils they intend to protect.

Fossils uncovered in mining and construction, are almost always lost to science forever (Martil, 2011). For example, limestone and other rock quarries crush fossils in the production of aggregate and cement. Strip-mining for coal destroys any fossils in their overburden. Oil companies may destroy fossils in construction of roads, pads and ponds. The oil shales and oil sands of the West are rich in fossil plants, insects, fish, mammals and reptiles, yet demand for oil ultimately results in the destruction of these fossils for increased energy, construction and progress. As shown here, it seems that it is acceptable for large corporations that lease this country's public lands to mine coal, oil, minerals, rock, sand and gravel, while in the process destroying untold millions of fossils every year without any obvious penalties, yet an individual or small business could be prosecuted if they try to save fossils from the same public lands. If the fossil business was so lucrative do you not think that oil, gas, coal and other large corporations would have a large staff employed to collect and prepare fossils and they would actively be lobbying for permits to collect them instead of destroying them in order to get to other natural resources?

Free enterprise in the various aspects of fossil recovery and preservation, does not conflict with the science of paleontology. Indeed, fossil commerce enhances paleontological research. Most professional collectors in the AAPS have at least one degreed, institutional paleontologist they work with and share their finds with. How much better could it be if every institution and every institutional paleontologist worked

with and advised at least one professional collector. We encourage Shimada et al, and all other paleontologists, academic and commercial, to work together as colleagues.

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4. Using both approaches, scientist have also dated many fossils that we know appear only in certain geological eras and are common. So, if you find a fossil with the company of any of those fossils, or in a stratum that is older or newer than another stratum that contains any of those fossils or whose age have been measured previously by any of those methods, you should be able to stimate the age of your fossil.

3. Related Questions. There is an International Commission on Stratigraphy that has regular conferences to argue about details according to the latest discoveries. Fossil commercialism is a matter that not only concerns vertebrate paleontologists, but. rather all paleontologists. Consequently, the com-mercialization of fossils is fundamentally destructive to the science of paleontology. It is noteworthy that the SVP bylaws provide room for commercial collectors to work cooperatively with academic paleontologists to bring scientifically sig-nificant fossils into public trust. To be clear, the SVP bylaws also allow hobby collecting where con-ducted legally. Invertebrate paleontology deals with fossils such as molluscs, arthropods, annelid worms and echinoderms. Paleobotany studies fossil plants, algae, and fungi. Consequently, paleontologists must usually rely on stratigraphy to date fossils. Stratigraphy is the science of deciphering the "layer-cake" that is the sedimentary record, and has been compared to a jigsaw puzzle.[46] Rocks normally form relatively horizontal layers, with each layer younger than the one underneath it. If a fossil is found between two layers whose ages are known, the fossil's age must lie between the two known ages.[47] Because rock sequences are not continuous, but may be broken up by faults or periods of erosion, it is very difficult to match up rock beds that are not directly next to one another.