

The Price of Value

*Commercial Fossil Trade
and Natural History Museums*

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Introduction

In all of the history of life on Earth that humans study, there has been no more sensationally popular and fascinating animal as the dinosaur. People of all ages, nationalities, education levels, and economic classes have enjoyed seeing reconstructed skeletons and artists' depictions of these animals for centuries. Especially in the setting of the museum, visitors have kept dinosaurs and fossils in general alive through their interest, enthusiasm, and attendance; the Smithsonian Office of Policy reported in 2010 that a third of visitors come to the National Museum of Natural History specifically to learn about extinction.ⁱ Along with popularity and attention in museums, dinosaurs have become notorious in the media. Movies like *Jurassic Park*, *Dinosaur*, and *The Land Before Time* have drawn attention to these animals and the people who study them, bolstering the notoriety of highly publicized finds such as Sue the *Tyrannosaurus rex*, and Tinker, a juvenile of the same species. Millions of visitors have flocked to visit such dinosaurs in museums all over North America and much of the rest of the world over the past several decades. But with fame comes a price.

Becoming increasingly in vogue has created an interesting and distressing paradox for dinosaurs and their keepers. Paleontologists now find themselves at odds with amateurs, competing for the right and ability to find, collect, study, and display vertebrate fossils, especially dinosaurs. The immense demand for dinosaurs and other fossil animals has made them not only stylish and coveted, but has also put them at risk for another extinction: the extinguishing of their scientific value. Just as the favorites of human history, the ancient Egyptians, Romans, and Greeks, have become highly pillaged and commoditized on the black market for their artifacts and art, so too have the darlings of natural history. Though scientists and their museums and universities need the popularity and demand of their research on these animals in order to sustain funding, the very same demand ignites a craze in the lay public that has created a private market for such specimens. In reference to the highly publicized and contentious tyrannosaur Sue, Kirk Johnson – Director of the Smithsonian Institution's National Museum of Natural History – says, “the day Sue got auctioned is the day fossils became money.”^{xiii} Consequently, the

commercial fossil market has become a real problem for natural history institutions - especially cash-strapped museums.

No single museum type is more popular among such wide demographics of audiences than the natural history museum. The Smithsonian Institution's annual visitor statistics report showed that over 7.5 million people visited the National Museum of Natural History in 2012 alone, surpassing all other types of museums available to those visitors, and more than tripling the amount of visitors to the National Zoo.ⁱⁱ Clearly, there is something about natural history museums that attracts and holds the public interest in a way that few other subjects can. The public loves a particular constituent of the natural history museum: dinosaurs. The animals perceived as gargantuan, completely extinct, and totally mysterious to the majority of museum audience members have ignited interest in visitors for centuries. America's oldest natural history museum, the Academy of Natural Sciences of Philadelphia [of Drexel University], celebrated its 200th anniversary in 2012. What about natural history has managed to hold the public's attention so raptly, and for so long? I argue that the answer is dinosaurs, and in a larger sense, paleontological science. Furthermore, I maintain that the popularity of dinosaurs and fossils in general has had profound, and often detrimental, effects on museums and their collections.

Background

Dinosaurs roamed the Earth for over 150 million years during the Mesozoic Era, and suffered almost total extinction at the end of the Cretaceous Period 65 million years ago (the only survivors of the lineage are birds). Fossilized remains of dinosaur bones and behaviors are preserved on every continent on Earth. Not only are these animals known universally to the vast majority of the modern world, but they are also the subject of what is essentially a cult following. Hollywood, television programs, and the toy industry have only made dinosaurs more available and appealing to the lay public. It is no wonder that much of the museum-going public will more readily visit exhibits focusing on dinosaurs than those featuring math, chemistry, or even physics: in 2012, the National Air and Space

Museum's annual visitorship was, for the first time, lower than that of the National Museum of Natural History.ⁱⁱ Paleontology's very nature is attractive to people; it is a science with flexibility, imagination, constantly changing technologies, and direct analogs (modern animals). It is *relatable*, and for most people, quite a bit easier to pick up than mathematical skills, or a solid understanding of chemistry or physics. It has been established that museums featuring dinosaurs can enjoy great popularity among such exhibits. So where do the specimens come from, and how do they get into museums?

The United States and its museums enjoy a plethora of rich fossil beds throughout the nation. Many of the world's most famous dinosaurs are found exclusively in North America, such as *Tyrannosaurus rex* and *Triceratops horridus*. Furthermore, the majority of active paleontological collection programs and teams in the world are in or from the US. Researchers from universities and museums seek to study the innumerable types of animals and plants that lived on the North American continent and in its coastal waters for some 600 million years before modern society. Thanks to the foresight of leaders such as Theodore Roosevelt, the National Park Service acts as steward to 60 million acres of protected public land.ⁱⁱⁱ Much of this land happens to be quite fossiliferous, and these protected areas are offered only to permit-holding scientists and academic teams for fossil collection. However, the popularity of paleontology and dinosaurs in particular has made even these protected lands unsafe for fossils.

History

The subject of the fossil market has been left essentially untouched in museum exhibitions and public programs. Some exhibitions have featured fakes or replicas and how to tell the difference (for example, the Royal Ontario Museum displayed a small exhibition in 2009 about fake artifacts), but these were not concentrated on fossils. Perhaps museums have tread lightly around this subject because the origin of many of their own collections is questionable. The bulk of many natural history museums' specimens throughout the world are made up of fossils that, if collected today, would be considered

illegal; this could make museum involvement in the future of the fossil market tenuous.

Consider the British Museum, or even the Smithsonian Institution. It is true that standards and laws have changed considerably in the last century and a half as paleontology went through phases of popularity, and as international politics have changed tremendously. 18th- and 19th- century “naturalists”, very often members of the military or aristocracy who could afford or had the opportunity to travel to foreign lands and collect specimens, compiled the oldest museum collections. Collections included animals, artifacts from foreign ethnic groups, fossils, and other “curiosities”.^{iv} It was possible for early paleontological collections to be compiled as they were because during the 19th century in particular, fossil collection became extremely popular among amateurs and there was little to no legislation that regulated the prospecting, collection, and exportation of these specimens. For example, early paleontologist and prospector Charles Sternberg was commissioned by the English government in the mid-1800s to collect American dinosaur specimens for the British Museum.^v Such a federal commission would be illegal today unless done with the explicit permission of property owners on private land, and even with that permission, it would still likely be considered unethical because those specimens are on American soil and therefore are perceived to “belong” to America.

The 19th and early 20th centuries were a time of “racing” to find and name paleontological specimens: the notorious Bone Wars paleontologists Cope and Marsh made “dinosaur hunting” into a real hunt^{vi}. This kind of competition created an era of unprecedented and unchecked collecting throughout North America. Though innumerable specimens in current collections would not be legal in today’s paleontological arena in terms of the circumstances of their collection and acquisition, these specimens are still invaluable to our understanding of the whole of natural knowledge. Perhaps a reason that museums avoided broaching the subject of the fossil market with the public in the past is because they may have feared that their previously unsavory collection practices would lower the public’s respect and trust in them. Regardless, it is now of utmost importance to the science of paleontology that

the public be aware of the fossil market, and be educated about its dangers and how it affects them personally.

Fossils: Hunting, Collecting, and Poaching

Fossil hunting is a pastime shared by amateurs and professionals alike in many demographics of the United States – from Montana ranchers to South Carolina divers, this natural treasure hunt is irresistible. This hobby was the predecessor of modern paleontology, and is responsible for the existence of countless scientifically valuable specimens in museum collections.^{vii} However, many laws and unwritten ethics have come into circulation since the days of fossil hunters Mary Anning and Charles Sternberg, and the “job” of collecting and caring for fossils has largely fallen to museums, and not by accident. Academia, tied closely to early university museums in the United States that housed the first fossil specimens, has long laid claim to these specimens.^{viii} The fact that fossil ownership has become popular for the lay public, not just museums, has threatened the integrity of all undiscovered fossils as well as specimens that have already been collected and sold into private collections.^{ix}

Anyone can become trained in prospecting for fossils with disciplined study and examination of maps, geologic formations, and anatomy. Finding fossils can be very difficult, and it is commonly argued that the number of eyes combing the ground should be as large as possible for the best outcome in field expeditions, even if those searching are amateurs.^{xxxii} However, it is what a person decides to do when she/he spots a fossil that is critical. When the process of prospecting is successful, the prospector has several options as to what to do with what they’ve found. Depending on what kind of fossil has been found, and the kind of geologic environment in which it has been found, movement or removal of the fossil can be a terrible choice, especially if the prospector has not been trained in such procedures.

If the fossil is an invertebrate animal such as a trilobite, it is legal to collect and keep in most cases if it was found on United States public land.^x This legislative information is generally available

online and is determined on a state-by-state basis, except in the case of National Parks, in which any kind of fossil collection is not allowed without explicit permission from the federal government. If the fossil is from a vertebrate animal, such as a dinosaur, the rules are very different. The fossil is generally considered to be more valuable and is therefore protected by more legislation.^{vii} If a vertebrate fossil is found on public land where it is legal to collect, there are state-determined laws about how to handle the finding. For example, if one finds fish or other vertebrate fossils of a certain age in Utah on public land, those fossils cannot be kept for private collection and the Bureau of Land Management should be notified. However, fossils of plants that are the same age can be legally collected if they are of no scientific significance.^{xi} Even if vertebrate fossils are legally collected on public land, they are still technically public property, and in some cases must be presented to a prominent local academic institution before being cleared for private ownership. For example, it is legal to collect vertebrate fossils in Florida with a permit (which is available online for a very small fee) as long as the fossils found are presented in written list form to the Florida Museum of Natural History in Gainesville before that calendar year has expired. If the museum is made aware of a very rare or significant finding, they can repossess the fossil for state collections and research. This allows people to take part in the wonderful recreation of fossil hunting, but sets reasonable limits in order to protect those scientifically significant fossils that may be found by an amateur.

If a vertebrate fossil is found on either public land, or on private land with permission from the landowner, the collection of that fossil is the pivotal moment in its future as an important specimen. One mistake can ruin what could possibly be a huge scientific discovery. For example, there was a noted case in Kansas where Triebold Paleontology, Inc., a company that prospects and collects fossils and makes fossil casts for museum ownership, had found a rare mosasaur specimen. Before they could excavate it, an oil worker came upon the specimen in the field and attempted to remove it from its matrix. In the process, the worker could not remove the skull bones and smashed them out with his rock hammer. He then poached the specimen to sell it. After much trouble, Triebold was able to recover the

skull pieces and reconstruct the specimen despite the severe damage inflicted by a greedy amateur. Ultimately the specimen proved important because of its species rarity and because it features preserved marks indicating shark scavenging, which are relatively rare on such fossils.^{xii}

In order to properly collect a fossil, the prospector must be trained or, ideally, willing to let an expert handle the excavation. The extraction process involves skilled, careful work around the specimen so as to separate the fossil and its immediate, supportive matrix (surrounding sediment) from the rest of the rock. The specimen and supportive matrix must be jacketed - carefully encased in a burlap and hardened plaster pod - and removed for transport to a laboratory facility for preparation by professional staff. It is essential that the general public is aware of what to do if they want to fossil hunt, in terms of obtaining proper permission and being sure that any collection is legal and ethical. It is highly disputed, however, as to what constitutes “ethical” collection.

The Commercial Fossil Industry

Fossils are becoming extremely big-ticket items in the United States as well as other nations.^{vii} Gem-, mineral-, and fossil- shows around the United States bring new life to local economies in places like New Mexico and Utah annually. The price for museum-quality dinosaur fossils has even become so high that there has been (thus unsatisfactorily supported) federal speculation that the fossil trade may be linked to criminal activities such as international drug trade.^{xiii} There are countless places to buy, sell, or trade fossils in the United States. This can be done via mail, online, at auction, at trade shows, at expos, privately, and even in museums whose gift shops offer such merchandise. The problem with the value of fossils is not the popularity and appreciation itself, but the fact that this fosters high demand, and this, in turn, creates and drives up market value.^{vii}

There are, however, other options than owning a genuine fossil that is of scientific value, and these are usually available as readily to the public as they are to universities or museums. Though it is understandable that people would want to own a beautiful museum-worthy specimen and display it in

their home because of its perceived rarity and eclectic value, the public must be made aware that this is not only an unethical and often illegal option, but that there are other ways of achieving similar – or superior - aesthetic value. The best way is to purchase casts, or replicas, of the fossil. These are available from many websites and companies (see appendix), and can be custom made to the size, color, texture, and material of the buyer’s choosing. A buyer can choose whether to purchase casts of individual bones of an animal, or a skull, or the entire skeleton. The buyer can also opt to purchase a cast that is made to look exactly like the real specimen, which many people prefer for its aesthetic value. However, if a buyer wants a *Tyrannosaurus rex* skull made of bronze, this is also available online.

One of the best “selling points” to convince the public of the option of buying casts is the fact that most vertebrate specimens found are only fragments of the original skeleton, and that though these fragments can be extremely important to science, they are nowhere near as aesthetically pleasing for a display collection as a full, reconstructed cast of a specimen. When given the option of buying a fossil, most people would likely prefer to own something “real” for its uniqueness; however, I argue that with a bit of accessible, informal education on the use of these fragments to science, and with the provision of many aesthetically pleasing alternative cast options, the public will come to understand why it is best to own a perfect, ethical, legal cast than to endanger a fossil’s scientific value by hoarding it as a mantelpiece. It is essential that the public is aware of their options when they decide that they would like to own and display an interesting fossil. Unfortunately, the commercial fossil industry’s effects on scientific inquiry into paleontological questions are hardly known to the public. Knowledge of fossil regulations is nonexistent for most people, and such information is rather technical and difficult to locate even if a person chooses to look.

What is Fossil Poaching?

It is well known in the museum world that theft of art, artifacts, and historical materials is unfortunately common and detrimental to museum collections. There is even a stolen art registry^{xiv}, and

laws such as the Native American Graves Protection and Repatriation Act (NAGPRA) which protect other priceless heritage materials. However, there is no such registry for fossils. Indeed it would be nearly impossible to create such a registry, at least comprehensively, because when a fossil is found in the field it is not always reported to the proper authorities. When a fossil goes up for auction, relatively little provenience must be provided to the auction house and bidders legally. Until very recently, fossils auctioned or otherwise traded could easily slip under the radar, with potential buyers and most auction houses having little education on fossil provenience. Because of this lack of information, and often a lack of regard for fossil legislation, poached and smuggled fossils grace the auction block with alarming frequency. In the words of David Herskowitz, head of Heritage auction house's natural history division, "If you're a fossil collector, where are you gonna buy your fossils? If you find a *T-rex*, where are you gonna sell it?"^{xv} In the free market, these specimens are clearly seen as commodities and luxurious "art" items, and this attitude actively fuels the market for fossils, even if they are poached. What is known in the scientific community as "fossil poaching" refers to the illegal collection, removal, and/or sale of paleontological materials. Private landowners may allow these acts legally on their own land in the United States; the acts become illegal when they happen on protected land, such as national parks. Other nations, such as Argentina, have banned the possession of all fossil materials, even if it was collected in one's own backyard.^{xv} One may ask why a collector would want to "poach" a fossil when they are readily available to those with access to private land; the answer is simply because there are only so many fossils, and as their market value grows, their availability shrinks. Private landowners are unlikely to allow a fossil hunter on their land and even less likely to allow the sale of these materials for the hunter's profit when they learn of the vast wealth to be made in the fossil trade. Kirk Johnson of the National Museum of Natural History has summed up the threat these sales pose to science in a recent article on the fossil market in *The New Yorker*: "even if [collectors] let you look at something, if they sell it, it might as well not exist."^{xv} Johnson speaks of a well-known fact in paleontology, explained further by journalist Paige Williams: "a fossil that has been separated from its geologic context – such as location

and stratigraphic position, which poachers do not document – becomes far less significant to science.”^{xv} Without this information, scientists cannot attach full confidence to their data. It is important to mention that advances are being made in the geosciences for reading the chemical signatures of fossil specimens to determine their geologic origins, and researchers working on this technology support the importance of firsthand provenance; “unauthorized collection of scientifically important vertebrate and invertebrate fossils from Federal lands has become a serious problem due to their high commercial value on the black market,”^{xvi} stated researchers in a Geological Society of America presentation in 2009. However, this chemical signature can only tell us so much – a poached fossil has still been stripped of its taphonomic (burial) context, and other information.

The illegal (and legal, but non-scientific) collection, exportation, trade, and profitable sale of fossils are growing phenomena that become more threatening to scientific knowledge every field season.^{xvii} In most countries there are laws dictating what may be excavated, collected, and exported from that nation. These laws, however, are clearly not effectively enforced in such nations as Mongolia, China, Argentina, Morocco, and even the United States.^{xviii} One quick search of fossils for sale on such Internet sites as eBay sheds light on this growing threat to scientific collections. In 2007, the Paleontological Resources Preservation Act was introduced to the US Senate as a bill, which fell under the legislation of the United States Department of the Interior.^{xix} It was passed under the Omnibus Public Land Management Act of 2009. The Paleontological Resources Preservation Act sought to tighten penalties for the illegal removal of scientifically significant fossils from federal land. The act was well supported by the scientific community, especially the Society of Vertebrate Paleontology.^{xx} However, groups such as the Association of Applied Paleontological Sciences, which is a group of commercial fossil dealers, opposed the act.^{xxi} Those opposing the measure most avidly are amateur collectors who feel that the current number of legal, professional paleontologists who do field excavation could not possibly remove all exposed specimens before they are destroyed by natural environmental elements, and will therefore lose important material if their ranks are not supported by amateur collectors. Though this is a

compelling and superficially valid argument, those who oppose the act have no ethical code that prevents them from acquiring the scientifically significant fossils for profitable sale. Kevin Padian, Curator of Paleontology at the University of California Museum of Paleontology, has written, “In general, commercial collectors don’t have scientific information as their first priority. They are of necessity businessmen. The faster they can get the specimen out of the ground, the sooner they can sell it; the longer it takes, the more costly it is. They don’t often provide information about the locality, for obvious business reasons.”^{xxii} What academic paleontologists are most concerned about, evidently, is the purely scientific value of a specimen; I argue for a further measure to be taken, and for scientists to recruit ideological reinforcements from among the museum-going public.

Without legislative acts to preserve unstudied new fossils, priceless specimens will disappear into the hands of private collectors, illegal traders, or amateurs unknowingly satisfying their hobby with invaluable scientific specimens. I suggest that legislation is confusing and blotchy at best because the paleontological community – professionals, commercial dealers, hunters, hobbyists, academics – does not currently speak out for such measures with one unified voice. Thus far there is no overarching group or society which offers membership to both those with a more conservative view on fossil ethics (such as most members of the Society of Vertebrate Paleontology) and those who assert that important specimens are being compromised each year because of the professional “monopoly” on fossil collection (the Association of Applied Paleontological Sciences, for example). I argue that neither camp is totally correct in their way of thinking about how to best go about preserving the scientific integrity of materials, nor in protecting the actual fossils. I propose an umbrella group, which would offer membership to those willing to sign an ethics agreement concerning the commercial fossil trade, scientific value, and collection methods. A coalition of scientists and commercial dealers, who currently overlap but do not see eye to eye on these issues, must be formed to determine what such an ethics agreement would state. This umbrella group must also offer universal “certification” to its members, which would identify them as parties interested first and foremost in the protection of fossil material

and the expansion of scientific research and education. For example, the group could require an in-person or online training course that refines members' skills in identification, collection, preparation, and research methodologies, which could be held at local natural history museums around the country. The participation in and passing of such a course, as well as a comprehensive legislation review and the submission of poaching solution proposals, could be criteria used to determine said certification. I believe that the administering and organization of such an umbrella group would be most effective in the hands of museum leadership.

The Museum and its Public: Responsibility, Compromise, and Cooperation

Introducing the subject of fossil poaching to paleontologists is unnecessary, as this group of individuals is painfully familiar with the problem. The people who can most effectively strengthen the ranks of those fighting for collective public ownership of fossils are *the public*. Educating the public about the trade that takes away specimens from their view is important and has been thus far vastly underutilized by those hoping to deprive private collectors and poachers from achieving personal gain through the commercial fossil trade. To turn the public against something harmful such as illegal fossil trade by creating awareness about its detrimental effects takes time (for example, refer to the overly gradual demise of the tobacco industry), but it is the most effective way to create a knowledgeable, involved public that cares about its academic and educational institutions; it also creates citizens who are active in protecting Earth's heritage. A cautionary suggestion would be to research and address the public's attitude towards and understanding of *nonrenewable resources*, a subject of contention and confusion for many Americans. Building an understanding of the nation's irreplaceable natural history - and a conviction to protect these materials - with the museum-going public is an effective strategy because it creates camaraderie and cohesion through a collective cause that is shared by many beneficiaries.

Constructing an awareness campaign around the ideals of national pride and ownership, which are considered to be extremely important to Americans, can only benefit the scientific community aiming to eradicate fossil poaching. To translate the pride of personal ownership to the pride of national ownership will be the most difficult, but powerful, aspect of this campaign undertaken by the scientific community. If the public cannot be convinced that they should all be collective owners of important fossils and the scientific knowledge these specimens bring, then the problem of illegal fossil trade will only become worse and will eventually completely overtake the “right of way” that scholarship struggles to maintain.

Museums must first begin to embark on a journey of rekindling the American amazement of science. By involving the public in important paleontological discoveries through education, and by offering those amateur and young enthusiasts an outlet for their fascination through institutional guidance, such a collective campaign effort would be the first step to not only saving invaluable fossils and knowledge, but to fostering a public appreciation of scientific material and processes. It is no secret that people of all ages find such animals as dinosaurs fascinating; simply consult statistics on box-office sales for museum IMAX movies like *Sea Monsters: A Prehistoric Adventure* (see appendix) and it is clear that adults and children alike already have a great appreciation of this subject. To cultivate that appreciation into activism is a most difficult transition to make, but I argue that the public would become motivated by the threat of losing dinosaurs in museums. Rallying the public to the cause of saving natural history collections from private hands would strengthen the connection between the public and the museum to promote lifelong learning and fossil stewardship.

In an age of extreme decreases in federal and state funding for educational and other non-profit facilities across the United States, it has become increasingly difficult for museums to obtain reliable income. This has made the continual prospecting, collection, and research of fossils nearly impossible for many museums, and has resulted in a dramatic loss of scientific material available to academia. With losses to science come losses to public access, and this is a serious problem for museums that face

dramatic cuts in funding. I propose that museums take the lead in offering scientists an organized forum where they may discuss how to best propose legislation that both protects fossils and allows scientists to study them – thus allowing the public to enjoy access to this knowledge.

It is a fact that the public, especially children, enjoy exploring dinosaurs enormously; and because most natural history museums have been relegated to catering to the public rather than to research in order to find income, it has become essential for these museums to find common ground with their audience about what kinds of exhibitions are important and interesting. Paleontology, and especially dinosaurs, is one of the last topics that both scientists and museum audiences overwhelmingly agree upon as interesting and important. The Smithsonian Institution reported in October 2011 that the National Museum of Natural History accounted for almost 6 million of their annual 25 million visits, making it the second most popular Smithsonian destination;^{xxiii} NMNH surpassed NASM for the number one title in 2012.ⁱ I argue that the exploitation of the overwhelming popularity of dinosaurs is the museum world's greatest weapon in combating further losses to paleontological science. Furthermore, I argue that it is the responsibility of museums to engage their public in fundraising efforts that will allow their curatorial staff to acquire new, unheard-of, unpublished, rare, and fantastic specimens that are currently going into private collections all around the world; it is also a museum's responsibility to its public, in my view, to look upon these types of acquisitions as ethical when any other home for the specimen in question would keep the public from viewing and learning from the fossil.

Current Concerns

Currently there are many “hot topics” in the field of vertebrate paleontology. Without access to pivotal specimens, paleontologists may never answer the most fascinating questions about dinosaurs and other extinct vertebrates. For example, there is little debate that theropod dinosaurs are the direct ancestors of birds,^{xxiv} but there are innumerable transitional fossils yet to be found and studied. It is problematic that the most important and abundant specimens pertaining to this topic are located in

China, because they cannot be legally exported and are difficult to access.^{xxv} Though these restrictions are good in the sense that they can protect the fossil, it is still a fact that some of the leading experts on the subject of feathered dinosaurs are located in the United States and Canada,^{xxvi} and it is essential that they be granted access to study the specimens. However, this is tenuous, because of all the fossil and scientific poaching that Chinese specimens have suffered.

Another important topic in paleontology is ontogeny. Currently, numerous researchers are studying the growth of many different kinds of dinosaurs, citing that in the past, a dinosaur specimen that looked different from previously discovered specimens would usually be deemed a different species and named accordingly. However, it has come to light - especially since the invention of a cladistic approach to studying dinosaur remains - that many specimens have been misnamed and misunderstood.^{xxvii} It is difficult to tell whether a specimen is an adult of one species, or a juvenile or baby of another known species, but each and every juvenile or baby specimen found is essential to piecing together the puzzle. Many of these specimens are poached or collected and sold for astronomical amounts of money because they are very popular among collectors (refer to websites listed in appendix).

A further example of a paleontological category demanding more research is dinosaur biology, especially in regards to discovering how such gargantuan creatures as the sauropods could have maintained a safe body temperature. Thermoregulation in dinosaurs is currently undergoing rigorous study^{xxviii} and answers prove difficult to procure. Though dinosaur skeletons alone may not hold the needed evidence to designate them to a certain mode of thermoregulation, the paleoenvironment in which they lived is likely essential to understanding their lifeways.^{xxix} The desecration of a paleontological site not only ruins the chances of researching the fossilized bones there, but can also destroy important ecological clues in the process.

Studies of dinosaur biology and diversification rely heavily on the ability of researchers to study specimens from geographically diverse areas. The most recent highly publicized commercial dinosaur

scandal, involving Florida fossil dealer Eric Prokopi, revolved around a rare species of tyrannosaur (*Tarbosaurus bataar*), which was poached in Mongolia and illegally smuggled into the United States for profitable sale to a private buyer by Prokopi and others.^{xxx} This specimen falls into several of the aforementioned categories of research of which scientists are deprived due to the commercial fossil industry. The attitude of commercial fossil dealers such as Prokopi reflects the worse end of a spectrum of false and detrimental opinions on the value of scientific specimens: when interviewed by *The New Yorker*, Prokopi asked journalist Paige Williams, “one thing I was wondering is if any of these paleontologists you’ve talked to have given their argument of why paleontology is important...fossils are just basically rocks...it’s not like antiquities, where it’s somebody’s heritage and culture and all that.”^{xxv} Furthermore, the government that could protect natural history specimens also casts them aside. In a 1994 analysis of legal proceedings in the case of the controversial tyrannosaur Sue, attorney Patrick Duffy reported “while Congress has abundantly provided for the regulation of ‘archaeological’ resources, those statutes are notably silent on the regulation of ‘paleontological’ resources, unless they are found in an archaeological context.”^{xxxi}

Essentially, there are hundreds of questions yet to be answered about extinct vertebrate life, especially dinosaur phylogeny, ontogeny, ecology, and paleobiology - and the illegal collection, exportation, and eventual private sale of any fossil can be extremely detrimental to the scientific study of these animals. Museums must strive to provide the public and the scientific community with a mode of communication about what is expected of them, and how to properly interact with one another in the best interest of the fossils. As the federal government has only just begun to understand the gravity of and publicize the black market problem for science with incidents such as the Sue or Prokopi cases, the time is ideal for the scientific community to work together to raise public awareness as well.

Voices from the Paleontology Community

Many researchers, fossil dealers, paleontologists and other individuals can offer invaluable insight into the future of fossils and their role in natural history museums. Two such individuals are Dr. Thomas Carr and Peter Larson, both of whom I have interviewed personally for this research. Dr. Thomas Carr is a tyrannosaur expert and the Senior Scientific Advisor at the Carthage Institute of Paleontology in Kenosha, Wisconsin. Peter Larson is a commercial paleontologist and the President of the Black Hills Institute of Geological Research in Hill City, South Dakota; though Larson deals mainly to scientists and museums, he is most renowned for his involvement with and incarceration for the collection of Sue the *Tyrannosaurus rex*. Both paleontologists have given statements and thoughtful insights regarding the issues of the commercial fossil market and its effect on museums, as well as the public.

When it comes to fossil sales, Carr errs heavily on the side of caution. “In my opinion, the fossil trade is unethical – period,” he advises. “No matter how you slice it, the sale of fossils to private individuals is a loss of scientific information. Fossils are our only data on past life. The sale of vertebrate fossils is very frustrating - I have seen instances where a scientifically significant specimen was sold simply because the amateur who collected the fossil did not know what it was!” Carr has gone on to emphasize his stance that “people clearly do not understand, or do not care, that fossils are nonrenewable resources. For example our knowledge of *Alioramus* (a tyrannosaurid) rests on two specimens that are in legitimate museums; however, there are at least two other skulls in private hands, which absolutely deprive us of that information. The commoditization of fossils hurts science, but that is the genius of capitalism: anything can be turned into a commodity,” Carr has stated.^{xxxii} His conservative opinion on the non-professional collection of and private sale of fossils is common among many in the paleontological community; these views, however, are countered by the opinions of Peter Larson.

“I would never call fossils ‘non-renewable resources’...you cannot practically remove all of them from the ground. That statement is very misleading. We use oil at too great a rate...but fossils will never be like that. You’ll never dig up all the fossils,” Larson has stated, going on to point out that the situation

is like that of “astronomy [in that] most of the important stuff is found by amateurs.” In terms of the commercial sale of fossils, Larson went on to say that “fossils are weathering out and being destroyed all the time...and just because they are in a museum does not make them safe. We [sellers] like to have control over where they go. Many buyers are trying to ‘save’ fossils that museums and scientists can’t or won’t buy that are scientifically important. They should be published and shared with everyone. Most of the people in the business would prefer to get these things into the ‘right hands’.”^{xxxiii}

Who constitutes the “right hands” remains to be agreed upon in the paleontology community. Just as those scientists in agreement with the sentiments shared by Thomas Carr hold a generally besmirched image of fossil dealers, the commercial collectors have their own negative mental portrait of scientists: “[it’s] dinosaur envy...academics can get annoyed that they didn’t find the bones themselves,” opined Peter Larson to a journalist with the Western Morning News in 2009.^{xxxiv} Richard Edmonds, geologist and chief scientific officer for the Jurassic Coast in the UK, asserted further in the same article, “these scientists complain – but...you never see them out on the rocks in all weathers looking for fossils”.^{xxxiv} These opinions aren’t factual, at least in North America, where academic paleontologists like Thomas Carr lead grueling field expeditions to isolated, rugged locations in Montana’s oppressive summer heat every year.^{xxxiii} Furthermore, because academic paleontologists are just that – academics – they must teach courses to university students, advise graduate students, craft grant proposals, do scientific research, publish papers, and represent their institutions at conferences year-round. If these constant demands were not part of their job as paleontologists, I could scarcely name a handful of them who would not also happily report to the field daily to hunt for fossils.

Other scientists have contributed opinions on the matter in the form of published papers and essays. One such researcher, John Nudds of the Manchester University Museum, makes some especially interesting points about the controversy of fossil ethics. He asserts that though having been a “fossil purist” for most of his career in geology, attending the famous fossil shows such as the annual Tuscon expo has shed new light on the subject of fossil legislation for himself and others. Nudds insists that

though it is unfortunate that countries suffer poaching of their fossil specimens, these specimens in no way represent the same kind of “national heritage” as ethnographic and archaeological artifacts do. He argues that the inclusion of fossils in heritage legislation is both misleading and false, as geologic time is deep and the Earth’s prehistoric specimens know no international bounds.^{xvii} It is true that an animal such as *Tyrannosaurus rex* is “American” because it is found exclusively in North America, but it is also true that current national borders are completely unrelated to this extremely old geologic material. In agreement with the ideas of Nudds, I argue that the “national ownership” of fossils be regarded explicitly as a country’s responsibility to care for fossils found within its borders. In other words, America is responsible for making sure that *T. rex* has a safe home in its museums, but the nation is also responsible for sharing this find and its scientific implications with the rest of the world, as well as access to the specimen by researchers, and casts of the specimen for anyone who wishes to purchase one. When a country is unwilling or unable to care for its paleontological heritage, it must find an institution that will.

All of the aforementioned individuals have a great deal of experience and knowledge regarding the subject of the fossil trade, and express valid ideas assessing the problem of losing important scientific information. Both of the interviewed paleontologists especially agreed on the issue of regulating fossil sales on the Internet, in admitting that it is likely “impossible”, and that education is the key to preventing losses to science; I argue further that Internet retailers as well as auction houses must be held responsible for illegal sales from which they make profit. Knowing that scientists on seemingly opposite sides of the fence can see eye to eye on certain aspects of the issue of the commercial fossil trade supports the notion that consensus can and must be reached among the scientific community regarding how natural history institutions, particularly museums, must step into the future.

The Future of Natural History Museums

This research has shown that:

1. Fossil poaching is a real and rampant problem, and it stems from the popularity and media sensationalizing of dinosaurs and other creatures.
2. Poaching happens because a market exists, and demand is high.
3. Museums have thus far taken a conservative stand against the inclusion of poached or smuggled fossils in their current acquisition planning, though their own collections contain countless specimens that would fall under the “illegal” category if accessioned today.
4. There are innumerable opposing viewpoints within the paleontological community itself about fossil poaching, commercial trade, and losses to science.
5. The lack of cooperation between the paleontology community’s different constituents and museologists has caused countless specimens to fall into the hands of private collectors and others who would not share this Earth heritage with the public. Museums are therefore missing out on important additions to science and their own collections.
6. Consensus on what to do about these problems has never been reached, but must be reached soon before academia no longer has the “monopoly” on specimen access.
7. The loss of specimen access by the scientific community directly and adversely affects the museum-going public.
8. Museums must work together with scientists, public institution-favoring commercial dealers, and the public in order to raise awareness and find solutions to the problem of fossil poaching and the market.
9. These groups must also work together to reach consensus on lobbying for better fossil legislation around the world.
10. Nations must take responsibility for their specimens through supporting museums; if this is not possible, it is then their responsibility to find suitable educational institutions elsewhere to protect and study their specimens.

The future of natural history collection literally relies on the immediate cooperation and action of all parties involved in the issue of the commercial fossil trade. It is clear that scientists take the stance that no money should be made from dealing fossils, while other amateur paleontologists and dealers friendly to science are interested in improving science, but feel they also must make a living. I argue that they must agree to disagree about the financial aspect of selling specimens to museums/other educational institutions, and work together as a team against the real enemy: untrained fossil poachers who would steal specimens and seek to make an enormous profit from this material, utterly depriving the entire museum-going public and all scientists from every seeing, studying, and enjoying specimens. In order to achieve this goal, I call for:

1. Recognition among all concerned parties that though some individuals choose to engage in paleontology on an academic level, others may be unable or unwilling to do this professionally and can make equally important contributions as amateurs. It does not take a PhD to discover an extremely important specimen, but it does take a love of the science to make an ethical choice about what to do with that specimen. Scientists and museums should not shame such amateurs to the point where they would rather turn to the private commercial market to have their finds appreciated.
2. An established umbrella group that extends a warm welcome to all members, whether they are classically educated or not, and whether they work for a museum or not. Membership will be based upon an ethics policy drafted and voted upon by cooperating entities and individuals. In order to do any fossil collection in the United States (and eventually, the rest of the world), paleo-enthusiasts must have certification from this umbrella group. Certification will entail taking an online or in-person course on ethics, prospecting, collection methods, preparation, and fossil legislation. All students and museum staff or volunteers, as well as teachers, professors, and anyone else in academia will enjoy free membership. The overarching membership qualification for this group will be the requirement of having the best interest of

the fossil, its science, and its public at the forefront of all actions and participation in paleontology.

3. National legislation on fossils must become an issue separate from other heritage materials, and should be equally important to lawmakers and the public. Legislation should be proposed and written by those with extensive training and experience in the field of paleontology. Nations must agree to care for their specimens in a satisfactory manner, and have established guidelines and rules in place to plan for specimens for which proper care cannot be given.
4. The public must be not only included in the saving of these fossils, but must be put at the forefront of fundraising and awareness efforts. If the public knew how serious the problem of fossil poaching has become, and how much of a threat it is to the museums they enjoy, I firmly believe they would be motivated to take action – and it is the job of the museum to make them aware.

Ensuring the safety and quality of future collections of natural history museums will be difficult with these new measures, but it will be absolutely impossible without them. The academic right-of-way to fossil access is dwindling by the day as involved parties continue to squabble amongst themselves and refuse to unite to a common cause: saving fossils and all their priceless information about the history of the Earth.

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APPENDIX – SEE ALSO

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<http://www.ebay.com/sch/i.html?odkw=fossil&osacat=0&trksid=p2045573.m570.l1313&kw=dinosaur+fossil&sacat=0&from=R40> (last accessed March 25th, 2013)
2. Websites for fossil shopping:
www.fossilmall.com (last accessed March 25th, 2013)
www.paleodirect.com/dinosaurfossils.htm (last accessed March 25th, 2013)

http://www.blujay.com/?keywords=&Search.x=43&Search.y=11&search_cat=7120200&page=search (last accessed March 25th, 2013)

3. Identifying fake fossils:

www.fossilmuseum.net/collect/fake-fossils.htm (last accessed March 25th, 2013)

<http://www.thefossilforum.com/index.php?/topic/17309-how-to-spot-a-fake-fossil/> (last accessed March 25th, 2013)

<http://www.extinctions.com/?fuseaction=home.fakefossils> (last accessed March 25th, 2013)

<http://fakefossils.webs.com/> (last accessed March 25th, 2013)

<http://www.paleodirect.com/fakefossils1.htm> (last accessed March 25th, 2013)

4. Auction houses that deal natural history specimens:

Heritage www.ha.com/naturalhistory

IM Chait www.chait.com

Sotheby's www.sothebys.com

Bonhams & Butterfields www.bonhams.com