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Dinosaur Representation in Museums: How the Struggle Between Scientific Accuracy and Pop Culture Affects the Public Perception of Mesozoic Non-Avian Dinosaurs in Museums

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Abstract

This thesis examines the struggle of museums to keep up with swiftly advancing scientific discoveries relating to the study and display of Mesozoic (approximately 250 million years to 65 million years ago) non-avian dinosaurs. The paper will explore the history of dinosaur discoveries, their display methodologies in museums, and how pop culture, including movies and video games, have influenced museum displays and public perception over time. The lack of updated dinosaur exhibits in smaller local museums leads to disbelief, or an outright denial, of new information such as feathered dinosaurs. Entertainment, such as movies and video games that have non-avian dinosaurs as part of their presentation, are examined over the past thirty years to determine how accurate or inaccurate they are to the understanding of dinosaurs from their respective years.

An informal survey was conducted at the Buffalo Museum of Science during April 2019, asking visitors to give their feedback on the *Rethink Extinct* exhibit. The author visited several museums and included their dinosaur exhibits in this thesis for comparison. These include the Museum of the Earth in Ithaca, New York, The American Museum of Natural History in New York City, and the Los Angeles Natural History Museum in Los Angeles, California. Additional information from the Smithsonian Museum of Natural History is included regarding their process of updating their Dinosaur Hall Exhibit. Comparing museum inaccuracies in both large and small museums, it was discovered that smaller museums are more heavily impacted by pop culture and are less prone to attend to details that offer up to date interpretations of their dinosaur exhibits.

State University of New York
College at Buffalo
Department of History and Social Studies Education

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Pop Culture Affects the Public Perception of Mesozoic Non-Avian Dinosaurs in Museums

A Thesis in
Museum Studies

by

Carla A. Feller

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Chapter I: Introduction

There is something awe-inspiring about pushing open very old and heavy wooden doors or even modern light ones made of glass and entering a chamber where the remains of creatures from millions of years ago tower overhead. Therein reside the bones of animals so large that, when fully assembled, they barely fit inside a one-hundred-foot-long hall. On display is an installation so tall that it easily dwarfs a two-story house. Since time immemorable, dinosaurs have been part of the human imagination. In bygone eras, these animals influenced both popular culture and religion. Dragons, griffins and cyclops may all have their roots in the discovery by ancient man of the remains of Dinosauria.

The bones of dinosaurs are at home in both the museum and the human imagination. Sometimes the public drives the museum's decisions. Modern museums, both large and small, financially strapped or well-endowed, all struggle to keep up with the ever-advancing march of science. Understanding and interpretation of skeletons millions of years old are constantly changing and being reexamined. Because of this, questions quickly arise. How often can or should exhibits be upgraded? Which installations are going to be granted a makeover? How will the museum pay for it? Smaller museums often have limited budgets for exhibit upgrades and updates. It can be difficult to try to play catch-up in the understanding of these ancient animals. There is also fierce competition with larger institutions that are both a tourist hot spot and have larger budgets and income.

Many children often appear to have a seemingly innate understanding of dinosaurs. The media provides them with new and interesting educational and entertainment opportunities from which to get their dinosaur fix. For museums, this information can be both a bane and a boon. Linking new species together, or dividing seemingly related species apart, leave institutions of

learning scrambling to convey current information to the public. This struggle to catch up often leads to a default of popular dinosaur exhibits that are not in sync to today's science.

It is easy to lean on popular cultural trends to draw people through the doors, yet what kind of impression does that leave a guest when what they see in a scientific museum exhibit is full of inconsistencies related to pop culture movie science? How do guests react to conflicting information given from labels and staff? Why is accuracy so important to dinosaur science? Finally, how can museums improve their exhibits without breaking the bank?

These questions, and suggestions for their solutions, will be explored in this thesis, along with an examination of literature with additional uses for fossil and geological collections with the budding discipline of Geomythology. A survey was conducted at the *Rethink Extinct* exhibit at the Buffalo Museum of Science (BMS) in Buffalo, NY in April 2019. (*Rethink Extinct*. Permanent exhibit. Buffalo Museum of Science, Buffalo, NY.) The author conducted this survey to gauge the reactions of guests to the BMS's dinosaur exhibit, and gauge where their previous knowledge was challenged or reinforced. This survey is very short and has been appropriately considered for its small sample size.

Chapter II: Literature Review

Dinosaurs have long been a focus of both popular culture and museum exhibits since their discovery in the 1600s. Even before early modern European history, the 16th century through the age of enlightenment to the beginning of the Industrial age, dinosaurs have been a part of popular culture. It is discussed later in the literature review in a section called “Geomythology: Breaking Down Exhibit Walls.” There are a virtually endless number of resources and references to dinosaur information, spanning their earliest discoveries, to modern discoveries, and theories of their lives.

It may be surprising that museum websites are very reliable sources of information. Museums regularly keep their dinosaur updates available to the public, often through blog posts about recent discoveries or interesting tidbits about their history. The Smithsonian Institution and the National Museum of Natural History (NMNH) are constantly sharing updates on their web and Facebook pages. On the one hand, their Facebook posts are fun and informative. On the other hand, their webpage articles are posted directly from their official magazine and often tackle discussions about modern and historical paleontology (*Smithsonian.com*, Smithsonian Institution). The Smithsonian Institution, with its staff of professionals in a variety of scientific and museological fields, is a well-respected and trusted institution. Their research and expeditions into the field of paleontological digs make them an authority in the field of dinosaur paleontology (*Smithsonian.com*, Smithsonian Institution).

The American Museum of Natural History (AMNH) in New York City is another authority on Dinosauria. They, too, keep their Facebook and webpage active with the history and the activity of their scientists and their extensive collections. With their 150th anniversary in 2019, they are even more active in updating information and sharing their own history with the

public, even exposing inaccuracies within old exhibits (*American Museum of Natural History*, www.amnh.org/). Their photographic and scientific archives are perhaps even a rival to the Smithsonian Institution in the diversity of topics and interpretation of fossil records. The historic paleontological discoveries in their collections provide a diverse historical record of famous paleontologists that worked with the museum to advance the understanding of ancient life (*American Museum of Natural History*, www.amnh.org).

Museums are a wonderful primary source for both historical and modern dinosaur research and representation. When it comes to individual scientists on certain topics, information should be examined carefully. Personal opinions and theories can often skew the scientific information toward educated but inaccurate conclusions. Two such opinions and theories, Dr. Robert T. “Bob” Bakker, and John “Jack” Horner, are used as examples.

Dr. Bakker was a former student of Dr. John Ostrom and helped to bring the theory of bird-like dinosaurs to the forefront of the scientific community and the public eye. Dr. Ostrom was not the first scientist to recognize the similarities between birds and dinosaurs--that would go to Thomas Henry Huxley, a close friend and supporter of Charles Darwin. Dr. Ostrom was a firm supporter of the theory much to the displeasure of the scientific community in the 1980s (Bakker, *The Dinosaur Heresies*).

Dr. Bakker’s doctoral dissertation, published in 1986 as *The Dinosaur Heresies*, provided the scientific community with more proof of the avian-dinosaurs theory, as well as other theories that were proposed by Dr. Ostrom and Dr. Bakker. By the 1990s, the scientific community had come to accept not only the large body of proof for avian and feathered dinosaurs, but also a good majority of Dr. Bakker’s work and theories presented in the book. To date, only a handful of Dr. Bakker’s theories have been disproved by the scientific community (Bakker, *The*

Dinosaur Heresies). His vibrant passion and personality brought him into the popular culture of the 1980s, 1990s, and even into the 2000s. He has written many books, including a novel, *Raptor Red*, which follows the fictional but scientifically examined life of a velociraptor in the ancient Mongolian desert. He has appeared on many television specials, and his expertise also led him to become a consulting paleontologist on the major motion picture *Jurassic Park*. His personality also inspired a character in the sequel *Jurassic Park: The Lost World*, named Dr. Robert Burke.

A contemporary and friend of Dr. Bakker's was John "Jack" Horner. While Horner does not have an official degree in paleontology, he was awarded an honorary doctorate based on his work on genetic research in modern avian dinosaurs, specifically chicken embryos, and paleontological discoveries (Horner et al., *How to Build a Dinosaur*). Horner's contributions to paleontological science are important and his discoveries of caring dinosaur mothers helped revolutionize the mindset of dinosaur parenting methods. His mothering *Maiasaura* has helped people see these animals as not cold-hearted lizards and depictions of the hadrosaur caring for their young grace many a museum hall. Some of his more exotic theories have been disproven by scientific research. For example, he is still a firm believer in the theory that *Tyrannosaurus rex* was a scavenger, not an active predator, and believes *Triceratops* is a juvenile of another ceratopsian species known as *Torosaurus*. Both theories have since been discredited, but that does not discredit Horner for his other important work in the field of paleontology, such as his contributions to understanding genetics in avian dinosaurs.

Horner, like Bakker, is a pop culture icon of paleontology. He has worked on numerous dinosaur movies, including *Jurassic Park*. His work in genetics has led to more exploration in CRISPR technology, technology that allows gene editing, and the child-like excitement that one day everyone could have a pet-sized dinosaur of our very own.

A variety of authors have written in detail about dinosaurs or institutions that have a long history of collecting dinosaur fossils. From biologist and botanist Randy Moore, to dinosaur enthusiast, journalist and editor Douglas Preston, dinosaurs are a well-loved and researched subject beyond vertebrate paleontologists.

Randy Moore is a professor of Biology Teaching and Learning at the University of Minnesota. His background is in biology, botany, and he holds a doctoral degree in plant development (“Randy Moore, “*College of Biological Sciences*). While the focus of his research and doctoral papers is on the life and functions of plants, he also has an interest in the understanding and consumption of the theory of evolution and how it is understood in public and popular culture.

One book that examines dinosaurs is *Dinosaurs by the Decades: A Chronology of the Dinosaur Science and Popular Culture*. Moore writes in detail about each significant event in dinosaur discovery since 1027 AD. Significant discoveries of dinosaurs and their fossilized remains are documented in the book along with their dates. Moore labels significant discoveries for readers who may be looking for something from a specific field (Moore xxiv). This makes it a wonderful reference for scientists and researchers looking to build on their own libraries of information. The book is filled with references and citations about dinosaurs and how they were interpreted throughout history by scientific and religious minds. Moore’s research is sound, if not entirely complete. He doesn’t discuss anything pre-1027 AD, and the gap between the Persian author Sina discussing fossils in 1027 AD and the next significant date in 1506 AD with reference to Leonardo de Vinci is very large compared with other gaps at nearly 479 years (Moore 1). There are also no other ancient accounts documented. Considering Moore’s specialties, perhaps the work of a cultural anthropologist could be used to examine ancient texts

for potential records of ancient animal bones and fill in the missing pieces. Such work would be in line with the field of geomythology, which is the study of alleged references to actual geological events in mythology. This field will be discussed more in the second half of the literature review.

With such an invaluable resource covering 1506 to 2012, and the possibility of even more updates in later editions, the book and Moore's research is a stepping-stone that describes not only dinosaur discoveries, but also interpretations, and references to other books and papers published. Combining this book with Adrienne Mayor's book, *The First Fossil Hunters*, could only continue to fill in the gaps in history referencing ancient fossils and dinosaur discoveries.

Douglas Preston is a well-known author of thriller novels and non-fiction experiences. He began his career in the American Museum of Natural History after earning his degree in English literature from Pomona College in California. He worked as an editor, writer, and manager of several publications. ("Author Bios: Preston," *Preston & Child*). His eight years at the AMNH inspired him to write a nonfiction history of the museum under the title *Dinosaurs in the Attic*. As with many of Preston's nonfiction books, the style of his writing is personable, and informal, and the stories he tells are more like a man speaking about an old and dear friend. *Dinosaurs in the Attic* tells the colorful history of the AMNH using Preston's eloquent story telling. As a history, it delves into the small hidden tales of the collection, as well as the founding of the museum and the history of building a natural history museum in New York City. The history is told with many references and direct quotes from letters, such as letters transcribed from the founder of the museum, Albert Smith Bickmore, to people fund-raising for the museum (Preston, *Dinosaurs in the Attic*). The stories and anecdotes humanize the institution, which can often be difficult to do with large institutions. While published in 1986, the book is still incredibly

relevant for its historical context on the institution and its dinosaur collection's stories. Douglas Preston has written many other papers and novels involving dinosaurs and their discovery and the science surrounding them. He is a wonderful source of historic information, in a package not presented in a typical historical format. It makes what could be a dry topic far more engaging and interesting to the public and humanizes an institution of science.

Not only are modern scientists important to discoveries, but it is also important to look to past scientific discoveries by scientists. This helps us to clarify our understanding as it has evolved over time. By looking at the past, we can better understand how we have come to understand science today.

In 1915, a book called *Dinosaurs with special references to the American Museum: Collections* was published by three gentlemen whose names have become synonymous with the golden age of dinosaur discovery: William Diller Matthew, Henry Fairfield Osborn, and Barnum Brown. The book documents not only the scientific understanding of dinosaurs circa 1915 by scientists, but also the environments in which dinosaurs lived (Matthew et al. *Dinosaurs with Special Reference to the American Museum: Collections*). The research is a wonderful resource for how the scientific community understood the Mesozoic era and its fauna as well as flora and geologic changes over time. This differs from our current understanding in a few ways but is a good source of our evolution of understanding. It is one of the most important concepts to keep in mind while examining dinosaur exhibits in museums and the popular culture that they inspire.

From how they describe the geologic changes to the occurrences of fossils of all types, it is a well thought out research of North American Mesozoic geology and paleontology. They also go into detail about the differences in each 'kind' of dinosaur. The text contains significant inaccuracies compared to modern knowledge in both descriptions of living animals as well as

how long they ‘ruled’ the earth. They reference only 9 million years from the first occurrence of Dinosauria, which is three times as long since their disappearance according to the same authors (Matthew et al. 17). Today we know that it has been 65-66 million years since the non-avian dinosaur extinction, and their total time of reign is well over 175 million years. Of course, our continuing understanding and scientific advancements often push these numbers into a margin of error that can be five hundred thousand to one million years.

The illustrations in the book, outside of the reconstructions, are largely based on fossils from the collections of the AMNH. There are detailed descriptions based on the Linnaean style of categorizing. Linnaean classification is the most common style of taxonomy seen in science and is the basis and standard for grouping and naming species. It uses a binomial naming system, such as *Tyrannosaurus rex*, and a hierarchy of categories that nest into each other based on differences on living animals. These categories are domain, kingdom, phylum, class, order, family, genus, and species. It is the genus and species which the binomial naming system is used. *Tyrannosaurus* is a genus, while *rex* (always lower case) is the species. Photographs, as well as illustrations of fully articulated skeletons and reconstructions by famous paleo reconstruction artist Charles R. Knight provide visual keys to the detailed descriptions that the authors give of the major North American genera of dinosaurs.

Authors Matthew, Osborn, and Brown, with their combined expertise in the fields of paleontology and geology and working with collections of fossils in the AMNH make *Dinosaurs with Special Reference to the American Museum: Collections* a wonderful historical reference to the understanding in the early years of dinosaur discovery and research. The use of specimens as illustrative guides, as well as photos from their digs into the western portion of the United States,

help to record these early fossils that may not be on display. The specimens that were exhibited inspired the public to flood into the AMNH in the golden age of dinosaur discovery.

The various authors and scientists across the decades and disciplines have not only advanced science but have helped change the interpretation of ancient non-avian dinosaurs. Museums themselves have also added to understanding dinosaurs by funding scientists' expeditions to find more fossils, study them and then exhibit them to the public. The fascination that dinosaurs have inspired in the past, and still do today, help to form a popular culture different from many other creatures of fantasy.

Stagnation is typically not a word that scientists want to hear in their interpretations or in relation to their specific field of science. The motivation for a change in understanding dinosaurs has not been one of proving prior scientists wrong, but rather is more like a sharper lens being added to a telescope to sharpen the focus on something farther away than the human brain can comprehend.

There are two additional influences that are important for dinosaur representation and development: mass media, being published intentional educational writing; and pop culture, material created primarily for entertainment. Movie industries, video game producers, and television media are the primary sources for the public, especially children's, first interaction with Dinosauria. Books are everywhere about dinosaurs, both as entertainment and education. Even Dr. Bob Bakker's novel *Raptor Red* is something for entertainment of the public than something a college scholar would pick up. Television shows like *Dinosaur Train* educate children with brightly colored dinosaurs on life lessons and on the lives of ancient creatures with a paleontologist explaining after each episode why some things in the show happened a certain

way, such as in an episode with *Pachycephalosaurs* swinging their heads at each other from the side, as opposed to dome-to-dome contact.

While artistic license is acceptable for media that is not strictly educational, when using a real animal as either a protagonist or antagonist, accurate physical description is important. Lizard like theropod dinosaurs may be popular as ‘monsters,’ but they are not accurate to scientific knowledge. If a movie, television show or video game claims to be more educational, then that media outlet is under increased risk of giving wrong information if they simply do not care to do the research.

Geomythology: Breaking Down Exhibit Walls

Geomythology is the study of alleged references to geological events in mythology. Geologist Dorothy Vitaliano, from Indiana University, defined the term for the first time in 1968. The study of the classics that involve mythology is often seen as cultural anthropology, yet when geologists and paleontologists take a close look at the often-detailed descriptions and locations, truth can often be found in the classic mythology.

As someone who more than just enjoys classic global mythology, this science is of peak interest to the author. My passion has led me to often wonder where these mythological creatures and events originated, especially the global phenomenon of dragons. When I started looking for ways to prove that the roots for these myths are based in truth, I stumbled across a book by Adrienne Mayor called *The First Fossil Hunters: Dinosaurs, Mammoths, and Myth in Greek and Roman Times* in the Los Angeles Natural History Museum.

I dug into the book with fervor and found that my long-held theories of the roots to classical mythologies of gryphons, cyclops and dragons, were more than substantiated. I decided then to focus on the past twenty years of research in the field of Geomythology—from 1998 to

2018—and on two more famous works from antiquity, Plato’s allegory of Atlantis, and *The Iliad* from Homer. These classic works are only a small portion of a vast work of mythological texts. While Geomythology is still in early development as a science, the works which it draws from are well documented and are from a breadth of cultures and continents.

Dorothy Vitaliano was a geologist at Indiana University, her studies helped to bridge the gap between serious mythology research and the hidden clues within them that hold scientific discovery. Her continual research helped to move the multidisciplinary study into a serious light. She was an advocate for the field of Geomythology throughout her life and is remembered as one of its founding scientists.

A brief paper written by Vitaliano was published in 2007, with an overview of the relationships between myths that describe geologic events, and the events that inspired them. From the first theories relating the city of Atlantis to the Island of Santorini, to the First Nation people explaining the shape of Devil’s Tower in Montana, to the events described in the Bible, a golden nugget of scientific truth lies at the center of every event.

Vitaliano details in her paper the geologic evidence that supports the narrative that was developed by the people who witnessed events. The one event she detailed that was perhaps the most interesting was the account of the Klamath nation that described two of their gods fighting on two mountains: Mt. Mazama and Mt. Shasta. The legend describes the god of the Below World fighting the god of the Above World by throwing fiery balls at each other as they stood on the top of the two mountains respectively (Vitaliano 3). When volcanologists looked at the details in the legend—the descriptions of how the god of the Below World was defeated and how the mountain he was on was turned into Crater Lake—they realized it was close to an eyewitness account of a violent volcanic eruption.

Crater Lake is a collapsed and extinct volcanic caldera which collapsed approximately 6,500 years ago (see fig. 1). The scientists were able to date it due to the First Nation artifacts found within the ash layer. This eruption would have caused violent fireballs to be hurled hundreds of miles in the air and eventually would cause the magma chamber to collapse and be filled in by water to create a lake. This description from the Klamath people matched perfectly with the evidence scientists discovered. The nugget of truth in the myth was the violent eruption that no doubt killed many people of the nation and the story was told of the war of two gods.

Beyond the borders of classic mythologies in Greece, Rome, and even North America, cultures have many mythologies and stories that relate to not only geologic and paleontological events but also astronomical events. In a paper written in 2009 by Hamacher and Norris, they describe and discuss in detail the sacred mythologies of the Aboriginal people of Australia and their connections to possible cosmic impacts (see fig. 2).

The difficulty in using the Aboriginal legends for geomythology is the closely guarded oral traditions. These stories are never written down and are passed down from generation to generation strictly through the spoken word. These traditions and teachings are viewed by historians as some of the most accurate retellings of history; leading them to be considered primary eyewitness accounts. They also are very protective of their sacred histories and often do not share with outsiders. These barriers can cause misinterpretations that often lead to scientists to disregard their legends as just folktales.

The paper goes on to give scientific locations of crater impacts that have been substantiated by Aboriginal stories (Hamacher & Norris 4-6) (see fig. 2). Their work is scientific and incredibly detailed, as well as respectful to the traditions and laws on Aboriginal beliefs.



Fig. 1. Crater Lake from Rim Village “Rim Village at Crater Lake National Park (U.S. National Park Service).” *The National Parks Service*, U.S. Department of the Interior, www.nps.gov/articles/400007.htm#4/34.45/-98.53.



Fig. 2. Crater in Australia from GÜth, Achim. Wolfe Creek Meteorite Crater, Western Australia. 28 Dec 2003. Photograph https://en.wikipedia.org/wiki/Wolfe_Creek_Crater#/media/File:Wolfe_creek_crater.jpg

Beyond astronomical events studied with Aboriginal traditions, there is paleontological evidence as well for the dreamtime legends of giant creatures like kangaroos and giant monitor lizards. These dreamtime stories were substantiated with the discovery of *Procoptodon*, a giant short, faced kangaroo, and *Megalania*, a giant prehistoric monitor lizard, both of which lived between 18,000 and 50,000 years ago. The first *Homo sapiens* to make it to Australia are dated back to just over 50,000 years ago, with more than enough time to see these massive animals alive and well and most likely be able to hunt them as well.

Adrienne Mayor’s work as a folklorist and historian of ancient science continues to build up the geomorphology of scientific findings. Her work follows not only classic Greek and Roman mythology, but also the stories of the First Nation peoples in North America, where fossil and geologic discoveries support the explanations of ancient people.

In Mayor’s book, *The First Fossil Hunters*, she focuses on the Greco-Roman time of the Mediterranean. She touches on everything from giants and centaurs, to cryptozoology, and even

modern mythologies and their connection to fossils and geology. The story that would make the cover art of her book is the one that I knew about to some degree: the legend of the gryphon (or griffon). Gryphons are one of the most recognized mythological creatures from the Mediterranean. With heads like eagles upon the bodies of lions with wings of great eagles, they are only overshadowed by dragons in recognizable iconography.

The legend of the gryphon, as Mayor describes it, is rooted in stories shared by the Saka-Scythian gold hunting nomads with Grecian travelers (Mayor 22-25). The gold prospectors described in detail the areas in which they saw the remains of the creatures, how they found nests of eggs and how they often found gold near them as well in the area of the Gobi Desert.

Tattoos found on mummified remains match these early descriptions of the gryphon, and the evolution of their design be the stories traveled back to Greece. Mayor began to talk to archeologists and paleontologists to root out the 'golden nugget of truth behind the well-known creature. She came upon the records of Roy Chapman Andrews expeditions into the Gobi Desert to seek out interesting artifacts for the New York City American Museum of Natural History. Andrews is known for his discovery of dinosaurs such as *Protoceratops*, *Psittacosaurus*, and *Oviraptor*. Photos of the near perfect skulls of *Protoceratops* sparked her imagination (see fig. 3).



Fig. 3. Protoceratops skull from: “Protoceratops Skeleton Fossils and Protoceratops Skull and Skeleton Cast Replicas,” *Taylor Made Fossils*, www.angelfire.com/mi/dinosaurs/dinosaurs_protoceratops.html.



Fig. 4. Greek Gryphon statue, from: Rijksmuseum van Oudheden, Leiden img.rmo.nl/imageproxy/proxy.aspx?server=62.221.199.226&port=5297&filename=\198894.jpg www.rmo.nl.

The beak, teeth, and often broken frill pieces matched up with the early descriptions of gryphons from the Scythian nomads and the early Greek depictions. The photographs of nests showed how the gold prospectors created a creature from the bones of well-preserved dinosaurs (see fig. 4). When Mayor approached others with her theory, they applauded her for putting pieces together that made it all make sense to both classicists and paleontologists. Her discoveries of missing pieces spurred her on to do more work to find other classic Greek mythologies and even North American First Nation mythologies and their nuggets of truth. A second book by Adrienne Mayor called *Fossil Legends of the First Americans* dedicated to North American First Nation mythologies was published in 2013 and focuses on many of the spiritual

stories that the First Nation's developed as part of their culture. The author is in search of a copy for continued research and addition to other studies.

In the most recent short article describing a theory about a biblical story of Sodom and Gomorrah, astronomical events are pointed to as the cause of their destruction. Madison Dapevich from the website *I Fucking Love Science (IFLS)* reviews research and discoveries made in the Jordan Valley that suggests the two "sinful cities destroyed by sulfur and fire" may have been victimized by a high-altitude meteorite explosion ("Biblical City of Sin Destroyed By 'Sulfur and Fire' May Have Been Flattened by Asteroid," *IFLScience*). Such explosions have been discovered and witnessed before, including the Tunguska event in Russia in 1908, and even more recently again in Russia in 2011.

These events are devastating and, depending upon the size of the meteorite, could have leveled two cities with one explosion. To imagine back in the bronze age, a sudden bright light followed by deafening noise and fire and no doubt the smell of sulfur and ash, it is no stretch to think that the people believed in a divine smiting.

For all the modern articles, it is also important to look at ancient texts and analyze their validity. Plato's story of the island city of Atlantis is a well-known allegory for the arrogance of man. Yet the story has so many specific details that lead the reader to wonder if perhaps there was another golden nugget of truth hidden in the myth.

Plato is known to the world as a historian and a philosopher of ancient Greece, hailing from Athens. He was a student of Socrates and his writings were both allegories and some believed to be true histories of past civilizations. One text features Atlantis, which borders both allegorical and strangely specific geologic landmarks, such as the pillars of Hercules.

Scientists for some time have looked to the island of Santorini in the Mediterranean as the source of the story. The island is around the same age as theorized of Atlantis and was the site of a massive volcanic eruption that caused the collapse of the cone and the sea to flood the island. Even in ancient maps and descriptions the island was a near perfect match for the three ringed city of Atlantis. While there is no consensus on the island of Santorini's identity as Atlantis, the story has been proven to be perhaps more than just an allegory.

Finally, Homer's epic poem, *The Odyssey*, has many mythological creatures wrapped up with actual locations and people to follow Odysseus on his journey home from the battle of Troy. As a classic piece of literature studied by high school students across the US, almost everyone knows the basic story. It is one of the first mythological pieces that high school students look at in depth in their English class.

On his journey, Odysseus comes across the strait of Charybdis and Scylla. Scylla is often described and depicted as a type of hydra living in a cave system across from the massive ship eating whirlpool Charybdis. Few would think of them as more than monsters to put more excitement into the story, but even in modern times the people of Greece are cautious of whirlpools that are known to sink ships. The chain of islands that stretch into the Mediterranean Sea cause strange currents and are affected by the tides of the moon. Through research and attempting to map out the journey of Odysseus by using known landmarks, they discovered an area that matches the tidal forces and creates a known ship-eating whirlpool. Across the strait, the soft rocks have eroded the shoreline and created a massive cave system. This discovery, at the very least, put the classic in a new light, and offers a blueprint of analysis to put other classic myths and stories in the category of plausibility. Further study is always needed to find the seed that sprouted the mythology.

Overall, the sources are strong evidence that the budding field of geomythology is one to take seriously, and to even work into museum exhibits. By referencing the examples described above, a holistic view of the sciences can be applied to museum exhibits as well. Continued research into how these sources can serve as inspiration for exhibit redesign will be beneficial to the field and should be considered as a new opportunity. I plan on obtaining Adrienne Mayor's second book on First Nation Geomythology, as well as digging out more recent research to continue to gather evidence for a holistic museum view of the sciences.

Why, though, is looking at non-dinosaur mythologies important? Because it shows something that we think of as a modern invention to be an ancient one: popular culture. While many of these mythologies have religious connections, they are explanations to events and geological anomalies that ancient people encountered in their lives. These were spread through word of mouth and shared as stories of great heroes and villains to be aware of while traveling in the world as entertainment. This is the same way that popular culture is shared in today's modern world. By understanding where the ancient cultures built their mythologies, we can understand why our own conceptions of dinosaurs change when popular culture takes over in our understanding of scientific animals. From that we can see where popular culture ruled science can take us away from truth and into entertainment and a disingenuous understanding of ancient creatures.

Chapter III: A Brief History of Dinosaur Study

The Early Years: 1600-1800s

Nearly every individual on the planet can remember a moment in their lifetime, typically as children, when they were digging in the dirt in search of undiscovered treasures. It is, perhaps, human nature to seek what is underground and bring it to the surface. It comes as no surprise then that when discoveries are made, there is a rush of energy to understand and explain said discoveries.

In the 17th century, the discovery of large prehistoric animal bones from 66 million years ago was first recorded by Englishman Robert Plot in 1677 (*Dinosaurs: A Visual Encyclopedia* 29). The discovery of the end of a femur of what is now known to be a large theropod dinosaur confused Plot. At the time, many scientists did not accept the theory of extinction, which is the scientific theory that living creatures — sometimes entire species — could die out completely due to external environmental forces, such as a meteorite. Although there were many discoveries of ancient bones of various humanoid and animal species, Plot attributed one of the bones to that of a femur of a giant humanoid from a biblical time before humans when giants ruled the planet. We now know that the femur was most likely from a *Megalosaurus*, the first giant lizard to be named in 1822 by Reverend William Buckland (*Dinosaurs: A Visual Encyclopedia* 29). However, Plot's explanations were acceptable for his time. His interpretation could be considered the end of the mythological age, where explanations were often linked to ancient stories or biblical passages and viewed as undeniable truth.



Fig. 5. Drawing of Robert Plot's Giant Femur from: "1677 First Ever Dinosaur Bone Robert Plot, Stock Image C029/0066." *Science Photo Library*, www.sciencephoto.com/media/719939/view/1677-first-ever-dinosaur-bone-robert-plot.



Fig. 6. Portrait of Robert Plot from: "Print Study / Drawing." *British Museum*, www.britishmuseum.org/research/collection_online/collection_object_details.aspx?objectId=750073&partId=1.

Discovery of ancient bones and fossilized sea-life prompted the study of these creatures by many early paleontologists. Often these large bones and teeth were dismissed as fish teeth or fish ribs since they were commonly found along coastal regions in Europe. In the 17th and 18th centuries, the study of living animals outside of Europe and expanding exploration to bringing back more specimens began in earnest. Comparative anatomy through the study of animals and plants was developed by comparing anatomical features of the specimens (Holtz 7). It became clear, as more collections of strange bones, rocks and crystals were examined, that they were both strikingly similar and, in some cases, vastly different from the specimens in pre-existing collections.

There was, however, no explanation provided by the early paleontologists for why there were no modern day animal equivalents in the new world that matched the bones of these ancient creatures – that is until Baron Georges Cuvier realized the answer was extinction. Cuvier theorized that since the bones found in the earth were unique and not found in nature during the current time, the creatures must no longer exist and only their petrified bones remained (Holtz 7).

Even one of America's founding fathers, Thomas Jefferson, was fascinated by and fixated on the enormous beasts that wandered the ancient world. In 1804, when Lewis and Clark started their expedition of the West, Thomas Jefferson instructed them to search for potential mammoths and other creatures fitting descriptions of bones that had been sent to him by colleagues and friends ("Monticello," *Extinction*). He also instructed them to search for any bones to send back to him for further study. Although Jefferson did not personally believe in extinction, he believed the bones deserved careful study and research ("Monticello," *Extinction*).

Of course, Lewis and Clark found no living mammoths, giant sloths, or lions as they journeyed west to the Pacific Ocean, but they did find other unusual bones which sparked a new era and understanding of these strange creatures from ages past. One discovery written about by the explorers was initially dismissed as an ancient fish; it has since been examined by modern paleontologists. It is now believed that they discovered a dinosaur rib bone in the Morrison Formation in Montana, an area known for massive and impressively complete Cretaceous dinosaurs (Spamer and McCourt, "Fossil Specimens").

Important Voices of the Early Years

Mary Anning



Fig. 15. “Mary Anning - Fossil Hunter - BBC Bitesize.” *BBC News*.

It was not only men who studied and discovered ancient prehistoric life. In fact, women were very dominant in early paleontology. The most well-known of these women paleontologists was Mary Anning. In the early 1800s, the inspiration behind the tongue twister “she sells seashells by the seashore,” Mary Anning was important to the discovery of marine reptiles in the coastal rock layers of England from the Jurassic period. Although not dinosaurs, these marine reptiles — specifically the *Ichthyosaur* which Mary Anning discovered and sold as a young woman — were cohabitants with dinosaurs. Yet the credit for her discoveries would not be given

to her, but rather her male counterparts in the scientific field. It is only recently that science has finally begun to appreciate the work of Mary Anning as an early paleontological pioneer.

Although Mary Anning was the most remembered female paleontologist — much in the same way that Marie Curie was typically the only woman scientist or chemist people remember — there are well over one hundred important women in the field of paleontology. An entire paper could be written about these many women and their contributions to the field and understanding of ancient life. Women in the field of paleontology make up more than half of students and experts in the field, but the public still views paleontologists as white, middle-aged, men. Examples can be seen in the fictional Dr. Alan Grant from *Jurassic Park*, or the real-life inspirations of Dr. Robert “Bob” Bakker, and Jack Horner; two incredibly popular paleontologists who started the Dinosaur Renaissance. (Black, “The Many Ways Women Get Left Out of Paleontology”).

The misconception of who a paleontologist should be or what they should look like was another misconception brought about by popular culture. It should be taken into consideration that some of these early discoveries may have been made by women who have been lost to history thanks to their male counterparts who took credit for the women’s discoveries and made them their own; through theft of information due to their position in a patriarchal society that often discredited women in most scientific fields.

From these first bits and pieces of bone, the fascination with dinosaurs developed and has left neither our minds nor lives yet. The following decades continued to provide the public with additional information which resulted in a growing passion for the ancient animals. The scientific world would continue be rocked with new arguments and new interpretations of Dinosauria.

Mary Anning's unique discoveries of fully articulated *Ichthyosaurus* fossils - meaning the bones were found in a life-like position - means that the interpretations remained incredibly accurate over time. The casts and original fossils she discovered are still used as pieces of research and study today. Even after her name was almost lost to time, there are many people who are fighting for a statue of her in her hometown to make sure she is never erased by time again.

The Crystal Palace and Bone Wars: The 1800s

The 1800s was the beginning of a boom for dinosaur discoveries and research. From the early years of budding understanding of Dinosauria, a few researchers and scientists began to put skin and muscle on these bones. While previous studies of fossilized bones yielded little in the behavior or looks of the animals, the early 1800s scientists embraced these ideas to understand what the animals may have been like while living. This was the beginning of what was known as paleo reconstruction.



Fig. 7. *Megalosaurus* as seen in The Oxford University Museum of Natural History, based on the original fossil discoveries by Rev. Buckland, from: “The Oxfordshire Dinosaurs.” *The Oxfordshire Dinosaurs* | Oxford University Museum of Natural History, oumnh.ox.ac.uk/megalosaurus-and-oxfordshire-dinosaurs.

Reverend William Buckland was the first person to name and describe a dinosaur, *Megalosaurus*, or giant lizard, in 1824. This was well before the term dinosaur was even coined.

So, what did they believe these creatures were? Quite simply, they thought they were extinct giant lizards related to their modern-day equivalents. Reverend Buckland had discovered a partial jawbone of the creature, along with a partial femur and other bones. He realized that the animal had an appearance like that of a lizard, with teeth like a monitor. The femur joint, however, showed the position of the legs directly under the body like that of a large mammal or bird. His theory led him to believe that the animal walked much like an elephant or rhinoceros (Holtz 7).

During the same time, Dr. Gideon Mantell and his wife Mary Ann had made discoveries of their own (Holtz 7). Mary Ann was an avid collector of rocks and explored strange rocks and minerals while on her walks through the English countryside. Workers at a quarry knew of both Mary Ann and Dr. Mantell's knowledge of rocks and fossils and brought them a strange series of bones (Chamberlain).

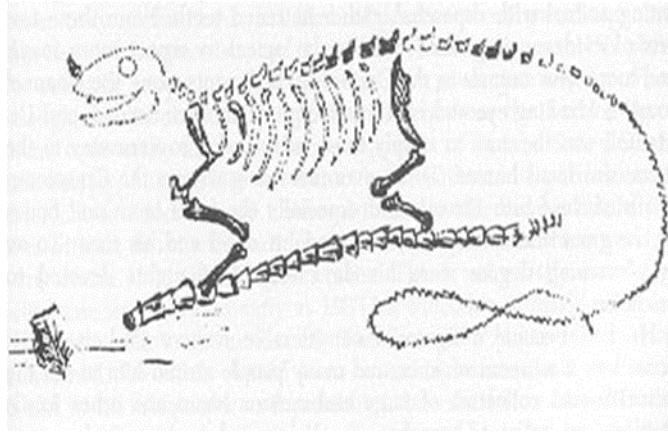


Fig. 8. First drawing of Mantell's *Iguanodon* from: Chamberlain, John A., Jr. *The Dinosaur Core: Dinosaur History* - Gideon & Mary Ann Mantell, Brooklyn College City University of New York Department of Geology, academic.brooklyn.cuny.edu/geology/chamber/mantell.html.

These bones were quite different from those discovered by Reverend Buckland. Instead of having sharp teeth like that of a monitor lizard, Mantell recognized them as being like that of

an iguana's tooth which was set deep into a socketed jaw. It had a similar upright body structure and a strange additional bone, he thought to be a horn on its nose. Dr. Mantell christened the creature *Iguanodon* or iguana tooth. The Mantells imagined it to be a giant iguana of an ancient era. The additional discovery of another fossilized creature would lead to naming a third ancient animal: *Hylaeosaurus*.

Almost twenty years after the discovery and description of these three animals, *Megalosaurus*, *Iguanodon*, and *Hylaeosaurus*, by two separate paleontologists, it would be a third person who finally grouped these animals into a brand-new family. In 1842, Sir Richard Owen examined the three descriptions and realized their similarities marked them all as being part of the same group of lizards separate from those, they saw every day. With their great size he dubbed the superorder of the saurischian reptiles “Dinosauria.” Thus, the word dinosaur was born (*Dinosaurs: A Visual Encyclopedia* 29).

It was at the first of the World’s Fairs, commonly called the Great Exhibition, that the first reconstructions of dinosaurs were made (Langille 8). Under the direction of Sir Richard Owen, Benjamin Hawkins was instructed to create life-like dinosaurs based on the illustrations and scientific knowledge of the time. There was even a dinner that was housed inside the *Iguanodon* structure before it was finished. (See fig. 10)



Fig. 9. Crystal Palace Dinosaurs Today from: Anderson, Ellen. “A Brief History of The Crystal Palace Dinosaurs.” *South London Club*, South London Club, 29 Aug. 2017, www.southlondonclub.co.uk/blog/a-brief-history-of-the-crystal-palace-dinosaurs.



Fig. 10. “Dinner in the Iguanodon | Crystal Palace Dinosaurs.” *Professor Joe Cain*, 18 June 2018, profjoecain.net/dinner-iguanodon-crystal-palace-dinosaurs/.

In the late 1880s, another scientist, Harry Seeley, would branch Dinosauria into two distinct groups based on the structures of their hips; saurischian or lizard-hipped dinosaurs which include theropods and avian-dinosaurs; and ornithischian or bird-hipped dinosaurs, which include ceratopsians and their cousins (Fastovsky and Weishampel 20). Today’s modern dinosaurs, now known as birds, are considered lizard hipped. It was an accidental mix up of the two names in Seeley’s work that has stuck through time.

In America during the late 1800s, two paleontologists who were once close friends and allies, were now waging an all-out war to see who the best was at finding and naming the most dinosaurs (“O.C. Marsh and E.D. Cope: A Rivalry,” *PBS*). Edward Drinker Cope of the American Academy of Natural Sciences in Philadelphia, and Othniel Charles Marsh of the Peabody Museum of Natural History at Yale, were once close friends and colleagues. While it was dinosaurs that brought them together, it would be dinosaurs — or rather, a marine reptile and the placement of its head — that would not only break them apart but ruin them both financially.

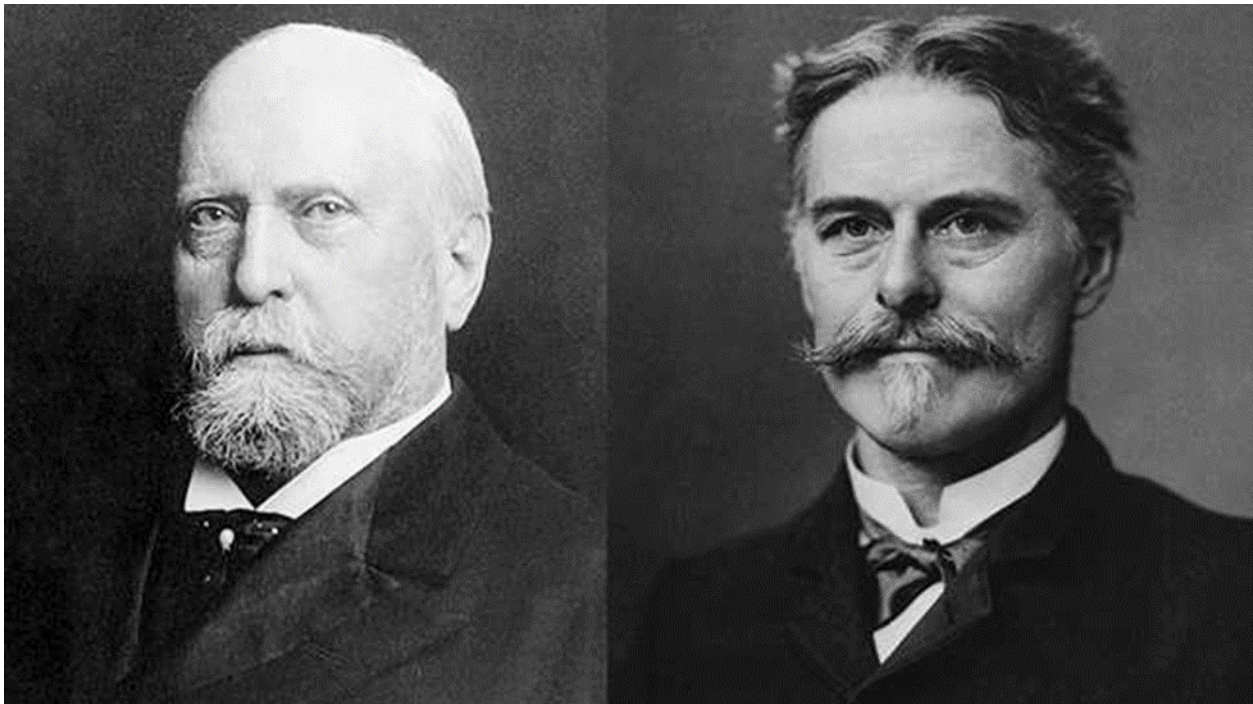


Fig. 11. Othniel Charles Marsh (left) and Edward Drinker Cope (right), from: “O.C. Marsh and E.D. Cope: A Rivalry.” *PBS*, Public Broadcasting Service, www.pbs.org/wgbh/americanexperience/features/dinosaur-rivalry.

It started off with a simple jab at knowledge of anatomy by Marsh to Cope. Cope had placed the head of an *Elasmosaurus*, a type of large marine reptile known as a plesiosaur, on the wrong end (“Bone Wars: The Cope-Marsh Rivalry,” The Academy of Natural Sciences of

Drexel University). Although Marsh only said that he was the one to correct Cope some 20 years later, the story has stuck. Evidence shows it was Joseph Leidy, a paleontologist under Cope who published a correction letter shortly after Cope. Regardless, the already strained relationship had broken, and the war begun.

With both men having money to spare due to a well-off family in the case of Marsh or an inheritance from a rich uncle in the case of Cope, the two began a rivalry that would best be described as a battle to be the one to discover the most dinosaur species in the Americas. Thus, began the “Bone Wars.” Their workers would head out to the Wild West, where there were reports from Lewis and Clark of large, strange bones jutting out of rocks. Both men spent money on the most advanced equipment available for their field workers and from farmers, bought up farmland that held a promise of fossilized remains. Their work would lead to the largest number of discoveries of new dinosaur species, and other animals, that the country had ever seen. Unfortunately, neither man was above sabotage. Bribery of quarry owners to ensure that one was sent the fossils instead of the other, scandalous publications in both newspapers and respected scientific journals decrying the other for vices both real and imaginary, guns being sent to their quarry men with orders to shoot anyone who entered without permission, and even dynamite used for both excavation of fossils and to ensure their destruction, was par for the course. While both men succeeded in discovering over one hundred new species and genera of dinosaurs, their petty war was all for naught. Both Cope and Marsh were left in financial ruin. The destruction of bones that may never be recovered from quarries also left the world wondering just how many species were lost in their fight.

Dinosaur Classics Era: 1900-1980

With the turn of the clock into the twentieth century, museums became packed with collections from paleontological expeditions all over the world which were finding an ever-increasing number of new species of dinosaurs. The public became more and more enamored with these creatures and the discoveries being made by scientists. Continued discoveries throughout the century brought new understanding and evolving representations of dinosaurs. These years saw some of the most controversial and well-known paleontologists and collectors, such as Barnum Brown, Henry Fairfield Osborn, and Roy Chapman Andrews.

Barnum Brown and Henry Fairfield Osborn worked together, financed by the AMNH in New York City, for various expeditions into Wyoming, the Hell Creek formation in Montana, and even into Alberta, Canada. Brown and Osborn are both credited with the first discovery of *Tyrannosaurus rex* and the full description of the species. The two men were also known for traveling in Alberta on the Red Deer River via flatboat. Photographs of their paleontological finds along the river have been analyzed and old sites re-discovered for continued research and excavation.

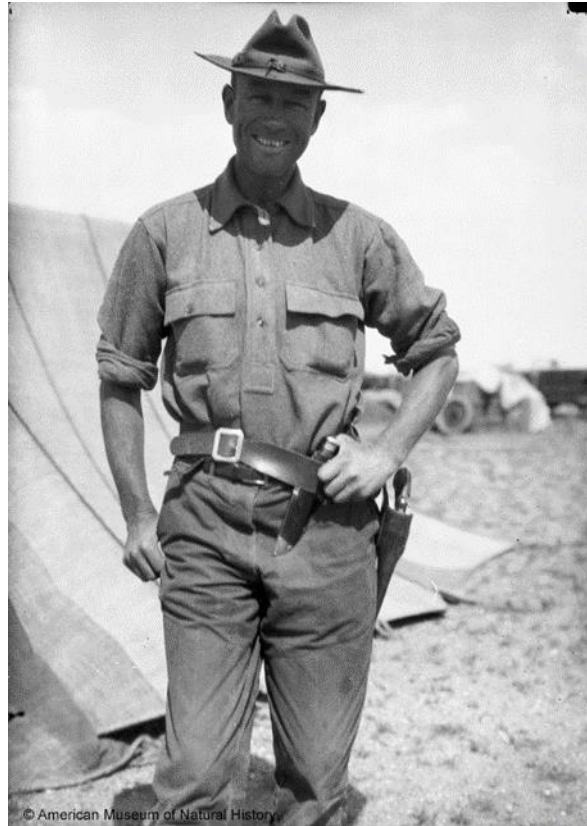


Fig. 12. Roy Chapman Andrews from “Who Was Roy Chapman Andrews.” *Roy Chapman Andrews Society*.

Roy Chapman Andrews was another paleontologist made famous by expeditions and finds in the Gobi Desert and northern China (*Roy Chapman Andrews Society*). His explorations were worldwide and included the exploration of both poles and the untamed jungles in between. Yet, he is best known for his discovery of eggs in the 1920s which he misinterpreted as belonging to *Protoceratops*, a species that had been previously discovered. His discovery of a fossilized theropod dinosaur, *Oviraptor*, would bring new behavioral interpretations. It was later found that the egg nests he discovered were that of the *Oviraptor*, although he discovered *Protoceratops* nests later.

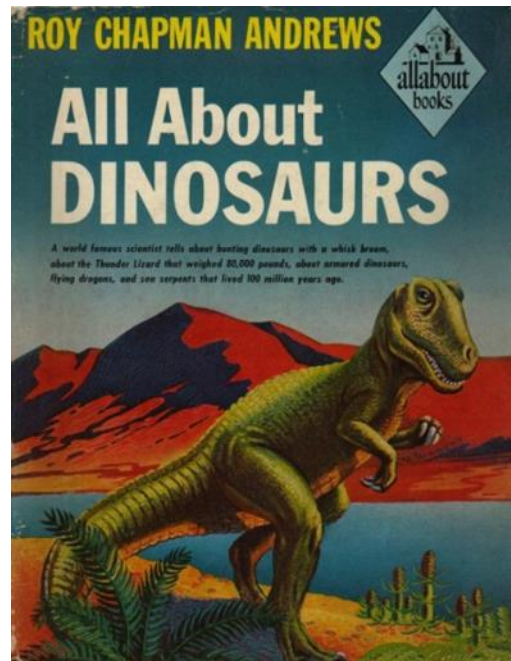


Fig. 13. Book about Dinosaurs for young readers by Roy Chapman Andrews from:

“Who Was Roy Chapman Andrews.”

Andrews would become the director of the AMNH, encouraging continued expeditions and discoveries. After his retirement from the museum in 1941, he continued to talk and write about his experiences.

With the rise of the Great Depression and the Second World War, dinosaur discoveries slowed dramatically, yet there were still some strange species that would be discovered and re-discovered after the war. Prior to and during the First World War, a dinosaur was described in Egypt by German paleontologist, Ernst Stromer.



Fig. 14. Ernst Stromer from: Schofield, Nick. “Iterations of a Theropod: An Abridged History of Spinosaurus.” Rex Machina, 6 Mar. 2019, Updated 27 Apr. 2018, rexmachinablog.com/2018/04/27/iterations-of-a-theropod/. Accessed 6 Mar. 2019.

The frontal part of the lower jaw of the animal was long and narrow, like that of a crocodile, while the vertebrae of the body held long vertical processes. The name given to the animal would describe it as the Egyptian spine lizard: *Spinosaurus aegyptiacus* (Schofield, “Iterations of a Theropod: An Abridged History of Spinosaurus”). During the Second World War, though, the only known specimens were destroyed and *Spinosaurus* was lost to the world. Thankfully Stromer’s detailed illustrations survived, and with increased research and discoveries in the latter half of the twentieth century the *Spinosaurus* lived again.

These are just a few of the many discoveries that occurred and drove fervor for more of the giant monsters, which would eventually lead to movies and other pop culture phenomena. Paleontologists really were the first to push dinosaurs into the limelight of popular culture. These began as animated shorts, stop motion animated movies, novels, and even using dinosaurs as advertising mascots for gasoline and other oil products. It was, and still is, easy to make dinosaurs accessible to the public through popular culture.

*Important Voices of the Dinosaur Classics Era*Barnum Brown

Named after the famous, and infamous, P.T. Barnum, Barnum Brown was one of the most prolific paleontologists of the early 1900s. Born to pioneer parents in 1873 in Kansas, Brown lived a life of adventure and passion (Dingus and Norell 5). His family's property was in the middle of a geologic treasure trove of fossils, which would become the building blocks for Brown's fascination with ancient life. Encouraged by his parents, Barnum would study and collect these strange fossils, appreciating the natural world just as his parents encouraged him (Dingus and Norell 17).

In his early years of education, Brown was educated by Samuel Wendell Williston. Williston had been part of the famous rivalry of Marsh and Cope as he had worked under Marsh. This rivalry would follow both Brown and Williston through Brown's college education as they began expeditions into the Badlands of South Dakota (Dingus and Norell 25). The competitive nature of paleontology in the late 19th century meant that many sites were burglarized and pirated by other scientists - especially those who worked for one of the feuding scientists in the east – specifically Marsh or Cope.

While in South Dakota, Brown and his advisor encountered other paleontologists in the field who would later lead Brown to the AMNH in 1896 under the same people he met in the field years before (Dingus and Norell 59). Personalities in these early years include Henry Osborn and others who would guide Brown back out into the field to hunt ancient mammal bones. Osborn's specialty was paleomammology, the study of ancient mammals in the fossil record. Bell Hatcher would then lead Brown back to the badlands and the ancient reptiles which Brown was more than eager to find (Dingus and Norell 61-78).

At the AMNH, Brown would often be sent off in search of ancient mammals by Osborn, leading Brown to Patagonia and making him a world traveler as he worked with Bell Hatcher to find ancient horses. But his return would mark the start of his own expedition into the Hell Creek Formation in Montana, the holy grail of Cretaceous age Dinosaurs of immense size. The field of dinosaur collection had expanded during Brown's time in Patagonia, and with the Carnegie Museum in Pittsburgh and the Field Museum in Chicago searching to expand their own collections, it was another bone rush to find the biggest and best specimens for museum collections (Dingus and Norell 96-99).

Brown had his work cut out for him. While he discovered many bone core horns from *Triceratops*, along with fragmented skull pieces, he was determined to find something far larger than bits and pieces for the collection at the AMNH (Dingus and Norell 98-99). He would discover a large collection of fossils from a carnivorous dinosaur in October of 1900, sometime after his official season, but the discovery was large enough that Brown was determined to gather it and stayed well into November (Dingus and Norell 99-100).

While the dinosaur expedition was where Brown intended to continue, Osborn sent him on different expeditions the following year, searching once again for the early mammal fossils that were the subject of Osborn's research. It would not be until 1902 that Brown saw his precious Cretaceous beds. In August, after learning from Osborn that his previous large carnivorous dinosaur was nearly useless to the scientific or museum community, Brown discovered another unknown large carnivorous dinosaur that would lead to his name being in the history books - the *Tyrannosaurus rex*. (Dingus and Norell 107-109). He would work to cut down on the cost of shipping the massive animal, preparing as much as he could in the field. He also cut down on costs by using flour paste instead of the more expensive plaster.

Shipping his discoveries back east, it would take two to three years before the world was introduced to *Tyrannosaurus rex* in the paper published by Osborn from the AMNH. This was only the beginning of the discoveries that Brown would have under his belt, and with many more expeditions over time, he would fill the coffers of AMNH's collections with specimens and stories far beyond imagining (Dingus and Norell 145-169).

Brown's discoveries and expeditions led him to be not only a prolific paleontologist but a prolific writer for the AMNH as well. His many papers about his discoveries were made available to both the general public and academia. They were easy to read and understand and his work encouraged the public to see these animals and learn more about the ancient past of not just North America, but of the world. In a way, he lived up to his 'showman' inspired name and sparked the excitement for paleontology in the early 20th century.

Brown is known for his discovery of *Tyrannosaurus rex* (*T. rex*), and its impressive size made an equally impressive impact on anyone who viewed it. Originally posed in a 'tripod' style, back nearly perpendicular to the ground, with tail dragging along the ground behind the hind legs, it reached well over 40 feet tall. This imposing posture would be a major feature in the AMNH until the 1990s, well after scientists realized the inaccuracies of the pose. This failure of updating lead many children even into the mid-1990s to believe that *T. rex* walked fully upright with its tail dragging on the ground. If anything, it was a thanks to Jurassic Park and the dedication to accuracy of science that the public perception began to change to view *T. rex* in the more accurate position. At over 20 feet high at the hips, a new pose gives the ancient animal a more imposing look, where the jaws are much closer to the ground and the tail swings high above. This change makes the animal's fossilized remains look far swifter and more dangerous than an upright, tail-dragging, lizard-like animal.

John Bell Hatcher

A contemporary of Barnum Brown, John Bell Hatcher worked under Othniel Charles Marsh when he was accepted into Yale. Hatcher had already collected many fossils from the Carboniferous period from his work in coal mines (Dingus, *King of the Dinosaur Hunters*). After graduating from Yale, Hatcher was hired by Marsh, who was notoriously hard to impress.

Despite Hatcher's humble plea to Marsh for, "...a job collecting fossils, anywhere, anytime, at any salary," Hatcher's strong, independent personality soon came to light (Dingus, *King of the Dinosaur Hunters*). Working under one of Marsh's sniped workers from his competitor Cope by the name of Charles H. Sternburg, Hatcher relayed in his required weekly letters that his working conditions were poor and that he could not write of his discoveries because he had no ability to work independent of other workers.

Even while working in the Long Island quarry in Kansas, Hatcher helped to uncover several important fossils, including ancient fossil rhinoceros, body parts of mastodon, as well as teeth and tusks. Hatcher mentions in many letters to his boss Marsh that he bemoans Sternburg's packing and ill treatment of the fossils (Dingus, *King of the Dinosaur Hunters*).

Most of Hatcher's early work in 1884 was with the ice age deposits, discovering ancient mammals, much to Marsh's enthusiasm. He continued for nearly a decade under Marsh's employment, discovering mammal fossils from Kansas to Texas. Marsh continued to send Hatcher to the west, and discoveries of large fossils in excess of thousands of pounds put Hatcher's skill in excavation to the test. Yet those who worked under Hatcher praised him for his work in not only successfully extracting fossils with little damage, but also being able to transport them up steep canyons to the railroad tracks to be shipped back east (Dingus, *King of*

the Dinosaur Hunters). In 1897, Hatcher left to work elsewhere, frustrated by Marsh's stingy payments for his expeditions as well as his reluctance to let him have a prominent position in the Peabody museum.

By the late 1890s and into the very early days of the 1900s, Hatcher's team had begun to uncover dinosaur bones. Shoulder blades and femurs of massive *Diplodocus* and other large herbivores were shipped to the Carnegie Museum. The discovery of *Diplodocus* would mark Hatcher's biggest discovery, and he would push for the animal to be cast and sent around the world to share with other museums. Nicknamed "Dippy", it would become the mascot for the Carnegie Museum.

Hatcher succeeded Marsh, who had passed away, as the head paleontologist for the United States Geological Survey. He was asked to finish the project on Ceratopsians that had been started by Marsh. Not only did Hatcher complete the project, but also added to the project by commissioning Charles R. Knight to paint one of his now famous scenes depicting *Triceratops*.

Having worked with inspiring paleontologists, and despite being ill throughout his life with what modern scientists now believe to be brittle bone disease, Hatcher left an impact on everyone he met. He passed away from typhoid fever in 1904, and many other scientists wrote kindly of him. His influence would be so important that the Smithsonian Museum of Natural History would name their *Triceratops* specimen "Hatcher" after him.

Hatcher's major discoveries in the world of Dinosauria included the genera *Triceratops* and *Torosaurus*, two ceratopsians that were described by Marsh. The former would quickly become one of the most popular with the public and would be made into many toys and movie characters. Both were posed in very similar ways – tail dragging on the ground, rear legs fully

elongated, front legs squat with elbows pointed out, and head low to the ground. This ‘bulldog’ pose was like the ‘tripod’ pose of *Tyrannosaurus rex* in popularity and would not be changed in many museums for decades, and in one museum’s case, not at all.

Fossil evidence found of ceratopsian trackways informed paleontologists that *Triceratops* and other large ceratopsians like *Torosaurus* walked fully upright, tail held high above the ground, with only a slight outward splaying of their front legs. Biomechanical experts examined the bones in the forelimbs and looked at the muscle attachment scars, which also supported the upright positioning of these animals. The updated pose has taken some time to correct in smaller museums where the capability of recasting specimens is not feasible. Larger museums, such as the Natural History Museum at the Smithsonian Institute, were able to make multiple casts of individual parts of their *Triceratops* in order to repose ‘Hatcher’ in their exhibits several times.

Henry Fairfield Osborn

Henry Fairfield Osborn was a well-educated man from Princeton when he arrived at his position as Curator of the Paleomammology department at the AMNH (Alexander, E. P. 19). As a professor at Princeton, Osborn was one of the first paleontologists to propose a revolution in the display of fossilized remains. He proposed that they be put on display to the public fully articulated (Alexander, E. P. 23). His mission was to provide the public with an educational experience outside of traditional schooling. His position at AMNH would lead him to hire contemporaries like Barnum Brown, and begin to build up the museum collections, at first focusing on mammal bones rather than dinosaurs.

Osborn’s curatorial position gave him the ability to not only continue his research in paleomammology, but also help identify new species of dinosaurs brought in by Brown from his

expeditions to Hell Creek and elsewhere. He was well known and appreciated by the public for his scientific explanations that were well understood and received. At that time, museums, like libraries, were another institution of learning for the public. The AMNH was a teaching tool rather than limiting itself to research (Alexander, E. P. 20). Osborn was asked by the President of Trustees of the museum, Morris K. Jesup, in 1899, to become Jesup's administrative assistant. After Jesup passed away a few short years later, it was Osborn who would succeed him.

For twenty-seven years, Osborn served as the president, and under his guidance the museum not only flourished but became a national and international institution for learning (Alexander, E. P. 23). There were over one hundred expeditions a year by the 1920s, and the AMNH was ahead of both the Chicago Field Museum of Natural History and the Smithsonian Museum of Natural History with these scientific expeditions and discoveries. It was even challenging the British Natural History Museum in London (Alexander, E. P. 23).

Under Osborn's presidency, many famous names would come to work or donate to the museum. J. P. Morgan donated privately to the museum, as he was Osborn's aunt's former husband. Charles R. Knight was brought in to provide illustrations and paintings for the museum's halls. Adventurer Roy Chapman Andrews came in the 1920s and his famous expeditions into central Asia would bring discoveries of both nests and eggs of dinosaurs. Osborn's excitement that his previous belief that museums were to be places of education was verified by the public's enthusiastic welcome of new exhibits (Alexander, E. P. 25).

Osborn and the AMNH were often pulled into public discourse, which showed the strange dichotomy of his beliefs. When the Scopes Trial was sweeping the nation, Osborn, a devout churchgoer, opposed William Jennings Bryan's firm belief that the theory of evolution should not be taught in public schools and was placed in the same boat with other atheists by

Bryan. Osborn was also an outspoken member of the eugenics movement and proclaimed the superiority of the Nordic race to others and denounced the intelligence of the African American and Asiatic races (Alexander, E. P. 27-28). Yet at the same time Osborn and other trustees pushed to educate immigrants from other countries that came to the United States. When he visited Germany after his retirement in 1934, he enthusiastically praised the Nazi movement. He passed away the next year without knowing the full horrors yet to come.

Osborn was a confounding and confusing man. On one hand, he was a well-educated man who pushed for public education being the foremost mission of the AMNH, yet he praised and agreed with some of the most horrible ideas to come out of the eugenics movements and the Nazi party. History has looked kindly on his many achievements, perhaps only because he passed away before the Second World War. It is hard, at times, to separate the man from the work, and knowledge of Osborn's beliefs have tainted his accomplishments for many who look to the AMNH as a pinnacle of truth and scientific advancement.

Osborn described the discoveries of the scientists and field paleontologists below him. While he did not discover any dinosaurs, he was the one, with the help of the field paleontologists, to give a detailed scientific description of the animals. His scientific descriptions have been corrected over time to better reflect our understanding of how the animals stood and moved.

Roy Chapman Andrews

The man who inspired Indiana Jones really does not need much of an introduction. Roy Chapman Andrews was born on January 24, 1884, in a small town in Wisconsin. At an early age, like any young child in those days, he used the fields and woods surrounding his home as his playground (*Roy Chapman Andrews Society*). As a young man, he learned taxidermy and from

this skill set, earned money to go to college. At Beloit College, Andrews studied English, but also anthropology and evolution in the Logan Museum of Anthropology.

When he graduated in 1906, he began work at the AMNH by sweeping floors and helping with taxidermy. A scant 5 years later, Andrews would be leading expeditions to study whales and seals, filming their behaviors and putting to the test the zoological knowledge he learned while in the museum (*Roy Chapman Andrews Society*).

His expeditions into Mongolia and Central Asia were funded by both the AMNH and their many trustees, including J. P. Morgan and other wealthy financiers, under the presidency of Henry Fairfield Osborn. He would write detailed journals that would be published, and with his background in English it would not only be informational to read, but exciting (Andrews 17). Three major expeditions would lead to many important discoveries that would rock the paleontological world. The discovery of nests, eggs, and hatchling dinosaurs, along with well-preserved fossils of *Protoceratops* and *Oviraptor* and other prehistoric mammals, brought a movie-like atmosphere to the AMNH (Andrews 19).

There is little doubt that if the political turmoil in central Asia had not increased to dangerous levels in 1930, Andrews would have continued his work there (*Roy Chapman Andrews Society*). Instead, Andrews would return to the AMNH and become acting director. He pushed the AMNH to conduct more research and study of fossils and finally retired in 1941 (*Roy Chapman Andrews Society*).

It would not be a quiet retirement. Andrews was passionate about teaching and telling his stories. He would publish memoirs of his life as well as children's books about dinosaurs in the mid- to late-40s, and his adventurous spirit would not end until the 1960s (*Roy Chapman Andrews Society*). His work would spark the archetype for the adventurous archeologist, one that

would take over the big screen as Indiana Jones. His public popularity would inspire children to see the world as one large adventure after another, and many would follow in his footsteps.

The many discoveries of Andrews can fill books on their own, but one of his most amazing discoveries was of two fossilized dinosaurs of different species, entangled together in a battle, even in death, and a nest of eggs not too far away. The two dinosaurs would be named *Protoceratops* and *Oviraptor*. Andrews named the raptor based on the assumption that the nest nearby belonged to the *Protoceratops* and that the strange beaked raptor was attempting to steal the eggs; ova meaning egg, and raptor meaning thief, in Latin.

It would not be until CT technology was able to analyze the eggs, and more nests of *Protoceratops* with hatchlings, that Andrews' naming would be realized as a misnomer. The nest was not that of the smaller *Protoceratops* but rather that of the *Oviraptor*. The original narrative of a protective parental ceratopsian defending its nest from an egg thief is not correct. It was the *Protoceratops* that was invading the territory and endangering the nest of the *Oviraptor*. It was the meaning of the name *Oviraptor* that gave the public the perception that the animal was a nest raider. Later discoveries of *Oviraptor* fossils determined that they demonstrated a 'brooding' behavior, where a bird will generally sit on its eggs to incubate them and not leave them until hatched. This fossil evidence also showed it was a fully feathered animal. Scientists now believe that *Oviraptor* specialized in eating clams and other tough shellfish in shallow waters. While dinosaur names are almost never changed (with exceptions being the same species named differently by two different paleontologists), names that describe behaviors should be corrected in museums, especially when it comes to *Oviraptor*.

The Dinosaur Renaissance: 1980-1990s

The 1980s and 90s brought about the dinosaur renaissance and many controversial theories about dinosaurs. Starting in the late 70s new theories and discussions about many of the most famous dinosaur genus and species were rocking the paleontological and scientific realm, as well as popular culture.

In 1976, Dr. John Ostrom was one of the first paleontologists to bring back a theory presented back in 1860 by Thomas Henry Huxley; that dinosaurs had more in common with modern day birds than they did with their assumed reptilian relatives. His discovery of additional fossils of the dinosaur *Deinonychus*, would also prompt him to propose another radical theory – that dinosaurs were warm-blooded. His published papers were met with ridicule and a fierce argument against such a drastic change in thought. There had never been, to that point, any large, feathered dinosaurs and the small *Archeopteryx* was barely considered even a bird due to its reptilian appearance (“*Archaeopteryx lithographica*,” *Natural History Notebooks*).

Yet, Ostrom’s theory caught the attention of one man who would take the reins from him for his doctoral dissertation. Dr. Robert “Bob” Bakker. Bakker was well into the birds-are-dinosaurs side of science and not only based his entire dissertation around building evidence for the acceptance of the theory of warm-blooded dinosaurs, and would coin the term for the era the “Dinosaur Renaissance” (*The Dinosaur Heresies*).

His research book, *The Dinosaur Heresies*, published in 1986, would shake the world again. Bakker is a strong proponent for warm-blooded, adaptive, swift, and intelligent dinosaurs. He provided evidence about the nurturing nature of *Allosaurus*, a theropod dinosaur considered to be a non-mothering species. His theories would prove accurate after the additional discovery of numerous fossils (Bakker, *The Dinosaur Heresies*).

Another scientist would also shake perceptions of dinosaurs as well. John “Jack” Horner does not have a doctoral degree in paleontology, but his self-education and knowledge discovered in the field make him an expert. Horner’s argument would put a spotlight on what could easily be considered everyone’s favorite: *Tyrannosaurus rex* (*T. rex*). His argument would divide people into one of two groups over one specific question – was *T. rex* a predator or a scavenger? Horner proposed that the mighty tyrant lizard king was an absolute scavenger due to many factors, including but not limited to the size of its eyes and the lack of useful front limbs. Continued research proved that *T. rex* was most definitely a predator. The eyes were perfectly positioned with binocular vision, and the arms did not need to be used when there existed a jaw lined with large two-inch diameter teeth and a bite force of 12,800 pounds.

While Jack Horner has had some theories disproven, he has been able to positively and accurately shape people’s perceptions about other dinosaurs. Horner is also known for his discovery of *Maiasaura*, a hadrosaur genus he discovered that nested and even cared for its young. His discovery helped to rebuild the perception of all dinosaurs as having the potential for caring mothers and family units. Horner’s work also would throw into perspective how we view modern birds. His work in genetics has made people realize the animals we rely on for eggs and meat are very much the descendants of dinosaurs. Horner’s work on chicken embryos has managed to activate several genes that lay sleeping in their DNA, making chickens grow longer tails and longer beaks with teeth (Geggel, “Dino-Chicken Gets One Step Closer”).

The end of the decade and millennia would also bring about a final answer to what happened to end the reign of dinosaurs. The discovery of not only an iridium rich layer at the end of the Cretaceous period 66 million years ago (iridium being a very rare earth metal often found in asteroids and meteors), but also a large crater in the Yucatan peninsula in Mexico dating to the

end of the Cretaceous, gave rise to the thought of an asteroid impact being the extinction event that ended the non-avian dinosaur supremacy. With continued research and discoveries through the late 90s and into the early 2000s, the last days of the non-avian dinosaurs was firmly agreed upon by scientists – a giant rock from space had been their death knell.

The Modern Dinosaur Model: 2000s to Today

The new millennium would bring about a slight stagnation in dinosaur passion by the public, but not in scientific discoveries. While no paleontologists showed up with more star power than that of Horner and Bakker, discoveries across the globe would put dinosaurs in new light, and the discussions would add to the thought of potentially bringing these beasts back.

Scientists across the globe agreed that birds were, in fact, dinosaurs. Discoveries such as the feathered *Yutyrannus* would bring ideas that *T. rex* may also be feathered. More dinosaurs of the raptor family were found feathered, and more transitory species of para-avian, or near avian, dinosaurs were uncovered as well.

Dinosaurs surged into the limelight again and again with news articles crediting the discovery of the largest sauropods from China, new species from the Triassic, the very early age of dinosaurs, and new interpretations and finds suggesting larger raptors that bridge the gap between the size of *Utahraptor* (a six-foot tall, ten foot long raptor) and the massive *T. rex*. Rediscovery of *Spinosaurus* through more complete specimens proved that it was indeed larger than the mighty *T. rex*, but the battles portrayed in movies would be debunked when scientists relayed it was a semi-aquatic fish eater and would no doubt be trounced by the terrestrial dino-killer *T. rex* if they were ever to meet through time and distance.

As of March 2019, there were new discoveries of fossils from the very end of the Cretaceous, further providing information on how the ecosystem collapsed from the asteroid impact (Preston, "The Day the Dinosaurs Died"). Robert DePalma was a graduate student in 2013 when he made a discovery in North Dakota in what is known as the Hell Creek formation. His discovery was not of a dinosaur, but of tropical fish with glass in their gills. His research

would be examined, and it would be confirmed as being fossils from shortly after the impact of the meteor far to the south (Preston, “The Day the Dinosaurs Died”).

In this era of rapid and sometimes conflicting updates, it is clear to see how museums can quickly fall behind in retrofitting their exhibits and revising their narratives as they rush to keep up to date with the latest information. How do they do it and what authority do they rely on?

Chapter V: Dinosaurs in Media History

The Early Motion Picture Years (1920s)

Before the advent of the motion picture, books, magazines, and articles published by museums and scientists were often the best way to bring dinosaur media into daily life. Books, such as *The Lost World* by Sir Arthur Conan Doyle, and dime store novels about dinosaurs living side-by-side with modern man, were made for popular public consumption of all thing's dinosaur. Magazines and publications from museums also were read by fellow scientists and professionals. For pop culture though, it was the movies that brought dinosaurs to life.

It was in 1912 when the world saw its first dinosaur moving on a big screen while simultaneously its first keyframe animation. Keyframe animation is when key still frames are made for the start and end points of a motion, and the points in between filled with motion frames. *Gertie The Dinosaur* is a short thirteen-minute film that can still be found on YouTube today. It combines film shot outside of the AMNH with keyframe animation (McCay, *Gertie the Dinosaur*). Gertie was a simple line drawing of a dinosaur, depicted as a long-necked lumbering creature who exits her cave at the prompting of McCay, the animator, and one of the key actors in the film. She obeys commands given to her by McCay with a few comical 'disobeying' moments and interactions with other creatures in her hand drawn environment. This short film was the first recorded 'movie' that featured dinosaurs walking on the big screen. But it certainly wasn't the last of the early 1900s' movies. Stop motion animation, affectionately known from those early years as 'claymation, due to the medium used for the puppets, helped to bring dinosaurs to life. The films continued to spur the public's passion for dinosaurs.

While Gertie was the first, from 1913 onward, the movie world found their stars in dinosaurs. *Brute Force* was released in 1913 and showed cavemen fighting *Ceratosaurus*, a

dinosaur distinct for it being a theropod with a single nose horn, at the doorstep of the cave home (Farlow and Brett-Surman 676). *The Lost World* by Sir Arthur Conan Doyle was one of the first books to be turned into a feature length movie. Not to be confused with the sequel to *Jurassic Park* in the late 1990s, the book and the first movie were about the discovery of a secret land that escaped the ravages of time. The claymation dinosaurs and other prehistoric life moved across the silver screen to the thrill of viewers (Farlow and Brett-Surman 679). They were all modeled after the artwork of Charles R. Knight, specifically the painting done in one of the halls of the AMNH (Farlow and Brett-Surman 679). Another incredibly popular and classic movie was *King Kong*. Although focusing on the story of the giant gorilla, Kong, the movie shows that Skull Island is more than just an island home for giant apes. Dinosaurs and other strange creatures roamed the island and threatened the humans that lived there (Farlow and Brett-Surman 684).

Claymation would eventually be overtaken by other practical effects – more famously by men in giant rubber suits, and more infamously by real lizards with glued-on frills. From the 1920s to the 1970s, the style of these movies would continue to improve, and the increase in practical effects and puppetry would lead to the innovations of the 1980s and 90s.

The 80s

This section focuses on three movies and examines other media and pop culture tropes that exist and permeate the minds of guests of museums and consumers of popular culture. The movie industry in America is known for triple A films that will thrill you, make you laugh, make you cry, and everything in between, yet when it comes to monster movies, there are few better monster in history than dinosaurs. It is no surprise that the movie industry takes a great deal of liberty with dinosaur representation in their movies, but how much is scientific fact and how much is fiction added for raising the thrill of the blockbuster? How do museums fit into this battle between science fact and fiction? You may be surprised how much popular culture can force the hands of museums to bring guests into the doors with fantastic recreations.

1986 was full of exciting dinosaur discoveries and a movie that would become a childhood favorite for many children born in the late 80s and early 90s. Three huge names were behind the now familiar title, *The Land Before Time*—George Lucas, Steven Spielberg, and Don Bluth— which arrived on the scene with all its childhood dinosaur adventure glory.

Based in the late Cretaceous period, the story follows a young *Brontosaurus*, called Littlefoot, as he and his mother and grandparents migrate to a place called the Great Valley, a paradise for herbivore dinosaurs, far away from a brutal empty outside world full of “sharp teeth” dinosaurs (Bluth, *The Land Before Time*). On the way, Littlefoot and his mother are separated from his grandparents and the rest of the herd when attacked by a large *T. rex*, leading to his mother’s valiant defense, but untimely death at the jaws of the sharp tooth. Alone in the world, Littlefoot continues and meets other friends, all separated or left behind by their families. Following instructions left by his mother, Littlefoot leads the party of little dinosaurs through dangerous landscapes and even bigger, dangerous sharp teeth to the Great Valley where they are

reunited with their families. Released the same year as the book *The Dinosaur Heresies* by Dr. Robert Bakker, the movie is surprisingly accurate when compared to Bakker's revolutionary thoughts on dinosaurs. People flocked to see the animated movie, and since its original release there have been thirteen—yes *thirteen*—sequels.

For museums, the movie brought in more visitors and created a bigger passion for both dinosaurs and the ancient environment in which they lived. People were eager to learn and to have their children learn about these ancient creatures. Museums were still displaying older versions of the dinosaurs, but they were beginning to play catch up.

While aimed at young children and families, the movie takes liberties with its depiction of dinosaur behavior and life. It follows the narrative of active warm-blooded dinosaurs that most paleontologists of the time would argue against. Toys were made, and children played pretend based on the adventures of these little dinosaurs. The toys were not scientifically accurate but mimicked what the movie showed. They were easy to produce and often found as promotions at food chains.

The 90s

Jumping ahead to the 90s, dinosaurs were often shown in movies and on television. Shows like *Land of the Lost*, *Dinosaurs!*, *Mighty Morphin' Power Rangers*, and *Barney*, continued to treat children and adults alike to the lives of dinosaurs. It would be the novel *Jurassic Park*, published in 1990, and the correlating movie released in 1993, that would once again make dinosaurs a household topic of conversation. The 1990s was the start of the dinosaur renaissance, and the movie would continue to bring dinosaurs front and center.

Using blood from mosquitoes preserved in fossilized amber, geneticists in *Jurassic Park*

were able to extract dinosaur DNA (Spielberg, *Jurassic Park*). The movie explains that although the DNA is not complete, they use frog and other reptile DNA to complete the sequences and then create a viable, female, embryo (Spielberg, *Jurassic Park*). From there, the dinosaur is hatched and raised. With continued collecting of more mosquitos containing amber with new dinosaur genetic material, the park is filled with both dinosaurs and people.

The story follows the owner of the park, John Hammond; his grandchildren, Timmy and Lex Murphy; Dr. Ian Malcolm, a mathematician; Dr. Alan Grant, a paleontologist; Dr. Ellie Sattler, a paleobotanist; and ill-fated lawyer, Donald Gennaro, on a private tour of the park as potential endorsers before the park fully opens to the public. Two forces are working against the park's opening to the public: a tropical storm, and John Hammond's own nephew, Dennis Nedry. Nedry is attempting to steal viable dinosaur embryos to sell to a competing company of InGEN and Hammond.

The chaos begins when power goes out. Thanks to Nedry, the predatory dinosaurs figure out they are free to escape the loud thunder. It does not end as the terrifying *Velociraptors* also escape their private pen, and now are on the hunt for the human inhabitants. While fleeing, Dr. Grant discovers that the dinosaurs have evolved in their own way and are breeding without any regulation from the scientists; a result of splicing DNA of reptiles that can change their own biological sex in cases of extreme lack of diversity.

The group must survive until the storm passes, and a rescue can come from the mainland. From escaping the marauding *T. rex* who manages to hunt those that move, to outsmarting the terrifying *Velociraptors* who hunt in packs, the movie is a thriller; and is a perfect allegory for the arrogance of man to control nature and play God.

The movie adaptation of *Jurassic Park* would be directed by Steven Spielberg and feature live actors, animatronic dinosaurs, and a total of only six minutes of CGI. These life-size dinosaurs would shock and awe people. The sound design would give people a chill at hearing the roar of the *T. rex* and the communicative barks and snarls of the *Velociraptors*.

When compared to the scientific theories at the time, the accuracy of the movie fell far behind. Oversized raptors, undersized *Dilophosaurus*, and a condition known as ‘shrink wrapping,’ or skin so tightly drawn over bone with almost no muscle mass under it leaving the animal looking like skin and bone, would have many experts scratching their heads. Perhaps the most glaring inaccuracy was the lack of any feathers on the *Velociraptors*, which by that time were known to be, if not a direct ancestor of modern birds, then a very close relative (Spielberg, *Jurassic Park*).

When it came to the toys of the 90s, I will admit I was one of those children who was obsessed with getting them all, and I still have them. Most of the big-ticket toys had electronics built into them, like the *T. rex*, who not only would stomp, but also roar. Vehicles and catchers for other dinosaurs like *Velociraptor*, were available too, as well as figures of the human characters. It was a big seller, and it would add to the movie industry’s formula that ‘lizard-dinosaurs sell.’

The 2000s to Today

It would be difficult for the public to really find anything that showed accuracy until 1999 when the BBC would release *Walking with Dinosaurs*, a multi-part series that depicted the age of the dinosaurs as scientifically accurate as possible (*Walking with Dinosaurs*, BBC). The series would become a smash hit, and the detailed animations of feathered dinosaurs and early birds began to grow in acceptance by the public.

Dinosaurs were moving from being seen as slow, dumb lizards, to intelligent, swift birds. Yet the movie industry would stagnate from the blockbuster that was *Jurassic Park*. Two sequels of *Jurassic Park* were made, *The Lost World: Jurassic Park* in 1997, and *Jurassic Park 3* in 2001. They followed a similar story but were not the money makers they hoped.

It would be in 2015 that a direct sequel to *Jurassic Park*, and ignoring the middle two movies, would have dinosaurs come back. It would be a blockbuster, and it would once again suffer from harsh critics of paleontology for its stagnant depictions of the dinosaurs.

Jurassic World would further discuss the genetic blending that was touched on in the original *Jurassic Park*, with a new challenger to *T. rex* for king—or in this case, queen—of the park. The raptors that had plagued the previous movies as villains who were more threatening than the larger carnivores would now belong in the neutral category. They showed the small squad of four raptors being trained, only to be lost when the *Indominus rex* communicates with them as their new ‘alpha.’

In the end, the park is abandoned again, the dinosaurs are left to roam on their own, and the *T. rex* has a new shadow in the form of the *Velociraptor*, Blue (*Jurassic World*, Universal Pictures). It left itself open to a sequel, *Jurassic World: Fallen Kingdom*, which would come out in 2018; and a third *Jurassic World* is in the works.

While entertaining and making a lot of money for Hollywood, paleontologists and dinosaur fanatics alike ripped the dinosaurs to pieces with no remorse. The educated public no longer wanted to see the lizard dinosaurs of the past, but rather the ‘six-foot-tall’ turkeys that science continued to find.



Fig. 16. Image of a Blue soft toy at the Museum of the Earth in Ithaca, NY from: Photo © Carla Feller.

Toys for the movie were near carbon copies of the old *Jurassic Park* toys, looking like their movie counterparts and not at all like the actual species they represented. There are numerous toys available that depict more accurately the actual dinosaurs, but they have not been turned into action figures and usually come at a much higher price.



Fig. 17. *Jurassic World: Fallen Kingdom* toys at Walmart from:

Photo © Carla Feller.

Video Game Media

Thankfully, other media forms have not continued to cling to archaic depictions of dinosaurs. Video games such as “Saurian,” have been working hard with paleontologists to depict a Role Play Game (RPG) simulation of life as a variety of dinosaurs from the Hell Creek formation of the late cretaceous. Books for children on dinosaurs depict more accurate colors and life positions; and even fully feathered large theropod dinosaurs like the smaller cousins of *T. rex*, *Yutyranus* and other small raptors.

Entertainment is all around us and easily consumed by people of all ages. From books, apps on our phone, mobile gaming devices, as well as diverse web page information, and television at our beck and call, it is easy to find at least a dozen or so dinosaur related items in less than an hour. Yet, how accurate these entertainment outlets are can vary depending on how much work is done, and what beliefs the outlet has.

Many creationists, or people of the Christian faith who push for literal interpretation of the bible, push inaccuracies that dinosaurs either are much younger, living among people, or are simply faked by people who wish to test their faith. They are often the first to say that the link between birds and dinosaurs is fake and can make visiting museums frustrating when they continuously argue the facts, or even demean scientists by calling them liars and that they are going to hell.

Religious texts and discussions aside, other media often has had a far more influential impact on the younger generation - in particular, video games. Dinosaurs have been the perfect villain for human protagonists through the years, as well as familiar assistants to some of the world’s favorite video game characters.

While it may not seem important to be concerned with video games, museums do compete with virtual entertainment in getting guests in the door. If the public, especially young guests, are expecting to see something learned in a video game, and the museum does not do anything to correct the inaccuracies of the pop culture phenomena, it leaves scientists scrambling to keep up with the ‘wow’ factor of the game. A review of some of the most popular games of the past and the present shows how video games are not trying to portray accuracy.

“Super Mario World,” released in 1990, was the first video game in the Mario Bros. series to introduce Yoshi, a small, friendly dinosaur that helped Mario and his brother Luigi through the platforming adventure. The green and white dinosaur, with red boots, saddle and long tongue, was perhaps not the most scientifically accurate dinosaur, but Yoshi was popular and through the years became a pop culture icon, spawning his own video games and toys.

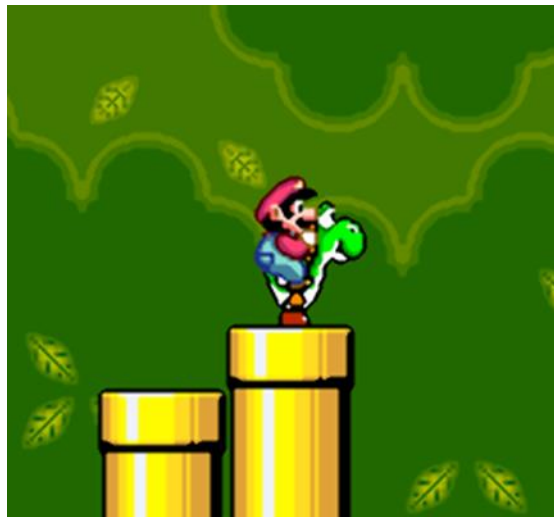


Fig. 18. Mario and Yoshi from *Super Mario World* 1990, from:

“Super Mario World.” *Wikiwand*, www.wikiwand.com/fi/Super_Mario_World.

It is almost impossible to tell what dinosaur Yoshi is, and as such, he is more of a caricature than an accurate representation of Dinosauria. His design has not changed much over

the years, despite his increasing popularity. Artistic license is more than acceptable, and the Mario Bros. games do not focus on dinosaurs as part of their larger picture, Yoshi is more of a cartoon representation and tool than a scientifically accurate character.

The *Jurassic Park* movies spawned their own video games. The most popular to date comes just after the resurgence and reboot of the movie *Jurassic World*, a direct sequel to *Jurassic Park*. The game, “Jurassic World Evolution,” is a park-building game where the player research, builds, and manages their own Jurassic World simulation. The game includes many scientific aspects to the gameplay - from sending out dig teams to search for fossils, to extracting the potential DNA, and splicing the DNA with other genes to recreate dinosaurs. As a “tycoon”-style building game, it is engaging with many issues faced with live animals and experiments that can be conducted splicing dinosaurs together, the game is fun and engaging.

When it comes to the dinosaurs themselves, they are only accurate to the world of *Jurassic Park/Jurassic World*. Dinosaurs are spliced with DNA sequences from different animals to increase their resistance to diseases and to alter their behavior. The dinosaurs look almost exactly like the animals in the movies, with all the inaccuracies included.



Fig. 19. A species of Raptor faces off for dominance in “Jurassic World Evolution” from: “Gallery.” “Jurassic World Evolution,” www.jurassicworlddevolution.com/en-GB/gallery#screenshots.



Fig. 20. *T. rex* in “Jurassic World Evolution,” from: “Gallery.” “Jurassic World Evolution,” www.jurassicworlddevolution.com/en-GB/gallery#screenshots.



Fig. 21. A “Stegoceratops” in “Jurassic World Evolution,” a fictional cross of *Stegosaurus* and *Triceratops* from:

“Gallery.” “Jurassic World Evolution,” www.jurassicworlddevolution.com/en-GB/gallery#screenshots.

It is not just major video game producers who are falling behind in embracing scientific accuracies. Smaller video game companies prefer to go for the wow factor as well, rather than try to make their dinosaurs accurate according to current scientific knowledge. One of these games is “Ark: Survival Evolved.” It is a first-person survival game that can be played as a single player or multiplayer server. As a human abandoned on a strange Earth-like planet and washed up on the shore of an island, it is up to the player to survive not only the elements but also the creatures on the island itself.

The island, desert, or strange cave system the player finds themselves on is inhabited by living animals from the Paleozoic to the Cenozoic era. Everything is present, from *Trilobites* and *Eurypterids* to *T. rex*, *Triceratops*, *Smilodon*, and Woolly Mammoth. There are also many

mythological animals that hide among the trees which require special summoning or events to conjure their appearance.



Fig. 22. *Dilophosaurus* in “Ark Survival” Evolved from: “Official Media.” ARK.

The dinosaurs are some of the first animals to appear, among them are the venom spitting, frilled, tiny, *Dilophosaurus*. The animal looks like a carbon copy of the highly inaccurate *Jurassic Park Dilophosaurus*. This animal was far from a tiny venom spitting killer, but rather a twenty plus foot long, six-foot-tall heavy bodied hunter. There is no evidence to support the frill or the venom that is depicted in the video game or the movie.



Fig. 23. “Raptor” from “Ark: Survival Evolved” from: “Official Media.” ARK.

Another dinosaur in the game that is depicted inaccurately is the “raptor.” Although the game does not say exactly what genus and species the “raptor” is, its look is heavily based on the *Jurassic Park Velociraptor*. The animal is scaly, with only small patches of feathers on its body, almost as an afterthought. As previously discussed, the creature has “broken wrist syndrome.” Without having an actual genus and species attributed to it, the animal is simply a generic “raptor” dinosaur mostly inspired from the *Jurassic Park* movies. For all the criticism I have given to video game representation, there is one video game that has not only heavily invested in the accuracy of dinosaurs, but is continuing to evolve their representation as they develop the game with new information coming from the paleontological field. The game is a simulation of dinosaur life in the late Cretaceous in Hell Creek Montana, called “Saurian.” The game is still under production and is in an Early Access stage which allows players to play the rough game

and then give feedback to the development team. Play style is that of a survival game, although you play as one of several dinosaurs - a *Dakotaraptor*, a *Triceratops*, a *Pachycephalosaurus*, and a *Tyrannosaurus*, along with other species in development for additional levels. “Saurian’s” development team has invested time, energy, and research into not only making the environment for a 66-million-year-old Hell Creek accurate, but also the behaviors and look of dinosaurs and other animals in the environment accurate (“Saurian”).



Fig. 24. *Dakotaraptor* ontogeny from chick to adult, from: “MEDIA.” “Saurian.”

Just looking at one of the playable dinosaurs, the *Dakotaraptor*, is impressive. The artists worked extensively to research growth patterns in the specimens of *Dakotaraptor* in order to accurately portray how the animal would change over time. Seeking input from paleontologists on the type and location of feathers was also key to the development of the dinosaur. The only artistic license that was used was in the coloration of the feathers. Even that, though, is based on real-world avian dinosaurs – birds – and their coloration.

The development team was also not afraid to question scientific findings. Several *Pachycephalosauridae*, once thought to be their own species, are now thought to be a possible growth series of one species, *Pachycephalosaurus*.



Fig. 25. *Pachycephalosaurus* ontogeny, showing what some scientists consider *Dracorex* as a juvenile, from:

“MEDIA.” “Saurian.”

When *Dracorex hogwartsia*, a name translating to “dragon king of Hogwarts,” was announced to the world in 2006 by Dr. Bakker and Robert Sullivan, there were some questions raised by Jack Horner. In an eerie echo of Cope and Marsh, Horner suggested that *Dracorex* and another member of the *pachycephalosauridae* family called *Stygimoloch*, named a genus in 1986, and were simply a sub adult and juvenile of *Pachycephalosaurus*. Dr. Bakker had far less of a chip on his shoulder than Marsh did and accepted the criticism and encouraged further studies of the three dinosaurs. In 2016, a paper published by Goodwin and Evens in the *Journal of Vertebrate Paleontology* firmly provided analytical research that placed both more recent dinosaurs as part of the growth curve of *Pachycephalosaurus* (Goodwin and Evans).

The development team of “Saurian” decided to research the paperwork and make the *Dracorex* and *Stygimoloch* part of the growth series for *Pachycephalosaurus*, pushing the scientific discussion of species identification and development, much to the displeasure of fans of both dinosaurs and *Harry Potter* alike. Their work may have been met with some push back but the acceptance by the scientific community in the final decision was the most important for the designers of the game.

The development team was also not afraid to correct their own developed dinosaur designs. With the feathered smaller raptor members well established, scientists in 2016 began to theorize that the great *T. rex* was also fully or partially feathered. The development team brought out their game with intentions of a fully feathered to partially feathered tyrant lizard king (Saurianson, “Tyrannosaurus Redesign 2018”).



Fig. 26. Original *Tyrannosaurus rex* design from “Saurian”, from “MEDIA.” “Saurian.”

When new information came out in 2018 that scientists had discovered skin imprints and information that *T. rex* was not fully-feathered as an adult, the development and artistic team completely redesigned the *T. rex* in their game to fit the new information (see fig. 28).



Fig. 27. Updated design in 2018 from: Saurianson, Kevin. “Tyrannosaurus Redesign 2018.”

The team met with some confusion from fans, but they released their entire process on their website to help explain their decision and the science behind it. The artists even released their anatomical development showing both the skeleton and the musculature which were based on anatomical references (Saurianson, “Tyrannosaurus Redesign 2018”). They discussed the process of developing a pattern of the skin so that they didn’t fall into the trope of a “dull colored” predator, but also pulled back on brightly colored feathers that were similar to smaller birds and animals seen today (Saurianson, “Tyrannosaurus Redesign 2018”).

The scientific community has praised “Saurian” as the most accurate dinosaur life simulation/survival game to date. While official release has been pushed back due to changing the *T. rex*, the game was still pushed out through early access. According to their “Steam” page, they are rated a 6/10, above average for an early access game.

Paleo-reconstruction as artwork, sculpture, and even large museums has embraced the evolving dinosaur motif, with few exceptions to certain tropes and themes. Why Hollywood continues to hide behind the monster trope of dinosaurs is a conundrum best left to another, but

the question of why so many museums are left behind is explored next, with suggestions on how they can continue to improve, even on a low budget.

So, why spend so much time on media and criticizing it, when the paper is about representation of dinosaurs in museums? Media representation of dinosaurs is often the first thing that catches an individual's interest in dinosaurs. Video games especially are more prevalent now in pop culture and compete for attention. People are more likely to cull information from media outlets, including pop culture, which means that inaccuracies are shared and spread as truth. This is what museums must combat against in their education of the public.

Chapter VII: Dinosaur Displays in Museums

Since their first discovery, long before any modern museum, dinosaur remains have been placed in public places for study, and many times worshiped as gods or bones of dragons.

Ancient people no doubt discovered skeletons of prehistoric creatures, and the budding science of Geomythology and the research conducted through independent study will be discussed later in this thesis (Mayor, *The First Fossil Hunters*).

The first displays and reconstructions of dinosaurs in modern times happened mainly during the Crystal Palace and the First World Expo in London in 1851, but it wouldn't be long before the London Natural History Museum and the rest of the world would begin displaying mounted skeletons. Museums were some of the first funding sources for expeditions that had set out to discover ancient, fossilized bones. As such, those discoveries were brought back to museums to be studied and put on display.

In the early days of dinosaur display, it was very common to exhibit the bones with steel braces drilled into them to put them in static, life-like poses. Full specimens were, and still are, very rare, so “Frankenstein” dinosaur displays, where bones from multiple individuals were represented as one complete skeleton - were very common. When put on display, the scientists would pose them statically, either standing or frozen in a walking posture.

One of the most famous dinosaurs posed during this time was the American Museum of Natural History's *T. rex*.



Fig. 28. Two children view a tripod *T. rex* in the dinosaur hall at the American Museum of Natural History from the 1960's from: "Picturing the Museum." *AMNH*.

The image of the *T. rex*, shown above with a mounted *Triceratops* next to it, was taken in the 1960s, but the mount was installed in 1937. Its upright posture, with its long tail dragging

across the ground and its head nearly brushing the ceiling, was imposing and awe-inspiring. This was a classic pose seen throughout the world in the late 1930s through the 1960s. This specific pose would not actually be corrected until 1992 when the Dinosaur Hall would undergo a large renovation (American Museum of Natural History, Facebook).

These real bone mounts were amazing to see, but the damage caused to the bones from the mounts would not be known for some time. What many people do not realize is that bones, like many other materials buried deep under the surface of the earth, are not entirely stable in the open air. Even though dinosaur bones are remineralized into stone, the minerals that make up the structure can rearrange and recrystallize at the surface.

A startling realization of this damage was seen at the Smithsonian in 1996 with their *Triceratops* affectionately known as Hatcher. After 90-years of being on display, it was a sudden and rather heartbreaking event that made the curators realize that Hatcher had a serious bone disease. While a guest was admiring the centerpiece fossil, a part of Hatcher's pelvis broke away and crashed onto the floor. When the exhibit managers and paleontologists examined the break, they realized that their beloved *Triceratops* had what was known as "Pyrite disease." This disease is when pyrite, or fool's gold, begins to grow from inside the fossilized bones, breaking down the structure (Fox, "An Elegy for Hatcher the Triceratops"). Thankfully, Hatcher's team reacted quickly, and in 1998 he was officially removed from display and a plaster cast was put in his place. The practice of casting with plaster would lead to more interesting posing, lighter exhibit structures, and less stress for scientists wishing to study the actual bones.

With the advent of more casts being made, museums began to pose dinosaurs in more dynamic and life-like ways. The American Museum of Natural History in New York City took these new possibilities to great heights. In 1991, the Museum put together a grand dinosaur

exhibit in the Theodore Roosevelt rotunda lobby to welcome visitors and guests to the historic museum (“Theodore Roosevelt Rotunda: Welcome to the Museum,” *American Museum of Natural History*). Rearing up and towering over guests is a large *Barosaurus*, with a smaller young by its tail. This towering long-neck herbivore is facing off against an aggressive *Allosaurus*. The mount is the tallest freestanding dinosaur exhibit in the world and was originally one piece at the base. In 2010, the museum decided to allow for a closer view and cut the *Allosaurus* and *Barosaurus* apart, allowing for people to walk directly under the massive, towering animals, and between the silent eternal battle.

This dynamic posing would never have been possible without the advancement of lightweight casting of bones. To support a real bone pose, supports of steel would have to be under the large *Barosaurus* all the way to the neck, and most likely include ceiling supports. The supports would take away from the impressiveness of the dinosaurs themselves.

Further west, the Buffalo Museum of Science has their own dinosaur mounts that have evolved over time. Once, in the massive dinosaur hall, stood a towering tripod posed *Allosaurus fragilis*. Erected in the late 1920s, the dinosaur, like the *T. rex* in the American Museum of Natural History, showed an upright animal, with the long tail dragging across the floor. As science advanced, the *Allosaurus* was left behind, much like the *Triceratops* that it shared exhibit space with. The museum, along with renovating museum space all throughout the four-story building, also decided to raise money to have the *Allosaurus* remounted. With over 60% bone, the dinosaur presented unique challenges. The museum did not have the money to cast the dinosaur completely, so it would be taken apart, repaired and remounted in a more scientifically accurate position. The money was raised and in 2013 the *Allosaurus* was back, hanging above the entrance to the new *Rethink Extinct* Exhibit hall. While *Allosaurus* was remounted, the full

Triceratops cast was left in its sprawled “bulldog” pose. As a smaller museum, it is tougher to raise money to redo exhibits, and the specimen mounts in its care. With continued revenue increase, exhibits will hopefully continue to be updated and renovated.

On the west coast, the Natural History Museum in Los Angeles, California has two dinosaur mascots, a *T. rex* affectionately known as Thomas, and a *Triceratops* as Thomas’ next meal. The LA Natural History Museum is one of the many museums that have scientists on-site. With science being conducted and discoveries being made in this larger facility, the museum can update its exhibit halls and galleries regularly. When they updated their dinosaur hall in 2015, guests were amazed by the casts and fossilized bones. The entrance hall has a massive *Triceratops* in an upright posture, albeit with a slightly crushed skull as that was how it was found. (“Dinosaur Hall,” *Natural History Museum of Los Angeles County*).

Arching above is a *Mamenchisaurus*, a large sauropod dinosaur. Following the length of the sauropod dinosaur are additional fossils of marine reptiles and eventually the main dinosaur hall. The centerpiece of the hall is three *T. rex* cast mounts. Three adult *T. rexes* alone would be awe inspiring, but these are part of a growth series, from a two-year-old baby, a sixteen-year old young adult, and the twenty-something sub-adult Thomas. These three mounts are poised over a dead hadrosaur, or duck-billed dinosaur, with Thomas and the baby moving in on the sub-adult (“Dinosaur Hall,” *Natural History Museum of Los Angeles County*). Since *Jurassic World* was released, this exhibit has led to many people “Raptor Training” or posing with the three dinosaurs, which involves visitors standing with their hands up as if keeping the dinosaurs in place with a hand signal. People stand in awe at the changes of the skeletons over the various ages of the three specimens. It puts into perspective how a young *T. rex* could be misidentified as a separate species from its adult form



Fig. 29. The main dinosaur hall at the LA Natural History Museum depicting an adult, sub-adult and juvenile *Tyrannosaurus rex*. From: Photo © Carla Feller

While not as impressive as the trio of *T. rex*, there are an additional trio that show just how much a bird and a dinosaur look alike. A *Struthiomimus*, an ostridge, and a snow goose stand in a small group, all skeletal mounts. This wonderful exhibit allows the guests to see the physical similarities of all three specimens, including the skull openings, the number of bones in the feet, toes, and the pelvis, and arm structures. The labels explain how all modern birds came from a branch of the dinosaurs.



Fig. 30. A *Struthiomimus*, an ostridge, and a snow goose in the LA Natural History Museum from:

Photo © Carla A. Feller.

It is not just the life of the dinosaurs displayed in the Dinosaur Hall of the LA Natural History Museum, but also the moment of their death. A label near the end of the exhibit includes a discussion about the day both the reign of the Dinosaurs and the Mesozoic-era ended. A section of rock with five of its six sides in a plaster cast, show the cross-section of the stone. Labeled with a small arrow, the thin, slightly lighter colored, band of rock - the KT boundary - is shown. This layer, rich with iridium—a rare earth metal found most in asteroids and meteors—is one part of the proof that dinosaurs were killed off by an extra-terrestrial strike.

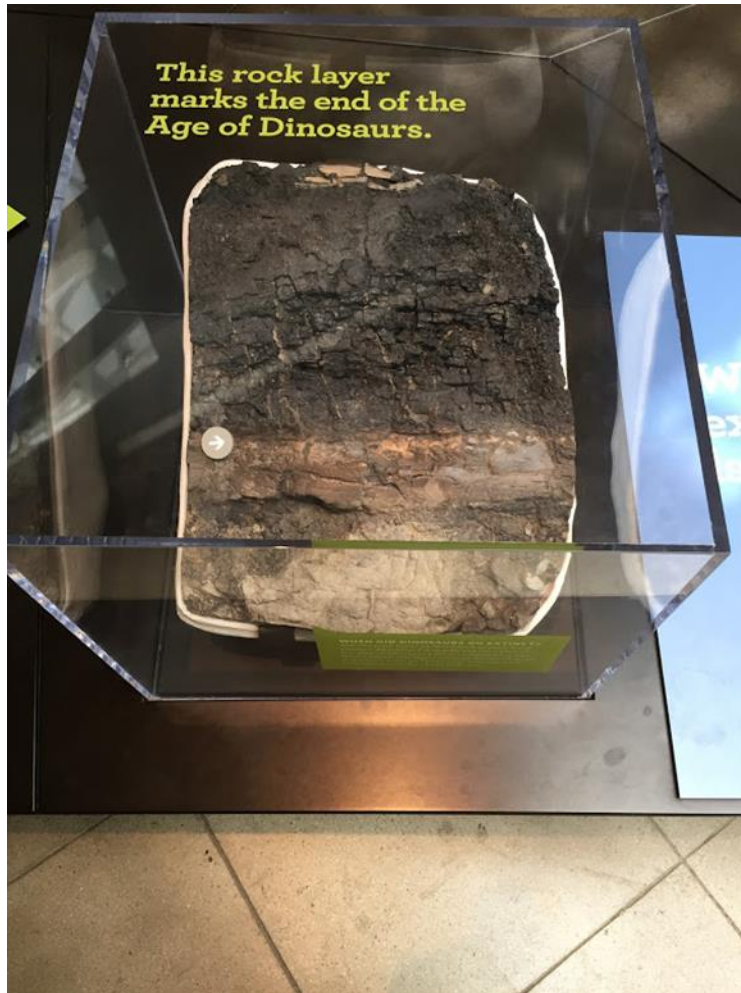


Fig. 31. Sample of Rock Strata showing the KT boundary, from:

Photo © Carla A. Feller.

All of these exhibits show how museums display their diverse dinosaur collections, from large exhibits of real bone, to dynamic casts of bone, to a cross-over with modern animals, and then a display of rock strata showing the end of the era. The diversity of the interpretations has the intention of communicating current information as accurately as possible to the public. Diversity in the display may have taken some time to advance, but where will these displays go next?

*Dinosaur History in Museums*The American Museum of Natural History

The American Museum of Natural History had an inauspicious start. In the first few years, the museum, a passion project and brainchild of Albert Smith Bickmore, made virtually no money and Central Park was a myriad of squatters' fields, pastures used by farmers, and a large African American community (Preston, *Dinosaurs in the Attic*). Mostly filled with fossil shells that came from Bickmore's collections purchased from other collectors, there was little in the way of large, impressive items that would draw people in.

It would be a rough few years, but Bickmore's passion and continued pressure and reassurances to his investors—men like Theodore Roosevelt, Sr., the father of the future President of the United States, J. P. Morgan, and many other men who were bankers, investors, and moguls—would ensure Bickmore's vision would finally see a profit. American Museum of Natural History found financial success in its third president of trustees, Morris K. Jesup (Preston, *Dinosaurs in the Attic*). Jesup would bring a few important names into the AMNH, which would lead to incredible advancements in its collections and increased visitor activity.

The additions of Henry Fairfield Osborn, Barnum Brown, and Roy Chapman Andrews to the staff of the AMNH would turn the museum around through its expansive collections and diversity of discoveries. It was Henry Osborn who, in his curatorial position at the museum in the late 1880s brought in Barnum Brown, and dinosaurs then began to move into the forefront of the museum's exhibits (Schwarzer 81). With the financing from J. P. Morgan, Osborn's uncle, and other rich financiers, Osborn and Brown were able to begin collecting some of the most impressive and largest specimens of American dinosaurs. The financial backers helped the AMNH compete with other museums in the so called 'golden age' of dinosaur expeditions and

discovery. The best specimens were highly sought after by every museum and those who had the money were able to get out into the field more regularly than those who struggled financially. Osborn also pushed for dinosaur and mammal fossils to be mounted fully and placed in exhibit halls for the public to see. He encouraged labels to be written in an informative way so that the layperson could understand the information, ensuring that the AMNH would be a place of public learning, as opposed to research for the enlightened few like college museums of the time.

When Osborn became the president of the AMNH after Jesup's passing in the early 1900s, it would not be long before another name was added to the list of famous diggers- Roy Chapman Andrews. Andrews started out as a floor sweeper and taxidermist but retired from the museum as director. Andrews was a super star with the museum's finances, and in the 1920s there were upwards of 100 expeditions a year to the far reaches of the globe to collect specimens from all possible scientific areas. Andrews' most famous expeditions were of course his travels into the central-Asian plateaus of Mongolia and China (Schwarzer 82). The discoveries he would bring back—dinosaur nests, eggs, and growth series from *Protoceratops*—were often followed by a parade of celebrations in the AMNH when they arrived (Schwarzer 82).

There would only be a small stagnation in collecting during the Second World War, before the museum resumed expeditions and explorations into fossil beds as well as continued research by scientists. This would shift the focus from public education, which was Osborn's wish, back to scientific discovery and academic explanation (Schwarzer 83). That is not to say that the museum had shut out the public; if anything, museums do more and more to bring the public inside, often relying on popular culture to reignite the smoldering fire of dinosaur fascination. Universities took over when social commentary demanded information. The

expeditions into other countries were far more diplomatic, and the regulations required of science demanded far more documentation (Schwarzer 85).

Over time, the museum's exhibits have changed drastically. From early arguments that bones should be placed carefully in secured drawers for only researchers and scientists to examine, to today's virtual reality and augmented reality applications in front of cast bones of giant creatures, museums have crammed a lot of information into smaller and smaller spaces. The AMNH keeps to the forefront of the evolving science of dinosaurs and how they are understood. The Hall of Saurischian Dinosaurs was updated with a new *Tyrannosaurus rex* exhibit that opened in the summer of 2019. The AMNH, with its funding from donors, the public, and New York City, was keeping up with other museums around the world in the accurate representation of dinosaurs.

The Carnegie Museum of Natural History

The Carnegie collection of museums was brought to fruition by steel industrialist and rival to J. P. Morgan, Andrew Carnegie (Rieppel 83). Carnegie was well-known for both his incredibly profitable businesses, as well as his generous donations and philanthropy, an act that was as self-serving as it was public serving (Rieppel 85). Having made his riches in the steel manufacturing business, Carnegie was known to donate his fortune to many cities for educational and public projects. One such project took place in Pittsburgh, where he endowed a natural history museum with his name (Rieppel 93).

It was not long after the museum's opening that its most impressive and famous dinosaur would be added to the museum's collections, a nearly complete *Diplodocus carnegii*, lovingly nicknamed Dippy. This dinosaur would promptly inspire Carnegie to prove that his museum

somehow outranked the AMNH which just unveiled their *Brontosaurus*. Carnegie, despite all his philanthropy, was a businessman first and foremost. He believed in social credit, which was built by giving away the fortune he accrued to public projects in his name (Rieppel 99). Such investment to the public endeared him to the lower economic classes from which he came. Carnegie ordered multiple plaster casts made of Dippy to be sent to major museums around the world (Rieppel 84-85). This generosity worked very well for Carnegie's business, securing him global contracts with some of the major powers in Europe.

This model of business ventures and public investment worked well for him, despite the less-than altruistic motivation behind it all. The Carnegie Collection of museums grew and became some of the most popular museums in the United States, rivaling the AMNH, the Smithsonian, and the Chicago Field Museum. The collection of Carnegie museums includes the museum of natural history, art museum, science center, and Andy Warhol museum.

The Carnegie Museum of Natural History also keeps up with current digital technologies to enhance their exhibits and the public's understanding (Jacobson 53). Through their OvirapTour theatrical extension of their dinosaur exhibit, which uses inexpensive video game technology, relevant fossil collections, and exciting moving picture technology, the public has been able to get a better understanding of the animals which fill the exhibit halls (Jacobson 54).

The Story of Dippy the Long-lived *Diplodocus*

Dippy had long been an unofficial mascot of the Carnegie Museum of Natural History, and recently become the official mascot. Discovered in 1899 by Carnegie scientists, Andrew Carnegie himself used the nearly complete *Diplodocus carnegii* as a tool to proclaim the

museum a success and to share a large fossil discovery with the world. This also led him to win a competitive game of discovery with other industrialists, which also raised his own standing with them. While the original fossilized material would remain in the Carnegie Museum in Pittsburgh, casts of the nearly complete dinosaur would be sent to major museums across the world, including one to the London Natural History Museum in 1905 (Nieuwland).

Being gifted to many museums, as well as England's King Edward VII, it was Carnegie's intention that, even beyond Dippy's scientific and entertainment value as a cast, it was a sign of potential cooperation in both political and economic spheres (Nieuwland). It was the most accurate depiction of a dinosaur, and although it wasn't the first large sauropod dinosaur to go on display, (that would go to *Brontosaurus* in the AMNH), Dippy was far more culturally important due to its global exposure.

Although it was not as impressive as other sauropods, the fossil cast was used not just as a tool of education, but also for its political power and influence as a gift from a wealthy financier. This influence would make an otherwise unimportant scientific discovery at the time far more important to the countries that wished to court Carnegie for business deals (Nieuwland). Back in the United States, Dippy was overshadowed by other fossil discoveries soon after her debut. Although she wielded political power in the United States as Carnegie's display, scientifically, she would be overshadowed by larger discoveries from the AMNH.

Dippy's popularity would remain, however, even after Carnegie's influence over her faded. The public would enjoy her permanency at the museum, and for one hundred years, Dippy would greet visitors to the Carnegie museum with both a fiberglass life-like reconstruction out front and her bones on display inside. Dippy was like a long-lived family friend to everyone who repeatedly visited the museum, and she became part of the popular imagination and culture of the

local community. In 2015, Dippy would finally get her crowning achievement. With 99% of the vote, the *Diplodocus carnegii* would become the official mascot of the museum. Dippy had long been a favorite, with crowds of people taking selfies with her outside where she was always dressed for the weather and holidays. She had even won the friendly competition between the four Carnegie museums as the most beloved physical item of the museums. Now she was the official mascot chosen by popular vote, with a silhouette of her gracing logos for the Carnegie Natural History Museum, making her the official ‘brand’ of the museum. (“Visitors Inspire New Carnegie Museum of Natural History Logo,” *Carnegie Museum of Natural History*)

This shows how even an ‘unimportant’ dinosaur discovery shared by one man who had ulterior motives could become a public favorite and mascot. Dippy became a perfect example of dinosaur’s impact on popular culture from their position as museum artifacts and how a museum can use popular culture to its advantage.



Fig: 32 Dippy ready for winter outside the Carnegie Natural History Museum (“Visitors Inspire New Carnegie Museum of Natural History Logo,” *Carnegie Museum of Natural History*)

Cultural Interpretations

Many science museums are not taking into consideration cultural interpretations of fossilized remains. By examining pre-modern and ancient fossil discoveries by various cultures, a fuller understanding of how humans interact with their environments through time can be reached. As Adrienne Mayor explains in her book *The First Fossil Hunters*, the ancient Greeks and Romans were fascinated by the large remains they discovered as they excavated for roads and buildings. Their writing was not exactly scientific, but rather more anthropological in nature, a perfect example of cross-disciplinary writing. The examination of ancient texts describing mythology through the eyes of modern knowledge of science was the basis of Geomythology. It is one way to break down the walls between prehistory and early human history by connecting human experiences from past to present.

Adding dinosaur fossils into anthropology and art exhibits can bring new context to old stories. For example, a *Protoceratops* skull posed next to a Greek gryphon would provide a juxtaposition of the real-life inspiration for the mythology of the gryphon. A variety of theropod dinosaur teeth could be placed next to east Asian depictions of dragons. Even adding the stories of ancient monsters and dragons to an educational program for adults and children increases the understanding and fascination for multiple historical topics. Dinosaurs are only a part of the potential for cultural interpretation of prehistoric fossilized remains.

Chapter VIII: Modern Corrections: Where Museums Stand Today

Museums today have with a tremendous amount of competition - from popular culture movies and television shows, to video games and toys - many institutions are turning away from static display models and exhibits and turning toward interactive digital exhibits and hands on experiences. Both display options have drawbacks and benefits, but when it comes to dinosaurs, it is often the big bones that people want to see, or reconstructions of their environments and their lives.

Many traveling animatronic shows, and many costume companies provide animatronic dinosaurs for rent or purchase. Both stationary and mobile dinosaurs are popular with the public. In the summer of 2019, the Buffalo Zoo was host to a series of stationary animatronic dinosaur reconstructions, allowing guests to see the animals as they would have appeared in an environment with other animals. Costumes of smaller dinosaurs, such as baby *T. rex*, or hatchling *Triceratops* can be found at the LA Natural History Museum. They dedicate a show on the weekends to one of two costumes, educating and entertaining children as the scientist actors are chased by one of the two puppets. These mobile costumes allow for a new visualization of how the animals that we are so used to seeing as bones would look and move, but in a real interactive environment instead of on the screen. Seeing a raptor or other predatory dinosaur peek around a corner at a museum and hearing a trill or growling noise, allows them to become real. There are many videos online of pranksters using the costumes to get spontaneous reactions from people. These visceral reactions are the same in a museum, and the screams-to-laughter squeals of children make for a wonderful memory.

One of the most challenging things in updating an exhibit space is creating the large mounts that can cost thousands of dollars. As a result, many of the mounts in smaller museums

are left as they are. Depending on the work of the exhibit designers, these incorrect mounts may or may not be discussed in labeling or additional exhibit pieces.

At the Buffalo Museum of Science in Buffalo, New York, the exhibit *Rethink Extinct* is a permanent paleontology and earth history exhibit (*Rethink Extinct*, Buffalo Museum of Science). The museum initially had half a floor dedicated to dinosaurs, but the entire museum was changed when a new mission was adopted. All their dinosaur pieces are now in one exhibit room at only a quarter of the original size. Over the wall between the doors to the room is an *Allosaurus* (see fig. 34). The dinosaur had not been on display as it was being remounted from the tripod style, upright with tail dragging behind its feet like a kangaroo, to the more accurate horizontal walking position. The museum raised over \$25,000 to have it professionally remounted in the correct position and was unveiled in November of 2015.



Fig. 33. *Allosaurus fragilis* mounted above *Rethink Extinct* at the Buffalo Museum of Science, from: Photo © Carla

Feller.

It is difficult to see in detail with the dinosaur standing over 10 feet above the floor, but the mount is still showing inaccuracies. The *Allosaurus* is 60% real fossilized bone which is potentially dangerous for the longevity of the fossil itself. It is missing its gastralia, which are also known as ‘belly ribs’ that connect from the collar bone area to the pubis (see fig. 34). While this is often a set of bones that is less likely to be fossilized, numerous specimens have been found with them intact and it cannot be considered a ‘complete’ skeleton without them.



Fig. 34. *Allosaurus* known as “Big Al” at the Houston Museum of Natural History, showing Gastralia, from: “About *Allosaurus*.” *FossilEra*.

The other inconsistencies with the mount are the wrists and hand positions. While not as dramatic as other smaller raptor mounts, one of which is a *Deinonychus* discussed in more detail later, the *Allosaurus* does suffer from broken wrist syndrome, more specifically on the right-hand side closest to the wall (*Rethink Extinct*, Buffalo Museum of Science). Such a rotation of the wrist would be difficult, but perhaps not completely impossible.

Inside the exhibit, there are only two other fully mounted dinosaurs: *Triceratops*, and a *Deinonychus*. There are several other pieces and parts of other specimens put out in a highly condensed and rather crowded exhibit.



Fig. 35. More Accurate *Triceratops* mount from the LA Natural History Museum, from: Photo © Carla Feller.



Fig. 36. The *Triceratops* from the Buffalo Museum of Science, with a sprawled tail dragging pose, from: Photo from Tripadvisor.

The *Triceratops* is the largest item in the exhibit. It is surrounded by other fragments of dinosaurs, many of which cannot be seen if one is up against the railing since they are on the floor or behind other pieces that flow into the Mesozoic section (*Rethink Extinct*, Buffalo Museum of Science). The mount, which is a full cast of two separate dinosaurs, is completely mismounted. The splayed front legs pose it low to the ground like a bulldog, and its tail is dragging across the ground. While this was at one time the assumption of how a *Triceratops* moved, it is completely incorrect by today's scientific knowledge. It has been proven that large ornithomimid dinosaurs like *Triceratops* and other ceratopsian relatives walked with a slight forelimb rotation to the outer edges, but otherwise fully upright. The plaque, shown below on the railing, does not discuss why the mount is still incorrect. It simply mentions that it was the way previous paleontologists thought they moved. This is in direct contrast with the plaque and label for the *Allosaurus* which discusses the difficulty, and the funding needed to remount the dinosaur correctly (*Rethink Extinct*, Buffalo Museum of Science). With the lack of important information, other than the specimen's number, location, date of finding and whether it was a cast, the label is practically useless. It does not change the perception of the dinosaur, nor does it discuss the inaccuracies.

The other fully mounted dinosaur in the exhibit is a *Deinonychus*. It is seven feet above the floor on a small ledge close to the two doorways that makes the exhibit hard to notice. This cast was purchased by the museum sometime in the late 1990s, as noted in the label, but unfortunately shows inconsistencies and inaccuracies as well (*Rethink Extinct*, Buffalo Museum of Science).

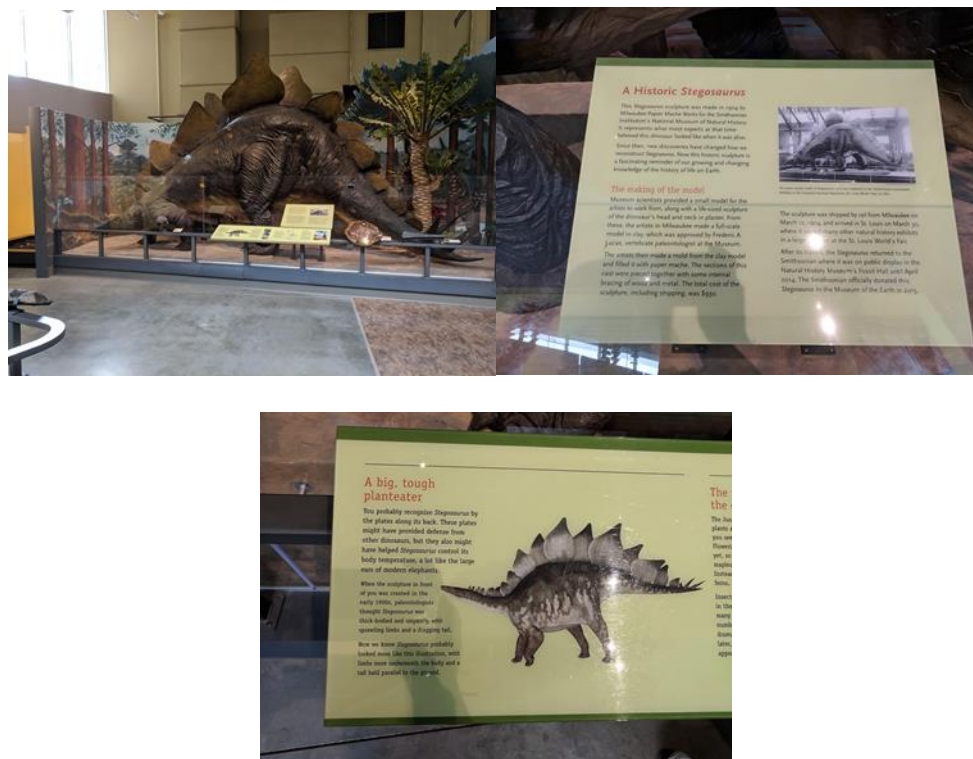


Fig. 37. *Deinonychus* cast on wall at the Buffalo Museum of Science from: Photo © Carla Feller.

The specimen is missing the gastralia, just as the *Allosaurus* is on the other side of the same wall. As a raptor, these animals would have had this bone structure to help support their internal organs, protect themselves during fights, as well as provide muscular attachments (*Rethink Extinct*, Buffalo Museum of Science). The other major inaccuracy is again the severe broken-wrist syndrome. The wrists have rotated to such a degree that the hands are pronated, or facing downward, just like the creatures in Jurassic Park. This motion is completely inaccurate and serves only to continue the inaccuracies often seen in pop culture media (*Rethink Extinct*, Buffalo Museum of Science).

While it is easy to pick apart museums that are not as actively correcting or talking about inaccuracies, it is also important to look at those museums who are doing things well. Museums all over the country and even North America are improving their exhibits and gift shops. A small

museum in the Finger Lakes, called The Museum of The Earth, is a great example of a small museum doing things correctly (The Museum of the Earth). Their life-sized model of a *Stegosaurus* is an old design from early in paleontology. They have added discussion labels and photos explaining what knowledge of dinosaurs it is wrong and how has evolved. They also do a similar display with three *Coelophysis* models over time.



Figs. 38-40. The *Stegosaurus* at the Museum of the Earth in Ithaca, NY, along with discussion panels of its evolution of understanding, from: Photos © Carla Feller.



Figs. 41 & 42. *Coelophysis* models and corresponding informational panels at The Museum of the Earth, from:

Photos © Carla Feller.

The nation's museum, the Smithsonian Institution, recently underwent a large renovation of the Dinosaur Hall in the Natural History Museum which reopened in 2019. The centerpiece of the hall is the large *T. rex* stepping on and biting the frill of a *Triceratops* known as Hatcher. The exhibit 'kills' the *Triceratops* after decades of being a favorite but gives a dynamic slice of life from 66 million years ago.

The American Museum of Natural History has such a massive collection of dinosaurs that it occupies two halls, The Ornithischian and Saurischian displays. The Saurischian dinosaur hall was recently renovated and opened in March 2019 with large fanfare. The renovated hall had a brand-new *Tyrannosaurus* exhibit. The Ornithischian hall displays the ceratopsian dinosaurs, the duck billed dinosaurs, and the other members of the 'bird hipped' dinosaurs.



Fig.45. *Triceratops* mount and small Charles R. Knight model from AMNH.

One of the most impressive exhibits mounted is a *Triceratops* skeleton, in a more modern pose, although still not completely accurate, with a small model of Charles R. Knight's take on the *Triceratops* next to it. While visiting the museum, there were questions about the juxtaposition, but when the label and the evolution of our understanding was pointed out, the guests brightened with understanding and new realization of its importance.

The Los Angeles Natural History Museum also has recently renovated their dinosaur hall. The dynamic dinosaur poses, interactivity that is not overwhelming, and ability to see dinosaur fossils being prepped out in their separate Dino Lab, make the hall a major visiting space and full of information to digest over multiple visits.



Fig. 44. *T. rex* skulls, showing the reconstruction of missing bone in the baby, juvenile and adult skulls at the LA Natural History Museum.

These museums are just a handful of the institutions that have dedicated themselves to showing the advancement in science, fighting the stagnation of museum displays, as well as encouraging discussion on the inaccuracies of the past.

Chapter IX: How Museums Can Stay Current

There is no doubt that modern museums have a lot of catching up to do when it comes to the accuracy of dinosaur displays in content and arrangement. While it is understandable that undertaking a complete gallery or exhibit redesign is not only costly but also removes those items from view for months or years at a time, there are many things that museums can do that are not as costly, nor do they call for removal of specimens from the floor.

One of the easiest things is to open the door to discussions with up-to-date labels. Even if the exhibit specimens themselves are not as accurate as they can be, or perhaps even drastically inaccurate, a museum should not overlook the problems with labels that give very little information. Limited labels, although they may prompt more critical thinking in visitors, can be a large drawback for younger audiences or people who are looking to gain more scientific knowledge from a visit. There are ways to include a significant amount of information on a label, without terrifying people with massive walls of text. Even supplementing labels with educational programming available during peak times can bring more people into an exhibit again and again. Creative labels, with the use of digital technology, can provide information in interactive and fun ways. Admitting that the specimens on display are inaccurate according to modern science shows how science, and our understanding of dinosaurs, evolved over time. Acknowledging that a *Triceratops* has an incorrect leg and body position does not discredit the specimen, but rather gives the specimen a greater meaning. Use of digital display labels, additional tablets to scroll through information in an exhibit, or even just well written traditional educational labels, can help to curb the pop culture flavor of an exhibit more than ignoring that there is a problem at all.

Another simple way to acknowledge changes is to talk about it. Holding discussions and public talks with scientists and the public helps to disseminate information to people, as well as

having discussions with other experts in the field. Allowing the public to talk to professionals in the paleontological field, allows people to care more about the museums they visit. When people care and know what it takes to update exhibits, they are more likely to donate more to help the museum with those efforts. The Buffalo Museum of Science held fundraisers for both their *Allosaurus* remounting project and the purchase of the *Deinonychus*, which were both successful campaigns.

The next step, both in complexity and expense, is to plan changes to the exhibit itself in smaller steps. To change a fully mounted skeleton in its entirety would be a massive undertaking and would remove the specimen from the floor. Yet, if the specimen's position is only slightly off—perhaps a theropod suffering from “broken wrist syndrome” or a squat “bulldog” framed ceratopsian front legs—these can be simply removed, if possible, and replaced with supporting information and labels showing how the specimen is changing. This process leaves the specimen on display, allows visitors to see how it is going to change when the specimen is put back together, and shows the care that a museum has for its specimens and the science it represents within its walls, as well as the care they wish to take for their visitors and guests.

Intensive research into updating the models should also come from the growing knowledge and understanding of biomechanical dinosaur research. While it should be noted that continued research is not one hundred percent accurate, there are many estimations and educated guesses of some information that must happen while dealing with fossilized remains which can be still be used for research. This extensive and growing understanding of how these prehistoric animals moved, walked, and even communicated, would not only be beneficial to exhibit designers but also for the public to better understand additional scientific ways dinosaurs are studied (Alexander, R. M. 1849–1855). Understanding the biomechanics is more than just how

an animal moved, but also how their bodies pumped blood to the brain in long-necked animals, as well as potential theories on their jaws and potential sexual display mechanics (Alexander, R. M. 1849–1855).

Finally, part of the responsibility of any public institution is the major reconstruction and restoration of exhibit halls to update dinosaur exhibits. This is a huge undertaking, costing millions of dollars and many months of exhibit redesign, remounting, recasting, and reinstallation. This massive undertaking would close off an entire exhibit or hall to the public, which can sometimes be a positive thing. While the public could be understandably upset about a temporary closure to an exhibit, humans are curious by nature and wanting to see what an area is going to look like after it has been restored may give a positive incentive to come back to see the exhibit when completed. With a schedule of updates, or even photos teasing a new area during its renovation, guests may be more likely to come again later or even plan a special trip for the opening of the new hall and exhibit.

Balancing the money needed for a renovation with the money expected to be lost from renovation, to the money expected to come in afterward is a difficult process, especially for smaller museums. Fundraising and getting grants for the project is a major consideration and may be a limiting factor for such an undertaking.

Another area in which museums should consider in helping to advance accurate information is the gift shop. The gift shop is an important part of the museum experience for both the guests and for the museums themselves. It is an area in which museums make more money by selling souvenirs and guests can take home physical representations of their favorite exhibit piece. The price, variety, age-range, and connection to exhibits displayed in the museum help to

not only finance the museum but also to promote the museum's exhibits and get people to come back.

While it depends upon the finances of the museum itself, the gift shop at a science or natural history museum should, in theory, have the most accurate items they can sell. Unfortunately, cost effectiveness of items seems to be the largest priority for museums stocking these items. It is often cheaper to purchase large quantities of items that are not as accurate. This is true for all toy collections. If you want something more accurate, you are going to spend more money. The following discussion is based on the sale prices from the Buffalo Museum of Science, where the author worked for one year. As an example, a 14-inch rubber *Tyrannosaurus* toy that is inaccurate in its depiction can be purchased in packages of 12 per case for \$5.50 (Adventure Planet Rhode Island Novelty Shop). That means a single *Tyrannosaurus* toy is \$.46. Sold at a price of \$9.99 (not including tax) is a profit of 95% per toy. In contrast, a single accurate posable toy raptor action figure is \$39.99 plus shipping from Beasts of the Mesozoic. Other shops with accurate dinosaur toys that do have bulk options are also far more expensive such as Safari Ltd.



Fig. 45. Beasts of the Mesozoic Velociraptor action figure. Cost point \$44.99 + shipping from: All Beasts of the Mesozoic Products *Welcome Creative Beast*.



©RHODE ISLAND NOVELTY

Fig. 46. Rhode Island Novelty Velociraptor soft toy, \$12 for 8 in case + shipping from: “Adventure Planet” *Rhode Island Novelty*.

This drastic difference in profit percentage means it is more profitable for a museum to sell inaccurate toys at a higher markup than accurate toys which are more expensive. While it is difficult, museums should invest in the more expensive options, even if they are offered alongside the cheaper ones. Having these items sorted in age groups will help to have a growth in the understanding of dinosaurs over time. Although it is not a perfect solution, it is better than having only inaccurate options.

These options depend upon the financial capabilities of the museum itself. With day-to-day operation costs, hiring and paying workers, and of course upgrades to the buildings themselves, it can be difficult for smaller budgeted museums to invest in more things for their gift shop. But small changes that are cheaper to implement right away can be a good start to a longer-term renovation of an exhibit hall. Larger museums make quite a bit of profit from their

gift shops and can even be considered an experience all on their own. The American Museum of Natural History has multiple gift shops, including a two-story shop, within the museum itself.

Chapter X: Conclusion and Findings

Dinosaurs are, and always will be—to the best hope of the author—a universal interest of the world’s population. Yet, when popular culture continues to use dinosaurs as monster stand-ins, the public begins to view them as monsters, or mythical like beasts, and continues the feedback cycle. The following is a Tumblr post discovered discussing this very topic. The blog “KaijuSplotch” is the author’s personal blog, reblogged to save for this very thesis argument. Meme culture is often used today to share jokes. In this case, it was a perfect example of how pop culture representation is overtaking scientific accuracy, and a perfect way to summarize my argument.

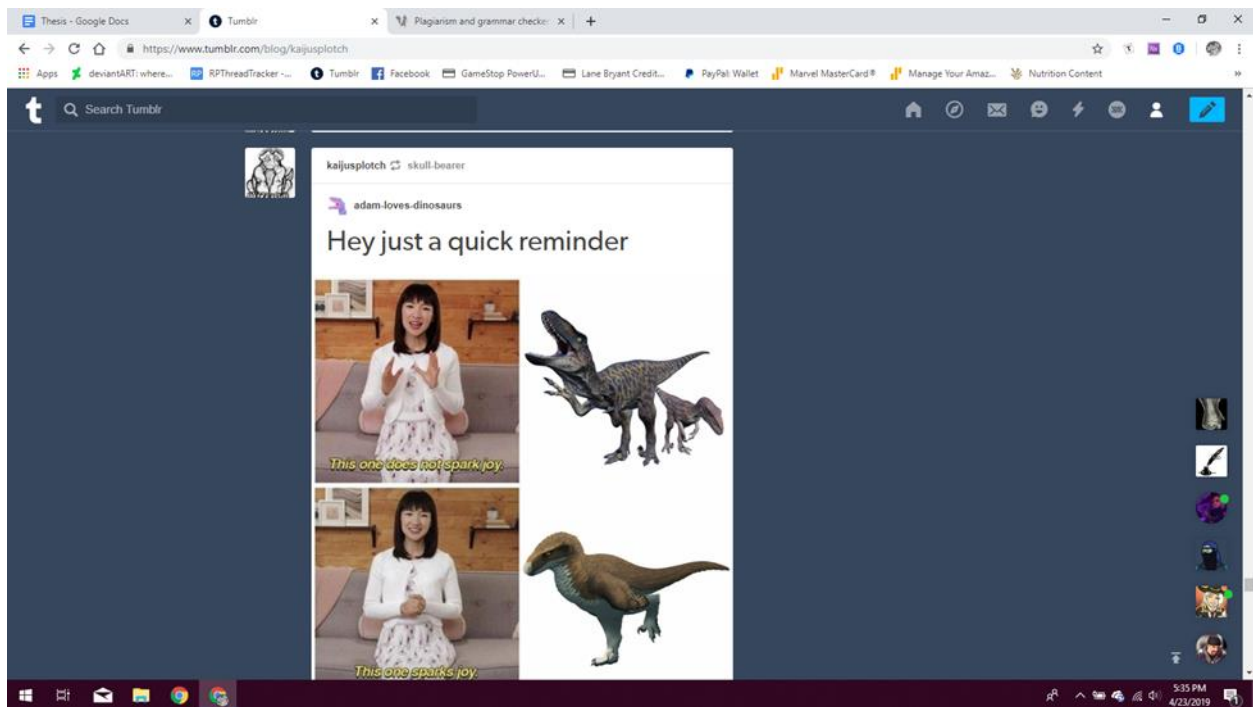


Fig. 47. Image of Marie Kondo sitting on a couch with an image of a feathered scientifically accurate raptor to the right: This one does spark joy, from: Tumblr, user “adam-loves-dinosaurs” with “Hey just a quick reminder” header.

Marie Kondo is a well-known organizing consultant known for her minimalist organization methods. Her method includes holding each item and seeing if the item ‘sparks joy.’ If it does, it is kept and put into an area to remind the person of joy, if not, the item is removed.

By using Marie Kondo's methodology of 'sparkling joy' in dinosaur representation, it should be more embraced to see feathered accurate dinosaurs. Unfortunately, as the thread continues, the discourse and impact of non-scientific accuracy can be seen.

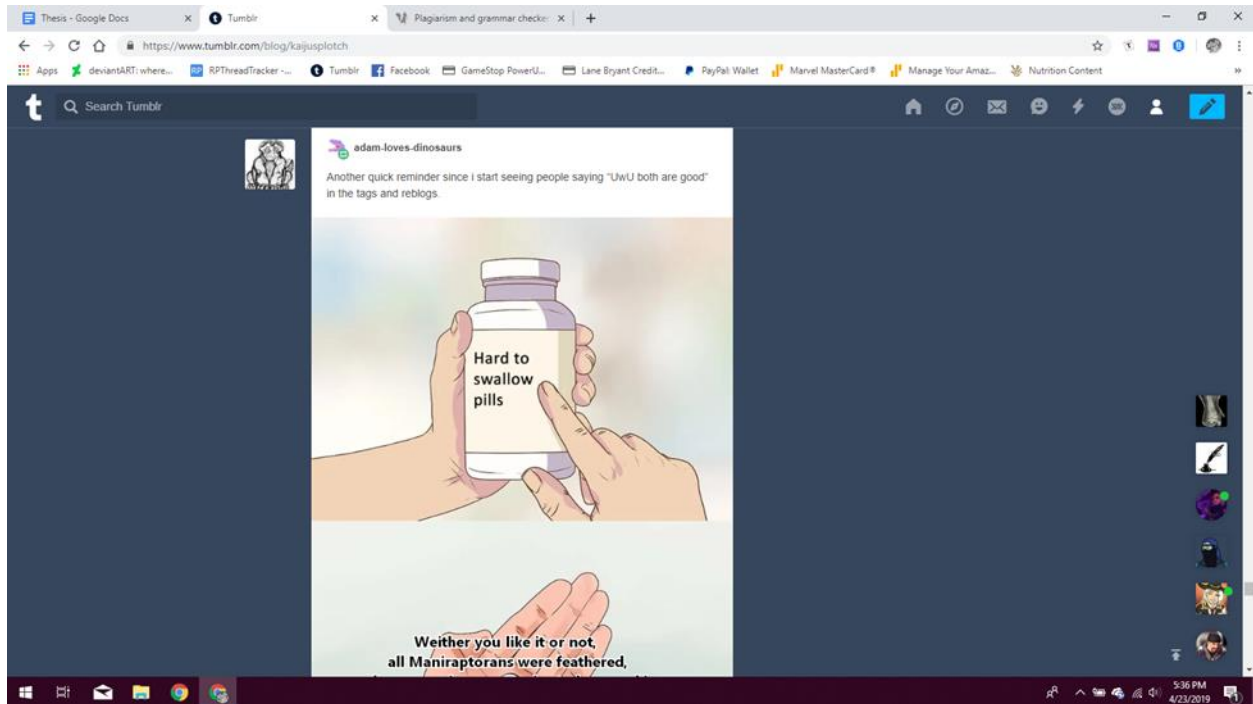


Fig. 48. Image description: a tumblr post/reply from “adam-loves-dinosaurs” with text: Another quick reminder since I see people saying “UwU both are good” in the tags and reblogs

Top image description of a bottle of pills with “Hard to swallow pills” from tumblr.

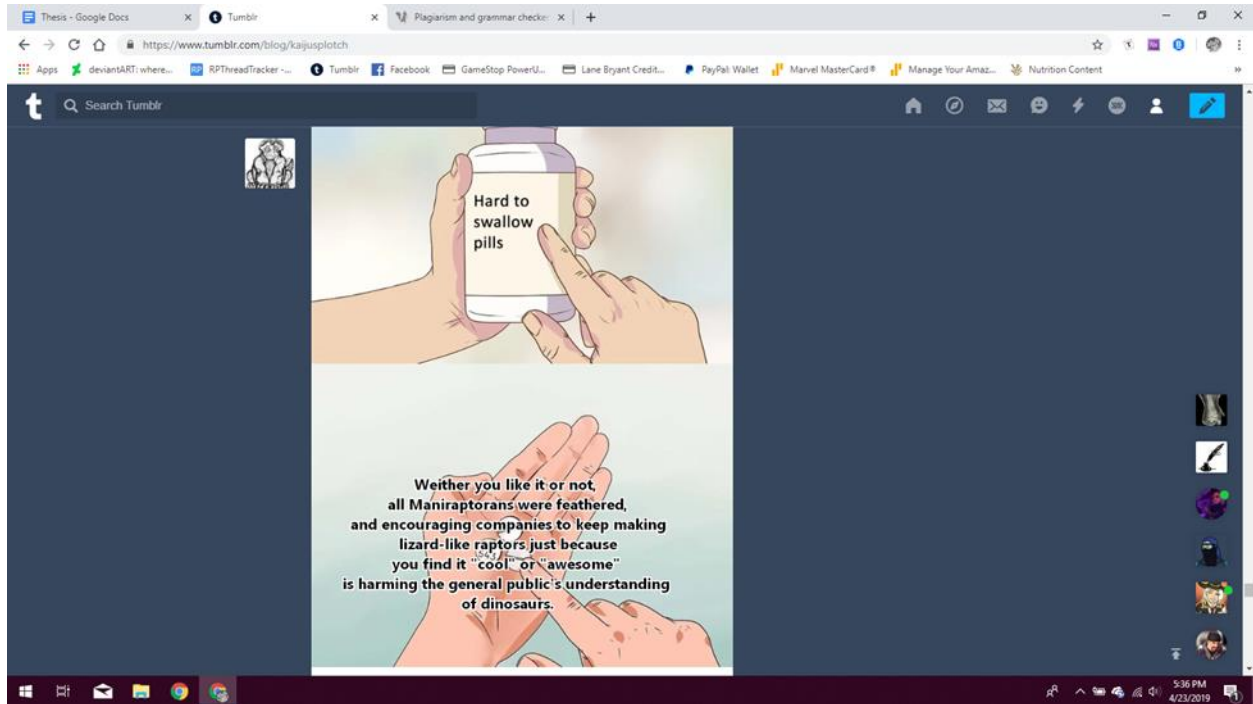


Fig. 49. Image description cont.: top image of bottle of pills with “hard to swallow pills” bottom image of pills in a hand with text overlaying reading: “Whether you like it or not all Maniraptorans were feathered, and encouraging companies to keep making lizard-like raptors just because you find it “cool” and “Awesome” is hurting the public’s understanding of dinosaurs.”

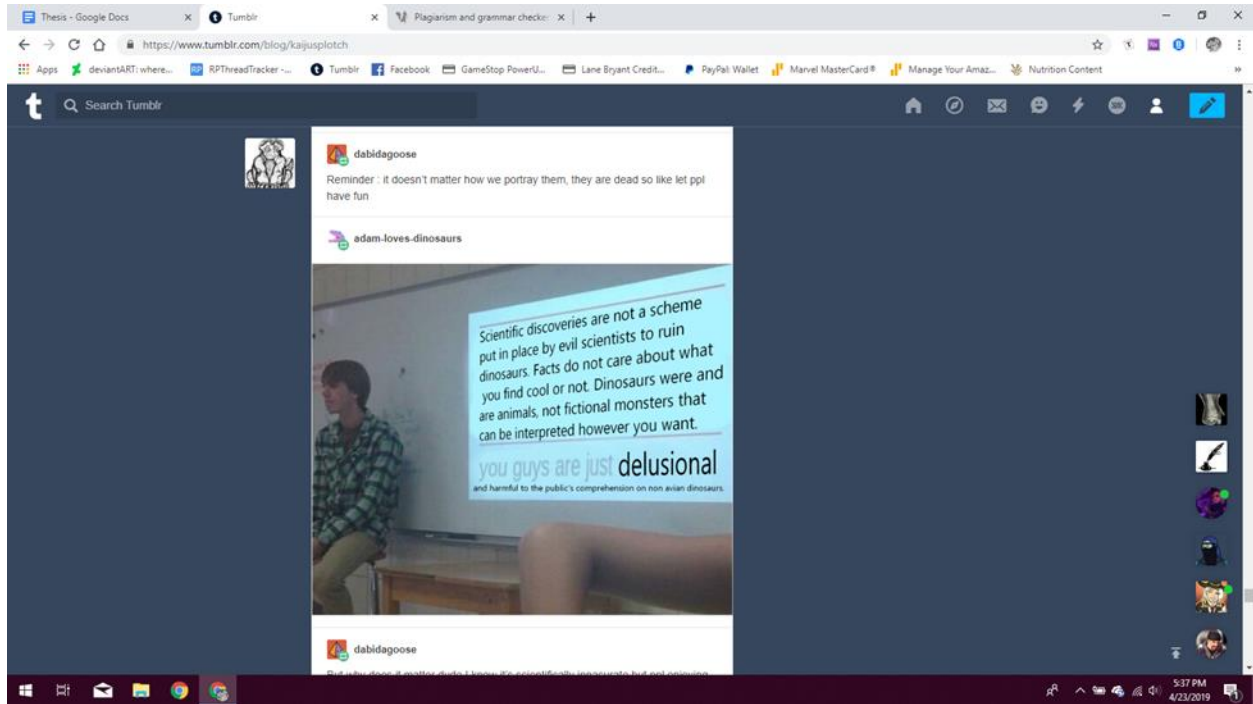


Fig. 50. Image description: Tumblr reblog from “dabidagoose” text reading: “Reminder: it doesn’t matter how we portray them, they are dead, so let ppl have fun”

Bottom image reblog from “adam-loves-dinosaurs:” meme image of a young man sitting on a stool with an overhead projector displaying the words: “Scientific discoveries are not a scheme put in place by evil scientists to ruin dinosaurs. Facts do not care about what you find cool or not. Dinosaurs were and are animals, not fictional monsters that can be interpreted however you want. You guys are just Delusional and harmful to the public’s comprehension of non-avian dinosaurs.”

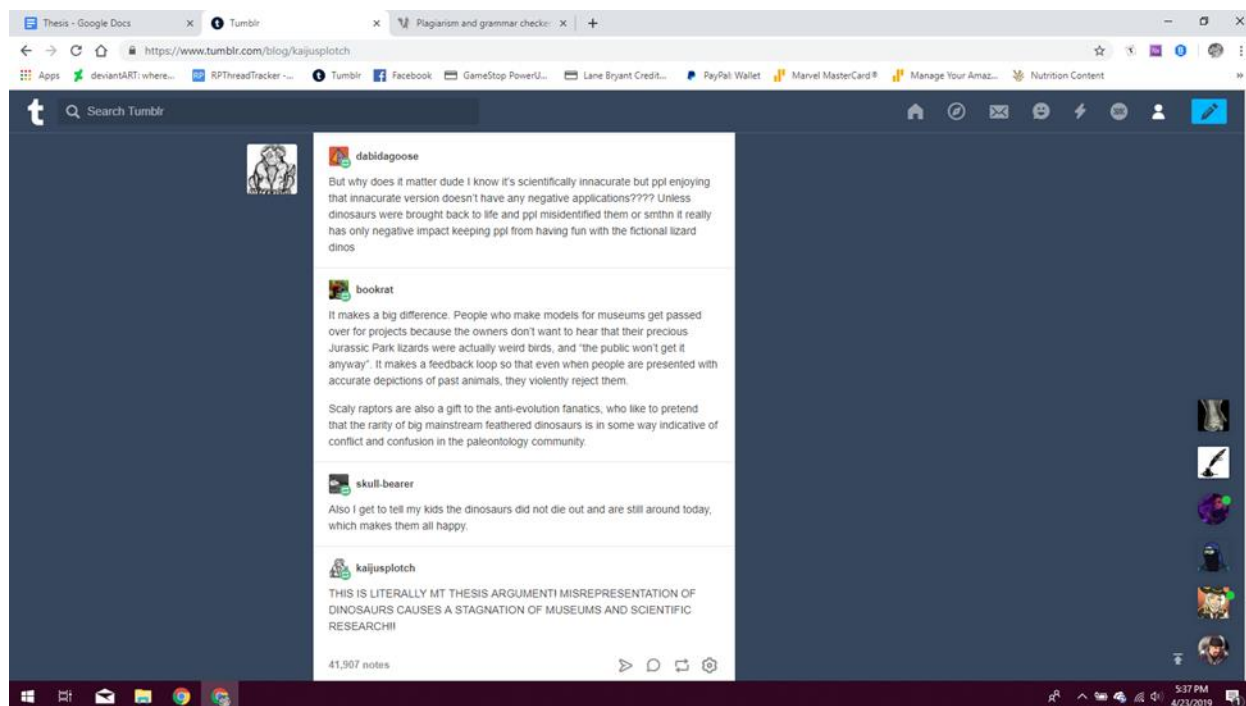


Fig. 51. Image description: text reblog from “dabidagoose” reading: “But why does it matter dude I know it’s scientifically inaccurate but ppl enjoying that inaccurate version doesn’t have any negative applications???? Unless dinosaurs were brought back to life and ppl misidentified them or smthn it really has only negative impact keeping ppl from having fun with the fictional lizard dinos”

Text reply from “bookrat”: “It makes a big difference. People who make models for museums get passed over for projects because the owners do not want to hear that their precious Jurassic Park lizards were actually weird birds, and “the public won’t get it anyway”. It makes a feedback loop so that even when people are presented with accurate depictions of past animals, they violently reject them.

Scaly raptors are also a gift to the anti-evolution fanatics, who like to pretend that the rarity of big mainstream feathered dinosaurs is in some way indicative of conflict and confusion in the paleontology community.”

Text reply from “skull-bearer”: “Also I get to tell my kids the dinosaurs did not die out and are still around today, which makes them all happy.”

Text reply from “KaijuSplothch” (the author of this paper): “THIS IS LITERALLY M(Y) THESIS ARGUMENT! MISREPRESENTATION OF DINOSAURS CAUSES A STAGNATION OF MUSEUMS AND SCIENTIFIC RESEARCH!!!”

The fact that children in school, by parents and unenlightened teachers, are given inaccurate information as to the looks of dinosaurs simply means a harder uphill battle for informal educators at museums. Scientists also face backlash for their scientific advancements and understandings. When scientists first theorized that *T. rex* was feathered, along with the rest of maniraptorans, popular culture fan backlash flooded social media with feathered dinosaurs were not scary. This is what museums must constantly fight against, the pressure that prehistoric animals are not 'cool' or 'scary' if they do not adhere to the pop culture stylization that has been present for so long. This must be a top down commitment to overhaul old exhibits with inaccurately posed mounts, or at the very least, investing in accurate labeling and public talks and discussions about the latest discoveries.

Appendix:

Overview of Survey Results

I conducted an informal survey of guests who visited the Buffalo Museum of Science, asking them to consider their visit to the *Rethink Extinct* exhibit and answer six multiple choice questions and two short answer responses. The survey was conducted in April of 2019.

As of May 1st, 2019, there were eleven responses, unfortunately not enough to have a substantial statistical analysis, but just enough to get an idea of what impressions guests may leave the museum with. The survey also may have a fault in the way it was performed. The surveys were placed online, and accessible via a QR code on a small 3x5 card placed on the admissions' desk of the museum and on certain areas in the *Rethink Extinct* exhibit itself.

Lack of being able to directly ask people while I was at the museum (as I was working there) also may have been a detriment to getting more responses for a larger sample size. Here are the responses gathered from the Google survey and placed in a spreadsheet. The numerical values are ranked from lowest to highest, related directly from bad to worse; a rank of 1 means very poor, a rank of 3 is neutral a rank of 5 is very good.

There is one outlier as of the last collection of data, but it is a representation of a small group of people we do receive at the museum. These people are staunch creationists and often harass not only workers about their work being lies, but also where they may be headed to after death. The author has personally been called a liar by such guests.

In a final conclusion of the extensive research over two years and data collecting over one month; it is my belief that although smaller museums suffer the most from this lack of updating exhibit spaces, all museums suffer from the continuing stagnation and pressure placed upon the public by popular media sources. Although there are areas in multi-media that do

include and impress upon the public the advancements in dinosaur paleontology, they are often purely educational, leaving entertainment venues to do as they will with animals that existed on our planet in the past.

Museums, the scientific community, and the public must continue to pressure accuracy, even in our entertainment media. There are plenty of real monsters that can be interpreted without continuing to perpetuate inaccuracies. Smaller museums must also count themselves responsible to give accurate information through labels, even on inaccurate mounts, if they are unable to raise the funds for repairing their mounted dinosaurs. It is not an impossible task; it is simply one that must be done regularly to ensure that the public is getting the most out of their nontraditional education at a museum.

Table 1

Rethink Extinct Feedback Survey. Buffalo Museum of Science, April 2019

Timestamp	How satisfied were you with the exhibit?	How accurately do you feel the dinosaurs were displayed?	What improvements do you feel could be done in the dinosaurs displayed?	How satisfied were you with the following [Educational information]	How satisfied were you with the following [Accuracy of information]	How satisfied were you with the following [Ease of understanding]	How satisfied were you with the following [Relevance of information]	Any overall feedback for the exhibit?
2019/04/10 12:54:22 PM AST	5	5		Satisfied	Satisfied	Satisfied	Satisfied	
2019/04/12 2:40:50 PM AST	4	4		Very satisfied	Satisfied	Satisfied	Very satisfied	
2019/04/16 4:57:32 PM AST	3	2	Better layout of display cases instead of cramming them all along the wall.	Satisfied	Satisfied	Neither satisfied nor dissatisfied	Neither satisfied nor dissatisfied	Good idea in theory
2019/04/19 3:11:34 PM AST	1	1	less fake news	Very dissatisfied	Very dissatisfied	Very dissatisfied	Very dissatisfied	i am a god fearing individual and this is all incredibly fake
2019/04/20 3:45:34 PM AST	4	4		Satisfied	Satisfied	Satisfied	Satisfied	
2019/04/22 6:41:29 PM AST	5	4	More things to touch	Satisfied	Satisfied	Satisfied	Satisfied	
2019/04/24 2:51:19 PM AST	4	3	More comparisons	Satisfied	Satisfied	Neither satisfied nor dissatisfied	Neither satisfied nor dissatisfied	More images and ways to interact
2019/04/24 8:40:19 PM AST	1	1	Provide accurate information	Very dissatisfied	Very dissatisfied	Very dissatisfied	Very dissatisfied	The exhibit is small, and the informatio

								n provided is either wrong or confusing.
2019/04/26 2:13:34 PM AST	4	4		Very satisfied	Very satisfied	Satisfied	Satisfied	
2019/04/26 3:37:57 PM AST	4	5	More skeleton examples of dinosaurs	Satisfied	Very satisfied	Neither satisfied nor dissatisfied	Satisfied	Well laid out but wish it was bigger
2019/04/30 10:00:17 AM AST	5	5	Oh really not sure.	Very satisfied	Very satisfied	Very satisfied	Very satisfied	

Source: Carla A. Feller, Survey conducted via Google Forms at the Buffalo Museum of Science in April 2019

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