Peering through the Mists of Time: Charles R. Knight and the Art of Imagining Dinosaurs

by

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A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Arts

in

History of Art, Design and Visual Culture

Department of Art and Design

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Abstract

This thesis examines Charles R. Knight's images of dinosaurs produced around the turn of the nineteenth century in comparison to natural history images of living animals. Using a combination of scholarship from animal studies and an analysis of the side of production, it argues Knight used visual strategies and methodologies of depicting living animals to show dinosaurs as animals like those alive in the present moment. As well as putting forward specific theories about the dinosaur species in question, Knight's images argue that dinosaurs were once alive, and that they were not that different from living animals. This thesis seeks to explore how Knight's images articulate the idea of a dinosaur as a group of animals that were once alive, and how Knight constructed images of animals as living beings. I situate Knight in the history of paleontology while examining how the broader history of science and settler colonialism impacted that history. In the second section of the thesis, I place Knight's work in the context of paleoart, natural history illustration, and his role with the American Museum of Natural History before comparing a selection of Knight's illustrations of Mesozoic dinosaurs and living animals. My analysis centers on the ways in which these images navigate the tensions inherent in depicting extinct animals as though they are alive, as well as the flexibility, anxiety, and uncertainty inherent in creating images of the distant past. Furthermore, this thesis puts forward a suggestion to scholars to consider paleoart as it relates to animal art and animal studies.

Acknowledgements

As with anything I have ever made, this thesis is the result of the ideas and actions of many, even if written by one. I cannot thank by name everyone who supported me by name, as I do not know all their names. My gratitude goes out to all who contributed their time, care, ideas, support, and critique regardless of the size of their contribution.

First, I owe my gratitude to Dr. Betsy Boone, who guided this project from its beginning to end. It was Betsy who years ago while I was working on my undergraduate degree encouraged me to join the honours program, and who introduced me to animal studies in my graduate career. Without her generosity, patience, thoughtful comments, and razor-sharp eye for editing, this project would have not made it to completion. I learned so much from her graduate seminars, as well as in my time working with her as a teaching and research assistant. Thank you for the thought-provoking conversations as well as the fun ones. I must also thank Dr. Lianne McTavish for coordinating my defence as well as the support she has offered over the years. I am a better writer and researcher because of her insight, resolve, and excellent advice.

I cannot go without thanking the following for their roles in my academic development. I thank Dr. Natalie Loveless for many thought-provoking conversations, Dr. Lisa Claypool for her kindness and drive, Dr. Joan Greer for being an incredible guide, Dr. Nikolina Kurtovic for her encouragement, and Dr. Andrea Korda for always providing excellent feedback and for acting as an examiner. I also thank Dr. Micheal Caldwell for serving as my external examiner and asking such thought-provoking questions.

Several institutions were key in my research, particularly the Royal Tyrrel Museum, the New York Public Library's Manuscripts and Archives Division, and the American Museum of

Natural History (AMNH). I owe my thanks to many individuals at those institutions who facilitated my research, especially Sue Sabrowski at the Royal Tyrrel Museum for arranging several research visits, and the staff at the Brooke Russell Astor Reading Room at the NYPL for their assistance. I also owe gratitude to the both the Internet Archive and the University of Alberta's Libraries for providing so many key resources.

I am profoundly grateful to all those around me who were there before, during, and now after this stage of my life. Thank you to all of you, Heather for being a steadfast friend and all-around wonderful person, Mark and Singee for letting me ramble over voice chat, Ali for years of long-distance friendship, Jessica for being my sister, my mom for her constant love and support, my dad for always encouraging me, and Carol, Jim, Bryan, and Sarah for welcoming me into their family.

I save my deepest thanks for Mark Bykowski, my partner in life. He supported me every step of the way, from when I first decided to apply to a master's program, through choosing a topic and wrestling with these ideas, researching, writing, editing, all of it. Mark was with me everywhere I travelled, he took photos when my hands were full, made me laugh, brought me snacks and water, gave suggestions both clever and practical, shared ideas, and offered endless love and encouragement. The world is so much more interesting when I'm with him.

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Introduction

What do we look at when we look at dinosaurs? Where do Charles R. Knight's reconstructions of dinosaurs fit within images of animals? How were dinosaurs understood as animals? Why do Knight's pictures of dinosaurs look the way they do?

In 1896 the American Museum of Natural History (AMNH) commissioned Charles R. Knight (1874-1953) to draw a reconstruction of *Elotherium*, an extinct pig which lived between 33 and 28 million years ago.[1] When the AMNH first approached Knight, he was working as commercial artist in animal illustration and stained-glass design, and as part of his work spent a great deal of time at the AMNH sketching specimens and otherwise studying animal bodies.[2] Dr. Jacob Wortman, who commissioned this drawing from Knight, was pleased enough with the reconstruction of *Elotherium* to recommend Knight to other paleontologists at the museum interested in reconstructing extinct animals. This launched Knight's career as a preeminent artist in the then new field of paleoart. Knight's "restorations," as he called them, were artistic re-creations of extinct animals. Knight relied on commissions from the AMNH for over twenty years of his career, while also creating restorations for various magazines, scientific books, and other natural history museums. Although Knight drew a variety of animals, including living ones, he is perhaps best known for his images of dinosaurs. Due to Knight's work being displayed in some of the most influential paleontological institutions in the United States, his paintings of dinosaurs came to define how these animals and the time they lived in were visualized for most of the twentieth century.

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[1] Marianne Sommer, "Seriality in the Making: The Knight-Osborne Restorations in the American Museum of Natural History," *History of Science* 48 no. 3 (2010): 285. Now known as *Entelodon*, this animal lived in the late Eocene and early Oligocene.

[2] Rhoda Kalt Knight and William Stroud, *Charles R. Knight: Autobiography of an Artist* (Ann Arbor: G.T. Labs, 2005) 38.

Knight is arguably the artist most responsible for creating the twentieth century's iconic scaly, gray-green dinosaur, an image not disturbed until the discovery of feathered dinosaurs in the 1990s and the release of *Jurassic Park* in 1994. His illustrations are at once widely distributed low brow decorations, and about as close to "high culture" as pictures of dinosaurs are allowed to be.[3] While not in the same ideological space as the art museum, their location in the halls of important, influential natural history museums elevated Knight's works into the realm of culture. Knight's work is still displayed in prominent natural history museums such as the Chicago Field Museum of Natural History, the Natural History Museum of Los Angeles County, the George C. Page Museum at the La Brea Tar Pits, and the Carnegie Museum of Natural History in Pittsburgh. The AMNH also built much of its current fossil halls around Knight's paintings and sculptures, even keeping the original early twentieth-century mounts posed to match Knight's works. Knight's pictures showed dinosaurs not as monsters inhabiting an alien world, but as animals like those that lived alongside humans in the nineteenth century. They were part of a larger project to fill the AMNH with plentiful visual representations of the past instead of simply displaying fossils still in rock matrix.[4] Knight's work was part of a project to make visible the ancient past as a tangible environment filled with living things.

Knights' artworks endow a sense of life-likeness to his dinosaur subjects. With close attention given to rendering the texture of skin, scales, and eyes in a palette of full, saturated colour, these animals are made immediate and above all else alive. Their eyes shine with personality as much as moisture. They interact with their environment, swimming, eating,

[3] Michele Bogart, "'Lowbrow/highbrow:' Charles Knight, Art Work, and the Spectacle of Prehistoric Life." In *American Victorians and Virgin Nature*, ed, T.J. Jackson Lears (Boston: Isabella Stewart Gardner Museum, 1999), 39.
[4] Victoria Cain. "The Direct Medium of Vision: Visual Education, Virtual Witnessing and the Prehistoric Past at the American Museum of Natural History, 1890-1923." *Journal of Visual Culture* 9, no.3 (2010), 285.

drinking, and even playing. Their bodies are in motion rather then held flat for an observational eye. Knight's pictures were intended to expand on the fossil displays and spark visitors' imaginations.[5] These artworks inspire a sense of wonder towards the past and the animals that inhabited it. In many cases his artworks were (and remain) part of a spectacular display that emphasises the biggest, most impressive dinosaurs. Knight's artworks are a mix of romantic notions of a lost world and the rationality and rigour of scientific empiricism.[6] In other words, they are made to inspire wonder in viewers as well as being educational. By creating images of dinosaurs as fleshy, animated creatures, Knight's artworks visually produced them as though they were alive. His artworks were a potent part of the reality-making process of natural history.

To locate my research in its historical context, I first must answer the question of what dinosaurs were in Knight's time and distinguish that understanding of dinosaurs from what they are today. The ways in which dinosaurs are understood is fundamentally shaped by the scientific organizational systems of taxonomy and geologic time. Dinosaurs are a taxonomic category as well as a cultural idea, and as such the idea of a dinosaur is shaped by categorization. Understanding how dinosaurs were and are organized helps explain their meaning. The ways in which fossils were collected and displayed likewise has a notable effect on how they were interpreted. I will also provide an outline to the theories and methods I use to explore Knight's work and a review of the scholarly literature on the history of imagining dinosaurs to better contextualize this thesis. In short, the first part of my thesis explores how dinosaurs were defined and constructed.

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[5] Robert Rainger, *An Agenda for Antiquity: Henry Fairfield Osborn & Vertebrate Paleontology at the American Museum of Natural History, 1890–1935* (Birmingham: University of Alabama Press, 1991), 150-151.
[6] Lukas Rieppel, *Assembling the Dinosaur: Fossil Hunters, Tycoons, and the Making of a* Spectacle (Cambridge MA: Harvard University Press, 2019), 2-3.

Part I. Constructing Dinosaurs

Introduction to Geologic Time

An introduction to some of the scientific terms used in this thesis will be useful. These terms, derived from the paleontological and biological sciences, are related to geologic time periods and taxonomy. Geologic time emerged in the late eighteenth century as a way of organizing the relative ages of rock, it is constructed primarily through analyzing the fossilized life contained in those rocks rather than through absolute dates. The most important unit of geologic time for this research is the Mesozoic era (fig. 1). The word Mesozoic was created from the Greek *meso* (between, middle) and *zoon* (animal, beast) in 1841 by British naturalist John Phillips as an alternative name for the period then known as the "Age of Reptiles." This is a length of time spanning from about 252 to 66 million years ago (Mya), between two catastrophic mass extinction events: the Permian-Triassic extinction, also called the Great Dying, and the Cretaceous-Paleogene (K-Pg) extinction[7]. The era is further divided into three periods, the Triassic, Jurassic, and Cretaceous. The Triassic and Jurassic each end with smaller mass extinctions. The K-Pg extinction event at the end of the Cretaceous caused the rapid extinction of the vast majority of marine and terrestrial species, including most four limbed vertebrates over 25 kg. All dinosaurs, aside from modern birds, lived, died, and went extinct in this window of time.

For all the focus on dinosaurs as representative of the Mesozoic era, they were certainly not the only animals living in that time. Familiar animals such as corals, sponges, starfish,

[7] For a more detailed discussion of deep time and geologic time scales, in the context of museums, see Diana E. Marsh, *Extinct Monsters to Deep Time: Conflict, Compromise, and the Making of Smithsonian's Fossil Halls*, New York: Berghahn Books, 2019.

bivalves, mollusks, arachnids, insects, crabs, amphibians, jawed fish, lungfish, as well as diapsids (the ancestors of reptiles) and synapsids (the ancestors of mammals) survived the Permian-Triassic extinction. A diverse variety of reptiles evolved in the Triassic period. Among those reptiles were dinosaurs, a group of flying reptiles called pterosaurs, the ancestors of modern lizards and turtles, and a variety of aquatic reptiles including ichthyosaurs and crocodilians. Mammal-like cynodonts, survivors of the Permian-Triassic extinction, evolved into the first mammals near the end of the Triassic period.

Many of the non-dinosaur reptile species that were widespread in the Triassic period died out in the extinction event around 201.3 Mya, the date that serves as the dividing line between the Triassic and Jurassic periods. The Jurassic period saw the broad diversification of dinosaurs, with the long-necked sauropods becoming pervasive terrestrial herbivores and carnivorous and omnivorous dinosaurs becoming dominant in other ecological niches. The massive size diversity among non-avian dinosaurs was also heightened in this period. The largest known sauropods could measure over 36 meters long while the smallest known dinosaurs topped out around 30 centimeters in length. Both lived in the Jurassic period. This difference in size demonstrates the numerousness and diversity of dinosaurs in the Jurassic. Feathered dinosaurs evolved in forests of conifers, gingkoes, and cycads, followed by avian dinosaurs (birds) in the late Jurassic. Non-dinosaur reptiles, including pterosaurs, marine reptiles, lizards, turtles, and crocodilians diversified alongside mammals, fish, and insects.

Flowering plants appeared in the early Cretaceous period, followed shortly after by the ants, bees, grasshoppers, butterflies, and other insects that evolved to live with this new type of plant. By the end of the Cretaceous, flowering plants had supplanted coniferous, cycad, and spore-based vegetation. Birds diversified and spread to every continent, even to polar regions.

Mammals, while generally small, were also an important part of Cretaceous ecosystems, outnumbering reptiles in some fossil beds. The first placental and marsupial mammals appeared at the end of the Cretaceous. A warm climate and decrease of sea basin volume created shallow inland seaways populated with marine reptiles alongside familiar animals such as corals, sponges, sea urchins, rays, modern sharks, and marine diving birds. A range of iconic dinosaur species such as *Tyrannosaurus rex*, *Triceratops*, *Velociraptor*, *Ankylosaurus*, and *Edmontosaurus* appeared in this period.

As most dinosaur specimens on display at the AMNH lived in the Jurassic and Cretacious periods. Knight's illustrations mostly depict dinosaurs from those periods. In art, the Jurassic period is often characterized by a warm, wet climate, such as can be seen in Knight's depiction of a *Brontosaurus* (fig. 2),[8] however Knight more often chose to portray the drier, cooler Cretaceous landscape with dry sandy ground between patches of vegetation (fig. 3). Along with his paintings of the Mesozoic, Knight also did a few drawings and paintings of the pre-dinosaur Paleozoic era, which ended with the Permian-Triassic extinction. He also depicted prehistoric humans, and a variety of other extinct and living mammal species in the Cenozoic era.[9] The exact dates where eras, periods, and mass extinction events are located can seem to shift as dating methods improve, but the organisms and extinctions which define those periods do not. The units of Mya I have listed here are not the exact same as the units Knight worked with in his career, but describe the same ecosystems and are bracketed by the same the extinctions.

[8] Brontosaurus is now recognized to be the same species as *Apatasaurus*. The current name for this animal is *Apatasaurus*. Throughout this essay I will refer to this image as showing *Brontosaurus* since it was thought to be a distinct species in Knight's time.

[9] The Cenozoic era began after the Cretaceous-Paleogene extinction and is the current geological era. The Paleozoic describes the time from the emergence of multi-cellular animal life (around 541 Mya) until the Permian-Triassic extinction event.

Introduction to Taxonomy

The Great Chain of Being

Before modern taxonomy was developed, a system called the Great Chain of Being organized the relationships and attributes shared between living and non-living things.[10] The logics underpinning this method of organizing all things can be dated as far back as Plato's *Republic* and Aristotle's *History of Animals*. Every spiritual, living, and non-living thing in existence could be placed in a hierarchical rank from God and the highest beings, to the lowest, non-living matter. This model is often illustrated vertically as a ladder or a staircase. Medieval and early modern descriptions of the chain of being had six major categories: God, angels, humans, animals, plants, and minerals. The attributes needed to be placed higher on the chain were linked both to physical complexity and (presumed) spiritual virtue. The ranking of larger categories was stable, while the ranking within categories was subject to debate as the qualities used to assess placement were multi-layered. A high-placed animal might care for its young, have keen senses, and move swiftly, while a low-placed animal might crawl in the earth and lack senses like vision or hearing. Despite the many differences found between the links on the chain, all were linked to God as well as to all other lower and higher beings.[11] The classification methods I briefly outline here share an understanding that all the things on this world are linked.

[10] For a greater discussion of the great chain of being in relation to paleontology, see Martin J.S. Rudwick, *Scenes from Deep Time: Early Pictorial Representations of the Prehistoric World* (Chicago: University of Chicago Press, 1992),

[11] Some of the language of the great chain of being is still in use. The phrase "missing link," first used by Charles Lyell to describe missing parts of geologic time, draws from the model of creatures as links in the great chain of being.

Linnaean classification

In 1758 Carl Linné, self-styled as Carolus Linnaeus (1707-1778), published his definitive edition of *Systema Naturae*.[12] This was the first of several books in which he laid out his system of biological classification. In many ways it is, like the great chain of being, a ranked hierarchical order. Linnaeus created six major taxonomic ranks: Kingdom, Class, Order, Family, Genus, and Species. His system sorted all living things into the kingdoms of *Regnum Animale*, holding all animals, and *Regnum Vegetabile,* holding all plants. All animals were then sorted into the classes *Mammalia, Aves, Amphibia, Pisces* (fish), *Insecta*, and *Vermes,*[13] with *Mammalia* as the highest rank and *Vermes* as the lowest. Each class was divided into orders, then in turn into families, genera, and species. Linnaeus strove to create a system where one could easily place any living thing into its place. In theory any species could be entered into this system and identified with a stable, unique name. The system was widely adopted by scientists in Europe and its colonies.

Darwin and evolution

When Charles Darwin (1809-1882) published *On the Origin of Species* in 1859 existing taxonomies were thrown into upheaval. Evolutionary theory demanded a whole new approach to taxonomy based on evolutionary relationships rather than assumed hierarchical similarities between organisms.[14] This shift in thinking is visualized by comparing the rows and columns Linnaeus used to chart taxonomy (fig. 4) to the branching tree of life diagrams used by Darwin and his followers (fig. 5). Taxonomy in this period was a mishmash of newly invented categories

[12] Carolus Linnaeus, *Systema Naturae*, Leiden: Theodorum Haak, 1735.
[13] Vermes described soft bodied animals and is roughly congruent with non-insect invertebrates. The category covered animals like worms, shellfish, snails, corals, and jellyfish.
[14] For a detailed examination of the pictures in Darwin's publications, see Julia Voss, *Darwin's Pictures*, New Haven: Yale University Press, 2010.

grafted onto existing Linnaean taxonomy. As well as moving animals between existing categories to reflect current knowledge, naturalists often added additional taxonomic categories to the Linnaean system. For example, in 1866 Ernst Haeckel developed the taxonomic rank of phylum to fit between the existing categories of kingdom and class. Because the categories developed by Linnaeus proved flexible enough to hold new ranks as they were developed and even accommodate evolutionary theory, the framework of Linnaean taxonomy remained in use.

The adoption of evolutionary theory meant that networks of evolutionary descent needed to become part of taxonomy. As naturalists attempted to understand the connections between taxa, they began linking living and extinct species to construct an organism's path through evolution and time. The phenomenon of extinction outside direct intervention by God or humans was a relatively new concept, introduced by Georges Cuvier in 1796.[15] The idea that an entire type of living thing could cease living shocked many naturalists. It took decades before extinction was widely accepted as a natural phenomenon.

Current scientific thinking

As flexible as Linnaean taxonomy is, its issues became apparent as time went on. The frequent discovery of new species and the often-slow communication of new classifications meant species were not infrequently "discovered" by different people each of whom came up with distinct names for their specimen. Furthermore, although Linnaean taxonomy is highly organized in theory, the addition of each new taxa made classification more complex and cumbersome. Reorganizing taxonomy around evolutionary ancestry meant many of the original

[15] Martin J.S. Rudwick, *Georges Cuvier, Fossil Bones, and Geological Catastrophes*: *New Translations and Interpretations of the Primary Texts* (Chicago: University of Chicago Press, 1997), 48, and in Rieppel, *Assembling the Dinosaur*, 19-20.

Linnaean categories simply would not work without reorganization. The categories needed to fit into each other rather than alongside each other. When animals are organized according to ancestry, Linnean classifications are simply not complex, or flexible enough. In the context of evolution, a category like "fish" does not accurately describe all animals down every evolutionary path emerging from fish. Naturalists continued using some Linnaean names in evolutionary taxonomy, as well as common terms like fish to describe physiological similarities, but those terms became increasingly complex and less useful to describe the relationship between different animals.

In the 1950s scientists began developing the system of cladistics to better organize taxa by evolutionary relationship.[16] A clade is a group of organisms composed from a common ancestor and all its descendants, including those that may look radically different but still descend from that common ancestor. For example, all animals with a spinal cord are in the same clade because they all share a common ancestor. What organisms belong to a clade is based on anatomical and genetic analysis to determine the relationships between ancestor groups. This is now the standard method used to determine evolutionary ancestry. Cladistics overlaps with earlier adjustments made to the Linnaean system.[17] It formalized the process of evaluating common ancestors and allowed for more flexibility in creating new taxa and adjusting where taxa fit in evolutionary history. Cladistics uses the same principles as Darwin's "tree of life" method of taxonomy, connecting categories by charting divergences and connections. Each species belongs to a series of clades, each one fitting into the next like a set of mixing bowls.

[16] Brian Noble provides a good introduction to cladistics in *Articulating Dinosaurs: A Political Anthropology*, Toronto: University of Toronto Press, 2016.
[17] The adjustments included the using the now standard ranks of Kingdom, Phylum, Class, Order, Family, Genus, Species as a simplified taxonomy.

Using adjusted Linnaean classification, the taxonomic designation of a domestic chicken is as follows: Kingdom Animalia, Phylum Chordata, Class Aves, Order Galliformes, Family Phasianidae, Genus *Gallus*, Species *Domesticus*. However, these categories represent a condensed, simplified explanation of the evolutionary ancestry of chickens. There can be dozens of quantifiable branches in between the kingdom, phylum, class, order, family, and genus of any given species. Cladistics seeks to accurately describe branches in ancestry wherever they happen, and therefore adds or removes clades anywhere they are needed. For example, according to the current taxonomy chickens belong to the following clades from their order to species: Galliformes, Phasianoidea, Phasianidae, Pavoninae, Gallini, *Gallus*, *domesticus*. The main changes cladistics brought about were to organize taxa through the last known common ancestor and to standardize the methods used to determine common ancestry.

What is a Dinosaur?

The category of dinosaur is a creation of the nineteenth century and was still in the process of being defined when Knight began his work for the AMNH. Dinosaurs were created as much through his artistic restorations as taxonomic categorization. Before the "invention" of the dinosaur, these animals were most often understood as relics from before the biblical flood or as monsters struck down by God.[18] Classifying dinosaurs as part of natural history turned them into an animal that could be studied rather than a curious religious object.[19] Even as an object of study, however, dinosaurs retained their biblical roots, associated with monsters such as the leviathan or the dragon defeated by St. George[20]. They were routinely referred to by terms such

[18] Rudwick, *Scenes from Deep Time,* 128.
[19] Idid, 165.
[20] Noble, *Articulating Dinosaurs*, 16.

as antediluvian monsters or antediluvian animals both inside and outside scientific literature until the early twentieth century, a direct reference to the biblical flood. By drawing from the anatomy of living animals to imagine dinosaurs, Knight shaped his dinosaurs to fit with an understanding of deep time as scientific and rational albeit mysterious and distant. His artworks show dinosaurs as alive and comprehensible, yet wonderous. The power of scientific knowledge was as wonderous as the dinosaurs themselves.

Dinosaurs were different from living animals and therefore necessitated the invention of new taxonomies. The collective name for the group *Dinosauria* was created in 1841by British naturalist Richard Owen (1804-1892), the same year as the term Mesozoic. From the Greek words *deinos* (terrible, powerful) and *sauros* (lizard), the word dinosaur described what Owen called "giant fossil lizards" in the taxonomic language of natural science. The term as it is used now is far more specific than when Owen created it to describe big extinct reptiles.[21] When Owen first invented the term "dinosaur" it was rarely used outside of technical research publications, with broader terms such as ancient reptiles or antediluvian monsters being more commonly used in popular publications.[22] Many were still unfamiliar with the term when the AMNH installed a *Brontosaurus* mount in their fossil hall in 1905, over 60 years after Owen coined the term.[23] When Knight first began working on his restorations in the 1890s the term dinosaur was beginning to replace "ancient reptile" as the term of choice, but it often retained the non-specific meaning of big extinct reptile rather than a specific taxonomic meaning.

[21] W.J.T. Mitchell, *The Last Dinosaur Book: The Life and Times of a Cultural Icon* (Chicago: University of Chicago Press, 1998), 10.
[22] Deborah Cadbury, *The Dinosaur Hunters: The First Dinosaur Hunters and the Birth of a New Science* (New York: Henry Holt and Company, 2001), 250.
[23] "Old and Young Call to See the Dinosaur," *New York Times*, Feb. 20, 1905, 12.

Terms like ancient reptiles made no distinction between Mesozoic non-dinosaur reptiles and dinosaurs. The cultural image of a dinosaurs is somewhat flexible since dinosaurs were a wildly varied group of animals. Flying reptiles such as pterosaurs, marine reptiles such as mosasaurs,[24] and terrestrial dinosaurs all fit that category of ancient, extinct, fossilized reptile and were often illustrated together and discussed in the same breath.[25] Many of the hallmarks of paleontological art, or paleoart, were developed in this part of the nineteenth century, meaning the visual language of paleoart was created when the boundaries between different types of extinct animal were much more permeable.

Although the *sauros* in the name suggests a close relation to modern reptiles like lizards and crocodiles, these groups actually exist as separate evolutionary lines (fig. 6). Dinosaurs are a taxonomic group first appearing in the Triassic period between 243 and 233 million years ago. They are distinguished from other taxonomic groups (clades) by a handful of anatomical features, including the placement and number of fenestrae (openings) in the skull and the presence of additional holes in the hip joints. Dinosaurs are diapsids rather than synapsids, meaning they have two openings in the skull located behind the eyes.[26] These openings provide places for muscles to attach, allowing more varieties of muscle arrangements around the head and jaw, which in turn allowed stronger, faster, and more specialized head and jaw movements. Diapsids also have holes in the hip joints to provide muscle attachment sites, allowing an erect posture with the legs held straight under the body rather than a sprawling posture with the legs held splayed.[27] This difference in posture can be seen in Knight's 1901 painting of the Paleozoic

[24] Mosasaurs are more closely related to snakes or monitor lizards then dinosaurs.
[25] Rieppel, *Assembling the Dinosaur*, 5.
[26] Diapsids first appeared ca. 300 Mya after the ancestors of mammals and reptiles diverged. *Diapsida* contains all reptiles/sauropsids, while *synapsida* contains all mammals and reptile-like mammals. Synapsids and diapsids are the two major groups of terrestrial animals.
[27] Imagine a flamingo's legs vs. a Komodo dragons.

era synapsids *Dimetrodon* and *Edaphosaurus* (fig. 7) and his paintings of the dinosaurs *Trachodon* (see again fig. 3) and *Allosaurus* (fig. 8).

Paleontologists have fine-tuned and tweaked the term "dinosaur" as the fossil record has expanded. The placement of dinosaurs in natural history has made it possible to compare them with living animals. However, even with dinosaurs' absorption into the realm of science, Knight still needed to contend with many uncertainties when creating his artistic restorations. Though a few skin impressions had been found, well-preserved fossilized skin specimens were incredibly rare.[28] Finding multiple parts of the same animal was cause for excitement. Vital information about an animal's appearance such as colour, soft tissues such as cartilage and fat, as well as detailed information on muscle arrangement was unobtainable in most cases.[29] This missing information made speculation necessary for Knight's "restorations."

In the late nineteenth and early twentieth centuries Dinosaurs were most often thought to have no living descendants.[30] Those who accepted Darwinian evolution thought dinosaurs shared a common ancestor with living reptiles such as turtles, crocodiles, and lizards, branching away into distinct taxa before or in the early Mesozoic era. This said, as early as the 1860s Thomas Henry Huxley (1825-1895) theorized birds as having dinosaur ancestry. Although he was not the only one to suggest a connection between birds and dinosaurs, the idea was not widely accepted even among those who adopted Darwinian evolution until the late twentieth century.[31] Birds

[28] The 1915 discovery of an *Edmontosaurus* with preserved skin and soft tissue was cause for great excitement and immediately became an important object of study as well as a centerpiece of the AMNH's dinosaur halls. The specimen was excavated by Barnum Brown and Joseph Sternberg Red Deer River Valley expedition for the AMNH detailed in Charles H. Sternberg's, 1919 *Life of a Fossil Hunter*. This specimen is currently on display at the AMNH.
[29] In the last twenty years techniques for identifying colour proteins in fossils have been developed, allowing for the colouration of skin and feathers to be determined in some well-preserved specimens.
[30] Rieppel, *Assembling the Dinosaur*, 224-225.
[31] Noble, *Articulating Dinosaurs*, 6.

were not understood to be related to dinosaurs for so long in part because scientists were unsure where to place birds. The beaks, feathers, and hollow bones that so define birds today did not fit with that distinctly, reptilian image of a dinosaur that developed in the nineteenth century. Current paleontology understands birds as descendants of dinosaurs, but this idea was not reintroduced as a serious theory until the 1980s and was not widely accepted until the 1990s.[32]

Animals that fall outside the clade *Dinosauria* are (and were) not considered dinosaurs by the scientific community, although this distinction is often murky in the popular sphere, even today. For example, *Dimetrodon* (see again fig. 7, front) is often included in dinosaur iconography though it does not fall within the clade *Dinosauria,* is not a diapsid, and is much more closely related to mammals than any modern reptile. Despite fitting the visual description of big extinct lizard, *Dimetrodon* is neither a lizard nor a dinosaur. Yet it is still often lumped in with dinosaurs because of its scaly, reptilian appearance.

In Knight's time, dinosaurs were firmly in the category of reptiles despite rigorous debate over whether they were warm-blooded and active or cold-blooded and slow. Dinosaurs were also thoroughly extinct, though they were understood to share some physiological similarities to living reptiles.[33] The scaliness of dinosaurs is less certain now that feathered dinosaurs have been in the cultural consciousness for a few decades, but the idea that dinosaurs are big extinct reptiles lingers more strongly than the nuances of cladistics. In a broader cultural sense, a dinosaur is a reptilian creature that is no longer living. Everyone knows what a dinosaur looks like. Dinosaurs are usually (but not always) big, usually (but not always) scaly, and usually (but not always) green.

[32] Noble, *Articulating Dinosaurs*, 137.
[33] Rieppel, *Assembling the Dinosaur*, 225.

Charles R. Knight

Knight was born in Brooklyn in 1874 to the U.S.-born Lucy Knight and the English-born George Wakefield Knight. His father was the personal secretary to J.P. Morgan, a connection which Knight made use of in his professional life as an artist. Knight was injured in his right eye at the age of six. This injury, combined with his already significant astigmatism, left him legally blind for the rest of his life.[34] Despite his poor vision, Knight began working towards an artistic career at age twelve, attending the Metropolitan Art School and drawing sessions sponsored by the Art Students League. By 1890, Knight had become a freelance artist producing illustrations for books, magazines, and museums. His speciality was pictures of animals. Knight spent a great deal of time sketching live animals at the Bronx Zoo and considered the close observation of living animals to be of paramount importance to his artwork.[35] His limited ability to see at any distance, even with eyeglasses, meant he needed to get as close to his subjects as possible. Observing live animals at a safe distance was simply not an option for him. Knight occasionally used taxidermied specimens at the AMNH, as well as photographs cut from newspapers and magazines, as supplements to drawing from life.[36] His pictures are heavily informed by animal painting as well as his study of animal bodies both living and dead. Knight's first commission at the AMNH was in part due to his frequent visits to the museum, as well as his social connections.

Knight's patrons framed his observation of moving, breathing animals as necessary for his artistic practice, and as something that set him apart from other paleontological illustrators.

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[34] Rhoda Knight Kalt and William Stout, *Charles R. Knight: Autobiography of an Artist* (Ann Arbor: G.T. Labs. 2005), 6.
[35] Richard Milner, *Charles R. Knight: The Artist Who Saw through Time* (New York: Abrams, 2012), 12.
[36] A sampling of the clippings Knight gathered can be found in box 8 of the *Charles Knight Papers*, New York Public Library Rare Books and Manuscripts Division.

Similarly, Knight's study of fossils was often mentioned as something that set him apart from other animal artists. As Henry Fairfield Osborn (1857-1935) wrote in a letter to Knight "few people have any idea of the amount of time and pains taken to make them [Knight's restorations] nearly authentic as possible".[37] Osborn was referring to the multiple preparatory sketches Knight made that built up to the final image, including studies of fossils and the steps in adding flesh to those bones. By basing his study on the living and the dead, Knight's reconstructions were considered authentic depictions of both living and extinct animals. Knight combined the scientific knowledge of a professional natural historian with anatomical study of living animals. This practice of showing dinosaurs as though they were living animals characterized Knight's work.

The issues with reconstructing an animal from often incomplete fossil skeletons are multitude. The bones must be re-articulated and the scars from muscle attachments carefully used to project the size and shape of muscles. Soft tissues are rarely preserved, meaning a large amount of an animal's body simply vanishes when it is fossilized. Fossilization leaves rock in the shape of only some parts of an animal body. Much of Knight's reconstruction was based on then-current scientific knowledge, as well as speculation based on a combination of observed evidence and the bodies and behaviour of living animals. Using the bodies of living animals to reconstruct extinct ones is a necessary, yet fraught process. It creates a degree of interchangeability between different animal species even through millions of years of deep time. In some ways it creates intimacy between the human animals who look at the non-human animal being looked it, but that gaze also carries a power dynamic of domination of human over animal

[37] Osborne to Knight, August 9, 1920. The Charles R. Knight Papers. New York Public Library Rare Books and Manuscripts Division. Box 1, folder 1.

that exists in the present moment.[38] Reconstructing an animal from fossils created an animal that could be looked at and therefore understood.

Settler Colonialism

Knight's artworks seek to produce a rational, comprehensible past that could be managed by the promoters of turn-of-the-century settler-colonial capitalism. The active animal-ness displayed by the creatures Knight restored was a potent force even when contained in a carefully produced image. Scholars such as W.J.T. Mitchell, Lukas Rieppel, Brian Noble, and Victoria Cain argue that dinosaurs were used to embody U.S. capitalism at the turn of the century, in all its fragility and spectacle.[39] The ideology of settler colonialism was integral to Knight's restorations, from the need for scientific accuracy to the vision of the past his paintings helped construct. The drive to catalogue and categorize that served as both reason for colonial expeditions and method of interpreting those expeditions findings reached even the animals of deep time. For dinosaurs to be categorized and then reconstructed, their fossils first needed to be found and excavated. The project to enliven fossilized remains relied on the land and resources appropriated through EuroAmerican colonization of Indigenous land.

The fossil collection at the AMNH, like every other collection in North America, is filled with specimens taken from Indigenous lands. Fossil hunters such as Othniel Charles Marsh (1831-1899), Edward Drinker Cope (1840-1897) (one of Knight's paleontology mentors), and Barnum Brown (1873-1963) extracted fossils from the frontier landscape like any other natural resource. Marsh, Cope, and Brown, like other fossil hunters in the United States and Canada,

[38] John Berger, "Why Look at Animals?" in *About Looking* (New York: Pantheon Books 1980), 5.
[39] Rieppel differs from other authors in his argument that dinosaurs were used to demonstrate the might of bureaucratic, managerial capitalism rather than an embodiment of racial anxieties.

often obscured the value of the resources they had come for in their dealings with Indigenous peoples.[40] When their relationships with Indigenous groups became strained, Marsh and Cope excavated under the protection of the United States Army, frequently breaking treaties to do so.[41] Fossils even experienced a resource rush like gold, land, and oil. Between the 1870's and 1890's Marsh and Cope, bitter rivals, entered an informal competition, known as the Bone Wars, to "discover" as many American dinosaurs as possible. The institutions they worked for, Cope at the Academy of Natural Sciences of Philadelphia and Marsh at the Peabody Museum of Natural History at Yale University, leveraged this very public rivalry to elicit funding and popularize fossil hunting. Discovering fossils, and to a larger extent the prehistoric past, became both an implicit and explicit extension of colonization and nation building. As an extension of resource surveys, cataloguing and studying fossils became an act of discovering new American animals in the new frontier of the American past.

I borrow Lukas Rieppel's concept of the "long gilded age" to historically situate my analysis of Knight's pictures. Rieppel defines this as the period between the end of Reconstruction and the start of the Great Depression, or about 1877 to 1929.[42] The concept of the "long gilded age" highlights the role of the explicitly capitalist settler culture within which Knight operated. The ideology of the wealthy supporters of natural history research was enmeshed in each commission Knight received. Industrialists at the helm of large, powerful corporations had a significant role in funding public institutions such as the AMNH and shaped those institutions on the model of those bureaucratic corporations.[43] This meant the projects that

[40] Lawrence W. Bradley, "Dinosaurs and Indians: Fossil Resource Dispossession of Sioux Lands, 1846–1875." *American Indian Culture & Research Journal* 38 no. 3 (2014): 57.
[41] Bradley, "Dinosaurs and Indians," 64.
[42] Rieppel, *Assembling the Dinosaur*, 3-4.
[43] Rieppel, *Assembling the Dinosaur* 4.

got funding were supported by and in turn supported the larger project of settler colonialism. Knight was involved in a project of making dinosaurs "real" by creating a stable image of them as living creatures.[44] The long dead world of the Mesozoic era was something to be stabilized and managed as part of a larger project to colonize the past.

The social surround of turn-of-the-century New York was shaped by a concern for preservation of the increasingly exploited and vanishing wilderness.[45] The relatively recent conquest of the American frontier, which was famously declared closed by Frederick Jackson Turner in 1893, suggested that wild land had essentially run out. While some Canadian territory retained its status as a frontier into the twentieth century, the implementation of the Indian Act in 1876, the signing of the numbered treaties, and the creation of the provinces of Alberta and Saskatchewan in 1905 meant that frontier in even this northernmost territory was shrinking each year. The near extinction of the American bison, and the extinction of other animals such as the passenger pigeon, sea mink, and Labrador duck helped cement the idea that nature was disappearing. Eugenic concerns became increasingly commonplace in public discourse, especially among wealthy patrons of the arts and sciences for whom anxieties over animal extinction extended to human populations. The perceived weakening or even extinction of the white race was often linked to alienation from nature in urban life, and the preservation of nature through increased management became as much an effort of self-preservation as one of domination.[46] Conservation efforts were often explicitly linked to the preservation of a vigorous

[44] Mitchell, *The Last Dinosaur Book*, 90.
[45] Rieppel, *Assembling the Dinosaur*, 156.
[46] This idea is covered in greater detail in Mitchell, *The Last Dinosaur Book*, Bogart, "Lowbrow. Highbrow," Rainger*, Agenda for Antiquity*, and Haraway, "Teddy Bear Patriarchy."

white race.[47] By engaging in conservation activities such as relocating bison to the Bronx Zoo, white city dwellers could save the bison from extinction, and by extension, save themselves.

When dealing with extinction, human fears of our own possible extinction inevitably surface. Unlike animals in a zoo, dinosaurs are extinct. For all they seemed to dominate the earth, dinosaurs died out and were replaced by other animals. The existence of species extinction implied that humans could similarly disappear entirely. There is tension between the desire to show dinosaurs as living animals and the inherent anxieties around knowing about they were extinct. The status of humans is very much at stake in the imagining of the dinosaur. Erica Fudge argues that by looking at animals, humans shore up their fragile status.[48] Knight's dinosaurs were a display of scientific rationality that proved human power to "look into" a distant past. At the same time, they reveal the limits of that power by referencing extinction and the vastness of time. They remind viewers of a "natural order" from which humans are not separate while retaining the status of a distanced window into the past. Discovering the prehistoric past represented a potential new frontier filled with new animals.

Theory and Methodology

I focus on Knight's small drawings and paintings of dinosaurs. Many of these original works are held at the AMNH. There are high quality images of his smaller paintings and drawings available on the AMNH's digital special collections. I have used these digitized images as well as my own photographs as a supplement to my in-person study of Knight's paintings and drawings, and sculptures. Between February 20 and March 1, 2022, I visited New York to study

[47] Brian Regal, *Henry Fairfield Osborn: Race and the Search for the Origins of Man* (London: Ashgate, 2002), 5.
[48] Fudge, "A Left-Handed Blow: Writing the History of Animals." In *Representing Animals* ed. Nigel Rothfels, (Bloomington: Indiana University Press, 2002), 10.

the paintings on display at the AMNH, in addition to the Charles Knight Papers at the New York Public Library. The Knight Papers mostly consist of the artist's own writings; they also include newspaper clippings, photographs, and other ephemera collected by Knight during his career, providing valuable insight into his approach to drawing living animals and restoring extinct ones. I have also already done research in the Bruce Peel Special Collections well as the research library at the Tyrell Museum in Drumheller. The Peel has copies of a few early twentieth-century books on prehistoric life which contain reproductions of Knight's artworks. The Tyrell Museum's library also has copies of early twentieth-century books with illustrations by Knight. I have used close visual analysis of the artworks, as well as research into the social history of those artworks as my main methodologies.

As this thesis engages with the field of animal studies, I have used several key animal studies texts as theoretical guides. John Berger's landmark essay, "Why Look at Animals?" (1977), remains influential for scholars working in animal studies. Berger's Marxist approach to thinking about animals meshes well with my own interest in social history, as well as that taken by Donna Haraway and Erica Fudge, other key authors for my project. Haraway's discussion of natural history dioramas in "Teddy Bear Patriarchy" (1984) is directly related to my topic and has helped develop my understanding of the social context at the turn of the century. Erica Fudge's "A Left-Handed Blow" (2002) is a more recent essay dealing with the historiography of animal studies, providing a useful overview of contemporary scholarship. Together, these three essays provide the theoretical underpinnings of my own analysis.

At the turn of the twentieth century the AMNH was engaged in a project of changing how the museum halls were constructed. After Henry Fairfield Osborn became head of the vertebrate paleontology department in 1891 and later as the President of the museum, Osborn strove to

change the displays from discrete objects to integrated scenes.[49] This involved a variety of projects including constructing dioramas, murals, signage, and mounting fossils into free-standing skeletons, a relatively recent way of displaying fossils. When Osborn took the helm of the department, the standard method of display was to show the fossils still partially in rock matrix, often with little signage or explanation, leaving visitors to figure out what they were looking at. The display methods put forth by people like Osborn embraced a different visual logic in which visitors would be shown reconstructions of what the animals, plants and environment liked like.[50] This method of "showing" included the addition of visual art, especially reconstructions of extinct animals. Knight's reconstructions were a vital part of this programme.

By constructing Mesozoic landscapes, Knight created an image of pure nature, untouched by human hand. Of course, the very idea of wilderness is a fabrication, an antidote to civilization.[51] The animals populating these pictures were, in a sense, newly discovered animals in an "untouched" landscape. Although they could not be seen at a zoo, they could be represented as though they were living, breathing animals that could be closely observed. Dinosaurs presented a potentially boundless pool of new animals to discover. At the same time, they were extinct and could not be seen in the flesh. Like the handful of bison at the Bronx Zoo, Knight's pictures of dinosaurs are representative of a large population that was long dead. I am comparing Knight's pictures of living animals with his pictures of dinosaurs using close formal analysis to understand how dinosaurs were or were not pictured as "living" animals.

[49] Sommer, "Seriality in the Making," 467-8.
[50] Cain, "The Direct Medium of Vision," 288.
[51] William Cronon, "The Trouble with Wilderness: Or, Getting Back to the Wrong Nature," *Environmental History* 1 no, 1, (January 1996): 8.

Knight's pictures attempt to show a moment in the lives of the creatures he restored. Knight shows dinosaurs as engaging in behaviour such as resting, swimming, eating, hunting, and fighting, just as living animals do. There is a sense of active movement in his pictures. Dinosaurs are shown walking, running, and jumping in comprehensible and familiar ways, even if the animals themselves are unfamiliar. There is a suggestion of how the muscles under their skin might move and shift. At the same time, there is a hazy quality to them, as though the viewer is looking through the mist of time, at a daydream of ideal nature.[52] The wilderness in Knight's pictures exists only in the imagination; there were no dinosaurs to see at the zoo. John Berger wrote that "the fact that [animals] can observe us has lost all significance. They are objects of our ever-extending knowledge… the more we know the further away they are."[53] While one cannot visit the zoo and meet the gaze of a living dinosaur, the dinosaurs in Knight's paintings do look back. But their gaze is unfamiliar, concealing as much at it reveals. The question of "what did they look like?" remains not fully answered.

Through the process of picturing a dinosaur, the uncertainties of that body and of the Mesozoic past become clear. Although Knight's pictures show a single moment, the scenes are constructed from fossils pulled from separate rock strata that were often formed millions of years apart. The level of temporal flexibility, and the fragmented nature of the fossil record, means any picture of a dinosaur contains a level of uncertainty, of instability. As scientific knowledge increases, the depiction of a dinosaur will only become more inaccurate as time goes on. Many of Knight's letters reveal contemporary disagreements on which interpretation of fossils to use,

[52] Berger, "Why Look at Animals?" 17.
[53]Berger, "Why Look at Animals?" 16.

as well as what constituted acceptable artistic licence and what ventured into fabrication.[54] This uncertainty is a key feature of Knight's work.

Literature Review

Paleontological reconstructions remain understudied by art historians. While the history of paleontology has received in-depth historical and anthropological study, few art historians have looked at paleoart. Only a handful of academic books dealing with paleontological illustration exist, a scant few of which are authored by art historians. Why have art historians overlooked these images while embracing the broader area of scientific illustration? Is it, as W.J.T. Mitchell suggests, because dinosaurs are "too kitsch," too juvenile, too far away from serious art history?[55] As art history turns increasingly towards exploring "low brow" visual culture, the value of exploring the kitsch and juvenile is becoming apparent. As Mitchell argues, images of dinosaurs are deeply entwined with their political and cultural context, occupying a space somewhere between myth and science.[56] What does it mean to picture an animal no human has ever seen? Why think about a pre-human world?

Knight has largely been overlooked by art historians despite his outsized influence on twentieth-century paleoart. Only a few art historians, such as W.J.T. Mitchell, Jane Davidson, Brian Noble, and Victoria Cain, have studied Knight's work, and only as part of larger projects on paleoart. Knight's murals of early humans at the AMNH are his most studied works, with some scholarly attention paid to his more famous paintings of dinosaurs by scholars. Two nonfiction books on Knight and his work exist, *Autobiography of an Artist* (2005),[57] derived

[54] Jane P. Davidson, *A History of Paleontology Illustration (Bloomington: Indiana University Press, 2008),*192
[55] Mitchell, *The Last Dinosaur Book*, 60.
[56] Mitchell, *The Last Dinosaur Book*,. 46.
[57] Kalt Knight and Stroud, *Charles R. Knight*.

from Knight's unpublished autobiography and written by his daughter, and Richard Milner's *Charles R. Knight: The Artist Who Saw Through Time* (2012),[58] which focuses on his artwork and approach to drawing animals. While neither of these are scholarly works, they are helpful resources to orient Knight's artwork in his biography.

Much of the scholarly attention paid to Knight focuses on his murals of prehistoric humans created for the Hall of Man at the AMNH, produced under Osborn's close direction. Scholarship such as Marianne Sommer's article "Seriality in the Making" focuses on Osborn and how his theories on race, evolution, and eugenics figured into his role at the AMNH rather than on Knight and his artwork. However, Sommer notably deals with Knight to a greater extent than other studies of this type, which generally focus almost exclusively on Osborn.[59] Sommer deals with how evolutionary history was constructed in Knight's work for the AMNH. While the focus of my research is on Knight's depiction of dinosaurs rather than humans, Sommer's attention to Osborn and Knight's working relationship, the museum, and Knight's approach to reconstructive art is invaluable.

Jane Davidson has published repeatedly on Knight, returning to him in *History of Paleontology Illustration* (2008) and *Patrons of Paleontology* (2018).[60] Davidson fits Knight's artwork into the larger field of paleontology and paleoart. Placing Knight within an overview of paleoart allows for his work to be seen as a part of larger scientific production in the nineteenth and early twentieth century. Davidson includes a short list of Knight's published paleoart in

[58] Richard Milner, *Charles R. Knight: The Artist Who Saw Through Time* (New York: Harry N. Abrams, 2012).
[59] Perhaps the most influential of these works is Robert Rainger's *An Agenda for Antiquity: Henry Fairfield Osborn & Vertebrate Paleontology at the American Museum of Natural History, 1890–1935.* Birmingham: University of Alabama Press, 1991.
[60] Davidson, *Paleontology Illustration* and Jane P. Davidson, *Patrons of Paleontology: How Government Support Shaped a Science* (Bloomington: Indiana University Press, 2017).

various magazines and articles. She also records how Knight's reconstructions of dinosaurs influenced the artists working on Disney's *Fantasia* (1940), which although outside the scope of my thesis, gives some idea of how Knight shaped pop culture perceptions of dinosaurs in the twentieth century. Davidson also incorporates Knight into sections on other paleo artists, giving a sense of the networks he was enmeshed in.

Knight has often been studied through his connection to other figures, as a small part of a larger project. Mitchell dedicated a chapter of his 1998 *Last Dinosaur Book* to dinosaurs in the late nineteenth and early twentieth century, where he used Knight as a point of transition between the nineteenth and twentieth centuries. Mitchell places his discussion of Knight in a section on what the figure of the dinosaur meant in American culture. Mitchell characterizes Knight as cementing the image of the dinosaur as a slow moving, green skinned leviathan through his work's extensive reproduction in educational material.[61]

Another scholar who has written about Knight in the context of a larger study of dinosaurs is Brian Noble in his 2016 book *Articulating Dinosaurs: A Political Anthropology*. Like Davidson and Mitchell, Noble examines Knight as part of the larger ideological programmes at the AMNH. Noble is like Mitchell in that neither are paleontologists and they approach the subject from the humanities rather than the sciences. *Articulating Dinosaurs* is a recent piece of scholarship and takes on concerns related to colonialism and race with more depth and nuance than Mitchell. Noble is explicitly concerned with the political ramifications of studying and depicting dinosaurs, and provides a thorough history of the political life of the dinosaur. Noble also discusses how Knight's work was incorporated into museum displays and

[61] Mitchell, *The Last Dinosaur Book*, 141.

other educational material around the world, paying particular attention to the political agendas behind them.

Cain, a U.S. historian focusing on the history of education, pays attention to how Knight and Osborn developed a sequential programme to represent specific theories of species development in the Hall of Man at the AMNH. Cain pays careful attention to the images themselves as well as how they relate to each other and the museum at large. Cain analyzes how act of reconstruction of an extinct animal was part of integrating visual representation into the AMNH.[62] She examines these paintings' role in pedagogy and takes careful consideration of the role of form in visual education. Cain is also one of few scholars to use visual analysis to examine the techniques Knight employed in his paintings.

A critical aspect of my thesis is theories of deep time. Authors I have previously mentioned, particularly Davidson and Mitchell, have dealt with deep time and provide some framework in this area. These authors owe much to Martin J.S. Rudwick's *Scenes from Deep Time*. Although it was published in 1992, Rudwick's theories of how "deep time" came to be pictured and understood are still influential in histories of geology and earth sciences. As well as generating key theoretical concepts, *Scenes from Deep Time* deals extensively with early paleoart. Rudwick focuses on nineteenth-century works, and as such does not deal directly with Knight, however, he deals extensively with the artists and scientists who influenced Knight and his contemporaries.

Extinction and fossilization created a series of problems with understanding dinosaurs. The difficulty of understanding their relationship to living animals, huge length of time between

[62] Cain, "The Direct Medium of Vision" 287.

dinosaurs and humans, the relative rarity of well-preserved fossils, and the absence of their bodies all proved obstacles in understanding them as once-living animals. Artists and scientists needed to solve some of these problems before they could create restorations of these animals. As paleontology developed dinosaurs were fit into taxonomies, their fossil remains were studied rigorously, and a concrete idea of what a dinosaur was emerged. With the idea of a dinosaur constructed, if not fully stable, the next step in making them legible to the museum-going public was to create images of dinosaurs as though they were alive. Knight's restorations were intended above all to make dinosaurs appear convincingly alive.

Part II: Animating Dinosaurs

Charles Knight spent a great deal of time studying the animals kept at the Bronx Zoo, and he used his anatomical knowledge from these close studies from life in his restorations, drawing direct comparisons between living animals and dinosaurs. Deep familiarity with animal anatomy enhanced his understanding of how they might behave, while observed behaviour in turn enlivened the animal bodies in Knight's pictures. Dinosaur anatomy was understood through the anatomy of living animals, a process which was carried over into visual restorations. Knight and the paleontologists he worked with used direct observation of living animals, as well as visual representations of those animals to construct dinosaurs as though they were alive. Beginning with its inception as a distinct field, paleontology relied on comparative anatomy to understand the bodies of fossilized animals, meaning a breadth of ideas about living animals were carried to extinct ones.

The process of enlivening dinosaur bodies unfolded through the detailed attention to skin texture, musculature, species specific anatomical features, and behaviour of living animals. By depicting dinosaurs with flesh and blood in vibrant colours Knight, in his own words, "put life *into* the dead bones."[63] Knight's works were understood as restorations, not reconstructions. Reconstruction implied the reassembly of existing parts, while restoration went a step beyond, requiring interpretation and imagination to "fill in the gaps" between fossils and a living animal body. The fossil record on its own did not provide enough information to fill out all the necessary details of dinosaur bodies. To begin this analysis, I will briefly discuss the established ways dinosaurs were visualized in the years leading up to Knight's career. I will then discuss a

[63] Charles Knight to Stephan Chapman Simms, Charles R. Knight Contract for Paintings for the Ernest R. Graham Hall, 1926-1981, file folder 2, folder 6, Archives of the Field Museum of Natural History, Chicago.

selection of Knight's artworks of living exotic animals, in comparison to his artworks of dinosaurs in relation to how natural history images were constructed in the long-gilded age. I will finish by discussing how fossilization and deep time interact with the process of "restoring" dinosaurs.

What Did Dinosaurs Look Like?

Before dinosaurs became a distinct category, their fossilized remains were often understood as creatures such as dragons, sea serpents, and even as an ancient race of giant humans.[64] In Europe, they were often understood as biblical monsters such as the Leviathan or as dragons similar to the one defeated by St. George. There was an established tradition of depicting dragons and other biblical monsters in European art long before paleoart emerged in the nineteenth century. As a result, images of mythical and religious creatures were influenced by discoveries of fossils and vice versa. Indeed, the image of dragons was deliberately co-opted into the paleontological art and writing of the nineteenth century, with paleontologists such as Richard Owen even going as far as to refer to them as dragons in their published writing.[65] Paleontologists imagined dinosaurs as a hybrid of mammals and reptiles and as a merging of old, mythological interpretations of dragons with new scientific ways of thinking.[66]

Referring to fossilized animals as antediluvian monsters or ancient dragons was common in both popular and scientific writing on paleontology until the twentieth century. The language and image of a monster were used to give laypeople a frame of reference for an active large reptilian animal.[67] Dragons and monsters were a point of familiarity to nineteenth-century

[64] John McGowan-Hartman, "Shadow of the Dragon: The Convergence of Myth and Science in Nineteenth-Century Paleontological Imagery," *Journal of Social History* 3, no.1 (2013): 54.
[65] McGowan-Hartman, "Shadow of the Dragon," 54.
[66] McGowan-Hartman, "Shadow of the Dragon," 56.
[67] McGowan-Hartman, "Shadow of the Dragon," 64.

European audiences, and the only close reference point for a reptilian creature as large as many early dinosaur discoveries. The primordial worlds of mythic history and deep time fold into each other. If there was something such as a dragon, it was like a dinosaur; a dinosaur was something like a dragon.[68] Despite their mythical status, dragons helped the nineteenth-century public forge a connection to the world of the Mesozoic.

Paleoart attempted to show to viewers a scientifically accurate, and perhaps more importantly, comprehensible image of the past. Constructing a scene, an environment in which to place restored extinct beings, became an important part of paleoart as did using living animals as a basis for those restorations. The scene, and the link to something currently alive, was a vital part of conveying a sense of reality, comprehensibility, and accuracy. Paleoart was (and remains) at least somewhat speculative; an element of uncertainty exists in any image of the prehistoric past no matter how much or how little physical evidence backs up the choices paleontologists and paleo artists make. Images of dinosaurs need to strike a balance between the familiarity needed to make an image audiences can parse and the uncertainty inherent to speculation. By borrowing the visual techniques of natural history illustration, artists could make restorations of dinosaurs read as more scientific, more accurate, and therefore closer to tangible reality.

Dinosaurs had existed as a category for fifty years by the time Knight began working on his restorations, and Knight was able to draw on previous images of dinosaurs in addition to living animals. The image of a dinosaur coalesced well before the term "dinosaur" entered popular use.[69] Earlier artists, many of them paleontologists themselves, had spent the years before and since 1848, the year Owen coined the word *Dinosauria*, creating restorations of

[68] McGowan-Hartman, "Shadow of the Dragon," 63.
[69] Lukas Rieppel, *Assembling the Dinosaur: Fossil Hunters, Tycoons, and the Making of a Spectacle* (Cambridge MA: Harvard University Press, 2019), 24.

dinosaurs for magazines, periodicals, newspapers, and books. Public interest in dinosaurs saw a demand for information about them, including pictures of them. Publications on dinosaurs, as well as other Mesozoic life, were almost always accompanied by at least one scene of them in their natural habitat. Scenes of extinct animals existing in their home environment were an important part of paleontological restorations from their earliest iterations.[70]

Henry De la Beche and *Duria Antiquior*, 1830

The first restoration of Mesozoic animals is generally accepted to be Henry De la Beche's *Duria Antiquior: Or a More Ancient Dorset* (fig. 9), from 1830. This watercolour was based on discoveries of *Ichthyosaurus* and *Plesiosaurus* from the coast of Dorset by fossil collector Mary Anning. De la Beche hired printmaker George Scharf to make a lithographic reproduction of his image with the intention of selling copies to his friends and colleagues in scientific circles, then donating the proceeds to Anning.[71] The print proved popular among geologists and fossil collectors and became influential in subsequent depictions of the Mesozoic. Although none of the animals in *Duria Antiquior* are now understood as dinosaurs, the image was nonetheless an influential work in creating the idea of what dinosaurs look like. The scene is densely populated. Animals are posed with the broadest side of their bodies towards the viewer, offering their anatomy for observation as they chase prey, tussle with rivals, and otherwise go about their business. De la Beche depicted his subjects with open mouths and visible teeth, underscoring the acts of eating and being eaten. Animals fill the visible space of the land and water, suggesting a rich ecosystem teeming with life.

[70] Martin J.S. Rudwick, *Scenes from Deep Time: Early Pictorial Representations of the Prehistoric World* (Chicago: University of Chicago Press, 1992), 4.
[71] Rudwick, *Scenes from Deep Time*, 44.

Half of the image is an underwater view, as though the viewer is observing the scene through a pane of glass. This partially submerged view is reminiscent of the view offered by glass aquariums, at the time a recent invention slowly gaining in popularity.[72] This technology, as well as the visual method it inspires, allows the viewer to observe what is happening below the surface of the water with as much clarity as what is above, permitting unimpeded observation of the animals in their habitat.[73] Their behaviour can be clearly observed no matter where in the image they appear. Several animals in the image are even defecating. Few artists followed De la Beche in showing defecation or feces, this perhaps being thought of as too vulgar for the imagined middle-class audience of the geologic texts these images often accompanied. The aquatic environment of *Duria Antiquior* also became less standard in depictions of the Mesozoic era as more land-dwelling animals were discovered, but many mid and late nineteenth-century paleo artists followed the conventions established by De la Beche. Open mouths and sharp teeth, scaly skin, a lateral view of the animals, and an emphasis on each species' identifiability became a standard in paleoart.

Benjamin Waterhouse Hawkins and the Crystal Palace Dinosaurs, 1854

Benjamin Waterhouse Hawkins borrowed many of these conventions in his 1854 restorations of four dinosaurs for the Crystal Palace Gardens at Sydenham. The dinosaurs were part of a larger project in which Hawkins collaborated with Oxford paleontologist Richard Owen to make 49 life-size sculptural restorations of extinct animals. There were four dinosaur sculptures in total, two *Iguanadons*, a *Megalosaurus*, and a *Hylaeosaurus*. These sculptures, and the species they depicted, were far larger than the livestock most Britons dealt with. Sculpted

[72] Rudwick, *Scenes from Deep Time*, 47.
[73] For more on the development of aquariums see Silvia Granata, "'At Once Pet, Ornament, and Subject for Dissection': The Unstable Status of Marine Animals in Victorian Aquaria," *Cahiers Victoriens et Édouardiens* 88 (2018): https://doi.org/10.4000/cve.3776.

from brick and concrete on cast-iron armatures, the sculptures were life sized, ranging between 2 x 5 and 3 x 10 meters. The Crystal Palace monsters, as they became known, were seen by millions of visitors to the Crystal Palace and were frequently reproduced in newspapers and periodicals of the day (fig. 10). Unlike *Duria Antiquior* and images like it, which were largely confined to geology texts, the Crystal Palace dinosaurs were displayed to the public at large. Millions of visitors to the Crystal Palace saw the sculptures, and millions more saw images of them in periodicals such as *The Illustrated London News* and *Punch*. With so many Britons (and foreign visitors to London) seeing the sculptures firsthand, and the wide distribution of images of the sculptures, the Crystal Palace dinosaurs become a reference point for the appearance of dinosaurs in general.[74]. Their intent may have been educational, but to many the hulking reptiles were more monstrous and fantastical than scientific.[75]

The *Iguanadons* were placed next to each other and arranged to look outwards at passersby (fig. 11). This image exaggerates the scale of the dinosaurs in comparison to the passersby, emphasizing their impressive size.Their mouths are slightly agape, revealing a battery of grinding teeth. The *Megalosaurus*, the sole carnivore of the group was placed as though creeping towards them. Its narrow, almost crocodilian snout hangs open, bristling with sharp teeth and suggesting a predatory hunger. Despite its thick limbs, it appears faster and stronger than the other three dinosaurs. The thick ridge between its shoulders suggests powerful muscles, while its hind legs appear ready to spring into motion. In contrast, the *Hylaeosaurus*' broad feet, heavy jaw, and thick spiny skin suggest a lumbering, heavy creature. Viewers' attention was directed away from its head, which at the time was fully unknown, and therefore pure

[74] Rebecca Bedell, "The History of the Earth: Darwin, Geology and Landscape Art." In *Endless Forms: Charles Darwin, Natural Science and the Visual Arts,* edited by Diana, Donald and Jane Munro (New Haven: Yale University Press, 2009), 67.
[75] Bedell, "The History of the Earth," 67.

speculation. *Hylaeosaurus* was turned away from the walking path to better display the spines running along its back and tail. All their bodies are large and bulky, with wide torsos and thick necks, reminiscent of an elephant or a rhinoceros.

The Crystal Palace dinosaurs look like pachyderms for a reason. Hawkins and the paleontologists with whom he collaborated chose pachyderms as a model for the Crystal Palace restorations because they were of a comparably large size.[76] Hawkins also used the scale patterns and ridges of iguanas and crocodiles to flesh out details of the dinosaur's skin and faces. Iguanas and crocodiles were exotic but somewhat recognizable large reptiles to London audiences.[77] In lectures, Hawkins and Owen justified using living animals as a basis for their restorations by arguing that they selected those living species by looking for animals with the closest limb and body proportions to the dinosaur species in question.[78] The same lectures reveal that Hawkins and Owen used living animals to further their goal of using the sculptures to make the prehistoric past more concrete.[79] These sculptures were made to convince viewers of the reality of deep time and the animals that populated it.[80] By using a living animal to model largely unknown bodies, the restorations were made more tangibly real.

The Crystal Palace sculptures were the first attempt to create life-sized sculptural restorations of dinosaurs that were scientifically rigorous. The sculptures were placed in a Geologic Garden alongside models of layered sedimentary rock, complete with fault lines and strips of coal, to suggest a narrative of geologic time. They departed from De La Beche's model of showing the animals actively engaged in a struggle between life and death, however. Placed in

[76] Richard Owen, *Geology and the Inhabitants of the Ancient World* (London: Bradbury & Evans. 1854), 20.
[77] Nancy Rose Marshall, "'A Dim World Where Monsters Dwell' The Spatial Time of the Sydenham Crystal Palace Dinosaur Park," *Victorian Studies*, Winter (2007), 290.
[78] Owen, *Geology and the Inhabitants of the Ancient World*, 6.
[79] Hawkins, *Lecture on Visual Education*. 15.
[80] Bedell, "The History of the Earth," 66.

a garden tableau arranged by their position in geologic time, they did not interact with each other as obviously. Rather than convincing viewers of these animals' reality through behaviour, as had De La Beche, Hawkins primarily used the sculptures' physical presence, references to both living animals and to fossil evidence, and their placement in a real environment to convey the idea that these were animals that once lived.

The gaping toothy jaws of the *Megalosaurus* and *Iguanadon* (again, fig. 11) followed the convention began by De La Beche of showing a full array of fossilized teeth. Though not visible in these images the *Ichthyosaurus* had visible sclerotic plates around the eyes, like those in *Duria Antiquior*. Many living animals have sclerotic plates, but they are an internal structure that is not visible while the animal is alive. However, sclerotic plates were visible in fossilized remains. By making the sclerotic plates visible, artists referenced the fossil remains of *Ichthyosaurs* and by doing so argued that their restoration was based in scientific fact. The official guidebook provided measurements of fossils that were used to create the restorations.[81]

Hawkins' sculptural restorations were displayed in an artificial lake and on an island build in its centre. The lake was planned to have a system of small dams that changed the water level periodically, mimicking the rhythm of tides.[82] These waterworks were meant to create a moving facsimile of the coastal environment that had become so ubiquitous in paleontological illustration. Although the tidal simulation never worked correctly, leaving the artificial lakes at a static level,[83] the visible teeth, the scleral plates, the use of measurements, and the simulation of an environment demonstrated that the artist was basing the restorations on material fossil evidence.

[81] Bedell, "The History of the Earth," 67.
[82] Marshall, "'A Dim World,'" 295.
[83] Marshall, "'A Dim World,'" 295.

In paleoart, the landscape environment of restorations was reconstructed through what was known about plant and animal life in the period being depicted, as well as any other information that could be gleaned from the rock matrix in which the fossils were found. This included references to how certain fossils were formed, such as whether they were formed in a seabed or riverbed, or even in a flood or volcanic eruption.[84] For example, after Hawkins' sculptures were unveiled, other paloeartists often depicted *Iguanadon* and *Megalosaurus* near water, an environment in which many fossils of those species formed. Likewise, plants found in the same rock formation as a dinosaur fossil were often used to fill out the environment of a Mesozoic scene, though often with less attention to detail than was devoted to the dinosaur.[85]

Depicting an animal in its natural habitat was of course a common technique across natural history illustration, not just paleo art. Hawkins was a natural history artist, and spent much of his career working on images of living animals rather than extinct ones. His illustrations, such as *Zebras* from 1846 (fig. 12), frequently depict animals in a landscape, in this case scrubland with sparse low-growing vegetation. Even his images of single animals include vegetation, rocks, or branches, giving an impression of the animals' habitat (fig. 13). As in other forms of natural history illustration, Hawkins placed his sculpted dinosaurs in the context of their environment in order to communicate additional information about the animal.

Images by Edward Drinker Cope in the 1860s

Early paleoart was often done by scientists such as De La Beche, who were eager to convey their interpretations of recent discoveries. Edward Drinker Cope, a paleontologist working from the Academy of Natural Sciences in Philadelphia, was also both a prolific scientist

[84] Bedell, "The History of the Earth," 56.
[85] Peter Vujaković, "Battle of the Giants: Plants versus Animals in Idealised Landscapes of 'Deep Time," *Plants, People, Planet* 1, no. 3 (2019): 189.

and an artist who often illustrated his own articles and books. Cope was responsible for early restorations of many extinct animals discovered in North America. As a mentor to both Osborn and Knight, his interpretations influenced Knight's restorations directly. While still following the existing convention of a coastal scene, Cope's restorations place the water line high on the picture plane, shifting the viewer's focus to the surface of the water and the terrestrial environment (fig. 14). The animals are also less stocky than those portrayed by Owen and Hawkins, suggesting a capacity for quick movement and speed. Cope emphasised the confirmed features of each animal: the long legs and sharp teeth of the *Laelaps* in the centre of the image and the long tails of the *Elasmosaurus* and *Plesiosaurus* trailing through the water. It should be noted that Cope made a significant error in his reconstruction of *Elasmosaurus*. He mixed up the tail and neck of the animal and placed the head on the wrong end of the body.[86]

Cope used this image to demonstrate his theories about these animals' behavior as well as their appearance. The *Laelaps*[87] stands on a rocky outcropping in the water, suggesting that it swam out from the shore. The two *Icthyosaurus* in the background have crawled up onto the beach. One peeks out from a patch of tall grass. Although the vegetation is not as closely observed as the animals, it serves a purpose beyond mere decoration. This picture shows these animals interacting with their surroundings in specific ways. The *Icthyosaurus* use grasses as shelter whereas a *Hadrosaurus* forages to their left. Cope placed these animals in a landscape, and showed them interacting with a larger ecological system.

By the time Knight began working, artists and paleontologists had been restoring dinosaurs to look as though they were alive for close to fifty years. There was an established idea

[86] Jane P. Davidson, "Bonehead mistakes: The background in scientific literature and illustrations for Edward Drinker Cope's first restoration of Elasmosaurus platyurus." *Proceedings of the Academy of Natural Sciences of Philadelphia*. 152, 1 (2002): 219.
[87] This species is now known as *Dromaeosaurs*, *Laelaps* is no longer used.

of what a dinosaur looked like, and what a scene of a dinosaur in the Mesozoic looked like. These images influenced Knight as well as the paleontologists he worked with.[88] His art built on these earlier artists' work and ultimately continued what paleoart had attempted to do since its beginning: show dinosaurs as though they were currently alive. The image of a toothy, scaly reptilian creature larger and stranger than anything currently living continued through Knight's restorations. To make these long extinct creatures seem tangibly real, Knight made use of the conventions, techniques, and style of natural history illustrations of living animals.

Natural History Illustration

Paleoart developed in a period in which natural history and the sciences solidified into the formalized institutional practices of institutions such as the AMNH and New York Zoological Society. Natural history illustration developed into a distinct style over the course of the eighteenth and nineteenth centuries, linked to yet distinct from animal painting, which like genre painting was often anecdotal, and animal portraiture. Natural history illustration attempted to portray an animal species clearly and accurately in a detailed and naturalistic style, showing as much of the body as possible.

According to Ann Shelby Blum, there are two major types of natural history illustration.[89] One shows the animal in profile against a white background, while the other places the animal in a landscape scene. The first type of illustration is often referred to by scholars of natural history illustration as a diagram, or as diagrammatic. The second type of image is a natural history scene. Knight's drawing of a *Tylosaurus* from 1903 (fig. 15) falls into this first diagrammatic category. It shows the whole length of the animal from a lateral view against a

[88] Mitchell, *The Last Dinosaur Book,* 141.
[89] Ann Shelby Blum, *Picturing Nature: American Nineteenth-Century Zoological Illustration* (Princeton NJ: Princeton University Press, 1993), 17.

blank white background, and is placed opposite a similarly positioned diagram of a *Tylosaurus* skeleton made by two other artists hired by the AMNH (fig. 15). The lateral pose shows as much of the animal's body as possible from a single view and implies that the other side looks the same. The diagram type of illustration is most frequently found in scholarly journals, textbooks, and texts for a professional scientific audience. In contrast, the natural history scene shows an animal as part of an environment, placing it in its natural habitat. This type of image appears most often in publications intended for a general audience as a supplement to or even a replacement for sober diagrams.[90]

There is of course significant overlap between these categories. Diagrammatic illustrations often include a smattering of vegetation around their subjects, though not a full landscape, while natural history scenes sometimes focus on a single animal. The idea of including natural history scenes in museum displays, rather than solely diagrams was part of a changing approach to education and museums. Artists and paleontologists drawing the subjects of their research often produced both types of natural history images. Both types seek to clearly depict the specimen's body, while the second also attempts to show something about the specimen's place in the natural world.

Knight primarily produced the second type of image: natural history scenes. His paintings of living animals are occasionally portraits of specific animals, but are more often generic representations of their species based on close observation of many living animals and many fragmented specimens. Natural history scenes and diagrammatic illustrations both usually depict an accurately represented, identifiable species type rather than a portrait of any individual animal. Much in the way a zoo presents an animal as a representative of its species than can be

[90] Cain, "The Direct Medium of Vision," 285.

examined and studies at the discretion of the viewer, the natural history scene creates an image of an animal that is at once every member of that species and none.

As much as Knight's work was carefully observed and anatomically precise, he thought of himself as an artist before a scientist.[91] He used loose brushstrokes, rich colours, and dynamic compositions when producing his work. Such paintings are natural history scenes, not scientific diagrams. This form of natural history illustration required careful scientific analysis to exist alongside artistic principles of aesthetics.[92] In other words, this form of natural history illustration requires images to be appealing as artworks as much as it requires them to demonstrate scientific knowledge. Closely observing a living animal was simultaneously an artistic and scientific activity. Illustrations were intended to be primarily informative, but also pleasurable to look at, often as accompaniments to an article.

In his early career Knight most often illustrated for literary magazines such as *The Century*, *Collier's,* and *McClure's*. These magazines included serialized fiction by authors such as Jack London, Arthur Conan Doyle, and Rudyard Kipling placed alongside nonfiction natural history articles by prominent individuals working in museums and universities. Knight often published images for articles written by scientists, including Osborn, his frequent collaborator and patron. Between 1900 and 1905, Knight illustrated four articles authored by Osborn, including an article on the evolution of the horse, and an article on recent dinosaur discoveries in the American West.[93] Two of these articles were on animals of the Mesozoic era, including dinosaurs.[94] Knight was trained as an animal painter and continued to paint living animals while

[91] Letter from G. Grosvenor to Charles R. Knight, 17 October 1913. Charles R. Knight correspondence, Division of Manuscripts and Archives, New York Public Library, Box 1, Folder 2.
[92] Cain, "The Direct Medium of Vision," 287.
[93] Henry Fairfield Osborn, "The Evolution of the Horse in America (Fossil Wonders of the West)," in *The Century Illustrated Monthly Magazine* 69, no.1 (November 1904): 2-21.
[94] Henry Fairfield Osborn, "Fossil Wonders of the West: The Dinosaurs of Bone-Cabin Quarry," in *The Century Illustrated Monthly Magazine* 68, no.5 (September 1904): 680-694, and Henry Fairfield Osborn, "Ichthyosaurus:

also making a name for himself as a paleoartist. He thought of himself as an artist who primarily worked on animals, even if extinct animals became his specialty.

A key part of Knight's role in creating restorations for the AMNH was that his natural history illustrations could strike a balance between beauty and truthfulness.[95] Both were of high importance to the method of visual education embraced by Osborn and many of Knight's other patrons. Osborn believed that vision was fundamental to learning.[96] Expanding on the intellectual tradition of museum designers in the nineteenth century, Osborn believed that seeing was equivalent to experiencing and that restorations could discourage intellectual laziness and advance the educational mission of a museum. An artwork must be both truthful and beautiful to accurately convey information about the natural world. Scientific accuracy was ensured by the scientist, and a beautiful artwork was ensured by the artist.[97] The artist's eye was often enough to ensure scientific accuracy when illustrating living animals, provided the artist studied from life and paid close attention to anatomy. However, this was not the case for the restoration of extinct animals.

Close Looking and Drawing from Life

Knight learned to draw animals as a student at the Metropolitan School of Art and used those methods throughout his career.[98] He prioritized drawing animals from life whenever possible, while also learning the basics of animal anatomy, and continuing to study animal bodies throughout his life. Studying animal anatomy was considered an important part of competency in natural history illustration.[99] Simply practicing drawing or sculpting an animal,

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The Evolution of Fitness in Ichthyosaurus (Fossil Wonders of the West)," in *The Century Illustrated Monthly Magazine* 69, no.3 (January 1905): 414-422.
[95] Sommer. "Seriality in the Making," 470.
[96] Cain, "The Direct Medium of Vision," 288.
[97] Sommer, "Seriality in the Making," 469.
[98] Kalt Knight and Stroud, *Charles R. Knight*, 31.
[99] Blum, *Picturing Nature*, 45.

whether from life or from earlier images, was not on its own enough to build a career as a scientific illustrator. Learning the underlying structures of animal bodies was also a necessity. In other words, being able to draw the skin was not enough, the entire body had to be understood. Observing living animals was important, but so was observing their dead bodies. Much like artists who depicted the human body, animal artists learned from dissection, as well as from images of dissected animals, as part of their training.[100] Knight describes eagerly waiting for specimens from the Central Park Zoo, sketching the various parts of the animals as they were skinned and dissected.[101] Knight's sketches include skulls, articulated skeletons, and the musculature of various animal subjects. Understanding not just what animal bodies looked like when they moved, but the mechanics of how they moved increased the accuracy of his depictions.[102]

The preserved skins of mammals were and remain an important source of scientific knowledge in museum collections, including that of the AMNH. Knight did not only study the living animal and their dissections after death, but he also studied parts of their bodies that were separated from the whole, such as study skins and skeletons.[103] Study skins and preserved skeletons do not seek to portray an animal's body as though it were alive, but instead allow scientists to study different parts of its anatomy closely. As long as the animals in the Bronx Zoo were alive, it was impossible to see past their skin. By contrast, in museum collections, one could examine the inner workings of an animal subject. Photographs and diagrams of a dissected animal provided further information about the internal structures of its body, from skeletal and musculature to cardiovascular systems. Using these resources was an important part of Knight's

[100] Kalt Knight and Stroud, *Charles R. Knight,* 39.
[101] Kalt Knight and Stroud, *Charles R. Knight,* 38.
[102] Kalt Knight and Stroud, *Charles R. Knight,* 39.
[103] Kalt Knight and Stroud, *Charles R. Knight,* 40.

work as an animal artist.[104] Close looking at an animal's body and understanding how its parts related to the whole allowed Knight to make convincingly alive images of animals.

Taxidermized specimens were also an important source of knowledge for his practice, and Knight spent the early 1890s frequenting the taxidermist's shop at the AMNH. He also purchased his own taxidermied specimens at least once.[105] Although the now famous Ackley Hall dioramas were not yet part of the AMNH, the museum began including taxidermy displays shortly after its founding in 1869. Mounted animals and skins allowed viewers to get as close as possible without the risks inherent in approaching a living animal and to look as long as they wished without the animal moving away. However, taxidermy alone was not enough. Knight believed there was no substitute for observing a living animal firsthand.[106]

Paintings such as Knight's 1901 *Grevy's Zebra* (fig. 16) are an example of his approach to painting living animals in natural history scenes. *Grevy's Zebra* was published in *The Century* (fig. 17) as part of Osborn's article on the evolution of the horse. The zebra is placed centrally in a savannah landscape of scrubby grass and trees. The vegetation is rendered in painterly brushstrokes, giving the impression of dry grasses moving in a gust of wind. The zebra is rendered in crisp detail, with careful attention given to the differences in texture between its shiny coat, the stiff hairs of its mane, and its velvety ears and muzzle. The zebra's body it turned slightly towards the viewer, clearly displaying Knight's anatomical knowledge, as well as its distinctive stripes. The lateral pose with all four legs made visible shows the individual markings unique to each animal, a pose borrowed from livestock portraiture.[107] Details like the brown

[104] Cain, "The Direct Medium of Vision," 287.
[105] Receipt from A. Richardson Naturalist and Taxidermist for "1 Barn Owl Skin, 1 Kingfisher, 1 Green Woodpecker, 1 French Part, 1 Common Part," October 14, 1902, Charles R. Knight Papers, 1867–1964, bulk (1892–1952), New York Public Library Manuscript and Archives Division. Box 1, folder 1.
[106] Knight, *Animal Anatomy*, 6.
[107] Harriet Ritvo, *The Animal Estate: The English and Other Creatures in the Victorian Age*, Cambridge: Harvard University Press, 1987, 59.

patch of hair on its muzzle and the mane slumping slightly to the side speak to the artist's observation of a living zebra; he is not relying on textual descriptions and drawings alone. The attention to details of the zebra's body enhances the sense of accuracy, such that viewers can learn what a zebra looks like from looking at this image. The experience of looking closely at an animal, of studying it and knowing it, is transferred to the viewer.

Knight inscribed the painting "London 1901" in the lower left corner, beneath his signature, and he painted this image while on a trip to England, where he visited several private game preserves[108] and zoos, including one near London where a small herd of Grevy's zebras were kept. Like many natural history illustrators, Knight drew from life as often as possible. This is one of many drawings and paintings he made on that trip that were later published in magazines and periodicals. [109] Observing animals in person was important to his professional career, as it lent his artworks a sense of realism.

Despite the importance placed on observing an animal subject in person, visiting the natural habitat of those animals was not given the same importance. Unlike his firsthand observation of animals, Knight relied on paintings and drawings of the African savannah done by other artists as well as photographs of the region to create the landscape setting. While the landscape the zebra is placed in is largely imagined, the attention to the details of the zebra's body argues that the zebra is not. It says: this is what a zebra looks like.

A perennial source of information for Knight's non-dinosaur subjects were the big cats kept at the Bronx Zoo.[110] Knight often spent afternoons and weekends outside, and occasionally

[108] These preserves were typically kept by landed nobility and included native animals such as red deer, rabbits, and pheasants as well as exotic species such as zebras, Indian antelope, and kangaroos. Several of these parks are discussed in Annie Hardcastle Knight and Charles R. Knight's "Animals in British Parks." *The Century Illustrated Monthly Magazine* 65 no. 2 (December 1902): 221-237.
[109] Milner, *Charles R. Knight*, 9.
[110] Also called the New York Zoological Gardens, the Bronx Zoological Gardens, and the Bronx Zoological Park interchangeably in gilded age sources.

inside, the big cat house drawing the lions, tigers, leopards, and jaguars.[111] In his sketches, Knight looked closely at the ways their bodies move in different circumstances, with attention given to how they lie down, walk, run, eat, and how their mood affects their posture. An 1897 drawing of *Four Big Cats* (fig. 18), commissioned to accompany an article in *Collier's* on the big cat house, shows a variety of cat species as they are being fed.[112] The unique features of each species' anatomy were carefully rendered with attention given to the tufted tip of the lion's tail, the broad, fluffy paws of the tiger, and the slender build of the jaguar. The tiger and lion, which have been already fed, show more relaxed postures than the jaguar and tiger still waiting for their portions. The animals that are eating have fully laid down and point their ears forward, whereas the lunging tiger on the right pulls its ears back in distress. Being able to identify and reproduce such emotional states was the result of time spent closely observing the cats and learning how to notice their expressions.[113]

Knight used his familiarity with animal anatomy to produce a wide range of animal images, including dramatized encounters between wild animals such as *Tiger and Cobra*, from 1904 (fig. 19). This image was included as a stand-alone illustration in the November 1905 edition of *Century*. It is slightly different that other natural history scenes in that it needed to be beautiful and exciting enough to stand on its own as a full-page colour contribution to the magazine, without an accompanying article.[114] Knight therefore included a narrative element in

[111] Kalt Knight and Stroud, *Charles R. Knight*, 34.
[112] According to Shannon's Auction house Collier's commissioned the drawing in the 1890s. In 1897 Collier's Vol. 19 no. 14 and vol. 19 no 13 both contain article on the Bronx Zoo which mention the big cat house, but have no accompanying images. The image does not appear to have been published in *Collier's* at any point.
[113] Knight, *Animal Anatomy*, 13.
[114] Letter from R.U. Johnson, Assistant Editor at *The Century Magazine*, to Charles R. Knight, December 21, 1903, Charles R. Knight Papers, 1867–1964, bulk (1892–1952), New York Public Library Manuscript and Archives Division. Box 1, folder 2.

Tiger and Cobra, showing an encounter between two animals that are as dangerous to each other as they are to humans.

The predatory nature of the subjects is immediately clear. The tiger stalks toward the cobra through a sun-dappled jungle. Its sleek, burnt orange fur contrasts with the muted blue green of the vegetation around it, highlighting a leafy branch that drags across the curve of the tiger's back. Its sharp teeth and muscular, agile body speak to years of successful hunts. The tiger snarls, its ears drawn back tightly, with its pale-yellow eyes locked on the cobra before it. Its front paw hovers just above the ground while the rest of its tense body is ready to move, to attack. The cobra is almost hidden, rendered in the same olive-green tones as the grass on which it is coiled. The markings on the back of its hood are visible, allowing knowledgeable viewers to identify the species. The image depicts a Monocled cobra and a Bengal tiger, which share a habitat in Bangladesh and northeastern India. It is unclear whether the cobra or the tiger is in more danger. This image is thrilling; it is also informed by Knight's knowledge of natural history.

Knight used his years of experience observing tigers at the Bronx Zoo to paint the tiger in this picture. He used his knowledge of tiger anatomy, of what that anatomy looks like when it moves as part of a body, to build a convincingly real animal.[115] The fur changes texture on different parts of the body and interacts with the light showing deep knowledge of what a tiger's fur looks like. The tension in the tiger's body makes the snarl not just a clear warning, but an indication of its wariness. It is clear the tiger knows the snake is dangerous. The body looks alive. Knight used the textures of the fur, the drape of the skin, and the shape of the skull under the skin to animate the tiger, to make this tiger look real. These details are brought about by close

[115] Cain, "The Direct Medium of Vision," 289.

looking, but they also suggest a wealth of knowledge developed through anatomical study. This specific type of detail was used to make the tiger seem as though it is a living creature.

Close observation of living animals was not just an exercise in looking at the living animal, but in connecting anatomical lessons to that living body. Knight believed the artist should be able to spot specific muscles and muscle groups, identify the places where the skeleton is visible through the skin, and most importantly, observe those anatomical features in living flesh.[116] Knight later reflected on this way of seeing, noting that students of animal drawing should pay attention to how the placement of muscles and bone affect the draping of the skin or the range of head movement.[117] Looking at living animals became an exercise in mentally disassembling and reassembling that animal. This type of close looking focused as much on how the parts of an animal fit together as on identifying those various parts. Being able to recognize organs in a living animal body had its paleontological counterpoint in the process of extrapolating the entirety of a body from a few discrete parts.

Pulling from Living Animals to Bring the Extinct Back to Life

Knight could not visit a game reserve or the Bronx Zoo to observe living dinosaurs. However, the purpose of a restoration was to show dinosaurs as though they were alive, meaning Knight needed to construct an image that convinced viewers of their status as once living animals. To achieve this goal Knight used comparative anatomy, the process of using living animal bodies to make decisions about what extinct animal bodies looked like. He also showed dinosaurs engaged in recognizable animal behaviours, a second aspect of comparative anatomy. Hunting, eating, and fighting were staples in paleoart throughout the nineteenth century.[118] Such

[116] Knight, *Animal Anatomy*, 6.
[117] Knight, *Animal Anatomy*, 7.
[118] Davidson, *A History of Paleontology Illustration*, 5.

activities showed dinosaurs as part of an ecosystem, behaving as wild animals did. Even in images that do not depict any of these behaviours directly, placing dinosaurs in scenes with other animals in a landscape implied the potential for these behaviours. By using conventions such as these, paleo artists drew a connection between their "scenes from deep time" and scenes of the current natural world. They also promoted their work as scientifically rigorous.[119]

While Knight was not a trained paleontologist, his work as an animal artist relied on many of the skills paleontologists used to classify and analyze fossils. Knight had enough knowledge of anatomy to make restorations, but he did not do the work of a paleontologist. Osborn did not think Knight was qualified to finalize the details of a restoration without close supervision by a professional scientist, writing to the artist's wife, "It is impossible for [Knight] to paint extinct animals without guidance by myself or some other lifelong student of the habits and structure of extinct animals."[120] Osborn, and the other scientists who commissioned Knight, collaborated with him closely to ensure control over the final image. Many of his restorations were published as Osborn-Knight restorations, indicating that Knight was not the source of scholarly interpretations of fossils.[121] Osborn attempted to maintain control over Knight's artwork, even having him sign a series of contracts that required him to defer to Osborn on all matters of interpretation.[122]

Despite not having the final say over his restorations, Knight was expected to have a command of dinosaur anatomy. To bolster his knowledge of dinosaur bodies, he was given access to the collections of the AMNH in addition to the personal collections of several of the

[119] "Scenes from Deep Time" is a phrase borrowed from Martin J.S. Rudwick's 1997 book, *Scenes from Deep Time.*
[120] Letter from Osborn to Annie Knight, September 22, 1932. Record Group 1262, Central Archives of the AMNH. Quoted in Lukas Rieppel's *Assembling the Dinosaur*, 225.
[121] Sommer, *Seriality*, 461.
[122] Sommer, *Seriality*, 466.

paleontology staff.[123] Among Knight's papers are preparatory sketches for his dinosaur artworks. One of these includes a sketch of some bones at the top of the page above an outline of his planned composition (fig. 20). The inclusion of the sketch of bones suggests they acted as a visual reference for his drawing of the whole animal. The process of building up from the bones is the same process Knight used to draw living animals, as is visible in his sketch of a feline. (fig. 21). He began with a skeleton, then added major muscle groups before creating the final image. Knight spent time with fossil specimens of the animals' body for the same reasons as he studied preserved skeletons and taxidermized animals: to build visual knowledge from close observation. While there were no living specimens of dinosaurs to observe firsthand, Knight closely studied the parts of their bodies he had access to and used the knowledge of paleontologists and his own knowledge of animal bodies to flesh out his restorations.

Knight used anatomical knowledge acquired from his study of living animals to restore a fleshy body to his dinosaur subjects, but that alone was not enough to breathe life into them. Animating their bodies required adding movement and behaviour to work in concert with those bodies. Some things could be clearly gleaned from single parts of fossil remains. For example, teeth provided a good estimation of whether the animal in question was primarily carnivorous or herbivorous, as well as what type of animal or plant they might have eaten. Other parts of the body were needed to figure out how the animal went about eating its food. Even then, having a more complete skeleton may not provide enough conclusive information to determine body shape, let alone behaviour. Paleontologists combined the knowledge gained from fossils with what was known about living animals to provide a more complete idea of what behaviours might have been.[124] Comparative anatomy argues that if an extinct animal had similar teeth and legs to

[123] Cain, "The Direct Medium of Vision," 287.
[124] Noble, *Articulating Dinosaurs*, 74.

a living animal, the extinct animal may have looked something like the living one and may have acted something like that animal as well.

Because dinosaurs did not neatly fit into the post-Darwinian categories at play in the late nineteenth and early twentieth centuries, restorations often pulled parts from many different living animals to build up a saurian body.[125] As did paleo artists before him, Knight drew from a variety of animals to restore his dinosaurs. He pulled from living animals available to him at the Bronx Zoo and dead animals from the AMNH specimen collection to build up a dinosaur through a collage of different animal bodies. This was by no means an innovation by Knight. Owen and Hawkins had used the body proportions of a pachyderm with the scaly skin and spines of an iguana to create the restorations for the Crystal Palace. Marsh, Cope, and Osborn likewise used snakes, seals, vultures, and monitor lizards, among other animals, to better understand their extinct subjects.[126] Cope, paleontology mentor to both Osborn and Knight, believed dinosaurs were closely connected to birds and that saurian posture and behaviour could be extrapolated from them, particularly birds of prey.[127]

The Bronx Zoo had several vultures in an aviary in the decade when Knight first began working on his restorations of dinosaurs. They proved useful models when he began working on a restoration of *Allosaurus fragilis*, a large theropod dinosaur which lived in the late Jurassic period. The species was first discovered during the Bone Wars in 1869, when Cope and Marsh were attempting to excavate and identify as many new dinosaur species as possible. As both men were perpetually in a rush to unveil their next impressive discovery, detailed study of many of

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[125] Mitchell, *The Last Dinosaur Book*, 54.
[126] This pulls from a variety of sources including Jane P. Davidson's, "Misunderstood Marine Reptiles: Late Nineteenth-Century Artistic Reconstructions of Prehistoric Marine Life," *Transactions of the Kansas Academy of Science* 118, no. 1 & 2 (2015) and Adrian Desmond's "Designing the Dinosaur" *Isis* 70, no 2 (July 1979).
[127] Henry Fairfield Osborn, "Edward Drinker Cope: The Great Naturalist," *The Century Illustrated Monthly Magazine* 55, no. 1 (November 1897): 12.

their finds did not begin in earnest until the 1890s. The specimen was excavated by Marsh in 1875 and purchased by the AMNH, but languished in the AMNH's storage until 1904, when museum staff began working through the backlog of fossils. *Creosaurus* was discerned to be the same species as *Allosaurus* in 1920 following a full scientific description of existing specimens. However, the name *Creosaurus* began falling out of use following Samuel Wendell Williston's 1901 article in the *American Journal of Science* noting that *Creosaurus* had never been distinguished sufficiently from *Allosaurus*.[128] Osborn, carrying on the work of his mentor, believed *Allosaurus* was primarily a scavenger, and turned to vultures as a potential model to reconstruct its feeding behaviour.[129] Knight illustrated this theory in a series of images made as preparation for a large oil painting of *Allosaurus* that became part of a display of a nearly complete *Allosaurus* skeleton at the AMNH.[130] Several of these preparatory images were published alongside an article by Osborn in the September 1904 edition of *Century* on dinosaur discoveries in the North American West.

This article included images of an *Allosaurus* eating and a vulture eating on facing pages (fig. 22). Knight's image shows the animal bent over and eating the tail of a dead *Brontosaurus*. On the opposite page is the image of a vulture captioned, "A vulture feeding in the New York Zoological Park; to show the manner in which the carnivorous dinosaur probably tore his food." The vulture is shown using its feet to grip and hold down the piece of meat while tearing with its beak. It leans down over its meal, holding its body parallel to the ground while bending its neck downwards. The *Allosaurus* is drawn in a similar posture; its feet grip and hold down the section

[128] S. W. Williston, "The Dinosaurian Genus Creosaurus, Marsh," *American Journal of Science* 11, 62 (February 1901): 111.
[129] Henry Fairfield Osborn, "Fossil Wonders of the West: The Dinosaurs of the Bone-Cabin Quarry," *The Century Illustrated Monthly Magazine* 68, no. 5 (September 1904): 688-689.
[130] Davidson, *A History of Paleontology Illustration*, 157.

of flesh it is eating from, its body is parallel to the ground, and it bends down from the neck. Knight has shown the *Allosaurus* using its claws to further manipulate the meat as it works to separate it from the carcass, as proposed by Osborn in the text of the article.[131] The vulture, having wings rather than hands, uses its beak to grip and tear the meat. The *Allosaurus* uses its teeth in a similar way to the vulture's beak, to grip and tear. Each animal grips the meat tightly with the front of its mouth. The similarities do not end with the way their bodies are positioned. The feet of the *Allosaurus* and the vulture are drawn in a similar way, down to the patterning of skin and scales. This comparison makes the *Allosaurus* seem like a living animal eating normally, rather than a monster devouring flesh.

This image became the basis for a large oil painting Knight completed to accompany a new fossil mount at the AMNH in 1907 (see again fig. 8), and the fossils of an *Allosaurus* were mounted in this same posture, with the *Allosaurus* leaning over the tail of a *Brontosaurus* as though it were eating it. A photograph of the installation from 1911 depicts school children viewing the recently installed display (fig. 23). The fossils are posed using an iron armature largely hidden from view, creating a sense that the bones are standing on their own. The overall display attempts to show the animals as though they were frozen in time, caught in a moment of life. The base of the display is covered in sand and rocks, mimicking an outdoor environment, and the sandy ground in the painting. The naturalistic pose and base imply the scene takes place in the natural world rather than the halls of the museum, an idea further reinforced by the placement of Knight's reconstruction beside it. This mount is not a full diorama like those that the AMNH would later become famous for, but it has many similarities.

[131] Osborn, "Dinosaurs of the Bone-Cabin," 688.

The construction of a frozen moment, as though viewers have caught the animal forever in their gaze, turns the fossil mount into a spectacular display such as that found in taxidermy dioramas.[132] Haraway argues that the taxidermy dioramas at the AMNH function as scenes where the viewer can gaze at the animal unimpeded, creating a totalizing vision of nature represented.[133] The animals hold their poses forever, something only possible due to their deaths. Fossil mounts likewise hold their pose indefinitely, existing in a state that mimics life but is only possible due to death. The fossil mount creates the idea of a living animal, only without the other the illusions of life made possible by taxidermy. These other illusions, which transfix the encounter between human and dinosaur, unfold instead in Knight's painting.

The rectangular object visible in the 1911 photograph of the display is Knight's painting (see again fig. 8), which has been displayed beside this mount since its unveiling.[134] The *Allosaurus* in the foreground of the painting is positioned in a natural environment, as is typical in natural history scenes, in a pose similar to that in the *Century* images of the *Allosaurus* and vulture. It is faced laterally to the viewer, showing the long side of its body clearly. The texture of its skin is described in painterly brushstrokes, giving the impression of rough, dry scales. The skin creases in thick folds near the base of its skull and its shoulder joints, recalling the flexible scales of modern lizards. Its teeth are clearly visible, as are the bony crests above its eyes. The *Allosaurus* in the background of the image is alert, standing on its hind legs and turning its head towards the carcass. It seems to be waiting in anticipation for its turn to eat. The bodies of both animals are on display as fully as possible, open to the viewer's scrutinizing gaze.

[132] Haraway, "Teddy Bear Patriarchy," 25.
[133] Haraway, "Teddy Bear Patriarchy," 25.
[134] Lowell Dingus, *Next of Kin: Great Fossils at the American Museum of Natural History* (New York: Rizzoli, 1996), 72.

The dinosaurs are placed in a landscape of scrubby grass and lush green trees rendered in loose brushstrokes, giving the impression of vegetation moving in the breeze. The hazy quality to the atmosphere and washed-out buffs and olive greens suggests the breeze is warm, if not hot. The carcass of the *Brontosaurus* is not overly graphic, with less flesh than in the *Century* image. The suggestion of heat only hints at the possibility of rancid meat. Most of the carcass has been picked clean, and only a few scraps of meaty flesh are visible. The *Allosaurus* is in a naturalistic pose, as though the viewer is encountering it in the wilderness. By displaying this painting with the fossil mount, it functioned as a visual tool to help visitors understand how these animals looked and behaved.[135] The image supplemented the fossils, and the fossils supplemented the painting; both enhanced the other. A visitor could look from the mounted fossils to the painting and back again to visualize the living body of the dinosaur. The painting functioned as a tool to make fossil remains legible as a thing that had once been alive.

Natural history scenes were often heavily informed by the observation of zoo animals. Knight's artworks were certainly informed by his visits to the Bronx and Central Park Zoos. Like museums, nineteenth- and early twentieth-century zoos displayed and relied on colonial power.[136] There was a deep relationship between the animals in zoos and the animals in natural history scenes as both ways of displaying animals positioned them as symbols of knowledge, public enlightenment, and the natural world. Berger argues that in modern zoos animals have been rendered so marginal that they cannot return the human gaze, that we can look at animals, but we cannot see them unless they look back.[137] However, the animals Knight painted frequently return the viewer's gaze. This suggests a desire to know these animals and forge some

[135] Cain, "The Direct Medium of Vision," 285.
[136] Berger, "Why Look at Animals?" 21.
[137] Berger, "Why Look at Animals?" 28.

kind of mutual relationship, not just study them from a distance. To confront a wild animal face to face and have it look back is a challenge as much as an invitation The presence of millions of years makes distance between humans and dinosaurs even greater and more difficult to meet their gaze.

Deep Time and Fossilization

For most of this thesis I have discussed fossils using terms such as bones and skeletons. However, fossils are not actually made of bone. Fossilization is the collective name for processes such as permineralization and carbonization, where organic material is slowly replaced by minerals. Fossilization can also form casts of organic material when the impression of on organic material, but not the material itself, is preserved. Most things that live and die never become fossils, because fossilization only occurs in specific circumstances. Plants and animals buried in volcanic ash, buried in silt in a slow-moving river, or in a continental shelf have a better chance of becoming fossilized than those dying in the middle of a field. Even in the best conditions, it is rare to find more than a few parts of the same animal fossilized. The actual bodies of dinosaurs do not make it through deep time unchanged in perfect preservation. Most museum mounts are composites of several different animals, often with manufactured casts filling in the missing parts.[138]

When one studies fossils, the flesh of the animal is not there. It is stone in the shape of the bones of an animal's body, an incomplete record of that animal's anatomy. To understand a fossil as part of a whole creature, it must be combined with the fossilized remains of other individual animals of the same species. The person who restores a dinosaur must pull from multiple fossil sources to understand what that dinosaur looked like. Creating the idea of a whole

[138] Rieppel, *Assembling the Dinosaur*, 211.

body was a necessary part of making an image of a dinosaur. Knight worked firsthand with fossil specimens whenever possible, including the few skin impressions then in the AMNH's collection.[139] However, fossils are not fully tangible as part of a once-living body in the same way as bone. The rock they are formed from is far denser and heavier than bone. During the fossilization process, bones are often crushed and twisted in the earth's crust over time. Fossilization can preserve incredible detail, but it also fundamentally transforms the animal body.

By studying fossils, Knight was able to imagine a skeleton to use as the base layer of a dinosaur body. Knight drew from many separate fossil specimens to create the image of a single dinosaur. By drawing from multiple sources, Knight created a composite, a representation of the idea of an animal, rather than a representation of any one specific animal. His painting of an *Allosaurus* is a representation of all *Allosauruses*. This is the same process natural history illustrators use to make images of living animals. This process is magnified in images of dinosaurs, for there is no living, whole dinosaur to use as a model. Every dinosaur becomes an ideal type; you can't make a portrait of a dinosaur. Knight's painting of an *Allosaurus* simultaneously represents all *Allosauruses* that ever lived, and none of them. Yet this image shows it with qualities that make it seem as though it could be alive. Its scales are recognizable as skin. It moves in a similar way to a vulture. Its eyes are bright and have a predatory gleam. It is eating, something all animals do. These images argue that this dinosaur is an animal.

[139] Kalt Knight and Stroud, *Charles R. Knight*, 39.

Conclusion: Peering Through the Mists of Time

Dinosaurs did not fit neatly into the categories that artists and scientists relied on. Although many of the species Knight painted were native to the land that became the United States, they were still exotic animals. Knight's 1904 *Kodiak Bear* (fig. 24) shows an animal in a similar place of limbo, between "native" and "exotic." The Kodiak bear, a subspecies of brown bear in Alaska, is an animal few in North America would ever encounter face to face. Although Alaska had been purchased by the United States in 1867, it was far removed from the lives and environment of most New Yorkers. The twin status as both native and exotic transformed animals such as the Kodiak Bear, like the dinosaur, into more than animal. The categories of native and exotic were shaped by settler colonialism and eugenics. Here, the binary of native/exotic interacts with the categories of living/extinct through late nineteenth-century anxieties around extinction and the future of the white race in North America.

There is a blending of the mythic and the real that happens when people try to imagine deep time generally, and dinosaurs specifically. Ostensibly, Knight's reconstructions were intended to make dinosaurs "real" by showing them alive, moving, with flesh and skin. This "reality" showed visitors something about dinosaurs, but it also suggested specific ways of looking and thinking about animals that made Knight's dinosaurs potent embodiments of the political and social ideologies of the New York elite. Knight generated pictures that allowed people to "witness" dinosaurs in the distant past as part of a series of interlocking tendencies. Knight attempted to depict a place and being he put together from traces left through fossilization and his knowledge of the living world. The context in which Knight produced pictures of dinosaurs was informed by settler colonialist ideals, and contradictory ideas about human domination over "nature" shaped how living animals, and dinosaurs, were understood.

Art historians are paying increasing attention to how nature is constructed in art. Scholars of natural history art have begun to ask how these images produce animals and nature as distinct concepts. Most art historians who focus on questions of ecology, ecocriticism, and animal studies have focused on images of extant rather than extinct species. Knight's dinosaur art fits well into this growing interest in animal studies, while giving attention to an understudied area of natural history art. Deep time is so large and so long human brains cannot fully comprehend it, and furthermore it challenges anthropocentrism by rendering the length of time humans have existed tiny. Scholarship on depictions of deep time is a small but vibrant field that I have attempted to bring into contact with animal studies. Berger, Haraway, and Fudge's work on animal history asks scholars to contend with dinosaurs as animals rather than purely political instruments, a challenge when the animal is extinct. Knight's reconstructions exist in an interesting meeting place of ideologies about human's place in the world in relation to nature, to the exotic, and to each other.

However, there is a complication I have not yet fully addressed. To put it plainly, there is no tangible way to meet a dinosaur's gaze. Even if an eye becomes fossilized, it will never again be part of a living thing. Through the passing of deep time and the changes wrought by fossilization, dinosaurs exist as once-living animals, and they will never be alive again. There is no way for a dinosaur to look back. This did not stop Knight from creating images of dinosaurs that meet our gaze. At the beginning of this thesis, I briefly discussed Knight's *Brontosaurus* (fig. 2), from 1898. The painting shows a herd of the animals wading through a swamp to graze, most in the water and one on dry land, with a *Brontosaurus* in the centre of the image looking directly at the viewer. Its eyes are a shade of amber that complements the blue tones of the water. Its gaze is curious, its expression almost playful.

The fact that the Brontosaurus looks back is not the only aspect of this image that argues it is an animal. Many of the methods Knight employed to enliven his subjects are present in this painting. The *Brontosaurus's* gray, wrinkly skin is similar to an elephant's, pale and dusty when dry and dark and shiny when wet. The way its feet are rendered is also drawn from elephants, from the way the skin wrinkles at the ankle to the shape of its toenails. They are grazing on aquatic plants that grow in a lush, detailed landscape. Multiple animals are shown from varied viewpoints, suggesting many individuals. The gaze argues that the central Brontosaurus is an individual, not a specimen. This image confronts the viewer with the reality that dinosaurs were once living; they were animals. It suggests there is something in these animals that cannot be neatly managed, part of them that may never be accessible to categorization.

The act of restoring dinosaurs as though they were alive creates representations that are at once definitive, in that they create an observable image, and in flux, in that the scientific and cultural understanding of dinosaurs is always changing. A restoration of a dinosaur can be completed and displayed, but the dinosaur it depicts is always unfinished. By the 1920s, when Knight was hired to create sketches for a planned Hall of Dinosaurs, the image of a Brontosaurus living partially in water to support its body weight was thoroughly outdated.[140] Scientific understanding of the animal had changed, but the painting had not.

[140] Mitchell, *The Last Dinosaur Book*, 115.

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Appendix

Phanerozoic				
Paleozoic	Mesozoic			Cenozoic
Permian	Triassic	Jurassic	Cretaceous	Paleogene
252	201	145		67

Fig. 1. Diagram of the Mesozoic era in geological time. Units are million years ago (Mya).

Fig. 2. Charles R. Knight, *Brontosaurus*, 1898. Gouache on paper, 45.72 x 72.39 cm. American Museum of Natural History, bibliographic reference number: b10007775. https://lbry-web-007.amnh.org/digital/items/show/90715

Fig. 3. Charles R. Knight. *Trachodon*, 1905. Oil on canvas, 109 x 155 cm. American Museum of Natural History, bibliographic reference number: b10007477. https://lbry-web-007.amnh.org/digital/items/show/91077

Fig. 4. Carolus Linnaeus, Table of the Animal Kingdom from *Systema Naturae*, Leiden: Theodorum Haak, 1735, 12-13.

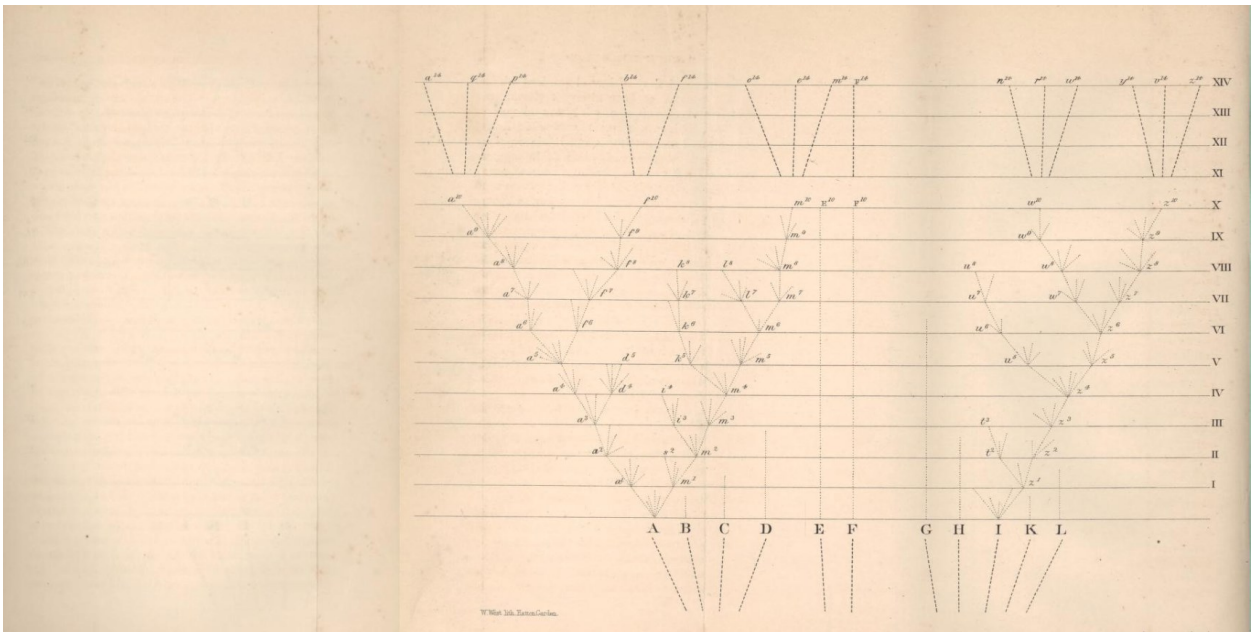


Fig. 5. Tree Diagram illustrating the divergence of species, from Charles Darwin, *On the Origin of Species by means of Natural Selection or the Preservatin of Favoured Races in the Struggle for Life*. London: John Murray, 1859, 117.

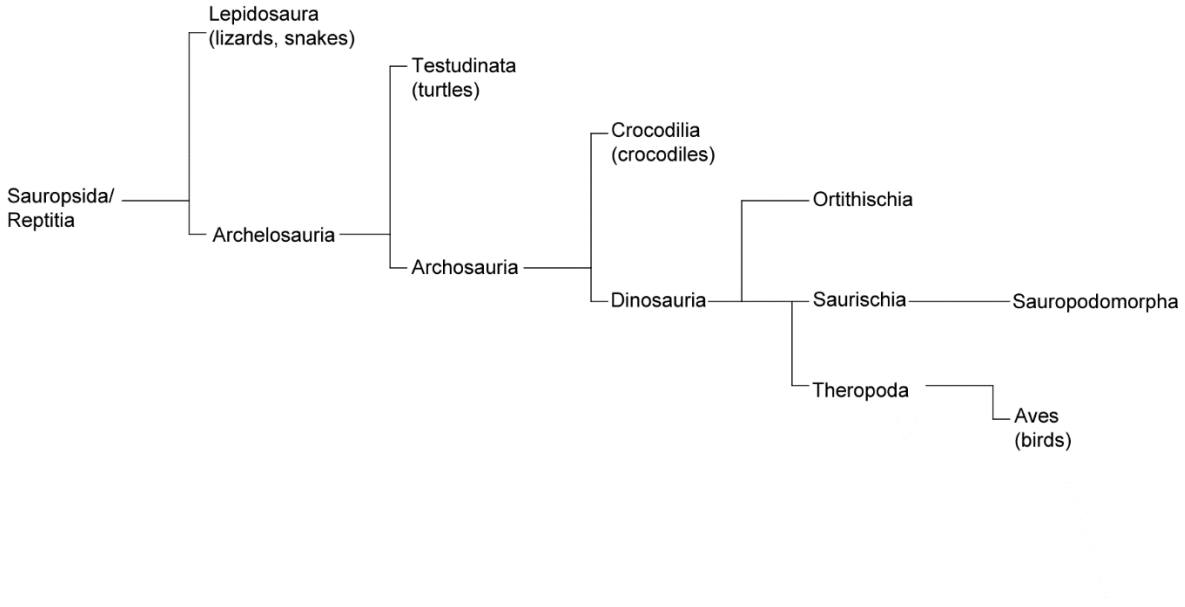


Fig. 6. Simplified cladogram of dinosaur evolution. The diagram reads left to right starting with *sauropsida*. Each line represents a different clade. Horizontal lines represent the last common ancestor of the branching vertical lines to the right of the caption.

Fig. 7. Charles R. Knight, *Dimetrodon and Edaphosaurus*, 1897. Gouache on paper, 40.6 x 63.5 cm. American Museum of Natural History, bibliographic reference number: b10007763. https://lbry-web-007.amnh.org/digital/items/show/90716

Dimetrodon is in the foreground with the convex snout, while *Edaphosaurus* with its concave snout is placed in the background. Note the splayed hind legs on both animals.

Fig. 8. Charles R. Knight, *Allosaurus Eating a Brontosaurus*, 1904. Oil on canvas, 43 x 73 cm. American Museum of Natural History, bibliographic reference number: b12126652. https://lbry-web-007.amnh.org/digital/items/show/91076

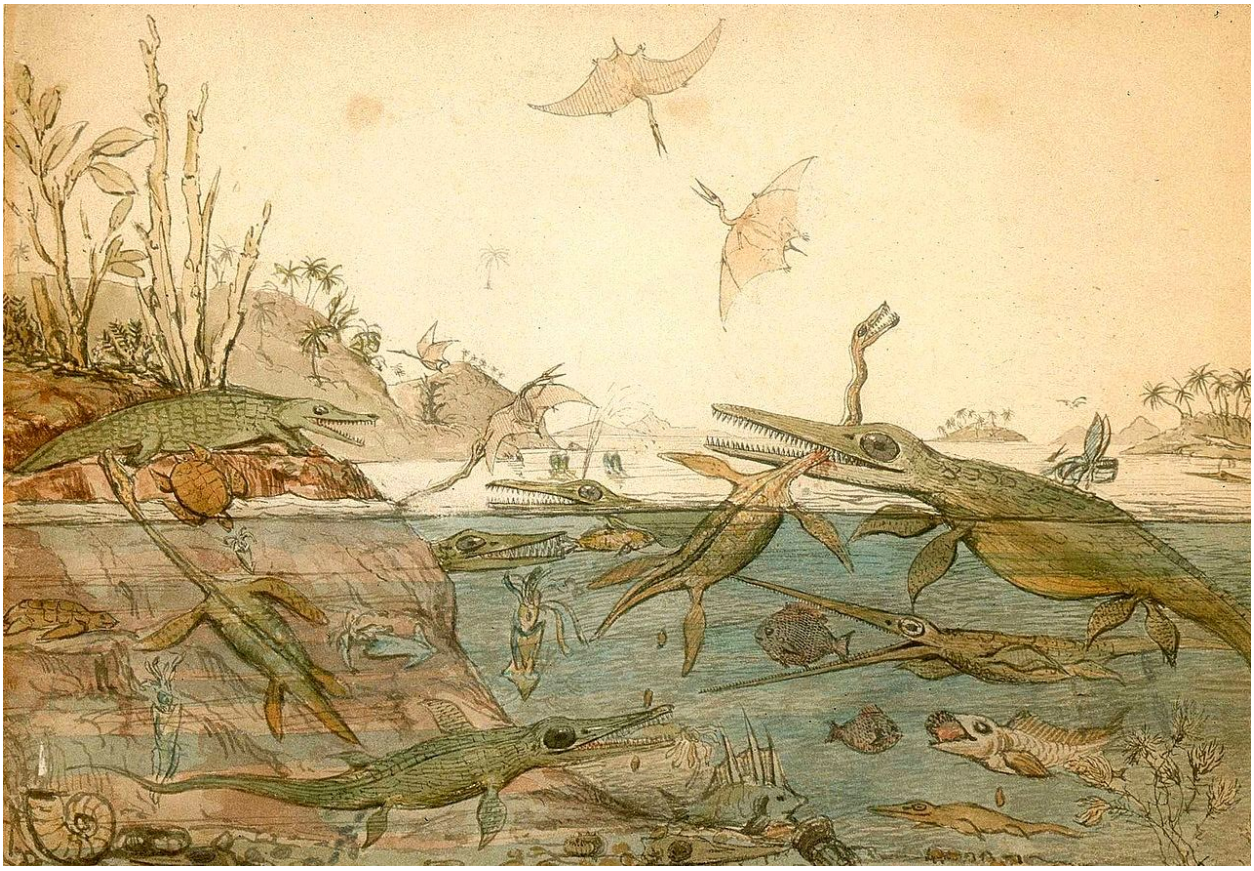


Fig. 9. Henry De la Beche, *Duria Antiquior: or a More Ancient Dorset*, 1830. Watercolour and ink on paper, 32 x 22.5 cm. Amgueddfa Cymru (National Museum of Wales). Accession number NMW 84.20G.368

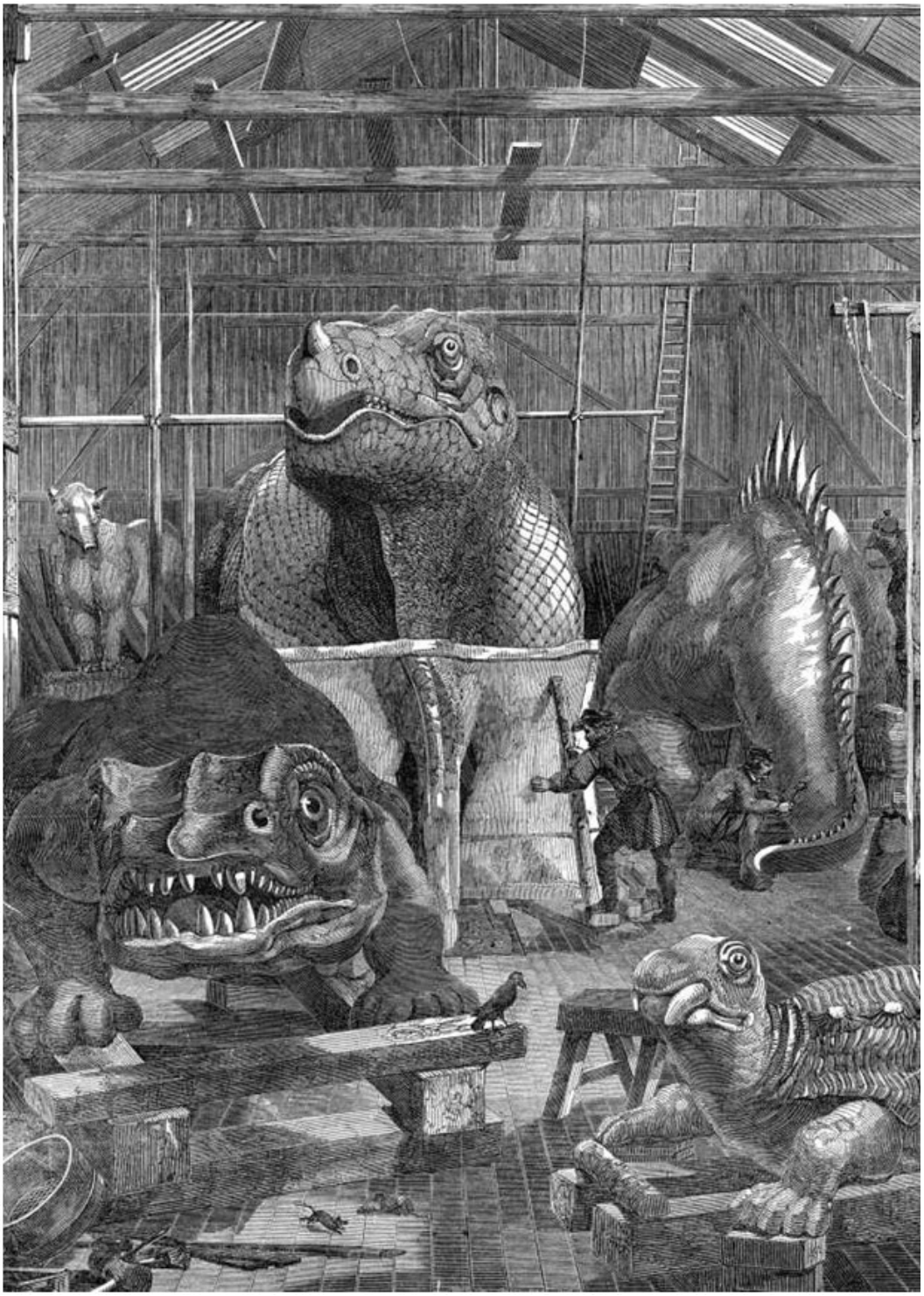


Fig. 10. “The Extinct Animals Model-Room at the Crystal Palace, Sydenham,” *Illustrated London News* 23, 661 (December 31, 1853), 600.

Fig. 11. George Baxter, *The Crystal Palace from the Great Exhibition, installed at Sydenham: sculptures of prehistoric creatures in the foreground.* Colour Baxter-process print. 10.9 x 16 cm. c.1854. Wellcome Collection, Reference Number: 39566i
https://wellcomecollection.org/works/c7nzvug2

Fig. 12. Benjamin Waterhouse Hawkins, “The Zebra- Asinus Zebra,” in John Edward Grey and Benjamin Waterhouse Hawkins, *Gleanings from the Menagerie and Aviary at Knowsley Hall. Vol. 2 Hoofed Quadrapeds*. London: British Museum, 1846, 200.

Fig. 13. Benjamin Waterhouse Hawkins, *Totenus Indica—The Indian Sandpiper, Limosa Hardwickii- Begondee Snipe*, 1835. Hand coloured lithograph in Grey, John Edward, and Hawkins, Benjamin Waterhouse, *Illustrations of Indian Zoology: Chiefly Selected from the Collection of Major-General Hardwicke*. London: Adolphus Richter and Co., 1835, 52.

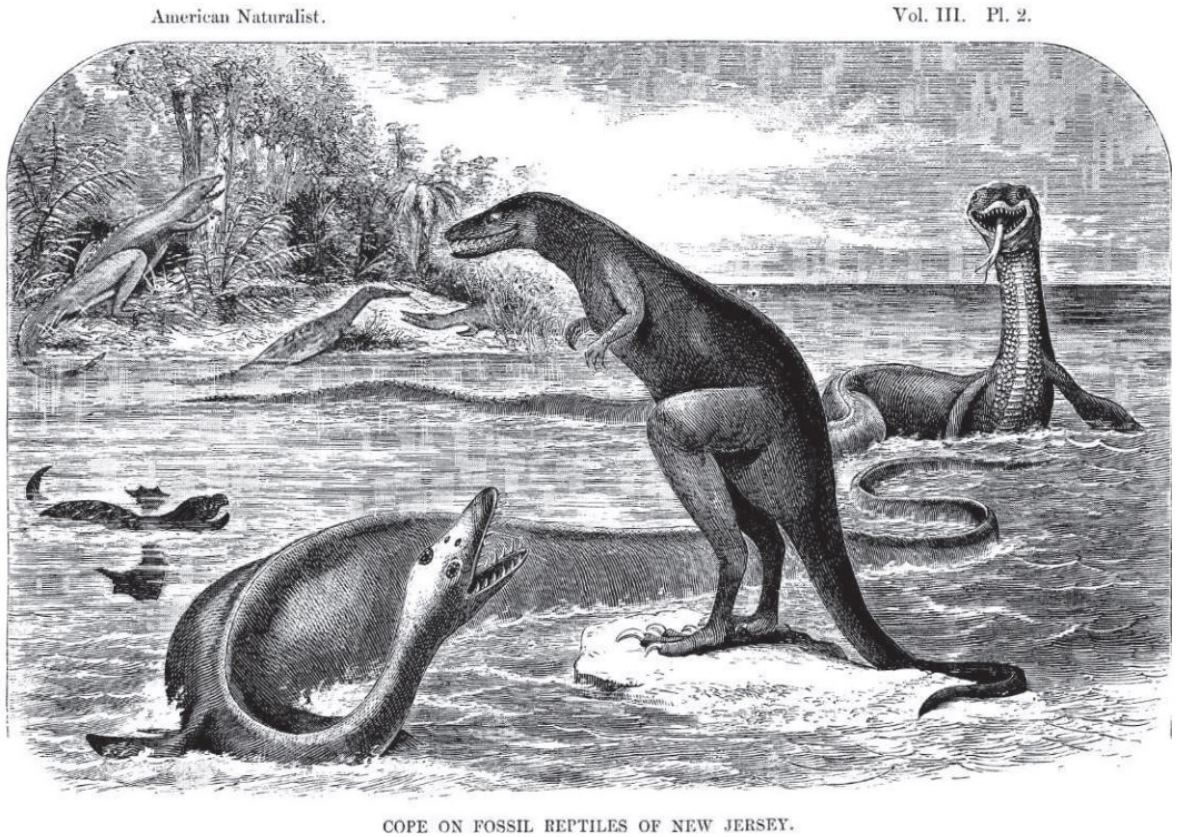
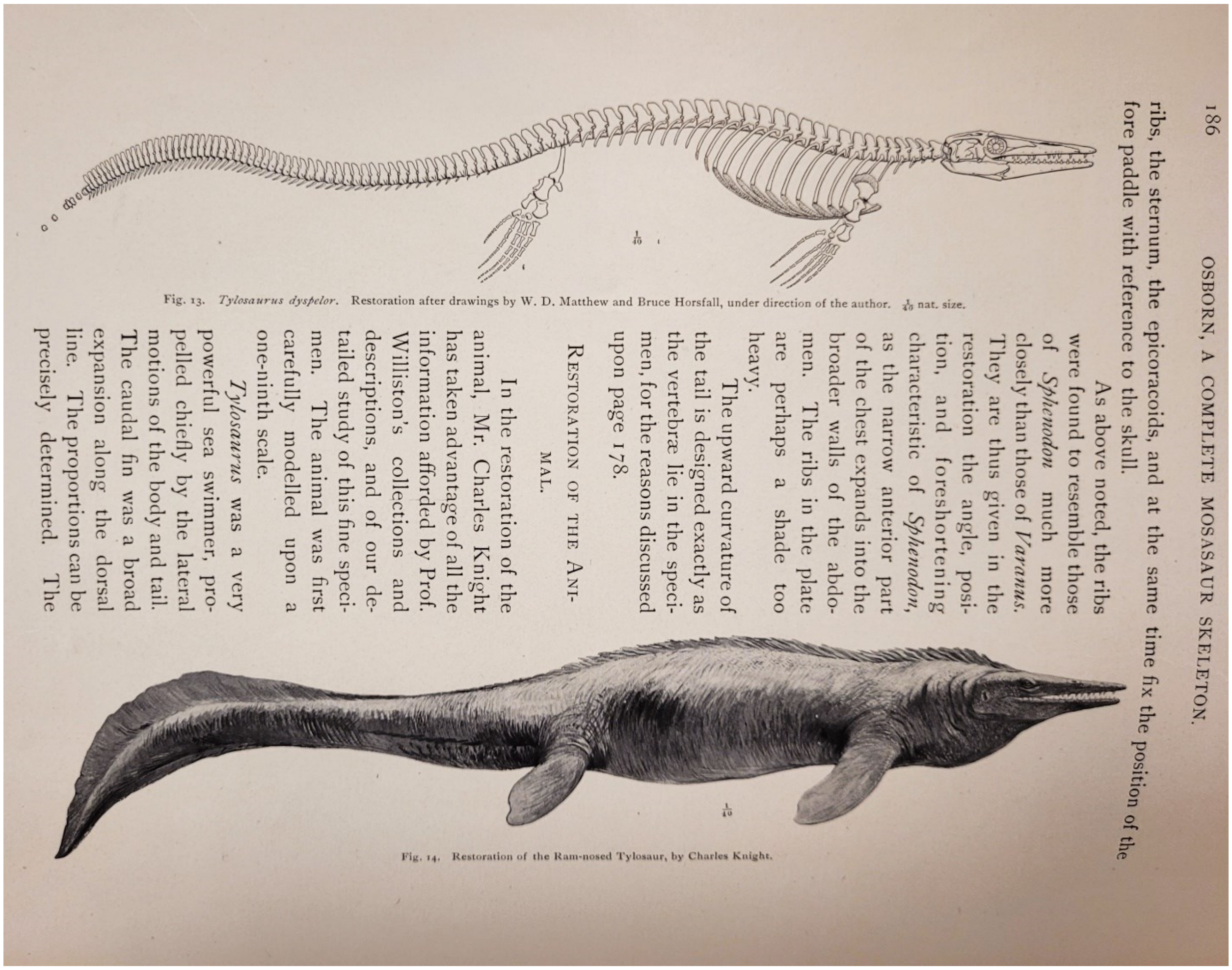


Fig. 14. Edward Drinker Cope, “Cope on Fossil Reptiles of New Jersey,” in *American Naturalist* 3, 2 (1869): 85.


186 OSBORN, A COMPLETE MOSASAUR SKELETON.

ribs, the sternum, the epicoracoids, and at the same time fix the position of the fore paddle with reference to the skull.

Fig. 13. *Tylosaurus dyspelor*. Restoration after drawings by W. D. Matthew and Bruce Horsfall, under direction of the author. $\frac{1}{40}$ nat. size.

As above noted, the ribs were found to resemble those of *Sphenodon* much more closely than those of *Varanus*. They are thus given in the restoration the angle, position, and foreshortening characteristic of *Sphenodon*, as the narrow anterior part of the chest expands into the broader walls of the abdomen. The ribs in the plate are perhaps a shade too heavy.

The upward curvature of the tail is designed exactly as the vertebræ lie in the specimen, for the reasons discussed upon page 178.

RESTORATION OF THE ANIMAL.

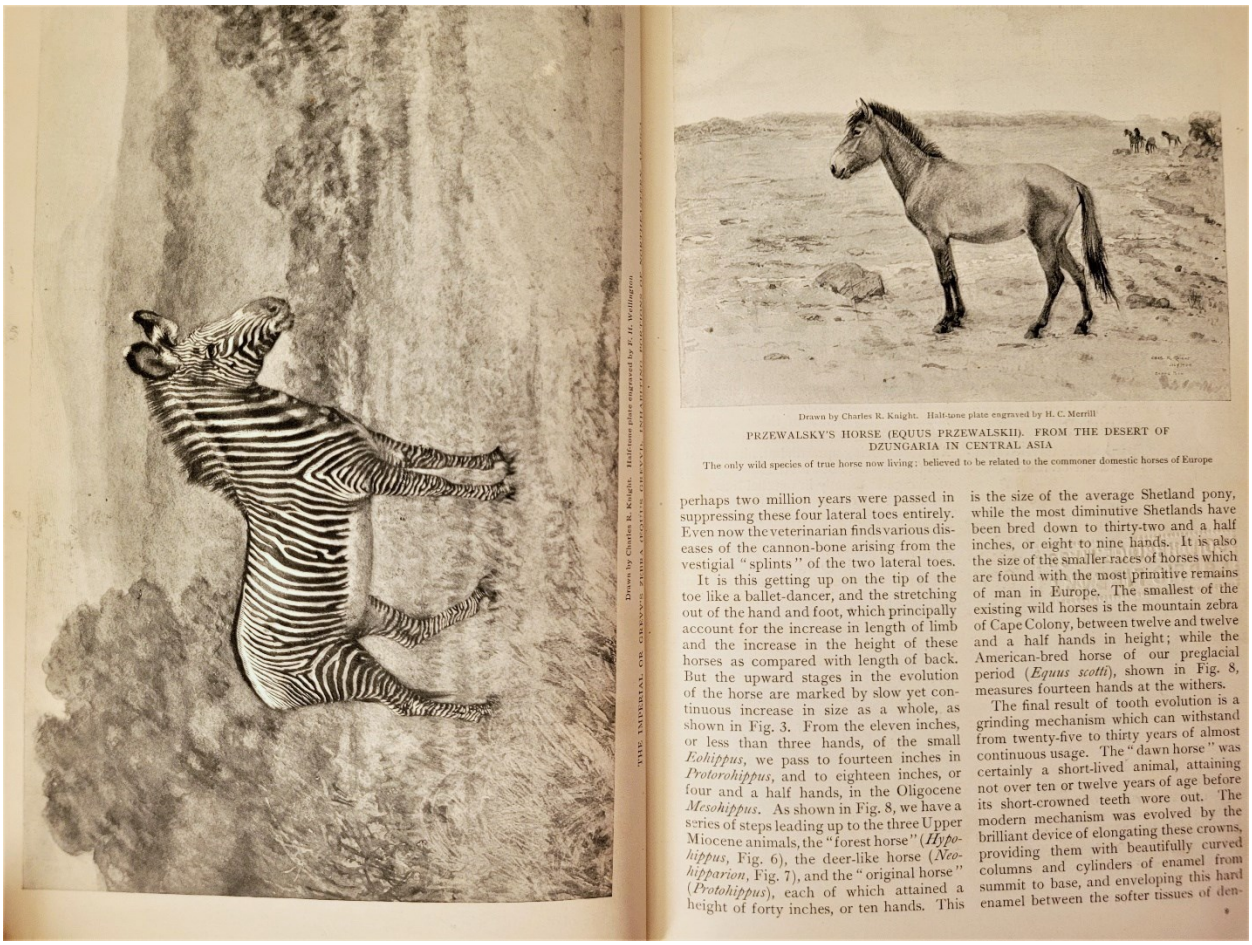
In the restoration of the animal, Mr. Charles Knight has taken advantage of all the information afforded by Prof. Williston's collections and descriptions, and of our detailed study of this fine specimen. The animal was first carefully modelled upon a one-ninth scale.

Tylosaurus was a very powerful sea swimmer, propelled chiefly by the lateral motions of the body and tail. The caudal fin was a broad expansion along the dorsal line. The proportions can be precisely determined. The

Fig. 14. Restoration of the Ram-nosed Tylosaur, by Charles Knight.

Fig. 15. Charles R. Knight, Restoration of the Ram-Nosed Tylosaurus and W.D. Matthew and Bruce Horsfall, "Tylosaurus dyspelor" from Henry Fairfield Osborn, "A Complete Mosasaurus Skeleton," in *Memoirs of the American Museum of Natural History*, New York: American Museum of Natural History, October 25, 1899, 186.

Fig. 16. Charles R. Knight, *Grevy's Zebra*, 1901. Watercolour and gouache, 34 x 37 cm. American Museum of Natural History, b10008299. https://lbry-web-007.amnh.org/digital/items/show/41698



Drawn by Charles R. Knight. Halftone plate engraved by F. H. Wellington

THE IMPERIAL OR GREVY'S ZEBRA (EQUUS GREVYI)

Drawn by Charles R. Knight. Half-tone plate engraved by H. C. Merrill

PRZEWALSKY'S HORSE (EQUUS PRZEWALSKII). FROM THE DESERT OF DZUNGARIA IN CENTRAL ASIA

The only wild species of true horse now living; believed to be related to the commoner domestic horses of Europe

perhaps two million years were passed in suppressing these four lateral toes entirely. Even now the veterinarian finds various diseases of the cannon-bone arising from the vestigial "splints" of the two lateral toes.

It is this getting up on the tip of the toe like a ballet-dancer, and the stretching out of the hand and foot, which principally account for the increase in length of limb and the increase in the height of these horses as compared with length of back. But the upward stages in the evolution of the horse are marked by slow yet continuous increase in size as a whole, as shown in Fig. 3. From the eleven inches, or less than three hands, of the small *Eohippus*, we pass to fourteen inches in *Protorohippus*, and to eighteen inches, or four and a half hands, in the Oligocene *Mesohippus*. As shown in Fig. 8, we have a series of steps leading up to the three Upper Miocene animals, the "forest horse" (*Hypohippus*, Fig. 6), the deer-like horse (*Neohipparion*, Fig. 7), and the "original horse" (*Protohippus*), each of which attained a height of forty inches, or ten hands. This is the size of the average Shetland pony, while the most diminutive Shetlands have been bred down to thirty-two and a half inches, or eight to nine hands. It is also the size of the smaller races of horses which are found with the most primitive remains of man in Europe. The smallest of the existing wild horses is the mountain zebra of Cape Colony, between twelve and twelve and a half hands in height; while the American-bred horse of our preglacial period (*Equus scotti*), shown in Fig. 8, measures fourteen hands at the withers.

The final result of tooth evolution is a grinding mechanism which can withstand from twenty-five to thirty years of almost continuous usage. The "dawn horse" was certainly a short-lived animal, attaining not over ten or twelve years of age before its short-crowned teeth wore out. The modern mechanism was evolved by the brilliant device of elongating these crowns, providing them with beautifully curved columns and cylinders of enamel from summit to base, and enveloping this hard enamel between the softer tissues of den-

Fig. 17. Charles R. Knight, "The Imperial or Grevy's Zebra (Equus Grevyi)," in Henry Fairfield Osborn, "Fossil Wonders of the West: The Evolution of the Horse in America." *The Century Illustrated Monthly Magazine* 69, 1 (November 1904): 8-9.

Fig. 18. Charles R. Knight. *Four Big Cats*, c.1897. Watercolour and gouache on paper, 36.8 x 32.5 cm. Image retrieved from https://www.shannons.com/auction-lot/charles-robert-knight-american-1874-1953-four_2A0435990D, lot 173, sold on January 24, 2019.

Fig. 19. Charles R. Knight, *Tiger and Cobra*, in *The Century Illustrated Monthly Magazine* 69, 1 (November 1904): 125.

Fig. 20. Charles R. Knight, Sketch of sauropods, undated, *Charles R. Knight Papers, 1867–1964, bulk (1892–1952),* Manuscript and Archives Division, New York Public Library. Box 8, folder 4.

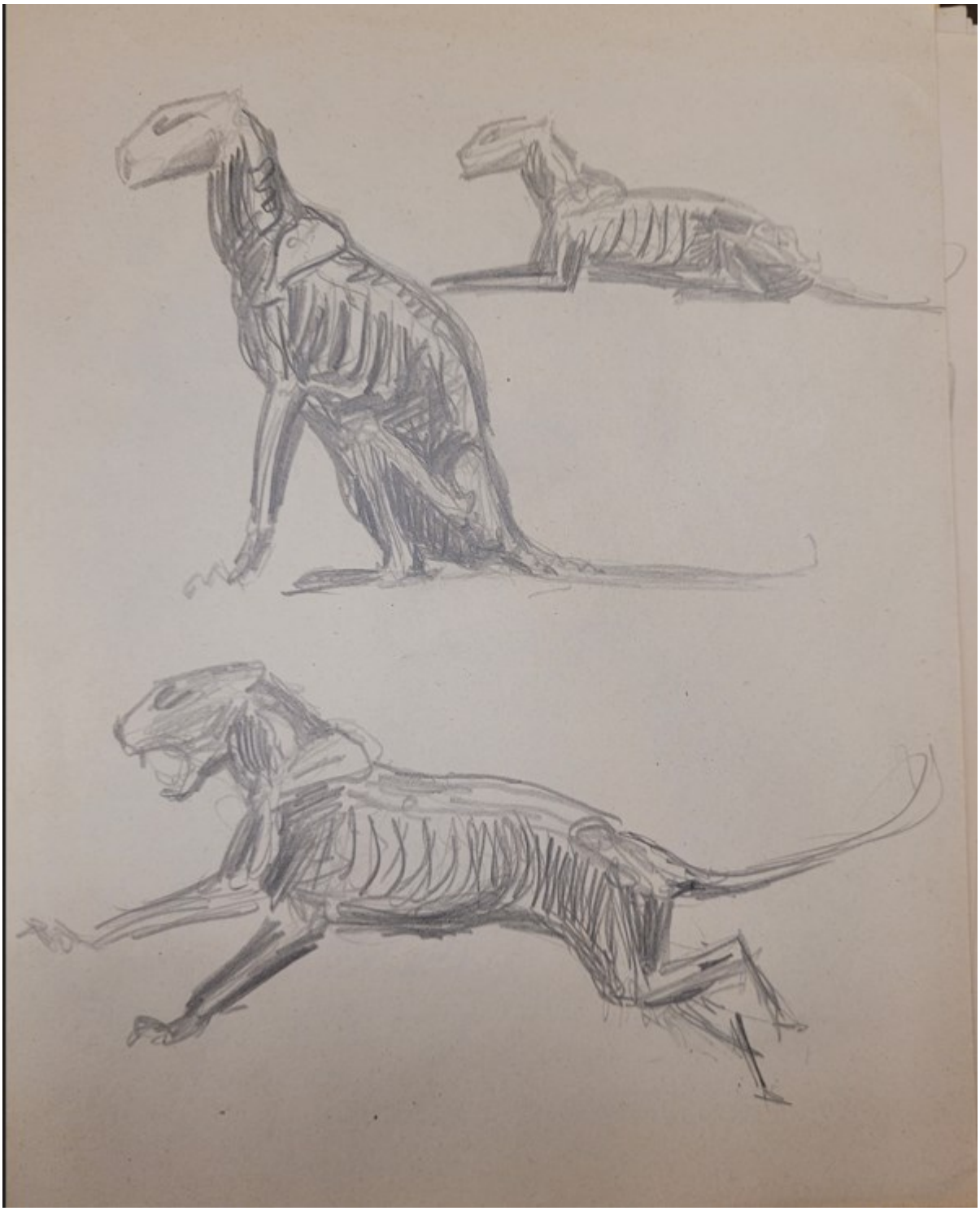
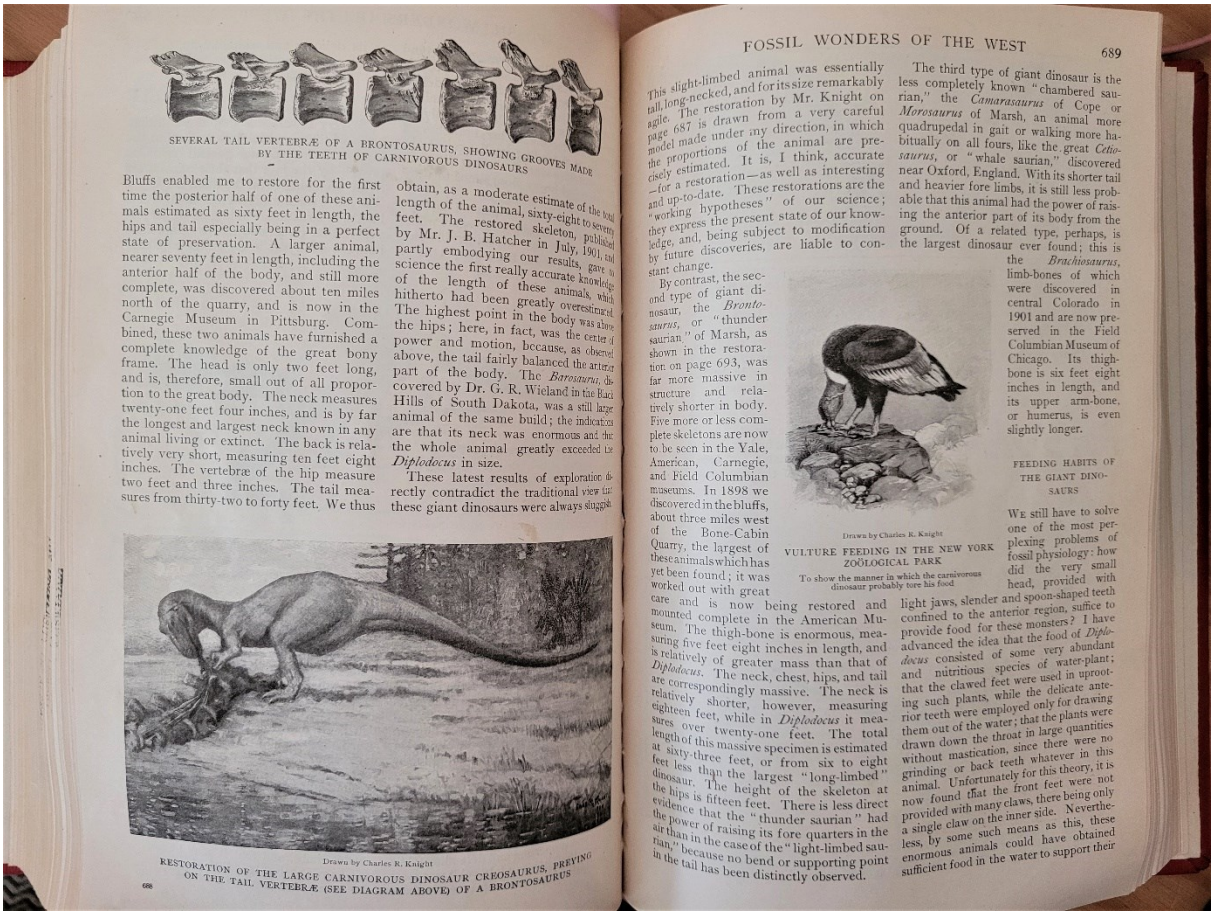


Fig. 21. Charles R. Knight, Sketch of a feline, undated. *Charles R. Knight Papers, 1867–1964, bulk (1892–1952).* Manuscript and Archives Division, New York Public Library. Box 9, folder 1.



SEVERAL TAIL VERTEBRÆ OF A BRONTOSAURUS, SHOWING GROOVES MADE BY THE TEETH OF CARNIVOROUS DINOSAURS

Bluffs enabled me to restore for the first time the posterior half of one of these animals estimated as sixty feet in length, the hips and tail especially being in a perfect state of preservation. A larger animal, nearer seventy feet in length, including the anterior half of the body, and still more complete, was discovered about ten miles north of the quarry, and is now in the Carnegie Museum in Pittsburg. Combined, these two animals have furnished a complete knowledge of the great bony frame. The head is only two feet long, and is, therefore, small out of all proportion to the great body. The neck measures twenty-one feet four inches, and is by far the longest and largest neck known in any animal living or extinct. The back is relatively very short, measuring ten feet eight inches. The vertebræ of the hip measure two feet and three inches. The tail measures from thirty-two to forty feet. We thus obtain, as a moderate estimate of the total length of the animal, sixty-eight to seventy feet. The restored skeleton, published by Mr. J. B. Hatcher in July, 1901, and partly embodying our results, gave to science the first really accurate knowledge of the length of these animals, which hitherto had been greatly overestimated. The highest point in the body was above the hips; here, in fact, was the center of power and motion, because, as observed above, the tail fairly balanced the anterior part of the body. The *Barosaurus*, discovered by Dr. G. R. Wieland in the Black Hills of South Dakota, was a still larger animal of the same build; the indications are that its neck was enormous and that the whole animal greatly exceeded the *Diplodocus* in size.

These latest results of exploration directly contradict the traditional view that these giant dinosaurs were always sluggish

Drawn by Charles R. Knight

RESTORATION OF THE LARGE CARNIVOROUS DINOSAUR CREOSAURUS, PREYING ON THE TAIL VERTEBRÆ (SEE DIAGRAM ABOVE) OF A BRONTOSAURUS

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This slight-limbed animal was essentially tall, long-necked, and for its size remarkably agile. The restoration by Mr. Knight on page 687 is drawn from a very careful model made under my direction, in which the proportions of the animal are precisely estimated. It is, I think, accurate —for a restoration—as well as interesting and up-to-date. These restorations are the "working hypotheses" of our science; they express the present state of our knowledge, and, being subject to modification by future discoveries, are liable to constant change.

By contrast, the second type of giant dinosaur, the *Brontosaurus*, or "thunder saurian" of Marsh, as shown in the restoration on page 693, was far more massive in structure and relatively shorter in body. Five more or less complete skeletons are now to be seen in the Yale, American, Carnegie, and Field Columbian museums. In 1898 we discovered in the bluffs, about three miles west of the Bone-Cabin Quarry, the largest of these animals which has yet been found; it was worked out with great care and is now being restored and mounted complete in the American Museum. The thigh-bone is enormous, measuring five feet eight inches in length, and is relatively of greater mass than that of *Diplodocus*. The neck, chest, hips, and tail are correspondingly massive. The neck is relatively shorter, however, measuring eighteen feet, while in *Diplodocus* it measures over twenty-one feet. The total length of this massive specimen is estimated at sixty-three feet, or from six to eight feet less than the largest "long-limbed" dinosaur. The height of the skeleton at the hips is fifteen feet. There is less direct evidence that the "thunder saurian" had the power of raising its fore quarters in the air than in the case of the "light-limbed saurian," because no bend or supporting point in the tail has been distinctly observed.

Drawn by Charles R. Knight

VULTURE FEEDING IN THE NEW YORK ZOÖLOGICAL PARK

To show the manner in which the carnivorous dinosaur probably tore his food

The third type of giant dinosaur is the less completely known "chambered saurian," the *Camarasaurus* of Cope or *Morosaurus* of Marsh, an animal more quadrupedal in gait or walking more habitually on all fours, like the great *Cetiosaurus*, or "whale saurian," discovered near Oxford, England. With its shorter tail and heavier fore limbs, it is still less probable that this animal had the power of raising the anterior part of its body from the ground. Of a related type, perhaps, is the largest dinosaur ever found; this is the *Brachiosaurus*, limb-bones of which were discovered in central Colorado in 1901 and are now preserved in the Field Columbian Museum of Chicago. Its thigh-bone is six feet eight inches in length, and its upper arm-bone, or humerus, is even slightly longer.

FEEDING HABITS OF THE GIANT DINOSAURS

We still have to solve one of the most perplexing problems of fossil physiology: how did the very small head, provided with light jaws, slender and spoon-shaped teeth confined to the anterior region, suffice to provide food for these monsters? I have advanced the idea that the food of *Diplodocus* consisted of some very abundant and nutritious species of water-plant; that the clawed feet were used in uprooting such plants, while the delicate anterior teeth were employed only for drawing them out of the water; that the plants were drawn down the throat in large quantities without mastication, since there were no grinding or back teeth whatever in this animal. Unfortunately for this theory, it is now found that the front feet were not provided with many claws, there being only a single claw on the inner side. Nevertheless, by some such means as this, these enormous animals could have obtained sufficient food in the water to support their

Fig. 22. "Fossil Wonders of the West: The Dinosaurs of the Bone-Cabin Quarry," in *The Century Illustrated Monthly Magazine* 68, 5 (September 1904): 688-689.

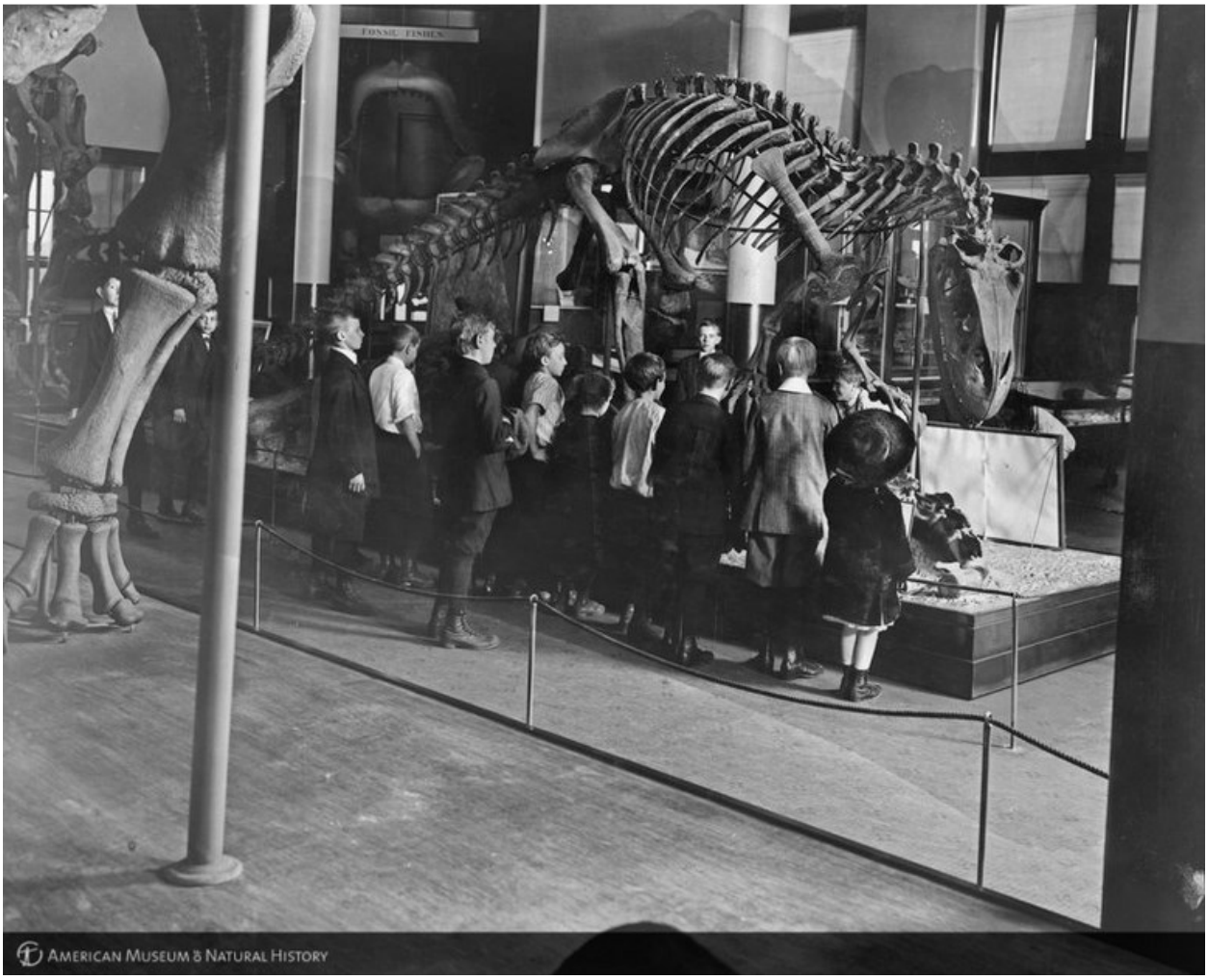

Fig. 23. Julius Kirschner, *Children Viewing Allosaurus, Hall of Fossil Reptiles*, 1911. American Museum of Natural History, ID: 33605. https://lbry-web-007.amnh.org/digital/items/show/22339

Fig. 24. Charles R. Knight, *Kodiak Bear* in John Burroughs, John Muir, and George Bird Grinnell, *Harriman Alaska Expedition (1899) Alaska vol. 1 Narrative, Glaciers*. New York: Doubleday, Page & Company, 1901, 84.