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Natural and Unnatural Histories: The Many Aspects of Dinosaur Science

Abstract

The year 2024 marked the two-hundredth anniversary of the first formal scientific description of a dinosaur fossil: Megalosaurus, described by William Buckland in 1824. On this occasion, Fondazione AGO Modena Fabbriche Culturali and the University of Modena and Reggio Emilia (Italy) jointly organised the exhibition “Natural Unnatural. Dinosaurs and other creatures”. The exhibition used the changing image of dinosaurs as a vehicle for communicating the cumulative and revisable character of scientific inquiries. This paper, which describes and extends the contents of the exhibition, traces the evolution of dinosaur science and its visual representation over two centuries, from the earliest reconstructions of the 1840s to the feathered, behaviourally complex animals of contemporary palaeontology. Using the Allosaurus fragilis skeleton held at our University as a case study, we discuss how museum collections can serve as material witnesses to the history of scientific knowledge, and how the successive remounting and reinterpretation of the same specimens encodes history in tangible form. We argue that history of dinosaur imagery is a uniquely accessible metaphor for science as a process and that natural history museums are ideal when dealing with such a topic.

Riassunto

Storie naturali e innaturali: i molteplici aspetti della scienza dei dinosauri. Il 2024 ha segnato il bicentenario della prima descrizione scientifica di un fossile di dinosauro: Megalosaurus, descritto da William Buckland nel 1824. In questa occasione, Fondazione AGO Modena Fabbriche Culturali e l'Università di Modena e Reggio Emilia hanno realizzato in partenariato la mostra “Naturale Innaturale. Dinosauri e altre creature”. La mostra ha utilizzato l'evoluzione dell'immagine dei dinosauri come strumento per comunicare il carattere costruttivo e in divenire della ricerca scientifica. Il presente articolo, che descrive e approfondisce i contenuti della mostra, ripercorre l'evoluzione della scienza dei dinosauri e della loro rappresentazione visiva nel corso di due secoli, dalle prime ricostruzioni degli anni Quaranta dell'Ottocento agli animali piumati e dal comportamento complesso della paleontologia contemporanea. Utilizzando lo scheletro di Allosaurus fragilis dell'Università come caso di studio, si discute di come le collezioni museali possano fungere da testimoni materiali

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della storia della conoscenza scientifica e come il rimontaggio e la reinterpretazione successiva degli stessi reperti ne codifichi la storia in forma tangibile. Riteniamo che la storia dell'iconografia dei dinosauri rappresenti una metafora straordinariamente accessibile della scienza come processo e che i musei di storia naturale siano nella posizione ideale per rendere tale processo visibile e comprensibile al pubblico.

Keywords: *Dinosaurs, University Museums, History of Science, Palaeoart, Museum Education and Interpretation*

Parole chiave: *Dinosauri, musei universitari, storia della scienza, paleoarte, didattica e interpretazione museale*

1. Introduction

Objects in museum collections have been studied, preserved and occasionally forgotten for centuries, only to be sometimes rediscovered and returned to public view. The history of any such object includes not only its origin, but its journey through space and time: why it was collected, where it was kept, who studied or restored it, and how it was displayed and interpreted at different moments. In particular, university museum collections reflect the intellectual history of the institutions to which they belong and the objects they hold can serve as powerful metaphors for core scientific concepts.

Among these objects, fossils (and dinosaur fossils above all) have long held an almost unparalleled capacity to engage curiosity as well as a sense of wonder among people. The history of how dinosaurs have been viewed by scientists and artists as well as the general public since their formal recognition as a group of animals in the 1840s is therefore not only a history of palaeontological discovery, but also a history of science as a human and cultural enterprise. The bicentenary of the first formal scientific description of a dinosaur fossil (*Megalosaurus*, described by William Buckland of Oxford University in 1824) provided in 2024, was a chance to reflect on how much our understanding of these animals has changed over two centuries, and how such changes are encoded in objects, illustrations and museum displays produced by following generations.

On this occasion, Fondazione AGO Modena Fabbriche Culturali and the University of Modena and Reggio Emilia (Italy) jointly organised the exhibition "*Naturale Innaturale. Dinosauri e altre creature/Natural Unnatural. Dinosaurs and other creatures*" (Palazzina dei Giardini, Modena, 25 October 2024-16 February 2025), part of the broader cultural programme "Il tempo della meraviglia" (The Time of Wonder), focused on remounting the university's *Allosaurus fragilis* skeleton replica in a pose consistent with current scientific knowledge. This paper describes the *Allosaurus fragilis* collection held at the

university, its acquisition history and scientific relevance. Moreover, it traces two centuries of evolving dinosaur science and visual representation as well as discussing the curatorial approach and outcomes of the exhibition.

2. Two Centuries of Dinosaur Science and Visual Representation

2.1 *Early discoveries and the establishment of Dinosauria (1824-1860)*

On 20th February 1824, William Buckland presented a description of a fossilised jaw from a quarry at Stonesfield, Oxfordshire, naming the animal *Megalosaurus* (“great lizard”) (Buckland, 1824) to the Geological Society of London: the first scientific name assigned to what would later be recognised as a dinosaur. In 1842, Richard Owen reviewed the available material of *Megalosaurus*, *Iguanodon*, and *Hylaeosaurus* and established the Order Dinosauria. Owen subsequently advised the sculptor Benjamin Waterhouse Hawkins on the first three-dimensional reconstructions of dinosaurs, unveiled at Crystal Palace Park, London, in 1854. These life-sized models depicted the animals as massive, quadrupedal, crocodile-like creatures, reflecting the fragmentary nature of the fossil record available at the time. The interpretation of *Iguanodon* as a gigantic iguana (with a conical element misidentified as a nasal horn and later correctly recognised as a thumb spur spike following the discovery of complete skeletons at Bernissart, Belgium, in 1878) is emblematic of this early phase.

2.2 *The “Bone Wars” and the consolidation of the classical image (1860s-1930s)*

Large-scale fossil collecting in North America during the 1870s-1890s, driven in part by the intense rivalry between Edward Drinker Cope and Othniel Charles Marsh (the so-called “Bone Wars”), dramatically expanded the known diversity of dinosaurs and provided the material basis for the first complete mounted skeletons in major natural history museums. *Allosaurus* (Marsh, 1877), *Stegosaurus*, *Triceratops* and *Tyrannosaurus* were all formally described in this period. The mounted skeletons displayed at the turn of the 20th century established a visual template that would persist for decades: bipedal dinosaurs posed in an upright, semi-erect “kangaroo” stance with the tail resting on the ground. Scientific illustrations made by Charles R. Knight and, later, Zdeněk Burian gave canonical pictorial form to this template, depicting slow, bulky, and behaviourally simple reptiles. Alfred Sherwood Romer’s *Vertebrate Paleontology* (1933) provided the first comprehensive synthesis of vertebrate skeletal anatomy and evolution, but introduced relatively few revisions to the prevailing interpretation of dinosaur biology.

2.3 The Dinosaur Renaissance and the revision of dinosaur biology (1960s-1990s)

A fundamental reappraisal of dinosaur biology began in the 1960s with the work of John Ostrom, whose 1964 description of *Deinonychus antirrhopus* (Theropoda, Dromaeosauridae) identified a suite of anatomical features suggesting an active, agile animal with a high metabolic rate and revived Huxley's earlier hypothesis of a close relationship between dinosaurs and birds (Ostrom, 1969). These ideas were further elaborated and popularised by Ostrom's student Robert Bakker in *The Dinosaur Heresies* (1986). From the late 1980s, the dynamic, horizontally-postured axial reconstructions developed by palaeoartist Gregory Paul replaced the earlier kangaroo-like poses as the new standard in both scientific illustrations and popular culture. This new iconography directly influenced Michael Crichton's novel *Jurassic Park* (1990) and its 1993 film adaptation by Steven Spielberg, which introduced a new visual language for dinosaurs to a global audience as well as being a genuine watershed in the cultural history of these animals.

2.4 Feathered dinosaurs and 21st century palaeontology

Exceptionally well-preserved deposits in the Liaoning region in northeastern China, yielding small theropod dinosaurs with unambiguous evidence of feathering from the mid-1990s onwards, definitively solved the longstanding debate on the origin of birds and confirmed their dinosaurian ancestry. The first two decades of the 21st century have seen exponential growth in palaeontological knowledge, underpinned by CT scanning technology, synchrotron imaging, histological analysis, and molecular taphonomy. These approaches have provided data on soft-tissue anatomy, integument texture, feather morphology, coloration (through the study of melanosomes preserved in fossil feathers), vocalisation and reproductive biology. Contemporary scientific reconstructions depict colourful, behaviourally complex animals far closer in appearance and ecology to modern birds than to the monsters from 19th century imagination (Fastovsky & Weishampel, 2012). The popular cultural image, however, remains largely anchored to the now-obsolete iconography of *Jurassic Park*, which reflects the cultural influence of the film's disproportionate representations of dinosaurs.

3. The *Allosaurus fragilis* Collection at the University of Modena

3.1 The Cleveland-Lloyd Dinosaur Quarry and the Morrison Formation

The University of Modena and Reggio Emilia's *Allosaurus fragilis* skeletal elements originate from the Cleveland-Lloyd Dinosaur Quarry (Utah), one of the most productive dinosaur sites in North America. The quarry is located

on an outcrop of the Morrison Formation, deposited during the Late Jurassic (Kimmeridgian-Tithonian, approximately 155-143 million years ago) in a continental environment with a seasonal tropical to subtropical climate. The formation has yielded remains of many iconic Jurassic dinosaurs, including *Stegosaurus*, *Apatosaurus*, *Ceratosaurus* and *Allosaurus*, alongside a rich paleofauna of insects, crustaceans, fish, amphibians, reptiles and primitive mammals as well as plant remains documenting flora dominated by conifers, tree ferns, cycads and horsetails near wetlands (Peterson *et al.*, 2017). The unusually high concentration of carnivorous dinosaurs at the Cleveland-Lloyd site has been attributed to natural traps (mudflats or quicksand) or alternatively to the aggregation of weakened individuals around diminishing water sources during dry seasons (Gates, 2005).

Allosaurus fragilis Marsh, 1877 belongs to the theropods, the clade of mostly bipedal, mostly predatorial and often feathered dinosaurs that includes all modern birds. Its name comes from the Greek word for “different lizard” in reference to the distinctive morphology of its vertebrae, *Allosaurus* was a large apex predator approximately 8-8.5 metres in length and over 2,000 kg in body mass (Fig. 1), with characteristic lacrimal crests anterior to the orbits. Biomechanical evidence indicates reliance on powerful forelimbs and hooked manual unguals to subdue prey, compensating for a relatively low bite force. Multiple bone pathologies across the known specimen record suggest an active and physically demanding predatory lifestyle (Alessandrini, 2015).

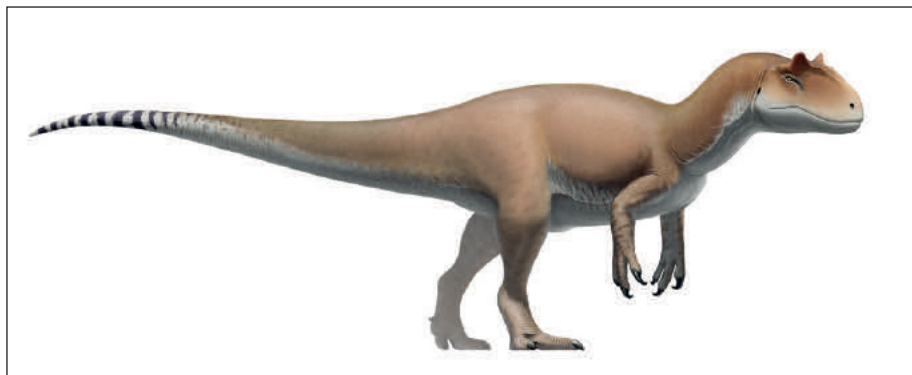


Fig. 1 – *Allosaurus fragilis* (reconstruction by Fred Wierum via Wikimedia Commons).

3.2 Acquisition and history of the collection in Modena

In 1964, the University of Modena acquired a collection of skeletal elements belonging to multiple individuals of *Allosaurus fragilis* from the

University of Utah, together with a plaster replica of a complete skeleton, as part of the “University of Utah Cooperative Dinosaur Project”. The acquisition was reported by Eugenia Montanaro Gallitelli, then Director of the Institute of Palaeontology, who noted that the purchase of objects of particular educational and scientific interest had begun in anticipation of the opening of the new Palazzo delle Scienze (Montanaro Gallitelli, 1966), which unfortunately was never built.

The original skeletal material comprises 97 elements, predominantly vertebrae in a good state of preservation, characterised by a dark colouration resulting from enrichment in heavy metals including Fe, Mo, As, U, Pb, Sr, and Zn (a taphonomic signature consistent with the geochemical environment of the Cleveland-Lloyd Quarry; cf. Peterson *et al.*, 2017). The plaster skeleton replica measures approximately 6 metres in length and 2.5 metres in height.

The *Allosaurus* skeleton replica and a co-acquired *Camptosaurus* replica were displayed in the “Sala dei Dinosauri” in Viale Berengario, Modena, from the early 1990s until 2012, mounted in an upright “kangaroo-like” posture with the tail dragging behind the body (a convention reflecting the scientific understanding of the late 19th century). In 2012, the earthquake that struck the lower Emilia plain caused structural damage to the Sant’Agostino complex housing the Sala dei Dinosauri, and all museum objects were dismantled and placed in storage. Prior to the 2024 exhibition, the collection was the focus of a Science for Education Master’s thesis (Cozzolino, 2023) which provided a systematic review of the skeletal elements and laid the groundwork for the remounting project. The skeleton replica was subsequently remounted in a dynamically active pose consistent with current scientific knowledge, with the tail raised horizontally as a counterbalance, and displayed publicly for the first time since 2012.

4. The Exhibition “Naturale Innaturale. Dinosauri e altre creature”

4.1 Context, venue and curatorial approach

“Naturale Innaturale. Dinosauri e altre creature” was a joint project between Fondazione AGO Modena Fabbriche Culturali and the Università di Modena e Reggio Emilia, as a part of “Il tempo della Meraviglia”, Fondazione AGO’s cultural programme for Modena. The exhibition comprised two sections: a scientific section on the history of dinosaur science and visual representation by Veronica Padovani (University of Modena and Reggio Emilia) with scientific advice by Richard Kissel, Cesare Andrea Papazzoni and Giovanni Serafini, as well as an artistic section dedicated to the work of Dario Ghibaudo, by Gianlorenzo Chiaraluce (art historian, researcher and independent curator). The present paper focuses only on the scientific section. The exhibition was

held at Palazzina dei Giardini, an 18th century pavilion located within Modena's Public Gardens adjacent to the Dukes' Palace, characterised by richly frescoed interiors. The juxtaposition of this ornate setting with the stark, black-painted *Allosaurus fragilis* skeleton mounted on a low plinth at the centre of the main hall (Fig. 2) created immediate visual tension between deep geological time and human cultural history.



Fig. 2 – The remounted *Allosaurus fragilis* skeleton replica on display in the central hall of the Palazzina dei Giardini, Modena (photo by V. Padovani).

The scientific section was structured around a “big idea” (Serrell, 1996): a single, clearly formulated interpretive statement providing unambiguous focus for the exhibition's content, object selection and visitor experience. The idea was basically: “Scientific advancements in the study of dinosaurs which have informed their depiction in the past can help us reconstruct what *Allosaurus fragilis* looked like.” This anchored the narrative to a specific object while connecting it to the broader historical and epistemological argument about the evolution of scientific knowledge and its visual expression.

All exhibition texts were both in Italian and English, with translations by Veronica Padovani and Karen Elaine Whittle. The visual identity and graphic

design of the exhibition were developed by the Modena-based graphic design studio “Intersezione”. The exhibition ran from 25 October 2024 to 16 February 2025 and attracted approximately 8,000 visitors.

4.2 *Exhibition structure and content*

The exhibition was organised across three interconnected rooms.

The first room was dedicated entirely to the remounted *Allosaurus fragilis* skeleton replica, displayed in a dynamically active pose consistent with current scientific understanding of theropod biology (hands facing each other, forelimbs extended, tail horizontal, body inclined forward), restored and remounted by “Di.Ma. Dino Makers”.

The second room presented a visual and material timeline of two centuries of dinosaur science, running along the north wall from 1824 to 2024, marking key events from Buckland’s description of *Megalosaurus* to the Liaoning feathered dinosaur discoveries and the exponential growth of 21st century palaeontology. Three display cases positioned in front of the timeline (Fig. 3) held taxidermy specimens of modern animals historically used as anatomical templates for dinosaur reconstructions (a monitor lizard, a crocodilian, and a bird of prey from the University’s zoological collections) alongside original historical books and scientific publications. The juxtaposition made the interpretive process tangible, thanks to which scientists have reasoned from known to unknown anatomy across two centuries.

The third room offered a more detailed treatment of dinosaur biology and *Allosaurus* in particular. A life-sized skeletal outline of *Allosaurus fragilis* printed directly onto the wall was accompanied by circular insets illustrating soft tissue reconstructions, integument details, and internal anatomy at the corresponding positions on the skeletal outline (Fig. 3); original skeletal elements from the University collection were displayed in adjacent cases. Thematic panels addressed dinosaur systematics and the three major groups (Ornithischians, Sauropods, Theropods); the bird-dinosaur relationship and the concept of non-avian dinosaurs; osteological evidence for posture, locomotion, and physiology, including pneumatic vertebrae as evidence for an ancient origin of the avian respiratory system and bone microstructure data indicating fast metabolism and rapid growth; integument (scales, downs, and feathers, and their functional implications for thermoregulation and display); and reproduction, with reference to *Scipionyx samniticus* (“Ciro”) from Pietraroja (Campania, Italy) as one of the world’s best-preserved dinosaur fossils. A final panel presented the history of the Cleveland-Lloyd Quarry and the university’s acquisition of the collection, directly quoting Eugenia Montanaro Gallitelli’s 1966 report to the Società dei Naturalisti e Matematici di Modena (Montanaro Gallitelli, 1966).



Fig. 3 – Room 3 of the exhibition: the life-sized skeletal outline of *Allosaurus fragilis* printed on the wall, with circular insets illustrating anatomical reconstructions. Original pastel paleoartwork by Giovanni Serafini. Original skeletal elements and taxidermy specimens from the University collection are displayed in the cases (photo by V. Padovani).

4.3 Science, art and educational activities

A defining feature of “Naturale Innaturale” was the deliberate permeability of the boundary between scientific and artistic representation styles. The large *Allosaurus* wall graphic and associated palaeoartistic reconstructions (produced by Giovanni Serafini using a combination of anatomical data and informed speculative interpretation) embodied the argument that imagination has always been a key element of palaeontological reconstruction, without abandoning scientific accuracy. Richard Kissel (The DoSeum - San Antonio Museum for Kids) created the exhibition mascot, a wide-eyed, cartoon-like depiction of *Allosaurus fragilis* which served as a visual bridge between the exhibition’s scientific content and its younger audiences (Fig. 4). The mascot was made available in a range of merchandise available at the exhibition shop, including a paper toy and temporary tattoos, functioning as an accessible and deliberately light-hearted introduction to the exhibition themes for visitors of all ages and as a reminder that palaeoart spans across a wide range of visual registers.

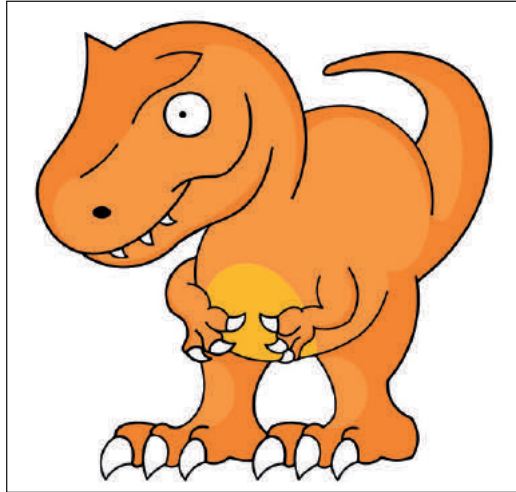


Fig. 4 – The exhibition mascot (drawing by Richard Kissel).

The complementary section of the exhibition was dedicated to the work of artist Dario Ghibaudo, whose ongoing project *Museo di Storia Innaturale* ironically engages with the classificatory conventions of natural history. Ghibaudo and Serafini worked together on the exhibition logo, featuring a hybrid creature embodying the dual nature of the project. The image combines a scientific skeletal rendering of *Allosaurus fragilis* with a fictional creature drawn from Ghibaudo's *Museo di Storia Innaturale*, embodying the dialogue between science and imagination that defined the exhibition's concept of interpretation (Fig. 5).

The educational programme, managed by the Fondazione AGO education department, included guided curatorial tours, school day trips, family activities, and a teachers' focus programme. A central component of the school workshops was a dinosaur drawing activity in which groups of children, seated on the floor of the central hall around the base of the *Allosaurus* skeleton, were invited to produce their own scientific reconstructions with the help of a facilitator (Fig. 6). This activity enacted on a miniature scale the same epistemological process the exhibition addressed on a historical scale: the translation of skeletal evidence into a living animal through a combination of scientific knowledge and informed imagination. Additional programme partners included the Museo della Figurina (co-curating a satellite exhibition on dinosaur-themed trading cards) and the Future Film Festival (organising a dinosaur-themed film cycle).

Altogether, the panels, objects and activities constituted a coherent interpretation of the university's *Allosaurus fragilis* collection: a single

assemblage of bones and a replica skeleton which became the narrative fulcrum of a broader story about two centuries of palaeontological knowledge, visual representation and the nature of science itself.

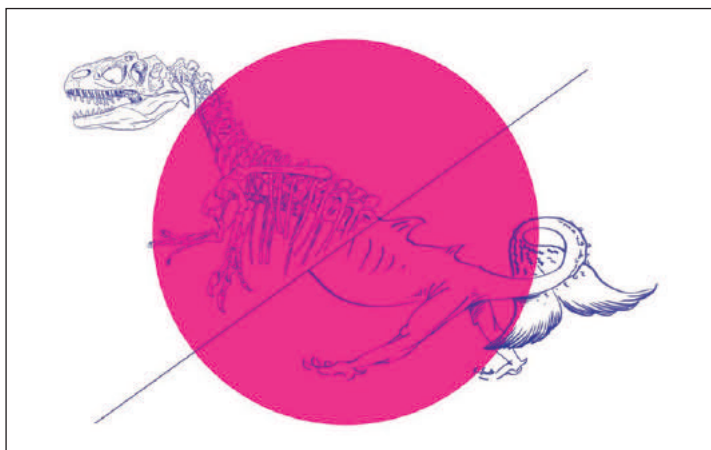


Fig. 5 – The exhibition logo, created by Giovanni Serafini and Dario Ghibaudo (graphic design by “Intersezione”).



Fig. 6 – A visitor participating in the dinosaur drawing workshop for children (photo by V. Padovani).

5. Discussion

The history of how dinosaurs have been depicted over the past two centuries is, in a way, a compressed history of science itself. Each following reconstruction (from Owen and Hawkins's Crystal Palace monsters to the scaly predators of *Jurassic Park*, to the feathered, colourful animals of contemporary palaeontology) reflected the available evidence, the interpretive frameworks, the technological capacities and the cultural assumptions of its moment. The image of a dinosaur is simultaneously a scientific hypothesis and a cultural artefact.

This dual character makes dinosaur imagery very productive for communicating the nature of science to a wider audience. The contrast between a quadrupedal, tail-dragging *Megalosaurus* and a dynamically active, feathered theropod communicates, more directly than any description, the cumulative and revisable character of scientific knowledge. Natural history museums are particularly geared to make this argument, holding not only the material evidence on which scientific reconstructions are based, but also the history of how that evidence has been understood and reinterpreted over time. The *Allosaurus fragilis* collection in Modena illustrates this concretely: the same bones mounted in an outdated pose can be remounted to reflect current knowledge, and the history of their successive depictions can itself become an object of exhibition.

The "big idea" framework proved effective in maintaining narrative focus across a broad thematic range. The integration of scientific and artistic approaches reinforced the central argument: that speculation, imagination, and aesthetic judgment have always been part of scientific knowledge about prehistoric life.

6. Conclusions

The exhibition returned the University's *Allosaurus fragilis* collection to public view (albeit temporarily) after more than a decade of inaccessibility and did so in a manner consistent with the current state of palaeontological knowledge. The remounting of the skeleton replica was both a practical outcome and a symbolic statement: museum displays are not static documents, but active interpretations subject to revision as knowledge advances.

The evolving image of dinosaurs is a uniquely accessible window onto science as a process. The incompleteness of the fossil record means there will always be an irreducible element of imagination in palaeontological reconstruction. Far from being a weakness, this is one of the features that makes palaeontology both a productive medium for communicating the nature of science to various audiences and a constantly evolving fascinating discipline.

The experience of “Naturale Innaturale” suggests that even average size collections can serve as a starting point for ambitious curatorial projects, provided they are approached with academic precision, institutional commitment and the willingness to engage with partners across disciplinary boundaries.

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