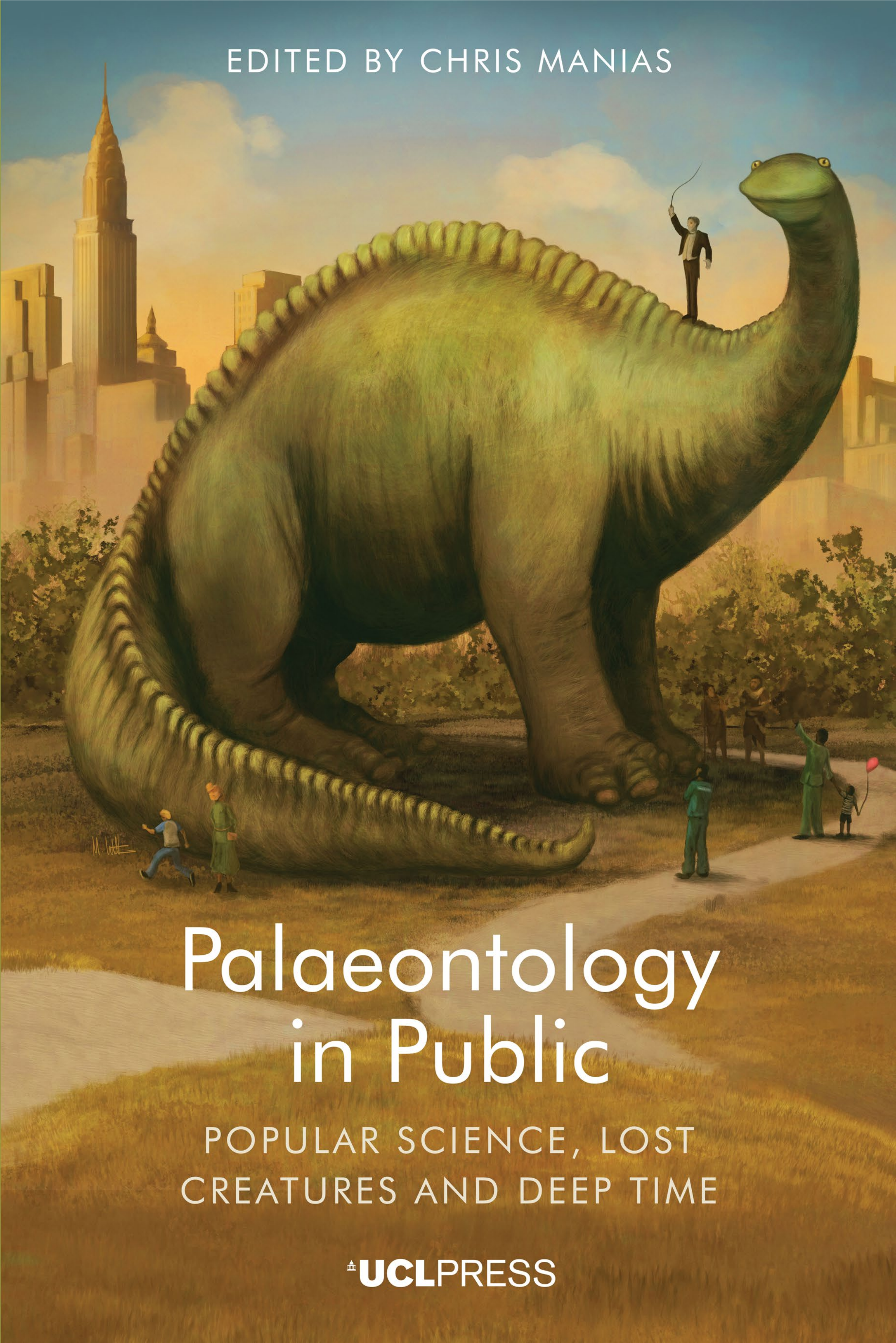

EDITED BY CHRIS MANIAS

Palaeontology in Public

POPULAR SCIENCE, LOST CREATURES AND DEEP TIME

UCLPRESS

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Popular science, lost creatures and deep time

Edited by Chris Manias

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Acknowledgements

The origins and prehistory for this book date to when I was first moving from my initial formation as a historian of human sciences, race and nationalism, and becoming interested in the history of palaeontology. On looking around the field, there was a clear groundswell of interest in literature studies and the history of science on the deep time sciences as a crucial test-case for understanding the dynamics of 'popular science', especially as related to the nineteenth century, but also connected with current debates and methods in science communication. This interest has only grown since then, and has become connected to important questions around the connections between deep time, the environment, colonial history and non-Western perspectives. At the same time, when I started to look at the current state of the field in palaeontology, it quickly became apparent that there was a huge amount of extremely interesting, reflexive and historically-informed engagement with the public role and history of the field, not just around the mechanisms and opportunities of popularisation, but thinking about how it has shaped the field, wider society and palaeontological careers. Both of these trends were highly complementary, but were not speaking to one another. So this set off a series of efforts to bring them into dialogue. This book is the largest result so far of these conversations.

These discussions have been based around the (up to now) eight years of work and discussion within the Popularizing Palaeontology: Current and Historical Perspectives group. Starting off in an experimental workshop at King's College London over a (very hot) couple of days in 2016, this continued as an International Research Network funded by the Arts and Humanities Research Council (AH/R007411/1) between April 2018 and Sept 2019, and – following the COVID-19 pandemic – a fairly continuous online discussion group, interspersed with in-person workshops, informal meetings and link-ups at events like BSHS and TetZooCon. Over the years, the group has changed in membership, but always followed a core agenda of thinking about the complexities and challenges, as well as the possibilities, of palaeontology's public role. And I could not have wished for a more collegial and stimulating group of friends and collaborators. Those of you who are interested can trace these developments, and see some recorded talks, on www.poppalaeo.com.

The collaborative nature of this work means that there are a large number of people to thank, possibly even more than in a standard edited volume. Special thanks go to the other people who have helped me organise the network at various times. First among these is Joe Cain, who was co-investigator on the AHRC-funded leg of the project, and was also the person who initially suggested using the first workshop to build into a larger and more extensive network. Ilja Nieuwland and Paul Brinkman helped us branch out into the Netherlands and the USA, and also (on a more long-term basis) showed me that the history of palaeontology was a field worth sticking with, since we first met at the *Dinosaurs – their kith and kin: A historical perspective* conference at the Société géologique de France in 2011. Darren Naish and John Conway are also to be greatly thanked for establishing the famous Tetrapod Zoology Convention, which has worked alongside the Popularizing Palaeontology group, and linked up more extensively since 2022. Work with Friends of Crystal Palace Dinosaurs – who are stalwarts at the Popularizing Palaeontology public events and worked with me on the spin-off 'Beyond the Dinosaurs' project – also informed the discussions and the book a great deal (as well as doing the crucial practical work of supporting some of the key and originatory examples of palaeontology in public). So many thanks are due to Ellinor Michel, Adrian Lister and Sarah Jayne. Also all the other chapter authors – Victoria Coules, Richard Fallon, Oliver Hochadel, Dave Hone, Lydia Pyne, Lukas Rieppel, Elsa Panciroli, Irina Podgorny, Zichuan Qin, Will Tattersdill, Mark Witton, and Rebecca Wragg Sykes are to be thanked not just for their contributions, but for playing central roles in keeping things going in different ways at various times.

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Introduction

Chris Manias

Palaeontology is one of the most high profile sciences. New finds in palaeontology, and especially those to do with dinosaurs and human evolution, are reported on almost weekly in the media. Indeed, only global health and astrophysics are comparable as scientific subjects of press attention. Toys, films, computer games and visitor attractions drawing on prehistoric life are widespread in entertainment. And a canon of prehistoric animals, including dinosaurs like *Tyrannosaurus*, *Brontosaurus* and *Triceratops*, other human species like Neanderthals and *Homo floresiensis* ('the hobbit'), extinct fossil mammals like the woolly mammoth and sabre-tooth cat, and a range of invertebrates like the trilobites and ammonites, are all part of general knowledge and popular culture. The lost worlds of the deep past are some of the most conceptually familiar topics drawn from modern science.

But if we reflect on this public prominence of palaeontology, it is slightly puzzling. In academic settings, palaeontology has often been regarded as a relatively marginal field. Palaeontological research receives very little funding – the budget of a film like *Jurassic World II* ($516.1 million) dwarfs any palaeontological research institute. The American Museum of Natural History, one of the largest natural history institutions in the world, had an operating budget in 2021 of $178 million for all its activities, of which palaeontology is only a part. In academic status, there has also been a long-standing discussion of palaeontology's place 'at the high table' of science, and how far it was a contributor to important scientific knowledge, or more a source of curiosities (Sepkoski and Tamborini, 2017). And the methods of palaeontology – often highly technical, based on the interchange between different scientific disciplines, and beset by complex issues around the reconstruction of the past from fragmentary fossil material, or large datasets of information drawn from the fossil record – do not necessarily lend themselves to easy presentation. Indeed, the idea that palaeontologists are simply 'making stuff up' when reconstructing fossil organisms and landscapes is a fairly common criticism. Palaeontology has in fact been just as important for stoking ideas of doubt or criticism at scientific work than in promoting more optimistic views.

A range of explanations have been given for the outsized influence and position of palaeontology within the public arena. Some emphasise the connections of palaeontology with deep cultural motifs, ranging from the spectacular scale of some aspects of the life of the past (if we consider dinosaurs), the immensity of the deep time chronologies which undergird the field, and the way that particular palaeontological creatures mirror long-standing myths of dragons and giants – a point strongly made by Boria Sax in *Dinomania* (Sax, 2018). The mysteriousness of the field, constructing entire environments and animals from fragmentary material, ordered across time and space, can in many senses make palaeontological work seem like an intriguing source of puzzles or mysteries, frequently likened to detective stories. Palaeontology simultaneously provides a sense of origins for modern nature and familiar animals, but also a series of lost worlds and creatures which are often presented as utterly alien. Palaeontology's public and cultural role therefore oscillates uneasily between familiarity and strangeness. However, there are also of course material dimensions. Palaeontologists have persistently drawn off the public profile of their field for support and funds, connecting palaeontology with spectacular forms of showmanship, and using public appeal to gain sponsorship and interest from philanthropists and media institutions. Therefore, the public position has been integral to the practices of palaeontology across its history.

This public role of palaeontology has emphasised some things, but hidden others. The overwhelming focus on dinosaurs in current narratives occludes a much more complex history of life, and also ignores that the overwhelming majority of fossils consist of invertebrates, plants and microorganisms. Public discussions of palaeontology also tend to focus on particular geographic regions. The fact that the most iconic dinosaurs (with a few notable exceptions, like *Velociraptor* and *Spinosaurus*) were excavated in North America in the late-nineteenth and early-twentieth centuries demonstrates the geographic power imbalances of the field, and how it has been connected with particular national contexts. The marketing of palaeontology to children, especially from the 1890s, has also meant that the field and its objects of study have been regarded as childish and not serious, compounding the disputes about its position at the 'high table.' And how 'useful' palaeontology is – whether it constitutes an important science essential for understanding time, nature, and environmental change, or whether it is more of a 'luxury' field, primarily associated with entertainment – is another compounding and tense area. When thinking about the public role of palaeontology, many issues are entangled, and some points which could be regarded as a boon for the importance of the field also start to seem rather problematic once we think about them further – and many things which might on first glance seem like problems actually become benefits in public discussions.

This volume is intended to think through explanations and tensions within the public role of the palaeontological sciences, from their consolidation in the years around 1800 to the present day. Palaeontology is a subject which has simultaneously been conditioned by public engagement with science, but has also had an outsized impact on the ways in which science has been conceptualised. The history of the public entanglements of the field therefore provide a significant example of general processes within the public discussion of science, and a very specific instance of a field where dynamics around science, money and the media, and wider concepts of time, nature and biodiversity, have played out. The need for a wider of understanding of why palaeontology has been such a persistently publicly-embedded science, where the public role has defined the science in many important respects, led the contributors of this book to build a research network since 2016, under the name of 'Popularizing Palaeontology: Current and Historical Perspectives.' This has linked together a range of specialists from different fields – working palaeontologists and earth scientists, humanities scholars, artists, museum professionals, and science communicators – to think about these questions from a range of different angles, and combine insights from their different fields of expertise. This volume represents the results of the discussions of this network so far, as well as thoughts for the future on where these studies, and forms of cross-disciplinary collaboration, could go next.

The core contentions of the network – and this book – are three-fold. The first is that in order to understand the role of palaeontology in the public arena, we need expertise and insights from a range of different fields, working together on these shared problems. But secondly and notably, a strongly historical perspective is needed. It is not only the case that palaeontology has been deeply entangled with public contexts since the inception of the field, but also that stereotypes and institutions from the history of the discipline still exert a strong influence over the present, either as tropes or legacies which are still recycled and engaged with, or cited as myths and lessons to be reacted against and moved away from. As a result, present concerns and the history of the field are inseparable. And finally, there needs to be a shared commitment to engaging with the complexity of these processes – remembering that palaeontology has had at many points a highly problematic history, and that the public role of palaeontology, while certainly beneficial for some aspects of the field, has come with a very definite price, and led to problems and trade-offs.

The history of palaeontology in public

The history of palaeontology in the public arena is a long and deep one. This section will provide something of a narrative account of the different ways in which palaeontology has been entangled with wider popular culture since its inception. The story outlined here may be familiar to some, but it is important to present, to provide a clear spine to position the case-studies in the book, to show how the history of palaeontology has been traditionally narrated (itself a key part of the public discussion of palaeontological ideas), and to think about the tensions, omissions and problems within these narratives. An important issue is that historical accounts of palaeontological science have been an important way of building a tradition for the field, and narrating and debating its principles and assumed significance.

It is increasingly conventional to begin discussions of the history of palaeontology with accounts of lore and traditions attached to fossils in many different cultural contexts throughout the world. This includes the use of 'dragon bones' and 'dragon teeth' (now understood as the fossils of Pliocene and Pleistocene mammals) in Chinese traditional medicine (Kjærgaard, 2012a), to traditions around geological landforms and fossils among Indigenous people in the Americas and Australia (Mayor, 2015; Nunn, 2018), and references to large bones of Pleistocene animals in European and North American Christian contexts as the remains of the Nephilim mentioned in the Book of Genesis (Morris, 2013). Highlighting these usages has served a range of purposes. In some circumstances, it is used to argue that understandings of the earth have always been culturally mediated, interpreted through a variety of belief systems, and that interest in what would be termed 'fossils' by modern palaeontologists is widespread around the world. However, there are also counter-points, that extracting and isolating traditions about what modern scientists would call 'fossils' and 'geology' from much wider cosmologies and belief systems can be both reductionist and instrumentalising. And historically ideas of 'geomythology' have deep roots, and have at times been a means of 'naturalising' non-Western peoples as more akin to the earth and the past than to the modern world (Chakrabarti, 2020).

The role of palaeontology in these ostensibly 'mythic' discourses and debates has been an important feature in some recent historiography. Historians of the science of the early-modern European and Atlantic worlds have drawn much attention in recent years to the way in which concepts of 'deep time' have longer antecedents. Lydia Barnett's work on the resonance of ideas of the Biblical Deluge, and how it was used to understand and debate time, nature, humanity and the lines separating different epochs of creation, is a particularly important study (Barnett, 2019). The often-mocked example of Johann Jakob Scheuchzer's description of the petrified *Homo diluvii testis* – 'the man who saw the deluge' – which was later classed by Georges Cuvier as a fossil of a giant salamander, has itself passed into palaeontological mythology as an example of 'pre-scientific' ideas about fossils. But nevertheless, the example of Scheuchzer still shows strong engagement with notions of time and change across long durations of history.

The 'birth' of palaeontology as a scientific field is traditionally dated to the years around 1800, in a process traced in great detail by Martin Rudwick, and many other scholars following his lead (Rudwick, 2008, 2005, 1992, 1976). Patriarchal metropolitan figures, especially in Britain and France, like Georges Cuvier, William Buckland and Richard Owen, have been shown as driving forward new ideas of lost worlds of deep time and ancient inhabitants, while relying on denser networks of commentators, collectors and fieldworkers – with the most celebrated of these being the Dorset-based fossil collector Mary Anning. Palaeontological specimens, like the initial location of ichthyosaurs and plesiosaurs, great fossil mammals like the mammoth and *Megatherium*, and the defining of the Dinosauria in 1842, all saw a combination of learned scholarly treatises, and a whole range of texts and images, including narrative epics of earth's history, the first flowering of palaeoartistic reconstructions of animals and environments, works of self-conscious popular science, and fictional accounts of time travel and movement across space (Dawson, 2016; Desmond, 1979). Indeed, Ralph O'Connor has shown the deep connections between scientific and literary texts in this period, with links between them being crucial for constructing new understandings of deep time (O'Connor, 2007). The deep past was integrated relatively quickly into nineteenth-century conceptualisations, despite its potentially unsettling implications, and provided a narrative history of the earth, and vignettes of landscapes and eras. This was partly because palaeontological finds and narratives were quite quickly framed by contemporary concerns, conditioning the development of the field – whether this was through tremendous interest in Carboniferous landscapes as the period from which the coal driving new steam power technologies derived (Yuval-Naeh, 2019), or through thinking about the deep past as a series of historical eras of progress, leading towards the present and humanity.

A particularly noteworthy example within this mid-Victorian promotion of palaeontology is presented by the Geological Courts at the Crystal Palace in South East London, built between 1852 and 1855, which were simultaneously a major effort at the public promotion of science and a dramatic media event (Witton and Michel, 2022). Through a series of models and landscaping projects, carefully constructed by whole teams of workers under Benjamin Waterhouse Hawkins and David Thomas Ansted, these included a series of 'geological illustrations' showing the rock formations of the British isles and different geological eras, the succession of life across the 'Secondary era' as a march of progress from the Labyrinthodonts and Dicynodons to the *Megalosaurus*, *Iguanodon* and flying reptiles, and then on to vignettes from the 'age of mammals'

Figure 1.1 'Der Kristallpalast von Sydenham: Die geologische Insel', Illustrirte Zeitung 580, 12 August 1854. A stylised reconstruction of the Crystal Palace Geological Courts in a German periodical. Image in public domain, obtained from the Staatsbibliothek zu Berlin.

through some of the most iconic fossil beasts like the *Palaeotherium* and *Megatherium* (see Figure 1.1) The 'Crystal Palace Dinosaurs' show both the tremendous profile of deep time in this period, but also some of tensions around it – most notably because the more dramatic dinosaur models became out-of-step with scientific reconstructions within a couple of decades. The story of the Crystal Palace has veered between a range of different interpretations, ranging from them being 'wrong' and faintly ridiculous (and therefore warnings against over-speculation and pandering to public interest), or – as more recent revaluations of the site have presented – deeply thought-out attempts to visualise unknown animals and processes through available data.

One of the strongest implicit narratives in the history of palaeontology is a move from Europe as the centre of the field in the earlier part of the nineteenth century, to the dominance of the United States from the second half of the century. Indeed, vertebrate palaeontology has been presented as one of the first sciences in which Americans became leading scientific authorities (Thomson, 2008). This can be seen in Waterhouse Hawkins' own temporary move to the United States in the 1860s and 1870s to work on a range of projects linking the scholarly and the public, including the ill-fated Paleozoic Museum in New York's Central Park, the mounting of *Hadrosaurus foulkii* in the Academy of Natural Sciences in Philadelphia, and the working of a series of images of ancient life for Princeton University (Coules and Benton, 2023; Peck, 2008).

The late-nineteenth century is a somewhat legendary time in the history of palaeontology. The famous and much storied rivalry between Othniel Charles Marsh and Edward Drinker Cope, both of whom sent teams to the newly annexed lands of the North American interior to excavate, name and promote as many fossil animals as possible, was linked with a range of cultural tropes – the increased power of American science, prospecting and commercial rivalry, the myth of the frontier, the dispossession of Indigenous people, and concepts of geological transformation and possibility (Jaffe, 2001; Bradley, 2014). As well as this there was deep engagement with the media: the conflict most dramatically exploded into the press with the *New York Herald* article 'Scientists Wage Bitter Warfare' on 12 January 1890, which precipitated intense acrimony between the two scholars, and wider debates on the public role of science and proper use of government funds (Wallace, 2000: pp. 209–54). The legacies of the Cope–Marsh feud have been a consistent feature of the public promotion of the discipline, having been narrated and re-narrated in popular histories (Jaffe, 2001; Wallace, 2000), novelisations (Crichton, 2017), comics (Ottaviani, 2005), and even an

Austrian children's musical. Although, interestingly, there still has not yet been a monograph in the history of science engaging specifically with the dispute in all its dynamics, with it at most featuring as short case-studies or references in wider works (Rieppel, 2019; Vetter, 2016).

While much attention focuses on the Cope–Marsh feud, probably more important for cementing wider images of palaeontology in both field research and the canon of lost animals and environments, was what has been termed the 'Second Dinosaur Rush' in the years around 1900, driven by large-scale philanthropically-funded museums especially on the East Coast of the United States (Brinkman, 2010; Rieppel, 2019). In this respect, palaeontology became conditioned by new forms of capitalism developing in the US at this time (a point strongly and consistently made by Lukas Rieppel) and the rise of new types of museum, which bound public education, civic pride and natural historical research. These simultaneously competed to excavate and mount complete fossils of Sauropod dinosaurs, but also promoted them through a whole range of media, including new styles of palaeoart, magazine and newspaper articles, postcards, and exchanges with foreign collections. Indeed, these years (and through these processes) are when it has been convincingly argued that the term 'dinosaur' moved into everyday language, at least in Anglo-American contexts (Fallon, 2021). The gifting of casts of *Diplodocus carnegii* by the steel magnate Andrew Carnegie to the leading heads of state of Europe (and their associated natural history museums) was one of the most dramatic instances of this (Nieuwland, 2019), but was indicative of a much wider set of trends, seeing palaeontology being enmeshed within the drive for internationalist organisations and peace movements in the years before 1914. And the expansion of palaeontology was not just limited to the United States. European museums still held their own through traditional influence, and palaeontology in Australia, South Africa and Argentina developed in a large-scale manner, taking advantage of local fossils and promoting distinctive images of the meaning of the field (Douglas, 2004; Podgorny, 2021, 2016).

This global dimension should indicate that a key issue in these years was the self-conscious tying of palaeontology and imperialism (Figure 1.2). This had of course been present almost from the inception of the field: the *Megatherium* in Madrid, often cited as the first mounted fossil animal, was excavated in the final decades of the Spanish empire in South America, and sent to the imperial capital (Pimentel, 2017; Podgorny, 2019). Fossils from Africa, Asia, and Australasia were exploited through a diverse set of forms of European and American colonialism in the nineteenth and twentieth centuries. These were simultaneously used to ‘naturalise’ particular landscapes and their inhabitants as representing primordial antiquity, while also exploiting and seizing fossils in the same manners that territories, people and resources were through colonial systems (Chakrabarti, 2020). The huge exploitation of dinosaur fossils at Tendaguru in German East Africa (modern Tanzania) was perhaps the largest example of this, and served as the focus for a range of popular literature after the event, and the excavations themselves relied on large subscription campaigns for funding (Heumann et al., 2018; Maier, 2003). And into the interwar period, the Central Asiatic Expeditions of the American Museum of Natural History into northern China and Mongolia took advantage of US informal economic and diplomatic power in the region, and similarly mobilised narratives of spectacle, adventure and technological and cultural superiority to promote a range of finds – giant mammals like ‘*Baluchitherium*’ dinosaur eggs, and the fossils of *Velociraptor* – in a way which generated publicity, but also sponsorship for continuing the expeditions (Kjærgaard, 2012b; Manias, 2014).

Palaeontology’s connections with urban spectacle and empire ensured that there was wide public engagement with the field in the late nineteenth and early twentieth century. This ranged from fictional serialisations and novels with prehistoric themes, with Arthur Conan Doyle’s *The Lost World* (1912) consolidating many of the formulae around prehistoric storytelling, and J.-H. Rosny pioneering literary representations of stone age Europeans through works such as *Vamireh* (1892) and *La Guerre du feu* (1911). Prehistoric animals also featured in marketing, ranging from collectable cards to (in a deep entanglement with the fossil fuel economy) publicity for the oil industry, especially through the Sinclair company (Nieuwland, 2019; Laurence, 2023). New techniques in film and animation were frequently deployed to reconstruct prehistoric animals, including stop-motion dinosaurs used in the 1925 film adaptation of *The Lost World*, and followed by *King Kong* in 1933. These worked palaeontology into a range of tropes, representing the life of the past as simultaneously strange and alien, but also reflecting much deeper anxieties over time, nature, modern society and the animal. And this interest in technological modernity fed back into palaeontology itself, with skyscrapers and mechanical engines not just serving as analogues for the scale of many past creatures, but as anatomical models, with dinosaurs and other prehistoric beasts frequently being analysed in terms of modern engineering processes.

One important feature about the position of palaeontology in the public arena is that it is not a linear story of continuous increase, nor is it one of fossils and deep time being ‘discovered’ and then

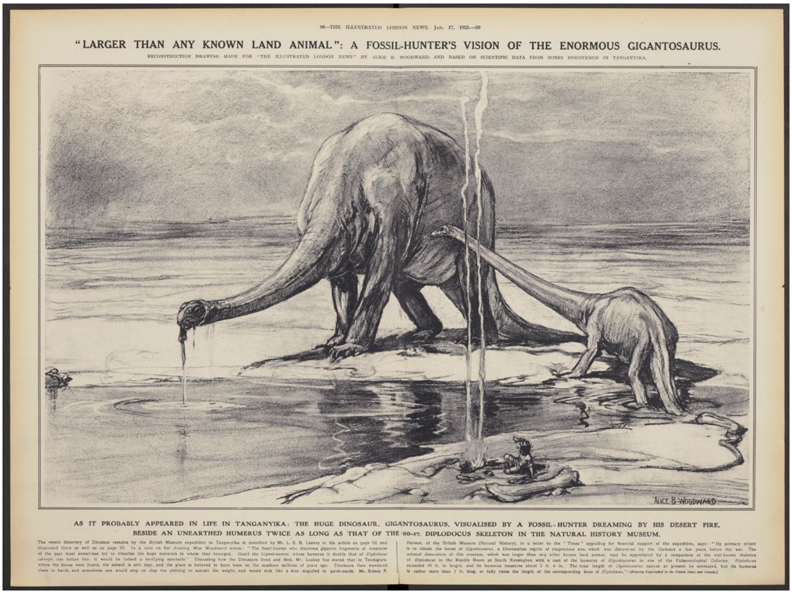

Figure 1.2 *Illustrated London News*, 17 January 1925. News report on the British excavations in east Africa, featuring an illustration by Alice B. Woodward, depicting a fossil-hunter dreaming of a pair of *Gigantosaurus*. Image in public domain, obtained from the Staatsbibliothek zu Berlin.

being persistently and consistently widely engaged with. There were numerous waves and lulls in the position of the field. The 1930s to the 1960s have often been taken as such a period of decline of interest (Buffetaut, 1987). There were certainly many high-profile palaeontological productions in this period – most notably the Rite of Spring sequence in Disney's *Fantasia* (1940) and the huge murals by Rudolph Zallinger at the Peabody Museum, depicting the 'Ages' of Reptiles and Mammals (Naish, 2021; Volpe et al., 2007; Wallace, 2004). But more generally, the funding, prestige and scope of palaeontological work seems to have declined. Why this was (or whether this is an accurate characterisation) is still unclear, but it does seem to be the case that in these years considerations of the deep time of geological and palaeontological eras were often secondary to other fields of scientific debate, most notably visions of deep space, and debates on human nature in the context of Cold War anxieties over nuclear annihilation. Recent work has however shown that there were links here, particularly the connections between the revival of theories of mass extinction with

Cold War fears of nuclear annihilation (Sepkoski, 2020) or the ways human evolution was understood in terms of innate human violence and warlike tendencies (Milam, 2019; Weidman, 2011).

There were also important upsurges in these years. The 'dinosaur renaissance' of the 1960s and 1970s was itself a managed and media-entangled process. John Ostrom's papers arguing for the active lifestyles of *Deinonychus* and other dinosaurs were of course hugely significant (Ostrom, 1969), but the public profile of Robert Bakker and others was also crucial, with works like *The Dinosaur Heresies* (Bakker, 1986) and *The Hot-Blooded Dinosaurs* (Desmond, 1975) promoting these ideas, and the personalities of the theorists, to wider publics. Parallel developments occurred in human evolution, as the Out of Africa model of human evolution began to be cemented, promoting particular views of humanity's African origins and early human development through interaction with the continent's nature and environment. These ideas were driven into the public arena through Robert Ardrey's *African Genesis* (1961) and (in another link with cultures around space and science fiction) the famous sequence of the apes and the monolith in *2001: A Space Odyssey*.

2001 was one hugely influential media instance, but for the public position of palaeontology, *Jurassic Park*, both the Michael Crichton novel of 1990 and the Steven Spielberg film of 1993, set the tone more than anything else for the public discussion of palaeontology, and an increased profile from then onwards. Crichton's warning on scientific hubris was reworked into a tale of wonder and the sublime in Spielberg's film, in ways which connect in important but uneasy manners with concerns over scientific development, and the position of science in the public arena. Tying the active dinosaurs of the Dinosaur Renaissance with significant media debates over the role of genetic technology (Jones, 2022), this very much linked the promotion of a particular view of prehistoric life with wider concerns over the nature and social role of science. And the film was a huge media event, breaking a series of records for ticket sales in its opening days, and making just over a billion dollars in worldwide ticket sales since its release.

The years since the 1990s have seen a continuous, although shifting, position of palaeontology in the public arena. Only a few large features can be picked up here, but one of the most significant is the globalisation of particular forms of palaeontological outreach. Despite persistent issues in funding, there has been a great expansion of palaeontological institutions and media in a range of places, with South Africa, South America and East Asia being particularly prominent. There are still of course centres in the field, which map on to traditional scientific powers in Europe and North America, but the public role of palaeontology has also expanded significantly. However, this globalisation has also seen something of a flattening of palaeontological interest. From a much more varied form of prehistory often focused on local fossils (such as the wide interest in Permian therapsids and Pareiasaurs in South Africa and Russia, or in Cenozoic mammals in South America), the focus has, since the early 1990s, been on dinosaurs – even in regions without much of a tradition of dinosaur palaeontology. This relative homogenisation in public palaeontology has been a striking feature. But it has also had an important counterbalance, in that it has brought new regions to the fore in terms of palaeontological research, such as Patagonia as a 'land of giants' due to the fossils of titanosaurs (and the increasing use of reconstructed titanosaurs in larger museums), and the role of China as both an expanding palaeontological powerhouse and as a source of dramatic fossils leading to further shifts in understandings of the relations between dinosaurs and birds.

This globalisation of palaeontological work has, in recent years, led to a much starker and more extensive engagement with the problematic history of the field, tied as it was to colonial and imperial institutions, and practices. These have simultaneously impacted palaeontology in cultural and ideological manners, with many tropes and motifs drawing off late-nineteenth and early-twentieth century stereotypes (such as the widespread depiction of palaeontologists in pith helmets or cowboy hats), but also in material terms. Large palaeontological collections in Europe and North America still possess extensive material taken from former colonial territories, and other places which were subjected to unequal economic relations from the nineteenth century to the present. The current position of palaeontology in public is often deeply politicised, and tied to calls for restitution and repatriation of fossils, and the support for palaeontological communities in formerly marginalised countries. These calls are of course not entirely new – the Central Asiatic Expeditions of the AMNH were forced out by Chinese cultural institutions owing to accusations of 'plundering.' But there is certainly a major upsurge, often galvanised by social media and new forms of international solidarity – as shown in the recent controversy over '*Ubirajara jubatus*' and its repatriation to Brazil (Lenharo and Rodrigues, 2022), or around the exploitation of Myanmar amber in the context of large scale human rights abuses (Dunne et al., 2022).

As well as the globalisation of palaeontological work, palaeontological public engagement has, in recent years, been strongly affected by new forms of media, especially those based on digital and online communication. More traditional forms of palaeontological presentations in public culture – through artworks, films, newspaper and journal reports, and so on – have persisted, and even expanded. But a much larger wave has seen the growth of new communities, often based around social media, which are engaged in palaeontological research in often highly complex and participatory manners. This fed into the tremendous rise of palaeontological blogging (through which many science communicators gained their initial profile), and also podcasting and online streaming, with social media simultaneously being an important part of the communications strategy of large institutions like museums and universities, but also a means through which some individuals have been able to gain prominent positions as palaeontological communicators outside of formal institutions. The current rise of communities around palaeoart and particularly the more conjectural forms of palaeoart drawing from Conway, Naish and Koseman's *All Yesterdays* (Conway et al., 2013), and its more collaborative follow-up work (Conway et al., 2017), have been fundamentally tied with fan communities and new means of engaging with science, in which the boundary between artist and palaeontologist, and hobbyist and professional, have been blurred (Figure 1.3). In a context where funding for palaeontological work has often declined, and palaeontological programmes at many universities

Figure 1.3 John Conway, Giraffatitan brancai *at the Mudbaths* (2013). An example of the more speculative forms of palaeoart current over the last decade. © John Conway.

been closed, this has meant that the interface between palaeontology and the public has become even more important, and continued to condition not just the field, but wider public engagement with science. And the feedback loops which have been so persistent in the history of the discipline have been in many respects reinforced, with palaeontological work often now taking place within this wider public culture.

Goals and methods of the volume

As the narrative in the previous section should indicate, the position of palaeontology in the public arena over the past two centuries has been complex, operating on scales from the local to the global, and with implications for a whole range of cultural motifs and wider processes: the changing position of science in society, the expansion (and contestation) of Western power, ideas of development and nature, and cross-cultural influence. The history of palaeontology in public should reinforce what has become a core underlying assumption within studies of science within public life, and methods in science communication, which have moved away from 'deficit models' implying that popular science simply represents scientific knowledge being transmitted to unknowing publics, and then either accepted, misunderstood or rejected, towards more complex ones based on co-production and mutual influence. Culture and science are not separate but deeply entangled, and 'science' and 'the public' are not sharply delineated spheres, but poles orientating numerous transmissions, circulations and feedback loops (Broks, 2006; Cooter and Pumfrey, 1994). The history of palaeontological outreach shows this strongly, having been very much defined by exchange, interaction and mutual influence between the scholarly and the public. Throughout the history of the field, palaeontologists have appealed to public audiences for resources, recognition and funds, and palaeontological research and institutionalisation has been closely enmeshed with changing forms of media and literature – to the extent that in many instances, drawing clear demarcations between the two areas is either impossible or counterproductive.

As mentioned, this volume is based around the contention that understanding these developments requires multiple forms of expertise, and a cross-disciplinary framework. While academics in all fields have been long presented with the potentials of inter-disciplinarity, examples of successful interdisciplinary work are much thinner on the ground. This book, growing from a long-standing network aiming to link together humanities scholars, working scientists, artists, science communicators and museum professionals around the core problem of why palaeontology has persistently been such a prominent field within the public arena, and the impact this has had both on wider culture and the development of the field itself, is one attempt.

What though does a framework linking different disciplines actually mean? The academic literature on interdisciplinary work has developed a range of models to describe this. Julie Thompson Klein for example constructed a 'taxonomy' of forms of collaboration, ranging from multidisciplinary work (in which knowledge and expertise is juxtaposed and presented as complementary), interdisciplinarity (where knowledge is integrated and blended) to transdisciplinarity (where approaches are hybridised in new configurations) (Klein, 2017) – although acknowledging that the boundaries between these ideal types are fuzzy and fluid, and that particular projects can move between them at various different times. The approach adopted through the Popularizing Palaeontology network was more of a practical one, setting up a single large problem, and then seeing where collaborative interests developed. This is reflected in the chapters in this volume. Some are written by individual specialists using the insights of their fields to bridge arts and sciences research, some are co-written between palaeontologists and humanities scholars and presented as finished products of cross-disciplinary discussions, and two are constructed as dialogues and exchanges between specialists with shared interests, but from distinct backgrounds. In doing so, the book and the network is not attempting to create one model of interdisciplinary work, but seeing the different forms that this can take, and examples of how this can operate in practice.

There are also some particular features of palaeontological outreach which make it a natural ground for collaboration between sciences and the humanities. For one thing, palaeontology itself is something of a transdiscipline already, mixing approaches from geology, evolutionary biology, comparative anatomy, modern natural history, and a range of technical skills around artwork, sculpture and fossil preparation. This has been to such an extent that the question of how far palaeontology should be regarded as a geological science, a biological one, or something *sui generis*, has been persistent throughout the history of the field (and answered very differently in different times and contexts).

There are also some key points of intersection between science and the humanities. Three of these are particularly noteworthy, and allow natural bridges for interaction. The first is art, as visual reconstruction has persistently been an essential mode of palaeontological work – whether this be through technical illustration of fossil material, converting often scrappy material into illustrations useful for analysis (drawing off the drive for 'objectivity' in modern science discussed by Daston and Gallison (Daston and Galison, 1992)), or the important role of palaeoart in visualising entire lost worlds and ecosystems. Secondly, how the discipline has been shaped by cultural motifs has been a major topic of discussion among palaeontologists. There is a common recollection among many palaeontologists that they were inspired by dinosaur toys or watching *Jurassic Park* – or for older generations, seeing *The Lost World*, *King Kong* or Zallinger's Age of Reptiles mural, showing the importance of popularised palaeontology in many life-stories. The awareness of the cultural implication and contingency of palaeontological reconstructions also goes the other way, with more reflexive palaeontologists being keenly aware of how cultural tropes have shaped interpretations in the past, and how they continue to do so in the present. Finally, palaeontology is itself a historical subject, thinking about the history of life on earth, but also requiring engagement with the field's past practitioners. The small number of palaeontologists both today and historically mean that monographs and textbooks produced over a hundred years ago are still engaged in scientific research, and historic field notes in museum archives are often used to develop understandings of field sites and plan research projects. These and other elements therefore provide very natural spaces for collaboration and interaction between palaeontology and humanities scholars.

What though is the added benefit of bringing these perspectives together? There are some key thoughts that emerged over the course of the volume. The first is directly related to the above points, of palaeontology as being a historical discipline, both in terms of its constructions of the past, but also in terms of the careers and socialisation of many scientists. The discussions of this network have brought together a key issue which has bridged arts and sciences perspectives: that interest in the past is common across multiple fields, and forms a natural bridge for collaboration and combined research. This has gone some way beyond clichés often presented by historians of science, that scientists are only interested in whiggish narratives to prove the correctness of current ideas, or that interdisciplinary collaboration with scientists will lead to humanities work simply becoming 'decorative' in the face of scientific authority. It has instead raised a range of more productive discussions, in which humanities and the sciences can work on an equal footing, in order to engage with shared questions.

Additionally, the book and its collaborations have allowed us to question and revise clichés and stereotypes within narratives of the history of palaeontology, and the ways it has been embedded within cultural life. The notion for example that dinosaurs are 'cool' and have been intrinsically the focus of the field since their first definition in the 1840s is questioned quite significantly across this volume, which emphasises the cultural importance of other aspects of the palaeontological past across the history of the field. The reasons for why and when dinosaurs have been regarded as significant and emotive, and the ways in which the canon of fossil beasts has been constructed, are in fact quite arbitrary, and depend on a mixture of history, the media, research, materiality, and other factors. And more conceptually, the histories of the field traced in this book have also reinforced drives to move away from large stereotypes in the discipline – of narratives of progress, and the White Male frontier scientist as the archetypal palaeontologist. The interplay between scholarly research, art, and wider public articulations have been essential to the foundation and course of the field.

Structure

This book is approaching this large topic through a range of case-study snapshots, examining different episodes within the large trajectory of palaeontological engagement with wider culture, and thinking about these changes on a host of levels – the material, cultural, intellectual, and scientific, and how these have interacted. These range from across the past two hundred years, and across the world. The chapters, with a general European and North American centre of gravity but with important examinations of South America, Africa, Australian and East Asian contexts, show on the one hand the global scope of the field, but also how it has been conditioned by different patterns and structures of inequality across history and the present. This will provide both an entry point into this complex global story, but also potentially jumping off points for future investigations.

In what was a difficult decision, when planning this volume it was decided to focus primarily on vertebrate palaeontology. This does of course potentially miss some wider important issues, most notably the role of grander overarching narratives of life like the 'evolutionary epics' which have absorbed a large amount of analytical attention (Hesketh, 2015a, 2015b; Lightman, 2007; O'Connor, 2009), and the importance and persistence of invertebrate palaeontology, and the public role of fossil plants, fish and amphibians. The implications of these aspects will be discussed in the final chapter, as they are too important to leave out entirely. However, vertebrate palaeontology has loomed particularly largely within public discussions of palaeontological work, with animals given a status as 'charismatic' dominating discussions. Tracing the development of palaeontological outreach through a series of taxa provides a set of anchors. Focusing on fossil reptiles, mammals and hominins allows some of the largest elements of palaeontology's position within wider culture to be ascertained, and also allows comparisons, thinking about how similar issues are conceptualised in a range of different media and geographic contexts.

The focus on particular organisms was a specific organisational choice, especially as opposed to a possible alternative – thinking about the position of palaeontology in terms of different genres of popularisation. As will be seen across the volume, palaeontology has been engaged with through a whole range of forms and media. As well as the obvious fields of palaeoart and popular science literature, palaeontological themes have been promoted through newspapers, film, animation, novels, poetry and public architecture. It has also defined entire genres and forms of institution. The mutual dependence of palaeontology and the press is a common theme in many of the chapters. And the crucial role of museums as institutions which bridge education and spectacle, and the public and the private, and have frequently emphasised palaeontological research and displays, is another key area. Examples of all of these areas will be seen throughout the book. Palaeontology did not just provide subject matter for these diverse forms, but the challenge of reconstructing and imagining prehistoric animals was actually a major driver of new techniques and methods. What is striking though about the position of palaeontology within public culture is how themes, issues and subjects move between different genres, in highly fluid ways. For just one example, sauropod dinosaurs in the first decades of the twentieth century could simultaneously be brought to life in animation (most notably through Winsor McCay's Gertie the Dinosaur) and other film genres, feature in novels and fictional accounts of prehistoric life, be used to understand the scale of new architectural forms in cities like New York, and became the most dramatic centrepieces within public natural history museums – with the Sauropod being deployed as an example of scale, spectacle, and the challenges of reconstructing something so unlike anything living today. The way palaeontological popularisation works through a multimedia and cross-genre is a crucial thing to consider, as the life of the past becomes a way of linking and mediating themes across different cultural forms.

This book is divided into two halves. The first section focuses on the importance and significance of fossil reptiles, which have also been the most widely engaged with group in the secondary literature on the history and cultural impact of palaeontology. These chapters are thematically organised around some definite topics. On the one hand, we necessarily engage with and develop issues which are present throughout much of the existing secondary literature on the history and cultural role of dinosaur palaeontology – namely the role of scholarly institutions in Victorian Britain and the twentieth-century USA in promoting particular visions of the deep past, and also the idea of prehistory as marked by strangeness, drama and scale. However, a common additional theme within these chapters is the role of dinosaur palaeontology as a source of doubts and challenges. The extremely fragmentary and often highly unstable fossils of dinosaurs, and the great difficulty in reconstructing these creatures given their scale and difference from modern animals, has meant that they have been an important source of doubt and uncertainty over the deep past, and the meanings which could be attached to it. Indeed, public discussions of dinosaur palaeontology have often been as much about attempts to engage with scientific methods and the limits of interpretations as they have been about constructing lost worlds of 'big, fierce and extinct' animals.

To trace these issues, we start with a chapter by Richard Fallon and Dave Hone comparing the role of science in two of the most iconic fictional works around dinosaurs: Arthur Conan Doyle's *The Lost World* (1912) and Michael Crichton's *Jurassic Park* (1990). Next follows the movement of dinosaurs and prehistoric animals into new forms of media in the early-twentieth century, with Victoria Coules examining Winsor McCay's construction of the animated 'Gertie the Dinosaur', which bound together a range of cultural and media forms of early-twentieth century New York to engage with the problem of how to bring to life a sauropod through the new medium of animation (and also test the limits of that new medium). Next we have two chapters on sail-backed reptiles moving across a range of national contexts, illustrating the potentials and difficulties of reconstructing fossil animals through dialogues between scientific research and popular culture. First, Mark Witton and Will Tattersdill discuss the reconstruction of *Spinosaurus* across the twentieth century, as it moved from a relatively obscure set of remains (which were themselves destroyed during the Second World War) to one of the most iconic dinosaurs, and a core part of the dinosaur canon – despite major controversies over the appearance and lifestyle of the animal. And then Ilja Nieuwland traces another creature, *Naosaurus*, moving in almost the opposite direction, starting off as a curious subject of debate in early-twentieth century USA and Germany, but eventually being undone and rejected as a chimera. And finally, we move to a different geographic context, as Zichuan Qin and Lukas Rieppel discuss the history of work on dinosaurs in China, both in the long-term but especially in the present, and how the discovery and promotion of feathered dinosaurs has led to new communities and networks within China, and new visions and understandings of dinosaurs globally.

The next group of chapters examine the role of fossil mammals (including hominins) within popularisation efforts. This linkage is deliberate, as while there is a large, extensive and sophisticated literature on history of ideas and engagement with human origins (Bowler, 1986; Goodrum, 2009; Landau, 1991; Moser, 1998), broader studies of the role of fossil mammals have been much less extensive, and their significance has only recently begun to be fully engaged with. These chapters emphasise the importance of palaeontological discourse for issues around progress, identity and values, and also for their role within the formation of scientific careers bridging the public and the academic. While there have certainly been numerous challenges around the reconstruction and public discussion of fossil mammals and human ancestors, these have more often moved quickly onto issues of their significance within ideas of hierarchy and life's history. The lineages which have been conceptualised as either most closely related to humans, or leading to humans in a direct way, have been given a consistent importance within palaeontological discourse and popular science, and the way in which they have been integrated into a range of evolutionary just-so-stories, and hierarchies around race and gender has been generally noted (Schiebinger, 1993). However, they have also been a source of uncertainty, with questions of mysteries in their development, wondering at the significance of particular stages of their development, and doubt at attempts to reconstruct human ancestors from bones and stone artefacts, being frequently present.

In the first of these chapters, Elsa Panciroli and I discuss the role of the mammals of the Mesozoic in entangled scholarly and public discourses, thinking about how these animals – conventionally discussed as shrew- or rat-like creatures living in the shadow of the dinosaurs – have fed into wider concerns around progress, hierarchy and diversity within the natural world. Next Irina Podgorny discusses the role of fossil mammals within twentieth-century Argentina, tracing how they were engaged with across film, architecture and literature, to provide an image of the deep past marked not necessarily by progress, but by deep uncertainty and pessimism. And then Joe Cain discusses a research expedition to Venezuela in the late 1930s led by George Gaylord Simpson and Anne Roe to locate (among other things) fossil mammals, which led to few results in palaeontology but which Simpson was nevertheless able to use to reinforce his public prominence. Then we move on to discussing the only aspect of the deep palaeontological past which has potentially drawn as much attention as dinosaurs – human origins, which have persistently been an important means of defining basic and essential characteristics of humanity. Firstly Rebecca Wragg Sykes and Lydia Pyne provide a discussion on the relative public prominence and meanings attached to the two most iconic groups of ancient humans – the Australopithecines and Neanderthals. And then Oliver Hochadel presents the entangled history of human origins studies with the media, examining how they have grown together and influenced one another strongly across the twentieth century.

Across all of these areas, we see a number of key issues: how science and the public have persistently interacted, in mutually reinforcing and contested ways, to build and give significance to numerous aspects of the deep past; how palaeontology has been a continual topic of discussion across the nineteenth and twentieth centuries, and across a range of different media; and how the meanings attached to the palaeontological past and its inhabitants have been wide-ranging and diverse, sometimes leading to optimistic visions of progress, but also to feelings of doubt and uncertainty, and with lost worlds being constructed of majestic scale, terrifying difference, and close familiarity. Palaeontology has been extremely flexible and varied across its history, and has been used to give a range of meanings to the world and the means of knowing it. And in order to understand this, it is of course necessary to bring a similarly varied and diverse range of perspectives and expertise to bear on the issue of the prominence of palaeontology and the deep past in public culture.

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Part I
Extinct reptiles

2

Arthur Conan Doyle, Michael Crichton, and the case of palaeontological fiction

Richard Fallon and David Hone

On 6 November 2005, American novelist Michael Crichton (1942–2008) delivered a provocative lecture to the Washington Center for Complexity and Public Policy. His theme, 'Fear, Complexity, and Environmental Management in the 21st Century', was illustrated by an oddly familiar case study: the establishment of a unique nature preserve, filled with extremely rare species (2017 [2005]). This ostensibly noble undertaking quickly turned into a disaster, Crichton explained, but the worst excesses were kept out of the public eye. The park's management had attempted to control an ecosystem they did not understand, with violent unforeseen results: animal populations inexplicably grew or interacted unpredictably, and predators became a threat to visitors. Humans cannot control all the mysterious contingencies of nature, Crichton (2017 [2005]) stressed, but, if we are to expect the unexpected in a more scientific manner in the future, 'we must embrace complexity theory'. Here he referred to the interdisciplinary field more widely recognised under the name of one of its branches: chaos theory.

Readers would be excused for assuming that Crichton referred to the events of his novel *Jurassic Park* (1990), to its 1993 film adaptation, and to the exhortations of one of its protagonists, the chaos theoretician Ian Malcolm. In fact, he was describing the problems that had faced the environmental managers of Yellowstone National Park, established in 1872. The point underscored the climate change scepticism that motivated his lecture: Crichton insisted that action taken to combat climate change – an imperfectly understood, and, he argued, perhaps natural process – would, without attention to the difficulty of predicting behaviour in complex systems, be a waste of time and money at best, or at worst would cause the same kinds of chaos that had taken place at Yellowstone. Crichton's lecture built upon the furore stirred up by his recent novel *State of Fear* (2004), which villainised climate scientists (and which introduced his analogy between Yellowstone and climate activism). His more famous work, *Jurassic Park*, has been characterised as a retelling of Mary Shelley's cautionary *Frankenstein* (1818) (Rollin, 1995: 72–7), one which drew accusations that Crichton, who trained as a medical doctor, was buttressing a 'technophobic' (Bains, 1993) distrust of science. These disputes took place long before his doubts about climate change made headlines (Besel et al., 2012).

If *Jurassic Park* is known for its criticism of science gone wrong, it is also famous for publicising palaeontology more widely than ever before. At the dawn of the same century, another doctor-turned-bestselling-novelist had performed a similar feat. In *The Lost World* (1912), British author Arthur Conan Doyle (1859–1930) memorably depicted an expedition to a plateau filled with prehistoric animals, providing the name for an entire genre of 'lost world' fiction. The stop-motion saurians in the book's 1925 film adaptation astonished interwar audiences, just as Steven Spielberg's CGI dinosaurs would later revolutionise special effects. Crichton paid tribute by naming his own 1995 sequel to *Jurassic Park* after Doyle's novel. The 1912 classic has never been out of print since its first publication, while 12 million copies of *Jurassic Park* were in print in the US alone by the century's close (Maryles, 1999). These two novels represent twentieth-century literature's most influential examples of palaeontology in public, bringing evolution, extinction, and dinosaurs to truly massive audiences. It was in a review of *Jurassic Park*, novel and film, that palaeontologist and science writer Stephen Jay Gould (1993) coined the term 'dinomania'. The well-known film adaptation of *Jurassic Park* (1993) has recently been examined in an extensive scholarly collection edited by Matthew Melia (2023); however, in this chapter we demonstrate that focusing on Crichton's far less frequently discussed original novel, which features important differences in tone and content, and juxtaposing it with Doyle's famous predecessor, draws out surprising critical insights.

We bring Doyle and Crichton into conversation because their starring role in the literary popularisation of palaeontology was intriguingly twinned with another shared characteristic: scientific heterodoxy. As Crichton observed in his autobiographical *Travels* (1988: 190), 'I had in the past strongly identified with Doyle, and now I appeared to be following in his footsteps rather closely.' Here he was referring to the unsettling similarity between his own forays into paranormal research and Doyle's belief in Spiritualism (Kerr, 2013: 209–54), a religious movement whose proponents attempted to communicate with the dead. In 1979, Crichton visited the Spiritualist Association of Great Britain, once endorsed by Doyle himself, and he investigated psychic research throughout the 1980s (Trembley, 1996: 10). The creator of Sherlock Holmes had spent his last years defending séance mediums against the scorn of the scientific establishment, and, although his Doylean interest in the paranormal did not endure past the 1980s, Crichton's even more explosive stance on global warming dominated his final decade. Despite their saleable literary mythologisation of scientific expertise, both men became deeply alienated from the institutions of mainstream science.

In this chapter, we argue that this simultaneous movement – popularising palaeontology while criticising trends in establishment science – is integral to Doyle's *The Lost World* and Crichton's *Jurassic Park* and to their place in the history of palaeontology in literature. For these two novelists, the wonders of palaeontology symbolised an antidote to all that was wrong with elite scientific culture in the twentieth century. For the former, this was its narrow-minded refusal to take the unknown seriously, and for the latter, its hubris and corruption by industry and politics. We contend that, despite the differences in their targets, both authors can helpfully be seen as addressing what has been called 'the problem of disenchantment' (Asprem, 2014). As sociologists and historians of religion demonstrate, desire for 'enchantment' was an almost ritualistic refrain in a twentieth-century Western world that many felt had been emptied of wonder and mystery by industrialisation, rationalisation and global colonialism. Modern scholars investigating this anxiety about disenchantment have sketched the variety of ways the notion was wrestled with by historical actors (McClure, 1994; Landy and Saler, 2009). Scholars have punctured any simple claims that the modern world truly became 'disenchanted', but palaeontology has not played a significant role in this research, even though dinosaurs and their fossil brethren have long been cited as proof that science brings superior marvels to replace what it demythologises. The notion that palaeontology was more wonderful than myths and fairy tales, because it was *true*, was the key message of popularisers who sold this science to the public in the nineteenth century (O'Connor, 2007: 153–8).

The Lost World and *Jurassic Park* brought a new and critical edge to this tradition in the popularisation of palaeontology. Reading Doyle's novel as a semi-serious challenge to disenchantment is by no means a new interpretation (Belk, 2017: 129–62; Fallon, 2021: 136–73), although it is one that has rarely been considered in relation to longer traditions of palaeontological writing. Linking it to *Jurassic Park* helps us to see unexpected continuities in the cultural work performed by palaeontology in modern fiction. In the eyes of Doyle and Crichton, palaeontology represented one of the most enchanting ingredients of a scientific worldview, as it had done for authors working in older, more didactic models of imaginative writing about palaeontology. Doyle and Crichton's increasingly anti-establishment attitudes, however, meant that their paeans to palaeontology became tools for critiquing the purportedly compromised direction of twentieth-century science.

The evolution of the palaeontological novel

Palaeontological fictions like *Jurassic Park* can trace their origins to scientific and literary genres circulating during the early nineteenth century, designed to explicate, to dignify – and to market – the new earth sciences. These genres brought lost worlds to life through the language of myth, magic and romance. During these early decades of formal geological and palaeontological research in the West, imaginative views into deep time were brief and often hedged with irony. As authors gained confidence, late Georgian and early Victorian geologist-writers in Britain began to offer more ambitious textual descriptions of prehistoric ecosystems, framed as visions, dreams, or Dantesque journeys, sometimes accompanied by speculative illustrations (O'Connor, 2007: 102–4, 366–75; Buckland, 2013: 204–7, 247–73). In what became a cliché, Gideon Mantell's *The Wonders of Geology* (1838: I, 31) declared the prehistoric world, or in this case Cretaceous Sussex, to be 'a country more marvellous than any that even romance or poetry has ventured to pourtray [*sic*]'. Essayists, poets, novelists and artists concurred with this sentiment, exploring evocative notions of deep time, monstrosity and extinction in their works (Zimmerman, 2008), although, at this time, prehistoric animals did not encounter humans in realistic stories or images intended to be taken seriously.

As imaginative passages within didactic nonfiction grew more ambitious, authors began to incorporate more developed plot structures, especially in France. Pierre Boitard's ground-breaking *Paris avant les hommes* [*Paris before Men*] (serialised 1836–37; revised 1861) employed the demon Asmodeus as a supernatural guide to accompany a human protagonist on an informative trip to prehistoric Paris. The framing of educational palaeontological content within a rudimentary time-travel narrative has had a long afterlife in works aimed at young audiences. In Czech director Karl Zeman's 1955 film *Cesta do pravěku* [*Journey to the Beginning of Time*], for instance, a group of boys use a time-travelling boat to learn about previous geological ages. The boat concept arose a century earlier in Henry Morley's article, 'Our Phantom Ship on an Antediluvian Cruise' (1851), a work of imaginative nonfiction published in Charles Dickens's periodical *Household Words*. Dickens, whose hatred of arid scientific instruction was legendary, was one of the most eloquent proponents of the idea that palaeoscience is enchanting and that prehistoric saurians surpass folkloric dragons in interest (Buckland, 2013: 254–5; Keene, 2015: 21–53). This prominence of this stance was a testament to the skill and success of palaeontology's earliest popularisers.

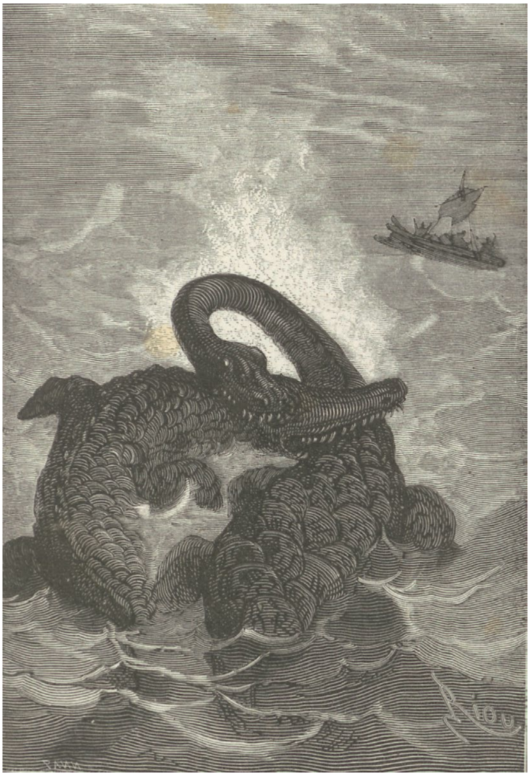

Figure 2.1 Illustration by Édouard Riou, in the revised edition of Verne, 1867: 161. *Ichthyosaurus* and *Plesiosaurus* clash in an underground sea, not far from the human protagonists' raft. Image in public domain, obtained from Wikimedia Commons [https://commons.wikimedia.org/wiki/File:Voyage_au_centre_de_la_Terre_1867_(140965245).jpg].

The instructive narrative devices of texts like Boitard's *Paris*, in combination with older epic and romantic conventions of the subterranean quest (Sommer, 2003), provided an almost seamless transition into works of pure fiction. The first palaeontological novel in which humans encounter prehistoric animals in the flesh, shedding any supernatural apparatus of demons or time-travel, was Jules Verne's *Voyage au centre de la Terre* [*Journey to the Centre of the Earth*] (1864, revised 1867). This was heavily inspired by the content of a popular science treatise of the previous year, Louis Figuier's *La Terre avant le deluge* [*The Earth before the Deluge*] (1863), and even shared its illustrator, Édouard Riou (Debus, 2006: 26) (Figure 2.1). Despite Verne's manifestly novelistic plot about the discovery of an underground world, this was still an educational tale and one intended to communicate the latest scientific advances. In the words of one scholar, Verne's publisher tasked him with producing a 'home remedy' for the deficient state of science teaching in French schools by constructing a 'new' kind of novel 'that mixed scientific didacticism with fast-moving dramas of travel and adventure' (Evans, 1988: 14). Verne's depiction of exciting, informative encounters between explorers and hidden pockets of prehistoric life was to be ceaselessly imitated and this Vernean sense that fiction about palaeontology ought to function, even if superficially, as instruction, long persisted.

After the publication of Verne's romance, anglophone novelists, too, began introducing plesiosaurs, pterodactyls and mammoths into plots set in the present day. Many authors of these newer works downplayed their predecessors' earnest scientific didacticism. During the 1880s, the irreverent genre that would, after Doyle, be retrospectively dubbed 'lost world' romance exploded onto the literary scene. Over the following decades, authors of these bestsellers exploited the excitement of a galvanised phase of Western empire-building, when discovery, evolution and extinction became charged literary subjects, not least because important fossils were often unearthed in colonised territories envisioned as evolutionarily primeval, and shipped back for display in spectacular new metropolitan museums (Rieppel, 2019). Blending fast-paced adventure with mischievous verisimilitude, lost world novels, usually serialised in international mass-market magazines, encouraged the modern man or boy vicariously to pit himself against atavistic monsters surviving at the poles, underground, in South America, or in Africa (Deane, 2014: 147–70). With the caveat that they were not intended to be taken too seriously, lost world novels promoted the view that the planet still held surprises for audiences who felt that material science and colonial expansion had revealed all there was to know (Saler, 2012: 60–78). It should be no surprise that palaeontology, renowned as combining science with romance, became a recurring ingredient in these stories. When Arthur Conan Doyle approached the genre, however, he brought to it his own disobedient views on the use and misuse of science at the beginning of the twentieth century.

Conquering *The Lost World*

After completing medical training at the University of Edinburgh in 1881, Doyle briefly set himself up as a general practitioner, and subsequently as an ophthalmologist (Figure 2.2). By the 1890s, buoyed by the success of his Sherlock Holmes stories, he devoted his life chiefly to writing, ranging widely across fiction as well as journalism, history and psychic research. His interests included palaeontology: even the products of Holmes's famous deductive methods, by the detective's own account, were analogous to palaeontological reconstructions (Dawson, 2016: 358–62). Doyle's curiosity about this subject grew in the Edwardian period. In May 1909 he unearthed footprints of the dinosaur *Iguanodon* near his house in Crowborough, for example, and, in the 1920s, he and his wife Jean (*née* Leckie) would claim to have spotted a live *Ichthyosaurus* or *Plesiosaurus* near Aegina back in 1907 (Lycett, 2007: 347–8). These experiences fed into his epochal contribution to the lost world genre, serialised in the American *Sunday Magazine* newspaper supplement and British *Strand Magazine* in 1912.

The Lost World, dedicated to 'the boy who's half a man, / Or the man who's half a boy' (Doyle, 1912: ii) and published with tongue-in-cheek counterfeit photographs of its characters and locations (Belk, 2017: 146–56), is presented as a documentary account (Figure 2.3). The narrator is Edward Malone, a young journalist who joins an expedition to South America. This expedition is led by the contentious naturalist Professor Challenger, who claims to know of the existence of an Amazonian plateau upon which prehistoric animals survive, but, due to the disbelief of the British scientific establishment, he must verify his claim with a team of independent witnesses. Along with Malone these include sceptical scientist Professor Summerlee and sportsman Lord John Roxton, assisted by black servant (and racial caricature) Zambo. Upon reaching the plateau, apparently 'lifted' up by a 'sudden volcanic upheaval' in the Jurassic period (59), they discover that it is filled with dinosaurs, pterodactyls (pterosaurs), plesiosaurs, ichthyosaurs and a group of vicious 'ape-men', among other animals both prehistoric and imagined.

Figure 2.2 Photograph of Arthur Conan Doyle, 27 January 1913. LC-B2- 2614-9, George Grantham Bain Collection, Library of Congress Prints and Photographs Division [https://www.loc.gov/resource/ggbain.12334/].

Challenger's men help the plateau's indigenous humans in exterminating the ape-men and escape back to London, where they prove the truth of their story by releasing a pterodactyl into the Queen's Hall. The plateau is christened 'Maple White Land', named for the American artist from whom Challenger learnt of its existence.

Like Verne before him, Doyle was a keen reader of popular science writing (Doyle, 1907: 248–51), which he consulted to ensure that the novel's broad palaeontological details were current. He took most of these from *Extinct Animals* (1905), a work aimed at young readers by the eminent naturalist E. Ray Lankester, and direct references to *Extinct Animals* appear in the text and illustrations of *The Lost World* itself (Doyle, 1996: 250–2). Challenger and Summerlee reiterate the scientific

Figure 2.3 Doyle, 1912: frontispiece. One of the fabricated, composite photographs reproduced in early editions of *The Lost World*. The photographer, William Ransford, portrayed Malone, while a disguised Conan Doyle acted as Challenger. Doyle's brother-in-law, P. L. Forbes, played two other protagonists, Roxton and Summerlee. Image in public domain, obtained from the Internet Archive [https://archive.org/details/lostworldbeingac00doylrich/page/n5/mode/1up].

consensus that dinosaurs like the predatory *Megalosaurus* were 'practically brainless', having become extinct elsewhere 'on account of their own stupidity, which made it impossible for them to adapt themselves to changing conditions' (Doyle, 1912: 221), echoing Lankester's (1905: 209) hypothesis that creatures with 'ever increasing brains outdid them in the struggle for existence'. In an enthusiastic letter, Lankester himself congratulated the author on 'rightly' withholding 'any intelligence from the big dinosaurs' (quoted in Carr, 1949: 258). Michael Crichton himself would later suggest that Doyle's adherence to contemporary notions of dinosaurian incompetence made them insufficiently deadly adversaries in the story (n.d. [2003]), and characterised early twentieth-century palaeontologists as having naïvely viewed dinosaurs as 'fat, lethargic, and dumb—big dopes from the past' (1997 [1995]: 83). In drawing a stark line between Doyle's *Lost World* and his own revisionary novel of the same name, Crichton oversimplified. In Doyle's book, ferocious speed is attributed to the *Megalosaurus*. In a then-common analogy, Lankester

(1905: 204) had noted the 'kangaroo-like carriage' of this dinosaur, and young Malone in *The Lost World* similarly observes that the dinosaur 'hopped … like a kangaroo, springing along in an erect position upon its powerful hind-legs', with 'movements' that, 'in spite of its bulk, were exceedingly alert' (Doyle, 1912: 217). Dinosaurs are later depicted as effective pack hunters (273–5).

Doyle was not incurious about these 'dopes from the past', but, despite his engagement with Lankester's work, he did not intend his novel to be mistaken for thinly veiled popular science. Many 'lost worlds' from the same period, such as the island of Caspak in Edgar Rice Burroughs's *The Land That Time Forgot* (1918), are improbable lands in which the locations of extinct species spatially mimic their geohistorical age, a relic of palaeontological fiction's didactic origins. In contrast, Maple White Land is an evolving ecosystem populated by 'old types surviving and living on in company with the newer ones' (Doyle, 1912: 252), all with richly imagined behaviours and appearances. When Challenger's crew watch a browsing *Iguanodon* 'put his fore-legs round' a tree and tear it down, causing the tree painfully to come 'crashing down upon the top of it' (171), the speculative scenario likely derived from a case of palaeoecological detective work by Victorian anatomist Richard Owen (1842: 148, 157–8), who had memorably postulated identical behaviour in giant ground sloths. Malone's narration is also carefully attentive to the bodies of these animals, from the *Iguanodon*s' 'skins like black crocodiles' (Doyle, 1912: 170) and the 'web-coloured shawls' of the pterodactyls (176) to the 'fish-like iridescence' of a predator identified as resembling *Megalosaurus* (174). These verisimilar details were key to Doyle's transformation of the information in *Extinct Animals* into a living world.

The Lost World is, however, committed to notions of the progressive evolutionary growth of intellect explored in Lankester's work (Manias, 2017: 21–3). These ideas underlie the ease with which four white men, with the assistance of Zambo and by rallying the Indigenous human population, rise to almost total domination of the dangerous plateau. The protagonists undertake a gleeful conquest of Maple White Land that, even at its most perilous, is, in Roxton's words, 'doocedly interestin'' (Doyle, 1912: 236). Pursued by the megalosaur and briefly entertaining the disturbing notion that nature's 'struggle for existence' might suddenly include 'modern man' (216), Malone is saved by a trap designed by the 'developed brains' of the plateau's human inhabitants, reminding him that '[m]an was always the master' (221). As Bradley Deane (2014: 156–7) has observed of the lost world genre, the progress of mind is typically twinned with a quasi-atavistic physicalism: the brain of the white European Professor Challenger lies in a body so comically bristling with animal energy that, to his embarrassment, it resembles that of the king of the ape-men (Doyle, 1912: 242). Indeed, it is by their combination of barely-harnessed primeval brutality and twentieth-century intellect that the British expedition match up against musclebound apes and dinosaurs. Reflecting on the extermination of the ape-men, Challenger declares that the humans have participated in one of 'the real conquests' of evolutionary history, ensuring that 'upon this plateau the future must ever be for man' (268).

Doyle's enthusiastic vision of the subject matter of palaeontology, however, harboured more wry commentary on a British scientific culture in flux. In the late nineteenth century, disciplinary specialisation had intensified while professional career paths for researchers emerged across the Empire, putting pressure on scientific generalists and challenging traditional reliance on gentlemanly independent wealth (Porter, 1978). Contributing to scientific knowledge at the highest levels now broadly meant publishing original research in technical journals like *Nature*, where contributions from dilettante polymaths and popularisers were looked upon with scepticism (Baldwin, 2015). These periodicals and most major scientific bodies also marginalised overtly religious perspectives and suspicious fringe sciences (Rupke, 2019). Despite the pressure of these developments, scientific practice remained a heterogeneous, if still disproportionately white and masculine, affair. Nondisciplinary explorer-naturalists such as Alfred Russel Wallace remained eminent models of scientific endeavour, while undeniably heterodox research was still sometimes pursued by elite figures (including Wallace, a Spiritualist). Moreover, if they appeared to relish debunking fringe scientific claims, even sceptics like Lankester (1905: 184) could not always afford to ignore rumours about the survival of prehistoric animals on the colonial frontiers. Nonetheless, for those on the scientific community's margins, it appeared increasingly to resemble a cabal with little patience for truly novel claims about the natural world.

Doyle watched the contradictions of modern science with interest. He publicly committed to an oppositional stance when he became a spokesperson for Spiritualism in 1916, and famously argued in favour of the existence of fairies in the 1920s, but many statements dating back to the 1880s attest to Doyle's longstanding belief that the ratiocination employed by Sherlock Holmes had far wider applicability than was usually attested to in mainstream science. In the years before *The Lost World*, he was denouncing the 'materialism' (or sceptical naturalism) of leading scientists, pushing against overspecialisation and pedantry

(1907: 249–50) and provocatively comparing the controversial work of scholar Frederic W. H. Myers 'in the dim regions of psychic research' to the more widely accepted scientific achievements of Charles Darwin (253). In this context, *The Lost World* depicted a nostalgic scientific fantasy and Professor Challenger represented a figure at odds with major trends in British science. A generalist savant of independent means, he is no narrow-minded specialist but is rather constructed from romantic conceptions of the man of science as a virile, imaginative genius (Ellis, 2017: 49–85, 117–48). He boasts expertise in synthesising palaeontology, geology, biology and anthropology (at least), and in his restlessness he is neither pinned down to any professional desk nor in thrall to the prosaic and misguided scepticism of his colleagues at the fictional London 'Zoological Institute' (Doyle, 1912: 23).

Furthermore, for all its celebration of Challenger's scientific conquests, Doyle's novel also accommodates extreme impatience with a narrowly scientised world. After all, the grotesquely self-obsessed Challenger is regularly an object of affectionate satire at the hands of the layman Malone, whose pedantry-deflating first-person narration ensures that, for all its author's care with the book's science, *The Lost World* makes little effort to educate readers about palaeontology in the manner of Verne. For Malone, Maple White Land is a space of personal re-enchantment, not scientific study, and his adventures resemble 'the first strange happenings of our childhood' (Doyle, 1912: 276). The plateau's probable future as a 'vulgarised' commercial space, 'the prey of hunter and prospector' is sadly contrasted with its brief life as a 'dreamland of glamour and romance … *our* land' (292). Maple White Land's most compelling characteristics are the intangibles reflected upon by a wistful Malone towards the end of the novel: the unidentified 'nocturnal white thing' that 'flitted about with a faint phosphorescent glimmer in the darkness' (276–7); 'the 'mysteries' of the 'enchanted' Central Lake (302); and the pterodactyl finally unleashed at the Queen's Hall, and which 'squeezed its hideous bulk through' the window 'and was gone' (311). Doyle's own world was enchanted too. What attracted him was science revealing the scientific establishment to be utterly wrong, as gently dramatised in *The Lost World* and less gently in Spiritualist works and studies of fairyland written thereafter. Doyle offered mass readerships a masculine playground in which the spectacular deductions of British palaeontologists were animated and the more donnish, disenchanting characteristics of modern professional science gleefully discarded.

Managing complexity in *Jurassic Park*

In 1912, *Strand Magazine* issues containing instalments of *The Lost World* had been shipped across the world via the extensive channels of the British Empire. In 1990, when *Jurassic Park* was published in the United States by Alfred A. Knopf, palaeontology and the literary marketplace, not to mention geopolitics, all looked very different. As we shall discuss below, the US, already renowned for its fossil resources and wealthy museums in Doyle's time (Rieppel, 2019), had consolidated its eminence and become the centre of new developments in dinosaur palaeontology. Meanwhile, in the country's decades of postwar prosperity and rise to the status of global superpower, the US publishing industry was pedalling the new king of the literary marketplace – the paperback – to domestic and global audiences larger than ever before (Luey, 2009: 30–4, 42–3). One of the key genres of this mass literature was science fiction. A multimedia genre only nascent when *The Lost World* was published, science fiction had become the main site of engagement with palaeontology in imaginative media (Debus, 2006, e.g. chapters 4 and 5). Often, these media were symbiotic, as in the case of *The Beast from 20,000 Fathoms* (1953), a Warner Bros. film directed by Eugène Lourié and based on a 1951 short story by Ray Bradbury, originally published in the *Saturday Evening Post*.

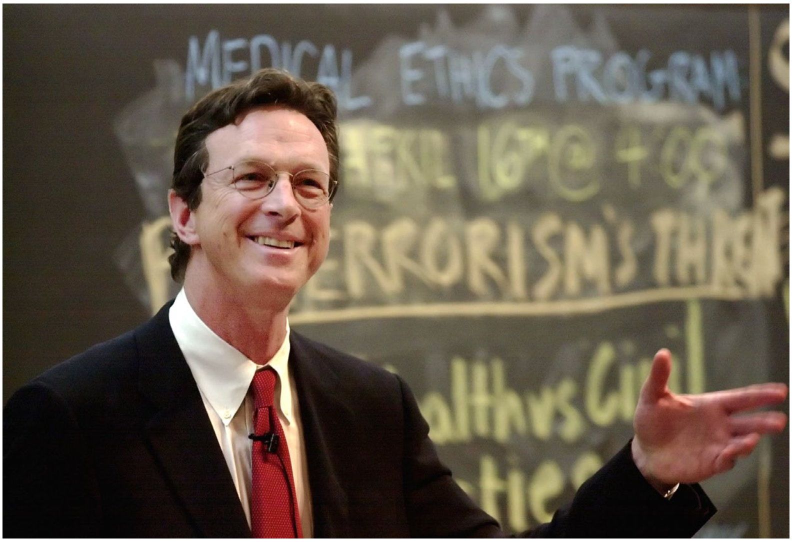

Figure 2.4 Michael Crichton speaking at Harvard University, 18 April 2002. Jon Chase/Harvard News Office, CC BY 3.0. Wikimedia Commons [https://commons.wikimedia.org/wiki/File:MichaelCrichton.jpg].

Michael Crichton himself could claim significant responsibility for science fiction's continuing rise in profitability (Figure 2.4). He had received his MD from Harvard University in 1969, the same year that his first literary success, *The Andromeda Strain*, was published. As John Sutherland (2007: 70) notes, this was 'the first "true" science fiction novel to make it into the upper reaches of the annual bestseller lists'. Crichton thenceforth became known for his own sub-genre – carefully researched 'techno-thrillers' depicting the misuse of technologies developed behind closed doors, or the unexpected ramifications of new scientific discoveries.

The most successful of these techno-thrillers was, of course, *Jurassic Park*. The plot was broadly replicated in Spielberg's film adaptation, although the novel, written with a more adult audience in mind, differs in many important details. It begins with a brief history of commercial biotechnology which segues into an introduction to the fictional International Genetic Technologies (InGen), a firm founded on venture capital by entrepreneur John Hammond. Following a series of animal attacks on Costa Rica, InGen, who are developing a theme park on nearby Isla Nublar, call in a team of 'academic consultants' to evaluate the park's safety (Crichton, 1991 [1990]: 37–8). These include University of Denver dinosaur palaeontologist Alan Grant, palaeobotanist graduate student Ellie Sattler and University of Texas mathematician Ian Malcolm. On Isla Nublar, it becomes apparent that Hammond's geneticist Henry Wu has used chimeric DNA to recreate live dinosaurs. This manner of introducing dinosaurs into plots, without recourse to Doylean lost worlds, had been gaining steam since the 1970s (Monnin, 2023), propelled in the 1980s by interest in the 'celebrity science' of ancient DNA (Jones, 2022). Wu's animals escape during a power outage caused by the industrial espionage of MIT programmer Dennis Nedry, but most major characters are able to escape their attacks. The fatalities include Hammond, Wu and Malcolm.

Even more so than Doyle before him, Crichton proudly foregrounded the latest research in dinosaur palaeontology. *Jurassic Park* prominently cited figures from the 'Dinosaur Renaissance', a movement in post-1960s palaeontology associated with American researchers John Ostrom, Jack Horner and Robert Bakker. According to the media-savvy Bakker (1975), earlier scientists had depicted dinosaurs as sluggish, unintelligent, solitary and totally extinct, but in fact many dinosaurs were likely hot-blooded, living in complex units and bearing direct evolutionary connections to birds. In an afterword, Crichton acknowledged drawing upon the work of these palaeontologists (1991 [1990]: n.p.), while Grant's research on the 'maternal instincts' of 'duckbilled dinosaurs' (37) and on dromeosaurids (43), as well as his self-illustrated books (93), indicate that he is a composite of Horner, Ostrom and Bakker respectively. He is even described as a co-author, with Horner, on the description of *Maiasaura*, Horner's 'good mother lizard' (260). Hammond's park of living dinosaurs animates the ideas of the Dinosaur Renaissance, his bioengineered animals contradicting older palaeontological wisdom at every turn. Grant's first sighting, a 'surprisingly active' herd of terrestrial *Apatosaurus*, immediately refutes earlier notions that this sauropod spent 'most of its time in shallow water' to 'support its large bulk' (80). The behaviour of the intelligent, birdlike *Velociraptor* pack, moreover, is far removed from that of Doyle's comfortably brainless predatory dinosaurs.

In contrast with Doyle's *The Lost World*, in which the prehistoric animals depicted would have been familiar to any contemporary reader casually acquainted with palaeontology, Crichton referenced obscure genera with euphoniously technical names like *Othnielia*, Euoplocephalids (1991 [1990]: 164) and 'cearadactyls' (278). In the book, Sattler notes that '*Procompsognathus* is so 'obscure' that '[e]ven people familiar with dinosaurs have never heard of it' (44). While Crichton's details appear painstakingly researched, they are often concocted. Seemingly particular details like the distinctive 'three-toed lizard' tracks (44) that draw the attention of baffled scientists early in the novel, for instance, or the observation by young Tim Murphy, Hammond's grandson, that '*Tyrannosaurus* should only have thirty-seven vertebrae in the tail' (95), are factitious. Crichton's verisimilar use of technical terminology is shored up by persuasive coinages like 'central saurian encephalitis' (21), 'gamma-amino methionine hydrolase' (27) and '*Serenna veriformens*' (85). His inaccurate narratorial description of pterosaurs as 'flying dinosaurs' (279), also suggests uninterest in basic taxonomy. Material like this is used in the factual, expository digressions undertaken by Crichton's free indirect narration, which moves between characters' minds to provide a polyvocal narratorial voice very different to that of Doyle's Malone. In *Jurassic Park* these multidisciplinary digressions include asides on Costa Rican biodiversity (23), 'ecological hyperspace' (44) and, of course, chaos theory. As Sherri Crichton (2017: 291), the author's widow, later contended, 'You always came out of a Crichton novel, film, or television event smarter and wanting more'.

This impression of scientific currency – some real, some concocted – bolstered Crichton's authoritative tone. Just as Doyle dovetailed current palaeontology with commentary on contemporary scientific culture, Crichton's popularisation of Dinosaur Renaissance thinking served to critique a subject that he felt was about to have an explosive effect on society: industrial bioengineering. ‘The commercialization of molecular biology’, the semi-journalistic introduction to *Jurassic Park* declares, ‘is the most stunning ethical event in the history of science’ (1991 [1990]: viii). Crichton’s novel contributed to a conversation that had been rapidly evolving ever since the Second World War and subsequent Cold War tensions generated unprecedented professional opportunities for US scientists, including at ultra-rich universities (significantly, universities hardly figured in the boisterously backward-looking science in Doyle’s *The Lost World*). Crichton’s introduction lays out an idealised history of ‘pure’ science as ‘free and open enquiry’, characterised by a ‘long-standing antagonism’ between ‘university scientists’ and ‘contaminating industry ties’ that was obliterated by the birth of a largely ‘thoughtless’, ‘uncontrolled’ and profitable biotech sector in late 1970s California (vii–viii). The reductive, polemical notion that academic science had sold out, financially and ethically, was a constantly reheated narrative in postwar media, although academic and industrial science had undeniably become deeply cross-pollinated (Shapin 2008: 41–6, 87, 98). In *Jurassic Park*, even the noble Grant, working in the ostensibly uncompromised field of palaeontology, takes on his role as InGen consultant in exchange for funding on his digs (37–8).

As *Jurassic Park*’s framing implies, Crichton intended his techno-thrillers as interventions, albeit saleable ones, skewering science’s problematic role in modern life. Joanna Radin (2019: 308), who sees what she calls the ‘speculative present’ of Crichton’s novels as complementing contemporaneous scholarship in Science and Technology Studies (STS), observes that Crichton’s readers were, even if inadvertently, ‘voting with their wallets, demonstrating concern about how they had been excluded from the decision-making process’ of science’s place in society. His novels, supplemented by quasi-nonfictional prefaces, graphs and afterwords, blended plausible technoscientific concepts into fictional plots. The approach is pithily expressed in a later novel, *Next* (2006), part of his media campaign against gene patenting, which declares itself to be ‘fiction, except for the parts that aren’t’ (n.p.), and ends with an ‘Author’s Note’ relaying the ‘conclusions’ of Crichton’s ‘research’, including the imperative: ‘Stop patenting genes’ (417).

Attacks from bestselling novelists were no insignificant matter to professional scientists. During the 1980s and 1990s, the scientific community was attempting to understand how an apparently immense faith in scientific methods among non-scientists socially coexisted alongside unprecedented scepticism about institutionalised science, fuelled by nuclear scares, ethical controversies, fringe theories and, it was claimed, 'postmodernism' (Thurs, 2007: 1–2). Crichton (1993) at times placated scientists, downplaying the seriousness of his novels' criticisms, and his aforementioned fringe interest in psychic research during this period was neither as intense nor as well publicised as that of Doyle. However, he also contributed to scientists' siege mentality by making strident statements in prominent forums, as when denouncing aspects of biotechnology as an 'absurd' meddling 'with our ecological heritage' in a 1990 *Today* interview. Throwing fuel on the fire, his antagonists in *Jurassic Park* are painted with broad brushstrokes as amoral appropriators of scientific research, as when Hammond theatrically insists that he 'would never' do something so unprofitable as '*help* mankind' (Crichton, 1991 [1990]: 200).

The film's earliest viewers recognised that its characters are mostly divided into those who respect and fear the natural world and those with 'a callous disregard for' it (Uhlir, 1993: 94). This symbolic divide is even starker in Crichton's novel. The avaricious Hammond's right-hand man in the control room is geneticist Wu, lured from Stanford University to private industry by Hammond's argument that, after 'World War II, all the really important discoveries have come out of private laboratories' (Crichton, 1991 [1990]: 123). The talented but ethically flexible Wu is in thrall to the resources at his disposal in industry, numbering batches of dinosaurs 'like software' (128). 'Your Dr. Wu', argues Malcolm, 'does not even know the names of the things he is creating' (305). At Hammond's left hand is systems engineer John Arnold, previously employed in designing both submarine missiles and theme park rides. Arnold unfailingly insists that the disintegrating park will be brought back online (248, 251), amidst a flood of some 11 separate chapters sardonically titled 'CONTROL' (111, 126, 138, 149, 160, 218, 228, 238, 298, 359, 369), and he dies attempting to restore the park's power supply after twice underestimating a *Velociraptor* (307, 309). Similarly, Wu is killed by a *Velociraptor* moments after triumphantly reflecting that the revelation that the dinosaurs can breed – catastrophic though this is to the park's stability – confirms that he has 'put all the pieces together correctly' (334). Malcolm, who previously predicted that the park would fail, dismisses the short-sighted 'thintelligence' of these men (284).

The downfall of Hammond, Wu and Arnold is their failure to acknowledge the complexity of the systems and behaviours they are dealing with. The analysis of complex systems and chaos theory became a longstanding enthusiasm for Crichton. At the end of *Jurassic Park,* he cites physicist and science writer Heinz Pagels as having 'provoked' the character of Malcolm, as well as noting his debt to 'discussions of chaos theory' by science journalist James Gleick and mathematician Ivar Ekeland (n.p.). In *The Dreams of Reason* (1989 [1988]), Pagels chronicled the recent emergence of an interdisciplinary 'synthesis of knowledge based … on the notion of complexity' (36) and 'the realm … that lies between order and chaos' (55). As described in *Jurassic Park*, mathematicians like Malcolm 'used computers constantly', 'worked exclusively with nonlinear equations, in the emerging field called chaos theory' and 'appeared to care that their mathematics described something that actually existed in the real world' (Crichton, 1991 [1990]: 72). Malcolm's 'real world' belief that the park will fail is based on two conclusions from chaos theory: 'that complex systems like weather have an underlying order' and 'that simple systems can produce complex behaviour'. The apparently airtight Jurassic Park, he continues, is 'inherently unpredictable, just as the weather is' (158).

Victor Monnin (2023: 59) points out that the novel's dinosaurs stand as a warning about 'the rising inability to decisively distinguish the natural from the technological'. We would add that dinosaur palaeontology is also Crichton's vehicle for a broader message about the dangers of underestimating complexity in science and technology. The park's energetic and intelligent dinosaurs, inspired by the work of Dinosaur Renaissance scientists, display weather-like behaviour, and, unlike the 'thintelligent' industrial technicians, the main protagonists of *Jurassic Park* are academic researchers who respect this complexity. Grant works on dinosaur nesting and social behaviour. For all his expert knowledge, he remains open-minded, confessing that despite '150 years of research and excavation', palaeontologists 'still knew almost nothing about what the dinosaurs had really been like' (Crichton 1991 [1990]: 58). As such, he humbly weighs his palaeontological preconceptions against live evidence. Sattler, a palaeobotanist, is aware that, in the park and beyond, nature's 'green background' is 'busily alive' in 'a complex, dynamic process' that 'most people simply didn't understand' (86).

While Crichton had more respect for academic specialists than Doyle, he was keen not to paint these figures as cloistered pedants. Reflecting the tone and content of Bakker's book *The Dinosaur Heresies* (1986), Grant's research is characterised as iconoclastic and he propounds a masculine preference for 'outdoors' fieldwork in opposition to domesticated 'Teacup Dinosaur Hunters' in museums and laboratories (Crichton, 1991 [1990]: 34–5). The game warden, Robert Muldoon, provides another dose of reality. Muldoon, who is killed by a *Velociraptor* in the film but survives in the novel, holds an 'unromantic view' of animals that alerts him to the difference between 'cloning dinosaurs in a laboratory' and ‘[m]aintaining them in the wild’ (146). The near-mindlessness of Doyle’s early twentieth-century dinosaurs allows the complex ecosystem of Maple White Land to be brought substantially under human control, but, in Crichton’s story, the nature-harnessing bluster of high imperialism is gone. Indeed, so persuasive was Crichton’s message about the neither fully ‘comprehensible’ nor ‘totally chaotic’ nature of the environment that one reader commended the novel to the US National Park Service’s industry magazine, *Park Science* (Valen, 1992: 19).

While many of Malcolm’s chaos-founded predictions are validated, his own function as a protagonist, and his role in Crichton’s critique of industrially compromised science, is more ambiguous. A wound received in his unwise attempt to flee the *Tyrannosaurus* renders him unhelpful during the second half of the narrative, finally killing him (and almost the exact same sequence of events occurs in Crichton’s sequel *The Lost World*, which begins with Malcolm being retrospectively declared alive). In *Jurassic Park,* as other characters fight to survive, a morphine-fuelled Malcolm descends into what Radin (2019: 310) has shown are STS-influenced attacks on the truth-claims of Western science, denouncing the ‘penetrative act’ of ‘pure scientific discovery’ (Crichton, 1991 [1990]: 284) and attacking scientists’ ‘dreams of reason’ (351). These aspects of his personality are based less on the chaos theoreticians Crichton was so impressed with than on relativistic, ‘postmodern’ philosophers of science like Paul Feyerabend, whose opinions Crichton may have encountered in Pagels’s *Dreams of Reason* (e.g. 1989 [1988]: 259), and they hardly align with Crichton’s own commonplace views about pure science’s apolitical access to truths. Moreover, Crichton’s sequel, *The Lost World* (1997 [1995]: 429), expresses an anti-intellectual scepticism about misanthropic ‘theories’, including Malcolm’s speculations about the destructive nature of humanity. As such, Malcolm should not be read as a straightforward authorial mouthpiece in *Jurassic Park*.

In 1995, during a Charlie Rose interview about *The Lost World*, Crichton was already commenting that he was ‘not persuaded’ by the threat of global warming. By 2003, lecturing at Caltech, he declared his general ‘anger’ at ‘post-modernist claims … that science is just another form of raw power’, except with regard to climate science, where he felt the ‘post-modernist’ stance was validated by the ‘political’ nature of evidence for global warming (which he compared to ‘fraudulent’ data used to argue for the negative effects of second-hand smoke). This returns us to Crichton’s lecture to the Washington Center for Complexity and Public Policy, with which we began (2017 [2005]). We have already mentioned its striking, albeit implicit, parallel between the history of Yellowstone

National Park and of Jurassic Park, and its explicit parallel between the dangers of attempting to introduce controls on Yellowstone's ecology and those of attempting to ameliorate changes to the world's climate. If we take these analogies seriously, we see that, in his scenario, those who actively attempted to protect Yellowstone's endangered species, and those who wish to enforce measures to combat global warming, are the equivalents of Hammond, Wu and Arnold: hubristic and naïve. Those who doubt the efficacy of these measures are equivalents of Grant, Sattler and Malcolm, representing caution, moderation and doubt. It perhaps goes without saying that Crichton's account of the history of Yellowstone should be adopted no more uncritically than his pronouncements upon climate change.

Crichton was in this respect a small-c conservative. As such, while he was enraptured with the power of scientific methods, he distrusted scientists whose actions threatened his way of life. For him, the palaeontology practised by Bakker, or Grant, was a skilled, politically untainted detective work that shone light into the abyss of deep time. Commercialised bioengineering and politicised climate science, in contrast, threatened to bring disturbing, depressing changes to the contemporary world. One of Crichton's strongest weapons was denialism. Practitioners of denialism work by 'sowing doubt, calling for more research, and muddying the public's understanding of a clear consensus in the scientific community' (Gordin, 2021: 94). This was the strategy of Crichton's lecture, which went on to use discredited apocalypse scenarios like the Y2K bug to argue that theoretical dangers described in 'excessively frightening' terms in newspapers 'won't matter in six months'. Climate change was not 'the end of the world', but, rather, it '*is* the world' (Crichton, 2017 [2005]). These words recall Malcolm's assertion in *Jurassic Park* that 'sudden, radical, irrational change' is 'built into the very fabric of existence' (Crichton 1991 [1990]: 171). Just as Malcolm makes little effort to fix Jurassic Park, Crichton was less interested in applying the sciences of complexity to climate change studies than he was in preventing infrastructural change. Whether in the pages of a palaeontological techno-thriller or in a lecture on global warming inaction, chaos and complexity functioned as computer-age expressions of an older theme, familiar also to Doyle: the enchanted mysteriousness of the natural world.

Prehistoric enchantment in the twentieth century

Even in Doyle's time, mass audiences no longer needed to be convinced by purveyors of popular science that dinosaurs were as exciting as the dragons of romance. Gazing upon the skeletons of prehistoric animals in natural history museums appeared to provide almost self-evident proof that science had not robbed the world of all enchantment. Palaeontologists possessed the power to imagine scenes beyond all experience, a power crucially containing within it an acknowledgement of the ultimate impossibility of revisiting these scenes. Palaeontology's empowering scope and final humility seemed to provide a unique escape route from, rather than a collusion with, the sordid and depressing aspects of modern scientific culture. Arthur Conan Doyle and Michael Crichton addressed very different moments in the development of this culture, but their message relied on a shared vision. *The Lost World* eulogises the conquering imperial naturalist's ability to stand at the peak of evolution and, in the process, to generate endless wonders never to be fully conquered. In *Jurassic Park*, palaeontology's practitioners humbly gather evidence for their time-transcending deductions about the behaviour of long-lost animals – the ultimate riposte to the perversions of pure science Crichton saw in the bioengineering industry and, subsequently, in climate research.

Diagnosing 'The Growth of Antiscience' in the *Skeptical Enquirer* in 1994, secular humanist Paul Kurtz called for 'partisans of science' to enact a 'public *re-enchantment* with the ideals expressed by the scientific outlook' (263). Kurtz cited the apparently technophobic *Jurassic Park* as an example of prevalent antiscientific sentiment, but it would have been more accurate to characterise it as a manifestation of '*re-enchantment*', albeit not a manifestation in the form of what Crichton (1999: 1462) dismissed as 'round-the-clock boosterism for science and technology'. For all its scepticism about technoscientific hubris, few viewers of Spielberg's 1993 film could fail to recognise that moments like the protagonists' encounters with *Brachiosaurus* and *Triceratops* represent almost unparalleled pieces of propaganda for the wondrous potential of science and technology. Admittedly, viewers turning to Spielberg's source material are met by a far more cynical tone. Without Richard Attenborough's misguided but kindly Hammond, John Williams's ecstatic score, or Industrial Light and Magic's CGI, the wonder underlying the tainted theme park impresses itself very little. In contrast with the *King Kong*–like gates through which the visitors enter the park in the film (Figure 2.5), in the novel they are greeted by 'a crude, hand-painted sign'

(Crichton, 1991 [1990]: 80). Grant groans at the disillusioning fact that the *Tyrannosaurus* has 'sensitive skin' that 'sunburns easily' (145). When Hammond rants that the visitors 'aren't experiencing the wonder of it all', Arnold responds that '[w]e can't make them experience wonder' (153). Lex, Hammond's granddaughter, complains that the dinosaurs 'just sit there like a picture in a book' (143), as if the dinosaurs were merely illustrations in a work of popular science. Crichton's tainted theme park is not Malone's unspoilt playground.

Once the dinosaurs escape, apathy is replaced by terror until the novel's climactic scene, one excluded from the 1993 film (the screenplay for which was originally written by Crichton but revised almost beyond recognition by David Koepp). Grant asserts that, before the park is destroyed, the dinosaurs' nesting sites, made possible by their unpredicted 'gender transition' or 'plain changing sex' (Crichton, 1991 [1990]: 375), must be inspected. In a chapter called 'DESCENT', Grant and Sattler climb down a hole in a 'hellish' and 'sulfurous' volcanic field (376) into the abandoned industrial space where the raptors have nested. This underground descent in search of truth is a classical literary trope (Sommer, 2003), present in Verne's *Voyage*, the protagonists of which descend into a volcano.

Figure 2.5 The famous gate to Jurassic Park, as depicted in Steven Spielberg's film. This version taken from a recreation in Jurassic Park: The Ride at Universal Studios Hollywood. Photograph by HarshLight, CC 2.0. Wikimedia Commons [https://commons.wikimedia.org/wiki/File:Jurassic_Park_(28733067663).jpg].

When Grant first appears in the novel, he is excavating an '[i]nfant velociraptor', it being 'one of Grant's dreams … to study infant-rearing behaviour in carnivorous dinosaurs' (Crichton 1991 [1990]: 43); now, underground, he sees what he has 'thought about … for his whole life' (377). Gazing through the eerie 'phosphorescent green glow of the night-vision goggles' (388), Grant marvels at the wild raptors' behaviour, especially the coordination of their movement in a strange

> northeast-southwest spatial orientation. That was beyond Grant. But, in another sense, he was not surprised. Paleontologists had been digging up bones for so long that they had forgotten how little information could be gleaned from a skeleton … a skeleton was a poor thing, really, from which to try and deduce the total behaviour of an organism.
>
> … Like other palaeontologists, Grant had become very expert at working with bones. And somewhere along the way, he has started to forget the unprovable possibilities—that the dinosaurs might be truly different animals, that they might possess behaviour and social life organized along lines that were utterly mysterious to their later, mammalian descendants (394–5).

Scientific enchantment is not to be had within the managers' dream of total control, but without it, where the bioengineered dinosaurs have constructed their own 'mysterious' world. Grant's lack of illusions about the completeness of his knowledge allows him to see his earlier hypothesis of a 'dominant male' (58) *Velociraptor* hierarchy give way to an understanding of the true 'matriarchal pecking order' (394). When the Costa Rican Air Force break up the captivating scene, an officer asks the survivors who is in charge. Grant replies, 'Nobody' (397).

The fact that Grant, even in his moment of rapture, is formulating a new theory of dinosaur behaviour, points to another divergence between Crichton's novel and Doyle's. Unlike *The Lost World*, *Jurassic Park* takes pure scientific research seriously. If Doyle took his science from a children's book, and addressed his own book partially to children, Crichton read the work of leading architects of the Dinosaur Renaissance, in addition to consulting volumes on the cutting-edge subjects of complexity theory and genetic engineering, in order to build a narrative voice that emanated scientific authority. Doyle distanced palaeontological fiction from its didactic origins, and his depiction of science wilfully pushed against the mundane realities of scientific practice; Crichton pulled palaeontological fiction and instruction together again, aiming to entertain mass readerships while enflaming them with the desire to become informed sceptics of industrial science. Although much had changed since popularisers first espoused palaeontology as one of the 'fairy tales of science', both men idealised it as a form of modern enchantment – but now this idealisation also contained the barbed implication that not all scientists have science's best interests at heart.

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3
Winsor McCay's *Gertie*: the first living dinosaur

Victoria Coules

On 8 February 1914, a living, breathing dinosaur appeared on the stage of the Palace Theatre in Chicago (Canemaker, 2018). The tame dinosaur, '*Gertie*', was the centrepiece of a vaudeville act, *Gertie the Dinosaurus*, and performed (mostly) to command by Winsor McCay (1866–1934) (Figure 3.1), who was dressed in formal evening wear like a circus trainer and carrying a short whip. They interacted for about seven minutes, until Gertie picked McCay up and carried him offstage, to thunderous applause. What *was Gertie*? A puppet? Men in a costume? No, *Gertie* was an animated drawing of a dinosaur projected onto a screen, while McCay on the stage next to the screen appeared to engage with it.

McCay is crucial to any discussion of the relationship between palaeontology and the public for two reasons. He brought the dinosaur out of the domain of palaeontologists and museums into the world of entertainment – and he was the first to make a dinosaur *move*. As this chapter will show, McCay based his animation on the most up-to-date palaeontology of the time. He lived in New York so had access to the American Museum of Natural History (AMNH) and its displays of vertebrate palaeontology, yet *Gertie* was created purely for entertainment. McCay performed in vaudeville but his 'day job' was as a commercial artist, drawing comic strips for newspapers, and he became fascinated by a new form of drawing – animation. His animated dinosaur was a simple sequence of line drawings of the *Brontosaurus* displayed at the AMNH, projected onto a screen and giving the illusion of responding to McCay's commands.[1]

Along with the circus, vaudeville was an entertainment that catered for the working classes. In the post-Civil War period there had been a massive influx into the cities, a mixture of rural workers and immigrants,

Figure 3.1 Portrait of Winsor McCay in 1906, a version of which appeared in the *New York Herald* on 17 February 1907. Image in public domain, obtained from Wikimedia Commons [https://commons.wikimedia.org/wiki/File:Winsor_McCay_1906.jpg].

so by the start of the twentieth century, urban centres such as New York City were bursting at the seams, and these workers wanted to be entertained. The theatre was expensive, perceived as high-brow and upper class, and cinema as entertainment was yet to be established. Vaudeville consisted of a programme of short, varied stage acts such as singing, dancing, juggling and acrobatics, and like the circus, it was affordable to working men and women. In animating *Gertie* for a vaudeville act, McCay not only created a dinosaur for entertainment but took palaeontology to the working classes, purely for fun rather than education. There were illustrations of prehistoric creatures in popular books such as the Joseph Smit drawings in Hutchinson's *Extinct Monsters. A Popular Account of Some of the Larger Forms of Ancient Animal Life*, but *Gertie* could move and was intended to make the audience laugh (Hutchinson, 1897).

The cartoon of *Gertie* was later preserved in a 14-minute silent film, *Winsor McCay, America's Greatest Cartoonist and Gertie,* made by McCay and released at the end of 1914.[2] The film was made because of a conflict of interest. McCay's vaudeville act was so successful, with enthusiastic reviews in New York newspapers such as *The American* and the *The Morning Telegraph*, that McCay's employer, newspaper magnate William Hearst (1863–1951), thought McCay was spending too much time on the act when he should have been working on illustrations for his newspapers (Canemaker, 2018). Hearst started to block any advertisements for the vaudeville show in all his papers. So McCay made *Gertie* into the stand-alone film, with the cartoon book-ended by a live-action story featuring McCay, and what would have been his stage commands replaced by intertitles. This film was made and distributed by the Box Office Attraction Company, owned by one William Fox, which was to become one of the largest and most powerful media corporations in the world, counting Twentieth Century Fox, the Fox Networks and National Geographic among its subsidiaries.

So why have I called *Gertie* the 'first living dinosaur'? Because *Gertie* was the first dinosaur to be animated. Also in 1914, the notable director D. W. Griffith (1875–1948) released *Brute Force*, a 33-minute film that includes a brief scene of live action cavemen meeting and defeating a crude, model, stop-frame dinosaur but this was not until later in the year, in September (Griffith, 1914). *Gertie* is on screen for over seven minutes and is the central character. She engages the audience, and has a clear identity and a personality, albeit somewhat anthropomorphic, and McCay drew on the scientific knowledge of the time about dinosaurs to give her that identity.

The potential of film to show 'unreal' creatures and situations through trick photography and animation was realised very early on and dinosaurs were an ideal subject. Their skeletons gave a sense of their appearance, but they were, effectively, imaginary animals. The challenge to animators was, and still is, to extrapolate their understanding of how extant animals move to create a believable animal that no one had ever seen – let alone witnessed their movement – that appeared to move in a realistic way.

By the time he was ready to introduce *Gertie* to the world, McCay was already well-known for his newspaper comic strips, and an advertising poster for the film made by the distributor, the Box Office Attraction Co., shows an inset image of McCay, labelled 'America's Greatest Cartoonist' (Figure 3.2). The scale of the dinosaur is vastly exaggerated against the building and the cars. The enterprise is sponsored by the Acme Motor

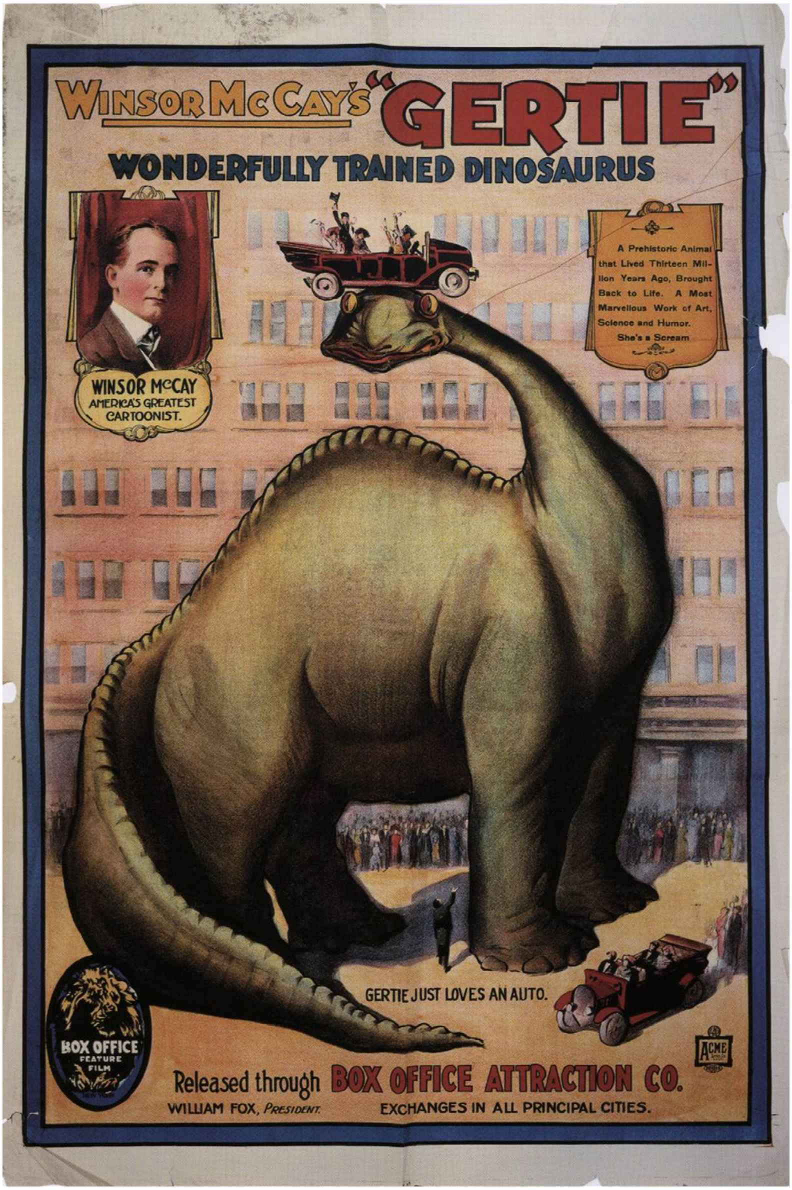

Figure 3.2 Advertising poster for Winsor McCay's film *Gertie the Dinosaur*. Image in public domain, obtained from Wikimedia Commons [https://commons.wikimedia.org/wiki/File:Gertie_the_Dinosaur_poster.jpg].

Company, hence the tag line 'Gertie just loves an auto', with images of the cars on the ground and on her head, so the film was considered profitable enough to attract commercial sponsorship. Again, vastly exaggerating the scale, there is a tiny figure at the dinosaur's feet, presumably meant to represent McCay in the act. A block of text top right explains 'A Prehistoric Animal that Lived Thirteen Million Years Ago, Brought Back to Life. A Most Marvellous Work of Art, Science and Humour. She's a Scream'. The marketing of the film promotes the science – however inaccurately – so although firmly in the genre of humour, the film and the act are grounded in the science of palaeontology.

As previously noted, McCay based his animation of *Gertie* on the mounted *Brontosaurus* skeleton in the AMNH, New York.[3] Although the museum had a display of *Allosaurus*, a carnivorous theropod, it was shown in a scavenger pose and the attraction of dinosaurs was their size rather than ferocity. 'Fierce' dinosaurs did not capture the public imagination until much later, after *Tyrannosaurus rex* was displayed in 1915, in the same museum. Victoria Cain analyses the AMNH initiative to feature the idea of visual education in their exhibits. This was part of a wider philosophy that aimed to encourage the urban working classes to engage with the natural world by giving them images rather than text or isolated objects with no explanation (Cain, 2010). The museum's curator of the Department of Vertebrate Palaeontology, Henry Fairfield Osborn (1857–1935), employed the artist Charles R Knight (1874–1953) to paint representations of prehistoric creatures as if extant and in their environments as part of their displays. He believed that the museum's role included a '…social responsibility to expose Americans to the natural world through such reconstructions… (Cain, 2010).' So McCay would have been able to visit the museum to see Knight's paintings as well as the articulated skeletons to give him references for *Gertie*.

What were the influences on McCay that led him to create Gertie?

To understand the influences on McCay and the context of his vaudeville act and film, it is useful to briefly consider his early life story. The animator and historian John Canemaker (1942–) has written extensively about McCay, including a comprehensive biography, revised and updated in 2018, *Winsor McCay: His life and art* (Canemaker, 2018). This is the most authoritative source of information on his life and work, including his comic strips and political cartoons as well as animated films.

McCay's exact date of birth is difficult to confirm as he gave different versions during his life, but the best estimate was that he was born in Canada in 1867. The boy's passion for drawing became apparent at an early age and he drew incessantly, mostly from life, apparently for his own satisfaction rather than to show to others. Winsor's father sent him to business school at Ypsilanti, near Detroit, but he skipped classes and went into Detroit where he earned money drawing caricatures and cartoons. He worked for Sackett and Wiggins' Wonderland, a dime museum – one of the many lowbrow establishments that displayed sensationalist oddities for a nominal entry fee.

McCay's reputation as an artist grew, and in 1888 he attracted the attention of Professor John Goodison, of Michigan State Normal School, who offered to give him private lessons in drawing. These lessons emphasised drawing from direct observation (rather than copying existing images) and the principles of accurate perspective, which became the foundation for McCay's drawing style throughout his career.

Figure 3.3 Mrs Maude McCay, c.1910–15. Image in public domain, obtained from Wikimedia Commons [https://commons.wikimedia.org/wiki/File:Mrs_Winsor_McCay_circa_1910%E2%80%931915.jpg].

By 1889 he had moved to Chicago and worked as an apprentice at the National Printing and Engraving Company, where he created promotional posters for clients that included travelling circuses and, in 1891, he moved to Cincinnati. He carried on working for dime museums and later in 1891, after a whirlwind romance, he eloped with society beauty Maude Dufour (1877–1934) (Figure 3.3). But the marriage and, before long, children, put financial pressure on McCay, who started taking additional work sign-painting and making posters. In 1900, he was approached by the *Cincinnati Enquirer*, and for a regular pay cheque, albeit on a non-exclusive contract, started work as a newspaper illustrator and cartoonist.

He began to develop his interest in fantasy and humour and as a freelance artist, he also submitted cartoons to *Life*, which, at that time, was a humour magazine (O'Sullivan, 1976). In 1903, he was contacted by the *New York Herald* and offered a staff job, so he moved his family to New York. He was creating regular comic strips, published weekly in the Sunday editions, which made him a popular and recognised contributor to the paper. While working on his newspaper comic strips, McCay began his career in vaudeville with his 'lightning sketches', or 'chalk talks', where the act of live drawing was the performance itself (Telotte, 2007). This act was not new; indeed, the British sculptor and palaeoartist Benjamin Waterhouse Hawkins (1807–1894) had used lightning sketches to illustrate his talks both in Britian and during his period in America.

McCay's performances were well received and within three years he was a celebrity in his own right. He had seen stage performances of James Stuart Blackton (1875–1941), who used 'trick films' made from doctored photographic film as part of his stage act, which gave McCay the idea of making his own animations (Canemaker, 2018). McCay's first attempt was a film version of his well-known regular comic strip *Little Nemo in Slumberland*, which he made in 1908, and McCay was assisted by his neighbour, art student John FitzSimmons (O'Sullivan, 1976). The animation used the *Little Nemo* characters but they were shown in empty film space, moving in a strange 'dance' that stretched and compressed their bodies. He followed this success with the rather bizarre *The Story of a Mosquito* (or *How a Mosquito Operates*), a sequence of a close-up sleeping man's face and a mosquito (mysteriously called Steve) landing on him and drinking his blood, its abdomen distending until it explodes (McCay, 1912).

Then he was ready to make the more sophisticated animation of *Gertie*. As he toured in 1912, his interest in dinosaurs led him to declare to a film trade magazine, *Motography*:

> What interests me the most… is the possibilities of serious and educational work with this method of producing moving pictures. I have already had a conference with the American Historical Society looking to the presentation of pictures showing the great monsters that used to inhabit the earth. There are skeletons of them on exhibition and I expect to draw pictures of these animals as they appeared in real life thousands of years ago and show them as they trampled their way through dense jungles, ate a stump or pulled down a tree or had a battle with others of their kind. There is almost no end to what an artist might do with such an idea (Canemaker, 2018).

Despite this declared interest in using animation for educational purposes, McCay was operating in the competitive, commercial arena of popular entertainment. He was working on the drawings for *Gertie* in 1913 and moving pictures as mass entertainment had only begun in 1895 with the first film projected by the Lumière Brothers in France, but the concept of sequences of images generating apparent movement was not new (Bendazzi, 1996). Experiments in moving picture devices included optical toys such as the praxinoscope, which used a strip of pictures around the inner surface of a cylinder; viewing the spinning images by a system of slits and mirrors produced the illusion of movement. The first flipbook had appeared in 1868 and indeed, McCay is said to have been intrigued when his son brought home 'flippers' (flipbooks) from school (Bendazzi, 1996; Connelly, 2011). But in the 10 years of development of moving photographic images as entertainment, although a few such as Blackton had experimented with 'trick photography', the idea of creating a moving image for film from line drawing was little explored.

Why did McCay chose a dinosaur to animate for his stage act? He was clearly interested in them, as he had featured dinosaurs looking very similar to *Gertie* in some of his earlier strip cartoons such as *Little Sammy Sneeze* and *Dream of the Rarebit Fiend*. It has been suggested that McCay animated a prehistoric creature to prove he wasn't simply tracing or copying the frame-by-frame photography of animals in motion pioneered by Eadweard Muybridge (1830–1904) but there seems to be no direct evidence of this (Roeder, 2014).

Although he had already included dinosaurs in his popular comic strips, along with other types of animals, the time and energy to create *Gertie* was a significant commitment; he would be in competition with other popular entertainment and would need to be confident that his act would give him a return against the time invested. Considering two sectors of public entertainment will put this decision in context.

The first sector draws on the observation of the Other, the term used to denote another person or people different and separate from oneself. This was the circus. At the end of the nineteenth century, the circus was integral to American culture and 'Circus day' was the biggest day of the year in small towns as well as the big cities (Mishler, 1994). During the so-called 'Golden Age' of the circus (1860–1918), P. T. Barnum's (1810–1891) extravaganza, 'Barnum and Bailey', performed to thousands every day. The public paid to see displays of extraordinary skill, such as trapeze artists and novelty acts, but were just as fascinated and curious about the Other, in the form of unnatural human oddities such as a bearded woman, conjoined twins or unnaturally tall or short performers. They were also drawn by animal performers including lions and elephants, and the thrill of seeing the human ringmaster control 'wild beasts', subjugating them to his will while risking that the animal might refuse to cooperate. Barnum's circus had several Indian elephants but in 1882, Barnum purchased the African elephant 'Jumbo' from London Zoo (McClellan, 2012). Jumbo was publicised as the largest elephant in the world, so much so, that the name, 'Jumbo', derived from the Swahili word for 'Hello', became synonymous with 'very large.' Jumbo was the central attraction of Barnum's circus acts until the elephant's accidental death in 1885 and even after this, Barnum still publicised Jumbo; the animal's skin was prepared and stuffed so it could still travel with the circus, and the skeleton eventually resided in the AMNH (McClellan, 2012).

The structure of McCay's act draws directly on the circus; many of the big cat acts of the early twentieth century circuses followed just this pattern (Bouissac, 2014). The lion or tiger tamer asserted his authority by ordering the animal to obey simple commands, but then part of the way through the act an element of jeopardy was introduced, when the cat might roar or lunge at the trainer; it looked dangerous to the audience but had been rehearsed in advance. The tamer admonishes the animal, the act continues and at the end, the tamer and cat interact in some direct way, for example, a hug. In *Gertie*'s act, McCay would start by asking her to bow to the audience, then raise her right foot, which she did. When he asked her to raise her other foot, she became distracted and restless then lunges at McCay standing to the right of the screen, so he told her off, which made her cry. At the end, he appeared to go behind the screen and then, on screen, his figure was picked up by *Gertie* in her mouth and placed on her head, before carrying 'him' off screen.

The second factor was that described by Paul Brinkman as the 'second Jurassic dinosaur rush' (Brinkman, 2010a) – 'second' because it followed the 'first' dinosaur rush, the undignified feud between Edward

Drinker Cope (1840–1897) and Othniel Charles Marsh (1831–1899) during the 1870s and 1880s. Both palaeontologists, they collected fossils of extinct mammals, birds, marine reptiles and dinosaurs from the American Midwest and, although originally friends, became bitter rivals, competing to find and name the most dinosaurs, often resorting to direct sabotage of each other's expeditions. This prolific 'first' dinosaur rush became known as the 'Bone Wars' (Dingus and Norell, 2010). However, when this unseemly furore eventually died down, fossils were generally considered the province of palaeontologists, shut away in museum collections. The exception was when, in 1868, the Academy of Natural Sciences, Philadelphia (ANSP) had displayed the full skeleton of a dinosaur, *Hadrosaurus foulkii*, in a lifelike bipedal pose and the response was overwhelming. The public had flocked to see the specimen, fascinated by its size – it stood at over 4 metres tall – and that it was posed as bipedal, similar to humans but not human.

Historians Paul Brinkman and Lukas Rieppel describe how the second 'rush' occurred. Museums began to compete to display fully mounted skeletons of dinosaurs, preferably the biggest and most spectacular. So many people had visited the ANSP museum to see the *Hadrosaurus foulkii* skeleton they found they could charge an entrance fee of 10 cents and visitors would still flock to see it (Rieppel, 2012). Brinkman gives a detailed description of how the 'big three' natural history museums – the AMNH, the Field Colombian Museum in Chicago and the Carnegie Museum in Pittsburgh – brought palaeontology out of the realm of private collections into the large museums, funded by philanthropists who had amassed vast personal fortunes from the fast expansion of America's industry (Brinkman, 2010a; Rieppel, 2019). Rieppel explores the financing of these museums and establishes the context of dinosaurs in American capitalism, at its peak in the early twentieth century.

By the turn of the twentieth century, the race was on between the AMNH in New York to show a *Brontosaurus* (Figure 3.4) and Andrew Carnegie's Museum of Natural History in Pittsburgh to show a *Diplodocus*. In his book *An American Dinosaur Abroad*, Ilja Nieuwland explores the role of tycoon Andrew Carnegie and his ambition to display an immense dinosaur, resulting in his museum acquiring the *Diplodocus* skeleton; Carnegie then presented casts of this skeleton to crowned heads of state in Europe and South America (including the well-known 'Dippy' formerly in London's Natural History Museum) (Nieuwland, 2019).

In 1905, the AMNH 'won' by revealing their *Brontosaurus* on 16 February, to a much-publicised tea party in the museum, hosted by the director Henry Fairfield Osborn (1857–1935) and the financier of the

Figure 3.4 The *Brontosaurus* mount in the Hall of Dinosaurs of the American Museum of Natural History. Photographed in 1921 by Kay C. Lenskjold. Courtesy of the American Museum of Natural History Library [Image ID: 38715].

operation, wealthy banker J. Pierpont Morgan (1837–1913). Osborn was the museum's head of vertebrate palaeontology and was determined to continue the trend of the museum to display skeletons and associated images and models to the public; it helped that Morgan was his uncle, and he and Osborn moved in the wealthy and high society circles of New York, so Osborn could raise funds for the museum. Pittsburgh eventually unveiled their *Diplodocus* in 1907 (Brinkman, 2010b). Winsor McCay had been living in New York since 1903 and the unveiling of the AMNH skeleton was covered extensively by the New York press, so he would have been very familiar with the specimen and the accompanying paintings of sauropods by Charles Knight (O'Sullivan, 1976).

Knight's colour painting of a *Brontosaurus* and a *Diplodocus* was displayed underneath the *Brontosaurus* skeleton, and a monochrome version of the painting was reproduced in the museum guide of 1911 (Sherwood, 1911). A later painting by Knight shows a *Diplodocus* rearing up to browse on vegetation at the treetops. Knight had worked closely with staff at the museum to portray the dinosaurs as accurately as was possible in the context of what was known at the time, to be presented to museum visitors as definitive. McCay would have been able to view these paintings in the museum and keep his own copy of the monochrome version published in the museum guidebook.

In the guidebooks, the caption in both versions of their image reads: 'Restoration of *Brontosaurus*. One of the largest of the amphibious dinosaurs, coldblooded, slow-moving, unintelligent creatures that grew to large size 65 ft. in length in the rich vegetation of the Reptilian era' and this was the prevailing view of dinosaurs when McCay was creating *Gertie*. In today's popular representation of dinosaurs, the dinosaur of choice is most often the fierce predatory *Tyrannosaurus rex*, but throughout the first part of the twentieth century, the fascination with dinosaurs was simply their size, so sauropods such as the AMNH *Brontosaurus* and the Carnegie Museum's *Diplodocus* were the iconic dinosaurs of the time.

Although McCay had previously thought about animating prehistoric creatures, his decision to animate the *Brontosaurus* is described in the *New York Tribune* of 12 July 1914:

> McCay conceived his novel idea from a chance remark made by a friend of his during a visit to the Museum of Natural History in this city. They were in the large room where the bodies of the immense prehistoric animals are shown. They were standing in front of a reproduction of an immense dinosaurus, when the cartoonist's friend jokingly remarked: 'Wouldn't a man with a trained dinosaurus be a riot in vaudeville?' It was only a casual remark, but the idea took root in Mr. McCay's brain (Nathan and Crafton, 2013).

So, combining the popularity of circus animal trainers controlling their wild animals and his fascination with the *Brontosaurus* gave McCay the subject for his famous and most successful animation.

The animation of *Gertie* is significant in the history of palaeontology because she bridged the gap between the representation of dinosaurs in museums as part of their role in demonstrating science to the public, and their role in entertainment, with a commercial value in engaging audiences who would pay to be amused, scared or amazed. Yet, she is equally important in the history of animation. It was the first animation to set its subject in a static landscape throughout the cartoon; it opens with a landscape of receding cliffs and a lake of water on the left of frame, and *Gertie* emerges from a cave in the cliff. She ambles towards camera, moving directly forward through the film space to face the audience and to do her tricks to McCay's staged commands. No previous animation, including McCay's, had achieved this.

When McCay made the film to display the cartoon, it opened with a scene of him and some friends inside the AMNH, next to the *Brontosaurus*, and he bet his friends the price of a dinner he could make a dinosaur move. This was the first time that movie cameras were used inside the museum. Live action then shows McCay creating the drawings, followed by the staged dinner, where a screen beside the table shows the projected cartoon. At the end, McCay is applauded, and the bet is settled. When the film was released, it would be shown on screens on stages in the vaudeville circuit.

How did McCay bring science and art together to create a moving dinosaur?

The cartoon is a simple monochrome line drawing, with very occasional solid black on the edges of the shoreline and the soles of *Gertie*'s feet, and no shadows or shades of grey to imply form, so the sense of three-dimensional depth relies entirely on McCay's command of perspective learned in Professor Goodison's drawing classes.

The Disney animator Paul Satterfield (1896–1981) was an art student in Atlanta and, around 1915, met McCay. He reported that 'Mr. McCay said he haunted the museums of New York trying to figure out what breed of animal or classification of animals the dinosaurs belonged in' (Canemaker, 2018). Choosing to make *Gertie* a *Brontosaurus*, McCay was representing a dinosaur much bigger than any extant animal and to represent her size and weight, he used several visual techniques. Her large feet are slightly splayed in contact with the ground, emphasising her weight; these feet appear bigger than those of the skeleton in the AMNH, and I suggest he is doing this for the sake of perspective. He draws her as if we are looking up at her head, using the perspective of a second vanishing point as in drawing a tall building. This was the technique used by the animators drawing the large dinosaurs in the 'Rite of Spring' sequence in Walt Disney's 1940 feature animation *Fantasia*.(Roberts and Satterfield, 1940). Bill Roberts, the co-director of *Fantasia*, instructed the animators to 'Draw a twelve-story building in perspective then convert it into a dinosaur and animate it' (Culhane, 1999).

But McCay needed to understand how *Gertie* would *move*. A significant decision, which bears further consideration, is to have *Gertie* walking on the ground. A controversy that arose among palaeontologists as soon as sauropods were first described was the question of if and how such big, heavy animals could stand upright and walk on dry land. One argument was that they were so heavy they must be semi-aquatic, living in water, partially or entirely, so that the water could bear their weight. This debate was ongoing around the time McCay was considering *Gertie*. A few palaeontologists, such as Elmer Riggs (1869–1963), proclaimed that sauropods did not have the skeletal features and shape of limbs common to amphibious animals, but the prevailing opinion was that they lived in water (Hallett and Wedel, 2016). Yet, McCay decided to place *Gertie* on land, possibly because of the complication of drawing her moving through water.

In another first in animation, *Gertie* had to be positioned within the frame so that her feet were in the correct place relative to the rest of the trees, rocks, edge of the lake, and cliffs. McCay would no doubt have been taught the principles of positioning with respect to the horizon in his early drawing lessons, so he could make successive drawings, using accurate, relative size changes, to give her the illusion of walking from the back of the film space to the front (Figure 3.5).

McCay was familiar with Barnum's circus and could also visit the Central Park Zoo and the Bronx Zoo, both of which housed elephants and where he could get close enough to see details of the animals such as their feet. Indeed, *Gertie*'s feet are drawn similar to elephant feet in the

Figure 3.5 'Gertie emerges from her cave.' Screenshot from film Winsor McCay's *Gertie,* at timecode 07.24.

shape of the flat sole and arrangement of toes. When *Gertie* lifts a foot, she moves her weight to the opposite side, and the balance of the body and limbs as well as the walk cycle were clearly understood by McCay. To examine how successful he was in achieving a valid reconstruction, Professor John Hutchinson has viewed the film and analysed how she moves in the cartoon compared to how he would expect a big animal to move using his experience and expertise in both extant and prehistoric biomechanics.[4] As Hutchinson noted, McCay would have had access to the work of Eadweard Muybridge, whose innovative photographic technique had revealed the walk sequences of various animals.

Muybridge was an English photographer who had emigrated to the USA, and in the late nineteenth century pioneered innovative photographic techniques to investigate animal motion. It has been claimed that the motivation was to settle a bet whether a trotting horse had all four legs off the ground during the trot cycle, but there seems to be no evidence of this bet. The work was sponsored by businessman Leland Stanford (1824–1893) who commissioned Muybridge to portray, among other subjects, his horse, Occident. It is often claimed that the first images were of a galloping horse, but Muybridge's first experiments were with a trotting horse pulling a two-wheeled carriage, a popular competitive sport at the time (Stillman, 1882). Stanford wanted to understand how horses moved, so Muybridge designed sophisticated photographic equipment to take sequential photographs of the horse running on a track, showing the sequence of different gaits. In the trot, and later shown in the gallop, it revealed that the horse's legs were indeed all off the ground at a point in the cycle. His work was so popular that he went on to create high-speed images of other animals in motion along with human movement such as running, jumping and wrestling; he also included big animals such as elephants and bison. He published the sets of images in books and his work would contribute to later development of the science of biomechanics as well as being hugely influential in photography.[5] The material was certainly available to McCay, either owning his own copy or in the newly opened New York Public Library. Hutchinson confirms that McCay got the walk cycle right: 'The short walk sequence from 06:15 is interesting as the feet contact the ground LF-RH-RF-LH, which is a correct "normal" quadrupedal walking sequence used by most animals.'[6]

McCay did not always get it right. For example, Hutchinson points out that the short hop at the beginning was not possible for a big animal such as an elephant, let alone a *Brontosaurus*, and that her rolling side-to-side motion is not likely in a very big animal because its spine would not be flexible enough. This also applies to the rocking motion she adopts when waiting for McCay's commands, and I suggest that this is a filmic device to keep the image moving all the time, to keep the audience attention on her and avoid appearing as a still image.

McCay seemed to draw on a contemporary discussion about dinosaur digestion when *Gertie* eats a rock, and we see the rock go down her gullet. It is possible that, if McCay was spending time at the AMNH, he would have been aware that dinosaur fossils had been found with gastroliths, 'gizzard stones', stones in the stomach that helped to crush food in the gut in a way similar to many birds (Hallett and Wedel, 2016). The idea of gastroliths in dinosaurs had been suggested by palaeontologist Barnum Brown (1873–1963) in 1907, but recent studies with ostriches have shown that this might not have been the case (Brown, 1907).

In a comic moment, *Gertie* casually pulls the top off a tree to eat it – also another device used by McCay to emphasise her size. She then swallows it more-or-less-whole. Hutchinson points out that she chews side-to-side which is now known not to be the case for sauropods because of their teeth and jaw structure but he is not sure whether that would have been known then. The chewing does lend a sense of authenticity to her eating and swallowing. When *Gertie* dances, McCay draws her on her hind legs, with a large belly pulled downwards by gravity. The question of whether sauropods could rear up was another disputed issue in McCay's time. In Knight's 1907 painting portraying a *Diplodocus* reaching up to browse foliage, it stands in a tripod formation on hind legs and tail, so this could have been a familiar idea to McCay, although Hutchinson suggests that the dance is a clear touch of anthropomorphism, based on the image of an obese human.

Gertie is another first in animation, in that she is a character with a distinctive personality and does not always obey McCay's commands immediately. She can get tetchy, she snaps at him, opening her mouth as perhaps a tiger might roar at the circus ringmaster, but when he scolds her, she cries profuse tears and is only consoled when he throws her a pumpkin (Figure 3.6). McCay maintained the illusion that she is still partly a wild animal, obeying him as suited her, but, as with circus lions and elephants, there is a hint of danger.

Other creatures appear in the cartoon and distract her so that McCay must compete for her attention. At one point, an 'elephant' comes into frame from the left and, perhaps intending to keep the prehistoric sense of the dinosaur, McCay drew it to look more like a mammoth than an elephant, with a tuft of hair on its head and curved tusks (Figure 3.7). *Gertie* and the elephant seem friendly, both waving their tails, curious rather than aggressive, and McCay tells her '*Gertie*, don't hurt Jumbo',

Figure 3.6 'Gertie cries when McCay scolds her'. Screenshot from film, Winsor McCay's *Gertie,* at timecode 09.10.

assuming that the audience would be familiar with the circus elephant. Perhaps Jumbo entering the frame is not only consolidating the circus reference but emphasising the scale of the dinosaur. Jumbo had died in 1885 and the skeleton was on display at the AMNH, certainly by 1914 (although not mentioned in the 1911 guide), so available for McCay to study, but his representation of Jumbo and *Gertie* distorts the scale, making Jumbo appear unnaturally smaller than *Gertie* (Lucas, 1914; McClellan, 2012). She is on her hind legs, leaning forward and pulling back as she peers at Jumbo walking past, but suddenly, *Gertie* hurls him into the lake. This is perhaps another reference to her strength, but as Hutchinson points out, the neck muscles of a sauropod were certainly not strong enough to lift an elephant, let alone throw one. It is not even clear how high a sauropod could have raised its head. But in this comic moment, we also see McCay's mastery of perspective, proportionally reducing Jumbo's size as he flies backwards in frame, and the splash as he disappears into the water.

Gertie celebrates by dancing on her hind legs and does not see Jumbo swim back to the edge of the lake; he gets his revenge by squirting water at her. McCay could have seen the trick performed by circus elephants,

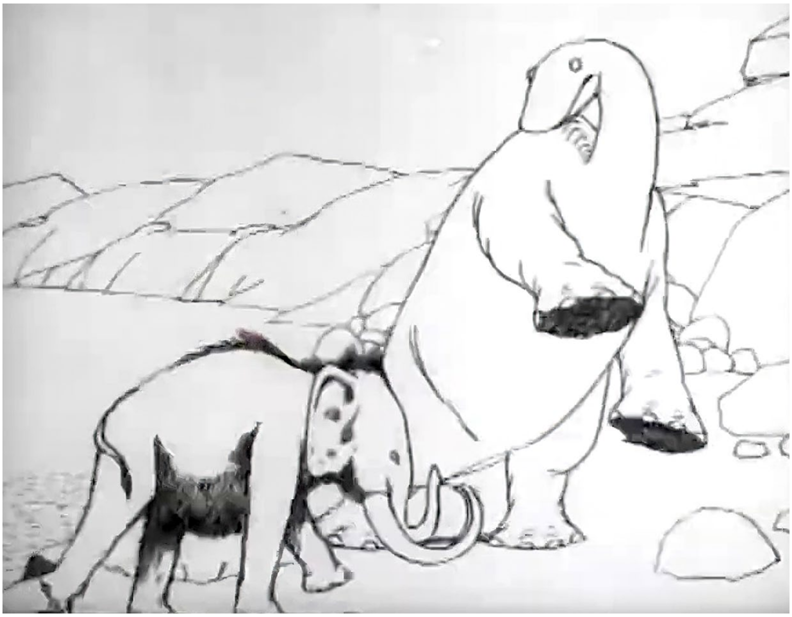

Figure 3.7 'Gertie meets "Jumbo"'. Screenshot from film, Winsor McCay's *Gertie*, at timecode 10.01.

but this is still a considerable amount of water for the relative size of Jumbo. *Gertie* then lies down and uses the end of her tail to scratch her nose, which is funny but impractical with the skeleton and musculature of her spine and tail. A strange four-winged lizard flies past her, a deliberate theatrical sleight of hand by McCay. He had been confident in animating *Gertie* lying down (Figure 3.8) but was unsure of how she would have moved to get up, so by having the lizard flying past – and in the vaudeville act, actually pointing it out – the audience's attention is distracted, and they do not notice the slightly uncertain drawings of her standing up. He admitted to this in a conversation with Paul Satterfield in Atlanta:

> He had [*Gertie*] laying down one time and wanted to get it up. He was trying to figure out how to make this thing get up correctly. Well, the people in the museum didn't know how, and what would the public care. But when he had his dinosaur get up, he brought a flying lizard up through the sky— he told us this there in Atlanta— and he had a pointer, and he said, 'Oh, look at the flying lizard,' (Canemaker, 2018).

Figure 3.8 'Gertie trying to stand up'. Screenshot from film, Winsor McCay's *Gertie,* at timecode 13.10.

A sea serpent briefly appears out of the water, and both the lizard and this sea serpent seem to be included as filmic devices to distract *Gertie* and provide opportunity for her to interact with her surroundings.

Gertie's movements are very smooth, and to achieve this, McCay needed to be able to 'run' the sequence and check it before committing to the expense of generating the film strip by having them photographed. He built a contraption that operated rather like a mechanical flip-book, so that once the drawings were glued onto the card, they could be stacked in this box and flipped so that he could see the motion produced and correct any errors (O'Sullivan, 1976). McCay gave *Gertie* a distinct personality yet drew little in the way of facial characteristics – just two simple circles for eyes and a wide mouth that can open or shut and give some hint of a smile. McCay used *Gertie*'s body movement to imply her nature, including the position of her head and neck to show where she is looking. Once the drawings were finished, they were taken to the Vitagraph studios to be photographed and made into the finished film print (Crafton, 1993).

Although the *Brontosaurus* in the AMNH is not identified by gender, McCay decided to create a female dinosaur with an endearing personality. Her name could be considered as a contraction of 'Gertrude' but, according to Paul Satterfield:

> He heard a couple of 'sweet boys' [gay men] out in the hall talking to each other and one said, 'Oh Bertie, wait a minute' in a very sweet voice. He thought it was a good name but wanted it to be a girl's name instead of a boy's, so he called it '*Gertie*'! (Canemaker, 2018) .

Both McCay's statement and Satterfield's relating of it seem to bear no judgement that could be read as homophobia. McCay seemed adamant that his dinosaur would be female, but there is no clear evidence to explain this decision. It might be construed that it was a reference to McCay's marriage; his marriage to Maude seemed to have been stable but Maude was, by many accounts, a feisty, determined, and single-minded woman, and McCay might have created *Gertie* as a more compliant partner that he could (almost) control, if only in a stage act. McCay kept copious personal journals, but they were destroyed in a fire in 1943 so it is unlikely that this could be further clarified (Canemaker, 2018).

As well as given a female name, *Gertie* is heavily anthropomorphised, with childish traits such as being easily distracted and reluctant to always obey commands, and she bursts into floods of tears when McCay admonishes her, the personality of a child contrasting with the huge frame of the dinosaur. As the sauropod dinosaurs, including *Brontosaurus,* were considered as placid, slow herbivores, McCay's characterisation of *Gertie* was consistent with this. The combination of *Gertie*'s gender and personality implies McCay controls her, wields power over her – he was her master.

At a dinner on 22 February 1914, McCay performed the stage version for the assembled two hundred or so newspaper illustrators and cartoonists of New York, and as well as his act, he gave a long speech about his techniques of animation (Nathan and Crafton, 2013). Although McCay had invented many of these techniques, he refused to patent them, saying: 'Any idiot that wants to make a couple of thousand drawings for a hundred feet of film is welcome to join the club' (Canemaker, 2018). His refusal to patent opened him up to plagiarism and, indeed, in 1915, John Randolf Bray (1879–1978) produced a copy of *Gertie* which was close to the original but identifiably a fake, as well as patenting many of McCay's techniques. Bray saw animation as a potentially lucrative commercial business and when he founded the Bray Studios, he stressed the development of technology as opposed to the artisan craft of McCay (Bendazzi, 1996).

McCay had intended to create a sequel to *Gertie*, provisionally entitled '*Gertie* on Tour', but although he started the drawings and created a few scenes, the film was never finished. Only a few minutes of the sequel have been found; in one scene she plays with a trolley bus, and in another she falls asleep and dreams she is dancing for other dinosaurs, her family and friends. However, some of McCay's sketchbooks have been preserved and one shows his experiments with ideas for *Gertie*'s antics in New York. She uses the Brooklyn Bridge as a trampoline and investigates whether the Washington Memorial is edible; he has made her even bigger in these sketches to interact with the iconic landmarks (Merckl, 2015).

Gertie's influence

The techniques McCay developed from first principles to animate *Gertie* are still used today, even though they are applied by computer instead of pen and ink.[7] Following *Gertie*, dinosaurs appeared in films more frequently as animation techniques developed. Watching the film version of *Gertie*, a young Buster Keaton was transfixed by the tame dinosaur. When making the 1923 film *The Three Ages*, Keaton had asked his writer: 'Remember *Gertie* the Dinosaur? ... The first cartoon comedy ever made. I saw it in a nickelodeon when I was fourteen *[sic; he was at least nineteen]*. I'll ride in on an animated cartoon' (Cline and Keaton, 1923). In a sequence where he appears as a caveman, clay models were used to show him riding on the back of an animated dinosaur that bore a close resemblance to *Gertie*, with a long neck, and short body (Crafton, 2012).

In 1934, Winsor McCay died suddenly, aged 62, of a massive cerebral haemorrhage. He had been drawing the day before it happened and had shown no sign of illness before collapsing, dying a matter of hours later (Canemaker, 2018). His heritage outlived him and would influence the teenage Walt Disney; it is not clear whether young Walt, who was 12 at the time of *Gertie*'s release, saw the cartoon then, but the ability to give what was essentially a simple moving line drawing a distinctive personality was formative in Disney's own development of cartoon characters (Bendazzi, 1996). McCay's techniques established the methodology for animation used by the Disney studios and which are still used today. In 1955 the Disneyland TV series showed a dramatisation of McCay's stage act, with his son Robert McCay as the consultant. Disney freely acknowledged Winsor McCay's contribution to animation and on one of Robert's visits to the studio, Disney pointed out the window of his office to the studio complex and said, 'Bob, all this should be your father's' (Canemaker, 2018).

In 1989, the Walt Disney Studios created a rather ignominious memorial to *Gertie* in the Disney Hollywood Studios at Echo Lake, Orlando, Florida. A full-size replica of her that also served as an ice cream stand stood in the lake, although this was not so much a reference to the earlier aquatic sauropod controversy as to make construction easier, with her standing on blocks in the water rather than legs. Synthetic 'snow' on top of the model and the marketing of the 'Ice Cream of Extinction' were references to an idea that the dinosaurs were rendered extinct by an Ice Age, but it is not clear where the studio accessed this idea. This was before the model of the asteroid impact had been accepted, and the most common explanation at that time was of a prolonged heatwave and drought.[8]

Gertie's significance is not lost on contemporary animators and is taught and discussed in computer effects courses today. In discussion with young professionals in the animation business, it is clear that *Gertie* is still remembered and McCay still admired.[9] Chuck Jones (1912–2002), the director of Warner Brothers cartoons and creator of *Coyote and Roadrunner* and *Bugs Bunny*, to name but a few, was emphatic in his admiration of McCay. He wrote in 1989:

> It is as though the first creature to emerge from the primeval slime was Albert Einstein; and the second was an amoeba, because after McCay's animation it took his followers nearly twenty years to find out how he did it. The two most important people in animation are Winsor McCay and Walt Disney, and I'm not sure which should go first (Canemaker, 2018).

It would be over a quarter of a century after the premiere of *Gertie the Dinosaurus* before another dinosaur of any type was represented by cartoon animation, in Walt Disney's *Fantasia* of 1940, and, even then these dinosaurs do not have individual personalities as such. McCay was finally recognised for his innovation in animation in 1972 by the establishment of the annual Winsor McCay Award, a lifetime achievement award for services to animation, presented by the International Animated Film Society. A belated but fitting tribute.

Conclusion

Winsor McCay was first and foremost an entertainer and his vaudeville performances were a way of supplementing his income, yet he created one of the most famous individual dinosaurs in the history of palaeontology. He was primarily influenced by where – and when – he lived, drawing on a specimen that represented the philosophy of museums such as the AMNH that brought the science of palaeontology to the public. Already known for his popular comic strips, he was aware of the power of images to tell stories, and he lived at the time when film was just emerging as entertainment and, with it, the potential for 'trick photography' and animation. Living in New York, he could witness the popularity of dinosaurs with the enthusiastic public response to new displays in the AMNH such as the *Brontosaurus* and its associated imagery. At the same time, the circus was a well-established entertainment across America and the relationship between wild animals and the ringmasters provided a model of how human/animal interactions could be entertaining; he integrated some of the conventions of the circus acts into his performance.

By far the biggest factor in McCay's success in bringing *Gertie* to life was his ability to draw. He was confident that simple ink lines could create three-dimensional space within the frame that implied depth, and he could make believable filmic objects move around in that space. He treated each frame as an individual drawing which maintained the style and look of the whole animation.

McCay could have made *Gertie* a comedic, loose impression of a dinosaur but he clearly wanted her to be as accurate as he could make her and based her on the nearest he could find to a 'real' dinosaur – the specimen of the *Brontosaurus*. Comparing *Gertie*'s body form and proportions with that of the mounted skeleton and Knight's paintings, he created a character that is recognisably not only a dinosaur, but as a *Brontosaurus.* McCay used perspective to imply her size such as the viewpoint looking up at her, and used other characters, including himself, to give a comparative scale. Although this scale was not always consistent, he maintained the illusion of her being at least the size of a big sauropod. He drew her feet large, flat, splayed and elephant-like to suggest her weight, and she walks with a waddling gait that implies her huge mass. The walk cycle is accurate and McCay had likely used Muybridge as a reference for this, striving for believable movement. That he admitted that he was not confident about animating her getting up on her feet once she had laid down indicates a level of perfectionism that he applied throughout the whole animation process so that the audience believed the world of *Gertie* that he created.

His reluctance to move animation from a crafted artform to the industrialised process that started with John Bray – and reached its height with the likes of Walt Disney – limited his output capacity. That, along with his employer's disapproval of his vaudeville and animation activities, contributed to him not building on the success of *Gertie* and being less well-known than he deserves.

Gertie is, however, generally more well-known by dinosaur enthusiasts today, and I suggest this is because she represents a known, recognisable dinosaur. McCay used humour in the animation, but he intends his audience to laugh in sympathy with her, not *at* her. He created a dinosaur that straddled the worlds of science and art, education and entertainment, from museums to comic strips, and appealed to audiences of mass entertainment of the circus and the stage. The animation looks fresh and engaging more than a century after its premiere which is a tribute to McCay's expertise, attention to detail and commitment to accuracy. He made a creature that had been extinct for millions of years, the remains of which only consisted of fossilised bones in the province of science and museums, into a unique, living, breathing, eating, dancing, mischievous character with her own personality. Winsor McCay and *Gertie* established dinosaurs in showbusiness.

Notes

1 The video of Gertie the Dinosaur can be viewed here: https://youtu.be/BIj4oh8mYZE
2 This is the title of the film as on the opening title card. The title varied on other publicity material and advertisements.
3 I will use the term *Brontosaurus*, rather than the revised *Apatosaurus*, as it is likely this is how McCay would have known it.
4 John Hutchinson, Professor of Evolutionary Biomechanics at Royal Veterinary College, London, email to Vicky Coules (050418). I am indebted to Professor Hutchinson for his interest in this project and for his generous time spent in reviewing the film and writing his professional opinion.
5 The 11-volume *Animal Locomotion* was published in 1887 by University of Pennsylvania; an abridged version, *Animals in Motion*, was published 1899.
6 John Hutchinson, 'Professor of Evolutionary Biomechanics', edited by Victoria Coules (2018).
7 For a full explanation of these techniques see Nathan and Crafton, 2013.
8 Professor Mike Benton, email to Vicky Coules, 20418.
9 E.g. Drew Johnson, B.Sc. Computer Animation and Visual Effects, University of Teeside, currently Shoot Assistant at Double Negative Ltd, email to Vicky Coules, 130418.

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4

The 'Spin' in *Spinosaurus*: inventing a modern dinosaur superstar

Will Tattersdill and Mark P. Witton

Teeth bared, wreathed in dry ice, the creature dominates the cover of the October 2014 *National Geographic*. It fits onto the page only because of its dramatic backwards head-flick, and even then, the end of its slender tail – *too* slender, it is now suspected – has had to be cropped out. It fills the cover both with size and action. It has no background, and needs none, although a wider shot of the same model inside the issue (Mueller, 2014: 101–2) shows that it is surrounded here by theatrical equipment, literally stepping into the spotlight. Both on the cover and in the article, the challenge to the dinosaur orthodoxy could hardly be more straightforward: 'Move over, *T. rex*: The biggest, baddest carnivore to ever walk the Earth is *SPINOSAURUS*' (Mueller, 2014: 101).

Tyrannosaurus rex is the obvious comparison to make when introducing a charismatic new dinosaur to the public, both because of its household familiarity and its literally regal name. The contents page of this *National Geographic* calls *Spinosaurus* 'King Cretaceous', surely another direct jab at the world's most iconic theropod (the predatory dinosaur lineage) and perhaps a necessary nickname given the practical and descriptive *Spinosaurus aegyptiacus* – 'Egyptian spined lizard' (Figure 4.1). But by even admitting that *Spinosaurus* needed introducing, *National Geographic* undoes some of its own argument. As the article goes on to explain, *Spinosaurus* was not 'new' at all. It was first described, in fact, just a decade after *T. rex*, and had been largely ignored by popular culture for the better part of a century.

Figure 4.1 *Spinosaurus* model at the Museu Blau, Barcelona (shared to Wikimedia Commons by user Enric). This is the model pictured on the front cover of the October 2014 *National Geographic*, against a black background and surrounded by dry ice, beside the words 'MOVE OVER, T. REX.' The subheading 'The Quest for the Biggest, Baddest Predator on Earth' appeared beneath its tail. Also advertised on this cover were stories on 'The Truth about GMOs,' 'Drought in the West,' and 'Nuclear Tourism.' CC-BY-SA-4.0 [https://commons.wikimedia.org/wiki/File:035_Spinosaurus_davant_el_Museu_Blau,_pl._Leonardo_da_Vinci,_F%C3%B2rum_(Barcelona).jpg].

Nor was this the first attempt to bring *Spinosaurus* into the public eye. In 2001, film director Joe Johnston had made it the antagonist of *Jurassic Park III*. Here again, direct comparison with *Tyrannosaurus* was the mode of argument: not only does the upstart's distinctive skeleton replace *T. rex*'s on the iconic *Jurassic Park* logo, but it fights and easily beats a *T. rex* on our first encounter with it. Despite this, it is clear in the movie that knowledge of *Spinosaurus* is restricted only to the ultra-experts: Billy Brennan (Alessandro Nivola), an associate professor in palaeontology, asks his boss Alan Grant (Sam Neill) if he thinks it might be a *Suchomimus* – which has a similar-looking head – despite the fact that *Suchomimus* had been first described only three years before *Jurassic Park III* came out. 'Not with that sail,' Grant replies, referring to the unique and very obvious character which had entered palaeontological literature eighty-six years earlier, instantly recognisable to any dinosaur expert or child with a decent dinosaur book.

Why hasn't Billy heard of this long-established, charismatic predator, even though he's familiar with *Suchomimus*, and thus obviously up on the most recent technical publications of the time (Sereno et al., 1998)? Why, following the enormous publicity implied by *Jurassic Park III*, does *Spinosaurus* need propping up against *Tyrannosaurus* for its reintroduction by *National Geographic* in 2014? A colleague of Stephen Jay Gould famously proposed a three-word formula to explain the archetypal popularity of dinosaurs – 'big, fierce, and extinct' (Gould, 1995: 223) – but *Spinosaurus* met all of these criteria for decades without attracting any serious publicity. It met them better, in at least some respects, than the most well-known dinosaurs in the children's playroom. How, then, can its absence – and presence – in popular culture be understood?

The answer to this may lie in the peculiar and perhaps unique circumstances regarding the 'canonisation' of *Spinosaurus* into popularised palaeontology, the history of which we review here. Given that the science on *Spinosaurus* remains controversial at time of writing (late 2023), our perspective can only be a snapshot of dinosaur science and culture in flux: readers of this chapter just a few years from now may know a different *Spinosaurus* to the one we are familiar with today. But even as the science of *Spinosaurus* moves on at pace, its history shows that the adoption of prehistoric animals into mainline culture or even the subculture of popular science requires a combination of science and art, and *Spinosaurus* is arguably a superior case study than better-known animals because of its complex history of popularisation. It is a story of slow, relatively low-key acquisition into enthusiast-driven conversations followed by major, self-conscious attempts to launch it into the wider dinosaur pantheon by prominent media corporations.

Although those efforts can be said to have been successful, and *Spinosaurus* is now part of the standard 'dinosaur canon', its attainment of this status has not been straightforward or uncontroversial. This may reflect another important factor at play: the enigmatic quality of the beast itself and the inherent difficulties in restoring it. Unlike many other well-publicised dinosaurs, *Spinosaurus* has continually morphed and transformed in scientific interpretation and artistic restorations over the last century, such that dramatic 'reinventions' have provided unique angles, challenges and opportunities for exploitation (Figure 4.2).

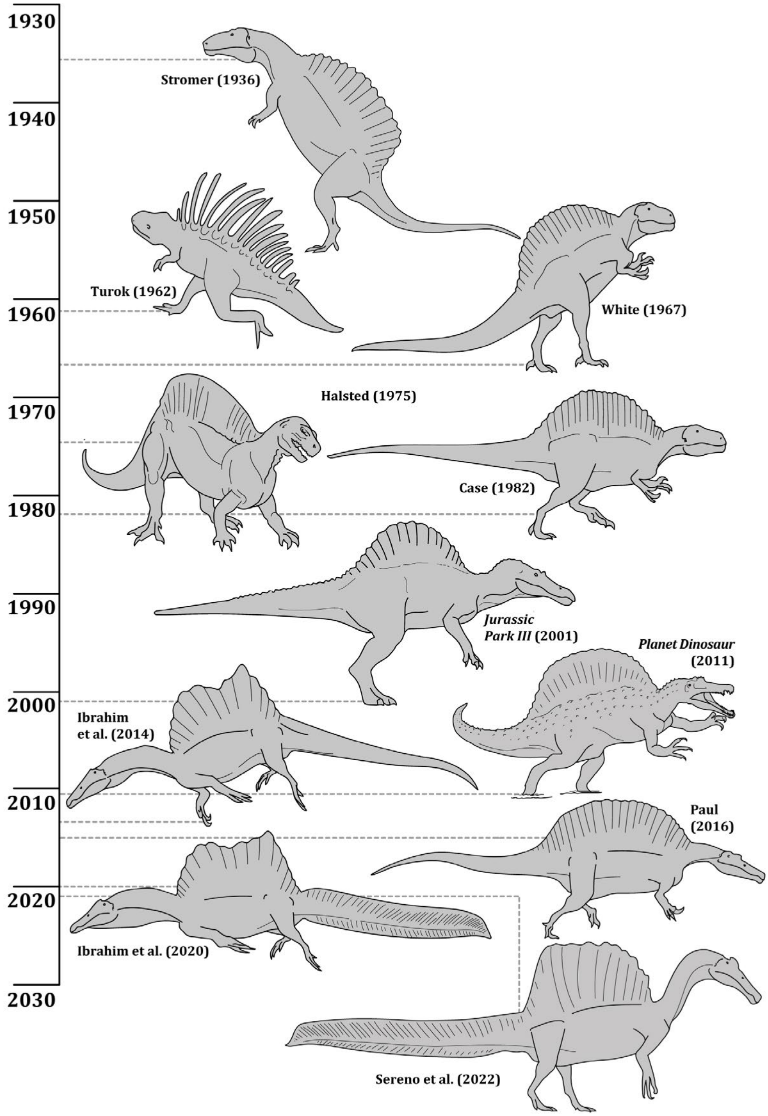

Figure 4.2 The ongoing evolution of *Spinosaurus* in published works and major media products. Although it is not unusual for concepts of a dinosaur's appearance to change over time, our ideas of *Spinosaurus* appearance have evolved in an increasingly public space, and the rate of modification and reinterpretation has gathered pace in the last two decades. © Mark Witton.

'An exercise in pure fantasy'

The issue of 'restorability' – in essence, whether artists and scientists are able to produce a defensible vision of an extinct organism from available fossil material – has run through the history of *Spinosaurus* research and remains evident today. Though first described by Ernst Stromer in 1915, *Spinosaurus* was known for most of the twentieth century only from its type fossil, destroyed during a British air raid on Munich in April 1944. Detailed drawings of these remains survive in Stromer's descriptive papers, showing that the specimen was very incomplete, consisting principally of a jawbone, some teeth, vertebrae (including parts of the iconic sail), and ribs (Stromer, 1915) (Figure 4.3), while a secondary specimen – of dubious relation to the first – revealed details of the hindlimbs (Stromer, 1934). Tantalising as these remains were, their capacity to reveal whole-body insights into *Spinosaurus* anatomy was questioned by Stromer as early as 1936 (see below). Decades later, influential palaeoartists such as Mark Hallett maintained similar views – there was simply not enough material available to understand what *Spinosaurus* looked like:

> The artist and consultant must sometimes decide whether a restoration should be attempted at all. *Spinosaurus*, confidently depicted in popular illustrations as a megalosauridlike [sic] theropod with a 'sail', is very poorly known and may not even be a dinosaur. When it was proposed as an illustration for a recent book, my consultant, Robert A. Long of the University of California, Berkeley, and I decided that a painting of this animal would be an exercise in pure fantasy and should not be attempted until more complete remains are described.
>
> (Hallett, 1987: 99)

Even as new *Spinosaurus* remains began appearing in the late 1990s, they remained difficult to interpret and integrate with other fossils. This is still the case today after the discovery of Faculté des Sciences Aïn Chock specimen FSAC-KK 11888 (Ibrahim et al., 2014a), the most significant *Spinosaurus* fossil since the early twentieth century. Even with this new data, the life appearance of *Spinosaurus* remains controversial and open to dramatic changes. Some of these reflect new discoveries, such as when the team behind the FSAC-KK 11888 finds published their 2020 re-envisioning of the animal, catching significant public attention with a newly found, purportedly water-adapted tail (Ibrahim et al., 2020a).

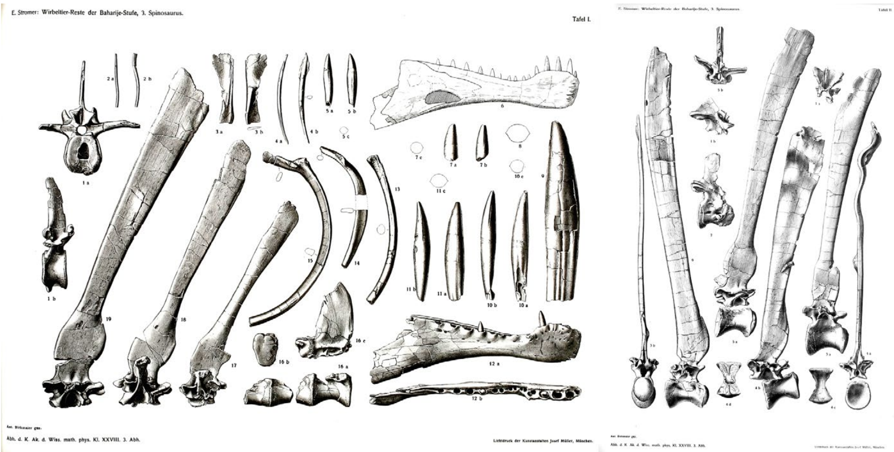

Figure 4.3 The original *Spinosaurus aegyptiacus* fossils described and figured by Stromer (1915), later destroyed during World War II. Image in public domain, obtained from Biodiversity Heritage Library.

Associated with these updates to the animal's appearance are reinterpretations of its lifestyle, such as radical proposals that *Spinosaurus* was a largely aquatic, swimming animal perhaps occupying a similar niche to the extinct species which eventually gave rise to whales (e.g. Ibrahim et al., 2014a, 2020a; Fabbri et al., 2022a). This view is by no means universally accepted (e.g. Henderson, 2018; Hone and Holtz, 2017, 2021; Sereno et al., 2022), and debates continue not only about how long *Spinosaurus* spent in the water, but also about fundamental details such as its basic proportions, overall size, and the shape of its sail (e.g. Hartman, 2020; Sereno et al., 2022).

In short, *Spinosaurus* keeps changing as a result of a fundamental paucity of fossil evidence, and its current interpretation is very unlikely to be final. Indeed, the debate around *Spinosaurus* prompted one of its leading experts, Nizar Ibrahim, to write that we 'should finally accept that there is no such thing as a 'final word' in dinosaur reconstructions, weight estimates and behavioral interpretations' (Ibrahim et al., 2014b). This is inarguable, but some words are more final than others: scientific interpretations and artistic impressions of *T. rex* – though they have changed considerably – have been comparatively fixed since the early, much more substantial, fossil discoveries of the 1900s.

Perhaps it is partly because it will not stay still, because there is so little bone to attach a reconstruction to, because it is almost fantastically strange, that *Spinosaurus* has had such a winding path to its current status as a dinosaur celebrity. These and other factors may also explain why it has struggled to achieve *Tyrannosaurus*'s cultural footing as a dinosaurian household name despite some very focused efforts to attain or surpass *T. rex* in popularity. For even in relatively specialised publications, there has been little to say about *Spinosaurus* until recently. For instance, William Nothdurft's *The Lost Dinosaurs of Egypt*, a book-length popular history exclusively focused on Stromer's North African discoveries, of which *Spinosaurus* was by far the most charismatic, mentions the animal only on eight pages (Nothdurft et al., 2002). While the contention and lack of fossil evidence surrounding this species might tend some practitioners towards Hallett's position, it has certainly not prevented many writers, artists and scientists from attempting the 'pure fantasy' of a *Spinosaurus* reconstruction – as we will see in the next few sections, which run through the phases of the animal's public life in greater detail.

Discovery and early interpretations

The first and, for a long time, only bones referable to *Spinosaurus* were recovered during expeditions launched to the Egyptian Bahariya Formation by the Bayerische Staatssammlung für Paläontologie und Geologie (Bavarian State Collection for Palaeontology and Geology, whose public-facing museum is now the Paläontologisches Museum München) in the early twentieth century. Although Stromer's name has become most closely attached to *Spinosaurus* over time, its fossils were actually discovered in 1912 by Richard Markgraf, a long-term collaborator of Stromer's, and by other prominent palaeontologists who worked in various African nations (Nothdurft et al., 2002), to say nothing of the Egyptians and Syrians who performed the labour of packing and transporting the fossils. Stromer described and published illustrations of these in a 1915 paper which expressed his desire to reconstruct the entirety of the animal, but his efforts in this were frustrated by the outbreak of war across Europe. A second shipment of *Spinosaurus*-like bones awaited study in Egypt, held back by the authorities even from respected scientists like Stromer because of tensions and mistrust between Anglo-Egyptian and German governments. These fossils were eventually shipped to Germany in 1922 and described by Stromer in 1934. Along with the type, they formed the totality of Munich's *Spinosaurus* material when he summarised his thoughts on this animal in 1936.

While the First World War frustrated Stromer's work on *Spinosaurus*, the Second World War destroyed it outright. Despite Stromer's well-documented concern for safeguarding the Bavarian State collections against Allied bombing, the museum took no action to remove them (Northdurft et al., 2002). On 24 April 1944 the entire collection was destroyed during an Allied raid, excepting material previously smuggled away by concerned museum workers. The *Spinosaurus* fossils were among the casualties, leaving only the descriptions and illustrations published by Stromer, along with a few then-unpublished photographs (Smith et al., 2006), as evidence of their existence.

Needless to say, the destruction of the original and only-known *Spinosaurus* fossils was surely a major factor in the initial obscurity of this animal on the public stage, but it is probably not the only reason *Spinosaurus* remained out of the public eye in its early history. The early twentieth century was a golden era for the promotion of vertebrate palaeontology (Witton, 2018; Nieuwland, 2019; Rieppel, 2019; Manucci and Romano, 2022) and German scientists and artists, despite the political turmoil they lived through, were very active in the reconstruction and promotion of dinosaurs. Notable events included radical reposing of dinosaurs in German museums (see Nieuwland, 2019), Othniel Abel's first major review and critique of palaeoart theory and methods in 1925, and the Berlin aquarium's murals, friezes and statues of iconic prehistoric species designed by Heinrich Harder (Lescaze, 2017; also mentioned by Nieuwland in this volume). *Spinosaurus*, a giant and most atypical predatory dinosaur ripe for public interpretation, had been announced during a rich period of popularised palaeontology and had a window of two or three decades to gain wider attention before its type material was obliterated.

We posit that Stromer himself may have played a role in keeping *Spinosaurus* out of the public eye. As an aristocrat with private means, Stromer had no need to pursue the funding avenues opened up by mass publicity and, moreover, the Bavarian State Collection was more focused on education than popularisation. Stromer was also sceptical of the value of palaeoartistic reconstructions, especially where they were based on poor fossil material (Stromer 1934, 1936). His views were not as extreme as those of some nineteenth-century palaeoart critics (see Witton and Michel, 2022) and he did publish reconstructions of extinct taxa, but his approach was a cautious and meticulous one. He wrote in 1915 that he would not attempt to reconstruct *Spinosaurus* before the additional fossil material held in Egypt had been analysed (Stromer, 1915: 28–9) and, when he did oversee illustrations of restored bones or skeletons, he provided extensive footnotes justifying their appearance, explaining their measurements and noting sources of reference (e.g. Stromer, 1936: 68, on *Carcharodontosaurus*; also see below). We might directly contrast this with a more publicity-hungry scientist, like the American Museum of Natural History's Henry Fairfield Osborn, who had *Tyrannosaurus* named and reconstructed in both skeletal and fleshed-out illustrations before its type specimen was even fully prepared from its rock matrix (Osborn, 1905). As a response to W. E. Swinton's well-illustrated 1934 textbook, *The Dinosaurs: A short history of a great group of extinct reptiles*, Stromer stated plainly in 1936 that 'skeletal reconstructions are made too lightly, even from very poor finds, and published speculations about [dinosaur] lifestyle are based on rather vague analogies' (Stromer, 1936: 62, our translation).

With all this in mind, it is perhaps surprising that Stromer made any effort to reconstruct the poorly-known *Spinosaurus* at all. He did, however, follow up his 1915 desire with a guarded attempt at visualising the *Spinosaurus* skeleton in 1936. Working with a colleague who executed the drawings under his guidance (a Dr Erhardt, whose first name is unknown to us), Stromer had several hesitations about this endeavour, including concerns about the scant material and the errors that would arise from reconstructing *Spinosaurus* from more than one individual. He persisted, however, because he felt it was important to visualise the bizarre and unprecedented *Spinosaurus* sail. He wrote:

> Despite such misgivings [about reconstructing extinct animals], I believe I must have some reconstructions of Theropoda drawn by Dr. Erhardt according to my information. In *Spinosaurus aegyptiacus* […] this is very daring due to a lack of knowledge of the skull and extremities, but this is the only way to visualise its strange dorsal spine processes, and after all there are quite a number of different parts of one individual. Of course, a lot is hypothetical. (Stromer, 1936: 63–4, our translation)

The Erhardt illustration referred to here is the first reconstruction of a *Spinosaurus* skeleton. It was necessarily chimeric, blending elements of *Gorgosaurus* and *Tyrannosaurus* with *Spinosaurus* fossils to visualise a gigantic and spectacular predatory dinosaur (Stromer, 1936) (Figure 4.4). But Stromer was as meticulous with finer details as his *Spinosaurus* fossils allowed, estimating the sizes of partially known elements, using teeth to predict the depth of the upper jaw and carefully considering the order of the sail vertebrae. These concerns led to several commendable

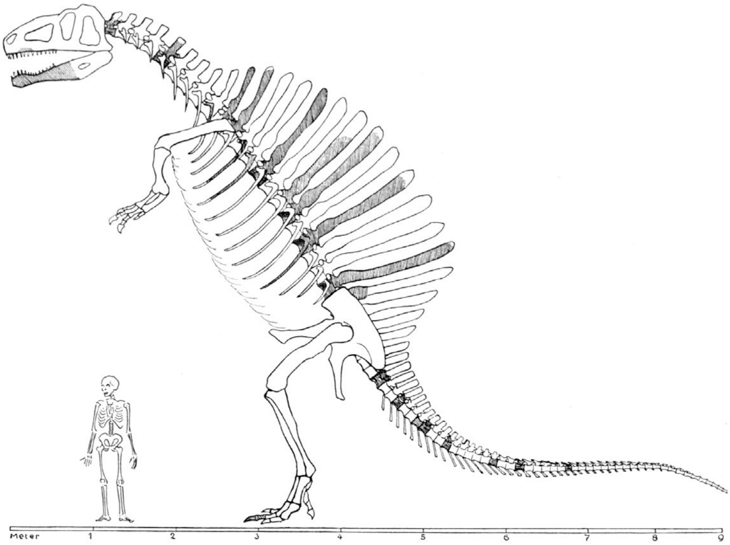

Abb. 8: † *Spinosaurus aegyptiacus* STROMER. Typ Nr. 1912 VIII 19 bei Gebel el Dist, Schicht p. Skelettrekonstruktion in $^1/_{54}$ nat. Gr. (nach STROMER II, 3 1915, Taf. I, II; II, 13, 1934, Taf. I, Fig. 5, 6, 8, 9, 17, Taf. II, Fig. 19). Erhaltene Teile sind schraffiert.

Figure 4.4 Erhardt's speculative skeletal illustration, published by Stromer (1936), the first effort at reconstructing the appearance of *Spinosaurus aegyptiacus*. Image in public domain, obtained from Biodiversity Heritage Library.

insights, such as a long torso and short legs, both of which are still thought to characterise *Spinosaurus* today (e.g. Ibrahim et al., 2014a, 2020a; Hartman, 2020; Sereno et al., 2022).

It seems that Erhardt's drawing was destined for technical literature alone and was not used to communicate information about extinct life with the public in publications or (it appears) museum exhibits (Smith et al., 2006). While other early twentieth century museums competed to build the most dramatic and lifelike displays of fossil animals and had vivacious life reconstructions executed by skilled artists (Brinkman, 2010; Rieppel, 2019), the Paläontologische Staatssammlung München displayed its *Spinosaurus* fossils modestly, with no apparent effort at representing the complete animal (Smith et al., 2006). Little is known of the circumstances surrounding the Munich *Spinosaurus* mount, and we cannot rule out practical limitations associated with displaying these large bones in a lifelike configuration, but displaying the fossils in a case without any real indication of its whole-body appearance certainly fits Stromer's documented attitudes towards palaeontological representation.

It may be wondered why, if Stromer had so many reservations around restoring and promoting *Spinosaurus*, other agents did not step in to do it for him. After all, no-one 'owned' the concept of *Spinosaurus* and there would be nothing to stop others from writing about and illustrating it. Nationalism and institutional interests may have played an important role here. The 'golden era' of publicising vertebrate palaeontology outlined above was not a magnanimous global celebration of extinct life but the result of self-aggrandizing, competing scientific institutions promoting their own brand of palaeontological science (Brinkman, 2010; Rieppel, 2019; Nieuwland, 2019). Museums constructed their publicity in line with their own achievements and collections in a way that dissuaded focus from unsung discoveries in other research institutions. The Paläontologische Staatssammlung München was, indeed, an outlier for being so reserved. Other German institutions, such as the Museum für Naturkunde Berlin, saw value in promoting their work on '*Brachiosaurus*' *brancai* (now *Giraffatitan brancai*) and '*Naosaurus*' (on which see Ilja Nieuwland's chapter 'A good officer. The Long and Remarkable Career of the Chimaeral *Naosaurus*'). American museums, meanwhile, were so successful at promoting their dinosaur studies that the twentieth-century dinosaur 'canon' became dominated by North American animals. Thus, the exploits of the Munich researchers – a small and academic-focused unit working on the other side of the world – may have seemed not only irrelevant to these institutions but even potentially a threat to their own PR efforts. One of the most prominent institutional voices in early-twentieth-century palaeontology, the American Museum of Natural History, was deeply invested in portraying *Tyrannosaurus* as the largest, most formidable predatory dinosaur of all time (Witton, 2025) and, fragmentary as it was, *Spinosaurus* clearly challenged the tyrant king in raw size (Stromer, 1936). Such conflicts of interest and the need to present an 'institutionally compliant' version of prehistory may have actively or passively shaped the early lack of interest in *Spinosaurus*, even if that meant ignoring some truths of contemporary knowledge.

Mid and late twentieth century

Following the destruction of the Munich *Spinosaurus* fossils in 1944, only Stromer's descriptions and illustrations of the *Spinosaurus* bones evidenced the existence of this species. Its ghostly scientific presence was mirrored in anglophone popular culture, where it remained relatively obscure despite its size and spectacular appearance. When mentioned, such as in vertebrate palaeontology textbooks, it was invoked primarily to discuss its unusual vertebrae (e.g. Romer, 1933; Swinton, 1934, 1970). Restorations of its life appearance remained rare and may not have appeared until 1962, when a flesh reconstruction featured in the educational comic *Young Earth*, itself published within the series *Turok: Son of Stone*. *Young Earth* introduced palaeontological topics via a traditional comic format and fleetingly showed *Spinosaurus* in *Turok* issue 29, within the story titled 'Coming of the Flesh Eaters' (see Figure 4.2). This was a strange volume for *Spinosaurus* to make its life restoration debut, as *Turok*'s prehistoric animal depictions were almost universally copies of familiar and famous palaeoartworks by Rudolph Zallinger, Charles Knight, Neave Parker and others, rather than novel reconstructions. This may explain why the *Turok Spinosaurus*, drawn by comic artist Rex Maxon, is a small and simple drawing restricted to one panel. Looking like a modified version of Neave Parker's c. 1960 *Megalosaurus*, it differs so sufficiently from Stomer's consideration in overall proportions, in the extent of the spinal processes, and in lacking soft-tissue between the sail spines (something hypothesised, though not illustrated, by Stromer, 1915) that we suspect it was based more on textbook descriptions rather than the 1936 skeletal illustration. Though it seems irregular for a children's comic to produce the first flesh reconstruction of a dinosaur, the episode foreshadows the far more prominent role that popular media would eventually have in popularising *Spinosaurus*.

After *Turok*, the presence of *Spinosaurus* in popular media began to increase throughout following decades, and by the end of the twentieth century it had become a semi-regular feature in popular dinosaur books. Its sail remained a chief catalyst for popular interest, but its size and status as an African dinosaur also drew the attention of authors and illustrators. By this time, its gigantic stature was well known: estimates put *Spinosaurus* at 15 m long (Glut, 1982), a value that compared well to the first length estimates of *Tyrannosaurus* (e.g. Osborn, 1912) but not to mid-twentieth century revisions that had shortened the *T. rex* tail by 4 m (Newman, 1970). Following these, *T. rex* was now smaller than *Spinosaurus* at 'only' 11 or 12 m in total length, although this did nothing to displace it as a hugely popular dinosaur.

Two illustrations from the mid-twentieth century would define the appearance of *Spinosaurus* until the end of the 1990s: a second skeletal reconstruction published in Theodore E. White's 1967 *Dinosaurs – At Home*, and Giovanni Caselli's painting of a *Spinosaurus* eating the end of a sauropod tail, published in L. B. Halstead's influential 1975 book *The Evolution and Ecology of The Dinosaurs* (see Figure 4.2). The former has little of the precise anatomical consideration exhibited by Stromer (1936), presenting *Spinosaurus* as a *Tyrannosaurus* with a sail and a three-fingered hand. Copies (sometimes slightly edited) of this illustration appeared in subsequent works (e.g. Boneparte, 1978; Case, 1982) and were probably the bases for several long-legged, three-fingered life restorations in popular works (Burton and Dixon, 1984; Lambert, 1990) and newly emerging *Spinosaurus* toys. Caselli's artwork, in contrast, was seemingly influenced by the 1936 skeletal in showing *Spinosaurus* with four fingers, a long torso and shorter legs. This painting was the first of a parallel strain of *Spinosaurus* depictions which, through referencing Caselli – or Stromer (1936) – contrasted with White's long-legged, *T. rex*-like version (e.g. Moody, 1977; Glut,1982; Norman, 1985). Another brief appearance in a comic, this time *2000 AD*'s science fiction story *Flesh*, added a pulp quality to a Stomer-esque vision of *Spinosaurus* in 1977.

While *Spinosaurus* eventually found attention among dedicated dinosaur fans, it lacked traction in other quarters of professional palaeontology. Little research was conducted on it – hardly surprising, given the absence of fossils to study – and it remained untouched by the most influential artists of the early- and mid-twentieth century, such as Charles Knight, Rudolph Zallinger, Zdeněk Burian and Neave Parker. This artistic boycott extended to the palaeoartists closely associated with the Dinosaur Renaissance, such as Gregory S. Paul, Ely Kish, Douglas Henderson, and Mark Hallett who – as noted above – regarded it as too poorly known to attempt a reconstruction. Leading late twentieth-century palaeoartists embraced scientific rigour and prioritised understanding animal anatomy through substantial fossil remains, a view that required meeting certain informational thresholds before a dinosaur's life-appearance could be restored. In contrast with earlier high-profile fossil reconstructions, it was now felt that one could not rationalise the anatomy of a whole animal with just a few bones (e.g. Czerkas and Olsen, 1987a, b). In his seminal *Predatory Dinosaurs of the World*, Paul (1988) echoed Hallett's reservations, lamenting the inability to restore *Spinosaurus* in his catalogue of reconstructed theropod skeletons. To our knowledge, the scepticism surrounding restorations of *Spinosaurus* at this time meant that, among the big names in palaeoart of this era, only a few, including John Sibbick and William Stout, attempted the feat (Glut, 1982; Norman, 1985), both seemingly basing their work on Stomer's 1936 restoration. Without further information, *Spinosaurus* seemed unrestorable to science-focused artists, and would remain so until more fossils of it, or at least of a close relative, were unearthed.

The battle for the big screen

Whatever profile *Spinosaurus* had attained by the approach of the twenty-first century, it was developed without vested interests in its status. Its inclusion in books and toy lines was always as part of efforts to show Mesozoic dinosaur diversity at its fullest and it was never, by itself, a focal point. But as the end of the twentieth century approached, this situation changed. New fossil discoveries catalysed more research into *Spinosaurus* itself and permitted more informed, if admittedly still far-reaching, reconstructions, transforming *Spinosaurus* from a species known only to dinosaur devotees to one that could take a commanding position in popularised palaeontology.

This transformation began with radical developments in spinosaurid dinosaur research during the 1980s and 1990s. New spinosaurid species that were represented by relatively complete skeletons, *Baryonyx walkeri* (Charig and Milner, 1986, 1997) and *Suchomimus tenerensis* (Sereno et al., 1998), were unearthed and dramatically changed views of spinosaurid anatomy, augmented by less complete but nevertheless important fossils (Martill et al., 1996; Kellner and Campos, 1996; Russell, 1996; Sues et al., 2002). Possible new *Spinosaurus* material was also identified at this time from across Northern Africa, ultimately marking a shift in consideration of *Spinosaurus* as a traditionally Egyptian animal to one more routinely found in the Kem Kem beds of Morocco (Bouaziz et al., 1988; Buffetaut, 1989, 1992; Russell, 1996; Taquet and Russell, 1998). Among these remains was purported evidence of a second *Spinosaurus* species, *S. maroccanus* (Russell, 1996; Taquet and Russell, 1998), although the validity of this was disputed (as remains the case for virtually all North African spinosaurid material; we return to this subject later).

The glut of new spinosaurid fossils revealed that these dinosaurs were far from the *T. rex*-like creatures of earlier reconstructions. They had long, narrow snouts, tall dorsal vertebrae and stout, strongly clawed forelimbs. Much was made of the superficially-crocodylian nature of their skulls, and a number of lines of evidence, including functional studies and fossilised gut remains, hinted at a diet that included fish as well as other dinosaurs (e.g. Charig and Milner, 1986, 1997; Buffetaut, 1989; Sereno et al., 1998; Holtz, 1998). In spite of the new remains referred to it, the anatomy of *Spinosaurus* remained enigmatic, but the close kinship of this species with *Baryonyx* and *Suchomimus* – the species Billy mistakes *Spinosaurus* for in *Jurassic Park III* – implied that a bold reimagining was in order: *Spinosaurus* was probably a gigantic, sail-backed dinosaur with a superficially crocodile-like face and large, powerful arms.

Spinosaurus was thus primed for reinvention, and its status as the biggest of a newly recognised, visually distinctive group of dinosaurs gave it potential candidacy for prehistoric celebrity. Interest in these developments was not confined to academics, but also included Hollywood producers looking for a new dinosaur face for the flagship franchise of palaeontological cinema *Jurassic Park*. Production on a third *Jurassic Park* film had begun in the late 1990s and, after two *Tyrannosaurus*-dominated entries, the series was actively looking for a new predatory dinosaur antagonist (Universal Studios Home Video Inc, 2001a). Perhaps on account of their distinctive anatomy, a spinosaurid was chosen as the new dinosaur lead, and the film entered preproduction with the intent of making *Baryonyx* its new villain (Universal Studios Home Video Inc, 2001b). This was soon replaced, however, by the gigantic *Spinosaurus*, seemingly with little concern regarding its obscure status – perhaps this was even an asset. Facing their third film of dinosaurs chasing people around tropical islands in less than a decade, *Jurassic* filmmakers were looking for ways to surprise and excite audiences enough to draw them back to cinemas for another dinosaur adventure (Universal Studios Home Video Inc, 2001a). In doing so, they would transform a dinosaur whose biggest pop-cultural moment had hitherto been single panels in decades-old comics into a major force in modern palaeontological media.

In 'behind the scenes' features and articles promoting the film, the *Jurassic Park III* production team speak openly about the challenges of replacing *Tyrannosaurus*. The creative angle seemed to be that *Spinosaurus* must dominate everything within and around the film to prove its worth as the series' new primary antagonist. The film goes to great efforts to show that *Spinosaurus* is no mere *Tyrannosaurus* substitute but a transcendence to the next level of dinosaur mayhem – the greatest prehistoric threat yet seen. Quite apart from defeating a *T. rex* in battle, *Spinosaurus*'s activities frequently and perhaps deliberately subvert the capabilities of *Jurassic Park*'s earlier star. Where *Tyrannosaurus* in the first movie was frustrated by attempting to reach humans in vehicles, *Spinosaurus* removes the front of a plane and eats people trapped inside. While metal fences proved obstacles for *Tyrannosaurus* (at least temporarily), *Spinosaurus* charges through a larger, stronger-looking barrier without injury. And where the arms of *T. rex* are famously small and of questionable effectiveness, *Spinosaurus* uses its own front limbs to grip objects, support its weight and swipe at enemies. This is emphasised with shots that show every component of *Spinosaurus* in an aggressive or menacing light, its sail even rising like an ominous shark fin during a swimming sequence. *T. rex* is not even given the dignity of challenging the franchise newcomer at the film's climax: it dies early, as mentioned above, and it is the humans, with their fire, who must drive *Spinosaurus* away.

Despite wanting a wholly new antagonist, the *Jurassic Park III* filmmakers seemingly ignored much of the then-new data on spinosaurid anatomy, and created a *Spinosaurus* that blended attributes of *Baryonyx* and *Suchomimus* with *Tyrannosaurus* (see Figure 4.2). While its head was relatively accurate to spinosaurid fossils, its body, neck and tail are overly short, and its limbs are overly long. The hands also possess three large claws, instead of the single large thumb claw and two smaller claws of real spinosaurids. Most egregiously, the sail is also only a loose approximation of the structure hinted at by Egyptian fossils, differing in the angle of the vertebral spines (a common mistake in virtually all *Spinosaurus* restorations up to this point), size (it is much smaller than it should be), and overall shape (a low gentle arc rather than the tall, sub-rectangular structure predicted by Stromer and subsequent researchers). Little is also made of the likelihood that fish made up a portion of spinosaurid diets, the aforementioned swimming sequence surely owing as much to the yet-unadapted river scene in the first *Jurassic Park* novel, as any allusion to piscivorous habits. The vaguely crocodilian motif that extends across the skin design is a further departure from the reality of dinosaur biology captured in earlier *Jurassic Park* films, the *Spinosaurus* having noticeably rough, large scales rather than fossil-accurate small, polygonal ones. This pseudo-crocodylian morphology is reinforced by a recurring gag where a phone swallowed by the *Spinosaurus* rings from its digestive tract, recalling the clock-swallowing crocodile that plagued Captain Hook (our thanks, for this point, to Jordan Kistler).

Collectively, these creative choices subtly tip the *Jurassic Park Spinosaurus* from an interpretation of a real animal into the realm of 'movie creature'; specifically, an especially nightmarish, exaggerated version of the tyrannosaurs that antagonised the human characters in previous films. And yet, the filmmakers promoted their take on *Spinosaurus* as both naturalistic and even educational, the famous special effects creator Stan Winston opining that audiences learn something about dinosaurs simply by watching *Jurassic Park* movies (Universal Studios Home Video Inc, 2001a). This seemingly conflicts with an in-film conversation about the realities of the *Jurassic Park* dinosaurs, however, which are described as 'theme park monsters' and thus not the same entities as the fossilised forms excavated from sedimentary rocks (on the wider issue of the first film's relationship with scientific orthodoxy, see Fallon and Hone's chapter in this volume). The friction between following and sensationalising science that has existed in, and been dramatised by, all *Jurassic Park* films is perhaps especially obvious in these conflicts. The liberties taken with *Jurassic Park III*'s 'theme park' version of *Spinosaurus* can be seen as the first major step in the franchise's progression towards the wholly fictitious, thoroughly-monsterised dinosaur creatures of later entries, such as '*Indominus rex*' in *Jurassic World* (2015) and '*Indoraptor*' in 2018's *Jurassic World: Fallen Kingdom*.

Released to lukewarm critical responses and an underperforming box office, *Jurassic Park III* was the last *Jurassic* film for more than a decade. Critics felt that this third *Jurassic* film brought little to the series despite its new star and, worse, that the concerted efforts to subvert *T. rex* as the ruler of dinosaur cinema had fallen short. *Empire* concluded that 'the much-mooted spinosaurus [sic] fails to usurp the T-rex as Godfather of the dinosaur' (Errigo, 2001). *Variety* wrote that the 'lumbering spino, despite its larger size, longer jaw and fancy back fin, just doesn't cut it as a substitute T-Rex', further noting that 'this new addition to Winston's dino lineup looks more like an escapee from a Japanese monster movie' (Elley, 2001). This latter comment adds a prophetic edge to Hallett's (1987) concerns about the 'pure fantasy' of restoring *Spinosaurus* and implies that, despite *Jurassic Park III*'s claims to scientific accuracy, even mainstream audiences have some sensitivity to monsterised, exaggerated movie dinosaur depictions. A minority of reviews did speak up for poor *Spinosaurus* (*Rolling Stone* considered it 'badass' (Travers, 2001)), but its rejection by critics and, judging by box office receipts, the wider public, saw the *Jurassic* franchise abandon *Spinosaurus* in the more recent films. Its only subsequent appearance is as a skeleton (albeit one that is notably different from the *Jurassic Park III* design) on the main street of the theme park in 2015's *Jurassic World*.

It is difficult not to see the reduction of *Spinosaurus* to set-dressing, as an acknowledgement of the animal's pretender status to the *Tyrannosaurus* throne. In a series renowned for its lifelike dinosaur effects, and in a theme park where dinosaurs are literally brought to life, is there a greater shame than only being represented by a skeleton? That this osteological cameo is a response to the hubris of replacing *T. rex* is left in no doubt when, at the film's climax, a freshly unleashed *Tyrannosaurus* (the same individual seen in the iconic first *Jurassic Park*) literally crashes through it, effortlessly reducing its former foe to a pile of broken bones. Paltry as it seems in this context, of course, a complete *Spinosaurus* skeleton – even smashed – would of course be a dream come true for any real-life dinosaur scientist.

Spinosaurus 3.0

It is testament to the influence of the *Jurassic* series that its underperforming, single-film flirtation with *Spinosaurus* could nevertheless change the shape of popularised palaeontology. The initial run of *Jurassic* films may have been finished with *Spinosaurus*, but *Jurassic Park III* sowed seeds which grew the cultural cachet of *Spinosaurus* enormously throughout the 2000s. Its days as an obscure species known only to dinosaur fans and experts were in the past, as it now became not only included in dinosaur products, but could be used to sell them. *Spinosaurus*, often in a guise strongly reminiscent of its *Jurassic Park* appearance, appeared on the covers of books, became a much more common toy and model in dinosaur parks, and even headlined documentary series such as Discovery's sensationalist *Monsters Resurrected* (2009) and the BBC's more grounded, science-focused *Planet Dinosaur* (2011) (see Figure 4.2). Artists even sculpted *Spinosaurus* skeletons for special museum exhibits, such as that featured in the Gunma Museum of Natural History, Japan, in 2010 (Figure 4.5). *Spinosaurus* had failed to gain widespread acceptance from the cinema-going public, but it had established itself as a new, exciting face for science-focused entertainment and merchandise.

Scientific interest in *Spinosaurus* paralleled that of popular culture as research on it continued to gain pace in the early twenty-first century. With spinosaurids now generally better understood, attention shifted to not only reporting more fragmentary remains of Moroccan *Spinosaurus* (Dal Sasso et al., 2005) but to better understanding its size and ecology (e.g. Dal Sasso et al., 2005; Therrien and Henderson, 2007; Cuff and Rayfield, 2013). Perhaps thanks to the name recognition brought by *Jurassic Park III*, some of these studies were deemed newsworthy, especially if they demonstrated that *Spinosaurus* was larger or somehow more intimidating than *Tyrannosaurus* (e.g. Hecht, 2006). Here, the competition initiated by *Jurassic Park III* to justify their use of *Spinosaurus* as a movie monster was being put to different use: validating the importance of scientific research and outreach.

Competition with *T. rex* was incorporated into another large-scale media event surrounding *Spinosaurus* in 2014 – the *National Geographic* cover story with which this chapter began. Here, a new scientific paper (Ibrahim et al., 2014a) was the nucleus of a coordinated media extravaganza. The paper itself focused on the discovery of FSAC-KK 11888, a new partial skeleton of *Spinosaurus* discovered in Morocco during the early 2010s, described in the prestigious journal *Science*.

Figure 4.5 Skeletal mounts of *Spinosaurus*. [A] long-legged reconstruction at Gunma Museum of Natural History, Japan, in 2010, photo by Kabacchi, CC-BY 2.0 [B] shorted-legged, aquatic interpretation based on Ibrahim et al. (2014a) at the National Geographic Museum in Washington DC, 2014, B, photo by Ryan Somma, CC-BY 2.0.

Using this material, Ibrahim et al. presented a radically new perspective on *Spinosaurus* with a totally revised skeletal restoration characterised by remarkably short hindlimbs and an 'M'-shaped sail (Figures 4.2, 4.5b and 4.6a), a suggestion that it was a knuckle-walking quadruped when on land but a proficient swimmer in water, and a bold taxonomic proposal that incorporated much of North Africa's spinosaurine material into the *S. aegyptiacus* species. They also suggested that their new specimen, a partial skeleton incorporating hindlimb, pelvic and vertebral material, should be considered the neotype of *Spinosaurus aegyptiacus*, finally giving *Spinosaurus* a type specimen after the destruction of the original 70 years earlier.

This daring new interpretation of *Spinosaurus* was matched in scale by a tie-in media effort. Along with the 2D palaeoart and online coverage commensurate with modern high-key palaeontological papers was a television documentary, the front cover and key article space in October 2014's issue of *National Geographic*, and a touring exhibition featuring newly crafted, life-size flesh and skeletal reconstructions of *Spinosaurus* (see Figure 4.5b). As was now standard, the rivalry between *Spinosaurus* and *Tyrannosaurus* was a headline focus.

For all this use of a familiar angle, the extravagance and evident investment in this PR effort was unusual. It surely ranks as one of the most ambitious events ever to promote a new piece of dinosaur research, almost recalling the promotion of blockbuster movies or prestigious sports events, more than routine public scientific communication. With media hype of this scale, the boundaries between the dinosaur awareness campaign run by *Jurassic Park* and one run by *National Geographic* are more blurred than ever. Though the comparison is a complex one in many respects, we observe here that whatever the intentions behind both episodes, many of their techniques – and perhaps their attitudes to palaeontology – are very similar. Both capitalised on a romanticised ideal of adventurous palaeontological fieldwork in exotic locations, both sought to marvel and entertain with sensational dinosaur science, both employed leading-edge artistry to bring their stories to life, and both saw the same potential in dramatically reinventing a poorly understood but spectacular predatory dinosaur. Most significantly, both were prepared to invest heavily in their respective interpretations of *Spinosaurus* despite the still-developing science around the dinosaur itself.

Further echoing *Jurassic Park III*, *National Geographic*'s coverage takes an authoritative stance on *Spinosaurus*'s new guise. Any concerns about final accuracy are invisible in the abundant media surrounding Ibrahim and colleagues' new study and, outwardly at least, this looked to be a definitive take on this peculiar theropod. As it proved, though, the science fuelling this media extravaganza was highly controversial. Within days of its publication, academics and popular science writers penned articles expressing varying degrees of scepticism around just about every major claim made by the paper (e.g. Barrett, 2014; Black, 2014; Hartman 2014a, b) and follow-up studies provided more thorough criticisms and different interpretations shortly thereafter (e.g. Evers et al., 2015; Hendrickx et al., 2016; Henderson, 2018; Hone and Holtz, 2017). These attacked the very foundations of this new vision of *Spinosaurus*, including its new short-legged proportions, its competence as a swimmer, and the proposal of replacing the lost Egyptian type specimen with new remains from Morocco. The latter ties into complex issues about the identities of North African spinosaurid fossils and the question of whether the new Moroccan material – including the specimen at the heart of the *National Geographic* campaign – should really be identified as the Egyptian *Spinosaurus aegyptiacus* (Evers et al., 2015). Ibrahim et al. countered these criticisms, both online and in print (Ibrahim et al., 2014b, 2020a; Fabbri et al., 2022b), but it remains to be seen whether these controversies have been fully resolved.

Despite the academic backlash, the 2014 Ibrahim et al. vision of *Spinosaurus* went on to be enormously influential. Not only is the current era of *Spinosaurus* science framed by this study (as we go on to discuss) but pop-culture extensions of palaeontological science openly embraced their distinctly short-legged, semi-aquatic reconstruction. *Spinosaurus* now swims through popular dinosaur books, toy chests and model display cabinets in pursuit of fish, like a sail-backed crocodilian, pushing out *Jurassic Park*'s long-legged 'superpredator' in many, though perhaps not all, avenues of popular publications and merchandising. And yet, further changes awaited even this relatively recent reinvention.

More fossils, more controversy

A mere six years after their much-publicised research, Ibrahim et al. (2020a) presented another transformative study which dramatically altered *Spinosaurus*'s appearance yet again (Figure 4.6a). This time, additional material from a return to the Saharan dig site yielding the 2014 specimen showed an extraordinarily deepened tail formed from elongate, slender vertebral spines and mirroring chevron bones. This unprecedented dinosaurian tail, the team argued, was a paddle-like organ that could be sculled like the tail of a crocodilian to drive a swimming *Spinosaurus* through water. Coinciding with the study's appearance in the prestigious journal *Nature*, a second media blitz followed that included an abundance of high-quality artwork, animations, another dedicated feature in *National Geographic*, and the production of more life-sized

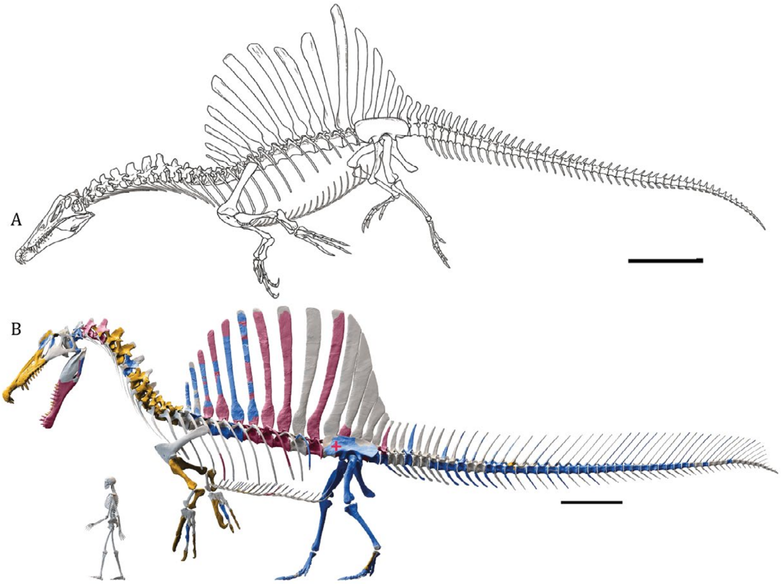

Figure 4.6a Interpretations of *Spinosaurus aegypticus* skeletal anatomy from the last decade, also showing contrasting interpretations of lifestyle. A, reconstruction based on data from Ibrahim et al. (2014a), showing *Spinosaurus* as an aquatic, swimming animal – the expanded tail was yet to be discovered.
Figure 4.6b The most recent reconstruction of *Spinosaurus* published at time of writing, from Sereno et al. (2022), showing the new tail described by Ibrahim et al. (2020a) but also a terrestrial, standing pose, reflecting the hypothesis of non-aquatic habits preferred by these authors. The varying hues show reference material used in the reconstruction: blue, FSAC-KK 11888; red; the destroyed *Spinosaurus* holotype; yellow; other remains referred to *Spinosaurus.* Scale bars represent one metre. A, from Ibrahim et al. 2020b, CC-BY 4.0; B, from Sereno et al. (2022), CC-BY 4.0.

restorations for museum display (Greshko, 2020). Though not quite on the same level as the 2014 media campaign, this was still a bombastic, show-stopping press event that leaves little doubt about the status of *Spinosaurus* among popularisers of science.

It wasn't only a high level of public interest which recalled the 2014 publicity: the new paper sparked further controversy among dinosaur workers who doubted the interpretation of the new tail as a swimming aid. Hone and Holtz (2021), in their analysis of *Spinosaurus* anatomy, concluded that the tail was a display structure, not a swimming aid, and that *Spinosaurus* would have found prey more like a giant heron than an aquatic pursuit predator. More data has been added to the debate in the form of spinosaurid bone density, which Fabbri et al. (2022a) argue points again to a specialist aquatic lifestyle, but others feel does not substantially challenge the heron-like model (Myhrvold et al., 2022; Sereno et al., 2022). Researchers are still unable to reach a conclusion on the proportions and appearance of *Spinosaurus*: Sereno et al. (2022) argue that Ibrahim et al. have made it too long in the chest and arm, while also challenging the M-shaped sail with a more traditional interpretation (Figure 4.6b).

Thus, almost a hundred years after Stromer's first tentative efforts at a restoration, and despite being equipped with much more fossil data, the ability to reconstruct *Spinosaurus* remains heavily dependent on inference. If anything, it seems the more researchers learn about *Spinosaurus* the more controversial it becomes, raising interesting questions about its status as a modern superstar dinosaur species.

Discussion: unspinning *Spinosaurus*

To think about the history of *Spinosaurus* is inevitably to think about how the popularity of an extinct animal is governed by interactions between evidence, imagination and the agency of individuals and institutions. Is it because of a lack of fossils that there was relatively little interest in *Spinosaurus* in the twentieth century, or is it because of the lack of interest that the fossils took so long to find? How much were attitudes regarding *Spinosaurus* shaped by Stromer's conversative views on reconstructing and promoting dinosaur discoveries? The history of this unusual and controversial dinosaur demonstrates how tangles of circumstance and interaction between different agents, each with their own goals and attitudes, shape mainstream interest in prehistoric life.

Particularly in its first century, *Spinosaurus* shows how individual philosophies can lead to thoroughly contrasting opinions of a dinosaur's role in popular culture. Remarkable as it seems, Stromer's cautious technical reconstruction is cut from the same cloth as the bombastic *T. rex*-destroying *Spinosaurus* of *Jurassic Park III*: both are based on largely the same fossil data and yet the confidence and impact of their restorations could not be more different. This distinction in approach does not simply reflect the discrete goals of a scientist and film company either, for it was palaeontologists who initially lifted *Spinosaurus* from purely academic literature and presented it in more accessible, popular venues (e.g. Swinton, 1934; White, 1967; Halstead, 1975). This case illustrates the difficulty of drawing a firm line between 'science communication' and 'entertainment' when thinking about how dinosaurs move through popular culture. Though clearly taking liberties with the animal's appearance and behaviours, *Jurassic Park*'s intervention is not devoid of educational impact either in its intentions or its after-effects. The consensus is that it was instrumental in updating the public image of dinosaurs to incorporate key ideas from the Dinosaur Renaissance. *National Geographic*, meanwhile, no stranger to bombastic publicity and a part of the Disney empire since 2019, has clearly embraced the sensational tone set by Hollywood alongside the serious – if controversial – scientific publications on which it reports.

This is not to say, however, that *Spinosaurus*'s ascendency to mainstream popularised palaeontology has been determined entirely by a few influential agents. It seems fair to describe its initial, mid-twentieth century popularisation as relatively low-key: a product of book and comic authors deciding that *Spinosaurus* was remarkable enough to incorporate into the canon of popularised prehistory. There may have been several independent 'adoptions' of *Spinosaurus* into non-academic literature. After its first, unillustrated mention in a textbook (Swinton, 1934), it appears in three unique reconstructions: the peculiar illustration in *Turok*, as a high-spined *Tyrannosaurus* presented by White (1967), and finally Caselli's Stomer-based illustration in Halsted's 1975 *Ecology and Evolution of the Dinosaurs*. The differences between these images are so great as to suggest minimal or no cross-fertilisation of reference material and imply communal, rather than individual, recognition of *Spinosaurus* as an especially noteworthy dinosaur species. Because popular interest in *Spinosaurus* post-dated the late-nineteenth/early-twentieth-century origin of 'Dinomania', this communal adoption tells us little about what makes dinosaurs *as a group* interesting to the public, but it does tell us something about why some dinosaurs are considered more interesting than others. Even with only a portion of its anatomy known, the qualities of *Spinosaurus* – a gigantic, Egyptian reptilian predator with an aberrant sail taller than an average person – were enough to single it out as unique and strange, and thus worthy of mention and speculative illustrations. This implies that our depth of scientific understanding is of less importance to the popularisation of dinosaurs than the superficial quality of being somehow distinctive, be it anatomically, geographically or ecologically. (See, for a complementary perspective on this point using Mesozoic mammals, Elsa Panciroli and Chris Manias' chapter in this volume on 'Mammals, the measure of success? The legacy of 'progress' in natural sciences.')

The discussion of *Spinosaurus* as a unique dinosaur raises Stromer's century-old question about its restorability. This not only echoes the concerns about reconstructing extinct animals aired during the earliest decades of palaeontological science (Witton and Michel, 2022) but also broader, contemporary observations on the 'medialisation' of science as a whole (e.g. Weingart, 1998). Without doubt, recently discovered *Spinosaurus* fossils show that Stromer and, later, Hallett and Paul, were correct to doubt our ability to restore *Spinosaurus* from fossils discovered in the early twentieth century. These, it has emerged, only hinted at the bizarre anatomy of *Spinosaurus*. But substantial questions remain about even our most current restorations, from the shape of the sail to the proportions of the body (Hartman, 2020; Sereno et al., 2022), and these stand in contrast to the confidence of and investment in twenty-first century *Spinosaurus* depictions. Two of the three major iterations of *Spinosaurus* in the last two decades – *Jurassic Park III* and the 2014 Ibrahim et al. reinterpretation – were shown as inaccurate relatively quickly after their unveilings, undermining the definitiveness and authority implied by their tremendous hype and media reach. These could be seen as echoes of other grand exercises in dinosaur popularisation, not the least being the dinosaur sculptures created for the Crystal Palace Park's Geological Court in the mid-nineteenth century. As with twenty-first century *Spinosaurus*, the Crystal Palace recreations resulted from private enterprise commissioning high-impact, public-facing reconstructions of dinosaur species that were at the margins of our understanding of extinct life, leading to their obsolescence within a few short years (Witton and Michel, 2022).

With the potential pitfalls obvious, a question raised by such endeavours is: what drives the creation of expensive, highly-visible, widely-promoted dinosaur reconstructions from incomplete fossil remains? Science medialisation theory posits that science–media couplings benefit from seeking earlier publicity of results, no matter how provisional or controversial, for the increased authority and steering that such exposure brings to scientific discourse, as well as the interest and reputational boost it provides media agencies (e.g. Weingart, 1998). These goals probably extend, consciously or not, to the creation of iconic reconstructions of charismatic fossil animals and may override concerns – however legitimate – about their inherent restorability. Whether created by filmmakers, a scientific media company or a museum, the creation and promotion of a novel, iconic dinosaur reconstruction takes a certain amount of 'ownership' of that species and primes it for exploitation. Beyond *Spinosaurus,* history shows that there is great cultural and commercial value in reconstructing unusual and impressive extinct species (Brinkman, 2010; Rieppel, 2019; Nieuwland, 2019) and our question, therefore, may not be about *why* companies and organisations invest so much in efforts to 'own' dinosaur species in this way, but why they do not do it more. (This phenomenon, of course, is not limited to dinosaurs: see Oliver Hochadel's discussion of 'Ida' in his chapter 'Palaeoanthropology and the mass media: an entangled history'.)

Critics of this approach and media-steered science in general (Weingart, 1998) might note that over-eager restorations of fossil taxa risk misleading the public about the status of a given fossil species, and confuse matters further with later efforts to correct the proliferation of erroneous, sometimes quickly outdated information. But *Spinosaurus* gives us grounds to wonder how valid such concerns are. Historically, such as when scientists first raised alarm over the longevity of superseded reconstructions in the nineteenth century (Niewland, 2019; Witton and Michel, 2022), slow media turnover could keep restorations of extinct animals persistent in popular media for decades after their obsolescence. But in researching this chapter, we found that the modern takes on *Spinosaurus* originating in Ibrahim and colleagues' 2014 and 2020 studies have assumed a prominent mantle among preceding interpretations, supressing, to some extent, even the mighty *Jurassic Park III Spinosaurus*. This could reflect a variety of factors, including the capability of a high-impact media release to thoroughly overshadow previous interpretations of a fossil species, something that does not, in our experience, occur through routine publications of new scientific papers or lower-key press events. In addition, we wonder if a shift towards rapid news turnover and media creation might now allow dinosaurs to transition to new interpretations with less baggage than in previous generations? These questions may be worth exploring in further detail elsewhere.

Perhaps, in addition, the tradition (and perhaps even expectation) of change and controversy around *Spinosaurus* has allowed it to have an especially evasive, dynamic public face. Whatever the general rule for dinosaurs, in the specific case of *Spinosaurus* it is perhaps this publicly visible *malleability* that is its greatest strength and weakness: the same property which makes it hard to restore incontrovertibly also makes it tantalising, eccentric, provocative and exciting, as it historically has for dinosaurs such as *Iguanodon* and *Megalosaurus*. We find that malleability matched at a formal level, as *Spinosaurus* shifts between the status of a curio, a superpredator, a monster, a cipher, a charismatic example of deep time's biodiversity. If the constant reinvention of *Spinosaurus* is now in danger of itself becoming a defining quality of the animal, it is perhaps worth recalling that it is only an exaggerated instance of the uncertainty which plagues all dinosaur reconstruction. There is no extinct dinosaur for which our information is complete, and few indeed have not been passed to some extent through the prism of popular culture. At the same time, it must be acknowledged that definite and improving data on *Spinosaurus* does exist, and that the fantastical baggage it has accrued on its journey through human history works both in harmony and tension with our developing scientific knowledge.

Underlying this chapter has been a question about appeal: why wasn't *Spinosaurus* popular earlier, and why did it then become so? Any serious attempt at an answer necessarily involves an appreciation of national and international politics, the special status of dinosaurs in (some) media culture, and the history of art as well as palaeontological research. To say that artistic or scientific factors alone were responsible for *Spinosaurus*'s status at any given moment is clearly an oversimplification. But if we are to admit the perhaps uncomfortable power of a Hollywood franchise in bringing this animal to prominence, we must also confront the importance of solid bones, however few and however fractured. The indefinite, protean quality of *Spinosaurus* is powerfully alluring – but not more so than the fact of its reality, even when the most fundamental features of that reality remain subject to revision. It is not the science or the fantasy of *Spinosaurus* which sustains it, but both.

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5

A good officer: the long and remarkable career of the chimaeral *Naosaurus*

Ilja Nieuwland

The story of Lieutenant Kijé started out as an anecdote relayed by Johan Christian von Dahl (1764–1821), one of Tsar Paul I's aides (Dahl, 1876). Through a misspelling, a nonexistent soldier is created in the Tsar's army and then, with unstoppable predictability, starts to make his way through the military ranks, ending up a Colonel. At this point, the Tsar demands that the newly promoted officer make his appearance at court. The bureaucrats go in search of the enigmatic soldier, but after finding out their original mistake they inform the Tsar that Kijé has died. The emperor sighs. 'What a pity. He was a good officer.'

Since that original publication in 1876, Kijé has been adapted to serve as a parable, in literature, music and film, about the absurdity of bureaucracy.[1] However, we can find such examples outside of the realm of administration, and early palaeontology appears to have been particularly susceptible to this phenomenon in its search for material.

Chimeras, animals artificially assembled from multiple specimens, have been a fixture of the discipline since its beginning. The impulses for this were both practical and commercial. Entertainers showing extinct animals as spectacle quickly realised how much more impressive and satisfying their exhibits were if they presented entire skeletons, and demonstrated great creativity in giving their audience what it wanted. Probably the best-known case of such an artificial creature is that of the infamous *Hydrarchos harlani*, a 15-metre sea snake–like contraption composed of no less than five skeletons of the extinct whale *Basilosaurus,* which amazed American and European audiences in the 1840s (Rieppel, 2017). Fossil traders also came to realise how complete remains would fetch a substantially higher price than partial ones, and hence saw to it that more than a few specimens, many of which are still part of museum collections, were 'completed'.

But questionable ethics weren't the only cause: often, excavators might find various parts of a skeleton in the same vicinity, and assume that they belonged to the same animal. Then there was ambition; the oft-described rivalry between Othniel Charles Marsh and Edward Drinker Cope was measured in the number of discovered and described species, which offered a perfidious incentive for all sorts of misbehaviour. For instance, the sauropod dinosaur *Brontosaurus/Apatosaurus* was generally depicted with the head of *Camarasaurus* for well over a hundred years despite early opposition, because of Marsh's support (Marsh, 1883; Osborn, 1905). Particularly in the early days of palaeontology, personal authority was crucial in getting concepts accepted. Then there were numerous species described using only very fragmentary scraps of fossil. Some proved to be genuine; others, such as Cope's *Agathaumas*, not so much.

In 1878, a party excavating in Texas for Marsh's great rival Cope, consisting of Jacob Boll and J.C. Isaac, stumbled upon the remains of an animal with unusually long dorsal spines. A skull was not present, but some distance from the side the two eventually discovered one (Geiser, 1937: 34; Davidson, 1997:41). Cope described the animal as *Dimetrodon incisivus* a year later (Cope, 1878). As the rivalry between Cope and Marsh was measured in the number of discovered and described species, the two sets of remains almost inevitably became one.

The name *Dimetrodon* ('two sizes of teeth') refers to an exceptional feature in reptiles. While mammals have different sizes and kinds of teeth, reptiles typically do not. It was a distinctly odd creature, particularly because of its spectacular, hugely elongated dorsal spines, up to a meter in height (in a three-meter-long animal) and each tapering to a point. As the name indicated, Cope considered it a close relative of mammals – and therefore of interest for our own history.[2] The spines, he concluded, were part of a 'sail' on the back of the animal. He mainly arrived at this conclusion because he couldn't think of any other purpose they might serve, but he found it difficult to imagine its use: 'Unless the animal had aquatic habits and swam on its back, the crest or fin must have been in the way of active movements' (Cope, 1886: 544–5).

He also produced a sketch of the animal in life, one of the very few we have by Cope (Figure 5.1). Since Cope's days, many more remains of various species of *Dimetrodon* have been found, along with an entire

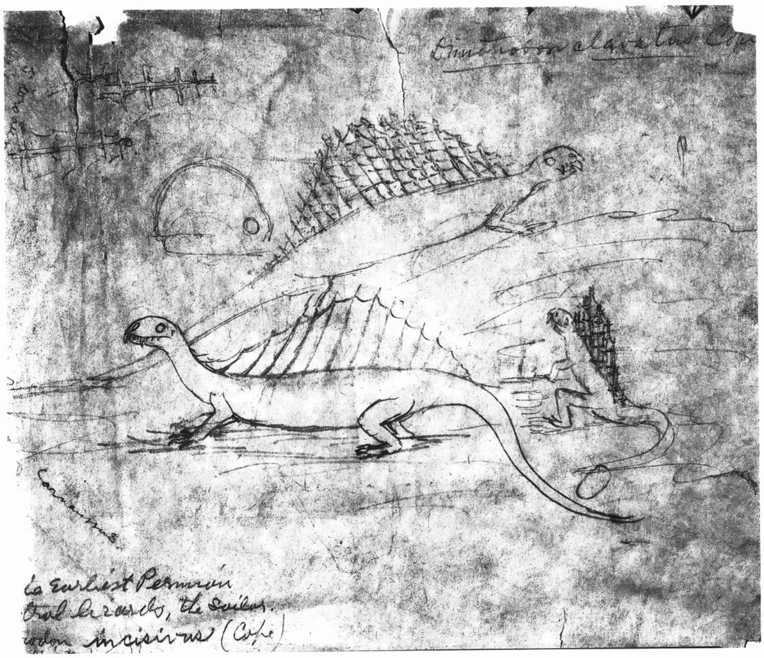

Figure 5.1 Cope's sketch of *Naosaurus* (top and bottom right) and Dimetrodon, c.1894. Private photo copy of a work in the public domain.

contemporary fauna of similarly sail-backed creatures. Today, the genus is considered a member of the Synapsida, a large group of Permian terrestrial vertebrates. The precise significance and utility of their sails is still debated. The prevailing explanation has long been that they must have played some part in metabolic regulation, but other interpretations have also been forwarded.

Knight's pseudo-dinosaur

Dimetrodon and its kin (informally referred to as 'pelycosaurs') preceded the first (non-avian) dinosaurs by almost as much as the time dividing us from the last of them. But mostly thanks to its outlandish appearance, *Dimetrodon* has become a familiar part of dinosaur literature and illustration, despite it not being one (Angielczyk, 2009). *Dimetrodon's* 'sail' and its toothy menace have turned it into something of an 'honorary dinosaur' in many museum shops and toy catalogues, much like the equally non-dinosaurian pterosaurs, mosasaurs and ichthyosaurs, and even mammals such as the sabre-tooth cat *Smilodon*. The fact that reconstructions of *Dimetrodon* portray it in a fashion quite similar to early (but long-persisting) depictions of dinosaurs is probably the root cause of this phenomenon, and demonstrates how the popular idea of what constitutes a 'dinosaur' was long ago determined by a limited set of physical characteristics (see Mitchell, 1998). In addition, the ongoing but antiquated use of the term 'mammal-like reptiles' for synapsids, and the identification of dinosaurs as 'terrible reptiles' in popular literature, affirms the idea of a far closer kinship, and temporal proximity, than is actually the case (Angielczyk, 2009: 257).

Much of this popularity can be traced to the adapted version of a painting made in 1897 by Charles Knight (Figure 5.2). Knight, at that point an impressionable 23 years of age, was guided by the older Cope himself, during a two-week session in the latter's fossil-laden Philadelphia home (Milner, 2011: 92–7). The resulting painting, as so many of Knight's works, turned out to be highly influential in shaping the public's image of the strange life of the past – and *Dimetrodon* subsequently became a very popular crypto-dinosaur.

However, Knight's picture originally did not feature *Dimetrodon* as its principal protagonist – prime place was given to what would later turn out to be a chimeral creature, *Naosaurus claviger*. In 1878, briefly after having described *Dimetrodon*, Cope introduced this creature from

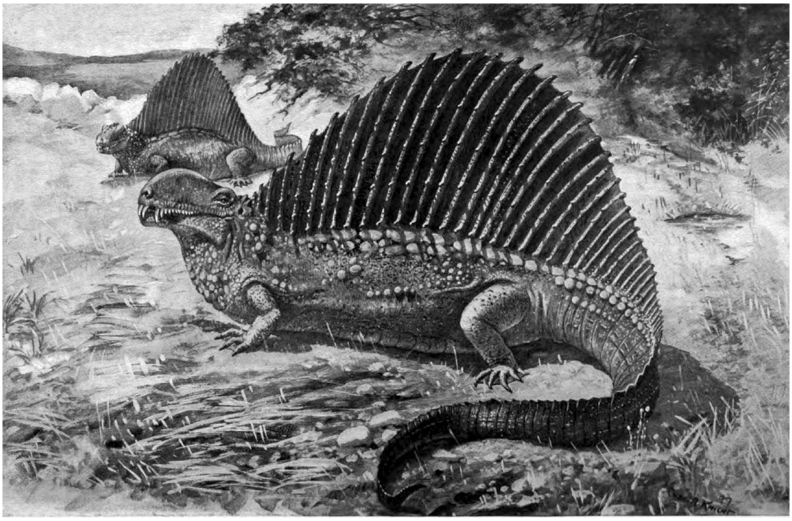

Figure 5.2 Charles Knight's depiction of *Naosaurus* (front) and *Dimetrodon* (rear), 1897. This painting does not exist in this form any longer, since it was later adapted. From Osborn, 1931.

remains found in the Wichita riverbeds. Affinities between various pelycosaurs were still poorly known at the time, and Cope ended up combining *Dimetrodon's* predatory skull with remains from various locales that were later attributed to its (apparently herbivorous) distant relative *Edaphosaurus*. While that animal bore similar elongated spines (and was initially considered as a species of *Dimetrodon* by Cope), the resulting 'sail' was somewhat less spectacular in size, and roughly oblong-shaped. Moreover, the spines bore sideways protrusions, 'like the mast of a ship', causing Cope to describe it as the 'ship-lizard' or *Naosaurus* (Cope, 1886: 544–5). Assuming these 'yardarms' had been much longer in life, Cope developed the idea of *Naosaurus* and *Dimetrodon* as Permian 'yachts', floating about in shallow ponds, propelled by the wind:

> The animal must have presented an extraordinary appearance. [...] probably, the yardarms were connected by membrane with the neural spine or mast, thus serving the animal as a sail with which he navigated the waters of the Permian lakes. (Cope, 1886: 544, quoted in Debus and Debus, 2002: 227)

However, Cope did not return to this speculative concept, and it was apparently not considered subsequently by other scholars. Attention for these pelycosaurs increased around 1907 through a combination of circumstances. The therapsid expert Ermine Case had discovered a fairly complete specimen of *Dimetrodon* around the same time that the head of the American Museum of Natural History's Department of Vertebrate Palaeontology, Henry Fairfield Osborn, decided to have a display of the *Naosaurus's* skeleton exhibited at the AMNH. Osborn made sure that the event was duly publicised in the museum's *Journal*, as well as in *Scientific American*, which devoted a cover illustration to it, again drawn by Knight. Walter Beasley's piece for *Scientific American* sensationalised the animal's ferocity ('the great battery of sharp, tiger-like teeth') and repeated the idea that there was little to be expected from such animals in the way of intelligence:

> While his habits are not fully known, yet from the structural make-up of the skeleton it is thought he was an awkward, slow-moving creature with a small brain, his actions being chiefly automatic, reflex, with little or no intelligence and cunning. (Beasley, 1907a: 368–9)

Beasley did not adopt Cope's concept of a 'yacht reptile', but rather suggested a protective or ornamental function for the sail. The animal was sculpted and painted again by Charles Knight, in a substantially different form from his earlier painting of 1897 (Figure 5.3).[3] Osborn anticipated criticism on the reconstruction by writing how:

> The reader will therefore thoroughly understand that the assemblage is largely composite. It serves, nevertheless, to give us for the first time an adequate conception of the unique and imposing characters of these great extinct forms. (Osborn, 1907: 266)

But apart from Osborn's article in the museum's *Bulletin*, a publication aimed at specialists, the AMNH refrained from advertising the composite nature of the display to the public. Even within the museum, some showed unease at '[combining] different individuals in this way' (Rieppel, 2019: 207). However, to visitors, *Naosaurus* was presented as a completely legitimate genus.

Exit *Naosaurus*

Osborn had covered himself in the *Bulletin* by stating early how 'Dr. [Ermine Cowles Case (1871-1953)], the chief authority on this group writes his belief that the sku1l of Dimetrodon cannot be used as a basis for the restoration of the skull of Naosaurus' (Osborn, 1907: 265; Black, 2007). However, although it was clear to Case that the 'neither by relation of bones nor by any record of number or label is there any considerable fragment of a skull unmistakably connected with spines of Naosaurus' he still considered it closely related to Dimetrodon, despite the difference in the spikes (Case, 1907: 58). What those spikes were supposed to achieve, or how they looked, remained a mystery, however:

> [...] recent discoveries have made it probable that Naosaurus was not an eater of flesh, but a peaceful, sluggish eater of shell fish and perhaps of vegetation. [...] The discovery that Naosaurus was an eater of molluscs and not a predatory form makes more perplexing than ever the question as to the use of the spines on the back. On such a thick-bodied, sluggish mud rubber, the cross-barred spines must have had about the same value as an ornamental frieze on a canal boat.(Case, 1908: 564)

Therefore, even for Case it remained largely conjectural whether *Naosaurus* ever possessed a 'sail', and how it functioned. However, he

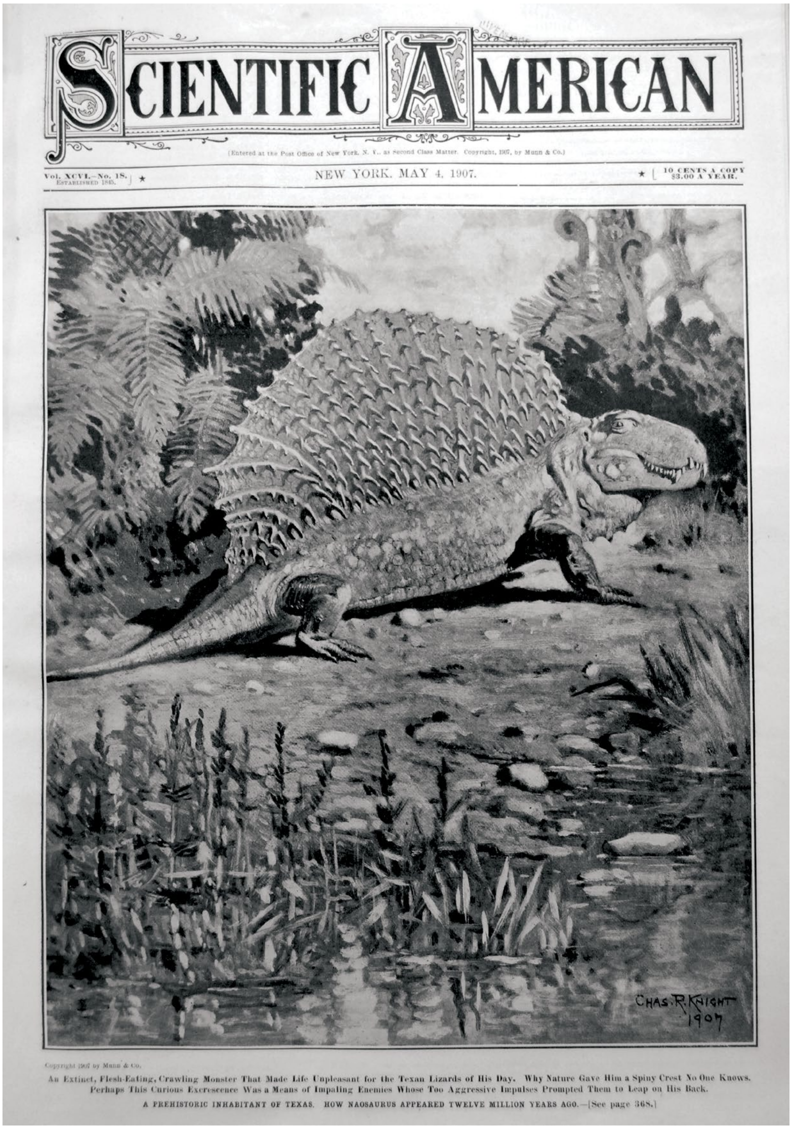

Figure 5.3 Knight's painting for *Scientific American*, May 1907.

still shied away from wholly denying Cope's association of the skull and the body, or the concept of a sail. Authority still counted for a lot in palaeontology, and to distance oneself from such an illustrious forebear required firm evidence.

We can see something similar happen in the case of another chimaera created during the ‘Bone Wars’ between Cope and his arch-foe, Othniel Charles Marsh. When the American Museum of Natural History first showed its mounted *Brontosaurus* to the public in 1904, it showed the animal with the boxy head of its relative *Camarasaurus*. A typical elongated, *Diplodocus*-like head had been found some distance away from the first skeleton; however, Marsh decided that the boxy skull of *Camarasaurus* was the more likely candidate for *Brontosaurus*’s head (Marsh, 1883). As a consequence, something similar found its way onto the New York *Brontosaurus*, where the skull of *Morosaurus* was used as a template (Rieppel, 2019: 205–6). Not onto the one in Pittsburgh, however, where director William Holland decided that the evidence in favour of the *Camarasaurus*-like skull was insufficient. However, despite conjecturing that *Brontosaurus* possessed a more *Diplodocus*-like head, he hesitated to place it on the mounted skeleton. Instead, the animal remained headless until Holland’s death in 1932, but a boxy, *Camarasaurus*-like skull was placed on it almost immediately after in a demonstration of how much weight the word of Marsh still carried.

‘Like a porcupine’

But the impact of authority can work two ways, of course. While adherence can prove loyalty to the community, rejection can be useful in distinguishing oneself from it. This is fundamentally what happened to *Naosaurus* in Germany.

Otto Max Johannes Jaekel (1863–1929) was something of an iconoclast: born as the seventh and last child of an architect and builder (*Baumeister*), he was determined to propel himself from his modest beginnings into the élite of German science (Nieuwland, 2019, 2020b, 2023). As a staff member of Berlin’s natural history museum he managed to strike up a friendship with Friedrich Alfred Krupp, the German Empire’s chief arms manufacturer, who wished to extend his fossil collection. Around 1900, Jaekel’s star was rising fast, and his position at the museum was a central one in Germany – not in the last place because by law, all discoveries financed by state funds had to be offered to the Museum für Naturkunde first, and therefore often passed Jaekel’s desk before anyone else’s. Shortly after, however, things started to take a wrong turn in this promising career. The escalation of several conflicts in Berlin, exacerbated by his impulsive and combative character, and the failure to secure a chair at the University of Vienna caused him to accept a professorship

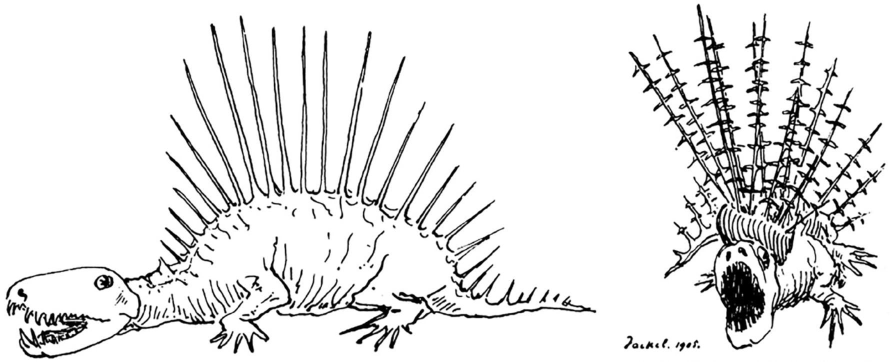

Fig. 1. Seitenansicht eines *Dimetrodon* mit einfachen Rückendornen.

Fig. 2. Vorderansicht eines *Naosaurus* mit gestachelten Rückendornen.

Figure 5.4 *Dimetrodon* and *Naosaurus* according to Otto Jaekel. From Jaekel, 1905.

at the university of Greifswald in 1906. Despite misgivings about being posted in what he considered to be a backwater, he was persuaded by the promise of a more fitting professorship in the near future. To his immense disappointment, he would eventually spend the remaining years of his German career at Greifswald.

Jaekel had first expressed interest in Pelycosaurs in the German Geological Society meeting of 8 May 1905 (Jaekel, 1905: 192–5). He reflected on the discovery of 'Naosaurids' in the German Triassic Muschelkalk formations, a layer about 230–240 million years old, and therefore considerably younger than the around 275-million-year-old layers that the American 'Naosaurus' remains had been found in.[4] Although the author of the article on the finds, Friedrich von Huene, did not suggest *Naosaurus* to be present in the German layers, he did spot a number of similarities between it and a species he described (*Anomosaurus*) from the formation.

Jaekel, who assumed *Naosaurus* to be present in German formations, went on to speculate on the purpose of its elongated spines. After concluding that any structure connecting the spines, such as a sail, would have made movement difficult for the animal, he suggested a different interpretation. According to him, the vertebrae would have been able to move independently along the axis of the dorsal column, thus enabling the animal to use them as a defensive weapon to be aimed at an attacker. He created two sketches to illustrate his concept of a pelycosaur, '*stachlich wie ein Stachelschwein*' (thorny like a porcupine).

Figure 5.5 *Edaphosaurus (Naosaurus?) credneri* plate A, RS14753, courtesy of Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie, Freiberg [left]; and Jaekel's gutta-percha cast, courtesy of Collections of Greifswald University [right].

For Jaekel, this was likely something of a 'one-off' – a pleasant piece of speculation at a society meeting. However, a few years later, in 1910, Jaekel returned to *Naosaurus* twice. An entry in the prestigious Meyer's *Konversations-Lexikon* about palaeontological reconstruction re-used his earlier images (Figure 5.4). In addition, he addressed *Naosaurus* more elaborately. Once more using the Journal of the German Geological Society (*Zeitschrift der Deutschen Geologischen Gesellschaft*), Jaekel described the rather fragmentary remains of a small specimen of what to him looked like a small, new species of *Naosaurus* (Figure 5.5). It had had been excavated an unknown number of years before from Permian formations near Dresden.

Given the lack of any cranial material – as mentioned, a common problem with pelycosaur finds – Jaekel made few assumptions regarding *Naosaurus's* life habits. But again, in his description there is no trace of a sail. Rather, he assumes that the dorsal spikes are used for defensive purposes, with the animals 'curling up their backs, and through lateral movement of the vertebral column [drawing] the spines [...] widely apart, thus drastically improving their defensive merit' (Jaekel, 1910a; my translation).

Because Jaekel also sees a strong connection with *Dimetrodon* (and comments on the pelycosaurs' apparent global success), his arguments against a sail in *Naosaurus* are also be extended to that animal. To further illustrate the point, the article includes a reconstructive sketch of the animal, with its spines pointing in different directions.

The material that Jaekel based his researches on are still present in the collection of Greifswald university. They contain several casts from the original – which resides in the Saxonian State Collections in

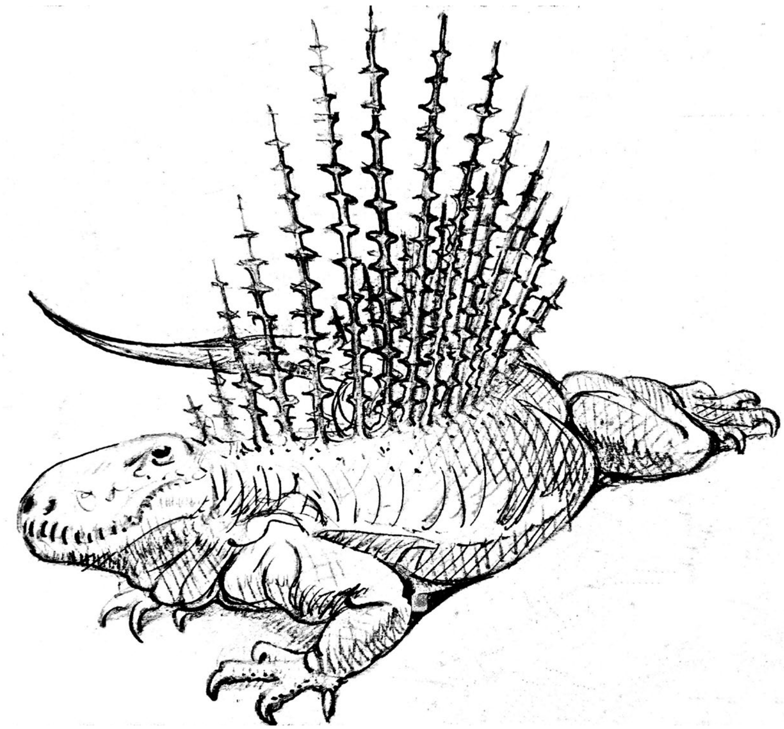

Figure 5.6 Reconstruction of *Naosaurus credneri*, probably by Max Rudloff. Collections of Greifswald University.

Freiberg – made out of gutta-percha, a kind of natural latex compound, and Jaekel's reconstruction as used in his article from 1910. However, the collections also contain a second reconstruction (Figure 5.6). It is not signed, but unlikely to have been drawn by Jaekel: it does not show his drawing style, and in fact demonstrates a greater artistic ability. We can, however, make an educated guess as to its creator.

At the time, Jaekel was working on displays for the new Deutsches Museum (DM) in Munich, a prestigious initiative intended to display the achievements of German science. The geological display was to form the entrance to the exhibit; in addition to Jaekel himself, the Munich artist Zeno Diemer and the Berlin painter Max Rudloff were engaged to supply several primeval landscapes, depictions of geological formations, and reconstructions of extinct animals. Although Rudloff completed a few pieces, his work was tragically cut short in 1907. In the summer of that year, he went excavating on Iceland with the geologist Walther von Knebel, who had also been working on the DM exhibit. On the morning

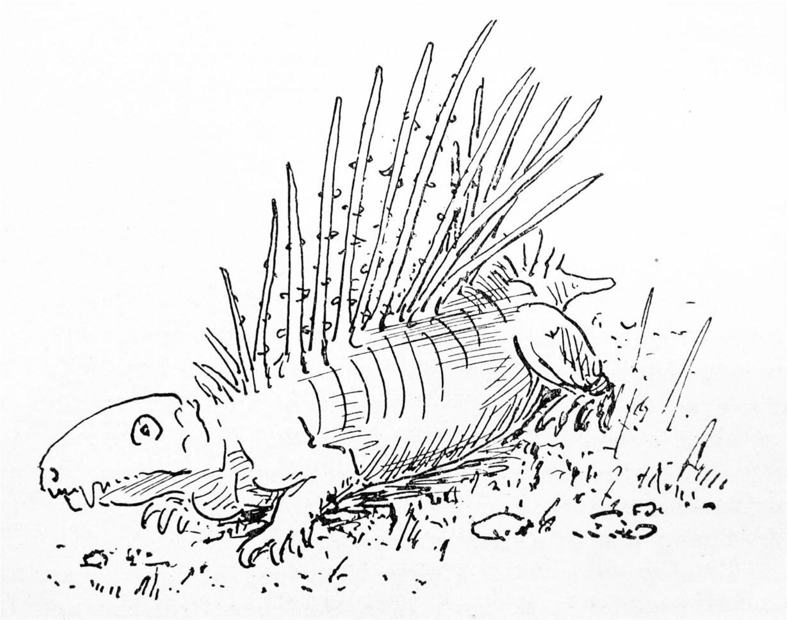

Figure 5.7 Otto Jaekel's published reconstruction of *Naosaurus credneri* with defensive spikes. From Jaekel, 1910a.

of 10 July, they left their tent camp on the shore of a crater lake in a boat to go collecting on its other side. Neither of them was ever seen again; it is likely they drowned in the lake (Lerner, 2015: 25–7).

With the deadline for the Munich museum looming, this left Jaekel with a considerable problem. Not only were the pieces for the museum far from finished, but it seems like Rudloff had been working on other projects on Jaekel's behalf. The timing suggests him as by far the most likely candidate for the drawing; moreover, it clearly shows his hand. Whether Jaekel started inking in the charcoal drawing and gave up at some point, or whether Rudloff had started that task, is unclear. Rudloff's drawing can likely be traced back to Knight's reconstruction model as photographed in *Scientific American* and subsequently reprinted in the German magazine *Über Land und Meer* (Beasley, 1907b). That places it in mid-1907, just before Rudloff's fatal journey to Iceland, which would explain its unfinished state.

We can only speculate why Jaekel abandoned this reconstruction. It might have been that because of scruples connected to Rudloff's fate, he felt reluctant to use it. But more likely is that he simply did not consider it dynamic enough. The idea Jaekel wanted to convey was that

Figure 5.8 Charles Knight's *Naosaurus* model, 1906. Photograph by author, in collections of the Institute of Geography and Geology, Greifswald University.

Naosaurus was able to turn the spikes towards an attacker, and Rudloff's drawing contained a more static pose, with parallel projections extending upwards; not really that different from previous reconstructions of a sail-bearing animal. Jaekel's own, more stylised but arguably livelier picture shows the spikes at various angles relative to the torso (Figure 5.7).

In the meantime, Jaekel had acquired a copy of Knight's (sail-bearing) model from 1907 through Henry Fairfield Osborn, whom he knew personally (AMNH DVP GC48, 1908). The plaster copy arrived in Greifswald in the autumn of 1908, and likely helped Jaekel to finish his own reconstruction (AMNH DVP, Osborn to Jaekel, 13 July 1908) (Figure 5.8).

Palaeontology and the empire

To understand why Jaekel picked up his work on *Naosaurus* again, and why he chose this particular subject, we should probably look at his personal and professional circumstances around 1909–1910. Jaekel's opposition to earlier, American views on pelycosaur lifestyle offers conspicuous similarities with how another American 'primeval reptile' was treated by a former colleague of his, the zoologist Gustav Tornier (Nieuwland, 2019: 159–208). In 1909 and 1910, Tornier subjected the work done on *Diplodocus carnegii* to a scathing critique, and proceeded to reinterpret the animal's entire skeleton in a litany of publications (Tornier, 1909a, 1909b, 1910, 1911). In the past, Tornier's work has been mentioned as an example of scientific nationalism (e.g., Parsons, 2001: 118–21). After all, palaeontology was one of the scientific disciplines where the United States was considered to be world-leading.

There were good reasons for Tornier to set his example using *Diplodocus*. At the time, casts of the animal were given away to several European natural history museums by the American magnate Andrew Carnegie. Germany possessed two of the enormous skeletons, however. The first was a gift to the new Frankfurt Senckenberg Museum by the American Museum of Natural History in October of 1907 and the second given by Carnegie to the zoological museum in Berlin, part of the Museum für Naturkunde, in May of 1908. The donations had been well-publicised, which made them eminently suitable to be exploited for what was mostly a PR campaign. Moreover, animals like *Diplodocus* had been uncovered in German East Africa, and excavations were under way that would bring them to Germany itself (Heumann et al., 2018).

But while Tornier's work certainly contained an implicit sense of German scientific superiority, it was more explicit in its advocacy of zoological methodology when researching the anatomy of extinct animals. In Prussia and most of Germany, palaeontology was mainly organised at this time as an auxiliary discipline for dating geological formations. Although prominent German palaeontologists like Karl Alfred von Zittel had emphasised its importance for evolutionary theory, neither he nor many others had attempted to carry through concrete organisational changes. This was Tornier's main objective: to ally palaeontology with biology, and in particular zoology, both to support ideas about evolution and to come to a more encompassing view of past life than traditional methods allowed. In that ambition he received the support of Jaekel who, like other German palaeontologists, did not hesitate to support Tornier's cause in publication (Jaekel, 1910c).

Just as with Diplodocus there is an element of competition in the case of *Naosaurus*; while originally American, this animal had apparently 'become' German as well due to the discovery of its remains in Saxony. Consequently, it was something about which German scientists needed to express an independent opinion. However, studying a fossil using biological methodology was as central to Jaekel's argument as it was to Tornier's: *Naosaurus* offered him the opportunity to support Tornier's cause by applying his methods to an entirely different creature. There are also conspicuous similarities in the ways their findings were publicised in both professional and popular publications. This made a viable reconstruction, which might help to promote public interest for the discovery, all the more essential. For the same reason, Jaekel procured a copy of the AMNH's *Naosaurus* model for his museum in Greifswald.

At the time, much more was at stake for Jaekel than just a description of an extinct reptile, and this may help to explain his interest in popular media. In 1904, he had been asked to write a memorandum for the German education and culture ('*Kultus*') ministry, headed by the virtually all-powerful Friedrich Althoff. Jaekel's intention was to give palaeontology in Germany a far more autonomous position by bringing it closer to biology – and simultaneously to improve his own chances of escaping Greifswald as the representative of this new, biological palaeontology. Encouraged by Althoff, he promoted his ideas in subsequent years through various channels, both professional and public (Jaekel, 1907, 1908a, 1908b, 1910d).

Eventually, Jaekel's proposal to found a new national institute for biological sciences became one of the foundations of the Kaiser-Wilhelm-Gesellschaft (KWG) (Wendel, 1975; Vom Brocke and Laitko, 1996; Sucker, 2002). When that came to pass, unfortunately Jaekel was left on the sidelines, along with most of his ambitions for German palaeontology and, by extension, himself. By 1910, Jaekel's future, which had seemed so rosy only years before, was looking decidedly shakier. Althoff, his main supporter, had died in 1908, and Adolf Harnack, a theologian chosen to whip the proposals for the KWG into shape, was eyeing Jaekel's materialism with suspicion.

While Tornier's campaign in favour of his re-designed *Diplodocus* did not create the kind of disciplinary re-orientation he and Jaekel sought, it did bring palaeontology more than a bit of public notoriety. Despite using both popular and scientific channels (Anon, 1911), Jaekel's remarks regarding pelycosaurs and *Naosaurus* failed to elicit the same kind of response. Partly, that was due to Jaekel's choice of subject: *Naosaurus* was hardly as illustrious a citizen as *Diplodocus*. But his approach was also more technical; he sought to use *Naosaurus* as an example of how palaeontology might be changed and improved, and particularly how a new and better German palaeontology could be created. In that sense, we should see both men's intentions and the cases of *Diplodocus* and *Naosaurus* as complementary.

In practice, however, it turned out that they were not necessarily of one mind. This became clear after Jaekel contributed an article on palaeontological reconstruction to the *Meyer's Konversations-Lexikon* encyclopedia, which was published in 1910 (Jaekel,1910b). Of course, *Naosaurus* and *Dimetrodon* made an appearance, but Jaekel also depicted both the traditional American and 'new' German way of reconstructing

Diplodocus. While the text strongly implies support for Tornier, who 'proved that the legs were bent like those of a reptile, and the feet put flat on the ground' (Jaekel, 1910b: Table 1), Jaekel also stresses how these two cases show the potential differences in outcome of palaeontological reconstructions, despite both being based on the same material. But this is not an exact outcome. Rather,

> [It] shows that only a correct assessment of the skeleton enables an understanding of the function and psychological significance of the individual parts. Their interaction in the living organism determines the so-called correlation between the parts, which also enables us to add what is missing from the shape and physiological significance of the other organs. [...] Such a reconstruction is at the same time an artistic work, and those who have no feeling for the organic and harmonic flow of lines, should not even attempt to give flesh, skin and color to these skeletons. Because of the external shape of the parts, the law of harmony apparently applies to the highest degree, or at least it is the first thing that laymen feel.

This illustrates how much Jaekel wished to persuade his audience by presenting them with a plausible depiction of a potentially living animal; in that process, he was willing to resort to a certain degree of speculation. In other words, to play with known unknowns of living nature. However, here he found himself at odds with Tornier, whose motivation had been all along to come to a greater degree of *certainty* regarding palaeontological reconstruction. Two years later, he took Jaekel to task for inconsistencies in his own reconstructions (Tornier, 1912).

On the Aquarium

The porcupine *Naosaurus* had one more trick up its sleeve. When the Berlin Zoo planned its new aquarium in the early 1910s, it was important that the building's monumental façade would convey something of its scientific importance to the outside world (of potential visitors), but also that it would connect the living world inside with its extinct ancestors and thus help to teach 'a lesson in biology' (Gradenwitz, 1913). To do so, the artist Heinrich Harder was contracted because of his previous depictions of extinct animals. Together with Gustav Tornier, he designed several

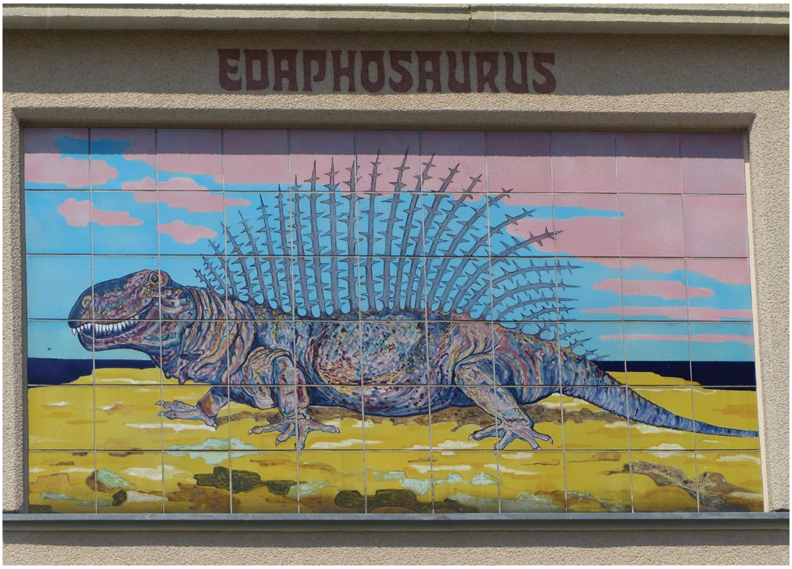

Figure 5.9 Harder's *Naosaurus* on the façade of the Berlin Aquarium, 1913. The name *Edaphosaurus* was added at the time of restoration in 1982. Photograph by Ger Dijkstra, 2021.

decidedly idiosyncratic depictions for the aquarium's front (Nieuwland, 2020a) (Figure 5.9).

One of these showed *Naosaurus* and shows something which looks very familiar to anyone who had been reading Jaekel's articles. The link might not be entirely coincidental. Harder's teacher, the painter Eugen Bracht, was also an intimate friend of Jaekel. As Zoë Lescaze has pointed out, Harder's tableau designs for the aquarium show a stylistic affinity with Japanese wood block illustration (Lescaze, 2017). Jaekel possessed one of the largest collections of Japanese wood block art in Germany, and one can easily imagine a scenario where that art found its way to Harder via Bracht (Nieuwland, 2023).

After 1910, Jaekel had been growing increasingly disillusioned with the scientific elite of the empire, and more and more desperate in the face of bureaucratic disinterest. In 1912, he erected the *Paläontologische Gesellschaft*, an organisation devoted to the fusion of palaeontology and biology, but it could hardly match the influence of a state-supported institute. One year later, he proclaimed a wish to become an art historian instead and devote himself entirely to his extensive collection of Japanese woodcuts (GSPK 21289, 1913). He might even have done so, had not the

First World War intervened and given him a new sense of purpose. In July of 1914, he signed up to fight for the fatherland.

The demise of Naosaurus

Meanwhile, for *Naosaurus* as a species, things started to unravel. After the seeds of doubt had been sown unwittingly by Osborn and knowingly by Case, the death knell came the year after Jaekel's paper, when Tübingen's Friedrich von Huene was able to couple the spines that had been attributed to *Naosaurus* to the skull of *Edaphosaurus* (Case, 1914: 118). However, in popular culture it clung on for a few decades longer, making it into renowned palaeoartist Zdeněk Burian's oeuvre as late as 1941 (Augusta, 1942) and sometimes even later (e.g., Petersen, 1962). Knight, the creator of that first *Naosaurus*, changed his painting to suit new ideas (Figure 5.10). Loath to eradicate *Naosaurus* forever, he rather chose to adapt it. But eventually even he relented, chopping the skull off his *Naosaurus* model and cutting it back to *Edaphosaurus's* tiny head.

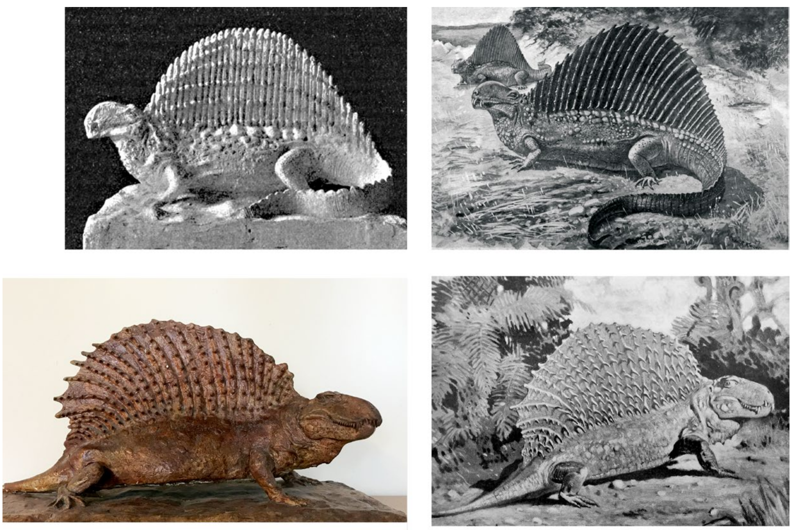

Figure 5.10 The evolution of Charles Knight's *Naosaurus*. Top right: Osborn, Henry Fairfield. 1897. 'Edward Drinker Cope: A Great Naturalist.' *The Century: Illustrated Monthly Magazine*; top left: Osborn, Henry Fairfield. 1898. 'Models of Extinct Vertebrates.' *Science*, New Series 7 841–45; 55 10–15; bottom left: *Naosaurus* model (1905) at Greifswald University, Faculty of Geography and Geology. Photo: Ilja Nieuwland; bottom right: Beasley, Walter L. 1907. '*Naosaurus*. A Fossil Wonder.' *Scientific American* XCVI (18): 368–9.

The history of *Naosaurus* is one of several which demonstrates how far-reaching speculative practices could be in nineteenth- and early-twentieth-century palaeontology once they were backed by a recognised authority. In the case of *Naosaurus*, the support from the American Museum, half-hearted though it might have been, made it all the more problematic to re-evaluate the evidence when it meant the judgement of the museum was found to be in error. A challenge of that judgement was not infrequently regarded as a challenge of the museum's authority. Otto Jaekel's re-evaluation of traditional views on *Naosaurus* and 'Pelycosaurs' in general, intended to challenge the way in which palaeontology was conducted in Germany – both in the way it received information from outside and how it wanted to contribute to other scientific debates, particularly in biology.

Through a combination of personal ambition, nationalism and inter-disciplinary struggle, Cope, Knight, Osborn and Jaekel helped to turn *Naosaurus* into a minor 'honorary dinosaur', mostly in Europe. The use of popular media helped to give the artificial *Naosaurus* a life that stretched well beyond the years of its scientific credibility.

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GSPK 21289, 1913: Otto Jaekel to Friedrich Naumann; Greifswald, 8 December 1913. Geheimes Staatsarchiv Preussischer Kulturbesitz, I. HA, Rep. 89, Nr. 21289.

Notes

1 By Yury Tyronov, Sergei Prokofiev, and Alexander Faint simmer, respectively.

2 For Cope's early work on Pelycosaurs, see Case, 1907.

3 When working on extinct animals Knight typically first fashioned a sculpture, which he then used for his painting. See Milner, 2011.

4 At the time, the Earth was perceived to be far younger than today's consensus. Opinions on the precise age of the Earth varied, with accepted ranges in the palaeontological community being around 60–80 million years (although some advocated a considerably younger or much older Earth). The adoption of radiometric dating in the 1920s caused the consensus to shift to its present circa 4.5 billion years. See Dalrymple, 2004.

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6

From '*Long*' to '*Feng*': the marvellous new era of feathered dinosaur discoveries in modern China

Zichuan Qin and Lukas Rieppel

This chapter offers a personal reflection about the culture of dinosaur palaeontology in modern China, taking the form of a conversation between a Chinese scientist (Qin) and an American historian (Rieppel). The conversation is wide-ranging and touches on several themes, including the discovery of new fossils that revolutionised our understanding of dinosaurs, the social and institutional structure of the palaeontological community, and the representation of prehistory in Chinese popular culture. To help orient readers, the first half of this chapter briefly summarises the long, tumultuous and captivating history of palaeontology in China, which extends back for several millennia. We then transition to an edited version of our conversation, which aims to provide insight on the current state of Chinese palaeontology.

The argument can be made that palaeontology has a much longer history in China than anywhere else in the world. A Chinese bestiary that may date as far back as the fourth century BCE and is often described as *The Classic of Mountains and Seas*, or *Shan Hai Jing* (山海经), contains many references to various types of dragons, some of which are believed to have been inspired by the observation of fossils. For example, an entry on the 'Dragon-Fish' claims that this elusive creature 'lives on a hill north of the plains of plenty and resembles a carp', although others say that it 'resembles a crustacean' (Strassberg, 2002: 173). Also 'known as the Tortoise-fish', it 'was said to have been ridden by a god as he travelled through the nine regions of the world' (Strassberg, 2002: 173). A more detailed account can be found in the

Taiping Yulan (太平御览), a massive encyclopaedia compiled during the Song Dynasty, which quotes an earlier work called the *Xuhanshu Junguozhi* (续汉书·郡国志) by Sima Biao. Written around 306 CE, the latter describes a mountain near the 'River Xiangjiang' where one can find 'stones' that are 'black and book-like' adding that 'in each slice of stone there is a fish' (Yap, 2019). Finally, in a mineralogical catalogue from the Song Dynasty, the scholar Du Wan speculated that these fossil fish might be the result of a process of petrifaction, writing 'I guess these places where we find fish stones are ancient lakes' whose 'muds became stone' (Schafer, 1961).

In *The Chronicles of Huayang*, a treatise on the Yangtze River valley composed around 350 CE, the scholar Chang Qu (常璩) described the excavation of 'dragon bones' from region near Chendu in Sichuan province, which remain highly sought after for their medicinal properties. 'In Wucheng County,' Chang tells us,

> there is a mountain called Somber Warrior Mountain, also called Three Corner Mountain, that has six bends and six rises. Dragon bones are taken from it. It is said that dragons flew up from these mountains, but when they found heaven's gates closed, they could not enter, and thus fell dead in that place, and later sank into the earth. That is why one can dig out dragon bones (Ren, 1987: 166).

According to the noted palaeontologist Dong Zhiming, 'Mesozoic rocks containing dinosaur bones are exposed today in that area of Sichuan province, so it is highly probable that Chang Qu's description is the earliest recorded occurrence of dinosaur bones' (Dong, 2009: 9).[1] Some readers may quibble with this interpretation, arguing that the vast majority of 'dragon bones' were actually mammalian fossils (Witton, 2021). Moreover, even if Chang's text made reference to dinosaur bones, he could not possibly have understood them as such. After all, another 1,500 years had to pass before the word 'dinosaur' was even invented (Owen, 1842). However, while it is true that Chang could not have invoked the taxonomic category *Dinosauria* in 350 CE, it remains entirely possible that he was referring to dinosaur bones as material objects, just as two words in different languages can mean the same thing.[2] Moreover, although Chang's concept of 'dragon bones' (Long Gu) surely had a very different connotation from Owen's 'dinosaur bones', modern scientists also imagine something entirely unlike the way Owen understood dinosaurs when he coined that word to describe these terrible lizards (Desmond, 1979). Hence, it is really a matter of convention – as well as the international code of zoological nomenclature – that scientists now talk of dinosaurs rather than dragons. Perhaps Chang ought to be given priority, and the nomenclature should change!

Joking aside, the question of whether Chang's description of dragon bones from Wucheng County properly belongs to the history of palaeontology offers a fascinating example of what the sociologist Thomas Gieryn calls 'boundary work'. That is, it touches on a much larger debate about the methods by which scientists jealously guard membership in their knowledge community (Gieryn, 1999, 1983). Often, this kind of boundary work serves to police appropriate conduct and prevent against disinformation and fraud (Rieppel, 2018). However, it has also been used to erect epistemic hierarchies and create barriers that prevent people from outside traditional institutions of learning, linguistic communities, and geographic areas from asserting their knowledge claims as legitimate and worthy of serious consideration (Schiebinger, 2004; Proctor and Schiebinger, 2008). In other words, the natural history of dragon bones has profound implications for the political history of palaeontology, which offers more than enough reason to warrant further discussion.

In classical Chinese literature, dragons (Long) are often associated with imperial power, and they are mentioned as one of the key emblematic figures appearing on the emperor's garments in the *Shoo King* or *Book of Documents* (Legge, 1970: 80–1). Indeed, at least two early emperors – Emperor Yao from the proto-historical period and Kao Ti from the Han dynasty – claimed to have descended from dragons directly (Visser, 1913: 123). In addition, dragons were closely associated with water, and were believed to cause thunderstorms, since ancient times. According to Visser, many classical texts therefore describe dragons as 'gods of cloud and rain, whose breath turned into clouds and whose power manifested itself in heavy rains'. As a result, these magical creatures were seen as a kind of 'blessing' and welcomed for the 'fertilizing rain they poured down upon the earth'. By the same token, dragons were frequently invoked for ritualistic and ceremonial purposes (often involving earthenware likenesses), especially during times of drought (Visser, 1913: 114–21).

Given their close connection to power and fertility, it comes as no surprise that dragons have important medicinal properties too. Their bones and their teeth are especially prized in traditional Chinese medicine. According to a famous story, dragon bone was first discovered around 120 BC during the construction of a canal, which was subsequently named *Lóngtóu qú* (Dragon-Head Canal) (Ban and Ban, 1964). In a *materia medica* that was compiled during the late sixteenth century, the scholar Li Shizhen reasoned that dragons die a natural death, and they periodically shed their skin, teeth and bones (Figure 6.1). Suggesting that there is almost no end to the range of maladies they could alleviate, Li sought to document all that was known about these wonderful animals. Among many other things, he recorded the dragon's love of swallows, beautiful jade, and *kongqing* stones, suggesting that medical practitioners who sought to employ their curative power 'ought to understand the dragon's affinities and aversions as they are presented here' (Nappi, 2009: 50–68). Li went on to cite Lei Xiao, who counselled that

> Slender bones with broad markings are from females, thick bones with fine markings are from males. Those with the Five Colors [i.e., multicolored] are best, white and yellow ones are of middling quality, and black ones are of the lowest quality. That which has already fallen and is unclean, or which has been collected by a woman, ought not to be used.

In addition, Li also reproduced several well-known recipes and concoctions, including an especially elaborate preparation that he attributed to Lei, who recommended cooking the dragon's bone in a 'decoction of fragrant herbs' before grinding it to a fine powder and placing it in a silken pouch, which in turn should be inserted into the viscera of a swallow. After hanging the resulting mixture at the mouth of a well overnight, it could then be 'added to medicines for nourishing or repairing the kidney'. While Li described the 'effectiveness' of Lei's preparation as 'miraculous', most recipes simply involved grinding dragon bones or teeth into a fine powder that could then be ingested to cure all manner of afflictions, ranging from 'diarrhea with bloody pus' and 'intestinal carbuncles and ulcers' to 'possession by goblins and daemons'. According to Li, dragon bone also 'nourishes vitality' and 'calms the five organ functions', and it 'stops nightly dreaming of sex with ghosts' (Nappi, 2009: 50–68). Because they could treat such a wide range of ailments, a considerable trade in these objects emerged. As a result, especially productive sites for the excavation of dragon bone began being mined on an industrial scale, and by the late nineteenth century the Chinese Imperial Maritime Customs documented the export of some 350 piculs (about 20,000 kg) of this medicine abroad every year (McCormick and Parascandola, 1981; Manias, 2016: 201–19)!

Dragon bones also caught the attention of Western geologists and palaeontologists, who developed a practice of acquiring choice specimens via purchase from apothecary shops.[3] When a German physician named Karl Albert Haberer visited China in 1899 and found himself confined

Figure 6.1 Illustration of a dragon (*long*, top right) and dragon's bone (*longgu*, bottom right) from the *Bencao gangmu*, a compendium of *materia medica* for traditional Chinese medicine compiled by Li Shizhen during the late-sixteenth century. Source: Li Shizhen, *Ben cao gang mu: Wu shi er juan, fu tu er juan* (Jiangxi Sheng: Zhang Dingsi, 1603). Courtesy of the East Asian Division, Library of Congress [https://lccn.loc.gov/2021666452].

to treaty ports by the Boxer Rebellion, he began frequenting the 'large drug traders' that one could find in the 'thatched-roofed alleyways' of Shanghai. To get his hands on the best specimens for scientific purposes, Haberer asked dealers to pour large bales full of dragon bone out into shallow baskets, where he could search through 'the chaos of stones, bones, fossils and recent skeletal material' to pick out 'the most valuable fossil material'. He then donated these specimens to the zoologist Maximilian Schlosser in Munich, who compared them against his extensive collection of mammalian fossils and identified the remains of about 90 extinct animals in Haberer's shipment, including several bears, hyenas, elephants, horses, hippos and camels, as well as a sabre-toothed cat (Schlosser, 1903).

Around the same time, a resident community of Chinese geologists and palaeontologists began to take shape. As the historians Shellen Wu and Grace Shen have argued, they were motivated by a palpable anxiety that in failing to take stock of its own resources, China had made itself vulnerable to exploitation by foreign empires (Shen, 2014; Wu, 2015). For example, Tian Wenlie, the head of China's Ministry of Agriculture and Commerce, publicly lamented the fact that information about China's 'mineral veins' had been so widely and often 'broadcast abroad'. 'Is this not letting valuables lie about and inviting thieves in?' he pointedly asked (Tian, 1919: 1; Wu, 2015: 160–1). These sentiments were widespread during the first decades of the twentieth century, inspiring a group of Chinese naturalists – including Zhang Hongzhao (章鸿钊), Ding Wenjiang (丁文江), Weng Wenhao (翁文灏), and Li Siguang (李四光) – to establish the Chinese Geological Survey, begin conducting their own field expeditions, inaugurate a formal course of instruction in Earth Science at Peking University, and publish their own journals, all in an effort to develop the knowledge and expertise required to ensure that the extraction of China's natural resources would primarily benefit its own people (Shen, 2014; Yang, 1985, 1986).

To promote the formation of a thriving scientific community, Chinese geologists made a concerted effort to enlist the help of scientists from abroad. For example, after Ding Wenjiang witnessed the 1911 uprising against China's last imperial dynasty – the Qing Dynasty – firsthand, he joined the Nationalist Party's efforts to build a republican government and, by 1913, was appointed as its head of geology in the Ministry of Industry and Commerce. The very next year, Ding invited Johan Gunnar Andersson from Sweden's Geological Survey to help him develop a mineral industry in China (Fiskesjö, 2004). Although he was initially hired to help create the foundation for a robust extractive economy, Andersson soon diverted his attention from economic geology to palaeontology and archaeology. In a professional memoir, he credited Schlosser's treatise with inspiring the shift, describing how the Chinese Geological Survey resolved 'to find the places where dragons' bones are obtained' in 1917. To that end, the survey contacted missionaries and other foreigners, telling them about Schlosser's publication and pleading for additional information. When several missionaries responded enthusiastically, Andersson identified a handful of especially promising quarries that 'stripped from the dragon a good deal of his mystery'. The richness of these quarries also helped persuade a young palaeontologist from Austria named Otto Zdansky to join Andersson's project. When they visited the Zhoukoudian cave just outside of Beijing, a local quarryman advised them to dig for fossils in a nearby locality called *Lónggŭ shān* (Dragon Bone Hill), which directly led to the celebrated discovery of many mammalian fossils, including Peking Man (Andersson, 1973: 70–1; Schmalzer, 2008).

While the excavations at Zhoukoudian and the research on Peking Man showcased the promise of international cooperation, Chinese scholars also accused foreign scientists of enriching themselves at the expense of the local community (Hopkirk, 1980). An ambitious – not to mention expensive – expedition into the Gobi Desert that was led by Roy Chapman Andrews from the American Museum of Natural History during much of the 1920s emerged as an especially volatile flashpoint in these debates. The 'Central Asiatic Expedition' aroused intense indignation among Chinese intellectuals, who accused Andrews and his team of plundering vast quantities of priceless treasures that rightfully belonged to the Chinese, including boxes upon boxes of dinosaur bones (Rieppel and Chang, 2023). Besides his insatiable desire for specimens, Andrews' arrogant habit of deriding the knowledge of local people – whom he accused of mistaking prehistoric fossils for 'dragon bones' that could be sold as 'a medicine for every kind of illness' once they were ground into a fine powder 'and mixed with a liberal quantity of superstition' – could not have helped his cause. Faced by an onslaught of treasure hunters from abroad, China's Legislative Yuan formally passed a new 'Law on the Preservation of Ancient Objects' in 1930, which categorically stated that 'All ancient objects underground or exposed on the surface belong to the nation'. This made it illegal to export archaeological artefacts or prehistoric fossils, mandating that foreign scientists had to collaborate with local scholars and institutions if they wanted to conduct research in China (Lai, 2016).

During the turbulent decades that followed, China's fledgling geological community underwent still more dramatic changes. In the 1930s, an especially promising young scientist called Yang

Zhongjian（杨钟健） began making a name for himself. After completing his studies at Peking University, Yang received his PhD under Ferdinand Broili and Max Schlosser in Munich, writing a dissertation about fossil rodents that Andersson had unearthed in northern China (Young, 1927). When he returned home, Yang took up a position with the Chinese Geological Survey's Cenozoic Research Laboratory, primarily working up the mammalian fossils being excavated from Zhoukoudian (Yen, 2021). But his efforts were soon hampered by international conflict, especially the Second Sino-Japanese War from 1937 to 1945 as well as the Chinese Civil War, which ended with the creation of the People's Republic of China in 1949. During this difficult period, the Geological Survey relocated its headquarters to Yunnan Province in the south-west, and Yang was named as the head of the survey's office in Kunming. During the autumn of 1938, Yang worked on a strategically important road from Kunming to northern Burma (Myanmar), when his assistant Bien Meinian and a technician named Wang Cenyi heard about the discovery of abundant dragon bones by construction workers just northwest of the Lufeng County town. Upon closer investigation, Yang and his colleagues unearthed and described many new fossils from the Cretaceous and early Jurassic period, including several crocodilians, mammal-like reptiles, and early mammals, as well as a pro-sauropod dinosaur that Yang named *Lufengosaurus*. The latter would go on to become the first fully articulated dinosaur skeleton to be mounted for public display in China, creating tremendous excitement and helping to encourage further research in vertebrate palaeontology (Figure 6.2). Eventually, the provincial government in Yunnan financed the construction of a large and impressive museum in Lufeng County to showcase its unusually rich and extensive fossil deposits (Dong, 2009: 106–13).

While academic exchanges with Western countries ceased for several decades after the People's Republic of China was founded in 1949, the palaeontological community continued to develop. A new generation of students joined the field, many of whom travelled to the Soviet Union for advanced training. As a result, Chinese scientists also developed collaborations with Soviet colleagues, which lasted until the political relationship between their two countries began to deteriorate in the 1960s. Because China experienced severe economic hardship and endured considerable social upheaval (including the Cultural Revolution) during this period, geologists and palaeontologists primarily devoted their energies to utilitarian ends. (The major exception being palaeoanthropology and Palaeolithic archaeology, which continued to receive substantial support from the Communist party's state apparatus

Figure 6.2 A herd of articulated dinosaur skeletons on display at the Lufeng Dinosaur Valley Museum, Yunnan Province, China. Photograph by Lukas Rieppel.

(Schmalzer, 2008).) Thus, most of the community's efforts were directed toward the completion of comprehensive surveys designed to locate new sources of oil, coal and other mineral resources to spur industrial growth. With fewer resources devoted to the collection of vertebrate fossils and the study of Earth history, the geological and palaeontological community contracted during the 1970s and 1980s (Committee on Scholarly Communication with the People's Republic of China, 1977). However, that slowly began to change during the period of market reforms that was inaugurated by Deng Xiaoping after Mao Zedong's death in 1976. With increased government funding and a renewed openness to international collaboration, the palaeontological community grew dramatically, and by the 1990s the field had entered what many consider its 'golden age' (Jia, 2019; Zhou, 2022; Ma, Wang and Wang 2022).

Without a doubt, the most momentous development in the recent history of Chinese palaeontology is the discovery of a world-renowned *Lagerstätte* – the Jehol Biota – in the north-eastern Province of Liaoning. The Jehol Biota has become famous for beautiful fossils of feathered dinosaurs and early birds that are exquisitely preserved in the region's 'paper shales'. These were created when successive waves of volcanic eruptions deposited layer upon layer of volcanic dust, or 'tuff', across the region's abundant lakes during the Mesozoic Period. As the sediment sank, it buried a huge variety of recently perished organisms under thin layers of tuff, creating ideal conditions for the preservation of integumentary structures and other soft body parts in magnificent detail (Chang et al., 2008). As the exquisite remains of feathered dinosaurs and early birds from the Jehol Biota became an international sensation, scientists developed statistical techniques that allow them to reconstruct the colour of these prehistoric creatures by analysing the size and shape of fossil melanosomes (small organelles that synthesise pigment) (Vinther et al., 2008; Vinther, 2015; Li et al., 2010). As a result, it is not too much to say that recent discoveries in the Jehol Biota have completely upended the science of vertebrate palaeontology and revolutionised the popular conception of dinosaurs. The palaeontologist Mark Norell put it well in an editorial for *Science* magazine, writing that, 'now, instead of scaly animals portrayed as usually drab creatures, we have solid evidence for a fluffy colored past' (Norell, 2011).

The Jehol Biota derives its name from a transliteration of Chinese characters '热河' using the out-dated Wade–Giles romanisation system. In reference to the many hot springs in this region, its Chinese name literally translates to 'the hot river', and it is now written as 'Rehe' using the Pinyin system. During the Qing Empire, this region housed the royal court's summer palace, and it constituted a separate province made up of what is now western Liaoning, northern Hebei, and south-eastern Inner Mongolia. The region's stratigraphy was first described by Amadeus W. Grabau for the Chinese Geological Survey in 1928 (Grabau, 1928;

Figure 6.3 Imaginative rendering by Brian Choo of *Yutyrannus huali* and *Beipiaosaurus inexpectatus*, covered in colourful feathers while patrolling the Jehol Biota in what is now Liaoning Province, China. © Brian Choo.

Mazur, 2004). Then, in 1962, a Chinese malacologist officially named the Jehol Biota based on the description of three representative fossils – two Arthropods and one fish. As a result, the bureaucratic rules of zoological nomenclature dictate that Grabau's name be given priority, which is why the Rehe Biota is still called 'Jehol' in the scientific literature (Rogaski, 2022).

While its abundant fossil resources have been known for some time, the spectacular feathered dinosaurs, early birds and angiosperms that have made the Jehol Biota so famous were only discovered during the past several decades. The first Mesozoic bird from Liaoning, *Sinornis*, was collected around 1987, but the region became truly world famous after a rural farmer named Li Yinfang (李荫芳) unearthed the region's first feathered dinosaur during the mid-1990s. Although he was not a trained palaeontologist, Li immediately realised that he was dealing with something special. After he sold one half of the fossil to the Geological Museum of China in Beijing and the other half to the Nanjing Institute of Geology and Paleontology, Li's dinosaur was officially christened *Sinosauropteryx prima* (meaning 'first Chinese lizard wing'), causing a scientific sensation, both inside and outside China (Ji and Ji, 1996; Norell and Xu, 2005). During the years that followed, many more important fossils have been unearthed in the Jehol Biota and beyond, cementing China's status as a world centre for vertebrate palaeontology. In what follows, we present an edited conversation between Rieppel and Qin that offers an insider's perspective on how these developments impacted the experience of young palaeontologists in China.

Lukas Rieppel: I know you became a dinosaur fanatic during your childhood in the 1990s. Was there already a robust culture of popular enthusiasm for palaeontology at that time?

Zichuan Qin: Yes, it was just starting to get going then. A good early example is a comedy film, produced by and starring the well-known Hong Kong comedian Stephen Chiau, called *From Beijing with Love*, that was released in 1994. This movie is a satirical take on the classic James Bond (007) series, but what sets it apart from typical Hong Kong action movies is that the national treasure which has gone missing, and must be found by the protagonist, is not a typical Chinese historical relic, but a *T. rex* skull. The idea that dinosaur fossils are a national treasure has become common sense since that time. I don't know if the screenwriter was a big fan of Chinese palaeontology, but the movie's release happened to coincide with the new era of extraordinary fossil discoveries in China. The exquisite Chengjiang biota fossils were first discovered in the 1980s (Xian-Guang, Siveter et al., 2017), providing many important and well-preserved fossils, including some of the earliest examples from significant mammalian stem-groups. When the attention of worldwide palaeontologists turned to China, the newly opened, mysterious ancient country, they found far more than expected. In the early 1990s, farmers from north-eastern China discovered many feathered 'bird' fossils, which led to another especially important discovery in the twentieth century – the Jehol Biota.

Rieppel: The recent history of Chinese palaeontology is fascinating, but I know there is also a much longer tradition of Chinese people taking a keen interest in fossils. Can you say a few words about the long-standing association between fossils and mythological characters in China, and how that tradition continues to manifest itself in modern palaeontology?

Qin: In the modern history of Sino-Western cultural exchanges, the names of exotic mythical creatures are also referred to by native civilisations in familiar terms. For example, '龙 Long' and '凤 Feng' are usually translated as 'Dragon' and 'Phoenix' in English (and corresponding meanings in other languages). While there are many differences between the Chinese '龙 Long' and the western 'Dragons', and between '凤 Feng' and 'Phoenix', they remain convenient translations. Chinese 'Long' are usually depicted as snake-like with four legs [see Figure 6.1], which makes them morphologically quite distinct from the western 'Dragon'. There is an even greater difference between the Chinese '凤 Feng' and the western 'Phoenix'. The '凤 Feng' are the males of mythological birds called '凤凰 Fenghuang' in Sinospheric mythology (the '凰 Huang' are females) rather than the name of a single creature. But in many cases, '凤 Feng' are blurred into a feminine creature that is frequently paired with '龙 Long', which is always described as male. As a pair, '龙 Long' and '凤 Feng' became symbols of imperial power, and also represented masculinity and femininity. Thus, for example, twins of different sexes are known as the '龙凤 Long Feng' babies. This symbol of imperial power also extends to the animal kingdom, or to be precise, the two kingdoms. While '凤 Feng' reign over all flying birds, '龙 Long' reign over other beasts. Finally, a conjoining of '龙 Long' and '凤 Feng' is considered the most auspicious and festive symbol, known widely as '龙凤呈祥 Long Feng Cheng Xiang'.

This cultural history also manifests itself in the practice of science, especially when it comes to naming conventions. In all Chinese-speaking areas, sauropserids (including living reptiles, extinct marine reptiles, pterosaurs, some extinct crocodiles, and all non-avian dinosaurs) are usually designated with a scientific name that ends in the suffix 'Long'. This convention originated with Japanese geologists who first translated the ‘Dinosauria’ into Japanese as ‘恐竜（きょうりゅう; Kyōryū), which in turn caused Chinese academics to use ‘恐龙 (Kong Long)’ when referring to these extinct reptiles. Moreover, the suffix ‘龙 Long’ is also widely used to designate most sauropsid lineages that don’t have a living relative (or have only a few, rare living relatives). Similarly, in synapsids, the suffix ‘兽 Shou’ (which roughly translates to ‘beasts’) is a popular designation. While we now know that birds are dinosaurs, most translations of their scientific names end with the suffix ‘鸟 Niao’, because the naming convention predates widespread recognition of the evolutionary relationship between dinosaurs and birds. Finally, the cultural significance of ‘Long’ also contributed to the increased the popularity of dinosaurs ‘恐龙 (Kong Long)’ in Chinese-speaking parts of the world. The wonderful coincidence between Chinese mythology and recent palaeontology thus had a big impact on popular culture, because recent discoveries about the way non-avian dinosaurs evolved into modern birds parallels ancient myths about ‘Long’ and ‘Feng’ myths, which greatly adds to the public’s interest in the latest scientific advancements.

Rieppel: Let’s return to the more recent fossil discoveries. Can you tell us a bit more about these, and how you became involved in them personally?

Qin: The impact of these discoveries in the last two decades of the twentieth century is profound, changing palaeontology itself and raising its visibility among the Chinese public. Although the western science of palaeontology was introduced to China more than a century ago, it entered the public’s field of version and daily life much more recently. Since the 1990s, the spectacular discovery of Jehol’s feathered dinosaur fossils from the Northwestern province of Liaoning has been especially important. Xu Xing（徐星, an outstanding representative of Chinese vertebrate palaeontologists who holds the honour of having named the most dinosaurs of anyone in the world, was not only an academic idol to young Chinese dinosaur fans but also focused international attention on this ancient country. I was very honoured to work with Xu in my early career in palaeontology. He loves the field so much and never stops exploring. During an amazing, unforgettable seven years in Xu’s lab, I travelled with him to almost every part of China. Our trips ranged from the most remote parts of the Gobi Desert and Northwest Xinjiang to the humid tropical rainforest in Southwest Yunnan. And of course, we also visited the famous fossil site in Liaoning, with its amazing, feathered dinosaurs. From these cities to the countryside, I saw how significant fossil discoveries are for local people, economically as well as culturally.

Because most of the digging at the Jehol locality has come to an end, my first field trip with Xu was to Erenhot, one of the most remote border cities between China and Mongolia. Though not that well-known, Erenhot is where Asia's first fossil excavation took place in 1893, and it is also where Roy Chapman Andrews discovered the first dinosaur egg fossils during the Central Asiatic Expedition (Andrews, 1932). On the main road leading to Erenhot, all of us who were visiting the locality for the first time were shocked by its 'City Gate' which features two life-sized sauropod dinosaur models kissing each other. Watching the Mongolian herdsmen slowly grazing their sheep under the gate ranks as one of the most surreal experiences of my life. The herdsmen just graze their sheep on the rocks of the Iren Dabasu Formation, exactly where one can unearth thousands of dinosaurs from the Late Cretaceous period! Wherever there is a flash of reflected sunlight, you might find the tooth of an ancient raptor. These herdsmen could be the first Asians who knew about and unearthed dinosaur fossils, and they often worked as guides, helping scientists from America, then the Soviet Union, and now their own country find specimens. In addition to Mongolia's beautiful grasslands and its ancient culture, dinosaur parks and museums are now popular tourist destinations. Many herders are also part-time fossil hunters who have discovered many important dinosaur fossils.

Figure 6.4 The 'Kissing Dinosaurs' sculpture in Erenhot. Photographed by Mieszko9. Shutterstock [Image ID: 1291802815].

Figure 6.5 Another sculpture at Erenhot, of a small Sauropod by a wind-turbine. Photographed by Mieszko9. Shutterstock [Image ID: 1333105541].

As a result of this new wave of enthusiasm for palaeontology, scientists are now receiving more funding and attention. Hence, these old fossil sites have undergone detailed re-excavation work in the past 20 years, and many new species have been described from them. One of the most exciting discoveries is the *Gigantoraptor erlianensis*, the largest known oviraptorosaurian, which reached 8 m in length and over 2 [imperial] tons in weight (Xu, Tan et al., 2007). The holotype, LH V0011, was discovered totally by coincidence. Before it was found in Inner Mongolia, China's abundant dinosaur beds were already well known throughout East Asia, especially in Japan, which experienced a dinosaur craze much earlier. Indeed, the first volume of Japan's most famous anime series 'the Doraemon' features a dinosaur story. As a result, a Japanese TV station invited Xu Xing to film a documentary on the excavation of dinosaur fossils in 2005. Xu Xing was conducting fieldwork in Erenhot at the time. When the film crew randomly chose to film a dinosaur thigh bone to document his excavation, Xu realised that it did not appear to belong to a sauropod, but was more likely an oversized theropod leg. So, he stopped the filming and described this new species in *Nature*. Before this important discovery, Oviraptorosaurs were always thought to be small-sized, feathered dinosaurs. Xu's discovery of *Gigantoraptor* thus challenged the conventional wisdom, which led to it being named one of the world's top 10 scientific discoveries of 2007 by *Time Magazine*. It is also a great example of public enthusiasm for science feeding back into research, with fortunate results!

On the other end of China, in Yunnan Province, is where the history of Chinese excavations of dinosaur fossils really began. During the Second World War, much of eastern China was engulfed in heavily armed clashes. But geological survey work continued during these difficult circumstances in the south-western part of China. In particular, the 'Father of Chinese Vertebrate Palaeontology', renowned palaeontologist C. C. Young (aka Yang Zhongjian) excavated and mounted the first dinosaur skeleton in China, naming it *Lufengosaurus huenei*. Although fieldwork was extremely difficult during the war years – scientists like C. C. Young not only had to make do with very little funding and frequent food shortages, but sometimes they were also threatened by warlords and bandits – and yet they succeeded in conducting ground-breaking research in south-western China.

After the Second World War, the focus of vertebrate palaeontologists returned to more affluent regions in northern and eastern China. But as enthusiasm for palaeontology continued to grow, Chinese palaeontologists have turned their attention back to the south-western mountainous regions again. Before I left China in the summer of 2018, I was very lucky to be involved in organising and participating in a new round of field examinations for dinosaurs in Yunnan. One very early branching armoured dinosaur (*Thyreophora*) has already been described (Yao et al., 2022), with more discoveries about to be published soon. Since the 1980s, with a great deal of fieldwork in the Cambrian Chengjiang Biota having already been carried out in nearby areas, Yunnan developed a rich culture of palaeontology with several teams of professional fossil hunters. The local universities are also thriving, which is bringing more and more relevant talents to the wild west. As the hotspot of academic research transitions from the question of how non-avian dinosaurs evolved into modern birds during the Cretaceous period to the early dinosaur evolution and adaptive radiation of dinosaurs in the Triassic and Jurassic, it is believed that fossil discoveries in the south-west will make even greater contributions in very near future.

Unfortunately, by the time I began my academic career, large-scale excavations of the Jehol Biota had already been halted for over a decade. Still, there is no doubt that the Jehol region remains the palaeontological Jerusalem of China. I first visited this area by chance during a meeting of the Palaeontological Society of China, which featured well-organised field trips that took participants around all the region's famous fossil sites.

Several of the young scholars who joined us were born and raised in this region. My friend Wang Shiying, for example, now returns to his home university as a lecturer in palaeontology, after receiving his PhD at Xu Xing's lab at the prestigious IVPP (Institute for Vertebrate Paleontology and Paleoanthropology) in Beijing. During the field trip, these friends explained that the Jehol sites are not nearly as busy now as they were 20 years ago. They remembered how, in their childhood, local quarries were full of fossil hunters and scientists, and there were many small marketplaces where beautiful fossils were sold. But none of these is visible today. Indeed, a glass shed already covers the most renowned quarries, above which there are now dozens of museums and exhibition galleries that exhibit the most beautifully preserved fossil feathers in the world. Standing outside these famous quarries reminds me that although I was not as fortunate as Shiying, who spent his childhood growing up in this wonderful place, we are still in a period of tremendous discovery, possibly the best period for any dinosaur lovers. Here is the place where it all happened, which is still amazing.

Rieppel: How did you first learn about Xu's research and become interested in joining his lab?

Qin: I first saw a video of him about 20 years ago. Xu was a young palaeontologist then, together with other Chinese palaeontologists – including Zhou Zhonghe（周忠和）and Wang Xiaolin（汪筱林 – he presented a fantastic series of keynote speeches about the latest discoveries in Jehol Biota on a TV programme called Baijia Forum, which was the most highly respected and popular science show on television in China. I was a very young but passionate dinosaur fan who never missed an episode of this show, and I watched the episodes featuring Xu many times. Before I learned about these important dinosaur discoveries in China, all my palaeontology books were translated from English and imported from America or Europe. To be honest, as a child who loved dinosaurs but did not grow up in a metropolis like Beijing or Shanghai, dinosaurs were very attractive, but also seemed very remote from my daily life. I did not realise that such amazing dinosaur fossils were preserved in my own country, let along in my own province! But after watching Xu's speech on television, I realised that dinosaurs are actually much more accessible to someone like me.

I started to learn more about palaeontology on the internet. Although it was still very hard to find much information in Chinese at that time, young palaeontologists were slowly starting to gather on some internet forums, including on Chinese dinosaur forums and the Chinese fossil forums, as well as the Chinese dinosaur Baidu bulletin boards. In a way, meeting new dinosaur lovers from all over China made me more envious of those who lived closer to famous fossil sites or in a big city with good natural history museums. Still, all of us young dinosaur lovers boasted that one day we would become palaeontologists like our idol Xu Xing and his colleagues.

The Golden Generation of Chinese palaeontologists were committed to giving back to society despite being so busy with scientific research. Xu Xing was a leader in this area, too, creating a popular textbook for the nation's primary school textbooks, *The Dinosaurs that Flew into the Blue*, which detailed the progress of research on feathered dinosaurs in the Jehol Biota at the time. Every young person born after 1990 has probably read it, and there is no doubt the basic ideas of palaeontology are now well known among young people in China. That's how the first generation of Chinese palaeontology enthusiasts came into being. When I was studying for my master's degree at the IVPP, China's most prestigious institution for vertebrate palaeontology, I could still feel the excitement. I and another student from Xu's lab, named Chun-chi Liao, also dedicated ourselves to the popularisation of dinosaur palaeontology. We have translated over a dozen books and written articles on Chinese internet platforms that received over a million hits. Further evidence for the sustained popularity of dinosaurs is the fact that the Paleozoological Museum of China is always crowded with visitors, from primary school children to university students – the hustle and bustle never stops.

Rieppel: How common was your experience? When you speak to other young Chinese palaeontologists, do they tell similar stories?

Qin: I always feel lucky to have chosen this path, but many others also followed their childhood dreams, even though academic opportunities remain scarce in China. I guess most dinosaur fans benefited from their passion for fossils, because this led them to become interested in biology, and many are now employed in the medical field or the pharmaceutical industry. Others are engaged in science journalism, writing popular articles on the increasingly prosperous Chinese internet, and making videos introducing the latest research. It is an honour many of the standout examples are my friends. Let me tell you about one of them to illustrate the evolution of the palaeontology craze in modern China.

Niu Kecheng（钮科程）is one of the youngest curators of a natural history museum in the world. Born in 1996, he graduated from college only 4 years ago (in 2018) and is already the head and curator of a museum that covers a total area of 25,000 square metres. This is the Yingliang stone natural history museum, the largest natural history museum in the Fujian province of China. For centuries Fujian has been a wealthy province on the eastern coast of China, which engaged in frequent exchanges with foreign countries. However, its relatively unique geology prevented a formal natural history museum from being built in the area. That changed permanently in 2018, thanks to the patronage of an entrepreneur named Liu Liang. Liu is a well-known local merchant of stone and building materials. During his trade in stone, he gradually developed an interest in fossils. While China's palaeontology boom was in full swing, he realised there was no decent palaeontological museum in his hometown, so he decided to do something about it. By then, a well-established group of fossil enthusiasts had already developed on the Chinese internet, which is how Liu met Niu, giving the promising young man an ambitious offer that he could not refuse: to build up his own natural history museum from scratch.

Niu later told me that he was so shocked by this surreal turn of events that, at first, he even thought Liu's offer might be a scam. Niu's experience is certainly unique, not only in China but throughout the world. He hardly fits the general idea of a museum curator should look like, but Niu absolutely nailed this job. During his amazing four-year career, he oversaw the construction of a museum with award-winning architecture, the expansion of a rich and abundant collection, and hired a team of renowned scientists who are conducting world-class research. Just in the past five years, fossils from the Yingliang Museum's collection have already changed our understanding of the ancient world. For example, a team of international collaborators joined Niu in describing a key 'missing link' in the origin of arthropods, *Kylinxia zhangi* (Zeng et al., 2020); as well as two unusually well-preserved embryos of oviraptorids and hadrosaurids (Xing et al., 2022a, 2022b).

Niu was raised in a well-educated family, and he spent his childhood as part of a community around a local hospital, which had a great atmosphere of biology. Like most dinosaur fans, he watched a lot of TV shows about palaeontology, which he still remembers very fondly. Though he majored in economics in college, he taught himself a great deal about palaeontology, and he was always among the most active palaeontology fans on Chinese-speaking internet. Fate always favours those who are well prepared, and when he graduated from university, he got an opportunity to be the assistant Curator of the recently created Yingliang stone natural history museum. His palaeontology and economic background gave him the ideal skills and abilities to manage and grow the museum. A large social network and advanced knowledge of palaeontology allowed him to amass and organise an impressive collection, and his professional background in economics came in handy when working on budgets. Moreover, Niu's contacts within the hobbyist community enabled him to gain access to many researchers, amateur fossil hunters and collectors early on in his career. As a result, he was able to build a world-class museum in just four years, in a province that didn't even have such a museum before, which is just marvellous.

Rieppel: That's amazing indeed! One thing that's becoming clear from your experience, as well as that of your friend Niu, is that vertebrate palaeontology has become an important part of Chinese popular culture. Can you tell us a bit about how that came to be, and the career paths that it has opened for people who are interested in dinosaurs but chose not to become practising palaeontologists?

Qin: The fast pace of China's economic growth and the discovery of so many new and spectacular fossils created opportunities for many more palaeontologists since the 1980s. However, the traditional, highly centralised research institutes and the elitist education system could not keep up with the demand for new talent. Luckily many enthusiasts emerged to fill the void. Niu is just one of the best – an outstanding representative. But there are many other passionate and clever minds who also made great contributions to the new field. Although some of them do not work in palaeontology directly, their contributions should not be ignored.

For example, Wang Jiwen got his PhD in Chemical Engineering and now is a successful engineer in the Chinese metropolis Shanghai. But he also has a second, more hidden identity: he is more or less considered a 'godfather-like' figure in the community of palaeontology enthusiasts. Although Wang is not that famous among the public, he is widely respected among popular science educators. All the popular palaeontology bloggers and vloggers have benefited from his masterwork, a fabulous series of 'Earth Romance' stories, in which a traditional Chinese literary genre has been adapted to popularise palaeontology. It must be the longest serialised palaeontological science story in the Chinese-speaking world; it is also the source of many science videos and documentaries.

This type of literary genre is known as '章回 (Zhang Hui)' and it forms part of the traditional style of Chinese serial novels (Zimmer, 2008), of which the classic *Romance of the Three Kingdoms* and *Water Margin* are typical. These novels are usually made up of stand-alone chapters, each of which has its own title, and new protagonists are often introduced with a poem. Zhang Hui is a perfect style for telling historical stories, especially narratives that develop through time and across space. They also allow authors to tell separate stories that take place at the same time. This makes them especially well-suited for telling evolutionary stories.

The night that Wang Jiwen became a father, a genius idea occurred to him: he decided to combine his two great loves, palaeontology and literature, by writing a Zhanghui-style novel about all the living things on earth as a gift to his beloved son. Each chapter or 'Zhanghui' is an exciting evolution story, in the heartwarming form of a father telling his son a bedtime story. Taken together, the entire series of evolution stories forms the 'Earth Romance'.

But Wang doesn't just write bedtime stories. His research training made him keep learning more about palaeontology and improving his writing skills. So far, he has written around 300 chapters, far exceeding his original plan of '100 bedtime stories', but what is even more amazing is that he has still only written about the Mesozoic period in Earth history. Each 'Zhang Hui' functions as a single time slice, describing a specific period of geological and evolutionary history. This is a clear advantage of the 'Zhang Hui' style, which is famous for telling the story of the hero while documenting the daily life of regular people in detail. This makes the style perfect for narrating evolutionary stories that feature star species as well as lesser-known species. Dinosaur lovers often complain about the '*T. rex* effect', in which the popular obsession with star fossils sometimes takes attention away from more ordinary but still very interesting species. In Wang's Zhang Hui, this effect is attenuated, helping to attract more public attention for some species that are not so well-known. Nowadays, most Chinese palaeontologists know his pseudonym, the Climbing Well Frog, and his fabulous work has become an inspiration for many articles and videos.

Rieppel: This is incredibly interesting! Can you say more about the importance of dinosaurs in contemporary Chinese popular culture, and how that has contributed to the development of China's palaeontological community?

Qin: Chinese science got off to a late start and did not experience an era of colonial expansion. It has grown rapidly in the last hundred years, but its impact has been limited compared to the size of China's population. This is particularly striking in palaeontology. It was not until the spectacular discoveries of the late twentieth century that palaeontology really became a cultural phenomenon with the general public. However, there are still very few professional researchers, both compared to the large number of fossils excavated and to the huge population of China. This limits the impact the impact that science can make on the public, making it difficult for scientists to balance research and popularisation. But fortunately, Chinese dinosaur enthusiasts stepped forward to fill the gap. In addition to the museum and popular science sectors described above, Chinese palaeontological artists have gained an excellent reputation. Artists like Zhao Chuang, Chen Yu, and Zhang Zongda, have become acclaimed throughout the world, and their work is regularly featured on the covers of top journals like *Nature* and *Science*.

The recent boom in Chinese palaeontology is different from most other parts of the world, where scientific research has generally benefited from extensive support by the culture industry, like film production companies sponsoring the work of young researchers. But in other parts of the developing world that resemble China in so far as they also don't benefit from a well-established culture of palaeontology – which is actually most of the world – the example of the Chinese can teach useful lessons. By fostering the development of a scientific research community first, even a small field like palaeontology can attract public attention and support, which in turn feeds into the growth of that discipline. Another lesson is how the interplay of palaeontological culture and indigenous culture looks very different in different cultures. Western films and television series are undoubtedly important channels for popularising science. But, at the same time, other styles, genres, and sub-cultures, including anime, manga and virtual streaming in East Asia, are worth further exploration and promotion too.

Rieppel: Thank you for sharing your knowledge and taking the time to speak with me!

Notes

1 Elsewhere, Dong writes that 'As we know nowadays, these "dragon bones" actually belonge [*sic*] to dinosaurs' (Dong, 2009: 84). (For more on dinosaur fossils in ancient China, see Li, 1974; Zhen, 1961).
2 Analytically minded readers will note that we are here making a distinction between what the late-nineteenth-century logician Gottlob Frege described as 'sense' and 'reference' (Frege, 1892).
3 In the *Bencao gangmu*, Li cites a particularly intriguing episode that links the concerns of traditional Chinese medicine to palaeontology, reciting how a dragon's entire skeleton 'emerged after a cliff collapsed, fully equipped with skin, body, head, and bones', and adding that it was 'unclear whether this was a dragon's effluvium or its corpse', both of which are 'invisible when the dragon is alive but observable when it has died'. Quoted in (Nappi, 2009: 58–9).

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Part II
Mammals and hominins

7

Mammals, the measure of success? The legacy of ‘progress’ in natural sciences

Elsa Panciroli and Chris Manias

Frameworks of progress and hierarchy have had a strong and longstanding influence over natural history. While scientists today claim that their ideas of evolution have moved on from notions of advancement, scales, hierarchies and ‘progress’, these outlooks have nevertheless remained stubbornly persistent in their language and interpretations. In this paper, we apply insights from the fields of palaeontology and history of science to address the origin and persistence of ideas of progress in evolution. We ask why notions of progress have been so entrenched in both scholarly and public debates, and in what circumstances they have been accepted or rejected. What is the impact and legacy of this for science and science communication? Phrases like ‘evolutionary success’ and ‘most successful group’ are still commonly used, but what do they actually mean, and what values have been attached to them? How do we measure this success, or should we be using such terms at all?

To consider these questions, we will be thinking about small mammals,[1] particularly those which lived in the Mesozoic (the Triassic, Jurassic and Cretaceous Periods, between 252 and 66 million years ago). Both authors of this chapter have written books on how mammals and their evolution have been understood (Panciroli, 2021 and Manias, 2023), bringing complementary perspectives from different disciplines. Elsa Panciroli is trained as a palaeontologist, specialising in the origin and evolution of mammals. She has also explored how problematic legacies in the field of palaeontology continue to impact science communication and public understanding of the mechanisms of evolution. Chris Manias is a historian of science who examines how the sciences that deal with nature and the world have been entangled with culture and ideology from their inception.

From the eighteenth century, natural historical modes of thinking based on hierarchy and progress placed mammals as the highest and most advanced type of animal. That same conceptual framework created internal hierarchies within the class. Specific mammal groups were judged as 'low' or 'primitive,' especially (as a manifestation of colonial ideologies) marsupials and monotremes. Small-bodied mammals such as rodents were also placed in a low position, and often depicted as 'verminous' and detrimental to human society and the economy. These ideas of hierarchy and development among mammals interacted with emerging understandings of fossils, which indicated that mammals had existed in 'the time of the dinosaurs'. Scholars were struck by the significance of these early creatures as marking the origin of the elevated group Mammalia, but were also disparaging and even disgusted by their small 'shrew-' or 'rat-like' characters, and what they perceived as their domination by more powerful reptiles for long geological periods.

As a result of this ambivalence, Mesozoic mammals have occupied a complex place in narratives of progress and evolution, which this chapter will trace and examine. Promoting these creatures to public audiences (and even championing them among scholars) has often been difficult, especially as animals of large size came to dominate popular images of the prehistoric world. This has meant that, in contrast to dinosaurs, or the dramatic recent mammal megafauna like sabre-tooth cats and mammoths, Mesozoic mammals were difficult for public audiences to conceptualise. Mesozoic mammals were consistently compared to modern animals which were themselves considered 'primitive', and value and narrative were ascribed to them even before fossil material was found to elucidate their true characteristics. By looking at how narratives of progress, evolution and advancement were – and still are – applied to the mammals of the Mesozoic, we can therefore directly address these wider ideas in the history of palaeontology, and their legacies, today.

Mammals in narratives of progress and development

Ideas of hierarchy and progress in nature have a long history in Western contexts. Before theories of evolution were adopted as the principal mechanism for understanding nature, the 'chain of being' was a widespread motif in European and Christian thought. This was the idea

Figure 7.1 'The Ascent of Life', a dramatic visualisation by F. Besnier of the chain of being in a developmental sense, from Flammarion (1883). Courtesy of Chris Manias.

that everything that existed on Earth could be arranged into a single scale or ladder, starting with 'low' things like rocks, plants, and then invertebrates, and ascending through fish, amphibians, reptiles and mammals, to humans as the corporeal pinnacle (almost always gendered as male as 'man'), and then, for Christian writers continuing up through the ranks of angels, to God (Figure 7.1). Many evolutionary thinkers, both before and after Darwin and Wallace, reinforced ideas of the chain, seeing it not as something fixed and unchanging, but as a scale on which some organisms, throughout their evolutionary histories, could move 'up' and potentially also 'down,' if they degenerated. While overt statements of the chain declined somewhat in the nineteenth century, it still provided a crucial way of structuring ideas of natural life as based around hierarchy and superiority, with quite dramatic visualisations drawing on the chain frequently featuring in both popular science works, and also providing structures for scientific texts and museum displays.

The idea of mammals as a 'superior' kind of animal was incorporated into the first definition of the group, Mammalia, in the eighteenth century. In the 1758–9 edition of his *Systema Naturæ,* Carl Linnaeus tabulated the animal world into five great classes, arranged with the Mammalia as the summit. Londa Schiebinger (1993) argued that Linnaeus's emphasis on the mammary glands which (unusually for a defining systematic characteristic) are milk-producing only in one sex of the group, was influenced by contemporary values around the essential gender roles of maternal caregivers. Over the following centuries, the superiority of mammals was interpreted in a number of ways. Overall physiology was highlighted, especially warm-bloodedness, as representing the pinnacle of what could be achieved by the physical body. For Richard Owen, the brain stood out as the core focus of mammalian superiority: he wrote that in Mammalia 'the brain is perfected: we can trace through the different orders the increasing complication of this organ, until we find it in man to have attained that condition which so eminently distinguishes him from the rest of the class' (Owen, 1837: 359).

At other times taxonomic diversity and morphological variation were used to demonstrate mammal superiority. Alfred Newton, the first Professor of Zoology and Comparative Anatomy at Cambridge, wrote how:

> The variation of form presented by the Monodelphian Mammals[2] is so great as to defy even their leading characteristics being here set forth. They may be covered with hair or be hairless: they may have a hundred teeth or none at all: they may inhabit the deepest seas, burrow in the ground or fly in the air: they may be gigantic

> monsters or almost as small as any known Vertebrate. Yet in all the main points they agree, and once more proclaim that unity of plan and diversity in its execution, which so strongly marks creation from its lowest to its highest form - MAN himself. (Newton, 1874: 89)

These valuations continue today, although usually stripped of the more overtly progressivist and human supremacist language. Mammals are currently understood as comprising around 6,500 recognised species (Burgin et al., 2018), and range in body mass from 2 grammes (Kitti's hog-nosed bat, *Craseonycteris thonglongyai*) to 200 tonnes (the blue whale, *Balaenoptera musculus*). They demonstrate a staggering diversity of life-styles, including specialisms for running, hopping, climbing, digging and swimming, and dwell in all habitats including deserts and polar regions (Nowak, 1999). These features are still used to demonstrate their supreme adaptive flexibility, as well as showcase the wondrousness of variation in nature and change across time.

Citations of mammalian superiority often included the argument that these were the animals most like 'us', that is, humans. Although humans are now uncontroversially placed within Mammalia, when Linnaeus did so in the eighteenth century, this was taken by many scholars as an affront to humanity's uniqueness and special nature. The esteemed French naturalist the Comte de Buffon argued that 'man is of an entirely different nature from that of the animal' (cited in Baum, 2008: 68). Later debates over Darwinian evolution often centred on concerns over the animal nature of humanity, or whether humans had developed through the same processes as the natural world (an idea with unsettling implications for Christian conceptions of the human soul, and the notion that humans were created in God's image). But even when humanity's place among the mammals was contested, it was still generally agreed that mammals presaged important human qualities. In conventionalised depictions, mammals were often shown living in family or social groups and demonstrating complex emotional lives – a trope present in sentimental Victorian natural history works and taxidermy, where 'family' dioramas are very common (Haraway, 1989; Machin, 2008), and continuing in modern nature documentaries such as *Meerkat Manor* (Animal Planet, 2005–) or *Dynasties* (BBC, 2018).

As well as a general tendency to anthropomorphise, outlooks on mammals can be even more bluntly anthropocentric. Mammals were often considered more important because they were the most 'useful' animals to humanity. In their 1891 survey of mammalian life, Henry Flower and Richard Lydekker wrote:

> of all the living creatures inhabiting our globe, mammals are by far the most important in their economic uses, since, in addition to being the only animals capable of labour for human benefit, they furnish the greater portion of the animal food of many races of man, and likewise a large amount of their clothing. In these respects the Ungulates hold the first place. (Flower and Lydekker, 1891: 4)

This statement was followed by two pages of discussion of the various uses to which mammals were put, from transport to meat, for their wool, horn and ivory, and a whole set of byproducts derived from whales and other marine mammals. While these stark instrumentalising ideas are no longer as widely publicly promoted today (although they can be observed by looking at economies of agriculture), nineteenth-century writers were quite open to these arguments.

While utility and subordination to humans marked mammals as unique among animals, their position of superiority also encompassed more fine-grained inferiorities within the class, and conceptions of hierarchy in nature more generally. Non-human mammals' ranking below humanity reinforced ideas of human dominance, and made mammals starkly 'other' and *in*human. Mammals who were not 'useful' were doomed in emerging human-dominated worlds, as were those that were rivals and enemies of humans and their agricultural systems, defined as 'vermin'. This more usually referred to small animals, and especially rodents – with the rat being the quintessential 'verminous' creature, and one which humans were unable to eradicate – although in the early modern period and nineteenth century, this category often included large carnivores like tigers and wolves (Cole, 2016; Nagai, 2020). This set of views was to have a strong impact on interpretations of small mammals more generally.

The prevalence of scale-and-ladder thinking in conceptualising Mammalia resulted in the erection of internal divisions and hierarchies within the group: dividing mammals into 'superior' placentals, then the 'lower', 'inferior' or 'primitive' marsupials, then monotremes. These hierarchies were based on valuations of modern geographic regions as much as anatomy. That the 'lowest' groups of mammals were associated with Australia (and in the case of Marsupials, also with the Americas) connected them with parts of the world classed by contemporary European scholars as strange, bizarre and inherently inferior. It was part of a whole complex of thinking which rendered landscapes, fauna, flora and Indigenous human inhabitants as out of time and out of place, and doomed in the face of White settlement. These ideas shifted somewhat in the twentieth century with the rise of stronger Australian national consciousness, as elements from Indigenous cultures and the continent's unique nature were increasingly incorporated into symbols of Australian nationhood (Byrne, 1996). However, they have not been entirely displaced. Even in the late-twentieth century, landmark nature documentaries like *Life on Earth* (BBC, 1979) were still structured according to a 'chain of being' schema, beginning with plants, moving through insects, amphibians, reptiles and birds, and finally mammals. Monotremes and marsupials are even treated separately within 'The Rise of the Mammals', before moving on to the myriad variations of the placental mammals. A material legacy of extinction also remains among Australian mammal groups since the nineteenth century, with many lost from their original population ranges, having an extremely vulnerable conservation status, or having been driven to total extinction (Ashby, 2022).

The Mesozoic: the discovery and relevance of fossil reptiles and mammals

> The gem of the Stonesfield fossils, the jaw of *Phascolotherium*, … the first, and, at one time, the sole evidence of mammalian life having once existed at the earlier period of the earth's history … Little did this tiny beast think that one day its under jaw would cause Dons to open their eyes great with astonishment, and Professors to tax their memories and brains for appropriate words wherewith to descant upon its beauty (F. Buckland, 1883: 12)

Although most narratives of mammal evolution begin at the mass extinction that wiped out the non-bird dinosaurs, it has been known for a long time that mammals have ancient origins. The first mammal[3] fossils from the Mesozoic were found and described at the same time, and from the same deposits, as the first dinosaurs. In 1824 William Buckland announced the discovery of what he named *Megalosaurus* at the Geological Society of London, making it the first scientifically described dinosaur. The size of dinosaurs was immediately among the most awesome of their recognised attributes. Buckland speculated that *Megalosaurus* 'would have equalled in height our largest elephants, and in length fallen but little short of the largest whales' (W. Buckland, 1824: 391). Extrapolating the animal's size based on the proportions of a sprawling lizard, Buckland estimated it would be 60–70 feet in length

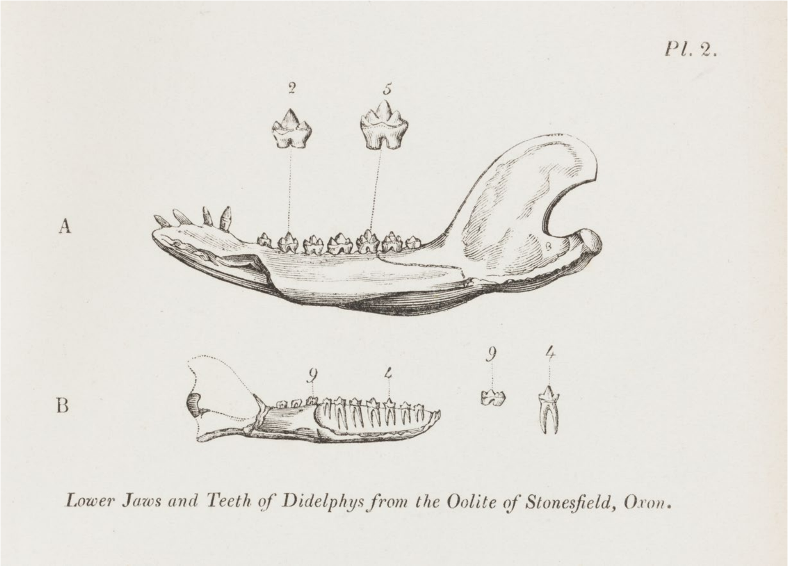

Figure 7.2 W. Buckland (1836), Plate 2. The Stonesfield Slate jaws and teeth. Courtesy of the Staatsbibliothek zu Berlin.

– considerably larger than later reconstructions of the animal, even the upright quadrupedal reconstructions by Waterhouse Hawkins at the Crystal Palace in London. In his paper dedicated to this giant, there was only brief mention of a smaller beast, whose presence so surprised Buckland that he said it was 'not less extraordinary' than *Megalosaurus*, and that 'I should have hesitated to announce such a fact, as it forms a case hitherto unique in the discoveries of geology' (W. Buckland, 1824: 391).

Buckland was referring to a tiny mammal jaw, just two centimetres in length (Figure 7.2). After some initial controversy, the French scholar, Constant Prévost, visited Stonesfield and reported on the remains to Georges Cuvier. Cuvier thought them similar to an opossum, a modern marsupial group endemic to the Americas. Their presence in reptilian dominated faunas of the deep past presented 'a most remarkable exception to an otherwise very general rule, that the strata of that high antiquity do not contain the remains of Mammals' (Cuvier, 1824: 349). The creature was named *Didelphis prevostii*[4] cementing its connection to the marsupials (although it was later recognised as belonging to an entirely separate, much earlier radiation of mammals). The specimen still resides in the collections of the Oxford University Museum of Natural History, where Buckland was Keeper of Geology.

This little bone was more controversial than the discovery of the dinosaurs. Despite its small size and superficially familiar appearance, it defied contemporary understanding of mammal origins because it came from Middle Jurassic rocks, known in the old classification as part of the Secondary strata. Scholars in the nineteenth century knew the Secondary as a 'time of reptiles', based on the many reptilian fossils already found. In 1784, Cosimo Alessandro Collini provided the first description of a pterosaur fossil, which he originally mistook for a marine reptile (Collini, 1784; Taquet and Padian, 2004). Mesozoic marine reptiles (the group including ichthyosaurs and plesiosaurs) were initially interpreted as fish or crocodiles, and were illustrated as early as 1605 (Rowlands, 1605). Their fossils were found throughout the eighteenth century and into the nineteenth, and they were widely depicted in early palaeoart and featured in popular discussions (Naish, 2023: 15–25; Rudwick, 1992).

The seeming abundance of these fossilised aquatic animals suggested that Earth in the Secondary period was a waterworld, dominated by expansive shallow and deep seas. This interpretation was also based on the types of rocks containing these fossils. Most were sedimentary, such as limestones, sandstones and mudstones, deposited in marine and near-shore environments. They contained fish fossils and abundant invertebrate fossils, and included some animals familiar from modern oceans, and others which were no longer present, such as trilobites and belemnites.

This waterworld interpretation was biased by the rock and fossil record in Europe, where the sciences of geology and palaeontology were initially developed. Most of this geographic region was indeed covered by shallow seas and island archipelagos during the Mesozoic (McCann, 2008), and Eurocentrically-minded geologists believed this reflected global environmental conditions. Fossils are also more commonly preserved in marine environments, where they can be rapidly buried by sediments, preventing scavenging and slowing decay. Terrestrial deposits on the other hand, are more likely to be eroded by weathering processes. This results in a greater proportion of marine rocks surviving the destructive processes of geological time, giving the appearance of marine dominance in the past. However, the waterworld interpretation was also reinforced by cultural stereotypes; many eighteenth- and nineteenth-century scholars believed that hot, marshy and tropical climates were more 'primitive' and unhealthy than drier and temperate ones.

The discovery of the Stonesfield mammal jaws, which belonged to land-dwelling mammals, ignited much debate. In 1831, the German scholar Georg August Goldfuß included these finds in the frontispiece of

Figure 7.3a Frontispiece to Goldfuß (1826–33), illustrating a crowded Jurassic scene, with small Mesozoic mammals in the background. Image in public domain, obtained from the Staatsbibliothek zu Berlin.

Figure 7.3b A detail from the frontispiece Goldfuß (1826–33), depicting the Mesozoic mammals as opossum-like creatures. Image in public domain, obtained from the Staatsbibliothek zu Berlin.

his *Petrefacta Germaniae*, reconstructing the life of the 'Jura Formation' (Figure 7.3a). This work depicted the various animals known from fossils at that time, including possibly the first published palaeoart reconstruction of a Mesozoic mammal,[5] hiding in the background between a cycad and a large turtle (Figure 7.3b). This set the convention of such animals as small, scurrying, opossum-like creatures, overshadowed and pushed to the visual and perceptual periphery by the much larger fauna around them.

For many contemporary scholars, it seemed unlikely that land-living mammals could have existed in an ancient waterworld dominated by reptiles. Some suggested the deposits were more recent than the Mesozoic, and when British geologists confirmed the stratigraphy, the discrepancy was dismissed as taxonomic misidentification instead – the jaws must be reptilian, albeit mammal-like and different from any other reptile seen before. Henri de Blainville, coiner of the term 'palaeontology', was especially doubtful, arguing through minute analyses of the teeth that the animal was not like an opossum, but instead was a completely unknown creature. He noted 'we cannot dare to pronounce on the order and the family'[6] (Blainville, 1838: 416–17).

Controversies over the presence of the Stonesfield mammal jaws in the Secondary rock often sprung from their challenge to ideas of 'progress' in the natural world. Some of the main critics of the idea that mammals existed in the Secondary period, like the Scottish naturalist Robert Grant, did so owing to their belief in highly progressivist ideas of evolution, which made the presence of 'advanced' mammals in the Secondary period very problematic (Desmond, 1984). Indeed, their apparent early presence even influenced Charles Lyell to reject a progressivist interpretation of the fossil record. Blainville meanwhile was an exponent of a renewed idea of the chain of being, something reinforced by his Catholicism (Appel, 1980). However, such dilemmas often arose from the complexity of analysing and understanding unfamiliar fossil animals. To reinforce his point regarding the ambiguities of the Stonesfield jaw, Blainville pointed to the example of *Basilosaurus* from the United States, a fossil marine creature which seemed to mix reptile and mammal features in a way that perplexed initial interpretation. Notably, this animal was itself revised in later decades, and despite its name (which means 'king lizard') was reinterpreted as an early type of whale – a mammal after all.

Ideas of advancement and progress also provided a solution to the problem of mammals in the Secondary 'age of reptiles'. Victorian interpretations of deep time were strongly influenced by notions of superiority and inferiority, colonial mindsets and heated debates on the deep chronology of the earth, life and evolutionary processes. The Stonesfield mammals and other Mesozoic mammal fossils uncovered through the second half of the nineteenth century were all small mandibles (most under 2 centimetres in length), tiny individual teeth, or fragments of bone. These suggested mammals in this time period were small in stature – a point correlating with their inferiority. In Owen's 1871 monograph of all known Mesozoic mammal fossils, he remarked in his usual acidic prose that 'Mesozoic Mammalian life is … low insignificant in size and power … We see … nothing moving of Mammalian life, save the low and the small; rat-like, shrew-like, forms of the most stupid and unintelligent order of sucklers' (Owen, 1871:111). Classing these jaws as belonging to marsupials indicated that Europe and North America in the Mesozoic had been inhabited by creatures like those of Australia. Owen noted that through studying the Mesozoic mammals 'my belief has been strengthened in the Law of the Progress from the General to the Special, from the low to high' (Owen, 1871: 114). By asserting the inferiority of the mammals of the Mesozoic, ideas of improvement through time could be cemented.

Through travel and colonial practices, Europeans had encountered both marsupials and monotremes by the late-eighteenth century. The monotremes generated especially heated scientific debate due to their unfamiliar anatomy and debates about whether they produced milk (a defining trait of mammalians) and laid eggs (associated with birds and reptiles) – both questions that had already been answered by Indigenous Australians (Olsen and Russell, 2019; Ashby, 2022). Through dissecting and analysing specimens acquired in colonial settings, scientists drew conclusions about the place of monotremes and marsupials in the scheme of nature based on their interpretations of reproductive organs and brains. It was suggested that marsupials represented a more basic, 'primitive' type of mammal than placentals, allowing researchers to complete a chain of descent from reptiles to monotremes to marsupials to placental mammals.[7] The German promoter of Darwinism, Ernst Haeckel, wrote that the platypus and echidna were 'two strange animals' and 'evidently the last surviving remnants of a formerly diverse group of animals which were the only class of mammals represented in the Secondary period, and from which only later, probably in the Jurassic period, did the second subclass of the Didelphia [Marsupials] develop' (Haeckel, 1868: 461–2).

Placing monotremes and marsupials lower on the chain of being made it conceptually acceptable for these groups to be present in the Secondary rocks of the Jurassic. Their 'primitive' status explained how they could have lived alongside other primitive beasts like marine and flying reptiles and dinosaurs, themselves inhabiting a lower rung on the evolutionary ladder. This enduring vision of the Secondary or Mesozoic world is perhaps best seen in Henry Knipe's verse epic *Nebula to Man* (1905), in which Jurassic platypuses are depicted feasted upon by crocodiles and pterosaurs (Figure 7.4) and described through the following series of (admittedly fairly tortured) rhymes:

> Strange rat-sized creatures now are in the woods,
> Seeking, in timid raids, promiscuous foods.
> And well for them if they escape the jaws
> Of crocodiles, sharp-toothed, and dinosaurs.
> …Small Monotremes are some: egg-laying creatures
> That still retain in structure reptile features
> …A strait they seem through which has Life to pass
> Up from the Reptile to the Mammal class.
>   Strange group it is, of which to-day alone
> Duck-bills, and Spiny Ant-eaters are known.
> Marsupials too are here, a higher order
> And well across are these the Reptile border. (Knipe, 1905: 55)

The biological interpretation of monotremes and marsupials as direct progenitors of placental mammals was challenged by scholars who recognised the monotremes were too 'specialised' in their anatomy to represent the actual mammals of the Mesozoic. Thomas Henry Huxley, while agreeing that they were 'low' on the scale of life, pointed out that features such as 'the absence of true teeth in both genera' and 'the long tongue, extraordinary external auditory passages, and relatively large convoluted brain of Echidna, and the cheek-pouches and horny mouthplates of Ornithorhynchus [platypus]' represented 'extreme specialization' (Huxley, 1880: 463). Even Haeckel clarified that while they represented the general type of the earliest mammals, the platypus and echidna themselves were highly specialised, and so were not completely reflective of the Mesozoic mammals. Other scholars, such as Harry Govier Seeley, thought monotremes were not like mammals at all, but a strange interstitial class linking birds, reptiles and mammals (a position which Seeley also ascribed to Pterosaurs). The shared ancestors of modern mammals were therefore likely to be more morphologically plastic, small and undifferentiated. This is where reflections on the small mammals of the Mesozoic began to play an outsized role in broader understandings of evolution and development.

Figure 7.4 Carl Whymper's image of Mesozoic 'duck-bills' being hunted by predatory reptiles. From Knipe (1905). Courtesy of National Library of Scotland.

Changing outlooks, persistent tropes

In the late nineteenth and early twentieth century, scholars began to re-evaluate the Mesozoic mammals, while retaining underlying progressivist interpretations. Older tropes persisted (as reflected in Knipe's *Nebula*), and Mesozoic mammals were still small and 'rat-like', but scientific depictions of these animals tended to emphasise their importance and potentiality, giving them a new spin. This developing narrative was fuelled by ongoing fossil discoveries, which provided new material for scientific interpretation. In the 1880s, the American palaeontologist Henry Fairfield Osborn conducted a survey of known Mesozoic mammal fossils around the world. He cited around forty specimens from Europe, double the number in Owen's earlier monograph, but still almost entirely restricted to teeth and jaws. Osborn used them to argue against earlier interpretations, including those of leading palaeontological authority, Othniel Charles Marsh, that Jurassic fossil mammals belonged to modern mammal groups (Osborn, 1887). He placed these fossils into multiple extinct groups, distinct from monotremes and marsupials on the basis of tooth structure, using them to elaborate on the emergence of mammals as a whole and their different lifestyles (Osborn, 1893).

By the 1920s, George Gaylord Simpson followed a similar research agenda for his PhD thesis devoted to Mesozoic mammal fossils. He left no doubt as to their fundamental importance:

> The known specimens of Mesozoic mammals are among the most precious and important remains of extinct life which have yet been discovered. They are the sole direct evidence of the fundamental first two-thirds of the evolution of the Class Mammalia, which is now dominant on the earth and to which we ourselves belong. This importance has long been rather vaguely recognized, but it can hardly be said to have been properly evaluated. The Mesozoic forms are usually briefly dismissed as being rare, fragmentary, and poorly understood – accusations which are true, but not in the accepted degree. The Mesozoic mammals are now represented by many hundreds of specimens derived from all the continents save Australia and coming from various horizons from the close of the Triassic to the first appearance of abundant mammals in the lowest Palaeocene. (Simpson, 1929: 1).

These expressions illustrate greater consciousness that mammal history extended far into the time periods before the recognised 'age of mammals' (the last 66 million years of the Tertiary, now known as the Cenozoic). Furthermore, Simpson argued that the Mesozoic mammals were highly diverse (although attempting to deduce their relationships was difficult), and globally distributed.

As Osborn and Simpson's emphasis on Mesozoic mammals indicates, this group was increasingly regarded as central to answering a range of evolutionary questions, most notably of origins and potential. Despite his recognition of their importance and antiquity, in the 1940s

Simpson continued to adapt progressivist ideas that evolution was driven by an increase in intelligence. In one popularising article, he wrote how 'mammals did persist during the dark ages of reptilian dominance', but that they were 'undergoing constant and fundamental evolutionary changes, oppressed by myriad foes, learning perforce to survive by some means other than reptilian brute strength' (Simpson, 1942: 101–2). Moreover:

> We must also specify some of the things that enabled mammals to succeed in the struggle for existence and to take over the earth when the reptiles' long day was done. And out of this comes an explanation, partial at least, of why man himself was able to arise and to rule, for we are mammals, too, in one respect the mammals par excellence. The most basic mammalian character is intelligence. Small in size, without armor, without large fangs, the earliest mammals survived mainly because they used their heads. Unable to outfight dinosaurs, they outsmarted them. The essential upward trend in mammalian history is an increase in mental power, in grade of intelligence, culminating (up to now!) in man … the most stupid mammal is a mental prodigy in comparison with the most clever reptile. [Simpson, 1942: 102]

Simpson's words bring with them the established hierarchical view of nature, and reinforce the continued placement of humans at the pinnacle of life. He excused their outward appearance, echoing Owen's emphasis on brain power, and expanding it to create a narrative of mammal success. This was an evolutionary 'just-so story', explaining how they persisted in the 'dark ages' of evolutionary time, and giving the reasons for their perceived ultimate triumph. While shunting Mesozoic mammals below all other mammals in the evolutionary hierarchy, they were simultaneously championed and elevated far above their contemporaries, principally on account of being mammalian.

These more positive scientific presentations of Mesozoic mammals interacted uneasily with wider public presentations, which still overwhelmingly depicted them as insignificant creatures perpetually fleeing beneath the footsteps of dinosaurs. Scholarly attempts to promote them in more complex ways, or highlight their importance to science and evolutionary studies, seemed to fall flat. In the 1920s, the Central Asiatic Expeditions of the American Museum of Natural History (AMNH) organised a series of excavations in China and Mongolia that recovered multiple significant new fossil mammals and other extinct animals. The museum took advantage of informal US power in East Asia, and deployed large amounts of local labour and expertise to expropriate these fossils and take them back to New York – something which eventually sparked large-scale resistance, and the expulsion of the expeditions by Chinese cultural organisations (Regal, 2002; Yen, 2014).

While the goal of the Central Asiatic expeditions was to search for conjectured human ancestors, scholars at the AMNH like William King Gregory and William Diller Matthew were fascinated by the exceptionally complete Mesozoic mammal skulls that had been found. These were some of the best preserved Mesozoic mammals yet discovered. One was interpreted as being a generalised, opossum-like ancestor of the marsupials, and the other was thought to represent the specialist insectivorous ancestor of placental mammals. This more complex

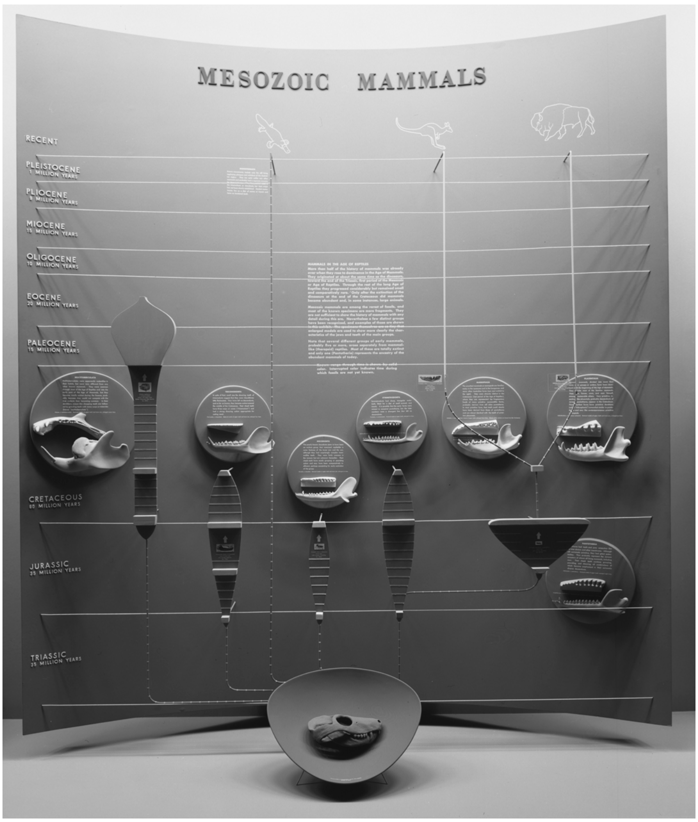

Figure 7.5 The American Museum of Natural History display of Mesozoic Mammals in the 1950s. Courtesy of the American Museum of Natural History Library [Image ID: 327409].

treatment of the fossil material, although still elevating placental mammals above the marsupials, reflected growing acknowledgement that the variation and diversity of mammals stretched far into the past. It also contradicted the linear chain of evolution, suggesting that mammals had already divided into their major groups before the end of the Mesozoic, and that the ancestors of marsupials and placentals lived alongside one another (along with other, now extinct mammal groups, such as the multituberculates). This was an interpretation which continued into later decades, which mixed variable and hierarchical modes of ordering. The Mesozoic Mammal display in the American Museum of Natural History in the 1950s continued to show a varied vision of mammals as all branching from a common ancestor, rather than following an overtly progressive logic – although the move from left to right through multituberculate, monotreme, marsupial and placental, could potentially indicate a progressive ordering (Figure 7.5).

Despite the significance of these fossils, public discussions of the Central Asiatic Expeditions barely mentioned the Mesozoic mammals. Instead, media reports focused on the sensational dinosaur eggs found at the 'Flaming Cliffs', or on large and dramatic mammals from later time periods, like the '*Baluchitherium*' (now known as *Paraceratherium*) (Manias, 2015). This lack of wider attention did not deter Gregory and Matthew from using them to reframe the narrative around the position of the Mesozoic mammals in the history of life, while drawing on anti-migrant sentiment in the interwar early-twentieth century US – a political programme which was prominently put forward by Henry Fairfield Osborn, Gregory's and Matthew's superior at the Museum (Bender, 2009):

> the Cretaceous mammal skulls are perhaps the most valuable fossils so far discovered. The swarming dinosaurs of the Cretaceous age in Mongolia probably paid little attention to the 'wee timorous beasties' with pointed snouts and furry coats that scampered around under their feet. With no one to warn them of the dangers of letting in a horde of immigrants that would eventually crowd them off the earth, the dinosaurs went on playing the game of life in the good old way and the immigrants did the same. For many hundreds of thousands of years the dinosaurs muddled through, but near the close of the Cretaceous age their doom was sealed and they disappeared from the earth in Mongolia as well as elsewhere. Thus the mighty were put down and the meek inherited the earth (Gregory, 1927: 225–8)

Stereotypes of dinosaurs as ponderous and unadaptable creatures, and the small, nimble mammals biding their time before 'inheriting' the earth, were increasingly common in the first half of the twentieth century, and came to influence how Mesozoic mammals were understood by subsequent researchers.

In the latter half of the twentieth century there was an increasing globalisation of research on Mesozoic mammals – albeit impacted by the geopolitical divisions and tensions of the period. This research built on the more positive take on these creatures, shifting emphasis to their taxonomic diversity and the fine-grained study of their anatomy. A large amount of work continued in Britain and the rest of Europe, particularly the discovery and description of *Morganucodon*, a Late Triassic mammal originally found in Wales, which would become a touchstone for understanding the emergence of the first mammals from their non-mammal ancestors. Meanwhile, new fossils were uncovered in South Africa, South America and Central Asia. The Polish palaeontologist Zofia Kielan-Jaworowska became one of the most high-profile and productive researchers on Mesozoic mammals, especially through the discoveries made during the Polish-Mongolian Expeditions to the Gobi between 1963 and 1971 (most of which Kielan-Jaworowska led) (Panciroli, 2021). She led writing of the only recent textbook attempting to record all known Mesozoic Mammals, *Mammals from the Age of Dinosaurs*, a 648 page tome including hundreds of species from every continent (Kielan-Jaworowska, Cifelli and Luo, 2004).

Meanwhile, discoveries of the first Mesozoic mammals from Australia further shifted the perception of monotremes away from notions of them being 'primitive' or 'originatory'. Today's echidas and platypuses have physical specialisations for semi-fossorial (digging) and a semi-aquatic lifestyles (Nowak, 1999), as well as being edentulous (without teeth), and possessing a staggeringly sensitive snout that can detect both chemical and electro-signals from their prey below the soil surface and underwater (Andres and von Düring, 1984; Manger and Pettigrew, 1995). These specialisms had already been highlighted as evidence against modern monotremes being direct analogues of the earliest mammals, and the new fossil monotremes – which were physically quite unlike today's echidna and platypus – confirmed this (Archer et al., 1985; Flannery et al., 2022). These fossils, alongside analyses of monotreme genetics, suggested that the handful of modern species were a relatively recent branch of a once bushy family tree (Flannery et al., 2022), further distancing Mesozoic mammal ancestors from living animals.

Later in the century Mesozoic mammals continued to be considered in terms of their relation to reptiles, as researchers grappled with why and how the non-bird[8] dinosaurs became extinct. As David Sepkoski has recently argued, views of extinction have consistently been an important arena for culturally-engaged science (Sepkoski, 2020), and the disappearance of the dinosaurs remained a subject of intense debate and mystery since the first discovery of the giant Mesozoic reptiles, and the understanding of the suddenness of their disappearance from the fossil record. Features especially associated with small mammals, such as gnawing teeth, warm-bloodedness, and an ability to burrow and eat almost anything, were highlighted as 'winning' adaptations in the context of whatever disaster had exterminated their reptilian compatriots. The triumph of mammals over dinosaurs was presented quite literally by those who suggested they devoured the eggs of the dinosaurs, leading to the extinction of the great reptiles. This reversal was caricatured by Bob Bakker in *The Dinosaur Heresies* as an argument against dinosaurs being cold-blooded. A ghoulish illustration captioned 'Mesozoic Nightmare' showed rat-like mammals feasting on the tail of a living sauropod as it slept, demonstrating, according to the author, that 'if big dinosaurs really were mass homeotherms, then the rainy season would have sapped their body heat and left them torpid and vulnerable to the warm-blooded mammals' (Bakker, 1986: 96).

When interpretations of the cause of the end-Cretaceous mass extinction shifted to a meteor impact on the Yucatan Peninsula (Alvarez and Alvarez, 1980; Smit and Hertogen, 1980), commentators once again seized on mammal exceptionalism and success. The notion of interstellar impact gained traction in the 1980s, and the Mesozoic mammals – already seen as living in constant crisis thanks to their lives alongside the giant reptiles – were able to shelter from this new disaster in the safety of their burrows. In one of the final sequences of the 1985 CBS documentary, *Dinosaur!*, an opossum emerges from its burrow underneath a dinosaur skeleton, accompanied by an uplifting synthesiser track, showing how 'smaller animals emerged to fill the evolutionary niche, left vacant by the rise of the dinosaurs', to inherit the earth as Gregory, Matthew and Simpson had portrayed half a century earlier.

Over more recent decades, perceptions of Mesozoic mammals expanded tremendously to emphasise not just their role as progenitors of the 'new masters of the earth', but their unexpected physical diversity and ecological complexity – foreshadowing their modern counterparts. Research in China beginning in the 1990s played a central role in these shifting perceptions. Two faunas in particular, the Yanliao Biota and the Jehol Biota from northeastern China, contained exceptionally well-preserved fossil skeletons of entire ecosystems from the Jurassic and Cretaceous (Fraser and Sues, 2017). As noted in the chapter by Zichuan Qin and Lukas Rieppel in this volume, the dinosaur discoveries dominated the headlines, but it is equally important to remember that almost every vertebrate, invertebrate and plant group was represented in these formations by sensational specimens. And this included a large number of extremely well-preserved Mesozoic mammals.

Thanks to the quirks of preservation, mammals are usually represented in the fossil record only by teeth and jaws – the densest skeletal elements, and therefore more likely to survive the destructive processes of geology. As a result, the new near-complete skeletons from China provided unprecedented information on the rest of the skeleton, and revealed the range of their physical capabilities for the first time. This included specialisations for semi-aquatic, fossorial, tree-dwelling and even gliding lifestyles, with animals like *Volaticotherium* possessing a skin-flap connecting their fore and hind limbs, similar to today's gliding mammals such as the sugar-glider (*Petaurus*) (Meng et al., 2006; Luo, 2007). The diets of Mesozoic mammals also appeared more wide-ranging, including specialisms for particular insect groups (such as worms, ants or termites), as well as meat-eating, scavenging and fruit-eating (Luo, 2007).

One particularly noteworthy specimen subverted views of the position of Mesozoic mammals in their ancient ecosystems. In 2005 a fossil mammal from the Early Cretaceous (around 125 million years ago) named *Repenomamus* was found with preserved stomach contents. This animal was already known from earlier fossils to be among the largest mammals from the time period (up to 14 kilograms for some species, similar to a modern badger). Astonishingly the remains of its last meal included the bones of juvenile *Psittacosaurus* (a dinosaur) overturning long-held perceptions of predator–prey dynamics (Hu et al., 2005). The discovery was widely presented both in palaeoart and the news media. An exchange in the BBC Radio 4 series 'In Our Time' illustrates some of the challenges people faced in digesting this new vision of ecological complexity in the time of dinosaurs:

> Melvyn Bragg: Mark, how were mammals adjusting to the change in the climate? There were mammals for, what is it 275 million years, all these meaningless statistics as far as I'm concerned. For 275 million years there have been mammals, but then they got crushed by dinosaurs, and they started to peep out of their holes again after the dinosaurs were crushed?

Mark Maslin: Yes … in some way, I mean, so you're right. Mammals evolved originally 225 million years ago and were oppressed [*laughter*] by the dinosaurs for about 120 million years.

Melvyn Bragg: Slaves to the dinosaurs?

Mark Maslin: Well, not quite. I mean there is a wonderful fossil from China of what can only be described as a killer badger, and inside it has in its stomach it has baby dinosaurs and eggs. So we did actually occasionally get one back on the dinosaurs.
(BBC, 2017)

Repenomamus was a subversion of a familiar trope, but could also be interpreted as the exception that proved the rule. It may have been a badger-sized dinosaur-eater, but its presence also reinforced the observation that most of the other mammals at that time were magnitudes smaller, and more likely dinosaur food than foe. The idea, 'we' – the mammal underdogs – 'did occasionally get one back on the dinosaurs' appealed to our narrativisation of the past. It made this animal a recent icon of palaeontology – one of the few Mesozoic mammals to achieve this status. But instead of instigating widespread appreciation of ecological complexity in deep time, for many it re-emphasised the enduring reptile–mammal dichotomy, and tropes around the 'oppression' of the mammals in that time period. When another new fossil of a *Repenomamus* entangled with an adult *Psittacosaurus* was announced in 2023, and was described as being locked in 'mortal combat' (Han et al., 2023), debate on social media centred on whether the mammal was an active predator, or 'just' a scavenger of the already deceased (and therefore, disarmed) dinosaur. Scientific interpretation of the fossil remains inconclusive, but conceptually assigning the role of active predator to animals so long portrayed as the victims of raging ruling reptiles was difficult to accept.

Outlooks on mammals from the time of dinosaurs are undoubtedly more positive in the twenty-first century, but undertones of 'chain thinking' and notions of superiority remain. The increasing globalisation of Mesozoic mammal research has brought a radical re-evaluation of their capabilities; the new evidence suggests that in this time period, they exhibited almost as much ecological diversity as mammals of similar size living in the Cenozoic 'age of mammals' (discussed further in Panciroli, 2021). While this re-writes the earliest narratives of 'primitive' mammals and progress in evolution, it arguably also reinforces the idea that they were inherently superior and predestined to rule. Mammals, it seems, with all their diversity and myriad physical adaptations, were fated to take over our planet from the very beginning.

Public communication has now veered from a script of Mesozoic mammal inferiority, and instead focuses on another major idea: that they were destined for dominance in the 'next' era of earth's history. This retrospective explains away the perceived inferiority of small mammals in the Mesozoic by contrasting them with what happened afterwards, when they 'inherited the earth' and blossomed in the Cenozoic 'age of mammals'. This was a strong narrative trope underlying presentations of deep time in the nineteenth and twentieth centuries, drawing on ideas of Providence, and parallels with the rise and fall in human empires in recent history. Just as human history could be told through successive civilisations, or royal dynasties, so could the history of life be told as a series of dominant groups replacing – often aggressively and certainly competitively – their predecessors. This imperialist framework is still commonly employed by popularising writers, who continue to talk about 'the rise and fall' or 'reign' of dinosaurs and mammals in ways that are as problematic as utilising the words 'primitive' and 'superior'.

For these narrative models to work, mammals had to be present, but waiting in the wings, ready to take over when the reptiles had passed away. Although cleared of active participation in the non-bird dinosaur demise, the meteor impact reinforced that this was predetermined destiny; constituting an 'act of god'. This seemed to address the conundrum of why mammals appeared physically unchanged[9] for the entire 'first two-thirds' of their development. The transfer of ages and the rulership of the world had not yet occurred; they had been subdued and oppressed in the previous age. The mammals were still a constant presence, and even held their own against their dinosaur rulers, occupying (literally as well as metaphorically – evidence suggests many were nocturnal) the night in the Mesozoic landscape, while dinosaurs held the day.

However, the underlying negative attitude towards Mesozoic mammals appears difficult to shake. In narratives of evolution, bigger is more often than not, considered better. Large body size can be analogous to being 'successful', whether implicitly or explicitly (see later in this chapter for discussion on the term 'success'). From the beginning, the small body mass of mammals in the Mesozoic was used to diminish their significance and contribution to the story of evolution. The widespread association of small mammals as vermin, and their frequent invisibility to humans, has likely also been a factor. Despite an increasing range of research to the contrary, mammals in the time of dinosaurs are still often thought by general audiences to have been unspecialised and insignificant, with most popular treatments giving them little space, instead favouring large-bodied mammals in the later Cenozoic.

Figure 7.6a Palaeoart by Dani Navarro, depicting the standard trope of a Mesozoic mammal being eaten by the dinosaur *Stenonychosaurus*. © Dani Navarro.

Descriptions of Mesozoic mammals as rat-, shrew- or opossum-like are often accurate comparisons for their physical size, but have persistently brought with them a number of preconceptions. It reinforced their generalised nature, a perceived 'primitive' lack of specialisation. Mesozoic

Figure 7.6b A subversion of the trope, also by Dani Navarro, showing *Repenomamus* attacking a nest of *Psittacosaurus.* © Dani Navarro.

mammals therefore took on an increasingly important role within histories of mammal life. An idea already present in some late-nineteenth-century discourses re-emerged, that specialised animals tended to have success in the short-term, but were more likely to face extinction during crises. Generalised organisms were more likely to survive when conditions changed rapidly, and could then capitalise in the aftermath to diversify and flourish. In this context, Mesozoic mammals were seen as predisposed to survival. Animals like monotremes, and other species facing threats to their survival due to human activity, could conveniently be re-classed as doomed in the face of environmental change thanks to their own biology (Figure 7.6a and 7.6b).

The meaning of 'success'

Crucial to examining how evolutionary history is discussed and depicted is the notion of 'success'. Those organisms that persist through time and mass extinction events are considered to be 'successful'. This word is commonly used to mean attaining wealth, favour, or eminence, or to achieving desired results, both of which tie in appropriately with narratives of mammal exceptionalism and predestination. Scientifically speaking, success is somewhat analogous to fitness: 'success in evolutionary terms is ultimately judged by an individual's success in passing on genes to future generations' (Colegrave, 2012). In other words, success is defined by passing on genetic inheritance.

When the word 'success' is used in relation to living organisms, both colloquially or among scientists, the intention is rarely to invoke the exacting biological definition. Four traits can be identified that usually elicit the descriptor of 'successful': 1) persistence over geological time; 2) abundance or diversity (this can be taxonomic or morphological); 3) wide geographical range; and 4) a vague perceived sense of being 'better' than other organisms in some way. The latter is most often associated with apex predators, which are said to be 'at the top' of food chains (which in many ways recapitulates aspects of the 'chain of being' model), and suggest they are doing a better job at existing than their (often far more speciose) herbivorous prey. Sharks are a good example of an organism commonly referred to as 'successful', having very early evolutionary origins, comprising many species in often astounding numbers, being geographically widespread in Earth's oceans, and being efficient hunters.

Examining the concept of a 'successful' organism using these various colloquial and biological definitions, small mammals, as well as insects, fungi, mosses, bacteria, and millions of other very small organisms, would be classed as *incredibly* successful. And yet, they are rarely discussed in these terms. How then does the perception of Mesozoic mammals seem if we regard them in terms of their success, notwithstanding their inability to attain larger body masses and their later diversity until after the end-Cretaceous mass extinction?

By the end of the Triassic and into the Jurassic, the earliest mammals had dropped from the more varied larger sizes of their immediate predecessors, to very small body masses (< 100 g; Kielan-Jaworowska, Cifelli and Luo, 2004) whereas dinosaurs generally exhibited the opposite trend (Benson et al., 2018). Although traditionally viewed as a sign of their diminishing importance in evolutionary history (and in Mesozoic ecosystems), scientists now understand that this was a crucial development in the assembly of the mammal body plan (Panciroli, 2021). Recent research has linked their small body mass with unique changes in anatomy and physiology, such as the re-arrangement of jaw musculature and development of the three-boned middle ear (Lautenschlager et al., 2018), which meant that later mammal groups could expand their ecological range further still. And as already outlined earlier in this chapter, the range of mammal ecological diversity in the

Jurassic and Cretaceous is now known to approach that of today's small mammals, suggesting Mesozoic mammals meet the criteria of diversity and geographic range as qualifiers for 'success'.

Mammals are also thought to have gone through a 'nocturnal bottleneck' in the Mesozoic, when almost all mammals alive on Earth were likely crepuscular (active at dawn or dusk) or nocturnal (Crompton et al., 1978). Their eyes adapted for vision in low light, resulting in the loss of colour vision in mammals; today the majority of mammal species are colour-blind, and are still more active at dusk, dawn and through the night (Heesy and Hall, 2010). Previous narratives framed this as a desperate attempt to escape their dinosaur predators during the day. Although escape from predation may have played a role, many other factors may have naturally selected for this behaviour, such as conserving moisture, escaping extreme heat, exploiting nocturnal food sources (such as night-flying moths and beetles), or other vacant ecological niches (Gerkema et al., 2013; Panciroli, 2021). Their already elevated metabolism would have provided resilience against the cold of night. The repercussions of the nocturnal bottleneck for mammal senses were myriad, including an enhanced sense of smell, touch and hearing range – all of them generally being more acute than the majority of other vertebrate groups.

Based on these factors, it is possible to build a new vision of Mesozoic mammals: not 'primitive' creatures trying to escape from dinosaur tyranny while they wait their turn at dominance, but equally 'successful' members of the Mesozoic ecosystem, neither inconsequential bystanders nor just a food source. In current scientific terminology around evolution, 'primitive' and 'advanced' are generally no longer used, in favour of 'basal' (or 'stem') and 'derived' (or 'crown'). This reflects new classification systems based on cladistics, which restructure Linnean taxonomy into frameworks based on common ancestry rather than lineages of direct descent. This evinces a changed way of thinking about the process of evolution over time: evolution is not improvement, and organisms are not getting better at surviving, but they are simply changing in response to fluctuating conditions, through the process of natural selection. Every organism is always adapted to their environment at that time, and because the environments on earth are always in flux, so too are the dynamics of animal and plant populations.

What is more, mammals of small sizes still far outnumber their larger kin. Around 80 per cent of mammal species alive today are rodents or bats, and therefore almost all are well below 5 kg in body mass (Burgin et al., 2018), most being very much smaller (<100g, similar to those in the Mesozoic). Much of the ecological diversity of small mammals was achieved early in their evolutionary history, with relatively few new lifestyles emerging since the end of the Cretaceous. Being small was not an evolutionary relegation mammals struggled to free themselves from, but such a 'successful' mode of life that they are still doing it over 200 million years later.

Views of the natural world and its evolutionary history are altering from chain-of-being derived notions of hierarchy and 'progress', and from definitions of prehistoric worlds as being defined by drama, spectacle and animals of tremendous size and ferocity. Being bigger and more ferocious is no longer valued in the way it was during the previous two centuries of expansion and colonisation. Many historians of science have traced the growth of new valuations of nature as being defined by ecological communities, variation, diversity and interconnected systems over the twentieth century. These views have come to the fore especially in the context of ecological thinking, and environmental and conservation movements (Sepkoski, 2020). New holistic visions of nature bridge strands of scientific and environmental thinking, and seek to move away from avowedly human-centred notions towards wider appreciations of variety in the natural world, both for the maintenance of healthy environments and for aesthetic and moral reasons. In these contexts, small creatures are frequently regarded as crucial, fulfilling a range of important roles within particular ecosystems. Mesozoic mammals, simultaneously diverse and encapsulating tremendous potential, could be regarded as both 'successful' and extremely important, despite their small size.

Conclusion and reflections

Scientists and science communicators are now grappling with perceptions of the natural world which were shaped by long-superseded historical discourse. A core feature of palaeontology is the lens it provides to see and understand evolution and ecology on geological timescales. This puts the current world in perspective and highlights cause and effect in the natural environment. Mesozoic mammals, along with many other groups of extinct animals, can be used as part of a conscious effort to facilitate accurate public understanding of the evolution and ecology of life on earth in the past as well as the present – and to inspire action to prevent future extinctions. Depictions of Mesozoic mammals and the language used to discuss them provides a vivid example of how long-standing tropes (many of them overturned by new research) are perpetuated, thanks to long-standing conventions around 'progress', the 'primitive', and the 'oppression' and insignificance of small animals.

The negative spin associated with small mammals and other humbler components of Earth's ecosystems can have far-reaching impacts for science literacy, thinking about conservation, and potential actions to tackle environmental damage. Portraying these organisms in such a negative light contributes to: 1) continued misunderstandings of how evolution works; 2) failure to recognise how healthy ecosystems are constructed and what they comprise; and 3) misidentification of what 'success' means in evolutionary contexts.

A lack of appreciation of small organisms' roles in nature and evolution has already had a massive and direct environmental impact. The role of pollinating insects has, until recently, been almost entirely overlooked by many scientists, and in much public discourse. Their destruction due to widespread use of pesticides is now considered one of the greatest threats to food security worldwide (Requier et al., 2022). Likewise the impact of chytrid fungus on amphibians has decimated populations of these animals, with a detrimental impact on habitats and other animals that rely on them as a food source (Fisher and Garner, 2020). Conservation charities recognise the struggle to fund protection for animals that are not 'charismatic' (Colléony et al., 2017), with animals generally assumed to have 'charisma' if they are large in terms of body mass, are aesthetically pleasing to humans, and usually apex predators. These stereotypes also inform scientific literature. A study by Prokop et al. (2023) attempted to argue for innate human preference for large predators, suggesting they trigger a tantalising mix of biophobic (fear) and biophilic (admiration) emotions that smaller, non-predatory animals fail to elicit. In an example of the lingering tropes outlined herein, they attribute humanity's biophobic response to the experiences of our mammalian ancestors as prey species for dinosaurs in our early evolutionary history. This is of course a tenuous argument, but one which draws on persistent historic interpretations.

Science communicators are attempting to confront and change views: in the case of Mesozoic mammals, efforts are being made to reframe the narrative (e.g. Panciroli, 2021). However, older ideas remain stubbornly persistent, and in many cases, even when new perspectives are included they are subsequently undermined within the same presentations, or in accompanying visual representations. Despite attempts to promote role reversals (such as by Bakker or by turning attention to *Repenomamus*), artists have been overwhelmingly preoccupied with the consumption of Mesozoic mammals by dinosaurs. While it is sometimes accurate and even amusing, the preoccupation with their size and position in the food chain diminishes these creatures (and others like them), preventing their multifaceted role as part of an integrated ecosystem within the larger evolutionary story being seen.

Why have these ideas of Mesozoic mammals as small and insignificant been so prevalent and enduring, despite shifts in scientific interpretation? Partly, it is the strength of long-standing tropes. Researchers investigating Mesozoic mammals have long seen them as hugely significant, providing the keys to understanding fundamental qualities of mammal life, and wider patterns of evolution. But the values of scientists have not easily transferred to wider cultural views of the ancient past – and of course, scientists' viewpoints have also been coloured by societal values. The persistence of concepts of scale and hierarchy in nature also influences the enduring negative views of Mesozoic mammals, as does valuation of large animals as inherently and uniquely impressive.

The narrative of Mesozoic mammals as underdogs among mighty dinosaurs, who later rise to 'success' and dominance, may fulfil other cultural needs, and reveal much about the human relationship with the natural world. This idea potentially appeals to narratives of self-improvement and triumph over adversity. But it could also be that dinosaur-eats-mammal tales and palaeoart tap into narratives of human dominance, with anthropomorphised dinosaurs filling the role of humans as 'masters of creation' in the Mesozoic, lording it over the small, verminous, 'unsuccessful', and the 'primitive.' These stories of evolution, told in terms of overthrowing incumbent powers, could suggest that humanity's own assumed 'dominance' of the world is contingent and temporary. 'We' mammals were not always the apex life-form on the planet. If the 'reign' of creatures as mighty as the dinosaurs could be overthrown, our current empire is also as liable to topple. This is a morality tale potentially derived from interpretations of human history, but here extended through geological time. The smallness of the Mesozoic mammals relativises our anthropocentric approach to deep time, and creates an uncomfortable assertion that even if there may be a tendency to regard ourselves as dominant, this is transient and threatened.

Recent views of Mesozoic mammals as diverse, variable, filling a range of ecological roles and persisting and evolving throughout the Mesozoic on their own terms, can help facilitate different understandings of the natural world. These are not based on progress or hierarchy, or the idea that life is striving to reach great size and physical power, but attempt to understand organisms on their own terms, and as parts of a much greater system, both within their own environments and across geological time. This is still an idea derived from values around nature, but aims to subvert entrenched notions – inherited from historical outlooks on the natural world – which regard nature from a human-centred vantage point. As well as coming closer to current scientific thinking on these animals, this newer view of Mesozoic mammals can potentially provide a less triumphalist, and more appreciative view of nature as a whole, and appreciation for the organisms of all sizes and forms that live within it.

Notes

1 In modern classifications, Mammalia nestles within a larger inclusive taxonomic group called Mammaliaformes, which sits within Mammaliamorpha. Throughout this paper we will use the term 'mammal' to refer to members of all of these clades, on the understanding that this taxonomic distinction was not made until the end of the twentieth century, and does not have bearing on the argument herein.

2 'Monodelphian' here refers to placental mammals.

3 These fossils are now classed as mammaliaforms, not mammalians (belonging to Mammalia) in the strictest sense.

4 *Didelphis* is one of the best known opossum genera, while the species name, *prevostiii*, honoured Louis-Constant Prevost.

5 Buckland included a reconstruction of *Didelphis* in plate 1 of W. Buckland (1836), and possibly commissioned earlier private reconstructions. This and Goldfuß's reconstructions closely resemble one another, and are more or less contemporary, making it unclear which came first. Buckland often based reconstructions on the work of others, making it possible that Goldfuß's frontispiece preceded Buckland's depiction.

6 This turned out to be true – albeit not in the way Blainville intended – as the Stonesfield jaws actually belonged to a hitherto unknown genus of extinct mammal.

7 All living mammals belong to the crown group, Mammalia. Although the branch that includes monotremes diverged early, probably in the Early to Middle Jurassic, this does not make them closer in ancestry to reptiles than any other mammal. Reptiles and mammals share a common ancestor that was neither reptile nor mammal (it is referred to as an early amniote tetrapod) and lived over 300 million years ago in the Carboniferous.

8 Birds are the only branch of dinosaurs that survived the mass extinction at the end of the Cretaceous, 66 million years ago.

9 Although their outward appearance may have seemed similar to the casual observer, anatomically and physiologically mammals underwent myriad changes during this time.

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8
Literary beasts: fossil mammals, bone seekers and palaeontology in twentieth-century Argentina

Irina Podgorny

The Argentinean branch of palaeontology has a long history of contortions between the living and the dead, between images and flesh, and the comings and goings of papers, quotes and things. One example is how in September 1940, the Argentinian film director Carlos Hugo Christensen (1914–1999) – one of the most prolific filmmakers in twentieth-century Latin America – released one of his first films. This was *El inglés de los güesos* (‘*The Englishman of the Bones*’), based on the novel of the same name written by Benito Lynch (1880–1951) in 1924. ‘*Güesos*’ refers to ‘bones’ (‘*huesos*’ in Spanish), mimicking the stereotypical pronunciation of the diphthong ‘*hue*’ by the gauchos of the Buenos Aires countryside. This was just one of the literary techniques which characterised Lynch’s writing, which critics called ‘neo-gauchesque’.

In the film, a peasant girl falls in love with James Gray, an English anthropologist who has come to Argentina to search for bones in Native burial grounds, and take them back to the Cambridge university museums. At his Professor’s request, Gray must return to his homeland, and the girl commits suicide. The message seems to be that contact with foreigners and scientists can kill.

El inglés de los güesos was also adapted as a theatrical production in 1933. It does not, in any of its forms, mention fossil mammals. But some critics had insisted that the English traveller was a fossil seeker. Lynch himself, a member of an old colonial family of Irish descent, affirmed that Gray’s character was inspired by Charles Darwin’s rides in the Buenos

Aires pampas, where Darwin combined searching for prehistoric animals with ransacking old Indian graves (Joiner Gates, 1961). This was part of a larger process, as Argentinean fossil mammal species were named all through the nineteenth century, showing that the country was a reservoir of fossils.

In creating his characters, Lynch was inspired by reading accounts of the voyages of Darwin and Alexander von Humboldt. These were iconic early nineteenth-century scholars who – thanks to an assumed 'universality' – overshadowed later foreign travellers and actual scientific bone-seekers, who were of little relevance to writers and intellectuals in the twentieth century.

There was also Lynch's own interests in local animals, his childhood in his family's estancia, and his residence in La Plata, where his father was the director of the city zoo. The zoo was located just in front of the La Plata Museum, a collection established in 1884/1889 to house impressive palaeontological and anthropological collections. Lynch – a distant relative of Che Guevara – was also related to two nineteenth-century Argentinean entomologists: the brothers Félix (1854–1894) and Enrique Lynch Arribálzaga (1856–1935), the sons of his great uncle, and companions of the Italian-Argentinean palaeontologist Florentino Ameghino (1853–1911), who also lived in La Plata between 1886 and his death in 1911 (Podgorny, 2021). Ameghino's private residence in La Plata was the site of a large collection of fossil mammals from Patagonia, obtained by his younger brother Carlos in the 1890s. It was there that Florentino received scientists from all over the world to discuss the age of the Patagonian geological formations, and the theories developed by him and Hermann von Ihering (1850–1930) about the origin of the mammals in Patagonia, and their dispersal from the region (Podgorny, 2005, 2009).

The importance of research in mammal palaeontology in late-nineteenth- and early-twentieth-century Argentina is still under-appreciated by Anglophone readers and scholars. But in those years, Ameghino's house was one of the world centres for the production of new palaeontological knowledge. In the 1890s, the Ameghino brothers' discoveries in Patagonia revolutionised the accepted panorama of primitive mammals, to such an extent that the German palaeontologist Karl Alfred von Zittel (1839–1904), in his *History of Geology and Paleontology*, remarked: 'next to the discoveries of Mammalian faunas in the west of North America, the most important palaeontological event of the last two decades of the nineteenth century has been the disclosure made by Florentino Ameghino of a rich Mammalian fauna in the Tertiary rocks of Patagonia' (Zittel, 1901: 423).

In the 1910s and 1920s, when Lynch wrote *The Englishman of the Bones*, Argentina had become the homeland of Florentino Ameghino (who was born in Moneglia, North Italy). Ameghino had become an icon of Argentine culture, a national character commemorated in schools, a hero of the working class, and a founding father of national science, arts, philosophy and literature (Podgorny, 1997). This transformation of Florentino Ameghino into a national character occurred at the same time his younger brother Carlos was involved in the debate over the discovery of a very ancient human ancestor in the cliffs of the Atlantic coast, about 500 kilometres south of La Plata (Podgorny, 1997; Simpson, 1984). In this context, the writer and critic José León Pagano (1875–1964) premiered the theatrical piece *Los Astros* ('The Stars') in Buenos Aires in 1916. The protagonist was an *alter ego* of Florentino and Carlos, a man obsessed by the quest for evidence of the evolution and emergence of humanity in Argentina. In the 1920s, bones were doubtlessly in the Argentine air, even while Ameghino's name and celebrity had started fading from the international scene.

The Englishman of the Bones barely refers to the museums or the specimens that Gray collected, or the animals and plants of the pampas. It is an exclusively human drama that includes a brief mention of Gray's anthropological collections, the exchanges between two British museums discussed in the press, and the conflict between popular and scientific names. In an episode between Gray and a gaucho boy, Lynch appeals not to a mammal but to a shorebird, the *tero real* (Black-necked stilt, *Himantopus mexicanus*), which was one of the animals that Lynch kept as a pet in his private zoo in his house in La Plata. Christensen's film only shows bones when Gray is seated on the shore of a lagoon with a human skull and a long bone at his feet, bones having been popularised by the debates over Ameghino's finds and theories. A femur and a skullcap were the objects which contributed to the Ameghinos' idea of the Argentinean 'origin of man', an image that eventually overshadowed their impressive work on mammalian palaeontology.

Literary works used images and tropes connected to the fictional Ameghino, who, as Gray, was supposedly mistreated by the rural population while doing fieldwork in the pampas (Podgorny, 2021). *The Englishman of the Bones* sets up the contrast between urban civilisation and rural barbarism: on one side, the Englishman formed in Eton, Oxford and Cambridge; and on the other, the parochial gauchos. In doing so, Lynch's work contributed to the idea that the gauchos mocked scientific travellers, local (such as the Ameghino brothers) and foreign alike. This contrast obscures how gauchos and rural workers were crucial for these fossil discoveries and that negotiating with locals, far from being a national peculiarity, is connected to class differences. The same conflict depicted in the pampas appears among peasants, sailors, workers and scientists all over the world, and is remarked on by Martin Rudwick in his study of the Great *Devonian controversy* (1985) and is discussed in other chapters of this book.

Beyond these stereotypes, *The Englishman of the Bones* shows how bones and bone collecting permeated early-twentieth century Argentinean literature in particular, and Argentinean culture more widely. The pampas and their dramatic inhabitants seemed difficult to depict without the omnipresence of the skeletons that occasionally emerged in the dry seasons, and in every small and large excavation in the city or countryside, in similar ways to what occurred elsewhere, as antiquities were obtained during agricultural work in the fields of Mexico, Peru, and Naples, and elephant bones in the excavation of streets in Oxford and London (Buckland, 1824; Manias, 2023, Podgorny, 2022).

This chapter is devoted to analysing how this omnipresence of fossil mammal bones and the worship of the figure of Florentino Ameghino were linked with a whole range of twentieth-century structures – including architecture, government policy, education and literature, in a particular context after the First World War marked by the end of the belief in unlimited progress. The intellectual pessimism around the future of humanity in general, and of Argentina in particular, drew on the mammal fossil remains recovered in the nineteenth century as a kind of local *vanitas*. The palaeontological past in Argentina seemed to go against a stereotype that prevails in literature drawn from nineteenth century contexts, that palaeontology necessarily connects with ideas of progress and development. Furthermore, Argentine intellectuals perceived museum specimens as mere artefacts created by bringing together pieces which no-one could clearly claim belonged to the same animal, and were arbitrary reconstructions. This was a clear indication of the ambiguous role that palaeontology played in a country that turned a mammal palaeontologist into a national hero.

One Argentinean tourist in Bombay recalled being told how 'abroad, we know Argentina as the country of Florentino Ameghino' (as today it might be said of Messi or Maradona). Ameghino was a global celebrity, connected with his spectacular discoveries in the Pampas and Patagonia. As such, Argentinean schoolchildren and youth commemorated his memory over generations, as did the writers, architects, and poets discussed in this chapter – not to mention the worship of Ameghino in the Socialist and Communist parties, who continued the nineteenth-century belief in progress (Podgorny, 2020b).

This chapter is not in chronological order – quite the opposite. It moves backwards and forwards in time. At its core is the work of the Italian-Argentine architect and artist Clorindo Testa (1923–2013), who was in charge of constructing the new National Library in Buenos Aires between 1961 and 1995. This chapter emphasises the ways in which the debates surrounding the construction of the library were validated by references to the giant prehistoric armadillos, known as glyptodonts, which symbolise many aspects of Argentinean national history, and were incorporated into twentieth-century Argentinean culture and fatalism. This chapter also refers to the work of Argentinean writers Leopoldo Marechal (1900-1970) and Enrique González Tuñón (1901–1943), and finishes with a short comparison between the uses of *Glyptodon* and the great ground-sloth *Megatherium,* the local fossil mammals described in the early years of palaeontology (and in contrast to the cast of *Iguanodon* exhibited in La Plata since 1906). An appendix reproduces the short stories that Enrique González Tuñón set at La Plata Museum where the fossil mammals talked about the futility of life. Thus, this chapter displays some constellations or episodes where these artefacts consolidated as natural facts to characterise Argentinian culture.

Clorindo Testa and his glyptodonts

Clorindo Testa earned a global reputation with his urban megastructures of rough concrete, such as the *Banco de Londres y América del Sud* (1960–66) and the *Biblioteca Nacional* (1961–95), both located in Buenos Aires (Cuadra and Corona Martínez, 2001). The national library – a structure of concrete plates – was designed in the early 1960s, but only inaugurated in the mid-1990s, following a long series of interruptions and delays. For many years, the construction of the new building for the national library was cited as one of the many abandoned projects that characterised the past and present of the country (Travnik, 2006).

In the 1970s, during excavation works for the foundations, a mechanical digger hit the well-preserved remains of a glyptodont, a huge four-legged animal with an armadillo-like carapace that lived and went extinct in South America, and which had been named by the English anatomist Richard Owen in 1839. A decade later, Testa likened the library building to the skeleton of this fossil mammal. Testa also revisited the animal in his sculpture *El Gliptodonte*, presented for the first time in 1988 in a collective exhibition of the *Grupo CAYC* in Buenos Aires named *Patagonia*. This sculpture, which compared the massive anatomy of the animal with the dimensions of the building, represented – like the unfinished library – the material remains and peculiar history of the Argentine plains. The fossil genus *Glyptodon* had been an iconic image of the South American deep past since the 1850s (Rudwick, 1992; Rupke, 1994). In the twentieth century, it became a material incarnation of the fragility of Argentine history, and of the impossibility of creating a national culture.

Since 1901, the collections of the Argentine National Library (first established in 1810 as Buenos Aires Public Library) were located in a building which had originally been constructed as the headquarters of the National Lottery. Several attempts to provide a new building for the overstocked library failed. Jorge Luis Borges (1899–1986), who was the director of the library between 1955 and 1973, engaged his vice-director José Clemente in the project of constructing a building envisioned to store 6,000,000 books, and an equal figure of maps, journals and newspapers. This project was very optimistic – a call to defeat the long history of aborted projects.

In May 1960, the Argentinean president Arturo Frondizi (1908–1995) proposed that a new building should be constructed in the three hectares of the Unzué Palace. This had been the former official residence of President Juan D. Perón and his late wife Eva, and was demolished in 1958, following his overthrow. In May 1961, the *Ministerio de Educación*, the Federation of Architects' Societies, and the *Sociedad Central de Arquitectos* called for a national competition for designs for the building, which had to reconcile the challenges of permanent expansion with its urban location (N/A, 1961; Testa et al., 1979). The National Government presented this call as evidence of its commitment to the preservation of Argentina's deepest values, despite contemporary economic difficulties, the burden of the past and the trend where 'contingencies use to rule over reason and planning'.[1] This kind of pessimism, broadcast and reproduced in several media, was counterbalanced by the hope for the realisation of what was called 'our obsession'– a new building for the National Library (Acuña, 2005: 102; Bullrich, 1969; Glusberg, 1980; Iribarne, 1992; Liernur, 1982).

The contest was open for about nine months. When it closed at the end of June 1962, the commission had received 28 proposals. In the meantime, President Frondizi had been overthrown. The first prize was awarded to Alicia Cazzaniga (1928–1968), Francisco Bullrich (1932–2011), and Clorindo Testa,[2] who set the building in the middle of the gardens, at the highest point of the site.

The reading rooms were to be located in the upper levels, and three levels of stores were to be situated underground. By elevating the public facilities, the garden space penetrated the building, and continued uninterruptedly beneath. The building structure was to be realised in reinforced concrete, through the use of a system of beamless slabs resting on columns at the basement levels. The elevated part of the building rested on four large supporting elements on independent pilings, to facilitate the construction of different parts of the structure. At different heights, the slabs were supported by systems of columns and tension-rods, suspended from large structural planes. This building was a highly expressive piece of architecture, which also incorporated the most advanced technological solutions. The engineers Hilario Fernández Long and Horacio Reggini were in charge of the construction (N/A Edificio, 1976; Glusberg, 1981). As Bullrich and Testa mentioned in an interview, when they first outlined the proposal in 1962, they were not sure if the four 'legs' could support the load of the building. They consulted the engineers and, waiting for an answer that arrived later than expected, they began to fear that the building would come back transformed into a hexapod (Iribarne, 1992). The engineers, however, were quite supportive of a four-legged structure, and suggested a deep foundation such as those used in large bridges. Thus, the library could become a quadruped, as the architects wanted.

Figure 8.1 Excavations for the construction of the National Library, October 1971. Courtesy of the Biblioteca Nacional de la República Argentina, Archivos del Patrimonio Histórico del Edificio.

While the original call for projects in 1961 planned for construction to begin within a year of the announcement of the results, it in fact only started in 1971, during the office of *de facto* president General Alejandro Lanusse (1918–1996) and continued until 1976, when work was stopped by the military dictatorship which had ruled since March that year (Figure 8.1).

When construction was stopped in December 1976, the work was already advanced: 75 per cent of the planned work was already done, which included the removal of 100,000 m^3 of sediment, the construction of 25,000m^2 for the repositories, and building the support structure for the reading rooms. The works were then launched again in 1982, during the presidential office of General Leopoldo Galtieri (1926–2003). After several interruptions, the building was finally inaugurated in 1993 and the books were transferred, during the presidency of Carlos Menem (1930–2021).

Figure 8.2 The National Library and its scaffolds (undated). Courtesy of the Biblioteca Nacional de la República Argentina, Archivos del Patrimonio Histórico del Edificio.

Over the years, the unfinished work became a city landmark (Varas, 2006), as scaffolds remained for several years, and nobody knew if or when they would disappear from the urban landscape (Figure 8.2). At the same time, the construction attracted local and worldwide attention. Defined as one of Clorindo Testa's '*rara-facta*' ('strange things'), critics compared the library with the anatomical pattern of a cow grazing in the Pampas or, more simply, with a generic mammal with hands, belly, back and limbs (Espartaco, 1980). This description was probably inspired by the article published in late 1976, which named 'in a biological sense' the two great structural planes (formed from two huge main beams crossed by a series of secondary beams) as the building's '*panza*' ('belly') and '*lomo*' ('back' or 'loin'), two colloquial terms more frequently used when describing the anatomy of domestic quadrupeds, such as horses, pigs, cattle or dogs.

In the late 1980s, Testa started comparing the building not with a cow but with another megastructure: the skeleton of the glyptodont discovered while digging for the foundations of the library, a common occurrence in almost any even medium-scale construction project in Buenos Aires. In contrast to such places as Mexico City, Rome or the surroundings of Naples, where the drilling of wells or the digging of underground channels can lead to the unearthing of antiquities or ruined cities, the pampas produce giant animal bones that were used as evidence of Argentina's wealth (Podgorny, 1999b).

More than a century before the construction of the library started, Darwin had already observed: 'any line whatever drawn across the Pampas would probably cross the skeleton of some extinct animal' (Darwin, 1838: 5–6; Podgorny, 2001) Thus, finding a glyptodont's skeleton in the foundations of the library was not unusual. It was a normal event for engineers and workers. As a mere matter of routine, it was not registered in the construction records and so there are no sources of it in the library archives. Testa did not remember either the exact date of the find or the fate of the bones once they were unearthed. In 2010, he only vaguely recalled that they were taken to the Museum of Natural Sciences of Buenos Aires.[3]

Late in the 1980s, when the excavations had long finished but the completion of the library was again postponed, Testa retold the find in a different way, as if 'the animal had been watching and waiting for thousands of years to be replaced' (Cuadra and Corona Martínez, 2001: 29). The first comparison between the library building and the glyptodont is not connected with the design of the building, but seems to have first occurred in 1987, when Testa gave a tour of the construction site to the Japanese Metabolist architect Kiyonori Kitukake (1928–2011). Testa described the building as a literal transformation of the glyptodont's mega-skeleton: a shell of concrete supported by four legs (Araujo, 1992). However, the comparison was more metaphorical than structural. A shell – in the anatomy of the *Glyptodon* and in engineering – has a curvature, as opposed to plate structures which are flat and which constituted the architectural elements of the library. Thus, the reference to *Glyptodon* in Testa's work cannot be taken as a description. Rather, it referred to the cultural associations acquired by this animal in twentieth-century Argentinean culture, to Testa's interpretation of history, and the contemporary events occurring in Argentina in the late-1980s, which included the permanent delay in finishing the national library building, as a call to defeat the cultural pessimism presented in the original call for projects.

Patagonia and archaeological remains from the future

Testa admitted that the comparison between the library and the glyptodont was an idea that came many years after the project was originally conceived. In this sense, rather than be an inspiration (as many authors believe), it was an afterthought inspired by the contingent finding of the skeleton, which was to be materialised as another of Testa's *rara-facta*. In fact, in September 1988, when the library was still under construction and scaffolds were still there or, at least, very well remembered, Testa created the sculpture *The Glyptodont* (Safons, 1988) (Figures 8.3a and 8.3b).

It was presented at the *Patagonia* exhibition by the CAYC Group[4] during the 22nd International Association of Art Critics Congress (AICA), held in Buenos Aires and devoted to *Art and Technoculture at the End of Postmodernism.* The exhibition geographically represented the south of Argentina. Conceptually it meant the space and time in which 'our fragmented national vocation developed Pat-agonizingly [*pat-agónicamente*]'[5]. The exhibition catalogue described the sculpture as a discovery which had occurred during the excavation works for the foundations of the National Library, and as the remains of 'a species that inhabited Patagonia'. The catalogue explains: 'the shape of the building is comparable to the glyptodont and Patagonia, which as well as the National Library, are living examples of old projects that remain forever unfinished … as a refuse from a past that is threatening to come back'[6] (Safons, 1988).

Figure 8.3a Clorindo Testa's Glyptodont: as a sketch. Collection of the author, presented by Clorindo Testa during an interview on 9 November 2010.

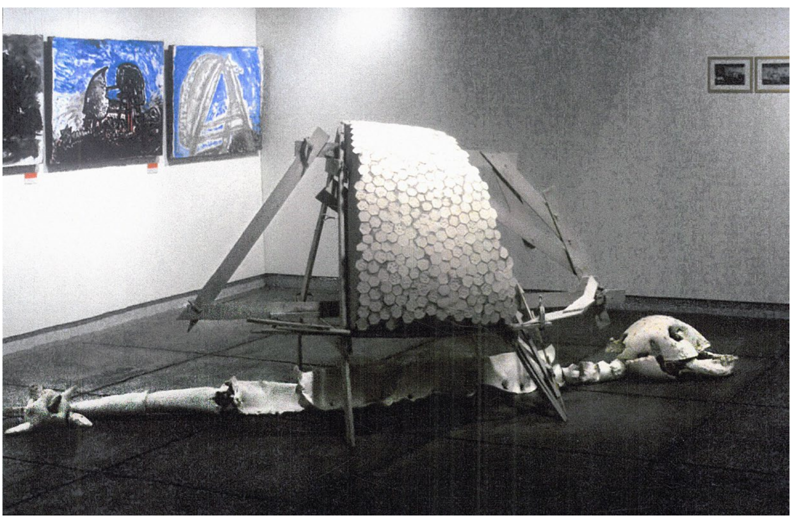

Figure 8.3b Clorindo Testa's Glyptodont: as a sculpture. Collection of the author, presented by Clorindo Testa during an interview on 9 November 2010.

For Testa, his glyptodont was in fact a fossil from the future: it was going to be found in Patagonia in 3800 AD, when Patagonia would be deserted by all human populations (Testa in Safons, 2007). Testa's glyptodont was a result of human worship, the only vestige of which was left, not of nature, but of a society that could not finish the projects it started.

This referred to the government plan named 'the Patagonia project', which was inaugurated in 1986 and envisaged the transfer of the nation's capital from Buenos Aires to a new federal district which would encompass the two towns at the mouth of the Río Negro: Viedma and Carmen de Patagones, the oldest settlement on the shore of Patagonia, established by the Spanish in 1779. 'Towards the South, the Sea, and the Cold,' were the presidential words that called for the establishment of a team of experts to design the new capital in the gates to Patagonia (Reboratti, 1987). Approved by Congress in 1987, the establishment of a new capital in Patagonia appealed to old tropes in Argentinean culture: Patagonia's emptiness, vulnerability, geostrategic position, and its potentials in terms of natural resources. The plan was rescinded in 1989, when the commission overseeing the project was disbanded by the government presided over by Carlos Menem. The scaffold-glyptodont, the scaffold-National Library, and Patagonia (both the region and the project) represented just three of many unfinished works that the elapsing of history was leaving to the Argentines of the future as archaeological remains.[7]

In 1988, when Testa's glyptodont was first exhibited, the project for the new capital was languishing. Hundreds of people had moved to Viedma, attracted by the possibility of new jobs that were not going to happen. Testa thought of them as the creators of the scaffold-glyptodont found in the third millennium of our era. In the elevation of the glyptodont, he wrote: 'this fossil was found close to one of the bridges of the Rio Negro, in the place that had been the new capital of the Argentine Republic. The remains of the port covered it. That happened in A.D. 3004, when man had already abandoned the region'.[8] Both the glyptodont from Patagonia and the library building with their scaffolds referred to the infrastructure which was going to remain as ruins of the unfinished, as material remains of a society where the future seemed to have been born in ruins.

Testa's glyptodont is a scaffolding skeleton made of clay, paper, wood and mud, composed of pieces that, far from being modelled on a *real* glyptodont, imitated the bones of animals like cows and horses, as if prehistoric and historical faunal remains had been mixed by the anatomist when restoring the skeleton. Moreover, the carapace of Testa's glyptodont did not use any of the sophisticated techniques and structures to construct thin shells that proliferated in the 1970s and 1980s.

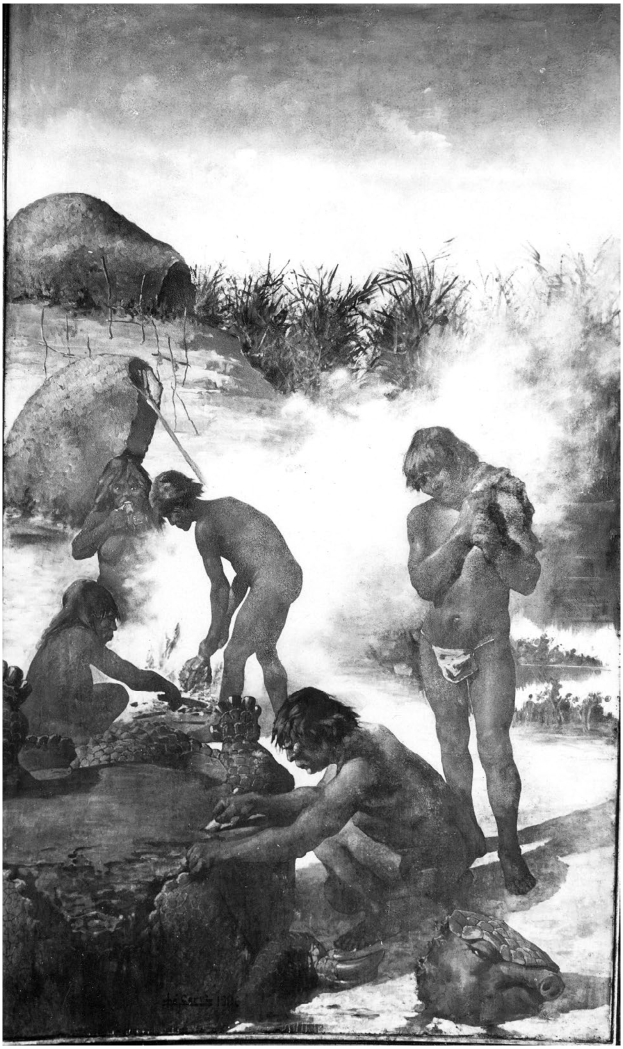

Figure 8.4 Prehistoric humanity from the Pampas living in a glyptodont shell, Museo de La Plata, Argentina. Author's collection.

(Chronowicz, 1959; Flügge, 1967) Rather, it was mounted through the simplest architectural devices, like wooden scaffolds and masonry. It is not a naturalist sculpture or an anatomical study of the animal. It is a silhouette that evokes a familiar form to any Argentinean that went to school in the twentieth century.

This sense of familiarity with this rather strange animal is what makes the glyptodont an interesting case to understand the cultural elements that define the material world of Argentine museums and the material culture of elementary education. Testa did not study comparative anatomy or natural history to compose his glyptodont. When asked which models he based his sculpture on, Testa mentioned the museum exhibits he visited as an Argentinean schoolchild. Testa was also convinced that glyptodont shells were used as shelter by prehistoric humans in the Pampas, an idea propagated in the years he went to school (Figure 8.4).

In fact, the depiction of the 'man of the great armadillo' was popularised in the first decades of the twentieth century through museums and schoolbooks, and was connected with theories of the local and southern origin of humanity (Ameghino, 1880–1: 292–5; Podgorny, 2009). The solidity of the shell was created by museum displays and book depictions, and not only inspired several scenes from Argentina's deep past, but also created a companion for the Argentines of the twentieth century, who – like Testa – accepted that the glyptodont's shell was the first home of local prehistoric humans.

Moreover, Testa associated the glyptodont with other memories from his childhood, such as when an armadillo was brought to the city from the lands his mother owned in the Territorio Nacional de La Pampa.[9] The armadillo ran out from the house and braved a police officer standing at the corner, who reacted by unsheathing his knife. Like Benito Lynch's bones and gauchos, armadillos and glyptodonts belonged to his childhood, to the world of museums, and to the territories beyond the city of Buenos Aires (Montaldo, 1993). Not surprisingly, the project that Testa presented in 2004 for the library of the lower house of Congress in Santa Rosa, La Pampa, also had the shape of a profile or section view of a gigantic armadillo carapace.[10]

The cultural meaning of the glyptodon thus brings together different stories, as a museum specimen and a natural thing from the pampas, foreign to urban life, which re-emerges over and over again, as a historical object and a deposit of hybrid cultural traditions.

Glyptodonts in science, museums and literature

In 1927, the Argentinean writer and anarchist Enrique González Tuñón published *El alma de las cosas inanimadas* ('The soul of inanimate things'), a collection of short stories whose central character was a person with X-ray vision. Equipped with that power, the protagonist visited the fossil exhibits at the Museo de La Plata (see Appendix, this chapter). While there, thanks to his vision, he discovered that the skeletons caged in the glass vitrines – far from being inanimate – could engage in conversation, and used the opportunity to complain about their lives in the museum. González Tuñón (who had in another short story in 1926 used a plesiosaur to describe the impressive size of a piece of beef), took two paradigmatic beasts as interlocutors of humanity: 'my friend from prehistoric times' a glyptodont, and the sceptical *Smilodon,* the sabre-tooth tiger which had been the past antagonist of humans and giant armadillos alike.

One of the most surprising elements of these stories is González Tuñón's acquaintance with the history of Argentinean palaeontology. The story is full of accurate references to real characters and events. He refers to Hermann Burmeister (1807–1892), the Prussian-born director of the Buenos Aires museum in the second-half of the nineteenth century, and enemy of Florentino Ameghino. He also mentioned François Séguin (1812-1878), a French confectioner and fossil trader, who sold a collection of fossil bones, including glyptodont specimens and human skeletons, to the Paris Natural History Museum in the late-1860s (Podgorny, 2001, 2020a). With irony and an extraordinary sense of humour, the *Smilodon* specimen philosophises, similar to Ian Hacking's later philosophising regarding what a glyptodont is.[11] The skeleton confessed: 'I find it hard to believe in my existence. I am a white lie of the palaeontologist, who invented me to make up for the mental disturbances and waste of energy caused by his unsuccessful dedication to the study of the great geological eras' (González Tuñón, 1927).

The museum specimen is a simple fiction created by a perturbed individual, who kills time bringing pieces together, fragments which no one could attest whether they belonged to the same animal – an interesting example of palaeontology being regarded as a problematic science. This scepticism goes further. The X-ray visioned protagonist exclaimed that if a faculty professor can claim he can philosophise, why should a museum specimen not do the same? In fact, the old skeleton has even more time to devote to futile activities than a human worried about trivial everyday matters.

González Tuñón was right in the sense that the glyptodont's carapace and the fossil tiger's skeleton were artificial objects that acquired the characteristics of natural things. They were a representation of themselves, as Hans-Jörg Rheinberger would say at the end of the last century (Rheinberger, 2003). Not only that, but these artificial objects created new realities and shaped the emergence of new ones. When the possibility of prehistoric humanity was being discussed in Argentina in the 1870s, a number of human bones were found mixed with charcoal and artefacts about sixty kilometres west of Buenos Aires. They were accompanied by a number of bones of extinct animals, on which there were trace-marks indicating they had been worked by human hands. Afterwards, the discovery of the actual dwelling-place of the early Americans was announced: the carapace of *Glyptodon*, all around which lay charcoal, ashes, burnt and split bones, and a few flints. The reddish earth of the original soil was consolidated. Below this level was revealed a stone implement, long bones of deer and llama bearing traces of human activity, and the teeth of other fossil mammals. The discovery of another shell under nearly similar conditions strengthened the conviction that in the midst of the pampas, vast plains without a tree or rock, humans might have found shelter by digging a hole in the ground roofed with the shell of a glyptodont, thus forming a cave-like retreat. Given the fact that glyptodont shells in their natural state fall apart easily, the idea of them being a resistant structure, similar to a cave, seemed more inspired by the museum specimens than in the facts found in nature.

In a territory perceived as deprived of history, antiquities and caves, the abundance of an impressive fossil fauna occupied scientific attention, and the fossils took on the role of monuments characterising the past of the pampas. As such, glyptodonts and prehistoric antiquities were included in the Argentine law 9080 in 1913, which concerned the regulation of archaeological and palaeontological sites. As part of the Argentine subsoil, fossils and archaeological objects were considered national patrimony and became property of the National State (Endere and Podgorny, 1997). Law 9080 reflected the scientific and public interest in the possibility of early humans in South America, a topic which would continue for many decades connected to the national cult of Florentino Ameghino, the promoter of the man of the great armadillo, among schoolteachers and scientific figures.

In this frame, the different theories about local prehistory and the geological origin of the pampas proposed in the late-nineteenth century permeated Argentine cultural debates. Glyptodonts appeared in *Adán Buenosayres* (published in 1948, but begun in the late 1920s), the novel by Leopoldo Marechal, a secular Book of Genesis located in the pampas, where the protagonist and a group of friends go out at night from the city to confront several voices of the Argentinean past. Many authors have identified the fictional characters of the novel as representing actual Argentinean intellectuals of the 1920s and 1930s (Marechal et al., 1977; Marechal, 1997; Navascués, 1992). Thus, Bernini, one of Adán's friends and an adept of natural science aiming to explain the local origin of man, is an incarnation of Raúl Scalabrini Ortiz (1898–1959), an Argentine thinker and son of the teacher Pedro Scalabrini, who was a fossil collector, correspondent of Florentino Ameghino, and creator of a kind of portable museum of fossil mammals which was sold to Argentine schools, along with plans to obtain duplicates from the national fossil collections to distribute among the schools of the country (García, 2007).

In *Adán Buenosayres* – as in *The Englishman of the Bones* – science and fossils do not bring good news. The characters meet a glyptodont as the 'spirit of the earth', who explains that it is a mistake to consider the Argentine plain as being of maritime origin. It alerts them that the destructive power of the wind created the Pampas, the 'great plain of destruction'. It refers to fragments resulting from the destruction of Europe that formed the Argentinean nation (Cheadle, 2000), which could therefore never be consolidated as a land of creation and the future.

This pessimism rooted in the landscape and the geology of the country emerged again in works such as *Radiografía de la Pampa* (*X-ray of the Pampa*, 1933) by Ezequiel Martínez Estrada (1895–1964), a comprehensive psychological study of the Argentine character laden with fatalistic overtones. In the pampas, civilisation and progress were impossible as nature devours and, in the end, engulfs everything, as is revealed by geological and palaeontological observations. It is not the X-Ray nor the physician, but the study of the sediments that reveal that history melts into air, experience does not accumulate, and progress becomes impossible. The gaze that penetrates the secrets of inanimate things reveals that in the end, the fate is death.

Yet, for Testa, the glyptodont and the library, as human works, challenged fate and displayed the superposition of contingencies which lead to the present and the future. In Testa's exhibitions, the glyptodont opens the history of a territory marked by conquest, war, and destruction, but also by the interactions of people, technical media and traditions, which continually reappear in his own work (Baktis, n.d.). In his exhibitions, he situated the fossil within a line of events that start with the glyptodont, continue with the scarce ruins of the Spanish conquest of the basin of the Rio de la Plata, move through colour illustrations depicting ruins and natural history made in Trujillo del Peru in the eighteenth century, and then the dead bodies resulting from the plagues in nineteenth-century Buenos Aires. It is not surprising that this prehistoric animal could be presented as the material remains of the beginning of Argentinian history. Testa was aligning his *rara-facta* with the material sequences proposed by Argentine museums and in public education. As María Élida Blasco (2011) remarks in 1936, the right-wing director of the influential Museo Histórico de Luján (established in 1923), organised a carnival parade that represented the succession of events of Argentine history. It started with a float carrying not a glyptodont but a giant *Megatherium*, the fossil sloth discovered in Luján in late-colonial times. By the early-twentieth century, Luján was a contested place. As the site of a neo-gothic Catholic basilica which hosted the cult of the Virgin of Luján, it was the centre of national pilgrimages. To fight this cult, the Socialist party in the 1910s proposed the organisation of annual homages to the birthplace of Ameghino, taking the form of secular pilgrimages (Podgorny, 1997, 2020b). Was the *Megatherium* puppet from the carnival parade presented as another celebration of the good Catholic colonial times, an antagonist of the secular *Glyptodon*, an alter ego of Ameghino, and – by implication – of the socialists? A futile debate, since both were creations made in European laboratories by Protestant anatomists: Georges Cuvier and Richard Owen respectively. Maybe in order to escape the futility of this conflict, Argentinean natural science students decided to adopt the *Iguanodon* cast exhibited in the Museo de la Plata as the mascot of the University of La Plata Students' Union.[12]

The treatment of fossil bones as antiquities, as symbols, or as part of the remains of fragile Argentine material culture still deserves further study. However, this article displays some constellations or episodes that consolidated these artefacts as the natural facts that characterised Argentine culture.

The Argentinean branch of palaeontology has – in addition to portentous beasts – a long history of contortions between the living and the dead, between images and flesh, between the comings and goings of papers, quotes and things. *Megatherium, Glyptodon, Smilodon* and their relatives reproduced themselves, generating more than one anatomical debate, more than one literary mess. This was like the expeditions organised in the 1890s to find a live specimen of *Neomylodon*, which others named *Grypotherium domesticum* to point out its status as a barnyard animal. Were it not for the Patagonian setting, these expeditions would be all too similar to Arthur Conan Doyle's *The Lost World,* treated in this collection by Richard Fallon and Dave Hone (Podgorny, 1999a). At the same time Doyle wrote his book, the Argentinean poet Leopoldo Lugones (1874–1938) published the *Elogio de Ameghino* (1915), as a homage to the palaeontologist. Lugones – maybe just for the sake of provocation – invented two authors of German origin, who had preceded Ameghino in the description of giant skeletons: 'Mister Riesen' and 'Mister Faultier' ('Mr Giant' and 'Mr Sloth'). These were an adjective and a noun taken from the title of a book on the Madrid *Megatherium* specimen published in Bonn in 1821: *Das riesen Faulthier* Bradypus giganteus ('The giant sloth *Bradypus* *giganteus*'). This is how, as argued by the Argentinean writer Ricardo Piglia, national literature was invented, many, many years ago. A fossil history of Argentine culture is still searching for an author.

PS: as for Jorge Luis Borges, he did not appeal to his country's mighty skeletons. There is an elusive mention to Patagonian geology in a poem from the early 1920s (*Yacimientos del Chubut,* 1922). However, there is a reference to glyptodonts in a short essay from 1941, published in his Complete Works, on 'The creation and Philip Henry Gosse's *Omphalos*' (1857). Here, he refers to Luján, where Ameghino lived as a child, to illustrate Gosse's ideas: 'Glyptodon skeletons may survive in the Luján creek, but there were never any glyptodonts. Such is the ingenious (and above all incredible) thesis that Philip Henry Gosse proposed to religion and science.'[13]

For Borges, Gosse's ideas had some monstrous elegance, but prefigure Bertrand Russell's scepticism in *The Analysis of Mind* (1921), where Russell surmised that 'the planet could have been created five minutes ago, with a population that "remembered" an illusory past'. Perhaps, after all, a fictitious past occupies our museums. Perhaps, after all, this Argentine essay could be used to remember that we all – not only the Argentineans – are (grand)sons and (grand)daughters of twentieth-century scepticism.

Appendix: 'My friend from prehistoric times'

From Enrique González Tuñón, *El alma de las cosas inanimadas*, 1927

English translation by Irina Podgorny.

Nobody knows in what mysterious silent dialogues the animals that populated the prehistoric Pampas spend their hours in the vitrines. No one. Neither the illustrious palaeontologist who examines the macabre collection of bones through the impressive seriousness of his glasses; nor the astonished student who begins to put a question mark over his ignorance; nor the indifferent janitor who, during working hours, is in contact with all the remote geological eras.

No one. The fossils of the Argentinean Diluvium, withdrawn from circulation by nature where everything is transformed according to the law of evolution, live a quiet museum life, imprisoned and most of them remanded by scientific presumption.

But I, who know how to decipher the mute and strange language of inanimate things, and have more than once surprised the sensitive point of the dead pages of life, entered the palaeontology room with the vague hope of intercepting a dialogue between the poor caged fossils.

The current janitor, disturbing the mysterious millenary mutism, swept away the dust that silence dropped on the glass like a shroud. He swept away the dust that is the cry of time.

The minimum wage of this employee, without sufficient value to ensure that his skeleton would be preserved tomorrow in a hygienic case, was not enough to understand the jocular sadness of the mortuary chamber that weighed on the palaeontology section.

He swept with his clerical duster, swallowing his unnoticed boredom in a popular *porteño* song:

'*¡Te acordás, hermano,*

qué tiempos aquellos!...'[14]

My eyes pierced the stained glass of the jail cell and caught an imperceptible movement.

I approached, concealing my eagerness to investigate, like a Scotland Yard detective. I approached, and in the empty orbits of the Glyptodon, two tears, like two of the coarse pearls that hang from the ears of poor girls, had also ossified.

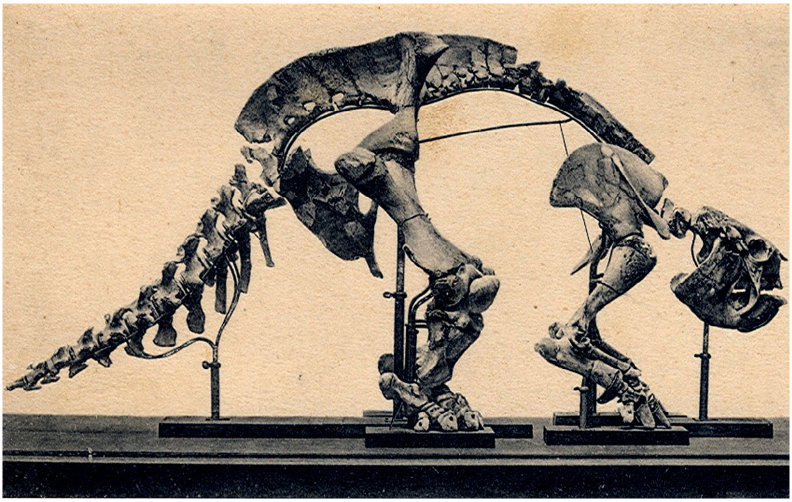

Figure 8.5 Image of a Glyptodon mount, from a series of postcards published by the La Plata Museum in the early-twentieth century. Author's collection.

‘*¡Te acordás, hermano,*

qué tiempos aquellos!...’

I prayed, in an echoing voice.

The Glyptodon suffered a new attempt at movement. No doubt it was stopped by the prudent fear of unbinding itself.

He lifted – barely – the bones of living flesh that formed part of his huge head, and his jaws opened to release this mute protest:

– ‘And this is what I have been reduced to!’...

He looked into my eyes and understood an emotion in my half-mast stare.

Then his huge tail thumped against the glass with sounds of gratitude.

Meanwhile, the porter, deaf to the pain of inanimate things, strove to gain the status of a trade for his simple occupation. And he swept away the dust that wept the silence.

The Glyptodon remained still for a few moments. Then he exhumed his two fossil tears again.

II

He had become so intimate with me that he violated visiting hours, transgressing general regulations, and received me without any etiquette, as a skeleton.

Very early in the morning, after breakfasting with a drink of freshness and a patch of sunshine in the forest of La Plata, fulfilling a duty of friendship, I approached the dungeon of the museum, where the extinct days of my old acquaintance, the sensitive Glyptodon, were passing.

– ‘If you only knew how impatiently I waited for him! This solitude bores me terribly ... I have in my jaws a fossil yawn ... Come closer. You are a man and I am an ancient friend of Man. I am your friend from prehistoric times...’

– ‘Thank you, Glyptodon,’ I replied, moved.

– ‘You see,’ he continued, ‘I don’t chat with anyone. The memory tortures me, and besides, I know how to keep my distance. With whom could I have a friendly dialogue? With the Toothless Ones, perhaps? No. The family of the Toothless is a family in decline. Of that magnificent species that populated the pampas, only the miserable species of anteaters and sloths remain ... The *nouveau riche* of Zoology.’

– ‘That’s the way the world is going!’

– ‘But I had the misfortune that a wise professor discovered my grave in the outskirts of Luján, and since then I have led a sedentary life, a museum life, in my eternal postcard stillness.’

– ‘Glyptodon ... Would you like me to recommend you to the Director? Perhaps I could spare you from the vitrine...’

– ‘Thank you, man, thank you from the bottom of my heart. But don’t you understand that outside the vitrine, I’d just go astray? Before, my aching bones endured a dreadful martyrdom: every visitor would steal a piece to keep as an amulet. Please, my friend! Let me stay in the vitrine, in this narrow glass room where I live happier than men...’

– ‘Well, I’m off, buddy. We’ll talk tomorrow, Glyptodon.’

– ‘See you tomorrow, my human friend.’

III

– ‘When I lived in Patagonia, gigantic herbivores roamed the prairies. In the pampas of Buenos Aires appeared, for the first time, interesting species of mammals of regular size, with whom I mingled in my forays.’

‘Typotheres, Toxodonts, Megatheres and Glyptodonts, we amused ourselves chasing foxes, vizcachas and rabbits in the diluvian terrain.’

‘Then a strange creature appeared. White, small, with no other weapon of defence than its transitional fur, on the bottom rung of the zoological ladder, and whose larynx, already evolved, was producing the first human interjections.’

‘I shuddered at the heroism of that tiny thing, defying Nature, and the armour of a fossil of my family was the first dome under whose calcareous-coffered ceiling the little man found refuge.’

‘Blocked by the hostile forces that contributed to the formation of the pampas, this puny, weak animal perched on my shell and tried to convince the carnivorous monsters with an inter-parliamentary speech that failed.’

‘The Smilodont, or ‘sabre-toothed tigers,’ formed an encirclement of fangs and a mist of ferocity surrounding the petulant figure of the first man. And in that hour of danger, with bloody imminence, a strange voice, as if from heaven, rebuked him.’

‘Man: trust in God and don’t run.’

‘But *Homo sapiens*, an atheist by conviction, without having yet read Jean-Jacques Rousseau’s Social Contract, ran desperately.’

‘And so he arrived, fearful and fatigued, at the refuge of his supportive friend, the Glyptodon, where neither the hungry pack of ferocious carnivores, nor the landlords, no less ferocious, with their rent receipts, could reach him. This is the help I gave to man. For him, I made an enemy of the Feline family, to which today’s tigers and lions belong.’

‘Who would have thought that, as the millennia passed, their descendants would repay my prehistoric favour by enclosing me in this vitrine!’

‘And now, my remote friend, look at that orderly, dusting the glass of my prison, and you will understand the depth of my regret in preventing the Smilodons from eating the first man for lunch.’

The Skeptical Smilodon

I am already in front of the glass urn where its pitiful, battered and sad skeleton is exhibited: the Smilodon, bloodthirsty persecutor of our remote and savage ancestors, who, for his exploits in prehistoric times, conquered the nickname ‘Sabre-toothed Tiger.’

With a merciful smile he carried out the beautiful revenge of humiliating the former ferocious animal that, with the solidarity of the gigantic Arctotherium,[15] provoked the tragic ruminations of the first wandering men of the pampas.

Incorporating itself in its millenary silence, the Smilodon focuses on me with its empty sockets, veiled by a weak spider’s web.

Then, with the eagerness to unearth a fossil history, I extend the gaze of my X-ray eyes to him, like a white flag of reconciliation.

But the Smilodon remains unmoved behind the stained-glass window. And at a new onslaught, he lets out with leaden heaviness the mute words of his strange voice.

– ‘Man, do not try to tear me from the comfort of my silence. Words have no more value than your petty understanding can assign to them.’

‘My philosophical position is skepticism. I find it hard to believe in my existence. I am a white lie of the palaeontologist, who invented me to make up for the mental disturbances and the waste of energy caused by his unsuccessful dedication to the study of the great geological eras.’

– ‘Smilodon … (Let’s suppose you are a Smilodon), where do you get that philosophy from?’

– ‘Man - since they locked me up in this glass dungeon, accusing me of having committed unspeakable misdeeds during the time of the pampean formation, I started to get bored to death. And looking for a sedative, I fell into meditation.'

I believe that a Smilodon has as much right to philosophise as any professor in the Faculty of Philosophy and Letters, whose skeleton might well deserve the honour of living with us.

Well, I agreed with him without unsticking my lips.

A negative feeling of human happiness drew me closer and closer to the strange pensioner in a glass case in the Museo de La Plata.

His scepticism and my bad humour were gradually welded together, in long silent dialogues.

He was no longer sullen with me when I tried to approach him. On the contrary, he spoke at a rapid pace, up to his collarbones.

At times, such was his excitement that he was forced to stop to wipe his empty eye sockets with the faint cobwebs. And then he would continue.

– 'Ever since I was put together to be exhibited in the museum, I have been submerged in a meditative sadness. All through my skull, a doubt pierces my brain. I don't know, frankly, if I am the skeleton of the Smilodon or a fantastic idea of the palaeontologist, who in bad time had the humorous idea of reconstructing me.'

'And even so, accepting that I belong to the family of the Felidae, another doubt arises in me: has each bone been placed in its respective place? And the bones ... do they all belong to my skeleton?'

'You are not unaware, my friend, that according to Burmeister, the age of the fossil remains found by Séguin in the river Carcarañá is apocryphal.'

'Burmeister claims that these bones were invented for purely commercial purposes.'

'Who assures me that there was no adulteration of the fragments of this skeleton, when they attempted to reconstruct me?'

'As you can imagine, I was an eyewitness to my reconstruction. They discovered my grave in Luján, and this gave rise to a series of hypotheses were transmitted by cable to the different cities of the world.'

'Then, in endless and patient days of work, the palaeontologist undertook the difficult task of assembling my presumed skeleton.'

'Each time he added a new fossil piece, my astonishment increased, and I found the sage's childish credulity somewhat amusing. But, I confess, when I was put together, I so much admired his skill, that I began to think how probable my existence was.'

This idea took shape in my skeleton, and now I open this optimistic question: if it wasn't the real Smilodon, why, when I met him, did I feel an undefined mandibular glee? Why am I dominated by various memories of outdated times?

– 'It is necessary to believe in order to live, Smilodon. The day you don't believe, you will cease to exist. After all, after all, we all don't know who we are, and no one is as they think they are.'

'I, who am your observer, assure you that you are a legitimate Smilodon.'

– 'Thank you, my friend.'

'Your affirmation spares me the burden of a terrible doubt. From this day I believe in myself, and will try to help myself with the threads of memory.'

'Let me vent my emotion in a sob. Is the porter in sight?'

– 'No, Smilodon.'

– 'Thank you. I'm going to sob. You are very obliging, and I thank you for the attentions you invest in me, for the small interest in my precarious word.'

'And I thank you still more for evoking our prehistoric enmity.'

– 'Are you sure we were enemies?'

– 'Oh, yes, don't contradict me, for then I would doubt my existence again. I was the enemy of primeval man and his fiercest and most bloodthirsty persecutor.'

'In the golden age of the ferocious syndicate, made up of Toxodonts, Mastodons, Megatheres and other widespread species, the first man emerged. When I spotted him, I felt like opening my fangs to embrace him benevolently. But I was stopped by a futuristic vision of life. Hearing the voice of the jungle advising me to exterminate him, I set off in pursuit.'

'I sensed in this poor thing the most wretched being in creation. To eliminate him was to save him from perpetual suffering.'

'When he saw me advancing, the little man fled in terror and sought a hiding place in the armour of the Glyptodon. And I, like a pendulum, swung the carapace, awaiting his exit.

'In vain I expounded to him the good reasons I had for devouring him. Uselessly I spoke to him of the tragic future of his species. The little man, cowardly by temperament, remained hidden for several moons.'

'And when, tired of waiting, I knocked at the door of the shell, the wretch refused my entry.'

'"Man," I said then, burning the last cartridge of persuasion, "give yourself up. I want to prevent you from resorting to cyanide tomorrow in search of eternal relief. I will devour you without pain."'

'Not understanding that life is not worth living, that living is a poorly paid job and procreating a premeditated crime, the little man fled.'

'He prayed to the heavens for strength and, lifting a block of stone with his weak arms, threatened me with death.'

'Too bad for him. His cowardice condemned him to live.'

'If I were invited to rejoin life, I would formally refuse. The spectacle of the world and its passions do not interest me.'

'The humankind of today is small, miserable, shapeless, ill-tempered and twisted.'

'The flesh of man is paltry and concupiscent – don't be angry, I am speaking to my friend - I foresaw the mud that will cover it in the future.'

'The God Jehovah had already foretold: "You will be devoured by doctors, scribes and notaries and intoxicated by writers and journalists. I will invent for your ills - as a just punishment for your selfishness - the tapeworm and the public offices' entrance table."'

'And since then, man has believed that God made him in his own image, when, in truth, he is the little paper bowtie that God made to entertain himself, like any Miguel de Unamuno, on the island of Fuerteventura in his divine boredom.'[16]

'I think that's enough. My skeletal memory is weakening and I find it hard to exhume fossil words.'

'Let man remain with his pox, applying mercury to himself, and let me remain in the vitrine, far from the madding crowd, as one of my contemporaries said.'[17]

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Notes

1 Discurso pronunciado por el señor Ministro de Educación, doctor L. R. MacKay, en el acto celebratorio del sesquicentenario de la Biblioteca Nacional, September 13, 1960, in *Bases y Programa,* 40.

2 The second prize – a tensile structure – was awarded to J. Sánchez Gómez, Justo Solsona, Carlos Libedensky, Flora Manteola and Antonio Díaz. Cf. 'Concurso de Anteproyectos para la construcción de la Biblioteca Nacional,' 5–6.

3 Archivos del Patrimonio Histórico del Edificio, Biblioteca Nacional de la República Argentina and Interview of the author with Clorindo Testa 9 November 2010.

4 On CAYC (Centro de Arte y Comunicación), a group inspired by Rauschemberg´s Experiments in Art and Technology and on the Group of the thirteen, see Giunta, 1999; Herrera, 1999; Rasmussen and Sullivan, 1992: 115–6.

5 Original: 'Abarca en la práctica como geografía todo el sur argentino y el archipiélago de las Islas Malvinas y como concepto, el espacio-tiempo en el cual se realiza, *pat-agónicamente*, nuestra fragmentada vocación nacional.' [Our translation]

6 Original: 'La forma del edificio es asimilable a la del gliptodonte y la Patagonia como la Biblioteca Nacional, son ejemplos vivos de antiguos proyectos permanentemente inconclusos. Esta obra que aparece soportada, reconstruida, dibujada en planta y fragmentada (a la manera de un laborioso trabajo científico), puede ser leída como proceso de restauración (en sentido biológico); como materialización unívoca de diferentes planos de la realidad, reunidos en mérito a la acción analógica; como medio físico de una operatoria cuasi mágica, en el que la configuración de las cosas responde a la magnitud del deseo o, entre otras más, como una eyección prospectiva de un pasado que amenaza retornar.' [Author's translation]

7 Paradoxically, the construction of the library was eventually finished under the same government that cancelled the Patagonian project.

8 'Este fósil fue encontrado cerca de uno de los puentes sobre el Río Negro de lo que fuera la nueva capital de la República. Los restos del puerto lo tapaban. Fue en el año 3004 de nuestra era cuando ya el hombre había abandonado la región' [Author's translation]. Testa changed the dates several times, however he always places the event ahead in the future.

9 Interview with Testa, Buenos Aires, 9 November 2010. See Glusberg, 1995: 91–106.

10 See the design of the Santa Rosa Library here: http://elplanz-arquitectura.blogspot.com/2012/03/clorindo-testa-biblioteca-de-la.html [accessed 14 May 2024].

11 'Suppose I have just told you that the glyptodon brought by Richard Owen from Buenos Aires has now been restored. Most people do not know the meaning of the word "glyptodon" and so may ask, What do you mean?

If we are standing in the museum I may simply point to a largish and preposterously shaped skeleton. *That* is what I mean. In Frege's parlance, that very skeleton is the reference of my words . . .

On the other hand, since you probably do not have a clue what the word "glyptodon" means, I may tell you that a glyptodon is an enormous, extinct South American mammal akin to the armadillo, but with fluted teeth. With this definition I indicate what Frege would have called the *sense* of the word "glyptodon". It is natural to think of a phrase as having sense, namely what we understand by it that enables us to pick up the reference, if there is one. Hearing the definition of "glyptodon" I can go to a museum and try to find their skeletons, if any, without looking at the labels beneath the specimens. Frege thought that a word has a standard sense, which is make a scientific tradition possible. The sense is what is shared by all communicators, and may be passed down from generation to generation of students.' (Hacking, 1983: 75–6).

12 Susana Valeria García, personal communication.

13 The original Spanish is 'Perduran esqueletos de gliptodonte en la cañada de Luján, pero no hubo jamás gliptodontes. Tal es la tesis ingeniosa (y ante todo increíble) que Philip Henry Gosse propuso a la religión y a la ciencia'.

14 'You remember brother, those were the days', the first two lines of a tango from 1926: 'Tiempos viejos' (Francisco Canaro-Manuel Romero), an ode to the past and a lament about the decline of life. It can be heard here https://www.youtube.com/watch?v=eQvCW2o4IrU [accessed 14 May 2024]

15 An extinct genus of Pleistocene short-faced bears endemic to Central and South America.

16 He refers to Spanish writer Manuel de Unamuno's 'Apuntes para un tratado de cocotología' (1902), where Unamuno (1864–1936) started developing his interest in origami birds.

17 A reference to Thomas Hardy's novel from 1874.

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9

When fieldwork goes wrong, go public: George Gaylord Simpson and Anne Roe in Venezuela, 1938–1939

Joe Cain

Black ties and formal gowns were on show when members of The Explorers Club arrived for a gala night at the 1939 New York World's Fair. More than 200 members, their wives, and guests gathered in the Ford Motor Pavilion to celebrate. The only routine part of the evening was the after-dinner talk by a Club member just returned from some far-off land. This evening, George Gaylord Simpson (1902–1984) described his recent expedition to Venezuela. Simpson was a rising star in American palaeontology. Based in New York City at the American Museum of Natural History (AMNH), he was slightly more than ten years into his career but already had several major expeditions and a long list of important publications to his credit.

Simpson's talk that night represented Venezuela as an exotic world. Travelling in the west towards Colombia and travelling in the southeast towards Brazil (Figure 9.1). Purchasing a blowgun from an indigenous community. Studying undocumented languages. Trapping rare mammals. He described the thrill of flying with a daredevil pilot; how one of their flights came to be lost in the clouds, nearly crashing in unmapped terrain. Simpson showed images of the famous tepuí region, where enormous plateaus rose straight up from the savannah landscape. This landscape beautifully matched Arthur Conan Doyle's *The Lost World*, and Simpson took full advantage of that imagery.

Without doubt, the climax of Simpson's talk was his story of Angel Falls.[1] Among the world's highest waterfalls, Angel Falls had only recently become known to outsiders. Simpson said he and his wife were among 'not more than ten people' from outside who had seen these Falls. He

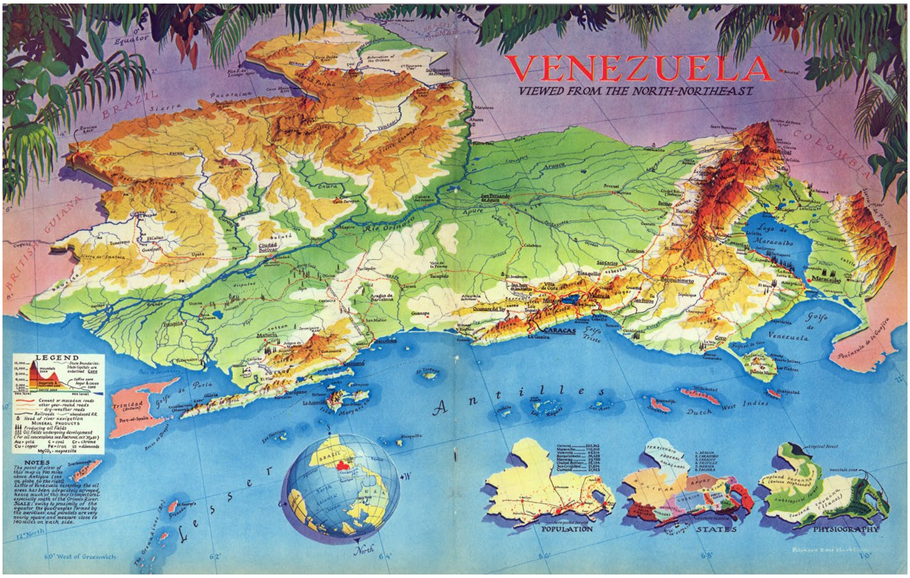

Figure 9.1 'Venezuela: Viewed from the North-Northeast,' by cartographer Richard Edes Harrison, first published in *Fortune* magazine 1939. In this 'view from America' orientation, South is up; North is down. The San Miguel site is located near Barquisimeto (right side equidistant from Caracas and Lago de Maracaibo) and the Gran Sabana region is located in the far upper left along the Caroni River. Courtesy David Rumsey Map Collection, David Rumsey Map Center, Stanford Libraries.

excitedly described how they made precise measurements suggesting the water fell nearly a full mile. Adding to the spectacle, Simpson showed 'two reels of Kodachrome' (colour motion picture film) of Angel Falls and the surrounding tepuí mesa as viewed from the air.

In 1939, Simpson was on top of the world. Angel Falls was a fantastic story. His expedition seemed a great success. At 37 years old, Simpson could do no wrong. However, there's more to the Venezuelan story than first meets the eye. In this paper, I'll describe Simpson's plan for Venezuela and compare the plan with its execution. There's a twist to this story. Owing to circumstances beyond Simpson's control, his season in the field was a disaster. At points, he might have returned with almost nothing. But Simpson didn't quit; he adapted. Shifting gears, he created alternative opportunities, some professional, but mostly focused on popular science. Simpson also turned to storytelling, bringing his voice as a public scientist into the foreground. Perhaps, he hoped, going public could turn mud into gold.

Figure 9.2 Anne Roe and George Simpson in camp in Gran Sabana flying a flag of The Explorers Club. In Simpson's photography logbook for Venezuela, this image is identified as XXVIII-14 'Anne and G at tent' and likely was removed from the series now catalogued as 'Venezuela 1938-1939 B' by Simpson for use in later publications. Series 11 Photographs. Box: George Gaylord Simpson and his Family. Courtesy APS Library.

Key to every story Simpson told about this expedition was his wife, Dr Anne Roe (Holland, 1985) (Figure 9.2). They married in May 1938. Anne accompanied George to Venezuela as part of the team, and her contributions were fundamental both to the expedition's original design and to its operation on the ground, including their opportunistic pivots. This paper primarily is about Simpson. In other work, I've examined themes of collaboration and identity co-construction in the Venezuelan narrative.[2] Because Simpson remained in charge of this project, and because he determined where and when the work would be undertaken, I'll continue to refer to the Venezuela project as 'Simpson's expedition'. Anne's presence shaped events, but she was not a captain.

Simpson was a rising star in American vertebrate palaeontology during the 1930s (Figure 9.3). Joining the American Museum of Natural History (AMNH) in the late 1920s, he was an expert in the systematics, distribution, and evolution of mammals. Simpson is remembered most as a theorist in evolutionary studies, with *Tempo and Mode in Evolution* (1944b) and *Major Features of Evolution* (1953b) central to the synthesis period

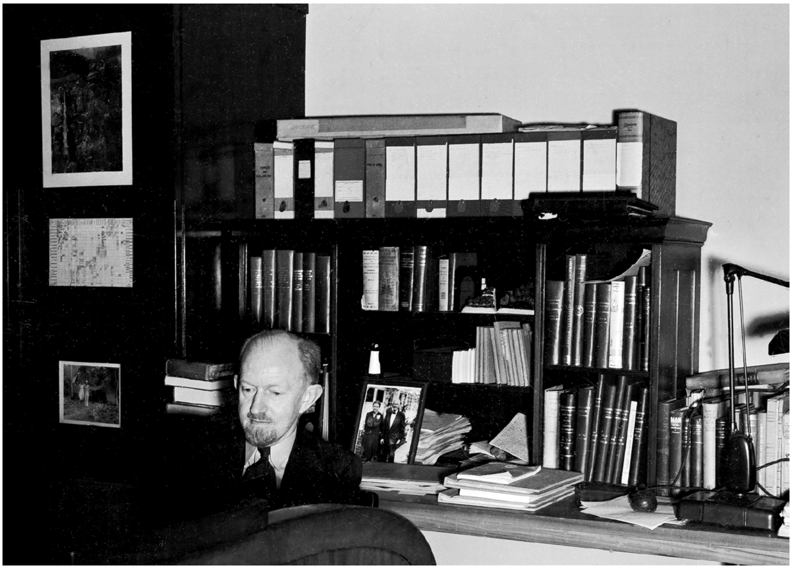

Figure 9.3 George Gaylord Simpson at his desk in the American Museum of Natural History, New York City. The dating is not certain: likely early 1950s though pencilled writing asserts 'about 1940 or 1941'. Framed images in the background include Simpson's parents (behind him), Angel Falls (top left), and Anne and George in Venezuela flying The Explorers Club flag (bottom left, also **Figure 9.2** here). Normally, a framed portrait of Anne was located on top of Simpson's desk, but it (and other materials such as the desk lamp far right) was removed for this posed photograph. APS Simpson Papers. Digital Image 188937. Courtesy APS Library.

of American evolutionary studies (Cain, 2013). He was praised widely as a synthesiser on topics such as mammal taxonomy (Simpson, 1945), biogeography (Simpson, 1953a), and methods of analysis (Simpson and Roe, 1939). Simpson (1978) penned an autobiography, but no full-length biography exists for him. Nonetheless, Whittington's (1986) biography is detailed and includes a nearly exhaustive bibliography of Simpson's work. Laporte (2000, 1987) is also an authoritative source on Simpson.

In 1938, when he turned 36, Simpson's bibliography included about 175 publications. In addition to descriptive and analytic papers, that list included a generous number of popular-audience works, three major monographs, the travelogue *Attending Marvels*, and a technically important provisional reclassification of all known mammal groups. Across the whole intellectual terrain of American vertebrate palaeontology, Simpson stood in the leadership of a young generation of university-trained, museum-based researchers then taking over the discipline (Cain, 1990). He worked in one of the world's finest facilities (AMNH in New York City). Within a few years after his return from Venezuela, Simpson would be elected to the National Academy of Science (US) and the American Philosophical Society.

Despite his later reputation as a theoretician, Simpson's self-image emphasised the 'field'. In the decade before Venezuela, Simpson led major expeditions to Florida, Montana, and twice across southern regions in South America. An expedition to Mongolia failed to materialise, but not without Simpson travelling to Moscow to plead his case (Simpson, 1978). To these larger expeditions, Simpson added many short collecting trips (lasting weeks to a few months) into the American southwest and southeast as well as across the Great Plains. He also travelled extensively abroad to museums and professional meetings. After Venezuela, Simpson's next major travel occurred December 1942 to August 1944, when he served as a US Army intelligence officer in North Africa, Sicily and southern Italy. In total, over the decades before and after Venezuela, Simpson spent more than half his time in the field or otherwise away from Manhattan (Simpson, 1978; Laporte, 1987).

Simpson's expedition to Venezuela took place between September 1938 and May 1939. It had two main goals. First, he wanted to collect Pleistocene mammals at several recently discovered sites in the northwestern Lara State, near Barquisimeto. A local naturalist, Brother Hermano Nectario Maria, served as their guide. He had discovered (or, at least, recognised) the Pleistocene material Simpson travelled to investigate. Visiting that region also allowed for opportunistic prospecting further west into the Andes to assess potential for further fossil collecting. Simpson knew a great deal about the historical biogeography of mammals in southern South America, and that part of the continent had been a key region for fossil collecting since the late eighteenth century. In contrast, palaeontologists as a whole knew little about northern regions of the continent, especially in geological periods experiencing busy interchanges with Central America. This trip was a chance to start filling that gap. As Simpson explained in an AMNH press release for the trip, western Venezuela was 'ideally situated to answer many questions of animal history' (AMNH, 1938). Most likely it was Simpson who also elaborated in *The Explorers Journal*,

> Dr. George Gaylord Simpson … is leading an expedition to collect fossils in heretofore almost untouched prehistoric beds of Northern Venezuela. … Intensive and specialized study will be made of a

> large and extinct fauna, and since no such intensive exploration for fossils has yet been made in Venezuela, it is expected that the scientific findings will be of great value. The region around the town of Barquisimeto in Northwestern Venezuela, where traces of prehistoric animals have several times been reported, will be the center of their activities. (Anonymous, 1938)

Simpson's second goal was more focused. He hoped to travel southeast from Caracas to Zaraza, in Aragua State. He wanted to find the middle Tertiary (Miocene) locality where one specific fossil mammal (an astrapothere) had been found. Simpson hoped to locate the quarry and excavate for more. Then, he wanted to prospect across nearby grasslands in a search for future sites.

This expedition originated when AMNH received a formal invitation from the Venezuelan government. Brother Nectario Maria's reports of rich deposits had been circulating among government geologists in Caracas and created an opportunity for investigation. 'As no one in the country had special knowledge or training in that field,' Simpson explained, 'the [Venezuelan government] decided to invite a vertebrate paleontologist to come at its expense and to make a thorough investigation…' After internal discussion at AMNH about how the opportunity could be best used, Simpson later explained, 'I was detailed to go…'[3]

One unusual feature (for Simpson) of the Venezuelan trip was the inclusion of his wife, Dr Anne Roe. A research psychologist by training, Roe first hoped to undertake interviews with local professionals. That plan quickly stalled as Roe considered her fluency in Spanish too poor. As she explained, '…since my lack of Spanish precluded my doing anything significant in my own line, I decided to occupy my time collecting recent mammals, and hastily learned the rudiments of preparing skins in the field.' (Roe, 1939a: 3). Those skins would add to the systematic and faunal collections in AMNH's Department of Mammals (AMNH, 1938: 233). Roe also agreed to serve as camp boss, quartermaster, and record keeper. She was determined to contribute substantially to this project. Simpson did everything he could to foreground those contributions.

Venezuela's invitation to AMNH coincided with a national 'renaissance' in the late 1930s. Expanding revenue from oil concessions supported rapid growth and commercial development (Pogue, 1939). As part of the country's economic strategy, efforts were made to 'plant the oil' – in other words, to invest oil revenues in infrastructure and expanded commerce with the United States and Europe (Fortune, 1939; Tomlinson, 1939; Allen, 1941; cf Dalton, 1912; Dennison, 1942). Improved infrastructure supported expansion and internal colonisation. In 1938 Venezuelan President Eleazar López (serving 1935–1941) introduced a three-year development plan. Special effort was made to expand geological education and to explore for natural resources: more oil, gold, and other materials (on geological survey, see Allen (1941:94-101)). The national-level political prioritisation of geology underpinned Simpson's presence and the generous support he and Roe received throughout.

AMNH engagement in Venezuela also was strongly encouraged on the US side. Approvals for the expedition were made easy by President Roosevelt's 'good neighbor' policies for inter-American relations (Pike, 1995). Tuned into domestic political initiatives, AMNH advertised Simpson's trip as yet another example of Pan-American cooperation (AMNH, 1938). Museum press officers also stressed the importance of sharing, noting it had agreed to return all fossils shipped to New York once they had been professionally prepared and studied.

Venezuela's Ministerio de Fomento paid all field expenses, and the AMNH paid transportation and costs associated with preparation and study of materials extracted. Patronage networks around AMNH were enrolled, too. Simpson gained additional financial support from his long-time patron, Horace S. Scarritt (Simpson, 1932, 1934b, 1936). In Caracas, Simpson and Roe would be guests of William H. Phelps, an American-born Venezuela businessman with sophisticated amateur interests in natural history (Aveledo, 1966; Murphy, 1970; Arnal, 2002). Phelps, his wife, and his son had long-standing relationships with AMNH. They were important social and political interlocutors for Simpson and Roe while these two were in-country.

In the following sections, I consider the Venezuelan expedition in terms of its two main goals (San Miguel and Zaraza) and the one unexpected addition (Gran Sabana). Rote description of the finer details will be left for elsewhere. The aim here is to describe events that led to difficulties, then explore Simpson and Roe's responses to their circumstances. Key will be their pivots to alternative projects and new opportunities.

Part 1: San Miguel

Simpson and Roe arrived in Caracas in September 1938. They spent two weeks in the capital before travelling west, first to Barquisimeto to meet their local sponsor and guide, and eventually to a site near San Miguel where they set up camp on a hilltop they named 'Los Robles'.

When first given a tour of locations where fossils had been found previously, Simpson realised the fossil-bearing potential of this region had been exaggerated. In the first week, he had trouble finding workable localities: '…I am somewhat crestfallen and discouraged by our prospects.'[4] The fossils he eventually extracted were poorly preserved, crushed and hard to separate from the surrounding matrix. After a week in the quarry, success seemed far off: 'I have never done so much work for so small a result…'[5] (Figure 9.4).

Figure 9.4 Labourers excavate fossil material from hillside quarry near San Miguel. APS Simpson Papers. Series 11 Photographs. Box: Venezuela 1938–1939 A. Image: III-33. Courtesy APS Library.

Roe also had considerable difficulty at the start. Animals were less abundant and less diverse than they had hoped. Her skills with the technically demanding preparation techniques took time to develop. Also, the job of camp boss proved harder than expected. Roe was inexperienced supervising (in Venezuelan Spanish) a cook and foreman, and she found local provisioning to be frustrating and time consuming. Keeping a good supply of drinking water, for example, required constant attention.

Despite relocating camp and finding some improvements, San Miguel badly failed to meet expectations. After a month onsite, Simpson's journaling regularly expressed his frustration,

> I am very bored and bothered by the work—we labor so hard for so little, the bones are plentiful but so poorly preserved that they take great efforts to get one out at all, and then are not worth it, yet we have to go ahead. I wouldn't give a peseta for our collection to date, large as it is, and feel very tired and discouraged.[6]

Simpson and Roe found ways to deliver on at least part of their original plan. However, their experience took a sharp turn for the worse after mid-November. The rainy season arrived early that year. It was unusually heavy. 'It rained, and rained, and rained.'[7] The rains grew into one of the most severe seasons on record. Rains washed out Simpson's quarries. Water-logged specimens were damaged. Collected material could not be moved. New work became impossible. 'My quarry is a sea of mud,' Simpson told his sister and mother in November 1938.[8] 'The whole country is disrupted by floods & I couldn't work anywhere…' Roe added, 'We spend our time going down & weeping over the quarry, writing, and looking to see which direction the next storms are coming from' (Laporte, 1987: 228).

Roe's mammal skins fared little better. Just as she was becoming confident in her preparatory work, the endless rains brought new difficulties: '…my skins and skulls would not dry, and began turning green with mold.' 'Everything in camp, including the toothbrushes, molded, and we weren't always sure about ourselves.' (Roe, 1939a)

Later, after returning to Manhattan, Simpson tried to put a brave face on the fossil collecting near San Miguel. 'Among other things,' his press release announced, 'a quarry was opened which proved to be [by] far the richest deposit of such fossils known between Argentina and the United States. Work at that locality is still going on, with workmen trained by the expedition…' Eventually, over 5000 kg of rock were sent to AMNH from the expedition (Laporte, 1987: 230). In reality, little came from the expedition in terms of palaeontological results. Writing more honestly in the 1960s, Simpson explained:

> The bones are not well preserved, at best, and the undue rainy season not only made collection more difficult--impossible for quite a while--but also inevitably damaged some specimens. On the whole the collection was not proportionate to the enormous labor involved, but the investigation was warranted. The commonest form, *Eremotherium*, a kind of giant sloth or megathere, is now much better known from other areas, especially Panama. The whole fauna, limited in variety as in preservation, has significance more in comparison with others collected or studied later, ... than in isolation.[9]

Stuck in their hilltop camp near San Miguel in the rains in November 1938, Simpson and Roe faced failure. This was something both were determined to avoid. While they worked to maximise the results from their primary work, they also pivoted to new projects. These new projects relieved their boredom. They also offered some hope for recovering something notable from all the time, money, and effort they were putting into these many months away from home and family.

Simpson decided to write another travelogue. In 1934, he published *Attending Marvels*, which told the story of his first expedition to Patagonia (Simpson, 1934a). Though the book achieved only minor commercial success, it marked a high point for Simpson's literary ambitions at the time. Several years later, returning from a second expedition to Patagonia, Simpson tried to sell a sequel. But the market had changed, and he found commercial publishers unwilling or unable to take it on.

Simpson's new project was titled, 'A Million Years in the Tropics: Observations and Adventures in Venezuela by George Gaylord Simpson and Anne Roe Simpson'.[10] It mixed the expedition's narrative with chapters on palaeontology, geography, Venezuelan politics, personality and commentary on current issues in Venezuelan life. Simpson knew he could do the fact-based research back in New York. In Venezuela, he concentrated on people, culture and custom. This new project gave extra value to Simpson's and Roe's ongoing (now expanding) practice of recording experiences with daily journal entries. They also expanded the content of their chain letters, a series of outgoing correspondence posted to one person at home with the expectation of their forwarding it to others along a preset chain of recipients including family and friends[11]

(Figure 9.5). Preserved by the last link in the chain, their serial narrative could be collected later and kept for posterity. 'Of course,' Simpson explained, 'these notes are written not without a thought of making a book of them.'[12]

While they were stuck in San Miguel suffering 'our enforced idleness', Simpson quickly exhausted available material for the travelogue. He simply ran out of new subjects to write. The project might continue, but it required a change of scene. As another pivot, the couple turned to writing fiction. In their case, starting 3 December 1938, they chose to write a murder mystery:

> On a January day in the jungle of southeastern Venezuela… buzzards were perching in [nearby] palm trees. Others circled slowly overhead. There was a strange bundle at the foot of one of the trees. Apprehension increased as my assistant and I approached. We recognized the bundle as [the] inert [remains of an] acquaintance of ours, one we had supposed to be a great distance from this wild and remote spot. We hardly needed to roll him over to determine that he was dead. There were no visible wounds, no indications of how he came to be there and [how he came] to die. All that already had long roots in the past, and it was to have repercussions in what was then the future.'[13]

Trouble in the Tropics was a story of two American scientists in Venezuela – one male, a cynical and seasoned mammalogist on a collecting expedition, the other, female, a beautiful, clever, and recently broken-hearted psychologist just beginning a consulting project for the Venezuelan government. These two scientists, the plot develops, meet on the voyage south from New York, flirt in fine professional-class fashion, and repeatedly cross paths during the investigation of an acquaintance's death. While sleuthing their way through the mystery, the two protagonists grow more interested in each other, fall deeply in love, and (as the closing line of the book explains) because they 'found being together so pleasant…they decided to make it permanent'.

Simpson and Roe alternated writing chapters – 15 chapters in roughly 15 days. Chapters appeared as diary entries in the pen of one of the two protagonists. Importantly, the female lead was a genuine, charismatic actor in this narrative – fully sentient and vocal. Parallels to their lived experiences were barely concealed. Following common practice in the industry, they adopted pseudonyms: 'Michael Larch' and

Figure 9.5 Anne Roe typing in Los Robles Camp near San Miguel. APS Simpson Papers. Series 11 Photographs. Box: Venezuela 1938-1939 A. Image: IX-9. Courtesy APS Library.

'Clarissa Van' for this 'autobiographical' production. After its completion, Simpson explained to his journal,

> ...it has tided us over a period of inaction that would otherwise have been deadly, and there's at least a chance that we can sell it and get a little money to help square ourselves with the world again, ajala as we say. I have taken out all my cacoethes scribendi on the book and have had none for the journal...[14]

During the rains, Roe kept busier than Simpson. In addition to her prescribed duties, she spent some of her time in camp writing parts of a monograph later co-authored with David Shakow (1942). She also had unexpected social obligations. Roe's presence in camp changed the social dynamic during all segments of this expedition, and her residency at Los Robles was no different. The presence of *Mrs* Simpson converted the camp into a home in the eyes of local matriarchs. As a result, etiquette required social intervention in the form of invitations and facilitation, especially on issues of labour, supplies and social engagement. As a direct result of

Roe's presence, and weather permitting, the expedition included a wider range and higher number of local excursions and social engagements than Simpson otherwise undertook during fieldwork. Their travelogue thus shows wider scope and experience. Their photographic record for the San Miguel stage likewise grew as Anne's social opportunities sometimes drove their itinerary.

The weather changed in the second half of December. Lara State dried enough to continue with the expedition's work. Simpson and Roe used the opportunity to complete one of their minor goals: prospecting southwest into the high Andes. They travelled as far as Merida. In the course of that travel, 'several important and promising deposits of Tertiary mammals were located, but time was not available for working them intensively'.[15]

Simpson and Roe returned to Caracas just before Christmas 1938 after three months in the field and more than one month mostly isolated in San Miguel. Simpson had never completed fieldwork with so little technical work completed. However, he and Roe had adapted to circumstances and developed a group of alternative accomplishments. The start of a travelogue and a reservoir of experiences, a novel, and some reconnaissance to go along with an admittedly minor collection of rocks and skins. Overall, these were disappointing results. However, the couple at least had *something* to show for their time in the field.

Part 2: Zaraza

When Simpson and Roe returned to Caracas, they needed transition. Specimens needed packing for shipment to New York. Records needed sorting. Reports needed completion. Simpson consulted Ministerio geologists and examined collections in Caracas. Meanwhile, Roe worked to rescue anything she could from her mammal collections. Second, the two needed recuperation from moderate health problems. Life in the field had taken a toll on each. Third, as guests of the Phelps family, they settled into the comfort and elegance offered by generous patrons (Laporte, 1987: 228).

The second ambition for this Venezuelan expedition was more open-ended than the first. The plan was to travel to the grassland regions, the llanos, near the town of Zaraza. Justified as a 'reconnaissance', Simpson was in search of one specific locality. Then, he wanted to sweep opportunistically in search of more. As he later explained (with comments added later),

> Our principal reason for coming here was that the jaw of an extinct ungulate, an astrapothere of quite distinct aspect, had been found here some years before. It was published by a Swiss paleontologist who had never been to Venezuela and had inadequate data for the occurrence. It indicated the presence of fossil vertebrates much older (Miocene) than those around Barquisimeto (Pleistocene). I hoped, first, to determine just what geological formation it was from (done), second to see whether exposures were extensive enough to justify a subsequent expedition (they weren't), and third, to collect more fossils if possible on a flying visit (some small success, see below).[16]

This stage had quite a different character compared with San Miguel. More an excursion, Simpson and Roe travelled with William Phelps Jr, the son, who preferred big safari-style travel. Simpson and Roe were guests. All logistics were arranged. They travelled in February 1939, first to sites near San Juan de los Morros, where mastodon teeth had been reported, and then to Zaraza.

Once again, overall results were discouraging. As Anne told family, 'G very discouraged -- feeling, I think, that he has accomplished nothing, etc., etc.'[17] Simpson found no fossil mammals of note. The one object he celebrated finding was the remains of a large turtle, which he later described as 'important and worth the effort'.[18]

The Zaraza segment of the Venezuelan project was truncated. This was because the plan had changed during their break in Caracas. In mid-December, President López announced he wanted a geological survey of the Gran Sabana region in the country's southeast (Angel, 2019: 149-150). By the time Simpson and Roe returned from San Miguel for Christmas, the Ministerio was hurriedly planning that work. Being on very good professional (and social) terms with the principal geologists involved, before the New Year, Simpson and Roe received an enthusiastic invitation to 'visit' one of the survey's sites in the Gran Sabana.[19]

Simpson jumped at the opportunity, making sure New York knew he was onto something big. 'Dr George Gaylord Simpson,' as The Explorers Club announced on his behalf,

> ...reports success on his fossil collecting expedition which is being carried out by the American Museum in cooperation with the Venezuelan Government. At last writing he had closed his excavation work in the vicinity of Barquisimeto and was about to

> join a Government exploration, by airplane, of the almost unknown jungle region lying south of the mouth of the Orinoco River. (Anonymous, 1939)

Survey geologists set out for base camps in March 1939. Privately, Simpson and Roe wrote to family on 3 March 1939 that they were at 'the beginning of what promises to be a Great Adventure.'[20]

Part 3: La Gran Sabana

When President López announced the survey that Simpson and Roe visited, he declared several goals (Angel, 2019: 149-206). Overall, he wanted Venezuelan scientists to better understand the southern states of their own country, especially the Gran Sabana in Bolívar State and more generally the Región Guayana. First, specifically, he wanted economic geologists to survey for mineral, metal, and petroleum resources. Second, he wanted a land survey as preparatory work for economic development and internal colonisation. Third, he wanted public health officers to assess the needs of indigenous people and to establish working relationships. Though not unprecedented, outsiders were rare visitors south of the Orinoco River. The airplane was rapidly changing how outsiders could access this region, and President López wanted neither rogue extraction nor undesirable political influences. His nation-sponsored survey aimed to give his government some ability to decide how best to steer future intervention in the region (Tomlinson, 1939; Allen, 1941: 99).

The decision to invite Simpson and Roe was a courtesy. It was a minor element of a substantial project already underway. Palaeontologically, this trip was a write-off from the start. Simpson expected to find no fossils, as the region did not seem to have exposures of relevant age. But, as Simpson explained in a letter home, one of the scientific leads on the project had 'the bright idea that we, being interested in mammals, should do anthropology for them, measuring Indians' heads, etc. So of course I said "sure, we'll do it."'[21] Roe was invited to join the expedition, too, though this was noted as an unusual offer both from male Venezuelan scientists and from male political managers. This prompted the expedition leader, Santiago Aguerrevere (1899–1984) to seek permission from a Kamarakotos leader for 'safe conduct' for Roe. Seeking legitimate work to justify her inclusion, Roe offered to continue collecting mammal skins for AMNH. The two further agreed to botanise, collecting specimens for a Venezuelan colleague in Caracas, who would later work up the material.

These decisions created a scientific justification for this visit. It also subtly changed an invitation to visit into an offer to participate. Officially, Roe was described as the expedition's mammalogist; Simpson, its naturalist.

The opportunity to travel with the expedition was unexpected. It is not mentioned in Simpson's application to carry an Explorers Club flag, written prior to leaving New York.[22] It is not signalled in the AMNH press release on departure. It is not anticipated in their journaling at San Miguel. Simpson later explained he 'had no inkling,' in San Miguel, 'that I would later visit that border area in person.'[23] More formally in the draft material for the Venezuelan travelogue, Simpson wrote:

> While I was in Venezuela and when most of my original aims had been sufficiently accomplished, the Ministerio arranged for very extensive investigation … of much of Venezuelan Guayana, the enormous, very poorly known, wild, potentially useful (or so it hoped) southeastern part of the country. I was invited to go along, although no discovery of fossils was expected, to help with whatever aspect I could, such as anthropology.

The offer to visit Gran Sabana appealed to Simpson on several levels. First, simply put, it represented an opportunity for adventure. This region was the 'lost world' of popular imagination. It was made famous in Anglophone literary circles by Arthur Conan Doyle's (1912) jungle adventure, *The Lost World*, and in international cinema circles by the special effects bonanza of the same name in 1925.[24] Exploration by airplane revealed the vast sabana landscape was dotted with large mesas or plateaus seemingly set on pillars pushed up from the surrounding landscape. The mystery of these features – tepuí (singular) in local dialect – seemed ever ripe for adventure. The region was also populated by indigenous communities rumoured to have had little-to-no prior contact with outsiders.

In early 1939, stories about Venezuela south of the Orinoco River were dominated by the adventures of American bush pilot, Jimmie Angel. Angel was one of the first to fly extensively in Región Guayana (Angel, 2019; Scully, 1954; Mydans, 1965). He claimed to have once brought out gold, and he was on the hunt for more. Angel also claimed to have seen dazzling sights and lived through thrilling adventures. For example, with his wife and another explorer, Angel had crashed on one of the tepuí mesas and climbed down to rescue. Simpson was attracted to Angel's charisma and to his passion for discovery. He knew New York's appetite for scientific adventure was voracious, and as a flag-carrying member of The Explorers Club, he was keen to sign up. Travel into the Gran Sabana might have been Roe's first time in the air. First were the supply flights delivering them to the Kamarata Valley. Thereafter, they were eager to fly with Jimmie.

Simpson used the flag of The Explorers Club to validate the scientific nature of his travels (Figure 9.2). It represented sanction from professionals back in New York. That flag 'is never given to anyone', Club rules declared, but it is only 'loaned for use on a specific expedition'. George had applied 'for the privilege of carrying the flag' and only after demonstrating the seriousness of his work did he gain approval of the official 'Flag Committee'. Ironically, it was the San Miguel project that the committee approved. George made use of the flag's symbolism on the Gran Sabana, and thus formally outside the Club's official sanction.

The second reason for wanting to go south was that AMNH zoologists already had explored in the region. Simpson had a competitive streak that sometimes manifested as encroachment. Back home later, he could always say he had been there, too. AMNH ornithologist Frank Chapman (1864–1945) was interested in the birdlife atop the tepuis, hypothesising the mesas were analogous to islands in a sea, possibly offering 'sanctuaries' from past eras and possibly offering a means for dispersal across the otherwise inhospitable savannah. He oversaw collecting around and atop Cerro Roraima, at the (disputed) border of Venezuela, Brazil, and Guyana (Chapman, 1931, 1937, 1939).

AMNH mammalogist George H. H. Tate (1894–1953) was interested in the distribution of mammals across northern South America, thinking the borderlands between Venezuela and Brazil were zoologically important as a transition zone (Tate, 1930; Tate and Hitchcock, 1930). AMNH teams, led by Tate himself, explored Amazonas State near Cerro Duida in the 1920s. Describing a 1931 talk by Tate about his experiences near both Cerro Roraima and Cerro Duida, *The Explorers Journal* wrote,

> These mountains have had a peculiar interest for explorers, not only because of the difficulty hitherto of reaching them, but because of the lure of … wealth. Mr. Tate, in the journey described, penetrated to these vastnesses, surmounted their table-like summits and found much that was both novel and admirable—good material for a fully illustrated talk. Mr. Tate is a fluent and entertaining lecturer, with a nice sense of humor. (Anonymous, 1931)

In late 1937, Tate led another AMNH party through what he thought was a biogeographical middle ground: the Karamata Valley and along the base of Auyán-tepuí. The AMNH expedition included Tate (only recently returned from New Guinea), William Coultas (former head of the Whitney South Seas expedition), James Dillion (mamalogist) , E. Thomas Guillard (ornithologist), and the two William Phelpses (father and son). This took advantage of transport by air, such as by Angel's service. Tate (1938a, 1938b, 1939) described a 'specialised and endemic fauna'. He also ascended and collected on the mesa atop Auyán-tepuí.

The Karamata Valley along the base of Auyán-tepuí was one of four locations chosen by the Ministerio's 1939 expedition for basecamps. There they set up a landing field for more-or-less regular supply from Ciudad Bolívar. This was the site Simpson and Roe visited.

A third reason for wanting to join the Gran Sabana expedition grew from Simpson's self-built identity as a 'man of science'. Simply put, the invitation gave Simpson *opportunity*. Once in the Gran Sabana, Simpson trusted himself to improvise in terms of scientific work. Confident, intellectually omnivorous, and risk-taking, all Simpson needed to justify to himself launching into any new project was the opportunity to create success. The Gran Sabana was no different.

Roe's inclusion was justified by collecting more mammals for AMNH, effectively supplementing collections made by Tate's team two years previously. It's inconceivable Simpson would have travelled to the Gran Sabana without Roe, and their journals clearly show her anticipating making a real contribution.

Finally, for Simpson, a strong pull to join must have been the opportunity to engage people from an indigenous community. He was a cultural voyeur with an enormous appetite for new languages and new encounters. For instance, a few years before Venezuela, Simpson took up learning Mongolian dialects in anticipation of fieldwork in that country. This excitement about language manifested itself in his professional bibliography with papers intended to connect systematists' language for animals with local, vernacular and common names for the same objects.

> 'It is a matter of integrity or scholarly pride to use names that are genuine, that really are or were applied to those particular animals by a considerable group of natives in the area in question, and to favor forms of the names as near the original as is consistent with thorough assimilation into English.' (Simpson, 1941a: 1-2)

Aside from pride and respect, knowing vernacular names had practical importance to collectors and travellers relying on indigenous peoples' help with collection.

Figure 9.6 Expedition members for Gran Sabana expedition, including George Simpson (bottom row first on right), Anne Roe (bottom row second right), Maria Angel (bottom row far right), Jimmie Angel (second row far left). Angel's plane is in the background. APS Simpson Papers. Series 11 Photographs. Box: Venezuela 1938-1939 B. Image: XXVIII-15D. Courtesy APS Library.

The Ministerio's expedition as a whole covered considerable ground across the Gran Sabana (Figure 9.6). The basecamp Simpson and Roe used was located at Uruyén, immediately south of Auyán-tepuí in the Kamarata valley. As guests, Simpson and Roe had no camp duties, and they were left to do as they pleased. The Simpsons arrived on 4 March 1939, and they stayed in camp approximately 4 weeks.

Simpson committed extraordinary energy to the anthropological project. Roe feared he might collapse from exhaustion. Simpson focused on language and vocabulary, material and political culture, technology, and social systems within families. Physical anthropology was undertaken, too, but this was perfunctory. He purchased items he thought representative of use and meaning. In his diary, Simpson took great pride in this project:

> It does seem odd for me to be doing anthropology, but it is what needed doing here and I think I'm getting it all right. I've always maintained that given a little basic background, a real scientist could transfer his scientific method to any field, and this will be a good test of my claim.[25]

While Simpson revelled in anthropology, Roe struggled with collecting mammals. Her traps were unproductive. For what she did collect, the variety was low. Roe turned instead to botanical collections and to supporting Simpson with the anthropology.

On 8 March, only a few days after their arrival in camp, Jimmie Angel offered to fly Simpson, Roe and others around Auyán-tepuí (Figure 9.7) – 'Anne and I jumped at the chance, although I was, frankly, pretty scared.'[26] This included an overflight of Angel Falls. Simpson was staggered.

> I have been practically speechless ever since and even now I just have a sort of sinking, hopeless feeling at trying to record even a bare hint of what all this is like. It is grand, awesome, awful, beautiful, marvellous, terrible. It seems impossible that such things can exist on our earth. It makes the grandest famous scenery of the world seem puny … A man who had been to the moon and explored its craters might feel similarly exalted and cut off by the depths of his experience from his fellows and from all that he knew before.[27]

On the flight, Simpson recorded readings from Jimmie's flight instruments. Bearing witness both to the grandeur of the falls and to those measurements of its drop would figure largely in nearly every later account of Simpson and Roe's time in Venezuela.

As their month in camp continued, relations deteriorated with some of the Venezuelan team. The couple increasingly complained about behaviours in camp and about general practices in research. There were arguments over responsibilities, such as for the botanical collecting. Simpson and Roe wrote scathingly about the team's interactions with indigenous people, effectively accusing them of cultural destruction.

Simpson and Roe left the Kamarata Valley by air for Santa Elena on 30 March. En route, they became lost in the clouds and worried openly about an emergency landing, or worse.[28] Otherwise, their short stay in Santa Elena was uneventful.

Simpson and Roe returned to Caracas on 7 April. 'It seems incredible,' Simpson wrote in their journal, 'but this morning we were surrounded by Indians down in the heart of the Gran Sabana near the Brazilian border, and tonight we are in one of the principal mansions of a populous and cultured city.'[29]

With departure in sight, Simpson and Roe finished work at the Ministerio and visited Barquisimeto one final time to review work continuing with collecting and preparation. They also made brief

Figure 9.7 Aerial view of Angel Falls photographed by George Simpson on 8 March 1939, during his and Roe's overflight with Jimmie Angel. APS Simpson Papers. Series 11 Photographs. Box: 'Venezuela 1938–1939 B'. Image: XIX-2. Courtesy APS Library.

reconnaissance visits near Valera and Betijoque (in Trujillo State) to complete that planned element of the expedition. Simpson gave a summary lecture at Universidad Nacional en Caracas about their work.[30] Then, home beckoned. Their journals abruptly stopped at the end of April, on the verge of their boarding the cruise heading north. They arrived in New York via Grace Lines on 22 May 1939.[31]

Pivoting to story-telling

The Venezuela expedition might not have been a complete failure in terms of collecting, but the accumulated palaeontological results fell far below what was originally anticipated. Still, Venezuela became an unqualified success for Simpson and Roe. It was the first story Simpson told in his autobiography. Images from Venezuela decorated his office. Venezuela catapulted Simpson to celebrity status as a scientific explorer. How did he accomplish this reversal of fortune? The answer is found in Simpson's ability to pivot.

By the time of his report to *Science* (1 September 1939), Simpson had refined his narrative about his palaeontological work. While the original site 'proved disappointing at first', a new locality 'turned out to be by far the richest deposit of fossil mammals yet known between Argentina and the United States'. This site was continuously worked, with 'modern methods of extracting fragile and broken bones … employed for the first time in Venezuela, and native workmen … trained in these methods, a result which may mean even more for the future of vertebrate paleontology in Venezuela than do the collection already made' (Simpson, 1939). Despite putting on a brave face, Simpson had little to show, and less to publish, for the effort expended.

But San Miguel was dwarfed by the novelty of the Gran Sabana. The largest research output from the expedition was a 460-page monograph Simpson wrote about the indigenous community he studied while in the south, *Los Indios Kamarakotos (Tribu Caribe de la Guayana Venezulana)* (Simpson, 1940). This was published by the Ministerio de Fomento in Caracas.[32] Primarily, *Los Indios Kamarakotos* is a descriptive monograph focusing on linguistics and cultural anthropology. Simpson justified his effort as documentation and salvage (cf Redman, 2021). This community was probably one of the last large South American populations 'still retaining their own speech, organization, and customs'. Simpson argued the threats of assimilation were real and immediate. He predicted a complete 'Venozolanization' of the Kamarakotos people – a result that meant certain extinction for their culture and possibly extinction for the Kamarakotos themselves. Disgusted by the way the Caracas-based team treated these people, Simpson suggested several schemes for preventing similar communities becoming too dependent on outsiders, on commodities from industrial countries, and on export economies grounded in selling tourist trinkets. In the end, however, a pessimistic tone pervaded Simpson's monograph. 'The end may … be slow in coming, but it appears inevitable.'

Simpson knew he was working outside the assumed boundaries of his professional expertise. While completing his study, Simpson told his parents the project was 'fun because I never did anything quite like it before & for that same reason is a lot of work' (Laporte, 1987: 230). And his sister: 'I'm having fun writing about Indians, doing a brief grammar & dictionary of the Kamarakoto language at the moment, which fascinated me but annoys my colleagues who want to know when is a paleontologist not a paleontologist' (Laporte, 1987: 231).

Publishing the monograph allowed Simpson to validate his time and effort as a scientist while in Venezuela. The Gran Sabana 'visit' wasn't a jolly. It wasn't mere adventure. It was science. Reflecting decades later on his ethnography, Simpson expressed great pride in the work, calling *Los Indios Kamarakotos*

> the most complete objective description of the whole nature and culture of a South American tribe. It has been criticized (not usually) as unsophisticated, which is true, but more sophisticated studies usually dwell on some one aspect or else have an anthropological axe to grind. I believe that my monograph is valuable in part precisely because I did not have a professional bias.[33]

Simpson also used publication of research to validate Roe's participation in the expedition. He ensured Roe's inclusion in formal reports produced by the survey (Roe, 1939b), which he described as 'one of the first technical reports on the mammals of Venezuelan Guiana'.[34] Writing about vernacular names of local mammals, he also was clear where credit should reside: 'The accurate equation of Indian with scientific names was made possible in many cases by the collection of mammals made on the same occasion by my wife, Dr. Anne Roe.' (Simpson, 1941b: 1)

Without doubt, Angel Falls dominated Simpson's stories about Venezuela. On its own, the Falls was a sensational story: almost inaccessible, viewed from the air by only a few outsiders. The very existence of the Falls was a matter of dispute at the start of the Ministerio's survey, as many doubted there could be enough surface on the mesa to collect rain water sufficient to feed so large a continuous cascade (Robertson, 1949). Jimmie Angel seemed a blusterer who lacked first-person credibility. Photographs of the falls first appeared in Aguerrevere et al. (1939) and had wide circulation in the United States with Gillard (1939, 1940) and Gillard and Scoggins (1941).

It was the height of the Falls that made headline news. Jimmie Angel claimed the Falls were nearly 6000ft high, but few believed him. In contrast, Simpson seemed unimpeachable. His account converted the estimate into a measurement. Simpson took pains to represent the Venezuelan expedition as a scientific one, and he was careful to describe how he and Angel used instrumentation to measure what had so impressed their eyes. Gillard (1940: 271) quotes Simpson suggesting the official Venezuelan estimate of 'in excess of 3,300 feet' was far too conservative:

> He [Simpson] saw the falls on March 8th 1939, at the end of the dry season in their lowest ebb and he tells me that 'the altimeter in Jimmy's [sic - Jimmie] plane showed the canyon to be about 6500 feet deep and the falls jumped most of that distance.' He believes that they may be 5000 feet high, nearly one mile! (Gillard, 1940: 271)

Simpson's verification attracted the attention of Robert Ripley for his 'Believe It or Not' radio programme. Ripley invited Simpson and Roe to appear with Jimmie Angel for a re-telling of their 8 March flight.[35] As with other popular accounts, Ripley's script foregrounded Simpson's credentials and his witnessing the altimeter to assert the mile high claim.[36] (Roe also spoke in the episode. She was identified as 'Mrs Simpson', and she did not add to the verification process.)

Simpson leant heavily on his affiliation with The Explorers Club, and the Club made good use of him. Simpson gave a briefing about Venezuela to the Club in 1939 shortly after their return. The Club sponsored another public lecture about Venezuela in 1941. It later borrowed some of the items Simpson and Roe collected (purchased from Kamarakotos locals) in Venezuela for exhibition (see *The Explorers Journal* (1941), 19 (2–3)). Indeed, George was speaking to the converted at the gala dinner at the World's Fair on 11 June 1940. Within the rhetoric of grand *scientific* exploration, Simpson's story seemed perfect. As long-time advocates of scientific exploration over trophy hunting and amateurish junkets, Club members prided themselves on their efforts to 'offset the distortional effects of current newspaper ballyhoo and motion-picture sensationalism' related to exploration. '[O]ne of the precepts of the Club,' its president declared in 1941, 'is the discouragement of telling more than the explorer sees or knows.' 'We wanted to prove that exploration was a profession that established rather high standards of brotherhood and was not composed of a bunch of hell-raising adventurers.'

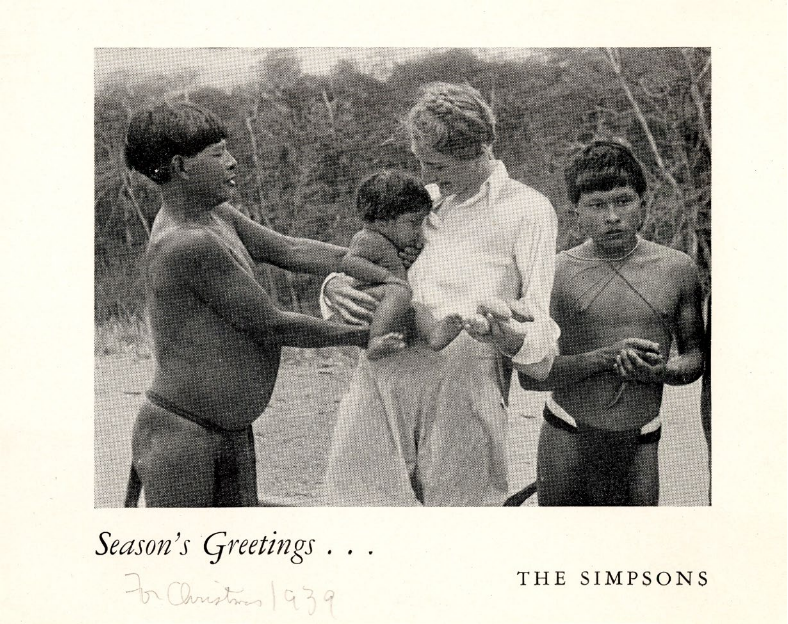

Figure 9.8 'Season's Greetings' card distributed by George Simpson and Anne Roe for the Christmas holiday season in 1939, the year they returned from Venezuela. Anne Roe (centre) holding unidentified child, with two unidentified Kamarakotos men. APS Simpson Papers. Series 11 Photographs. Box: 'George Gaylord Simpson and His Family.' Image: Season's Greetings ... The Simpsons. Courtesy APS Library.

The Gran Sabana stage transformed Venezuela for Simpson and Roe. On a personal level, it was sensational. Truly an adventure of a lifetime. They incorporated their experiences into every aspect of their domestic life, including using a photo of Anne with three Kamarakotos in their annual Christmas card (Figure 9.8). Meanwhile, the San Miguel stage of Venezuela was quietly minimised. *Trouble in the Tropics* was not published, despite an approach to a friendly literary agent. As Simpson explained in 1967, 'We finished a quick draft of this murder story (set in Venezuela) at a later date and even went so far as to submit it to an agent we knew. He didn't like it, on what seemed to us specious grounds, and we never bothered with it further.'[37] Over the following year (1967 into 1968), Simpson discussed with one of his daughters if revision would make the book more sellable. Ultimately neither was prepared to give revision the time they thought required, and their interest passed. Of the novel, Simpson wrote in 1967, 'Frankly I consider it unpublishable in A.D. 1967, but saw no harm in letting people look at it.'[38]

Likewise, Simpson chose not to complete the travelogue. He had the four chapters written while in San Miguel, but the project never seriously restarted. Back in New York, Simpson told a close friend in March 1940 that he was planning to see it to publication,

> Anne and I have a few chapters done on a popular book on Venezuela which we also hope to have out this year, perhaps by Little-Brown although the contract is not signed - I was very dissatisfied with the publisher's (Macmillan's) handling of 'Attending Marvels' and so am wary now...[39]

As with their murder mystery, Simpson returned to the idea of publication in 1967 with 'some thought of extracting a book from the journal (as I had from my first Patagonian journal).' Justifying his decision to abandon that idea, he noted in his own records, 'Apart from stylistic matters, it is too frank about some personal things of no interest to others – or none of their business – and also outspoken to the point of libel in some connections.'[40]

Simpson did not necessarily lose interest. More important, the murder mystery and the travelogue had lost their value as devices for rescuing their expedition from failure. The Gran Sabana pivot was much, much better. Simpson even boasted about their small botanical collection, 'Amateurish as they were, these were the first plant collections from the enormous area of the Gran Sabana and were the basis for a publication by Henri Pittier.'[41]

A press release issued from AMNH explained that 'the work developed into two distinct expeditions and two reconnaissance trips'. Of the San Miguel component, 'a large collection of fossil mammals was made ... a quarry was opened which proved to be [by] far the richest deposit of such fossils known between Argentina and the United States. Work at that locality is still going on, with workmen trained by the expedition...'[42] Roe repeated this narrative when she spoke about San Miguel (Roe, 1939a: 3). Of the Gran Sabana component, 'Dr. and Mrs. Simpson were attached ... as naturalists' to 'a large and elaborate expedition to the little known region between the Orinoco and the Brazilian border...' Their principal results involved 'the collection of plants, recent mammals, and ethnographic specimens and the study of the Kamarokoto [sic] Indians...' In the reconnaissance 'several important and promising deposits of Tertiary mammals were located, but time was not available for working them intensively'.

Once he had created a record of science (any science) and a sense of success (any success), Simpson did not capitalise further on Venezuela. He never returned to the country. Instead, he applied himself to work within the walls of AMNH. Venezuela decorated his office (Figure 9.3), but once the Kamarakotos manuscript left his desk, he turned to two entirely different major projects: the work that became *Tempo and Mode in Evolution* (Simpson, 1944b) which Simpson began conceptualising in 1937, and the work that became *Principles of Classification and a Classification of Mammals* (Simpson, 1945). Just over a year after their return, Simpson volunteered for military service and was preparing for North Africa. After the war, the kinds of historical biogeography that underpinned his first interest in Venezuela continued to be a major thread in his research programme, culminating in the early 1950s with major theoretical materials (Simpson, 1947a, 1947b, 1949, 1950, 1953a).

Conclusion

Scholars of science communication use a variety of reasons to explain why researchers transition between professional and public discourse (Felt and Davies, 2020; Bucchi and Trench, 2021; Hanganu-Bresch et al., 2022). It might be part of a multi-channel strategy of dissemination and persuasion (Besley et al., 2017, 2019, 2020; Besley and Dudo, 2022). It might be to transmit different messages to different audiences (Ruse, 1996). It might be a shift in register done to bypass resistance or to make use of alternative epistemologies (Bucchi, 1996). They are many possibilities from which to choose. This paper proposes another: rescue.

Fieldwork is risky business. The history of palaeontology is as much a history of failure, loss, and calamity as it is discovery, success, and collection. How do researchers recover when fieldwork goes wrong? Simpson decided that coming home nearly empty-handed was not an option. To rescue his position, he chose to go public. While isolated in the field, he pivoted to literary products that made use of his circumstances, experiences and available resources. Later in the expedition, when by luck new opportunities arose, he pivoted. He fully grasped new activities and cultivated them to maximise their value. He used story-telling to amplify their impact. This strategy worked. By the time Simpson returned home, the problem of failure had been solved, and he never looked back. Venezuela became a keystone episode in his life story with Roe. He later used Venezuela to leverage new opportunities for himself and his scientist wife.

Their unexpected opportunity to travel into the Gran Sabana changed everything about this expedition. We'll never know how to interpret Venezuela in Simpson's biography if the expedition had stayed on its original plan, i.e., kept to its original two-stage design focused on San Miguel and Zaraza. We'll never know if the few books and stories generated during these stages would have been enough to rescue Simpson. That's hardly the important message of this analysis. Instead, we can observe Simpson searching for solutions. In fact, Simpson proved an agile and resourceful researcher-entrepreneur. He adapted. He improvised. He was open to offers and quickly pivoted to create new products he thought would have value. Regardless of the circumstances, Simpson can be found searching for ways to be productive: a travelogue while new experiences were fresh. A murder mystery when he and Roe had little to work with but their imagination. A new turtle species to describe when that's pretty much all he found. Indigenous languages and material culture collected when that unexpectedly appeared in front of him. Simpson's time in the field showed a relentless pursuit of success. The important behaviour to notice is the pivoting towards popular writing likely as a last resort. That pivot was quickly displaced when alternative research came along. Of course, displacement is equally revealing about the priorities and values a researcher brings to their circumstances.

In terms of market success, only the story of Angel Falls stood the test of time. No matter. As with many other cases, immediate rewards can prove more important than long-term rewards. Within a year of their return from Venezuela, Simpson had new research projects underway at AMNH. He was writing work of fundamental importance. His and Roe's co-authored book, *Quantitative Zoology*, was getting attention. Meanwhile, Roe's positions in her social and professional circles were changing, too. Her professional standing was on the rise. She was balancing this with her new role as step-mother to Simpson's children. Within two years, the United States was at war. Simpson volunteered himself for military service, and he was sprinting to finish projects in the event he did not return.

Priorities in 1941 were considerably different compared with 1939. Pivoting in Venezuela rescued Simpson in the moment, and that's all he needed. Writing about commentary on a different expedition that referenced some events as failure, Simpson replied with a similar attitude, 'I do not think there were any failures. There were some problems all of which we coped with, and I call that success.'[43]

Notes

1 George Gaylord Simpson Papers, American Philosophical Society Library, manuscript collection 31 (hereafter **APS Simpson**), series 11 photographs, box: 'George Gaylord Simpson and His Family.' See caption accompanying photograph of Simpson wearing dinner jacket. Angel Falls featured as the cover image for *The Explorers Journal* Winter 1940 (volume 18, number 4) issue.

2 Cain, 2013. 'Honeymoon Caked in Mud: George Gaylord Simpson and Anne Roe in the Field, 1938', talk delivered University of Minnesota.

3 APS Simpson, 1992 addition, box #6, folders: 'Venezuela (1938-1939)' #1-#5.

4 APS Simpson, series 8, folder: 'Venezuela (1938–1939) #1', p. 37 for 21 September 1938.

5 APS Simpson, series 8, folder: 'Venezuela (1938–1939) #2', p. 48 for 30 September 1938.

6 APS Simpson, series 8, folder: 'Venezuela (1938–1939) #3', p. 86 for 25 October 1938.

7 APS Simpson, series 8, folder: 'Venezuela (1938–1939) #3', p. 100 for 21 November 1938.

8 Simpson to his sister in November 1938 (Laporte, 1987: 226) and the same to his mother three weeks later (Laporte, 1987: 227–228).

9 APS Simpson, 1992 addition, box #6, folders: 'Venezuela (1938–1939)' #1-#5, item: 'Notes on the Venezuelan Journal, 1938–1939,' p. 19 for page 330. Simpson had their Venezuelan journal retyped (570 pages) in 1966 and added notes to the manuscript in 1967 with the thought of possibly publishing some materials. Simpson's claim for importance is slightly disingenuous as so little fossil collecting had been done in northern South America prior to their work it would be hard not to be the most significant work on the subject.

10 Typescript and related materials are located in APS Simpson, series 3, folders 'A Million Years in the Tropics: Observations and Adventures in Venezuela' #1-#3.

11 Parts of the letter chain are shown in James G. Holland to Creighton Peet on 20 March 1939 in APS Simpson, 1992 addition to travel diaries, folder: 'Venezuela'.

12 Simpson claimed the journal was not meant for publication, meaning the verbatim version would not be published. Undated 'Interlude' APS Simpson, 1992 addition, box #6, folders: 'Venezuela (1938–1939)' #1-#5.

13 Typescript for 'Trouble in the Troubles' is in APS Simpson, series 3.

14 APS Simpson, series 8, folder: 'Venezuela (1938–1939) #4', p. 117 for 17 December 1938.

15 Undated press release from AMNH beginning, 'On May 22, 1939, G.G. Simpson and his wife, Dr Anne Roe Simpson...' in APS Simpson, series 12, Venezuela materials.

16 Undated 'Interlude' APS Simpson, 1992 addition, box #6, folders: 'Venezuela (1938–1939)' #1-#5, p. 21 for p. 350. The parenthetical inserts were added by Simpson in 1967 to the 1938 text.

17 APS Simpson, series 8, folder: 'Venezuela (1938–1939) #5', p. 159 for 19 February 1939.

18 Undated 'Interlude' APS Simpson, 1992 addition, box #6, folders: 'Venezuela (1938–1939)' #1-#5, p. 22 for p. 369. Simpson described his find as a new species, *Podocnemis geologerum* (Simpson, 1943).

19 Simpson used the term 'visit' when first describing their invitation, '...thence visit Aguerrevere in the Grass Sabana -- the wildest, least known part of Venezuela and among the last known of the world...' in APS Simpson, series 8, folder: 'Venezuela (1938–1939) #4', p. 128 for 31 December 1938.

20 APS Simpson, series 8, folder: 'Venezuela (1938–1939) #5', p. 166 for 03 March 1939.

21 APS Simpson, series 8, folder: 'Venezuela (1938–1939) #5', p. 147.

22 Questionnaire 'for the privilege of carrying the flag of the Explorers Club' in Explorers Club Archives. The approved application is for flag number 86, received by Flag Committee 11 August 1938.

23 'Notes on the Venezuelan Journal, 1938–1939,' APS Simpson, 1992 addition, box #6, folders: 'Venezuela (1938–1939)' #1-#5, p. 12 for p. 159.

24 The tepuí region jumped into American popular imagination with Harry Hoyt's 1925 silent film, *The Lost World*. Irwin Allen's 1960 remake of *The Lost World* featured an overflight of Angel Falls. Simpson spoke about lost worlds for WOR radio station, 19 April 1930, see: APS Simpson, series 5, folder 'radio scripts', item 'WOR Prehistoric Animals'.

25 APS Simpson, series 8: travel diaries, folder: 'Venezuela (1938–1939) #5', p. 201 for 29 March 1939.

26 APS Simpson, series 8: travel diaries, folder: 'Venezuela (1938–1939) #5', p. 173 for 08 March 1939.

27 APS Simpson, series 8: travel diaries, folder: 'Venezuela (1938–1939) #5', p. 175 for 08 March 1939. Simpson notes Roe was only the second 'white woman' (other than Marie Angel) to have seen Falls by the date of their visit. Simpson also pointedly noted in 1967 that when Tate ascended Auyán-tepuí in 1937, he failed to find Angel Falls, later 'denying their existence', in 'Notes on the Venezuelan Journal, 1938–1939,' APS Simpson, 1992 addition, box #6, folders: 'Venezuela (1938–1939)' #1-#5, p. 23, for p. 397 of journals.

28 The flight from Kamarata Valley to Santa Elena is the story recounted at the start of Simpson's autobiography (Simpson, 1978). The original account is in APS Simpson, series 8: travel diaries, folder: 'Venezuela (1938–1939) #5', pp. 202–205 for 30 March 1939.

29 APS Simpson, series 8: travel diaries, folder: 'Venezuela (1938-1939) #5', p. 213 for 08 March 1939.

30 APS Simpson, series 3, folder: 'Intro to lecture: Sociedad Venozolana Ciencias Naturales'.

31 Undated press release from AMNH beginning, 'On May 22, 1939, G.G. Simpson and his wife, Dr Anne Roe Simpson…' in APS Simpson, series 12, Venezuela materials.

32 *Los Indios Kamarakotos* was translated into English and circulated on microfiche through the Human Relations Area Files (Yale University) (Simpson, 1969). In 2010, Angel Conservation/ Fundación Etnika published a facsimile edition of the 1940 original (in Spanish).

33 APS Simpson, 1992 addition box #6, folders: '1938–1939 Notes and Supplement.' Item 1967 handwritten notes, p. 26. Simpson also published research papers on a myth complex (Simpson, 1944a) and on vernacular names of animals (Simpson, 1941a, Simpson, 1941b). For a review of Simpson's Kamarakotos monograph, see Crist (1941). Simpson contrasted his professional work with Dennison (1942).

34 APS Simpson, 1992 addition, box #6, folders: 'Venezuela (1938–1939)' #1-#5, and 1967 'Notes on the Venezuelan Journal, 1938–1939,' p. 27.

35 The script for Episode 21 (13 June 1942) is in APS Simpson, series 5, folder 'radio scripts'. Also see Laporte (1987: 232). This episode featured Simpson, Roe, and Angel on mic telling the story of their flight, quoting Simpson and Roe's Venezuelan journals. Recordings of the original episode sadly have not survived.

36 In the late 1940s, the Venezuelan government and the National Geographic Society jointly assessed the total drop to be 3,212ft (979m) (Robertson, 1949). Simpson later said 'Jimmie's barometer was off'. In APS Simpson, 1992 addition, box #6, folders: 'Venezuela (1938–1939)' #1-#5, and 'Notes on the Venezuelan Journal, 1938–1939,' p. 24 for pp. 399 and 400.

37 APS Simpson, 1992 addition, box #6, folders: 'Venezuela (1938–1939)' #1-#5, and 'Notes on the Venezuelan Journal, 1938-1939,' p. 17. The literary agent was Willis Kingsley Wing, whom Simpson and Roe used for *Quantitative Zoology*. Simpson to Harry Snyder, 11 June 1936 in APS Simpson, series 1, folder: 'McGraw-Hill #1 1932–1939'.

38 Simpson to Joan Meyers 13 December 1967 in APS Simpson, series 1, folder: 'Meyers, Joan'. Joan did oversee publication of other Simpson material, such as Burns (1996).

39 Simpson to Patterson 14 March 1940 in APS Simpson, series 1, folder: 'Patterson, Bryan #2 (1937–1940)'. Simpson wrote the same to the Phelps family, see Simpson to Phelps 29 January 1940 in APS Simpson, series 1, folder: 'Phelps, William H., Junior'.

40 APS Simpson, 1992 addition box #6, folders: 'Venezuela (1938-1939)' #1-#5, and 1967 'Notes on the Venezuelan Journal, 1938-1939,' p. 30.

41 APS Simpson, 1992 addition, box #6, folders: 'Venezuela (1938-1939)' #1-#5, and 1967 'Notes on the Venezuelan Journal, 1938-1939,' p. 23 for p. 393.

42 Undated press release from AMNH beginning, 'On May 22, 1939, G.G. Simpson and his wife, Dr Anne Roe Simpson…' in APS Simpson, series 12, folder: 'Venezuela materials.'

43 Simpson was commenting on Larry Marshall's introduction to a University of Chicago Press reprint of *Attending Marvels*. In 28 Nov 1982 Simpson to Susan Abrams in APS Simpson, series 1, folder: 'Abrams, Susan.'

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10
Shadows in the mirror: a discussion on understandings of Neanderthals and Australopithecines

Chris Manias, Rebecca Wragg Sykes and Lydia Pyne

Human origins research has persistently been one of the most evocative and publicly prominent branches of the deep-time sciences (Figure 10.1). While many areas of palaeontology have been involved in reflections on the nature and distinctiveness of humanity, those which specifically engage with stories of human ancestry present this in even more dramatic ways. It is therefore important that two chapters in this book specifically engage with the public entanglements of human origins research, and how it complements, but also differs from, other strands of cultural engagement with the deep past. One particularly large area has been the relationship of palaeoanthropology and human prehistory with the mass media, which will be examined by Oliver Hochadel in the next chapter. Palaeoanthropological finds have often been made into large-scale media events, and many palaeoanthropologists (or popular science writers drawing on the public appeal of palaeoanthropology) have been adept at engaging with the media, leading to particularly dramatic instances of mutual reinforcement.

This chapter will be taking a different track, involving reflections from two prominent writers on their perspectives on the cultural role of human evolution, and how they have been engaged with these cultural aspects through their own lives and careers. This chapter will therefore provide two perspectives on human origins research and its public implications over the last two centuries. Given the multiplicity and variance around these issues, and the importance of discussion in these fields, it

Figure 10.1 Reconstruction of *Australopithecus afarensis* ('Lucy') with museum visitor, at the Neanderthal Museum, Mettmann. © Neanderthal Museum.

will be presented in the form of a dialogue between two specialists with complementary expertise. Our first participant, Lydia Pyne, has written a number of books and articles on popular science, and especially on human origins research, in addition to creating a recent project on 'Fossil Nicknames' with Professor Julien Riel-Salvatore (University of Montreal), examining why and how particular fossils have been given specific names over time. Lydia has particular interests in Australopithecines and the history of palaeoanthropology in southern Africa (Pyne, 2016a, 2016b, 2016c). Our second participant, Dr Rebecca Wragg Sykes, is an archaeologist and public scholar who specialises in human origins, especially in relation to Neanderthals. She is the author of (among other works) *Kindred: Neanderthal Life, Love, Death and Art* (Wragg Sykes, 2020), and is a founder-member of TrowelBlazers, a project dedicated to highlighting the past and present contributions of women in the earth sciences, including archaeology. This therefore orientates our discussion and focus towards two authors, and two particularly significant and widely engaged with hominin groups, which especially highlight the core tropes in the history and cultural significance of human origins research.

Before we go on to the discussion though, it is important to outline some context, both in terms of human origins research in public on a general level, and also in relation to the specific human groups we will be going on to discuss – Neanderthals and Australopithecines. One of the most important issues around human evolution and its public presentation is the way that it interacts with a range of different media forms and narrative conventions. Indeed, the idea that evolutionary psychology, or explanations of human nature from the deep past, constitute 'just so stories' strongly indicative of the cultural values and stereotypes of their proponents, is so well-established that it barely needs elaborating. But there are other important narrative conventions around human evolutionary studies. In a highly influential, almost originatory, study, Misia Landau (Landau, 1991) discussed how hypothetical models of human evolution had a decidedly narrative structure. Similar key 'episodes' in the road to humanity, notably 'terrestriality', 'bipedalism', 'encephalisation' and 'civilisation' are all present among different models and thinkers, but arranged in different orders, with different causal mechanisms, and varying implications for what defined humanity.

A related issue around narratives of human origins connect with the discussions in Chapter 7 of this book – of human evolution being understood in terms of 'progress' and 'improvement', with humans asserted as being at the pinnacle of nature. The highly-visual 'march of progress' of human development through a linear series of apes to modern humans is indeed one of the most widely-disseminated scientific images. Stephen Jay Gould has called this the linear 'march of progress' (Gould, 1989: 1–52). The history of this image, and its use and subversion, especially through Benjamin Waterhouse Hawkins' frontispiece to Thomas Henry Huxley's *Man's Place in Nature* (1863) and the illustration by Rudolph Zallinger most famously depicted in the *Early Man* volume of the *Life Nature Library* (Howell, 1965), has been discussed by Gowan Dawson (Dawson, 2024). The idea of human evolution being a progressive story of increased 'human-ness' through a series of ancestors has been an important motif, but again has been persistently critiqued even as it was being promoted (as Gould's criticisms, and Dawson's elaboration of the complexity of the construction of these images, should indicate). Despite frequent underlying assumptions of 'progress', most nineteenth- and twentieth-century models of human evolution were extremely tangled and branching. And nowadays, there is strong and conscious resistance and subversion to these ideas of linearity. That non-*Homo sapiens* hominins were not lesser humans, but different types of human with a different way of being that made evolutionary sense in their own contexts, is a convention in the literature. And museum displays and public presentations have increasingly moved away from showing human evolution as the story of the succession of a series of 'types', to more multivalent and nonlinear presentations. Displays like those at the London Natural History Museum, the Smithsonian National Museum of Natural History and the Moesgaard Museum aim to show the contemporaneous existence of multiple human species for most of recent geological history, emphasise the links and commonalities between these different human species, and permit different routes through the galleries (Harcourt-Smith, 2012).

Narratives of human development have shifted considerably over the last two centuries, as ideas of human antiquity became deepened in terms of their chronology, expanded in geographic framing, and have been connected to a bewildering array of causes and value-systems. There has therefore never been one model of human origins. It has always been a field in flux, where different ideas, models and assumptions have been required to make sense of the ever-increasing range of physical remains of beings at once familiar, but also strikingly different. And these are also beings which have important implications for fundamental questions of ancestry, origin and what it means to be human. As such, literature, art, popular science, reconstruction and creativity have been critical. In addition, since many notions of human origins and evolution take the birth of 'definitively human' imagination, creativity, spirituality and sociability as core matters to explain, the modes of representation and questions being asked are fundamentally linked.

We also know that human origins research has had a dark history too, something emphasised in Stefanos Geroulanos' study of the topic (Geroulanos, 2024). The shadows are not just about coming face to face with dim ancestors, but also about defining who or what is an ancestor, who is excluded, and who makes those decisions. The way that Indigenous peoples around the world, especially those historically classed as 'primitive', 'stone age' or 'hunter gatherer', have been claimed as directly analogous to earlier stages of human evolution, and even other human species, is a crucial and widely examined issue (Sommer, 2005; Manias, 2015; Qureshi, 2021). These factors linked human origins research with attempts to legitimise dispossession, oppression and cultural eradication, defining Indigenous people as 'out of time' and relics of the past, doomed to be destroyed by modern colonial societies. Connections between some theories of human origins with stereotypes of masculine dominance and violence have also been important throughout the nineteenth and twentieth centuries (Weidman, 2011; Milam, 2019), and continue to have pop-cultural influence today. But there have of course also been openings for other counter-models, emphasising essential human unity, or imagining matriarchal, matrifocal or equitable pasts, rather than those of patriarchal dominance. And importantly, the history of interpretations – like narratives of human evolution themselves – has not been a linear arc of progress from dark nineteenth century ideas of race and patriarchy to modern liberal and 'enlightened' ideas. There have been counter-imaginings of the early origins of humans involving egalitarian or idealised conditions from the inception of the field. And today, we can see increasing instrumentalisation of human prehistory and evolution by far-right movements and political groups, using tropes of 'man the hunter' or references to modern 'stone age tribes', in nativist, nationalist and patriarchal projects (some British examples are discussed in Pitcher, 2022). Throughout history, promoters of human evolution have been distinctly aware of this cultural impact of their field, and how their work can engage with so many different ideas and narratives.

This leads to other issues not just about understanding human antiquity in geological history, but also reflections on the discipline itself. The training to become a palaeoanthropologist and the personas adopted by leading researchers (not to mention the notion that research in this field often emphasises 'leaders' rather than teams), have been extremely important for the field's public presentation, with many palaeoanthropologists themselves becoming 'scientific celebrities' (a point continued by Hochadel in the next chapter). Despite public respect for scientific training and qualifications, there has never been a single way of becoming an authority to speak about human origins in public, which has added to the multiplicity of discussants and interpretations. And this has not just been for people we could call scientific researchers and writers of popular science. Other key players have fed strongly into our understandings of human development. Writers like Jean Auel, Robert Ardrey and William Golding have been important not only for articulating key issues within human origins research, but for shaping it. The highly visual aspects of the field mean that palaeoartists and reconstructors specialising in human origins have been able to build extensive careers – with notable recent examples including Adrie and Alfons Kennis, Élisabeth Daynès and Tom Björklund, whose highly-expressive and resolutely human sculpted hominins have been commissioned by museums throughout the world.

The history of human evolutionary studies is therefore one which is essential for understanding some core themes of this volume. This chapter, rather than follow the gamut of human species, instead examines two of the most significant to understand the nexus of scientific and cultural views, which potentially illuminate complementary but distinct aspects of the role of human evolution within public life. Firstly, we discuss the first other human species to have been discovered – the Neanderthals, who have persistently been central to understanding prehistory and development. The second are the Australopithecines, the 'southern apes', who over the course of the twentieth century became established as the 'earliest' human ancestors, and today are understood as one of the first genera to branch from the lineages leading to other extant great apes. The Australopithecines illustrate a broadening of interest to include the world beyond Europe, and models of human origins 'out of Africa', but also show some underlying ideas about what fundamental humanity has represented.

Histories of Neanderthals

The story of engagement with Neanderthals has been told many times – and as we will go on to discuss, the history of the field has itself become an important trope within public depictions. It is taken to begin in 1856 in south-western Germany, when quarry-workers in the Neander Valley ('Thal' in contemporary German, meaning 'valley'), near Dusseldorf, found a partial human skeleton with highly distinctive features. The story of this initial discovery emphasises difficulties in placing the remains into any clear group then available to scientific interpreters, who debated a range of possibilities drawing on contemporary notions of anthropology, race, pathology and difference to attempt to classify the specimen (Trinkaus and Shipman, 1993). But an interesting point is that this 'ground zero' site had coincidental mythic qualities. As Rebecca Wragg Sykes has said, the literal translation of Neander Thal (originally referring to a particular individual's surname, Neander) is 'the valley of the new man', making it serendipitously appropriate and resonant.

A key issue however is that the remains found in the Neander Thal were not unique. Initial discussion, first in Germany and then in Anglophone contexts, saw theories veering between the skeleton representing either an aberrant individual or a particular racial type. Yet by 1864, remains excavated earlier in the century in Gibraltar were presented to the British scientific community, and rapidly understood as being like the Neanderthal remains. More remains – sometimes bones, and in some cases alongside stone artefacts – seeming to belong to this human type were found soon after, from a geographic range including Belgium, France and Croatia. What did these mean? Numerous answers were presented, and the same explanatory factors could be used for very different purposes. Sometimes presented as a distinct human type, but often as another human 'race' which might or might not be ancestral to living humans, the interpretations of Neanderthals veered between recognition of difference and similarity, often engaged with reflections on ‘savagery’ and ‘brutishness’ (Madison, 2020). That the Neanderthal remains were found at the same time as, and in sites relatively close to, other skeletal remains that seemed to be much closer to living humans, and with more complex technologies and representative artworks, also impacted the interpretation, bringing up ideas of interaction, change and multiplicity in human prehistory. Attempts to understand the relations between different groups of early humans depended on artistic and visual material (as well as inspiring new art), and engaged with contemporary ideas of race, gender and ‘progress.’ The famous triptych painted by Charles R. Knight for the new ‘Hall of the Age of Man’ in the 1920s at the American Museum of Natural History, moving through separate paintings of Neanderthal flintworkers, Cro-Magnon hunter-artists, and Neolithic stag-hunters, dramatised ideas of progression through differing types of humans, and the germination of particular key qualities. It was visible to millions of museum visitors (and even more who saw reproductions of Knight’s work in publications and the media) over the twentieth century.

But even for Knight, Neanderthals could not be entirely dismissed. In an article re-dramatising his Neanderthal depictions for *Popular Science Monthly*, he asked:

> What thoughts teem behind that slanted brow? Science cannot answer. It can only measure his bones and reconstruct his physical appearance. Who knows but behind those piercing eyes is there a yearning toward higher things? As he stands before us in all his primitive shagginess, grasping his heavy wooden spear … he thrills us. This is our ancestor. ... Forty thousand years separate us from him. But millions of years separate him from still lower animals. He stands close to us - this cunning, fighting, hunting, ferocious Neanderthal man. (Knight, 2021: 40)

There has always been something distinct about Neanderthals, which – even at the high-point of narratives of Neanderthal ‘brutishness’ – has made it difficult to entirely dismiss them as aberrations or totally dissimilar precursors. Yet, there has not been a steady acceptance of the ‘humanity’ of the Neanderthals from František Kupka’s image of the hairy ape-man of La-Chapelle-aux-Saints published in *L’Illustration* in 1909 to more enlightened, nuanced views today. Indeed, Stephanie Moser has written how other contemporary representations of the same specimen emphasised a more modern physical form, as well as imagining thoughtfulness and artistry as Neanderthal characteristics. There have always been distinct poles in understandings, and while otherness has persistently been emphasised, so has kindredness.

Perceptions of connection have often emerged from the way in which particular finds and sites have been understood, and the questions which have been asked about them. From the late-1950s, work at Shanidar in Iraqi Kurdistan involved the excavation of rich archaeological materials including remains from many Neanderthals, several of which were interpreted as burials. One of these – Shanidar IV – was dubbed the 'flower burial,' owing to the presence of pollen grains from local flowering species in sediments around the body, which were inferred to have been a kind of funeral bouquet. This work became iconic in public understanding, discussed by the excavation's director Ralph Solecki, not only in scientific works but also his popular book *Shanidar: The First Flower People* (1971). In the latter he specifically argued against 'ape-like' interpretations, stating that 'it is among the Neanderthals that we have the first stirrings of social and religious sense and feeling', (269) although he still doubted they had fully articulated language and counting systems. Solecki also ventriloquised 'the enthusiastic remark of a lady who, having heard me lecture on the Shanidar Neanderthals, said that she would not mind having Neanderthals as ancestors if they buried their dead with flowers' (Solecki, 1971, xiv). The significance and meaning of the find as an intentional burial has been hotly debated (and the cultural resonances with 1960 and 1970s hippy culture are clear and obvious), but its prominence was a key part of evolving understandings and public narratives around Neanderthals (Hochadel, 2021). In the last two decades of the twentieth century, as definitions and examples of imagination and creativity became especially important for defining ideas of hominisation, then the question of potential Neanderthal art or symbolism became especially widely discussed, rather than questions relating to their anatomy, technology or diet.

A further key and evolving question has been the possibility of interbreeding between Neanderthals and *Homo sapiens*, whether this has been interpreted through stereotypes and conventions around the sexual proclivities of prehistoric humans, morphological studies of particular skeletons like the claimed but now discounted hybrid 'Lapedo Child', or the veritable explosion in research in modern palaeogenomics, developed initially with mitochondrial genomes suggesting no interbreeding, but contradicted by the publication of a draft Neanderthal nuclear genome in 2010. And while earlier literature proposed 'multi-regional' theories with varying levels of admixture between hominin populations on different continents, current research in palaeogenomics (combined with archaeological finds) suggests a more nuanced picture, with living humans having an African origin and dispersals into Eurasia between c.200,000 and 40,000 years ago, but with genetic evidence for encounters and interbreeding with diverse other hominins both within and outside Africa. In particular, today's data suggests that Neanderthal genes from interbreeding are present in all living people: those with family backgrounds that do not derive from below mid-latitude Africa have between 1 and 2.4 per cent derived from ancient interbreeding, while those with ancestry from south of the Sahara have under 1 per cent, derived from much later prehistoric and historic 'reverse' genetic input. As well as underscoring the extensive evidence for literal kindredness across eras and species, this has also fed into commercial culture and identity. For nearly a decade now, genetic testing companies like 23andme have made analysing 'how much of your ancestry can be traced back to Neanderthals' a key part of their offer – depicting this information alongside a silhouette very similar to Knight's Neanderthal flintworkers, and tying these proportions with characteristics like 'straight hair' and 'a reduced tendency to sneeze after eating dark chocolate'.[1]

The uncertainty and need to imagine connections between *Homo sapiens* and Neanderthals has also meant that artistic and literary representations have operated in a reflexive manner, both informed by research, and helping scientists and the public understand and imagine them afresh. The thought-experiment of whether an urban crowd would recognise a Neanderthal in modern clothing is something of a cliché in documentaries and media reports, but is interesting for having a very long pedigree. An early example was presented by Carleton S. Coon in his 1939 work *The Races of Europe* (the title of which shows the continuation of overt links between Neanderthal research and racialising anthropology well into the twentieth century). Coon depicted a Neanderthal dressed in a Depression-era suit, imagining how he might look in a New York subway (Coon, 1939: 24; Cohen, 2007). Reconstructions of Neanderthals in museums are also long-standing, with some early depictions organised by the Belgian museum conservator Aimé Rutot as part of a large series of prehistoric human races (De Bont, 2003), and in the Field Museum, with the hairy and brutish Neanderthal family produced by Frederick Blaschke in the late-1920s being particularly iconic. The more current trend – presented especially strongly by palaeoartists and reconstructors like Adrie and Alfons Kennis and Tom Björklund – is to present Neanderthals as engagingly human characters and individuals, with vivid facial expressions, bodily postures informed by ethnography, and often actively engaging with finds from archaeological sites.

Literature too has been central to imagining Neanderthals, and again goes back very far in the history of their study, seeing similar moves between thinking about their essential humanness versus their difference (Ruddick, 2009). H.G. Wells considered Neanderthals in *The Grisly Folk* (1921), and Arthur Conan Doyle featured some potentially Neanderthaloid 'ape-men' in *The Lost World* (1912) framing them as brutish, even terrifying creatures, yet with some more complex features. In Wells' case, they used coloured pigment on their skin, and had at least a foreshadowing of modern morality. A noteworthy shift occurred within William Golding's *The Inheritors* of 1955, which sympathetically put the reader within the mind and experience of a Neanderthal, as he and his family come into contact with a group of ultimately destructive *Homo sapiens*. And finally, Jean Auel's book series Earth's Children, starting with *Clan of the Cave Bear* and moving through a cycle of five further books, follows Ayla, an orphan *Homo sapiens* who was raised (in the initial book) by a clan of what become clear are Neanderthals, and then follows her later life, with many episodes dramatising iconic Palaeolithic European sites and finds. Auel's work is notable in many respects. She used scientific research extensively in building her world (including the Shanidar IV burial, and the Shanidar I skeleton directly inspired a male Neanderthal shaman, Creb), and used some of the extensive profits from the books to fund prehistoric archaeology. While the 1986 film adaptation of the book was not a commercial success, the first two books especially often played a similar role in the formation of the careers of modern palaeoanthropologists and prehistorians as *Jurassic Park* did for dinosaur palaeontologists – another example of the mutual reinforcement between literature and science.

In the twenty-first century, many of the unfolding, reflexive processes of scientific knowledge construction and cultural ideation of Neanderthals described earlier in this chapter have continued. The apparent gaps in genetic and behavioural terms have continued to shrink, generally leading to ever-more human-like representations. In recent years new nonfiction and fiction books focused on Neanderthals have continued to be published, along with two touring exhibitions (MNHN, France, and Moesgaard, Denmark, and with a third currently in development by the Neanderthal Museum, Germany), as well as television documentaries (*Secrets of the Neanderthals*, Netflix, 2024) and even feature films (*In the Blink of An Eye*, Searchlight Pictures, forthcoming). Yet in all cases, the fundamental presence in Western culture of binary philosophical concepts and the deep influence of literary archetypes (heroes, orphans, journeys, redemption) remain challenges when investigating, interpreting and imagining Neanderthals in a genuinely nuanced manner (Peeters and Zwart, 2020) – and the extent to which we are willing to 'allow' true, even unpleasant, differences in these representations is unclear.

Histories of Australopithecines

Neanderthals occupy a complex position in understandings of human origins, being the first set of beings to be scientifically regarded as human but distinct, and also being very recent in terms of their placement in geological history (and this proximity, and interaction with *Homo sapiens* is certainly a large part of the reason for public interest). The other major group, the Australopithecines, present almost the opposite case. Made known from the 1920s onwards, they quite slowly and fitfully became enshrined as the earliest distinct human ancestors separate from the other great apes. This combination of later engagement and greater antiquity is important, for connecting them with deep and foundational ideas about what it means to be human, and for being entangled with the changes and developments of the twentieth century.

The story of Australopithecine research also centres another continent. While Neanderthal research has had a strong European centre of gravity (which has persisted in popular understandings, despite the importance of sites in western Asia for Neanderthal research), Australopithecine work has been centred on Africa. It has itself been crucial for debating humanity's African origins, which was a controversial point for much of the twentieth century, when there were strong competing 'out of Asia' and multiregional models of human origins (Dennell, 2001; Schweighöfer, 2018). This therefore ties work on Australopithecines with the history of southern Africa across the twentieth century, and therefore histories of colonialism, and moves to postcolonial systems.

This African heritage fed into the debates over the first set of remains to be included within the group – the skull known as the 'Taung child', and given the scientific name *Australopithecus africanus* by Raymond Dart, an Australian anatomist based in South Africa. The Taung Child was highly controversial in the 1920s, partly for presenting the possibility of African origins at a time when most leading scholars in Europe and North America favoured Asiacentric models of human development. As an apparently small-brained upright creature, it also confounded ideas of humans which had been cemented in the British context through the Piltdown skull. While later recognised as a forgery, Piltdown cast a long shadow over human evolutionary studies in the first half of the twentieth century, presenting both a possible British strand in the early narrative of human evolution, and for implicitly arguing that early humans would have been large-brained but also crouching and simian. Nevertheless, the Taung Child was not completely dismissed. It was widely reported on in the international media, and formed an important part of the South African Pavilion at the British Empire Exhibition in Wembley in 1925, alongside material representing the South African mineral and agricultural sectors (Richmond, 2009).

The later history of human origins research in Africa began to dismantle these criticisms, as increasing research established the Australopithecines as a definite type, and at the base of a much longer series of African human ancestors, including later hominins like *Homo habilis* and *Homo ergaster*, and contemporary species like *Zinjanthropus* or 'Nutcracker Man' (now classified as a 'robust' Australopithecine from a different genus, *Paranthropus boisei*). There is a conventional narrative of a series of finds to firmly establish southern and eastern Africa as the most likely 'cradle' of humanity, driven forward by prominent White scientists, most notably Dart and Robert Broom in South Africa, and the Leakeys in Kenya and Tanzania. However, this was of course never the whole story. These finds depended on the work and expertise of African quarriers, fieldworkers and preparators, and on the complex politics at the end of formal European colonialism in Africa, and the establishment of the Apartheid regime in South Africa. Christa Kuljian has traced – in a huge amount of detail and sensitivity – the ways in which this operated (Kuljian, 2016).

Stereotypes and conventions around Africa fed into ideas about early humans. One of the most high-profile collaborations between a scientific and a cultural figure in the mid-twentieth century was between Raymond Dart and the screenwriter and playwright Robert Ardrey. Adapting Dart's theory of the Australopithecines having an 'Osteodontokeratic' culture (using the bones and teeth of other animals as tools, a theory based on inferences from Australopithecine sites alongside assumptions of their intrinsic violence), this promoted the idea that these originatory humans were hunters. Violence and meat-eating were highlighted as key parts of the human story, and were dramatically emphasised in Ardrey's 1961 book *African Genesis* and what became known as the 'killer ape' hypothesis. These theories formed the basis for the famous monolith sequence in the film *2001: A Space Odyssey* (1968), with the early apes being inspired to use the bones of dead animals as clubs with which to attack a rival group. But these ideas of human conflict could work in complex ways. Nadine Weidmann has shown that they often had a pessimistic tone in this period, when combined with Ardrey's fears that the still present instinctual violence of early humanity was now being combined with the immense destructiveness of nuclear weapons (Weidman, 2011).

The most iconic find though, and almost the archetypal example of a named hominin fossil, is 'Lucy', a 40 per cent complete specimen of *Australopithecus afarensis* excavated in Hadar in Ethiopia in 1974, in a collaboration between the Ethiopian Antiquities Administration and French and United States palaeoanthropologists (and occurring just before the establishment of the Derg regime made Western scientific work in the country impossible). Following important trends in postcolonial science of large internationally-funded teams, this was also enshrined within a very particular narrative around the discovery. The story was told and retold, with a dominant variant presented by Donald Johanson, the American co-director of the expedition, following the initial find and debates over what it was:

> The camp was rocking with excitement. That first night we never went to bed at all. We talked and talked. We drank beer after beer. There was a tape recorder in the camp, and a tape of the Beatles song 'Lucy in the Sky with Diamonds' went belting out into the night sky, and was played at full volume over and over again out of sheer exuberance. At some point during that unforgettable evening - I no longer remember exactly when - the new fossil picked up the name of Lucy, and has been so known ever since, although its proper name - its acquisition number in the Hadar collection – is AL 288-1. (Johanson and Edey, 1991: 18)

Later retellings, such as in Johanson and Wong (2009: 7–8), would tone things down somewhat, presenting the camp as being animated by more sober discussions on anatomy, and crediting the naming of 'Lucy' to Pamela Alderman, along with claims by Johanson himself that he 'smiled politely at the suggestion' but was actually initially uncomfortable with the name, as 'I thought it was frivolous to refer such an important find simply as Lucy.' But across all of this, pop culture, celebrity, the idea of palaeoanthroplogy as comradely field-work, gender politics, and notions of origins all interplayed to give this fossil specimen a huge cultural resonance (Hochadel, 2009). While much less has been researched around Lucy's position in Ethiopia, she is also a scientific celebrity there, known as ‘Dinkinesh’ (meaning ‘You are Marvellous’ in Amharic), and with a key part of the excavation agreements being that the original fossils be kept in Addis Adaba, where they are currently prominently placed in the National Museum (though they have been on tour internationally).

In many ways, Australopithecine research has had as deeply entangled a media and cultural history as that of Neanderthals. Palaeoanthropology in modern Africa has been important for the cultural politics of postcolonial states, with the complex debates over *Zinjanthropus* between Kenya and Tanzania in the postcolonial period being one example showing the deep embeddedness of human origins research (Staniforth, 2009). Likewise, the use of notions of African origins in South Africa for wider socio-political projects like Thabo Mbeki’s African Renaissance has been a major instrumentalisation of these ideas (Kuljian, 2016). But this has also sat uneasily alongside the continuation of evolutionary just-so stories in pop-cultural presentations of evolutionary history about basic human capacities being forged in ‘African savannahs’, with all the Western stereotypes of wildness that implies. On the other hand, that ‘we are all African apes’ has also been a larger and more multivalent trope, promoting concepts of human unity and centring Africa as a single ‘birthplace’ for humanity.

More recently, large-scale externally-funded projects like the Rising Star expedition, led by Lee Berger, a University of Witwatersrand researcher and National Geographic Explorer, have led to tensions. This expedition combined extraordinary fossils of a new, anatomically intriguing and geologically young hominin species, named *Homo naledi*, with significant publicity and media engagement both during and after fieldwork. This included a Netflix documentary (*Cave of Bones*, 2023) which coincided with highly-disputed claims from the team about burial and art (Berger et al., 2023; Martinón-Torres et al., 2023). Berger, also known as the discoverer of *Australopithecus sediba*, was at the centre of another recent controversy involving Australopithecines. In 2024, he was instrumental in sending a *Homo naledi* bone into space in the pocket of billionaire Tim Nash, together with the type fossil of *Australopithecus sediba*. Despite gaining permission from the relevant curatorial authorities, the spaceflight’s inherently risky nature, the lack of involvement with the wider scientific community or any African researchers, and the promotion by US organisations like National Geographic and Virgin Galactic, and a White US billionaire, incurred widespread condemnation (Pickering and Kgotleng, 2024).

The *Australopithecus* fossil space flight was claimed as having been undertaken with the intention of raising public awareness and honouring

‘Africa’s deep roots of science and innovation,’ (Kgotleng et al., 2023) linking directly to the socio-political themes mentioned earlier).Yet, it also shows interesting echoes between human evolution and astronomy, with both disciplines asking ‘big questions’ about where we come from, and being used to represent opposite ends of a ‘progressive’ hominin pathway of technological achievement. This is highlighted by Berger’s comment that spaceflight is ‘what many consider the greatest human accomplishment of all time’ (quoted in Kgotleng et al., 2023). And in fact, Australopithecines have already symbolically represented that notion of hominin curiosity and endeavour in space, in the form of NASA’s ‘Lucy’ mission. Launched in 2021, it is currently en route to study the trojan asteroids, which share Jupiter’s orbit and are believed to be remnants of some of the building blocks of the early solar system. And in 2023, the Lucy probe had its first close encounter with one of the main belt asteroids, which was named Dinkinesh.

Following this contextual discussion, we will now move on to some insider views on the course and current public prominence of human origins research, through a discussion with our two authors. Reflecting the above points around the extensive place of human origins research linking science and culture, the questions and responses will range across museums, art, personal careers and literature, showing how all of these aspects can be interconnected not just with the history of the field, but in current professional engagement with it. In doing so, we will think about the legacies of these past traditions of work and theorising around Australopithecines and Neanderthals, their position within cultural and scientific debates, and how these ideas, and human origins research more generally, may potentially develop in the future.

Chris Manias: So firstly a question for Rebecca. How did you first become interested in human origins, and what has influenced you most in your career and development?

Rebecca Wragg Sykes: I’ve answered this question so many times and always say the same thing: I can’t actually remember a time when I wasn’t interested in the past. Although I might not have framed it in an explicit way, I definitely remember being a child and going to lots of historical sites and being completely focused not only on being there and imagining, but also the physical, material place; for example if it was a castle, I was wanting to touch the walls; and I was digging random stuff up in my garden, like bits of pot and things. And in terms of literature, that came a bit later in teenage years – but Jean Auel for sure inspired me. Specifically in relation to this conversation, the 1980s edition I read of *The Clan of the Cave Bear* had very striking cover art, clearly depicting Ayla as a central protagonist, which was a huge draw to me as a young girl. That was something unfamiliar and attractive even at that age.

Despite going through an academic career that has been tightly focused on archaeology, over the years I've also realised that the history of science is also a big thing for me. It's like a deep rabbit hole I fall into, whatever I'm writing about. When you're reading a scientific article, there are always history of science 'tidbits' and sometimes interesting images in supporting online materials or appendices.

And my Master's degree in the Archaeology of Human Origins at Southampton had an amazing way of teaching. They had a lithic [stone tools] training course, including an experimental archaeological collection with all sorts of different technologies. And they made a 'fake' archive to go with it, based on the real nineteenth-century excavations of Kent's Cavern and Paviland, and a pretend cave called Pob Ogof, created by Professor John McNabb, who is still at Southampton.[2] It's inspired by the Neanderthal cave Pontnewydd in Denbighshire, and I actually drew an imaginary visualisation of the site on the whiteboard at the end of the course! So there you go. There's art too.

Chris Manias: And for Lydia – how have you developed interests in this area? And what do you think has changed most significantly in the cultural role of human origins research over the period in which you have been engaged with it?

Lydia Pyne: I've had long-standing interests in history and archaeology that came together to help me write the kind of books that I do. Having a background in history of science and palaeoanthropology contributes to designing the projects I want, to write about themes I'm interested in, and create a fluency in being able to talk about deep time.

When I was first doing my own field studies, 'human origins research' was centred on going out and making discoveries. It was a science of discovery. But now I see a lot more discussion about reassessing collections – both artefacts and fossils – and going back and restudying what's already been excavated. One of the most interesting things is to see reassessments of museum collections, or to do the archaeology of historical excavations, and it's been exciting to try to bring those studies into popular media. If I'm writing for a more popular online publication, I want to pitch stories as historically relevant. Exploring and explaining are very different things. And so, for me, writing about human origins and deep time going forward, those are the things that I try and think about.

Another really notable change in the field has revolved around how much the field explores palaeogenetics. I had a conversation with a friend a while ago, and we were talking about a dig that we had been on in grad school and how when we were excavating, we sifted out the dirt. But now this friend was carefully cataloguing the dirt for DNA analyses. This was such a powerful moment and it really showed to me shifts in what you're writing about and how you write about it.

Also the language of talking about the group of organisms – hominins – has changed. We're now talking about 'human' or 'humankind,' and not 'man' or 'mankind.' It feels more flexible and dynamic here in the twenty-first century. I don't think we see that flexibility in the nineteenth- or early-twentieth-century literature that I've looked at. It feels like there's more of a shift between the category as exclusionary versus the category as flexible. To me, it is less about which species we put in which bucket, because I feel like if history tells us anything is that those buckets and species will change.

Chris Manias: Now for a much wider question – what do you both think is the most important way that current understandings interact with the long history of research and cultural engagement with Neanderthals?

Rebecca Wragg Sykes: Twenty years ago, Stephanie Moser was specifically talking about how there is this visual dialogue between illustration/reconstruction, and the production of scientific knowledge (Moser, 1992, 1998). Although people may not recognise that such imagery is an abstraction at the same time as a specific reconstruction, she notes that it is in some ways a distilling of scientific data. But it also serves then to support the particular inferences that the artist has drawn on, and that is then potentially influential in how we produce knowledge. There is also a wider context, because researchers and people like me explicitly pay attention to what the public are interested in and what people respond to emotionally. People's feelings have changed about Neanderthals. And that I think is partly to do with the archaeology, partly to do with the visual representations and how people respond to those, but also the scientific advances themselves, in particular palaeogenomics. How we actually deal with all this genetic information is such a big challenge within the discipline, and try to match it up to the archaeology. It's such a huge thing. In terms of big picture changes, it's rather like radiocarbon dating. That gave us time: chronology, absolute and direct dating. And palaeogenomics has given us connections at both a population scale, and for individuals in the past and present.

All those things go together. And it's definitely a messy process, but it's constantly being created. We could talk about the specifics of how images have evolved historically, but I do think that there is a broader recognition, in science and archaeology and how we work in the field, that we do pay attention to the public. It is far more openly recognised that they fund us and there is a duty of some kind to communicate about what we do; to involve. I don't think it's evolved to the state of a genuine dialogue with the public; I don't think that's how researchers would describe the process. But I think undoubtedly they understand that the public have a stake in how we present Neanderthals. And although it might be a little bit amorphous or hazy, I feel like there is a perception from researchers, and the public, and artists, of a duty to Neanderthals too. And I think that has evolved from this new feeling of relation or 'kindredness' to them. It's very interesting that it's acknowledged to different degrees on individual levels, and within those different spheres, I think.

Lydia Pyne: I really like the idea of 'the image being the abstraction of data'. It really struck me about how objects can be influential, which objects get pictures, and how that in turn influences what is studied and what is perceived. For example, it's a lot easier to have a picture of a skull and to imagine a reconstruction, then it is to do that with a test tube of ancient DNA, and the difference that these different objects can have. With one, you can have a character. But it's really hard to make ancient DNA a character, and that influences the kind of storytelling that is possible, historically and contemporarily.

But one of the things that really has been interesting to me to see unfold is the part of the Neanderthal story that says 'We used to think they were stupid, and now we don't anymore.' It's almost like explaining how we think about Neanderthals has its own story, and it feels it has become so codified now that telling that historical part of our understanding of Neanderthals is now part of Neanderthal history.

I don't think it's conveying scientific information. It's simply telling a story, setting the state and setting the scene. It's exactly the Neanderthal equivalent of 'Once Upon a Time'. And so it's really interesting to me to see that storytelling aspect come out of new discoveries, this new kindredness, this new association. But we're also seeing changes in how we tell the story. And I think that's really interesting.

Maybe it's just because over the last year I've spent so much time in folk tales, fables and wonder stories, and all of that literature – especially after writing *Endlings: Fables for the Anthropocene* (Pyne, 2022) – that I would definitely agree that this is our cultural wonder story of a Neanderthal. And to tell it, this is the language we use, this is the setting, this is the character. And so on one hand, you can say this is that anthropomorphising and maybe this is problematic, and maybe a fairy tale isn't the best frame for this. But on the other hand, I really like how it affords Neanderthal's agency, and gives them the agency to be a character. We've stepped back and made them a character in a new way.

And I'll make a controversial point, and say that I hope we don't lose this. Because I love that this is now part of the story. It's not about conveying 'facts.' It's about participating in this cultural process of 'Hey, this is how we think about Neanderthals.' And I contrast that with Australopithecines, where we don't have the same 'story setting' that we use to talk about the extinct species.

So we talk about Raymond Dart, and the Osteodontokeratic Culture, and maybe we'll throw in a reference to *2001*. But it doesn't have the same cultural participation of 'I know this story, and so I'm going to tell it back to you. I'm going to tell you that the Neanderthals buried their dead' – something that you, as a Neanderthal expert, know perfectly well. But it offers this dialectic of being able to go back and forth between storyteller and story receiver. It's between narrators, and it's participatory. Participating in the cultural story of how I tell you what I know. And I think that is a uniquely twenty-first-century phenomenon.

Chris Manias: And do you think that these 'wonder stories' are unique to human origins research, or do they reflect how we might understand prehistoric worlds more generally?

Rebecca Wragg Sykes: On this being a unique situation, I feel like it's really interesting to compare Neanderthals with dinosaurs. Is there a similar 'Once Upon a time' with dinosaurs? Yes, in that many historical interpretations of them proposed slow, even stupid creatures, influenced in part by the hindsight of extinction. That perception has fallen by the wayside for dinosaurs in scientific terms, but has their framing also evolved? Do people still do that recitation to the same extent as they used to? I'm not totally sure. I haven't read that many popular books on dinosaurs recently, although I'm reading Riley Black's *The Last Days of the Dinosaurs* right now (Black, 2022), which is absolutely brilliant. And she doesn't really do that so much. She just assumes that people are already cognisant with some of the more modern ideas. So I always wonder how this evolution of Neanderthals as a character matches dinosaurs as a character, and where can we see parallels and differences?

Black's book made me relate on a really emotional level to the end of the dinosaurs in a way that I haven't done before. It's a really powerful book, and I actually cared about *T. rex*, which I don't normally because they feel so 'overexposed' (and I'm aware how bad that sounds as someone that studies Neanderthals, who are totally 'overexposed' as well!). But yes, normally I wouldn't pay that much attention to *T. rex*, but I found the way that Black wrote is not only very, very good at really placing you in the scene, but also the absolute horror of the end of the Cretaceous, of mass extinction. How much you can reconstruct about exactly what happened hour by hour to the dinosaurs and the other creatures around then is quite mindboggling. And you have to feel sorry for the poor things.

Chris Manias: To move on to a related topic – if we are talking about human origins research, then we have an important issue in geography. We are engaging with stories that connect with humanity on a very wide global scale, but we are also dealing with finds, specimens and ideas that are strongly tied to particular places. So what in your view is the role of geography, and how interest in human origins varies between different places – whether these be countries, sites or other types of location?

Rebecca Wragg Sykes: Perhaps within China there has been a history of cultural interest in *Homo erectus* (Schmalzer, 2008), and Neanderthals I'm sure have had less focus in that sense. But in terms of being able to create these narratives about 'We used to think…' or the 'Once Upon a time,' I'm not sure if it occurs to the same degree. I think maybe the discussion has focused more on their place within human evolution and how they relate to us [more broadly], rather than what their lives were like. But you could also try to examine what themes are highlighted in palaeoart between these different Hominins: is there a richer or more personified element in art to do with Neanderthals, versus australopithecines or *Homo erectus*? Do they tend to be viewed more as members of an ancient biome, or more as a culturally rich form of human?

The British case is also interesting. I was having a conversation the other day with somebody about this, and why there are no 'flagship' museums *specifically* about human evolution in the UK? Yes, we have the Natural History Museum, we have the British Museum, they have material in there, and obviously include evolution. But in each case, they're much broader in scope. There's no big equivalent of the National Museum of Prehistory in Les Eyzies, France, or the Museum of Human Evolution in Burgos, Spain.[3] I wonder if, in some ways, there is a clearer national association with that heritage in those contexts. You do get the impression that there is a certain pride in that hominin 'family' from the Atapuerca site itself, near to Burgos.

And there is also the very clear fact that whether or not researchers want it, human origins is so politicised. And not just at a national level, but at an individual level within movements that are clearly racially-based, and that's something I think where there's much more energy in some quarters to actually recognise that. And to leverage what we do to actually tackle it.

It's difficult because some researchers will say 'People have always said stupid stuff and what's it got to do with us?' But I don't think it's that simple anymore. I think yes, as a discipline, there's an issue around how we perhaps need to have some professional guidelines on what one's responsibilities are in an ethical sense. We have various ethical responsibilities, though I have to say very, very little discussion of them goes on in human origins. This is especially to do with palaeogenomics, where there are professional ethics now in how we do human origins-related genetics research. But most of the time, there's not very much discussion about other stuff, like using old museum collections, for example, which include hunting and gathering populations and the source of that material is problematic at best, and it's not acknowledged. For example, in papers that use, say, material from Aboriginal peoples. There's a lot of scope for the discipline to look at itself and consider its practices.

Lydia Pyne: Your question really gets at the historical point that marks the beginning of the study of human origins with Neanderthals, and there is a European draw to it. I think that the dynamic of Europe versus Africa folds in all of the colonial, imperialist, racist issues and themes that are associated with early-twentieth-century research.

We do see characters develop in Australopithecines in a way that we don't see with Neanderthals through the nicknames, personas and characters that we create. So everyone knows 'Lucy' for example. And while most people might not be able to name a specific Neanderthal, the public writ large has probably heard of Lucy.

When Julien Riel-Salvatore and I were working on our @FossilNicknames project, we found that people had favourite nicknamed fossils, and this definitely created a connection. There is this human connection and maybe this is different than vertebrate palaeontology? Sure, people might really be into Sue the *T. rex*, but it's not going to have that same existential reflection that something like a Neanderthal, or Lucy or Turkana boy, is going to force.

And in the stories are Lucy, Ardi and Turkana boy, and all of these characters being folded in. I completely agree with Rebecca that they are characters in the narrative of human evolution writ large, of course. But

I also think that they're very powerful characters in nation-building, and stories of nationalism and identity associated with that. I think about the billboards of Lucy that you see when you're driving down the highway outside of Addis Ababa (Figure 10.2). And it feels that these earlier characters – hominins that are much older in geological age – get folded into a persona that we don't see with Neanderthals.

This was something I had not known before I dove into *Seven Skeletons*, but 'Lucy' was 'Lucy' before she was ever *Australopithecus afarensis*. She had her nickname, she had her persona, and she had her story of discovery (and the connection with The Beatles), and all of these things before she ever had a taxonomy. And so I think these elements of discovery, and how that discovery is told, go into creating these personas and these characters.

Then you see other names added on, whether she's been Dinkinesh or other later nicknames. And it's interesting to see that there's almost an expectation to create those personas, but again, we see that more with Australopithecines than Neanderthals.

Chris Manias: To return to questions of cultural representation, what do you see as the most important features in how Neanderthals and Australopithecines are depicted today, in art, museums and literature? Are there important commonalities between these different media, or do they have quite distinct modes of representation? And do you have any favourite representations?

Figure 10.2 Billboard depicting Dinkinesh/Lucy in Ethiopia. Photograph courtesy of Lydia Pyne.

Rebecca Wragg Sykes: There are a couple of things that come to my mind from that. One is the broad-themed presentations about Neanderthals, or prehistory, that you get now in museums. I have really liked seeing what the museum in Moesgaard, Denmark does, because they play with so many, many forms of communication and media, especially in their mini-dioramas.[4] I feel like there's a conscious acknowledgement of the fact that there was some power in old-fashioned dioramas, but at Moesgaard they shrink them down into tiny little model versions. They've jazzed it up because they all have modern light effects, which for example make it seem as if water starts to run. I think that's perfect because it's still there as an entity which people can relate to, but it doesn't dominate the spaces. And people love it. They crouch down and look at all these little things. So I think that's really interesting and intriguing, that some museums have chosen to keep that, but to play with it a little bit and to modernise it.

I first saw their mini-dioramas actually when I read the catalogue for the Neanderthal exhibition that Moesgaard created and is now touring, and then when I went to the museum recently, it's also present within other exhibitions as well (Bjarnø and Kellberg Nielsen, 2020). It's an effective way of putting them *into* landscapes in a bigger scale than you can actually do with a life-size diorama, so it's even more impactful.

But in terms of the history of how reconstructions have changed, I think one thing that is a crucial shift in representation is not just that Neanderthals were being moved away from troglodyte settings or primitive poses, but that now there is an absolute focus on them *looking at you,* creating a reciprocal gaze, an interaction with the audience. I looked back through a lot of the old nineteenth century and early to mid-twentieth century images, and there's hardly anywhere Neanderthals are looking straight out. It's always towards the side, or they are doing things which they're looking at. I was trying to pin down when looking at the viewer becomes common, and there are occasional ones very early on, so there is a very negative illustration actually from 1912 (by Alice Woodward, for a book by Knipe), with Neanderthals posed in a really odd and aggressive manner up against a cave wall, and looking outwards. But they look like they're also frightened of you as the viewer, which is really interesting (Figure 10.3).

There's an older example dramatising Haeckel's '*Pithecanthropus alalus*' where the woman is looking out at the reader (Figure 10.4). But in general images like that are rare. I think it's now become acceptable for there to be a presence behind the eyes, and to show they're going to look back at you, and it is so distinctive about more recent reconstructions. Perhaps it's how people actually may expect to encounter Neanderthals now. Again at Moesgaard, they have a series of sculpture reconstructions by Adrie and Alfons Kennis as you go down the stairs,[5] and so you don't just see them static, you actually get to have this experience that they're looking *at* you as you walk past.

It does fascinate me how people seem to relate at particular levels to different kinds of work. In the arts sphere there seems to be a tendency for people to have 'favourite' Neanderthal sculptors and artists. Some people really like Elisabeth Daynès,[6] other people are the 'Kennis brothers fan-club'! And I also find it interesting the reaction to new media artists. Particularly how massively popular Tom Björkland's work is amongst non-specialists. I also find a really interesting angle to consider is what the backgrounds are of the reconstruction artists working right now. What are their concerns and their interests, and how would they discuss their own individual takes on all this? And also how they feel about how people react to their work?

Tom Björkland is relatively unusual within hominin palaeoart, because he is quite interactive publicly with the audience, for example via social media.[7] So is there a new generation with a new approach, that's related to digital art? People who maybe have a different community that they connect to, even though they work professionally with major heritage organisations? So is there a new story in how the art is being produced as well?

Lydia Pyne: John Gurche's book *Shaping Humanity* really influenced how I think about reconstructions, landscape, and portraiture (Gurche, 2013). His discussion is so fantastic because he talks about giving the Neanderthals a hairstyle, and this is a really subtle way of humanising them, or making them human adjacent. But it was interesting to see photographs being taken of the reconstructions. And so at that point, it becomes art in the second degree. How do we frame the picture of the reconstruction?

I would also reiterate the role of storytelling – how to frame a story and how to explore it and not just how to explain something. Exploring and explaining are very different things. And so, for me, writing about human origins and deep time going forward, those are the things that I try and think about.

And science fiction has been hugely influential in looking at human origins and imagining spaces for that. In terms of the question about a favourite, I'll definitely throw a vote in for Claire Cameron's *The Last Neanderthal* (Cameron, 2017). And I think that books like that offer spaces to imagine endings and extinctions, and to do it in a way that is fundamentally about narrative, in a way that a lot of nonfiction books don't.

Figure 10.3 *Homo mousteriensis* by Alice Woodward, in Henry Knipe, *Evolution in the Past* (1912). Image in public domain, courtesy of Richard Fallon.

Rebecca Wragg Sykes: Yes, I'm really still sad that Claire Cameron's book is not released in the UK. But I do recommend it always to people because I think she comes fascinatingly close to Willam Golding's interpretations of thinking about Neanderthals (Golding, 1955), like a modern version of what he's trying to do in terms of really inhabiting other minds. Something I find interesting with Golding's vision of the Neanderthals, is that despite being immensely rich in a literary sense, they don't actually relate that strongly to the contemporary archaeological understanding when he wrote it. He intentionally created some kind of mythic being that's informed by, but not entirely 'of', the archaeology – which he was quite familiar with – so in a way drawing on the science, but going beyond it. With Claire Cameron's writing, she's much more strongly rooted in the

Figure 10.4 Gabriel von Max, *Pithecanthropus alalus* (1894), in the Ernst-Haeckel-Haus in Jena. Wikimedia Commons [https://commons.wikimedia.org/wiki/File:Gabriel_von_Max,_%22Pithecanthropus_alalus%22,1894.png].

Figure 10.5 A more recent reconstruction of a Neanderthal by Adrie and Alfons Kennis. © Neanderthal Museum.

detail from archaeology, and I think she wanted to vivify what we know, whereas Golding is doing something else, more like a legendary creature that's not quite in relation to reality.

I reread *The Inheritors* recently for a podcast,[8] and I was really struck by things he says that are clearly not in relation to what would have been known in the 1950s. So I think he was almost playing with an alternate version of the Pleistocene encounter. Like a science fiction-fiction, if that makes sense. But the feel of those characters and the feel of seeing the world through those different eyes, I think these themes make those two books so complementary to each other, and how those perspectives alter decades and decades apart. I really love considering them together for that reason.

We of course also have to talk about Jean Auel. Her early 'Earth's Children' novels were widely influential on archaeologists of my generation, and are favourites of mine for two different reasons. One is the fact that the Neanderthal characters are so sympathetic; though not in a way that the characters in Golding's book are, where they're a bit pathetic even though you feel an empathy with them, and you feel like they are really fated to not do so well. Whereas in Jean Auel's books, certainly in *Clan of the Cave Bear* (Auel, 1980) and *The Valley of Horses* (Auel, 1982), Neanderthals are doing just fine. They're even more strongly characterised as individuals and are actually very complex. They understand and can interact with the world in a way that is nuanced and complicated and self-aware, quite unlike Golding's Neanderthals (though they have similar extra-sensory/sensual perceptions of it that the *Homo sapiens* people lack).

Auel really positions Neanderthals as another kind of human, whereas Golding's characters are not like that. They are more animalistic. You relate to them and see the world through their eyes, but they are not persons in the same way as Auel's characters. The relationship from the outset of *The Clan of the Cave Bear* between *Homo sapiens* and Neanderthals, as personified by Ayla and Iza[9] respectively, is a positive one. I think it is important because it offers another possibility of how Neanderthals could be, and also our relations with them. And the other thing that is so influential in Auel's work – and it's this that inspired a lot of people to actually want to go and do Pleistocene archaeology – is in the world-building that she does. She spent so long researching, really trying to ground her stuff in what we know about the Pleistocene landscape. That was the level of detail I was looking for without really knowing it! And I think it's that which really makes her books very distinct, that she is trying to recreate an entire whole world, not just the Neanderthals and

Ayla. She's trying to actually place you there, as somebody inhabiting that whole space. And I think that's why those books have a lot of power, whether or not you actually engage with the ongoing story of Ayla and her character.

Chris Manias: And as a final question, what do you think are the most interesting developments happening today, in relation to the public role of human origins research?

Rebecca Wragg Sykes: One other thing I was going to say was to do with different media and history of the presentation of Neanderthals and human origins more broadly. We have literature, whether it's popular science or fiction. And then we have sculpture or images. But those, or at least the latter, privilege a visual relationship. And something that is of real concern in museums and heritage today, is how do you provide a more inclusive experience for people who don't have a visual or an auditory capacity, or have a reduced capacity? And so I'm really intrigued to see how people perhaps approach this question. What are the other sensory ways that we can communicate what human origins is about? Some museums like the Neanderthal Museum in Germany have touchable casts of the bones and a little auditory tour, and it's all very storied, and that's really fun.[10] But there's so much more that you could do with tactile stuff, with smelling things, and with sound. That is part of my current work with museums, I'm really interested to try and do things that are a bit more playful with the data we have. And so I'm interested to see how that evolves, because it's definitely part of the way some museums are going.

But there are always difficulties. Like if you do a smell thing, you have to make sure that it's not going to set off somebody's allergies. There are always competing issues around whatever you do in a museum. But I think for so long, in how we represent Neanderthals the visual aspect has been so dominating.

I might add one final thing to this question about the cultural role and the public profile. I feel there is dialogue maybe more than there has been in the past, like whether what we do and how we present all this information, whether it can be leveraged for things which are good. I guess there are two main things that human origins researchers can contribute to matters that are current and urgent. One is obviously climate change. All the research that I've seen about how to help people shift away from climate denial or fear is not to just bombard them with facts. It's actually to help them connect. And you do that with narrative. And there is a real potential here with human origins, that we can talk about timescales, about how people have done things in the past, and that we can't do some of the things that hominins used to do: that they could just move, when we can't necessarily do that, or at least in the same way.

Also the fact that the field does have gigantic impact. For me it's a bit like astronomy – it's so big, so mind blowing for people. And it has such huge power. And NASA and ESA are these overarching bodies, they are of course geopolitically-associated bodies, but they have an overarching narrative and a really strong existing structure within which that they communicate. They have big press conferences, phone-in conversations and it's very public facing. I don't really see any equivalent of that for human origins. But the same power and impact is there in what we do in terms of our research on human origins, and what it means to people. So I guess maybe I also see that as an area where there's a lot of potential to bring the discipline itself up to date and actually do something beyond just intellectual curiosity.

Notes

1 'Neanderthal Ancestry', *23andme* (2015) https://medical.23andme.com/wp-content/uploads/2015/10/NeanderthalAncestry1.pdf [accessed 14 May 2024].
2 McNabb has also written on these topics – see especially (McNabb, 2012).
3 https://musee-prehistoire-eyzies.fr/ and https://www.museoevolucionhumana.com/ [accessed 14 May 2024].
4 https://www.moesgaardmuseum.dk/en/ [accessed 14 May 2024].
5 https://www.kenniskennis.com/ [accessed 14 May 2024].
6 https://www.elisabethdaynes.com/ [accessed 14 May 2024].
7 https://www.tombjorklund.fi/ [accessed 14 May 2024].
8 https://www.nationalreview.com/podcasts/the-great-books/episode-228-the-inheritors-by-william-golding/ [accessed 14 May 2024].
9 The Neanderthal woman who finds and cares for the young *H. sapiens* girl Ayla.
10 https://www.neanderthal.de/en/home.html [accessed 14 May 2024].

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11

Palaeoanthropology and the mass media: an entangled history

Oliver Hochadel

Around the year 2000, something remarkable happened in Spain with regard to its national past. It was allotted a new beginning. For most of the twentieth century, Spanish history began with the famous cave paintings of extinct bison in Altamira. Yet browsing bookstores and looking at the covers of popular history books dealing with the *Historia de España*, the first word of the subtitle was now Atapuerca: *De Atapuerca al euro* (García de Cortázar, 2002)*; De Atapuerca a Los Reyes Católicos* (Campmany, 2004), or *Desde Atapuerca hasta el 11-M* (Montero and Roig, 2005; Hochadel, 2015a: 397–399).

The 1990s were the 'prodigious decade' for Spanish researchers excavating in Atapuerca near Burgos in Northern Spain. In the Sima de los Huesos ('Pit of Bones') they unearthed over 5,500 hominin fossils, dated roughly 400,000 years old. In another site, the Gran Dolina, the hominin fossils found were nearly 800,000 years old, allowing the palaeoanthropologists to name a new species: *Homo antecessor*. Propelled by their sensational discoveries, the Atapuerca researchers were able to build a strong alliance with the Spanish mass media. Since around 1993, thousands of articles have appeared in Spanish newspapers and magazines (Hochadel, 2013a: ch. 5; Moreno Lara, 2014). The findings were routinely characterised by superlatives. The Sima de los Huesos contained the largest assembly of hominin fossils, *Homo antecessor* was by far the oldest hominin fossil in Europe and Atapuerca was hailed as the most important prehistoric site in the world. Due to the constant media coverage, the word Atapuerca came to signify something ancient and became the beginning of Spanish history in the common imaginary. The three co-directors of the Atapuerca project, Juan Luis Arsuaga, José M. Bermúdez de Castro and Eudald Carbonell became highly visible scientists, keen to popularise their discoveries. They considered journalists to be their natural allies ('our friends') and the Spanish media gladly trumpeted their prehistoric exploits (Hochadel, 2015a: 396).

These few paragraphs on Atapuerca touch upon some of the major points this chapter would like to address in a broader historical dimension: the oftentimes symbiotic relationship between palaeoanthropology and the media; the impact this liaison may have on conjuring new imaginaries of a national past; and the focus of the press on 'leading' palaeoanthropologists unravelling 'our origins', for readers to identify with.

This overall volume aims to show how the palaeontological sciences have become crucial constituents within the public sphere. This chapter in particular will look at palaeoanthropology. Its basic thesis is that human origins research and the mass media have co-evolved since the mid-nineteenth century.[1] Newspapers and magazines played a crucial role in turning the discovery and interpretation of hominin fossils into a 'public science'. Palaeoanthropologists and the media have been feeding off each other in several ways, benefitting enormously from the general public's continuing interest regarding our origins as human beings they had elicited and kindled.

For some time now, historians of science have pointed out the close connection between palaeoanthropological research and its mediatic coverage. However, most of these studies focus on individual cases of fossil discoveries. The objective of this chapter is, rather than simply summarising this research, to pinpoint some of its most important themes. As both palaeoanthropology and the media have fundamentally changed in the last 170 years, an overview can identify the major shifts of this co-evolution. Such a critical synthesis might also provide a toolkit for further studies of this field.

To pervade this complex constellation, a few preliminary considerations are required. First, we will name some of the main concepts provided by the history of science and Science and Technology Studies (STS) to analyse the relationship between science, the media and the public. We will then provide a brief overview of the relevant secondary literature on prehistory and the press, and thereby also introduce the case studies that form the material basis of this article.

These introductory parts will help us to identify some of the most relevant features of this co-evolution of palaeoanthropology and the media that will be dealt with in subsequent sections: the media as 'extended battlefield' for debates about dating, phylogenies and origins, but also as an important platform of creativity and forging new concepts; the connections between hominin fossils nationalism and 'scientific colonialism'; and the emergence of the 'celebrity' palaeoanthropologist. One section will discuss the materiality of newspaper clippings and how collections of cut-out articles reveal their importance to palaeoanthropologists. Finally, we will ask: How does new media (including social media) change the relationship between palaeoanthropological research, the media and the public in the twenty-first century?

The medialisation of science

It is widely acknowledged now within the history of science and STS that no sharp line can be drawn between 'strictly' academic accounts and 'merely' popularising contributions. (Hilgartner, 1990; Gregory and Miller, 1998: 84; Bowler, 2009: 77; Nieto-Galan, 2016: 9–20) To do so is seen as an attempt to cement the authority of scientists in public discourse, a kind of boundary work that historians need to deconstruct (Nikolow and Schirrmacher, 2007: 25). Scientific knowledge is co-produced, and we should better speak of 'knowledge in transit', avoiding any kind of epistemological hierarchisation (Secord, 2004). Science and the public are not identical, but they are inextricably linked. We as historians need to tell a '*Beziehungsgeschichte*', an 'entangled history'.

Science and the media have been using each other as 'resources' – understood in a broad sense (Nikolow and Schirrmacher, 2007). Thanks to public visibility owing to their media presence, scientists might acquire more funding. In return, journalists receive 'good stories' according to the criteria of the mass media. The media might also provide an epistemological legitimatisation for the claims of the researchers. Scholars may in some cases bypass the internal scientific process of peer review and discussion by turning directly to the public. In a newspaper article, they might not even primarily address a general audience but their peers (Bucchi, 1996, 1998). Unshackled by academic conventions, the popular sphere has on occasion become a space of creativity and imagination, allowing for speculation and daring ideas (Felt, 2000: 30). At the same time this space may also be used for sharp, direct and unveiled criticism of scientific arguments and approaches, turning the public sphere into an extended battlefield. In exceptional cases, the media might even be deployed for *ad hominem* attacks on other researchers, inconceivable in peer-reviewed journals and conference papers.

All these approaches stress the strong interdependence of the academic and the public spheres, the co-production of knowledge, and even their partial overlap. Meanwhile, other approaches, such as systems theory, highlight the inherent autonomy of the mass media. They always impose their own 'logic' on any material, including scientific content. Science journalism should be understood as a field with its own norms (Kohring, 2006). The 'logic of the media' consists of the constant vying for the limited attention of the reader, that shapes the reporting on any issue. The topics that science journalists choose have to be current and (supposedly) relevant to media users, readers, listeners and viewers (Weingart, 2001: 237–8). To be reported, the news item needs to call upon a frame the media user can relate to. Put differently: it has to be 'connectable', that is address specific questions and anxieties of media consumers, taking into account their prior knowledge (and ignorance). In the jargon of journalists, an article needs to be a 'story'. A good story may be emotionally moving, entertaining and in any case intelligible. From this vantage point, accusing the media of being sensationalist, superficial and highly selective in their coverage (as scientists often have done) is therefore simply misguided.

Peter Weingart coined the term 'medialisation of science'. By 'medialisation' Weingart refers to 'the central role of the media for the communication with a society including the repercussions with all other parts of society'. This central role of the media forces scientists to follow the logic of the media to promote their research, be it by writing popular accounts of their work or by being in close contact with journalists. With the necessity to secure funding for their increasingly costly research, this attempt to directly address the public has become more and more important (Weingart, 2005: 12; Rödder et al., 2012). As we will see in the following, it might be fruitful to use these approaches to explore the relationship between palaeoanthropology and the printed press.

Palaeoanthropology and the mass media: An overview of the historiography

This chapter will focus on the printed press, in particular newspapers but also magazines and illustrated journals. In short, periodicals directed at the general public. Obviously, the debate about human origins takes place in other media and formats as well, and it would make no sense to try and neatly separate all these different channels. Scholars have studied popular science books dealing with palaeoanthropology

(Hochadel, 2008, 2013b), and also prehistoric novels, as important spaces to imagine our ancestors (Hackett and Dennell, 2003; Sommer, 2008: 138, 162–4). Visual representations of early humans (in publications and other media) have been analysed by Moser (1992, 1998) and others (Clark, 2008; Hochadel, 2022). The prevalence and longevity of gender stereotypes has been a recurrent topic in this scholarship (Gifford-Gonzalez, 1993; Moser, 1993; Wiber, 1997; Solometo and Moss, 2013). Exhibitions on human evolution in natural history museums are another influential medium (Scott, 2005a, 2005b, 2007). On the other hand, audio-visual media dealing with human origins research, especially documentaries and movies set in prehistory (and the role of palaeoanthropologists as expert advisors), seems to have received far less scholarly attention. Feldesman (1983) and Lieberman (1982) are two overtly critical reviews of the documentary *Lucy in Disguise* (1981) and the film *Quest for Fire* (1981). They do not take into account that these audio-visual representations of prehistory follow specific customs of the genre documentary.

A specific type of illustration is of particular relevance for our topic: caricatures and cartoons dealing with 'our ancestors' or more generally with human evolution, a mainstay of the printed press since the mid-nineteenth century. The widespread diffusion of these kinds of humorous and satirical images is a clear indication of the general public's high degree of familiarity with the subject matter. Again, it would be misleading to treat these representations as mere 'simplifications' of more sophisticated issues. Rather, cartoons owe their communicative power to their inherent simplicity. It makes them apt for all kinds of social and political commentary and to convey current notions of race and gender (Browne, 2001). Powerful images such as the witless caveman with a club, 'the missing link', 'the ape' as our ancestor or the iconic 'March of Progress' shape the debate about our origins despite being erroneous on a factual level (Clark, 2008, 2009; Dawson, 2024).

To stress this once more: while this chapter focuses on the printed press, the boundaries between these different media and spaces are porous, and images, tropes and ideas circulate between them. Palaeoanthropologists write newspaper articles, but also popular science books and curate exhibitions. Reconstructions of Australopithecines by palaeoartists appear as images in illustrated magazines or as three-dimensional figures in a museum diorama. Palaeofiction might formulate ideas that influence research, such as interspecies relationships between Neanderthals and *Homo sapiens*.

In what follows, we shall mention some of the secondary literature on the history of palaeoanthropology that has focused on newspaper articles as its central source material. There are a few books that explicitly include the mediatic dimension (mostly newspaper articles) of the most prominent finds of hominin fossils (Pyne, 2016; Schweighöfer, 2018; Hochadel et al., 2016). This includes the Neanderthal, whose discovery in 1856 may be taken as a starting point for the liaison between prehistory and the press that continues to this day. An especially revealing case study is the debate about the Neanderthal fossils discovered in 1908 in La Chapelle-aux-Saints (Sommer, 2006).

Historians have repeatedly pointed out the highly mediatic dimension of 'Piltdown Man', a skull 'discovered' in Sussex, England, in 1912 (Goulden, 2009; Pyne, 2016: 62; Schweighöfer, 2018: 226–39). (In 1953 Piltdown Man was found to be a fake, combining the facial skull of a human from the Middle Ages with the teeth and jaw of apes.) Several authors highlight the role of the press concerning hominin finds in China in the 1920s and early 1930s (Kjærgaard, 2012; Manias, 2015; Manias, unpublished). Lucy (*Australopithecus afarensis*, found in Ethiopia in 1974) is arguably the most famous hominin fossil, yet there are few thorough analyses of her media presence (Haraway, 1989: 191–3, 281–2; some first steps in Hochadel, 2009; Pyne, 2016: 153–86). In 2004, the announcement of *Homo floresienses*, a diminutive but very recent hominin species found in Indonesia, dubbed the 'hobbit', made headlines around the world (on the media coverage: Goulden, 2013; also see Madison, 2023).

There are several less prominent cases of hominin fossils (in terms of media coverage) that have received scholarly attention. These include 'Menton Man', found in southeast France near Monaco in 1872 (Cataldi, 2016), the Steinau Hoax of 1911 (Hochadel, 2016), the *Oreopithecus* discoveries in the 1950s (Florensa, 2016), the 'Orce Man' in Spain in the 1980s and 1990s (Carandell, 2013, 2020) as well as discoveries in recent decades in Brazil (Lagoa Santa and Pedra Furada) that question the traditional timeframe of the first human settlement in the Americas (Gaspar Neto and Santos 2010; Carandell, 2016). All these case studies will serve as examples for a more systematic analysis in this chapter.

The peculiarities of the press

In this section, we will give a brief overview of the development of the periodic press since the mid-nineteenth century. Drawing on the explanations made earlier in this chapter on how mass media 'functions', we might explain why the ‘fit’ with palaeoanthropology worked so well. At the same time, we would like to underline that talking about ‘the press’ may be problematic. Each case of ‘prehistory and the media’ requires careful contextualisation.

The increasing literacy in many Western countries and new technologies such as the rotary printing press (developed and patented in the 1840s) were arguably the two most important factors to turn newspapers into true mass media in the second half of the nineteenth century. The print run and number of newspapers increased massively and continuously from around 1850 to well into the twentieth century, in a period dubbed the ‘golden age’ of newspapers (for the US: Douglas, 1999; for Argentina and Uruguay, Acree, 2011; for a Central European perspective: Fritzsche, 1996). Many newspapers published two or even three editions a day. They became a crucial mode of political, social and national organisation, and thus played an important role in the formation of new scientific disciplines (for the British case: Cantor et al., 2004; for the role of journalism and knowledge production: Ziemer, 2023).

With the help of the telegraph, the printed press was also instrumental in creating a transnational sphere. The same year that Charles Darwin published his *On the Origin of Species* in 1859, an international news market emerged, when the three news agencies Havas, Reuter and Wolff merged into Continental (Wolff, 1991). This commodification of news included the circulation of illustrations (Smits, 2020).

The newspaper’s ubiquity, immediacy, plurality and large readership turned it into an ideal medium for the quick exchange of arguments, unlike the ‘slow’ academic journal with its restricted accessibility and visibility. Furthermore, the threshold to publish in a newspaper was much lower than in an academic journal. A focus on the mass media allows us to include voices that might otherwise escape the attention of the historian of science (in particular of non-academics).

The gradual emergence of palaeoanthropology as an academic field in the mid-nineteenth century coincides with this decisive transformation of the daily press. In this phase, the extensive media coverage of issues concerning human origins had an important community-building effect. During ‘acute’ controversies, the press was often the only space where one could quickly access information, and the interpretations of the scholars involved.

The ‘plurality’ of the press could mean different things. For our purposes, it might be sufficient to name two parameters that help us map the public discourses on fossil discoveries: ideological orientation and readership. (A third parameter might be nationality, which we will address below). As regards the first parameter: the ideological underpinnings of each medium might impact its interpretation of ‘prehistoric news’, as hominin fossils have always been attributed with a range of meanings related to human identity (gender, race, religion, nation and origins more generally). To give but a few examples of European fossil discoveries and debates that ran across similar lines: in the case of the flurry of publications around Menton Man in the 1870s (Cataldi, 2016), the La Chapelle-aux-Saints Neanderthal in early-twentieth-century France (Sommer, 2006) or the international debate about *Oreopithecus* in the 1950s (Florensa, 2016). Broadly speaking, conservative newspapers espoused rather Catholic and orthogeneticist (allowing for finality in evolution) positions while other newspapers (often but not necessarily liberal or left-leaning) espoused (neo)-Darwinist positions. This might even lead to a strong polarisation and the formation of, as we would say today, mediatic echo chambers, as was the case with the early press coverage of Darwin’s theory of evolution. (Ellegård, 1990: 35, 241; Kjærgaard, 2018: 95–6)

To turn to the second parameter, the intended audience. As we have emphasised before, the printed press is highly diverse with regard to the readership it addresses. Is the reporting on human prehistory fundamentally different between highbrow newspapers and Yellow Press (say, ‘serious’ information as opposed to sensationalist claims)? Or are they similar in the way they mobilise metaphors and superlatives in order to capture the attention of their readers? This has not been studied in much depth yet (for the differences in reporting on prehistoric finds in the British press see Bowler, 2009: 49; also Manias, unpublished, focusing on the Manchester *Guardian*). One publication that historians of human origins research have singled out is the *Illustrated London News*. This weekly produced numerous evocative reconstructions of prehistoric life from the 1890s onwards, be it Piltdown Man, Peking Man or other ‘famous’ hominins (Bowler, 2009: 49; Manias, 2015: 293). *Pars pro toto* this magazine shows how the printed press could satisfy the demand to visualise our ancestors, serving both the general public and the researchers themselves.

Founded in 1888, *National Geographic* might be considered the most influential medium on an international scale with regards to the representation of extinct hominins in the twentieth century (Scott, 2005b: 45; a similar case can be made for the sway *National Geographic* holds over dinosaur palaeontology, see Tattersdill and Witton, this volume). More than that, the National Geographic Society supported a number of leading palaeoanthropologists through funding, providing professional photographers and public visibility (articles in the magazine itself and books) (Dennell, 1990: 555). Among the most prominent researchers who collaborated for an extended period with *National Geographic* were Louis Leakey (since 1959; Kjærgaard, 2012: 353–5) and Donald Johanson from the mid-1970s. *National Geographic* also supported other high-profile palaeoanthropologists such as Tim White (Kjærgaard, 2011: 6-7) and Lee Berger (Kuljian, 2016: 249, 277–8; Berger and Hawks, 2017) and promoted their discoveries: respectively *Ardipithecus ramidus* in Ethiopia in 2010 and *Homo naledi* in South Africa in 2015. This interdependence is well known, but still lacks an in-depth historiographical treatment to reconstruct the exact nature of their collaboration and how it evolved.

With regard to the spectrum of periodical publications, *Science* and *Nature*, to name the two most prominent ones, are on the far end (Figure 11.1). In recent decades, these leading scientific journals have become more and more professional in advertising the content of their next issue

Figure 11.1 The oldest European? Photo of the hominin mandible (over 1.2 million years old) found at the Atapuerca site, used for the cover of *Nature*, 27 March 2008. Courtesy: Jordi Mestre / IPHES-CERCA.

by providing the media with a 'press kit' (information that is embargoed until the day of the publication, including illustrations and contacts to potential interview partners) and organising press conferences (on the promotion of *Homo antecessor* in 1997 and *Ardipithecus ramidus* by *Science* in 2009 see Hochadel, 2013a: 90–2; and Kjærgaard, 2011). These top-tier journals have been criticised for fostering sensationalism by prioritising spectacular finds. Many of their covers do indeed trumpet discoveries of hominin fossils as the 'oldest', 'the first' and so on, very much as you would expect from a popular journal. More research may be needed on the coverage of palaeoanthropology by *Science* and *Nature*. Yet, it seems clear that even these first-rate academic journals find it hard to resist the 'logic of the media'. This underscores once more the thesis that science communication should be understood as a continuum, and that it might be better not to draw a strict line between the public and the academic sphere.

Starting in the first decades of the twentieth century, the mass media framed prehistoric discoveries as spectacular events. It was therefore 'easy to generate public interest in this topic, and the regular discovery of new hominin fossils ensured that there was always a peg upon which to hang another account of the factors that might have shaped human nature' (Bowler, 2009: 48). This kind of coverage created the expectation of more such finds in the future, generating its own dynamic (Schweighöfer, 2018: 239).

Newspapers and other mass media are choosy in what they cover. With regard to palaeoanthropology, the press very much focused on discoveries, that is to say on individual events. There is generally a flurry of reporting in the immediate aftermath of a 'spectacular' find, only to turn silent very quickly. Complaints of palaeoanthropologists about the short attention span of the media are legion and can be traced far back. To give an early example: in 1872, the French anatomist Ernest Hamy (1842–1908) was dismissive of the scientific value of 'Menton Man'. Yet at the same time, he was fully aware that the printed press had a field day. The skeleton was well-preserved and the skull was decorated with shells (Figure 11.2). Menton Man provided exactly what the public expected from palaeoanthropology: a well-told story of discovery in a cave, and a visually attractive fossil (Cataldi, 2016).

In 1943, Roy Chapman Andrews (1884–1960), leader of the Central Asiatic Expeditions (1921–1930) of the American Museum of Natural History, reminiscing about the past, lamented the highly selective interest of the media. 'Primitive man was what they wanted and anything else bored them exceedingly' (quoted after Kjærgaard, 2012: 101). The

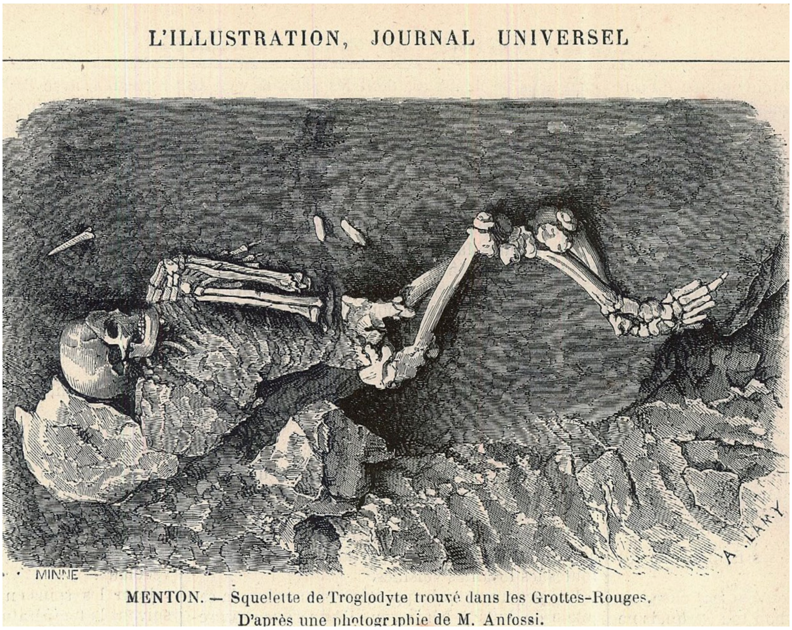


Figure 11.2 An attractive fossil? Menton Man as represented in *L'Illustration*, 27 April 1872. Image in public domain, courtesy of Arnaud Hurel.

newspapers did not follow the more prosaic work of excavation and were not interested in the process of research itself, but waited instead for spectacular discoveries and dramatic stories (Manias, unpublished).

Like many other human origins researchers before them, José M. Bermúdez de Castro and Eudald Carbonell, co-directors of the Atapuerca project, insisted time and again that they are no fossil hunters and that their field is *not* a race between palaeoanthropologists to find the oldest human remains, in the way the media tends to portray it (Hochadel, 2013a: 164–6). Yet at the same time, they are tireless popularisers of their research. It seems impossible to escape the medialisation of human origins. The science-media connection has long become a permanent fixture of their work.

Controversy and creativity – the science-media connection in palaeoanthropology

In the following, we shall see how far the concepts introduced in the previous sections may be applied to describe the co-evolution of human origins research and the press. The case of palaeoanthropology shows that the medialisation of science is as old as the field itself, emerging in the mid-nineteenth century. In the past 170 years, newspapers and magazines served as easily accessible platforms for the nascent scientific community of prehistorians. This function of the printed press as a 'meta-medium' was particularly important before palaeoanthropology emerged as a professional discipline in the course of the twentieth century. Scholars wrote articles to present their discoveries and to put forward their own, often contentious, interpretations. They launched, as we would say today, PR campaigns to give visibility to their research, and contacted journalists to push their own interpretations of a human fossil.

There are even some cases where the debate about a recently discovered fossil took place (at least in its initial phase) exclusively in newspapers. The ubiquity and immediacy of the medium allowed for it. To give but three examples from different periods, in which the concept of the press as an extended battlefield introduced above, seems helpful. The media serves as a space to attack and defend, as a forum for scientific controversies to convince the general public of a specific interpretation of hominin fossils.

The case of the Steinau Hoax is peculiar as it only lasted from May to August 1911, from the first articles that claimed the discovery of a potentially prehistoric skull to the discovery of the fraud (Hochadel, 2016).

In March 1956, Swiss palaeontologist Johannes Hürzeler presented fossils of *Oreopithecus bambolii* (a humanoid primate that might have already been bipedal over 7 million years ago) at a scientific conference in New York. Immediately, a public debate ensued in American and European newspapers about what this discovery meant for the theory of evolution. 'Darwin was wrong' was one of the headlines (Florensa, 2016) (Figure 11.3).

The fossil labelled Orce Man, part of a parietal bone, was discovered in the summer of 1982 near Granada. In June 1983, it was presented to the public as 'the find of the century', by far the oldest hominin fossil in Europe (over one million years). Yet the fossil was still encased in the matrix and was not freed from it until nearly a year later. In May 1984, the result of the analysis was leaked to the press: the fossil was not hominin but belonged to an equine (Carandell, 2020).

What these three cases have in common is that the debate about the new fossil finds was initially *only* led in the printed press. How old was the fossil? Is it authentic? Which creature did it belong to? What significance does it have for human phylogeny and the theory of evolution? Scholars could only refer to newspaper articles if they wanted to follow the debate

Le Dr Johannes Hurzeler, savant suisse, montre le dessin d'un crâne reconstitué d'après des fragments fossiles trouvés en Toscane, en 1872, et ayant appartenu à un être humain qui vivait il y a dix millions d'années. (*Lire en page 9, l'article de Léo* SAUVAGE.)

"Darwin s'est trompé..."

affirment deux savants suisse et américain en soulignant que l'oropithèque vieux de dix millions d'années n'est pas un singe mais le véritable ancêtre de l'homme

(De notre bureau de New York)

New York, 12 mars. — En raisonnant sur une mâchoire trouvée il y a plus de quatre-vingts ans en Toscane, un paléontologiste suisse et un géologiste américain viennent de soutenir devant un groupe de savants réunis à New York sous les auspices de la Fondation Wenner-Gren, spécialisée dans les recherches anthropologiques, que l'existence de l'oropithèque toscan contredit les théories de Darwin sur l'origine des espèces.

Les hommes qui ont avancé cette affirmation révolutionnaire, susceptible d'entrainer une revision complète de quelques-unes des hypothèses les plus fondamentales de l'histoire de l'homme, sont M. Jean Hurzeler, conservateur de la section de paléontologie au muséum de Bâle, et M. Helmut De Terra, professeur de géologie à l'Université de Columbia.

M. Hurzeler était resté penché pendant de nombreuses années sur des fragments de fossiles qui avaient été mis au jour, en 1872, dans une mine italienne et qui avaient été attribués, à l'époque, à un singe préhumain aussitôt baptisé *oropithecus* ou singe des montagnes. M. De Terra, de son côté, a longuement étudié les couches de charbon dans lesquelles ces fossiles étaient incrustés. A eux deux, ils sont arrivés à la double conclusion suivante :

1° Le prétendu oropithèque n'est pas un singe mais un être présentant des caractéristiques nettement humaines. Déballant la mâchoire qu'il avait apportée dans sa serviette, M. Hurzeler en a montré quelques-unes à ses collègues : plantation et forme des dents, point d'attache du maxillaire, orientation des narines, etc.;

2° le prétendu oropithèque est vieux, au moins, de dix millions d'années, ce qui le rend contemporain, à quelques milliers d'années près, de ces singes anthropoïdes — mais encore authentiques singes — tels que le *proconsul* et le *dryopithèque* dans lesquels nous avons été invités à saluer nos ancêtres.

Quelles sont les déductions tirées par les deux savants de cette double constatation ?

Le darwinisme, rappellent-ils, explique le passage du singe à l'homme en retraçant chronologiquement l'évolution commencée il y a dix millions d'années avec le *dryopithèque* (dernier échelon du singe) pour aboutir, il y a 200.000 ans peut-être, à l'anthropoïde de Java ou de Pékin, premier échelon de l'homme.

Si, donc, il était prouvé que l'apparition de l'homme remonte bien plus loin qu'on ne l'admet généralement aujourd'hui, voire même qu'il existait déjà à l'époque où existait encore le *pithécanthrope*, dont la lente évolution n'était censée aboutir à lui que des millions d'années plus tard, toute la construction darwinienne perdait son appui essentiel.

Devant le caractère révolutionnaire de cette conclusion, la Fondation Wenner-Gren a estimé que des preuves supplémentaires devaient être accumulées quant à la nature et à l'âge de l'*oropithèque* toscan. Voici pourquoi de nouvelles recherches vont être entreprises prochainement dans les mines de Toscane, sous la direction de MM. Hurzeler et De Terra et avec la participation de savants italiens.

Mais il semble bien que, dès maintenant, là où s'élevait la seule colonne de Darwin et de l'évolutionnisme, vient de s'ouvrir un espace libre prêt à recevoir les théories de ceux qui n'auraient pas peur de tout recommencer.

Léo Sauvage.

"Le Figaro"
Mardi 13 mars
1956

Figure 11.3 'Darwin was wrong'. A clipping from the French newspaper *Le Figaro*, 13 March 1956, on Johannes Hürzeler and his 'revolutionary' interpretation of *Oreopithecus*. Courtesy of Arxiu Miquel Crusafont de l'Institut Català de Paleontologia Miquel Crusafont.

or weigh in. Lack of access to the original fossil posed a major problem in each case. Black-and-white photos had to serve as the basis of their interpretations.

In the Steinau case, the public controversy lasted for about three months, too brief to materialise in academic publications. In the *Oreopithecus* case it took about two years, and in the Orce Man case over three years, for the first scholarly articles to appear – and the debate continued. Josep Gibert (1941–2007), one of the discoverers of the Orce Man, upheld the theory that the fossil belonged to a hominin for the rest of his life. He did so to a large degree by promoting his theory in the public sphere through 'working' the media, organising a major palaeoanthropological congress in Orce in 1995 and publishing a popular science book in 2004 (Carandell, 2020).

A classic case of a controversy that was fought out not only in the academic realm but also in several media, is the debate about the origin of *Homo sapiens*. In the 1980s and 1990s, two different scenarios competed with each other: 'Out of Africa' versus the 'Multiregional Theory' (for an overview: Minugh-Purvis, 1995; also see Kuljian, 2016: 194–6). The main proponents argued with each other in both the academic and the public sphere, including snide remarks in popular science books (Hochadel, 2008: 35–6) and a heated exchange in the *New York Times*, on the brink of accusing each other of racism (Stringer and McKie, 1997; Wolpoff et al., 1997).

The field of palaeoanthropology is, by its very nature, prone to generate controversies. To mention only a few possible 'bones of contention': hominin fossils are scarce, fragmented and notoriously difficult to date. Therefore, reconstructions (especially concerning issues such as locomotion, and brain capacity) are difficult, always provisional and prone to reflect the biases of the researchers. The phylogeny of hominins is constantly revised and has been fraught with assumptions about 'race' and human nature. After all, palaeoanthropology deals with *our* origins.

Yet the public sphere is not only an extended battlefield. It is also a 'creative' space. Historians have argued that popular science is not 'distorting' science but rather developing it (Gregory and Miller, 1998: 84; for palaeoanthropology Goulden, 2013: 584). The interplay between prehistoric research and the printed press has coined a number of concepts, ideas and imaginaries that have proven consequential. The new beginning of Spanish history, a coproduct of the Atapuerca team and the Spanish media mentioned at the beginning of this article, is only one example.

The concept of ‘early man’ or ‘primitive man’ was very much in vogue in the early decades of the twentieth century. To find this elusive ancestor was the goal of both palaeoanthropology and the media cheering on researchers (Kjærgaard, 2012; Manias, 2015). The notion of ‘the missing link’ has long been discarded by scholars of evolution as a useful concept but still works as a cultural reference point in the public sphere because it has name recognition (Kjærgaard, 2018; also see Clark, 2009).

The idea of the early human as a ‘killer ape’ had an enormous cultural impact, in particular in the post-war USA. The writer Robert Ardrey (1908–1980) based his claims in large part on the work of the palaeoanthropologist Raymond Dart (1893–1988), using prehistoric finds from South-Africa and a number of stereotypes of the ‘dark continent’ to claim the innate nature of human aggression (Weidman, 2011; Kuljian, 2016: 158–66; Milam, 2019).

‘Neanderthal’, arguably, is much more than the name of a hominin species. It is an icon of evolution permeating our culture (Sommer, 2008: 139–142). ‘Part of the reason our Neanderthal obsession never waned is the media … Neanderthals are cast as a foil for ourselves … the ultimate ‘Other’; the shadow in the mirror’ (Wragg Sykes, 2020: 363–4; also see the conversation between Manias, Sykes and Pyne, this volume).

These prehistoric creatures were always simultaneously objects of scientific research and public imagination. To give one last example: in 2004, the popular name of *Homo floresiensis* was chosen by the researchers themselves, not the press. ‘The Hobbit’ referred to the film series *The Lord of the Rings*, which had just been released (2001–2003) and everybody understood that the creature was of short stature. The palaeoanthropologists successfully selected a ‘media-compatible’ name to increase the public impact of the discovery (Morwood and Oosterzee, 2007: 153; Goulden, 2013: 582; Pyne, 2016: 204–6).

The Neanderthal, Piltdown Man, ‘the killer ape’, Lucy and the Hobbit all have become public icons. Yet there seems to be no identifiable mechanism that would explain how these prehistoric personae achieved their status as celebrities (Pyne, 2016). Depending on the historical context, the dynamic between palaeoanthropology and the mass media generates very different results.

Fossils with a flag? Nationalism and colonialism

It is well established that in many cases nationalism played an important role in the public discussion of our ancestors (Sommer, 2006: 223–4; Sommer, 2008: 155; Hochadel, 2015a). Historians have analysed the often fierce competition between national communities of prehistorians. Yet national rivalry by definition always implied a commitment to a certain kind of internationalism. Recognition from foreign colleagues was and is central to acquiring prestige 'at home' (Manias, 2009, 2013).

The point we would like to stress in this section is that sentiments such as national pride and national identity are key ways for the media to reach their readers. In order to analyse how the press spins the news in such a direction, it may be useful to distinguish two variants of this nationalist appropriation of hominin fossils. Firstly, the claim of a biological continuity of a 'race' or 'nation', connecting creatures from prehistory with the present population. Secondly, patriotic pride in the achievements of 'our researchers' – what we may call scientific nationalism. This pride is all the greater if it can point to recognition from abroad. These two variants are by no means exclusive, and often appear together in the reporting.

A well-known case of nationalist appropriation is Piltdown Man. Until 1912, the most mediatic finds of human fossils had been made in Germany, France and Java (at the time a Dutch colony). But now, so it seemed, it was time for the British to claim a central piece of the human pedigree (Spencer, 1988: 84; Bowler, 2009: 49; Goulden and Balmer, 2009). British newspapers highlighted the discovery in triumphalist tones. In the reporting, both variants of nationalist appropriation were present, biological continuity and scientific nationalism. 'The Ancestor of the English Race' or 'The Ancient Briton' were typical headlines (quoted after Goulden, 2009: 284; and Schweighöfer, 2018: 235).

All through the twentieth century and up until today, the media played an important role in promoting national pride in prehistoric finds. At the beginning of the article, we already mentioned the case of Atapuerca. The Spanish press presented the achievements of the Atapuerca team as a triumph of Spanish science overcoming its supposed backwardness. Claims of some kind of connection between *Homo antecessor* and modern Spaniards were rather humorous in tone and hardly meant seriously. The term 'first Spaniard' was rarely used, unlike 'first European'. Scientific nationalism was at the core of the media coverage, not biological continuity. (Hochadel, 2013a: 94–6; Hochadel, 2015a: 403–4)

Once more, it is of crucial importance to look at each case and its historical context individually. Generalisations remain difficult, yet the double concept of biological continuity and scientific nationalism might be helpful to map a spectrum. The finds at Zhoukoudian outside Beijing in the 1920s and 1930s represent an intriguing case. Western newspapers reported amply on the discoveries of Peking Man (Kjærgaard, 2012; Manias 2015, unpublished). By contrast, in the Republic of China these hominin fossils did not make much of a 'splash … outside scientific circles'. This was to change completely after the communist victory in 1949 (Schmalzer, 2008: 47). A major strand of Chinese nationalism claims direct continuity between the Chinese variant of *Homo erectus* and the modern Chinese (Sautman, 2001). In recent decades though, the Chinese government has been keen to highlight the importance of China as a centre for human origins research, to increase its international prestige (Schmalzer, 2008: 249–50).

Interesting tensions may be found in a number of other cases. South Africa prided itself early in the twentieth century as being the cradle of mankind, with the Taung child (*Australopithecus africanus*, 1924) being its major claim to fame. At the same time the descendants of Dutch and British settlers had to maintain their ideology of white supremacy, thus making any kind of discourse of biological continuity difficult (Schlanger, 2002; Dubow, 2008; Kuljian, 2016).

Brazil provides another intriguing case study in this respect. 'Luzia' refers to fossil remains, including the skull, of an anatomically modern woman found at Lapa Vermelha (Lagoa Santa), dated as roughly 11,500 years old. Around the year 2000, Brazilian scientists claimed that Luzia was of Australian-Melanesian origins, proving an earlier settlement of the Americas than previously thought. The Brazilian media quickly turned Luzia into 'a scientific-cultural icon'. There were numerous visualisations of her in the public sphere, portraying her as dark-skinned (Figure 11.4). Dubbed 'the first Brazilian', the discourse about Luzia intersected with more general – and deeply racialised – debates about the 'origins' of Brazilians (Gaspar Neto and Santos, 2010: quote 2).

Unlike the concept of scientific nationalism, 'scientific colonialism' is also an actor's category. It is hard to say precisely when exactly the term 'scientific colonialism' (or 'scientific neocolonialism') came into use in controversies in palaeoanthropology, but it has been quite common since the late twentieth century. It is an accusation levelled by researchers from a former colony against researchers of a former colonial power (or more generally from a Western country). In its most basic form, scientific colonialism refers to asymmetries in political influence, financial

Figure 11.4 The first Brazilian? Reconstruction of Luzia, National Museum of Brazil; Wikimedia Commons [https://commons.wikimedia.org/wiki/File:Reconstitui%C3%A7%C3%A3o_de_Luzia_MN_01.jpg].

means and scientific reputation. The 'scientific colonialists' were able to dominate excavations and reap the benefits of discoveries in terms of scholarly publications or by 'extracting' the fossils from the country they were found in. Researchers from low-income countries are side-lined, their vital work outright ignored and their prehistoric heritage taken from them.

Scientific colonialism is a highly complex issue (Cisneros et al., 2022; Raja et al., 2022 for the case of palaeontology; for palaeoanthropology, Dennell, 1990: 545–5; for the case of Indonesia, Drieënhuizen and Sysling, 2021; Madison, 2023; for the perspective of the 'colonialists', Straus, 2011). In the context of this article, we would like to focus on its 'mediatic' features. Accusations of scientific colonialism were hardly made within traditional academic modes of communication, such as peer-reviewed papers, although this seems to be changing now (Cisneros et al., 2022; Raja et al., 2022). In the past, these criticisms were by default relegated to the mass media or the comment sections of academic journals (for an example from Ethiopia see Haile-Selassie, 2001; Seidler, 2001; Hochadel, 2004: 122–5).

We often encounter these kind of accusations in controversies about access to promising sites and to hominin fossils, especially in the Rift Valley in East Africa, namely Ethiopia and Kenya (still a good overview: Lewin, 1997). The allegation of scientific colonialism is easily transferable. Even the Atapuerca researchers complained about French and US palaeoanthropologists exploiting the prehistoric riches of Spain for much of the twentieth century (Hochadel, 2013a: 61–5; Hochadel, 2015a: 394–5, 401).

Regarding future research, the topic of prehistory and the press could very much benefit from the inclusion of postcolonial perspectives. In concrete terms: do media in Kenya, China, Indonesia or Brazil, to name some countries with mediatic prehistoric findings in recent decades, report in different ways to Western media? Particularly when it comes to 'non-European' fossils, there is a certain danger for Western historians to view the debate through the lens of (readily available) Western media, including their biases and omissions. A systematic examination of the coverage of Lucy – 'Dinkinesh' in Amharic – in the Ethiopian media since the 1970s might provide a different perspective on the public history of this iconic hominin fossil. Another illuminating example is the controversy between Australian and Indonesian palaeoanthropologists about the interpretation (and ownership) of *Homo floresiensis* that ensued since its publication in 2004. A popular science book by one of the Australian protagonists merely provides one point of view (Morwood and Oosterzee, 2007) and Goulden (2013) only analyses the coverage of media in the UK. Madison (2023) is the first serious attempt to represent the Indonesian perspective in this protracted affair, including a long-term perspective going back to the first decades of Indonesian independence and observations on the role of the Indonesian media (Madison, 2023: 78–9, 90, 95, 97). A focus on non-Western media and postcolonial contexts might help to expand and modify the toolkit presented in this chapter.

Palaeoanthropologists as actors in the public sphere

The personalisation of content is a well-rehearsed method of the media to turn a topic into a 'connectable' story. The task of journalists is to create an intriguing human character – for the reader to identify with. An important question for our topic is how the mass media generated the public persona of the palaeoanthropologist, often in the form of the celebrity scientist (Fahy, 2015; Jones, 2022). Broadly speaking, a new kind of journalism evolved in the late nineteenth century. It strongly focused on sensations and with the intent to impact emotionally on the reader. We may connect this with the high point of imperialism that allowed for the mediatic creation of the intrepid explorer of unknown and dangerous parts of the world (Broks, 1996: 13,15; Schweighöfer, 2018: 245).

When did palaeoanthropologists first feature in this role? Florentino Ameghino (1854–1911, in the Argentine pampas since the 1870s, Podgorny, 2016) and Eugène Dubois (1858–1940, in the tropical forest of Java around 1890, Shipman, 2001) might be considered among the first researchers who presented themselves as actively searching for fossils under challenging circumstances. But these cases were rather exceptional. Roughly until World War I, the scholars featuring in articles on human prehistory worked in museums, laboratories and their private studies. Fossils were rather brought to them for analysis.

One of the first palaeoanthropologists who styled himself as a fearless explorer was Louis Leakey (1903–1972), bracing the African 'wild' (Figure 11.5). In his articles for *The Times* (and in his popular science books), he drew attention to his excavations in British Kenya in the early 1930s (Rees, 2016: 446, 450–1). Another example from the interwar period is Roy Chapman Andrews. While leading the Central Asiatic Expedition in the 1920s, Andrews frequently appeared in newspaper articles carefully crafting the persona of an explorer–hero making dramatic discoveries in 'uncharted' regions, pursuing theories of Central Asia as the original site of human evolution (Dennell, 2001). The 'personas adopted by the scientists' varied 'between the detective, the self-sacrificing adventurer, the heroic explorer and the metropolitan patrician' (Manias, 2015: 319).

Figure 11.5 Dedicated to tough fieldwork: Louis Leakey and his wife Mary Leakey, excavating at Olduvai Gorge, Tanzania. Courtesy of Smithsonian Institution Archives [Image #SIA2008-5182].

In the post-war period, in particular with the highly mediatic discoveries of hominin fossils in East Africa, the figure of the enterprising and fearless adventurer became a mainstay of much of the reporting on human origins research. Since the 1980s, 'Indiana Jones' has been the most popular short-hand for this public persona of the palaeoanthropologist.

This also led to a backlash. Donald Johanson, for example, one of the discoverers of Lucy and tireless populariser, has been criticised for being a 'media scientist' (Haraway, 1989: 406; Lewin, 1997: 272), only interested in fame, funding and power. Juan Luis Arsuaga, one of the Atapuerca co-directors faced similar allegations of only searching for the media limelight (Hochadel, 2013a: 164). One of the most outspoken critics of these 'palaeocelebrities' is the British-Kenyan palaeoanthropologist Martin Pickford (1943–) (Pickford, 2010). The context for Pickford's harsh words (including allegations of deceit) is his decade-long feud with the Leakey family, in particular Louis and Richard Leakey (1944–2022), especially over access to excavation sites, interpretation of fossils and political influence in Kenya (Pickford, 1997).

These tensions about the public persona of the palaeoanthropologist reflect some larger frictions between the norms of academia and the logic of the media. The printed press requires personalisation in order to catch the attention of their readers. But how can a thrill-seeking adventurer comply with the requirements of a trustworthy and sober scientist? It is important to note that accusations of being media-savvy and self-promoting are not levied by the media but by other palaeoanthropologists. This kind of denouncement is part of the boundary work between 'celebrity scientists' and 'real' scientists (White, 2000).

Cut out for more. Newspaper clippings and human origins

In this section, we shall focus on the material dimension of newspaper articles. Since the late nineteenth century, clipping services offered to screen a large number of newspapers for specific keywords which their customers were particularly interested in. Historians rejoice when they stumble upon a collection of cut-out newspaper articles. Not only does such an archival find provide a shortcut to a wealth of sources, but the mere fact that these collections exist indicates how much newspaper articles mattered to their owners. Mostly these articles have been cut out and glued into a scrapbook, with the newspaper and publishing date added by hand. When articles are transferred from one context (the edition of one newspaper) to another (the scrapbook) they acquire new meanings and may be used in new ways (te Heesen, 2014).

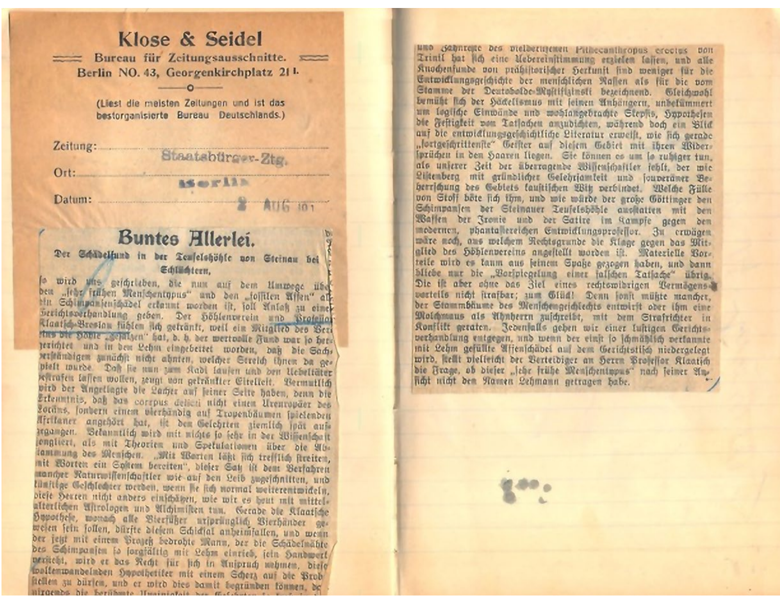
Natural history museums and individual palaeoanthropologists have collected articles related to their research since the late nineteenth century. One of the earliest examples is a hefty 306-page folder of the Argentine prehistorian Florentino Ameghino. It contains 330 clippings from more than 30 different newspapers, mostly from Argentina, some from Uruguay, spanning more than two decades, from 1874 to 1897. The folder documents the palaeontological discoveries of Ameghino and the public debate about their significance (Podgorny, 2016).

Another intriguing case is the collection of Marcellin Boule (1861–1942). The famous French palaeoanthropologist wanted to know what the public and in particular other scholars thought about his interpretation of the Neanderthal skeleton discovered in 1908 in La Chappelle-aux-Saints. Yet Boule's attempt to impose his interpretation of 'the Old Man' (as the fossil was dubbed) failed, and the flourishing of dissenting opinions in the public sphere was hard to control. The skeleton 'was physically reconstructed in Boule's laboratory, but the newspaper clippings and illustrations can be understood as alternative reconstructions' (Sommer, 2006: 209). In their totality these clippings displayed the variety of public opinions around the much-debated topic of human evolution and the ideological spectrum of the French Press at the time.

The collection about the La Chapelle-aux-Saints Neanderthal was assembled by the Muséum national d'Histoire naturelle in Paris where Boule worked. The Natural History Museum in London holds many collections of newspaper clippings, including an extensive one on the Piltdown 'discovery'. For the initial period between late November 1912 and the end of March 1914, the collection contains 220 articles, documenting the 'explosion' of the coverage (Schweighöfer, 2018: 24, 227). The University of Witwatersrand in Johannesburg holds a collection of newspaper articles related to the research of Raymond Dart in the wake of the discovery of the Taung Child. The collection allows us to reconstruct the to-and-fro of the reporting (in newspapers from South Africa, Great Britain and the United States) between February and April 1925, grappling with the significance of the small skull for 'our' phylogeny (Schweighöfer, 2018: 239–47).

In the case of the Steinau Hoax in 1911, the available information was scarce, as the skull had been brought to the Senckenberg Museum in Frankfurt. The newspaper articles were treated as precious evidence for or against the fossil nature of the remains. They were read, cut out, passed on, and assembled anew. In the Steinau case, they were kept by individuals rather than institutions. The forger Wilhelm Rappe (1879–1940) gleefully glued the articles in a diary, meticulously documenting his successful prank. Hermann Klaatsch (1863–1916), cited by the press as supporting the fossil nature of the skull, had asked a press service to keep him abreast of the media coverage – also internationally – in order to assess the damage to his scientific reputation, and then to counteract (Hochadel, 2016). Klaatsch had made it a personal custom to paste clippings in his personal diaries (Figure 11.6).

Newspaper articles drove the debate (in different ways) about the interpretations of 'sensational' fossil discoveries in the Argentine pampas, La Chapelle-aux-Saints, Piltdown, Steinau and Taung. Transformed into clippings and thus overcoming the ephemeral nature of the press, they provided the raw material for knowledge in the making. The historical actors involved kept their eyes on the daily press, often with the help of a clipping service, to keep abreast of what their opponents argued. Scrapbooks full of newspaper articles materialise the public sphere as an extended battlefield of scholarly debate.



Klose & Seidel

Bureau für Zeitungsausschnitte.

Berlin NO. 43, Georgenkirchplatz 21 I.

(Liest die meisten Zeitungen und ist das bestorganisierte Bureau Deutschlands.)

Zeitung: Staatsbürger-Ztg.

Ort: Berlin

Datum: 2 AUG 191

Buntes Allerlei.

Der Schädelfund in der Teufelshöhle von Steinau bei Schlüchtern,

so wird uns geschrieben, die nun auf dem Umwege über den „sehr frühen Menschentypus" und den „fossilen Affen" als ein Schimpansenschädel erkannt worden ist, soll Anlaß zu einer Gerichtsverhandlung geben. Der Höhlenverein und Professor Klaatsch-Breslau fühlen sich gekränkt, weil ein Mitglied des Vereins die Höhle „gesalzen" hat, d. h. der wertvolle Fund war so hergerichtet und in den Lehm eingebettet worden, daß die Sachverständigen zunächst nicht ahnten, welcher Streich ihnen da gespielt wurde. Daß sie nun zum Kadi laufen und den Uebeltäter bestrafen lassen wollen, zeugt von gekränkter Eitelkeit. Vermutlich wird der Angeklagte die Lacher auf seiner Seite haben, denn die Erkenntnis, daß das corpus delicti nicht einem Ureuropäer des Loräns, sondern einem vierhändig auf Tropenbäumen spielenden Afrikaner angehört hat, ist den Gelehrten ziemlich spät aufgegangen. Bekanntlich wird mit nichts so sehr in der Wissenschaft jongliert, als mit Theorien und Spekulationen über die Abstammung des Menschen. „Mit Worten läßt sich trefflich streiten, mit Worten ein System bereiten", dieser Satz ist dem Verfahren mancher Naturwissenschaftler wie auf den Leib zugeschnitten, und künftige Geschlechter werden, wenn sie sich normal weiterentwickeln, diese Herren nicht anders einschätzen, wie wir es heut mit mittelalterlichen Astrologen und Alchimisten tun. Gerade die Klaatsche Hypothese, wonach alle Vierfüßer ursprünglich Vierhänder gewesen sein sollen, dürfte diesem Schicksal anheimfallen, und wenn der jetzt mit einem Prozeß bedrohte Mann, der die Schädelnähte des Schimpansen so sorgfältig mit Lehm einrieb, sein Handwerk versteht, wird er das Recht für sich in Anspruch nehmen, diese wolkenwandelnden Hypothetiker mit einem Scherz auf die Probe stellen zu dürfen, und er wird dies damit begründen können, daß nirgends die berühmte Uneinigkeit der Gelehrten ...

und Zahnreste des vielberufenen Pithecanthropus erectus von Trinil hat sich eine Uebereinstimmung erzielen lassen, und alle Knochenfunde von prähistorischer Herkunft sind weniger für die Entwicklungsgeschichte der menschlichen Rassen als für die vom Stamme der Deutobolde-Mystifizinski bezeichnend. Gleichwohl bemüht sich der Häckelismus mit seinen Anhängern, unbekümmert um logische Einwände und wohlangebrachte Skepsis, Hypothesen die Festigkeit von Tatsachen anzudichten, während doch ein Blick auf die entwicklungsgeschichtliche Literatur erweist, wie sich gerade „fortgeschrittenste" Geister auf diesem Gebiet mit ihren Widersprüchen in den Haaren liegen. Sie können es um so ruhiger tun, als unserer Zeit der überragende Wissenschaftler fehlt, der wie Lichtenberg mit gründlicher Gelehrsamkeit und souveräner Beherrschung des Gebiets kaustischen Witz verbindet. Welche Fülle von Stoff böte sich ihm, und wie würde der große Göttinger den Schimpansen der Steinauer Teufelshöhle ausstatten mit den Waffen der Ironie und der Satire im Kampfe gegen den modernen, phantasiereichen Entwicklungsprofessor. Zu erwägen wäre noch, aus welchem Rechtsgrunde die Klage gegen das Mitglied des Höhlenvereins angestellt worden ist. Materielle Vorteile wird es kaum aus seinem Spaße gezogen haben, und dann bliebe nur die „Vorspiegelung einer falschen Tatsache" übrig. Die ist aber ohne das Ziel eines rechtswidrigen Vermögensvorteils nicht strafbar; zum Glück! Denn sonst müßte mancher, der Stammbäume des Menschengeschlechts entwirft oder ihm eine Molchmaus als Ahnherrn zuschreibt, mit dem Strafrichter in Konflikt geraten. Jedenfalls gehen wir einer lustigen Gerichtsverhandlung entgegen, und wenn der einst so schmählich verkannte mit Lehm gefüllte Affenschädel auf dem Gerichtstisch niedergelegt wird, stellt vielleicht der Verteidiger an Herrn Professor Klaatsch die Frage, ob dieser „sehr frühe Menschentypus" nach seiner Ansicht nicht den Namen Lehmann getragen habe.

Figure 11.6 Anthropologist Hermann Klaatsch commissioned the Berlin clipping bureau *Klose und Seidel* to observe the press for articles on the Steinau affair. The search term was 'Klaatsch' (underlined). Courtesy Privatarchiv der Familie Klaatsch, USA.

New media – promoting fossils in the twenty-first century

On 19 May 2009, a team led by the Norwegian palaeontologist Jørn Hurum published their finding of a 47-million-year-old primate fossil. For many months the team had secretly prepared an advertising campaign to present *Darwinius masillae* as the 'missing link' between the ancestors of man and ape. Their media offensive included a popular science book, a BBC documentary and a web page, all released on the same day. To add a human interest touch, the fossil was baptised 'Ida', after Hurum's young daughter. The researchers tried to 'do the job themselves', communicating 'directly' with the general public through their well-orchestrated PR activities – bypassing the media. The researchers did manage to create a global echo for a brief moment, but their campaign soon backfired. Science journalists felt marginalised and 'complained' in public. The scientific relevance of the fossil was fundamentally questioned, and the news coverage quickly focused on the way the research team had attempted to spin their discovery (Lehmkuhl, 2009; also Kjærgaard, 2011; Goulden, 2013: 576).

To conclude this article, we shall briefly return to Atapuerca. Just two months before the public announcement of Ida, in late March 2009, another prehistoric creature stepped into the public sphere. 'Benjamina' refers to more than 30 fragments of a skull found in the Sima de los Huesos. According to the Spanish palaeoanthropologists, the juvenile individual suffered from a rare symptom called craniosynostosis that leads to a premature fusion of one of the sutures of the skull. Her face was disfigured, and she was most likely had disabilities.

Benjamina means the 'loved child.' The members of her group must have helped the little creature to survive – otherwise she would have never reached the age of approximately ten years. In this case, the human touch spin given by the Atapuerca PR worked. The press package included an image of Benjamina drawn by the well-known palaeoartists Alfons and Adrie Kennis. Within a few days, well over 50 articles appeared in the Spanish press, all picking up on the message: our distant forebears already took good care of individuals in need (Hochadel, 2013a: 169; Hochadel 2015b: 114).

At this stage, in 2009, the importance of Atapuerca as an outstanding site for human-origins research had been long established. Telling tales about altruism and social cohesion might have hit many more nerves at this stage than trumpeting scientific nationalism, given the severe economic crisis after the crash of 2008. What palaeoanthropologists, the media and by extension society itself find in hominin fossils always reflects the anxieties of our present.

What's next? Some afterthoughts

The late nineteenth and early twentieth centuries have been described as the 'golden age of the newspaper'. This period also epitomises a crucial phase for the co-evolution of palaeoanthropological research and the mass media. All our examples for collecting newspaper articles in scrapbooks stem from that time. The continuing importance of the printed press in the remainder of the twentieth century as a public space for human origins research – to debate, develop and legitimise its results – has been amply documented in this article. Together with popular science books, exhibitions, visual representations and other media newspapers and magazines have shaped the view of 'our ancestors'.

The case of Atapuerca mentioned at the beginning of this article provides us with a periodisation of the relationship between prehistory and the media. It was still predominantly the printed press in Spain that in the mid- and late-1990s turned Atapuerca into the beginning of Spanish history. Yet at the turn of the millennium, the mass media underwent a major transformation: online media superseded the printed press in readership and relevance. As of 2024, *National Geographic* is no longer at newsstands. Social media supposedly 'democratised' the production of news. The cases of Ida and Benjamina might give us a first taste of the transformation of the public sphere of human origins research.

The digitalisation and virtualisation of palaeoanthropological 'content' (to use the lingo of the new media) has serious consequences for the historian of prehistory. Online databases and search engines have revolutionised the way we may access historic newspapers, including for the nineteenth century. Given the wealth of sources, we may come up with far more detailed and fine-tuned accounts of palaeoanthropological discoveries and debates. Yet this digitisation is quite uneven, once again privileging Western newspapers over the media of low-income countries (often former colonies) as sources. This would make the – much needed – decolonisation of the history of palaeoanthropology even more challenging.

The digitisation and 'democratisation' of current news coverage of palaeoanthropology pose new methodological challenges. Given the spread of news outlets today (including all sorts of social media), it hardly requires any effort to learn about new prehistoric discoveries. Yet it is quite difficult to document and store the 'content'. This information may be accessed instantly, but at the same time it seems infinite and hard to pin down. How should archives and historians document this often highly ephemeral coverage in an epoch where scrapbooks have long gone out of fashion? Only the future can tell. In any case, it will be intriguing to watch how palaeoanthropologists and the new mediascape will continue to co-evolve.

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Notes

1 As a convenient short-hand we will use the term palaeoanthropology to refer to research dedicated to human origins. It is understood that this kind of research has been carried out from researchers from a variety of fields, including (prehistoric) archaeology, geology, (physical) anthropology and so on, and that the term itself only came into use much later. For the complex and multidisciplinary early history of this field see Goodrum, 2009, 2014 and 2016.

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12

Pageants of life: conclusion and epilogue

Chris Manias

One of the most common modes for presenting palaeontology to public audiences (and indeed, organising palaeontological material and narratives) has been a model which could be termed the ‘pageant of life’ – a series of episodes, often starting with the formation of the earth itself, moving through the history of life, with each era in earth history being given its own distinct scene, before transforming or shifting into the next. After the formation of the solar system and the earth – a process often incorporated into grand palaeontological narratives (Figure 12.1)

Figure 12.1 Image from Figuier, 1863, showing the early earth circulating in space in the state of a gaseous star. Author’s collection.

– the first stirrings of life in primordial pools and oceans give way to the exuberance of the Cambrian, before shifting to the first fish, and then the movement of life onto land, especially through early Tetrapods venturing into Devonian forests. Carboniferous scenes of giant horsetails and invertebrates shift into a desertified Permian, before moving into the drama of the 'age of reptiles' – where the narrative frequently lingers, examining the variety and scale of dinosaur life across the Mesozoic, and the marine reptiles in the oceans and the Pterosaurs and early birds in the sky. And then, a mammalian period begins, moving through an invariably tropical Eocene, dramatic plains and forests of the Miocene and Pliocene, and finally the cold and dry tundras and glaciers of the Pleistocene. And at the end, our current world emerges, presented as a time of human dominance – and recent accounts will often emphasise how brief this has been, with the common metaphor of condensing earth's history to a single day placing all recorded human history as a few seconds before midnight.

This is a model with tremendous longevity and flexibility. It is extremely common in popular science works, indeed being entrenched in some of the first attempts to present the history of life to public audiences, like Louis Figuier's *La Terre avant la Deluge* (Figuier, 1863). It is also seen in museum displays, especially those of the late-nineteenth and early-twentieth century, where murals showing scenes from ancient life would be placed alongside fossils and descriptions of particular ages, most dramatically expressed through the Zallinger murals of the Age of Reptiles and the Age of Mammals at the Peabody Museum, and the paintings of Charles R. Knight accompanying displays at the AMNH and Field Museum, but also including a range of smaller scale expositions in museums across the world. It can also be seen in recent documentary presentations of the life of the past. The structures of the 'Walking with…' BBC documentaries followed this model, although with the series themselves released according to periods judged to be of successive public interest – starting with dinosaurs (1999), then moving on to the mammalian 'Beasts' (2001), and finally to the 'Monsters' of the Palaeozoic (2005), with excurses into 'Cavemen' and Mesozoic 'Sea Monsters' (both 2003).

This narrative is constructed according to a complex framework, moving across time in a linear manner, and – according to some formulations – 'up' the chain of being. And indeed, the way the narrative continually ignores persisting taxa which are not regarded as the current 'pinnacle' of life is a frequent criticism of these models. However, it is not simply a story of movement. Within the narrative of earth's history are a series of worlds, each with their own faunas, environments, logic and values, which need to be understood on their own terms. A further narrative trope is the rise and fall of lineages, as different creatures gain dominance or rulership of the earth for a time, only to decline or collapse dramatically, and have their position usurped. Some chapters in this book have gestured towards other possible models, around valuing diversity and variety in earth's history, or around the often-stated uncertainty and contention around knowing the deep past. But it is nevertheless the case that these large-scale narratives, mixing the historicist and the developmental, have been key to the field. And indeed, the unfathomably vast chronologies of deep time almost require this mixed thinking, drawing together change and development on the one hand, and cohesion and world-building on the other.

In a similar way, this book has traced the development of palaeontology across a long period and large geographic framework through specific case-studies, arranged into a structure which mirrors, but also questions, these dominating structures within palaeontological narratives. This compositional choice was of course only one possible arrangement, but has drawn off the narrative conventions of the field, focusing on a mix of famous and lesser-known examples, and showing the entanglement of vertebrate palaeontology with the media, culture and science across the modern period. In this conclusion and epilogue, we turn to thinking about some common threads throughout the book, and some issues that have been raised but have not been possible to follow in the volume itself, and potentially prepare the ground for future work.

Large themes

The chapters in the book have engaged with several large themes, showing the importance of the connections between palaeontology and the public across the history of the field. However, the chapters have also shown risks in this process. Palaeontology has frequently been used to criticise scientific authority (or at least particular brands of it). Some organisms have been stubbornly difficult to present to public audiences – or in some cases, stubbornly persistent in being used to reinforce old tropes and motifs long since rejected by specialists. And the connections between palaeontology and showmanship has been a source of funds and profile for the discipline, but also led to difficulties, as palaeontology became regarded as something unserious, or based on sensationalism or over-speculation rather than sober analysis. All of these aspects mean that palaeontology and its role in public life have been fraught, and so, as a conclusion to this volume, it is necessary to consider some of the deeper and consistent factors at work in the history of the field.

One way of starting to think about these challenges is to think about the very material that palaeontologists use to engage with the past – fossils. The question of 'what is a fossil?,' and under what circumstances geological material becomes regarded as a record of past life, is a long-standing and fraught one within the philosophy of palaeontology. The idea of dinosaurs and other prehistoric animals as essentially 'unobservable entities' who can only be known through indirect means has been presented by Derek Turner (Turner, 2007). But throughout this book, we have seen other factors at play. Fossils are complex things. They are simultaneously highly material – indeed their rocky 'thingyness' as defined by Robert Kohler (Kohler, 2007) is impossible to deny – but also variable and unstable. They are often delicate and fragile, subject to damage in transit, storage and handling, and with some suffering from chemical processes like pyrite decay unless stored under careful conditions. The restored fossils in museums, and particularly the most iconic remains, the skeletons of large dinosaurs and mammals, are often made up of considerable casted material (or are even entirely casts), or required huge amounts of labour and craft to transform the disarticulated fossil material into viewable specimens, as discussed by Caitlin Wylie in her studies of the importance of fossil preparators (Wylie, 2021). These reconstructed forms have consistently been seen as crucial for inspiring interest in natural history, with Richard Owen writing in 1862 how 'it is the common experience of officers of National Museums that no specimens of Natural History so much excite the interest and wonder of the public, so sensibly gratify their curiosity, are the subjects of such prolonged and profound contemplation, as these reconstructed skeletons of large extinct animals,' and that these could be 'gratified at comparatively small cost,' as 'a fossil bone and a coloured plaster-cast of it are not distinguishable at first sight, scarcely by sight at all' (Owen, 1862: 68).

Fossils and the relics of the past are unstable in other ways too. On conceptual levels, they can be used for many different things, and this heterogeneity has often led to a great deal of resonance. We have seen in many of the chapters of the book how tropes cluster around particular groups of organisms. Dinosaurs and their worlds are often regarded as emblematic of the strange and spectacular, but are also deeply puzzling and difficult to reconstruct. Meanwhile, fossil mammals (including hominins) are often regarded as familiar and connected with senses of origins, and attempts to imagine the present and the future. But these are poles around which understandings of the deep past can orientate rather than absolutes, and it is indeed the flexibility of the relics of the prehistory, and how they can be incorporated into a range of cultural concerns and debates, which gives them significance. These can include reflections on environmental change, the history of the earth and its inhabitants, and valuations of particular lifeforms. It can also feed into debates over the role of science in society, how to conceptualise technology and modernity, and the role of changing structures, and styles of the press and visual culture. Valuations of the creatures of deep time therefore veer between the strange and the familiar, and it could be said that this duality is what has rendered them so striking to both scientists and the public.

Palaeontology has also developed a series of 'canons' of iconic forms, most notably particular fossil organisms. To explain this, we could talk about the relative 'charisma' of particular taxa. We have seen some iconic organisms being constructed across the volume, either directly through being the focus of particular chapters, or indirectly as being normative models through which specific case-studies have been compared: whether these are Neanderthals, *Iguanodon*, Sauropods, *Tyrannosaurus rex* (and its potential rival, *Spinosaurus*) or *Dimetrodon*. We have also seen much greater difficulty in the presentation of other creatures, like the Mesozoic mammals or the chimerical *Naosaurus*. But the chapters in the book have also shown there is nothing inevitable about this, and that the presentation of prehistoric animals in the public arena and scientific debates has also depended on a whole constellation of factors – the fossil material itself, imaginings of the animal in life, media reconstructions, journalism, economic resources, symbolic value, and possible 'competitors' in both the public imagination and research interest. The building of the 'canon' of prehistoric animals is something which has shifted and developed with the changing values placed upon palaeontology across its history.

We can also see these issues feed into how particular researchers of the fossil past have been conceptualised and represented – whether this be iconic 'masculine' fieldworkers like Roy Chapman Andrews, 'museum masters' like Henry Fairfield Osborn and Richard Owen, national icons like Florentino Ameghino, figures taken as icons of marginalised contributions like Mary Anning, or modern media stars like Lee Berger. Palaeontological canons include researchers and theorists as well as specimens, and many figures have played an important role in building their own personas and profiles. But this has also worked in more complex manners. The figure of Mary Anning is particularly noteworthy, and tied to changing gender politics and memorialisation within palaeontology. She was acknowledged as crucial for fossil research during her lifetime, but still excluded from the masculine world of scientific associations and publications. After her death, she has been worked into a range of

Figure 12.2 Statue of Mary Anning by Denise Dutton at Lyme Regis (unveiled 2022), which was primarily funded through a crowd-funded subscription. Photograph by Tom Meaker. Shutterstock [Image ID: 2408673627].

narratives around exclusion and marginalisation – becoming a major scientific heroine, indeed one of the most widely-known palaeontologists in history, partly owing to this lack of contemporary recognition (Figure 12.2).

These varied ways of engaging with the deep past and its investigators also highlight another crucial issue present throughout the book – the importance of place and locality to how palaeontology has been discussed in the public arena. We have noted in the introduction that there has been a European and North American centre of gravity to historic studies of palaeontology, and the examples in the book have to an extent underlined this. But we have also seen that this overlays large differences within these areas, occludes the importance of palaeontology in other parts of the world, and also indicates that palaeontology has depended not just on movement and transfers between science and the public, but between different places. The predominance of large-scale palaeontological institutions in New York has shown the dynamics around media and science in urban agglomerations across the late-nineteenth and twentieth centuries. The national importance of palaeontology in the US, China, Germany, Argentina and Britain has been emphasised, sometimes as linked with national pride, but also through questioning or debating the place of science within particular national contexts. And the importance of whole landscapes associated with iconic fossils – whether these be the western states of the US, Liaoning, the Sahara, or the Argentinian pampas – and the cultural values placed on these regions, have all given additional importance to locality within palaeontology.

And this raises a further point of importance for palaeontology in the public arena, again reinforcing the duality of palaeontological work. The appeal of palaeontology and the deep past partly derives from feelings of distance, whether this be geographic through imaginings of romanticised field-sites (often in colonised territories), or temporal distance, in the lost worlds of the Palaeozoic, Mesozoic and Cenozoic when the fossil animals lived. But it is also directly connected with local identities much closer to the homes of the audiences and researchers (indeed, often right beneath their feet). This includes Buenos Aires construction sites or quarries in Oxfordshire and Sussex as places for fossil excavation, linking with shifting modern economies and urban environments. Meanwhile, the prominence of museum displays in large metropolises like London, New York, Berlin, Beijing and Paris, and smaller cities like Greifswald in northern Germany and Lufeng in Yunnan, ensure that educational and museum palaeontology is deeply enmeshed in a range of places, and provide centres of work and research with varied levels of influence and prestige. And the wide spread of palaeontology across different media genres – film, newspaper, cartoons, illustration, literature and photography – makes it ubiquitous across different forms of modern culture. The palaeontological past can be encountered everywhere.

This familiarity is a further issue relating to the popularisation of palaeontological science. By bringing the staggeringly vast chronologies and unfamiliar organisms of deep time into the everyday, it to a degree domesticates them, makes them safe, and thereby conceptually and ideologically graspable. There are still of course significant barriers in its presentation – including access to media and museum venues, and in levels of interest and emphasis – but palaeontologists have nevertheless been able to use the flexible motifs of the deep past to intervene on a range of levels, and public commentators have worked palaeontological discussion to address and engage with a range of concerns, issues and desires. And these drives have been mutually dependent throughout the history of the field.

Future directions

Of course, any book like this has notable gaps and areas which could not be covered, for reasons of space, cohesion and availability of expert commentators. As this book is by no means intended to be the last word on these matters, but is intended to act as a springboard for future work and commentary, it is important to discuss some of these absences here, and raise some examples which could not be treated in depth, but would be important avenues for future work. In some ways these reinforce the book's arguments, but also show other trends, and alternative perspectives. And – despite the upsurge of historical studies and reflective accounts around the cultural dynamics of palaeontology over recent years – there are many areas to be covered. One notable example is that despite the huge focus on dinosaurs in considerations of the history and cultural role of palaeontology, we still lack a good study of one of the key modern developments in the field: the so-called 'Dinosaur Renaissance' of the 1960s and 1970s. This has been shown throughout the book as being crucial for the development of current views of dinosaurs as active, dynamic animals, and was promoted through a combination of fossil analysis, tactical scientific publishing, popular writing and documentary appearances by key figures like Bob Bakker, and – according to Victor Monnin in one of the few academic studies of the 'renaissance' – new understandings of palaeoart and the history of the field (Monnin, 2023).

Going beyond dinosaurs, the largest omission, and possibly the most difficult for the composition of the volume, is that we still lack good studies on the history of invertebrate palaeontology – both in terms of its public role and the development of the field. While invertebrate fossils do feature in some classic works (Rudwick, 1976), they disappear from much of recent literature, with a few rare exceptions (Allmon, 2020). This is a huge gap. Invertebrate palaeontology was often institutionalised separately to vertebrate palaeontology and was often given a less overtly spectacular profile, but was nevertheless large in scale – with the majority of animal fossils being invertebrates (by an extremely significant margin), which could be arranged according to diversity and variation. Invertebrates have therefore played a crucial role in the development of palaeontological science, and its wider significance. Since the inception of the field, invertebrate fossils were critical for palaeontological and geological projects of understanding changing eras in earth's history, for correlating geological strata around the world, and for attempting to understand past environments, with changes between land-dwelling, freshwater and saltwater mollusc shells being used to identify periods of dry land, lake or riverine deposits, and marine inundation in particular locations. Invertebrates also played crucial roles in early debates on evolution and development. Even before Darwin, scholars like Jean-Baptiste Lamarck and Geoffroy Saint-Hilaire argued for their significance in showing how life may have transformed in previous eras. Meanwhile other scholars, like Georges Cuvier, noted changes and differences in invertebrate faunas across the eras as indicating great catastrophes and radical disjunctions. And more recently, invertebrates – converted into data – have been crucial for the development of new 'palaeobiological' models and to reinvigorate ideas of mass extinction and catastrophe (Sepkoski, 2012). Across all of this, the importance of invertebrate fossils for locating geological formations likely to include coal and oil, has been crucial for the entanglement of palaeontology with fossil-fuel based economies.

Invertebrate palaeontology has also been embedded in popular culture in important ways. While museum displays of prehistoric invertebrates tend to be relatively low-key, the abundance of invertebrate fossils has meant they have been widely engaged with for extremely long periods. The use of what palaeontologists would classify as ammonites in religious and mythic practices has for example been a huge feature of many cultures – from the use of shaligrams in Hindu temples to European 'snakestones'. And the abundance of invertebrate fossils has made them a core focus of fossil-hunting by interested amateurs, ranging from

Victorian naturalists, to schoolchildren, to quarry workers. Again in a link with the locality and public narratives, the idea of fossil collections being key to the formation of scientific careers is an important trope. Indeed, in both the BBC series *Lost Worlds, Vanished Lives* (1989) and the more recent biopic *A Life on Our Planet* (2020), David Attenborough – possibly the most prominent promoter of natural history in the global media – presented the story of collecting invertebrate fossils near his childhood home in Lincolnshire as the first germination of his investigation of the natural world. And the ability to find, own, possess and relatively cheaply purchase fossils of trilobites, ammonites and brachiopods makes them an important personal connection to the deep past.

The reasons for the relative neglect of research into the public role of invertebrate palaeontology in the secondary literature may partly be because of the assumed lack of 'charisma' of invertebrates. It may also connect to the stereotypes discussed earlier in this volume over the Chain of Being, with invertebrates by definition being understood as 'low' in the scale of life, and therefore less worthy of attention than huge dinosaurs or elevated mammals. But this very 'lowness,' and the assumed foundational nature of invertebrate life, has been important for interest in them. One particularly strong example is presented in May Kendall's *The Lay of the Trilobite*, which first appeared in the British comic periodical *Punch* in 1885 (Figure 12.3). This poem imagined a Victorian author (presumably a naturalist) being led on a reflection on humanity, science, progress and development by a fossil invertebrate. The full text can be seen in the accompanying figure, and starts with the overconfident human encountering the fossil trilobite, which emerges from the rock to regale him with its analysis of the confusion of modern scholarship and society, and the evils of war and colonialism (contrasted with the trilobite's own existence which was 'gentle, stupid, free from woe'). The matter ends with the scholar lamenting the pace and extent of evolutionary and social development. For Kendall, invertebrates could be brought into conceptual meditations on the strange and unfamiliar, the distance between different forms of life, and ambivalence over ideas of progress and superiority – and the scientific theories and debates which accentuated and defined these concepts.[1]

A later attempt to promote the importance of invertebrate life in a way which bridged the public and scientific was presented by Stephen Jay Gould in his popular science book *Wonderful Life* (1989). Gould was a key figure who combined high-level scientific activity, innovative work in the history of science, and prominent efforts at science popularisation. *Wonderful Life* brought all these interests to bear on the 80 years of

THE LAY OF THE TRILOBITE.

A MOUNTAIN's giddy height I sought,
Because I could not find
Sufficient vague and mighty thought
To fill my mighty mind.
And, as I wandered ill at ease,
There chanced upon my sight,
A native of Silurian seas,—
An ancient Trilobite!

So calm, so peacefully he lay,
I watched him e'en with tears.
I thought of Monads far away,
In the forgotten years.
How wonderful it seemed, and right,
The providential plan,
That he should be a Trilobite,
And I should be a Man!

And then, quite natural and free,
Out of his rocky bed,
That Trilobite he spoke to me,
And this is what he said:
"I don't know how the thing was done,
Although I cannot doubt it;
But HUXLEY,—he if any one
Can tell you all about it:—

"How all your faiths are ghosts and dreams,
How, in the silent sea,
Your ancestors were Monotremes—
Whatever these may be,—
How you evolved your shining lights
Of wisdom and perfection,
From Jelly-fish and Trilobites,
By Natural Selection.

"You've KANT to make your brains go round,
And CARPENTER to clear them,
And Mathematics to confound,
And *Mr. Punch* to cheer them.
The native of an alien land
You call a man and brother,
And greet with pistol in one hand,
And hymn-book in the other!

"You've Politics to make you fight,
And utter exclamations,
You've cannon, and you've dynamite
To civilise the nations.
The side that makes the loudest din
Is surest to be right,
And oh, a pretty fix you're in!"
Remarked the Trilobite.

"But gentle, stupid, free from woe,
I dwelt among my nation,
I didn't care, I didn't know,
That I was a crustacean;
I didn't grumble, didn't steal,
I *never* took to rhyme,
Salt water was my frugal meal,
With carbonate of lime."

Reluctantly I turned away,
No other word he said;
An ancient Trilobite he lay
Within his rocky bed.
I did not answer him, for that
Would have annoyed my pride,
I merely bowed, and touched my hat,
But in my heart I cried—

"I wish our brains were not so good,
I wish our skulls were thicker,
I wish that Evolution could
Have stopped a little quicker.
For oh, it was a happy plight
Of liberty and ease,
To be a simple Trilobite
In the Silurian Seas!"

Figure 12.3 The title image and text for Kendall's 'The Lay of the Trilobite,' 1885: Sharp-eyed observers will notice that the creature depicted is far more like what modern palaeontologists would class as a Eurypterid than a Trilobite, possibly reflecting the vague general understandings of the creatures of the age of invertebrates in this period. Author's collection.

research on the Cambrian fossils in the Burgess Shale formations in Canada, through the initial excavations in the early twentieth century (locked in contemporary views of inevitability and progress), and the new methods of morphological analysis and concepts of evolutionary development which re-evaluated the finds in the 1970s and 1980s. The strange, almost psychedelic invertebrate denizens of the Burgess Shale, including *Opabinia*, *Hallucigenia*, *Anomalocaris* and *Pikaia*, were presented as critical for understandings of life's history. Gould indeed asked the question (reflecting on the canon of prehistoric animals) 'Why is *Opabinia*, [a] key animal in a new view of life, not a household name in all domiciles that care about the riddles of existence?' (Gould, 1989, 24). More recent research indicated these animals represented a huge flowering of distinct forms, very difficult to understand but indicating a veritable 'explosion' of life, of which only a few lineages had persisted into later geological periods. The creatures of the Burgess Shale simultaneously presented a lost world of alien but innovative animals, and a vision of scientific activity which worked in a complex and fitful manner, linking scholarly communities and the public. Gould used the Burgess Shale fossils and the 'Cambrian explosion' to make a compelling, and much repeated argument, driving against ideas of progress and inevitability in life's history. Research on these fossils had:

> confronted our traditional view about progress and predictability in the history of life with the historian's challenge of contingency – the 'pageant' of evolution as a staggeringly improbable series of events, sensible enough in retrospect and subject to rigorous explanation, but utterly unpredictable and quite unrepeatable. Wind back the tape of life to the early days of the Burgess Shale; let it play again from an identical starting point, and the chance becomes vanishingly small that anything like human intelligence would grace the replay (Gould, 1989: 14).

Indeed, the metaphor of the 'tape of life' has been one of the most enduring quotes related to Gould's ideas (even if later technological change makes the reference increasingly antiquated). And these arguments were also important for relationships between fields and disciplines. It was history that had lessons for scientific thinking, and implications for the truth claims of palaeontology and narratives around the 'pageant' of evolution.

Fossil plants and palaeobotany have also been relatively neglected in the secondary literature, which palaeobotanist Susannah Lydon has cited as an example of the wider phenomenon of 'plant blindness' in wider culture (coined by Wandersee and Schussler, 1999), where plants are ignored and unrecognised in general engagement with the environment. But there is still a huge amount of interest and scope here. There has recently been something of an upsurge in drives for 'plant humanities', examining how plants can illustrate a whole range of important cultural, policy and scientific issues ranging from economic concerns, to understanding landscapes and shifting views of natural history (Driver and Cornish, 2020). And the connection of plants with important economic processes, most notably fossil fuels and agriculture, is a key interface for their significance. And indeed, one of the only studies on the cultural role of palaeobotany in history has raised fascinating points around how plants became central for linking ideas of deep-time, with attempts to understand nature and the coal-based economy, connecting Victorian crazes for fern collecting and building terrariums with interest and engagement with coal (Yuval-Naeh, 2019). This all indicates the deep roots and wide potential of considering plants as well as animals as crucial indicators of deep time.

As well as this, the history of engagement with other groups, like fossil fish and amphibians, have also seen relatively little study. While not as widely promoted in public contexts as even invertebrates, fish in particular have been important for histories of evolution and taxonomy, and have also in many places become the centre of particular fossil trades, most notably those from the Green River Formation in Wyoming. Fossil birds meanwhile would be a hugely important area for work. Large robust flightless birds, especially the New Zealand Moa and the Madagascan *Dinornis*, have been key to debates over palaeontology, comparative anatomy and extinction since their remains were first encountered by Europeans in the nineteenth century, and are also of course closely connected with Maori and Malagasy cosmologies (Barton, 2000; Anderson, 2013). And more recently, the history of bird evolution, and its connection with new finds from China, deserves further study. This has partly shifted understandings across both science and popular debate, but also led to a tremendous amount of resistance. This has not only been among certain public audiences claiming that placing feathers on reconstructed dinosaurs somehow 'ruins' them, but has also been part of a wider insurgent movement within palaeontology rejecting the direct connection between birds and dinosaurs (Feduccia, 2020). While now well outside the scientific mainstream, these issues show the continued importance of international connections within modern science, and the continuation of disputes around scientific authority.

There is another set of areas for additional work around the geography and the locations covered in the volume. While we have aimed for wide coverage in this volume, the focus has still been predominantly on Europe and North America. In some respects this is understandable, given that these are the regions where palaeontology has historically been most concentrated, where the largest amount of resources have been channelled into palaeontological work, and where palaeontological popularisation has been promoted for the longest. However, these are far from the only regions where palaeontology was prominent both today and in the past. While the upsurge in palaeontology in China from the later twentieth century has been in some respects a novel development (although drawing off long traditions), other places – such as Argentina, have persistently been crucial to the development of the field. And we cannot talk of 'Western' or 'Northern' palaeontology in isolation. Fossils and extant organisms from Africa, Asia, and Australasia have been essential to the elaboration of the palaeontological past since the inception of the field. And the role of palaeontology and discourses of prehistoric survivals has often been crucial for presenting particular parts of the world as being 'primitive' – whether this be Australia as an 'ancient' continent with 'prehistoric' flora and fauna, or that Africa and South America closely mirror past eras in earth's history. And notably, both Arthur Conan Doyle's *The Lost World* and Crichton's *Jurassic Park* use South and Central America as the site of the surviving or reconstructed prehistoric world.

Deep time has been significant in numerous geographic contexts, but this interest has been unevenly researched. There is a strong literature on the history and role of the geological and palaeontological sciences in Australia (Douglas, 2004; Minard, 2018; Chakrabarti, 2019) and South Asia (Nair, 2005; Chakrabarti and Sen, 2016; Chakrabarti, 2020). But there are other parts of the world where we have relatively little idea of the historical and cultural role of palaeontology. This includes some major scientific powers. The history of palaeontology in the lands comprising the former Russian Empire and the Soviet Union is extremely uneven, despite this being on a huge scale and presenting some of the most important finds in cementing ideas of deep time. We do have some work on the history of interest in Siberian mammoth remains, which were essential for cementing the idea of extinction in the late-eighteenth century, and connected with the expansion of Russian imperial power (Cohen, 2002; Mckay, 2017). And more recently, the trade in mammoth ivory and fossil bones from melting permafrost has become an important economic sector in north-eastern Siberia (Wrigley, 2021). But other aspects of northern

Eurasian palaeontology are much less well examined. The role of Russian palaeontology in the elaboration of the Permian as a period, and then through increased contact between Soviet and Western palaeontologists in the 1980s and 1990s, in developing concepts of the 'Great Dying' is barely appreciated (but is discussed from a participant's perspective by Michael Benton (2015)). There are also no significant histories of palaeontology in the USSR, despite the subject's very high profile role, and its connections with geology and evolutionary biology, two sciences regarded as hugely important for building the communist system. And with the notable exception of some work beginning on the history of the deep-time sciences in China, the development of these fields in the rest of the communist world in the twentieth century has been largely neglected, despite the extensive fossil work conducted in Romania and Hungary, and the importance and extent of the Polish–Mongolian expeditions in the 1960s and 1970s.

A further major gap in the literature is the history of palaeontology in Africa. There is work on North African fossils in the early-twentieth century, on the large-scale excavations in Tendaguru in modern Tanzania, and in human origins work, but this is still nowhere near as developed as it deserves to be. Africa has been a key field of palaeontological research since the nineteenth century, in ways which have been closely connected with particular valuations (and devaluations) of African wildlife and human society, and the expansion of colonial and extractive systems to exploit the continent's resources. The case of Tendaguru is particularly telling in this regard. The excavations in the region since the 1900s have been one of the most widely-studied projects in the history of palaeontology, but we still know relatively little about how the fossils were engaged with by African people, despite some consideration by the Dinosaurs in Berlin project (Heumann et al., 2018). The scope of current engagement with the region's fossil heritage is also little appreciated, despite there now being reconstructed dinosaurs in Lindi close to Tendaguru, and the finds have been promoted to Tanzanian audiences through Swahili publications like *Dinosaria wa Tendaguru* (1998) (partly funded through Germany's Goethe Institute). And this lack of study is in relation to an extremely well-studied site. Other parts of Africa are even less well investigated. The role of palaeontology in Nigeria (where the field is closely connected to the oil industry), the Sahara (exploited tremendously by French and American teams in the latter part of the twentieth century), and Ethiopia (crucial to the history of human origins research) is also essentially un-researched.

The role of palaeontology in South Africa has also been traced in human origins research, but the interlinkages of palaeontology in southern Africa with mining and the formation of state and economic systems is under-examined – with the exceptions of some conceptual works on the intellectual implications of deep time (Dubow, 2020). Also largely unstudied is how research into what were termed 'mammal-like reptiles' was – for much of the twentieth century – a field dominated by South African finds and scientists, and connected in important ways with building White South African scientific institutions, the development of conceptions of deep time within the continent, and particular visions of scientific nationalism in the Apartheid state. In the post-Apartheid period meanwhile, palaeontology has become increasingly widely engaged with, with human origins research being simultaneously connected with political projects like Thabo Mbeki's 'African Renaissance' (Kuljian, 2016) and with international media sensationalism, such as the Rising Star excavations and discussions around *Homo naledi*. And dinosaur work has also absorbed much attention, especially linking research in South Africa and Lesotho, through the promotion of local dinosaur finds like the sauropodomorph *Ledumahadi mafube* (meaning 'giant thunderclap at dawn' in Sesotho), projects like Sibusiso Biyela's translation of dinosaur terminology into Zulu to develop new forms of vernacular science-writing (Biyela, 2019), and the highlighting of sites in Moyeni/Quthing and

Figure 12.4 Photograph of palaeoart at the entrance to the Quthing Dinosaur Footprints site in Lesotho, taken by Ariadne Van Zandbergen. Alamy [Image ID: 2826R03].

Mokhali cave in Lesotho, in which dinosaur footprints have been found close to San rock art, potentially indicating long African engagement with fossil traces (Helm, Crause and McCrea, 2011) (Figure 12.4).

As well as issues around the significance of particular taxa and the need to bring neglected places more fully to the centre of analysis, there are also some more conceptual jumping off points for future work – and where similar multidisciplinary work, bringing communities of like-minded people with differing expertise to work on a shared problem, would have significant potential. One point which has been raised throughout this book is the significance of art for palaeontological work. Art has been crucial to the development and promotion of the field, and has been one of the clearest areas where public and scientific issues have been deeply entangled. In palaeontology, art has persistently been a core part of the scientific process. Illustration and technical drawing have been essential to reconstruct animal anatomy from fossil material, and fully-developed palaeoart has played a key role in visualising and imagining living breathing organisms and full ecosystems from the often fragmentary and scrappy fossil record. In this way, art has been an important tool for analysis, a means of testing hypotheses, and a way of engaging other scientists and public audiences with the field. This has necessarily ensured that collaboration with artists has been key to the development of palaeontology (with frequent debates and disputes over where authority ultimately lies), and has meant that many palaeontologists have themselves been trained artists. Palaeontology therefore provides an extremely interesting case of a field where art and science are fundamentally linked. While there have been some attempts to analyse this in a more in-depth manner (Witton, Naish and Conway, 2014), or position palaeoart within the sphere of art history (Lescaze, 2017), these are still initial steps, and further and deeper work would expand the field tremendously.

A further area where cross-disciplinary perspectives are necessary is the need to amplify marginalised perspectives within palaeontology. This is a process which is simultaneously very current, and also historical. In the present, palaeontologists are moving to diversify the field, by removing barriers to entry for people from under-represented and minority communities (Giles, Jackson and Stephen, 2020; Fernando et al., 2023), and bring palaeontological public engagement to broader and more diverse audiences. But it is also an area where history and the cultural development of the discipline have been key. This is partly in terms of the history of the field, and how it became so deeply connected with imperial, White and masculine tropes and structures over the initial years of its existence. These stereotypes have persisted to this day, but are slowly being deconstructed. However, history also potentially provides alternative perspectives and voices, and can be used to illustrate the much wider range of people involved in the history of the field who have nevertheless been marginalised in traditional histories of the discipline. These include women workers who were often crucial to the development of particular fields and research projects, but delegated to under-valued roles (like fossil preparators, artists, typists, and editors), and so excluded from final published reports. It also involves thinking about the actual fieldworkers within many excavation projects, who were frequently working-class and colonised subjects, who had considerable expertise and experience in working with the earth and identifying material. Projects like TrowelBlazers have been very effective in drawing out the contributions of women and other hidden figures in the history of the field. And this is all part of developing a fuller image of the history and current engagement of palaeontology, which can in turn link with developing greater variety and diversity in the present.

Palaeontology is also not the only field which has been defined and shaped by interactions between science and the public, and has frequently been linked with other scientific areas with similar dynamics. The most notable of these would be astrophysics and broader patterns of 'astroculture', where there has simultaneously been huge public interest feeding into highly complex (and often extensively funded) scientific research, and whose cultural impact has been engaged with through a range of recent studies (Geppert, 2012). Astroculture is also a field where links with palaeontology are often present, and links back to the very foundations of the field. Early evolutionary epics would often begin with accounts of the formation of the universe before moving on to the narrative of earth's history, clearly situating life within cosmic processes. In more recent decades, palaeontology and space culture have been closely entangled in many ways. Soviet palaeontologist Ivan Yefremov was a science fiction writer, Carl Sagan's *Dragons of Eden* (Sagan, 1977) connected human evolution and intelligence with broader cosmic forces, and the 'dinosauroid' thought-experiment by Dale Russell and Ron Séguin was frequently linked with tropes derived from science fiction, and interpreted as an 'alien' by public audiences (Naish and Tattersdill, 2021). As two of the most high-profile scientific fields, the deep time sciences and the space sciences both show similar dynamics and have been closely connected, and more work thinking about the links between them would potentially illustrate a great deal about public science.

The way in which ideas of the deep past therefore interact with scale and cosmology are therefore huge and crucial issues – and ones which have a much greater relevance today. The role of the climate crisis, and biodiversity loss in the present, has often been argued to operate on scales beyond human experience, and is another important area for consideration, and where thinking about the public role of deep time can help us tremendously. Both historians and palaeontologists have often been sceptical of ideas of the 'Anthropocene', given long-standing awareness of human impacts on the environment (Bonneuil and Fressoz, 2017), and that the Holocene is already a period defined by the presence of humans. This shared scepticism (if for different reasons) however overlays the significance of these fields for engaging with current crises. It is not just the case that past periods of earth's history can give us the closest models to possible futures of particular degrees of warming, or provide evidence of taxonomic diversity for most of life's history far more extensive than that present today, but they also potentially provide ways of engaging with the diversity of scales on which environmental change operates. The palaeontological sciences, and their public interface, have persistently been used to connect the planetary and the personal, and provide an important set of resources for engaging with current crises. In these ways, the public role of the deep time sciences is continuing to contribute to broader cultural and social concerns. And as throughout the history of discipline, it looks likely to continue to do so in ways in which public concerns and scientific debate affect and reinforce one another.

Notes

1 See also Holmes (2010) for a longer and deeper analysis of the poem.

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