



## THE SCIENCE OF LOST WORLDS

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## Loss and Wonder

Catching the awkward lull after Ichthy's exchange with the reporter, the Chair moves to wrap up the lecture. Before they can, the graduate student clutching the toy-like Broadfoot model interjects.

"What will you do now?" Many attendees turn to the young theropod in the mildly accusing way of an audience ready to go home, before switching their attention to Ichthy as they take up the question with a last wind of gusto.

"Now?" they ask. "Now I wish to return to the field, and return to the lab, and return to my conversations, and return to my work. I have so many questions still about Broadfoot. Did they burrow? Were they really oviparous? What role did their venom play? I hope that some of those questions will be answered by returning to the site where I found it and undertaking new excavations. And indeed I hope we'll find new questions to ask! With new excavations, we might find further evidence about the organisms that share Broadfoot's environment, as well as information about that environment itself. Broadfoot was presumably part of some ecosystem, and I want to know more about that ecosystem's nuts and bolts. In addition to these new planned excavations—which I admit aren't yet funded—"Ichthy shoots a meaningful look at some of the university administrators in the room—"there's still plenty of material excavated from the site that produced Broadfoot that we've not looked at. Imagine what surprises could be waiting in storage? And further, what new tests, theories, models, and ideas might myself and my colleagues"—another gesture to the cluster of graduate students—"come up with to build upon what we already know?"

"Much scientific work is careful, systematic—monotonous, even—but . . ." Prof. Ichthy's characteristic grin returns, "those moments when you find something new, when you are confronted by something from the past that makes you see everything—even yourself—as if for the first time, that's when I love it."



ILLUSTRATION 10.1 Prof. Ichthy in the Broadfoot Den

It's traditional to finish a book with a summation of the main arguments, and that's my task in section 1 of this chapter. In section 2, I'll expand on the value of studying the deep past, taking the discussion in one final direction. An emotional one. You might think nostalgia or grief are the most obvious emotions for a book about loss, and no doubt there's a lot to be said about these. But I'm not in the mood for the often regressive indulgence of nostalgia nor the necessary, heart-rending work of grief (for the latter, see Jorgensen 2019). Instead, I want to talk about wonder. To underwrite both our recap and discussion, I'll turn to another famous case in the history of the Earth sciences: the Reverend William Buckland's 1821 description and analysis of a Pleistocene hyena den in Yorkshire.

## 1. The Lost World of Kirkdale

Buckland is a usual suspect in any history of 19th-century English geology. According to Pemberton, he “possessed one of the most innovative minds ever to grace the science of geology, but he was also one of its most eccentric characters” (Pemberton 2010, 261). It is tempting to go on and on about Buckland’s eccentricities (if you have an entire book of doggerel verse published in your honour you know you’ve led an interesting life), but I’ll just indulge myself with Lyell’s description of Buckland’s presentation of his paper to the Royal Society on February 21, 1822 (deep breath) *Account of an assemblage of Fossil Teeth and Bones of Elephants, Rhinoceros, Hippotamus, Bear, Tiger, and Hyaena, and sixteen other animals; discovered in a cave at Kirkdale, Yorkshire, in the year 1821: with a comparative view of five similar caverns in various parts of England, and others in the Continent. By the Rev. William Buckland, F. R. S. F. L. S. Vice President of the Geological Society of London, and Professor of Mineralogy and Geology in the University of Oxford, andc. andc. andc.* “Buckland in his usual style, enlarged on the marvel with such a strange mixture of the humorous and the serious that we could none of us discern how far he believed himself what he said” (Lyell 1822, quoted in Pemberton 2010, 246).

Whatever the apparent levity of Buckland’s delivery to the society, the published text itself (as well as the book he published the following year) is serious business.

Buckland describes a large collection of disarticulated bones, partly encased by stalagmites, under thick layers of mud. The bones were from a startling menagerie, from small rodents to ducks to deer to elephants, rhinoceroses, hippopotamuses, and, in great quantity, large hyenas. At the time, the find had a handy explanation: the (or a) great diluvian flood swept the collection of tropical animals northward.<sup>1</sup> Instead, Buckland argued that these animals were part of the normal ecology of *pre-diluvian* (or “antediluvian” in the language of the time) England, and that the menagerie was explained by, as Alan Bewell has put it, “The catholic tastes and scavenging habits of hyenas [which] made them terrific natural history collectors: any animal would do for dinner” (Bewell 2014, 384). That is, Buckland claimed that antediluvian England was populated by species more typical of the tropics, some of which—like

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1 The notion of a cooling Earth was also popular at the time, although Buckland doesn’t discuss it in the Royal Society publication.

the large hyena that populated the cave—were now extinct. That is, Buckland described a lost world (these days we date it to around 130 kya).

Buckland's work was remarkable for several reasons. It was one of the first detailed reconstructions of a palaeontological site. To achieve this, he combined the comparative anatomy of Cuvier with the *in situ* analysis of geological features, becoming distinctive of geological science. It also represented, for those in Britain, a remarkably well-preserved set of perspectival tools underwriting an evocative realization of a lost world. Antediluvian England was not the same as postdiluvian England.

Jim Robins' image of Prof. Ichthy above is inspired by a caricature of Conybeare's, depicting Buckland and his lost world. It represents Buckland, crawling through the cave to be confronted not with disarticulated bones, but the hyenas themselves. As Rudwick describes it: "The picture is no simple reconstruction. Into the cave crawls Buckland himself, candle in hand, illuminating this scene from deep time with the light of science, penetrating the epistemic barrier between the human world and the prehuman, looking perhaps as surprised to see the hyenas as they are to see him" (Rudwick 1992, 40).

Rudwick highlights the caricature as the first visual representation of a lost world in palaeontology. Although textual descriptions existed much earlier, he argues that it wasn't until sufficient knowledge and material evidence had accumulated that the depth of and confidence for pictorial representation of lost worlds were possible. "Once the reality of extinction was generally accepted, these fossils provided in principle the raw material for reconstructed scenes that would differ significantly from any scene drawn from the world of the present day" (Rudwick 1992, 28).

As Rudwick chronicles, once this knowledge had sufficiently accumulated, representations of lost worlds took off, forming a lineage leading to the traditions of palaeoart that diverted us in chapter 7. Additionally, these worlds became increasingly diverse: it wasn't just that there was a world before the flood, but many antediluvian worlds (Rupke 1983). In addition to fossils themselves, palaeoartistic images are the major source for public imaginaries of pre-human times. This reiterates the historical discussion of the first chapter: early geology and palaeontology were motivated by and celebrated for revealing lost worlds.

But what makes a world *lost*? What made the past revealed by the Kirkdale cave a *lost* past? I've defined "loss" in largely ontological terms: something from the past is lost just in case it doesn't exist now. Hyenas, elephants, and hippopotamuses were known to a greater or lesser extent to scientists of the



FIGURE 10.1 Conybeare's Image of Buckland in the Hyena Cave. Wikimedia Commons

time, so in what sense did they no longer exist? *Loss*, recall, is sensitive to description. Although hyenas are not lost, they are certainly lost to England's wilderness (as is that wilderness itself). Buckland reported that "the fossil hyaena was nearly one third larger than the largest of the modern species" (Buckland 1822, 189). Thus, this species of hyena was hitherto unknown and long extinct. Further, the ecology and environment these organisms indicated spoke of an England sporting a much hotter climate and a wildly different fauna. As with all lost worlds we've examined, the Kirkdale cave combines the familiar with the unfamiliar.

In reconstructing the cave's formation and ecology, Buckland faced two kinds of challenges. One stems from *erasure*: the information provided by traces was incomplete. For instance, the bones were not preserved in beautifully articulated completeness, but in scattered pieces, "strewed all over like a dog kennel" (Buckland 1822, 183), as Buckland (rather leadingly) described them. The second relates to *loss*: England's caves no longer house hyenas, elephants, hippopotamuses, or rhinoceroses. With loss, we apparently lack the resources required to develop the understanding needed to infer from traces to the past, or to expand on that knowledge; with erasure, we lack the traces to make those inferences, even if we had the requisite understanding. While these challenges are deeply intertwined, this book has focused on loss. So,

given that Buckland and his contemporaries were faced with an apparently unknown world, how did they empirically ground their imagining and reconstructing it? I've argued that to understand this, we must understand how scientists confront both the possibility and actuality of loss and erasure—and we see just this in Buckland's approach. So, let's start with the combination of three strategies: grafting, anchoring, and artificing.

*Grafting* involves linking traces and the denizens they reveal with their particular histories. This includes trace-based reasoning. Using geological theories about cave formation and deposition, brought into deep engagement with the traces, Buckland argued that the cave had been untouched since its discovery, discounted diluvian explanations of its formation, and generally told its history. The close fit between the hyena teeth and marks on the bones provides reason to think the remains were consumed by hyenas. The particular position of the bones, the stalagmites they were clustered among, and the mud and gravel atop them, underwrote his reconstruction. He linked both the cave's particular story with the shared geological history being uncovered across Northern Europe and America.

The accumulation of these bones, then, appears to have been a long process, going on during a succession of years, whilst all the animals in question were natives of this country. The general dispersion of similar bones through the diluvian gravel of high latitudes, over a great part of the northern hemisphere, shows that the period in which they inhabited these regions, was that immediately preceding the formation of this gravel. (Buckland 1822, 201)

So, Buckland told a local story about the cave, but also integrated it into a broader narrative, grafting all the way.

A distinctively biological instance of grafting includes comparative thinking. Buckland's examination of the anatomy and habits of hyenas involved comparison with currently living examples. In addition to the size comparison we saw above, he also drew on behaviour. For instance, you might worry about the presence of macrofauna in the Kirkdale cave. While the numerous deer are highly plausible hyena prey, are we supposed to believe that these hyena, large as they may be, were in the habit of taking down rhinoceroses or elephants? Not at all, Buckland reassures us:

It is foreign to the habits of the hyaena to prey on the larger pachydermata, their young perhaps excepted. No other solution of the difficulty presents itself to me, than that the remains in question are those of individuals that died a natural death; for though an hyaena would neither have had the strength to kill a living elephant or rhinoceros, or to drag home the entire carcase of a dead one, yet he could carry away, piecemeal, or acting conjointly with others, fragments of the most bulky animals that died in the course of nature. (Buckland 1822, 198)

Here, the possible behaviour of extinct hyenas is understood by considering the behaviour of extant hyenas. Buckland is working prior to the emergence of modern notions of evolutionary ancestry (although transformationist ideas were about), so forgive some wince-worthy anachronism: through the lens of contemporary biology, we'd read him as situating his extinct hyenas with their closest relatives via their shared evolutionary history.

*Anchoring* involves examining other cases with specific similarities to the lost target to build a model of the relevant properties. Buckland canvases descriptions of other caves across Europe, noting similarities and drawing on differences to build his case.

The history of the diluvian gravel of the Continent, and of the animal remains contained in it, appears altogether identical with that of our own; and with respect to the bones that occur in caverns, the chief difference seems to be, that on the Continent some of the caves have their mouths open, and have been inhabited in the post-diluvial period by animals of now existing species [*italics in original*]. (Buckland 1822, 216)

The mixture of pre- and post-diluvian fauna in many caves, but not in Buckland's, is explained by the Kirkdale cave being undisturbed since its antediluvian burial. Further, differences in the markings and constitution of the bones are explained by the differences between the continent's bear-dominated caves and England's hyenas: "Such variation is consistent with the different habits of bears and hyaenas, arising from the different structure of their teeth and general organization; from which it follows, that bears prefer vegetable food to that of animals, and, when driven to the latter, prefer sucking the blood to eating the flesh, whilst hyaena are beyond all other beasts addicted to gnawing bones" (Buckland 1822, 221).

Thus, by navigating between various analogues (anchors), Buckland is able to both provide inductive strength to his hypothesis, while also deepening and developing it, along the way finding opportunities for testing by noting and explaining away differences. In a sense, he builds a comparative model of what we should expect from hyena-dominated and bear-dominated caves.

*Artificing* tackles loss by constructing simulacra of lost properties and examining them. Buckland reports that his hypothesis was “rendered almost certain by the discovery I made, of many small balls of the solid calcareous excrement of an animal that had fed on bones” (Buckland 1822, 186). Buckland was able to study a living hyena, “Billy,” when a travelling menagerie made its way past Oxford. He fed Billy ox bones, subsequently investigating both the remnant bones themselves and the droppings. “It was at first sight recognized by the keeper of the Menagerie at Exeter Change, as resembling, both in form and appearance, the feces of the spotted or Cape Hyaena, which he stated to be greedy of bones, beyond all other beasts under his care” (Buckland 1822, 187).

So, faced with a putative trace fossil, Buckland brought about something like the conditions under which such a thing would form and examined it. That is, he engaged in an early example of experimental taphonomy. Indeed, according to his son, Buckland’s examinations of Billy played a large role in underwriting his analysis.

Billy cracked the marrow-bones of oxen, and refused those bones which contained no marrow, exactly as did his ancestors ages before him in the wilds of Yorkshire, as yet untrodden by the foot of man. So wonderfully alike were these bones in their fracture, that, judging from this point alone, it was impossible to say which bone had been cracked by Billy, and which by the aboriginal hyaena of Kirkdale. Again, Billy polished with his feet and hide the sides and floor of his den of wood, as his ancestors did the sides and floor of their den of stalactite in the Yorkshire hills; and as the ancient beasts deposited “album graecum” in abundance after a dinner of bones, so did Billy deposit pounds of the same substance. (F. Buckland 1873, 52)

Here, artificing and grafting blur: Buckland both examines Billy as approximately the same taxon as his extinct cousins and sets up circumstances whereby similar properties are instantiated. As we’ve seen throughout this

book, the three strategies are often deeply intertwined, and it is in their combination that their epistemic prowess takes full flight.

In adopting these strategies, Buckland deftly demonstrates what I've called *strategic perspectivalism*. He characterized his target in an impressive variety of ways, thus isolating properties, which enabled him to connect his lost target to existing empirical information. He reconstructed the geology of a *pre-diluvial cave*, examined teeth both as those of *hyenas* and of *bone-crushers*, considered them as *partially preserved vertebrates*, as *hyenas*, as *scavengers*, and so on. These various isolated properties were then knitted together—recontextualized—to provide a coherent narrative about the cave, its inhabitants, and their collective history.

Further, these processes involved frequent *iteration* between isolated properties, ideas about them, and the various comparators. For instance, in his comparison between the Kirkdale cave and others in Britain, he didn't simply learn about his target, but also the other caves, "the origins of which though not before satisfactorily made out, becomes evident as a corollary from the proofs afforded by the cave at Kirkdale" (Buckland 1822, 208). That is, Buckland's Kirkdale interpretation makes sense of various other caves across Britain, not as well-preserved and untouched as Kirkdale, but nonetheless carrying the (now) telltale signs of the antediluvian lost world. The model, then, is built by navigating between various interpretations of the various caves.

It's striking that, although Buckland worked before many of the theoretical edifices of modern geology and palaeontology had been erected, using what are now outdated ideas about the Earth's history, he nonetheless adopted similar strategies, as we've seen modern palaeontologists use to uncover lost worlds. Although he wouldn't have seen his comparisons between extinct and extant hyenas in terms of evolutionary homologies and would have seen the cave as part of a diluvial history, these strategies enabled him to get a lot right. It is plausible that we see here the employment of a *style of reasoning* (Hacking 1992) that has been more or less stable across two hundred years of scientific development.<sup>2</sup>

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2 It is worth noting that artificing is significantly more limited in Buckland's approach compared to the modern cases that have dominated this book. David Sepkoski (2019) has emphasized the role of modelling and more formal approaches to data analysis through the Palaeobiological Revolution. It may be that artificing only really came into its own once those theoretical and technical capacities were developed and adopted into palaeobiology.

This style of reasoning, and its ongoing success, provides reason to think that the Earth sciences reveal a highly *peculiar* past. Buckland's analysis relied on a world boasting fragile regularities and flux. Patterns are explained in terms of the various generating and maintaining processes that account for them and their exceptions. The Kirkdale cave's being undisturbed contrasts it with many others and explains its special epistemic status; the pre- and post-diluvial worlds were deeply different—played by different rules and populated by different denizens—but were not so different that Buckland was left epistemically rudderless. Further, the knowledge he generated was deeply *modal*: Buckland's analysis didn't simply tell us what happened to the cave, but gave insight into how the cave might have been different. Had it been disturbed, say, we wouldn't have seen the same bone composition or distribution; had it been the domicile of bears rather than hyenas, we would have seen differing patterns in the bone. And this modal knowledge is not simply epistemic, but objective: when successful, it tells us how, in fact, things would have been under different conditions.

Commentators on Buckland's work and its reception have emphasized imagination. As Ralph O'Connor says of Conybeare's depiction: "Buckland's work enabled people to imagine a past neither seen by man nor revealed by Scripture—an act of visualization whose strangeness is conveyed by the need to represent the present-day geologist 'watching' the events depicted" (O'Connor 2015, 69).

I've argued that we should understand scientific imagination in terms of *artifactualism*. That is, Buckland and his contemporaries' ability to imagine and depict lost worlds was embedded in and carried by deep engagement with both the traces of the past and the various linguistic, theoretical, and formal models that they employed to understand them. Without the revelation of the Kirkdale cave and sites like it, it is highly unlikely that Buckland and company would have imagined such an antediluvian world—their imaginations were impoverished—and, had they happened to, there would be no reason to take such imagining particularly seriously—their imaginations were too arbitrary. However, with those traces, their analysis, and the deployment of various other perspectival tools, their capacity to so imagine becomes relevant and revealing of rich pasts.

Artifactualism is one way of pulling focus from the individual scientist and embedding them in the material culture of their work, as well as drawing attention to the collective efforts involved. Reflecting on Conybeare's caricature, again, consider Manias' discussion:

Fossil excavations were the work of many people. While the famous caricature by William Conybeare depicted Buckland's investigation of the Kirkdale "hyena den" as the personal journey of a gentleman scientist into a former world, other images illustrate more collective work . . . Geological surveying, infrastructural projects, and mining were the most extensive acts of digging in the nineteenth century, and a frequent source of fossils. While miners and quarry workers were often occluded in scholarly texts, they were often the people most responsible for excavating and finding fossils. (Manias 2023, 31)

That our narratives of scientific discovery frequently make invisible many of the workers crucial to it is a familiar theme in the sociology and history of science (Shapin 1989; Barnett 2020; Wylie 2021). An artifactualist account of imagination highlights the discovery, invention, preparation, construction, and maintenance of the artifacts that constitute scientific work. Presumably to his credit, Buckland's account of his discovery names not only broad-shouldered giants like Cuvier, but also figures like W. Salmond, Esq., who "has been engaged with much zeal and activity in measuring and exploring new branches of the cave, and making large collections of the teeth and bones, from which I understand he also intends to enrich our public cabinets in the metropolis" (Buckland 1822, 181–182), although the "workmen" who found the cave remain nameless.

So, in Buckland's two-century-old interpretation, we can sketch many of the contours I've developed throughout this book. He adopted perspectives strategically—grafting, anchoring, and artifying—before knitting it all together into a narrative concerning a lost world. In doing so, he used the artifacts of his work—the fossils, the cave itself, analyses of other caves, living hyenas, and reports about the hyenas—to facilitate his imagination and an exploration of possibility deeply rooted in an actual past. This lost world was peculiar, an ecosystem dependent on England's past environment and the contingencies of history. Hyenas lived, died, and gnawed bones in the cave for generations, but this stability was fragile. In the Kirkdale cave's uncovering and its reception, we can also draw out my final theme: the relationship between loss and wonder.

## 2. Lost Worlds and Seeing Anew

Historicity is negated by the assumption that the world is “already there,” whereby its “thereness” is taken for granted as the background of action in the present. To see the world as if for the first time is to notice that which is there, is made, has arrived, or is extraordinary. Wonder is about learning to see the world as something that does not have to be, and as something that came to be, over time, and with work. (Ahmed 2014, 179)

Buckland’s analysis of the Kirkdale cave underwrote a new imagining of England, one with a dramatically different past. Unsurprisingly for the era, this was often approached with a heavy dash of the romantic (Sommer 2003). The heroic wildness of this imagined antediluvian age and the romance of its loss is captured in Philip Duncan’s poem, *The Last Hyena* (one of those published in honour of Buckland):

High on a rock, which o’er the ragin flood  
Reared its bleak crag, the last Hyaena stood;  
Beneath his paws a kindred skull was seen,  
And he, with commons short, looked grim and lean;  
Potent his jaw to crack his bony rapine,  
Potent his stomach as the Pot of Papin;  
O’er this last bone of many a murdered brother  
He growled, for he in vain had sought another.  
Full oft, like Captain Franklin, did he prey,  
On bones rejected in a former day;  
But now the whelming surge had buried all,  
In caves below, of beast both great and small,

But e'er it rose to mix him with the rest,  
 Thus did he growl aloud his last request:  
 "My skull to William Buckland I bequeath." –  
 He moaned, and the ocean's wave he sank beneath;  
 Southward the flood from Yorkshire chances to travel,  
 And rolled the monster deep in Rugby gravel.  
 (Duncan 1869, quoted in Pemberton 2010, 255)

In a style reminiscent of romantic evocations of the loss of what we'd now call Indigenous cultures in the wake of colonialism, coupled with shades of the "heroic" sacrifices sometimes made by those colonists themselves, Duncan describes England's final hyena, starved of its usual diet and driven to cannibalism, being overtaken by the great deluge whilst giving its mortal remains to the future. Duncan's poem links the heroic past with its remains. The last hyena provides its skull to Buckland and is buried in Yorkshire, underneath familiar gravel. Understanding the past, and how it might have been different, can lead us to see the present and how it could be different, anew. We gain Turner's "stereo-temporal" vision. Where quarrymen now labour, once the hyena prowled. The "light of enlightenment," represented by Buckland's torch in Conybeare's picture, doesn't just fall on the hyena, but on the cave, and on Buckland himself.

In chapter 9, I sketched a set of ways in which knowledge of the past might be epistemically valuable. I want to add a final piece to this by highlighting a further element: *wonder*. In doing so, I'll largely draw on Helen de Cruz's recent *Wonderstruck*, which, generally speaking, provides a broad account of wonder, awe, and related emotions, as well as their importance in the history of thought and human flourishing (de Cruz 2024).

De Cruz defines wonder as an epistemic emotion involving both confronting the *unknown* and a subsequent desire for *accommodation*, that is, making sense of the phenomenon in some way. As they put it, "*Wonder* is the emotion that arises from a glimpse at the unknown terrain which lies just beyond the fringes of our current understanding [*italics in original*]" (de Cruz 2024, 4). Wonder is *epistemic* insofar as it involves some kind of desire to know, or at the very least the recognition of mystery. Wonder is

*self-transcendent* insofar as it involves opening ourselves to possibilities beyond what we usually consider, further helping “us move away from a focus on ourselves and our concerns” (de Cruz 2024, 6). Wonder underwrites and motivates a drive for discovery and pursuit by making our ignorance salient and guiding investigation. Wonder, then, is closely related to imagination in the sense I targeted in chapter 7: it involves the generation of new ideas, approaches, and concepts, as opposed to mental imagery.

Both de Cruz and Derek Turner have argued for a close connection between knowledge and various kinds of emotional and aesthetic affect. Turner, in *Paleoaesthetics* (2019), argues that knowing the history of some object of appreciation can enhance, deepen, or otherwise “make better” our judgments and appreciation of the object’s aesthetic qualities. On his view, say, seeing the Kirkdale cave as once inhabited by hyena better places us to appreciate what is aesthetically wonderful about it (see also Currie 2023c). The layers of mud, strewn bones, and stalagmites are the result of a particular history. And we can learn to see that history in it. Attending to those details helps us see it not as a mess, but the remains of a past world; or—perhaps—a mess, but a fascinating, beautiful mess (or, depending on our view of hyenas, perhaps a bit terrifying). De Cruz points out that epistemic emotions, such as awe and wonder, play important roles in motivating and shaping science: “Awe and wonder are not only required for the day-to-day practitioner of science; they are crucial to help reorient scientists’ thinking . . . They provide constant emotional motivation for scientists to continue their work, and instill openness to scientific ideas in the public” (de Cruz 2024, 152). Rather than focus on motivation, let’s consider how the investigation of past worlds can generate “newness.”

Wonder is closely associated with *newness*, or what de Cruz calls “firstness.” Some philosophers, most prominently Descartes, took wonder to require the novelty of the first encounter. On this view, wonder is fundamentally transient. We are wonderstruck by a Britain populated by hyenas, but this fades as we gain new understanding. By contrast, de Cruz doesn’t tie wonder to the *literal* newness of first discovery. They instead emphasize how wonder can emerge from seeing the familiar *as if* new. “My concept of firstness is inspired by and closely allied to Descartes’s view of the function of wonder, but slightly expanded so as to allow for the idea that we wonder not only at what we apprehend for the first time, but also at what we apprehend when we take the attitude that it is happening for the first time” (de Cruz 2024, 15).

“Firstness,” then, might not simply involve surprising encounters with the unknown, but surprising encounters of the known seen anew. Further, the connection with knowledge is more complex than the Cartesian might suppose—that firstness disappears as knowledge increases—because knowledge is *scaffolded* (Currie 2015, 2018a). Famously, learning something often opens new vistas of enticing ignorance. Sometimes we wonder at how what we have just learned demonstrates to us how much more we have to learn. There doesn’t seem to be a simple inverse relationship between knowledge and wonder: rich background knowledge can further deepen our wonder. Further, seeing something “as if” for the first time doesn’t erase our knowledge of its history, but rather reframes it. As Sara Ahmed puts it:

Does such an impulse to wonder require an erasure of history, by forgetting that one has seen the world before, or even that the world precedes the impulse to wonder? It could be assumed that the “as if” functions as a radical form of subjectivism, in which the subject forgets all that has taken place before a given moment of contemplation. But I would suggest that wonder allows us to see the surfaces of the world as made, and as such wonder opens up rather than suspends historicity. (Ahmed 2014, 179)

So, we can interpret “seeing anew” not as necessarily aligned with our first experience of something, but in terms of the object of wonder being *recast* in light of its history, in particular, the contingency (or I would say peculiarity) which that history reveals.

As we saw in the first chapter, the rhetoric of early geology was tied to its capacity to uncover lost worlds. This often included an appeal to the wonder these discoveries generated. As O’Connor puts it, “From the 1830s onwards, the story revealed by geology was promoted not only for upstaging ancient history—the ‘facts’ around which epic poems were spun—but also for equaling poetry in the wonder it evoked. With an increasing repertoire of bizarre monsters to call up before the mind’s eye . . .” (O’Connor 2008, 214). In his aptly named popular lecture series, *The Wonders of Geology Or, A Familiar Exposition of Geological Phenomena*, published in 1839, Gideon Mantell repeatedly emphasized the number and scale of diverse discoveries the Earth sciences have provided us: “From this general view of the physical records of the mutations which the surface of our globe has undergone, we learn how

numerous and important are the phenomena comprised within the sphere of geological inquiry, and how vain is the attempt to offer more than an epitome of its wonders in the brief space allotted to a popular course of lectures” (Mantell 1839, 181).

The past isn’t just different, but diversely so. Mantell further emphasizes how revolutionary and sudden our realization of these lost pasts has been.

Should an inhabitant of the new country express his wonder how brittle shells, delicate leaves, and bones of animals had become imbedded in the solid rock, and if when we stated the manner in which those changes had been effected, he should not only refuse his assent, but insist that the shells, leaves, and bones, were merely accidental forms of the stone, should we not feel astonished at his ignorance and prejudice? Yet not a century since, and such an opinion almost universally prevailed, and is even still entertained by many! (Mantell 1839, 320)

Such wonder-inducing changes to our own perception of the past continue apace. For instance, consider the last twenty years’ discovery of the bushiness of our recent species’ history. One hundred thousand years ago, *Homo sapiens* shared the Earth not only with Neanderthals (with whom, it turns out, we both bred and culturally mixed), but at least five other species of closely related members of the *Homo* genus (Galway-Witham, Cole, and Stringer 2019). In the astonishingly recent past, we shared the planet with diverse human-like lineages. That in itself boggles my imagination, but so too does the recentness of this discovery. Like Prof. Ichthy, I also wonder what revelations concerning our understanding of the past await us.

The connection between wonder and imagination—and our sometimes discomfort with it—is noted by Rudwick:

Buckland, and probably others too, were fully aware that the construction of any scene from deep time involved an act of imaginative epistemic penetration from the known present into the unknown past. Certainly that was what Conybeare made explicit in his cartoon of Buckland crawling into his own antediluvial cave. That cartoon’s magical or fairy-tale quality highlighted the problematic character of the act of penetration, as well as the sense of wonder that its achievement evoked. (Rudwick 1992, 57)

O'Connor and Rudwick emphasize the importance of Conybeare placing Buckland in the image, as a way of representing both the strangeness of his discovery and the risky inferences involved. The fantastical caricature of Buckland encountering the hyena makes the epistemic risk of the image, as well as its wondrous quality, explicit. The first half of this book sketches and I hope defends the effectiveness of the strategies scientists adopt when penetrating from the known present to the lost past. In chapter 7's discussion of palaeoart, I highlighted the challenge between getting the science as right as possible while also representing extinct organisms as real. Conybeare's image is an ingenious way of doing both.

In light of the connection with wonder, I'd add the stereo-temporal nature of Conybeare's image. The cave isn't simply depicted as it *is*, a muddy, bone-strewn mess into which Buckland crawls, but also as it *was*, hyenas and all. It also represents the apparent surprise—the shock—of the two coming together. Buckland's discovery, then, isn't only represented as changing our view of the past, but changing our view of the present as well. Thinking about the cave in light of its past helps us see it anew. It infuses the apparently familiar with the “firstness” de Cruz associates with wonder. In Ahmed's terms, we see the world not as given, but made.

Aiming for true pictures about the past isn't the only way to generate firstness, but—again reflecting on the arguments from chapter 7—there is reason to see it as an excellent one. If our unaided, present-oriented imaginations are impoverished, then we are badly placed to explore possibility. By aiming to get the past right, we generate rich perspectival tools that enable more diverse and wider imaginings of how the world could have been and, thus, how it might be now or might be in the future. Further, such tools provide ways of rendering fathomable the great scales of deep time, stretching and expanding our imaginative capacities.

So, discovering that the world was once different, often dramatically so, enables us to see the present anew. I've emphasized how discovering lost pasts requires that we “characterize” denizens to make sense of them in familiar terms, and how strategic perspectivalism enables us to move beyond the familiar to gain knowledge of lost worlds. Our wonder at strange past denizens motivates accommodating loss in terms of what we do know. But I've also emphasized the iterative nature of these investigations. In characterizing the past, we often re-characterize the present, and this provides bountiful experiences of firstness. A cave in Kirkdale was once haunted by hyenas; the Earth's now-separated continents have several times clustered together; the

apparently stable relationship between global oxygen and sea life is the result of the behaviour of microorganisms dead for millions of years; the familiar complex metazoa of our world were preceded by beautiful yet sessile, comparatively humble organisms attached to the seafloor. Further, our world as it is was in no way inevitable, but is as it is due to a bewildering array of past denizens arising, interacting, and falling away.

I know of no better source for seeing the present as if for the first time than the investigation of lost worlds. It is often discomfiting in its revelations of contingency and fragility (as well as the often risky epistemic bets that Rudwick highlights), often fills us with awe at the depths of time and contingency revealed—as well as our connection to those depths—and leads us to further wonder about what could have been in the past and what it might further tell us about our present and future.

For me, there is no better source of wonder than our hard-won knowledge of the deep past.

The applause drawing a final curtain across Prof. Ichthy's lecture ranges from enthusiastic to somewhat desultory (it has been a *long* lecture, after all), and Ichthy leaves the stage glad—grateful—of the attention they've received. They also carry the hope that some of the audience was perhaps sufficiently moved, sufficiently enticed, to themselves wonder about the deep past, as well as about the ingenious, creative—imaginative—work required to make sense of it. Ichthy scoops up the replica skull and shuffles away from the podium, joined by a gaggle of graduate students, as well as several family members, as they head into an adjoining room where presumably less formal discussion, congratulations, and most likely inebriation will take place.

The lecture, then, draws to a close with Ichthy looking both into the future and into the past: the future and its potential discoveries, the past with its surprising secrets, and Ichthy in the middle—the present—seeing each anew.