Journal of Geek Studies

jgeekstudies.org

Fossil Pokémon and the foibles of Paleontology

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Paleontology is the scientific study of life in the geologic past, which is visible to us today in the form of fossils. It studies the evolution and diversity of life throughout the entire history of our planet up to the beginning of the Holocene Epoch (roughly 12,000 years ago). That is not restricted to just naming extinct species; we can discover all sorts of stuff by analyzing the fossil record, from parental care in dinosaurs to the great extinction events that happened on our planet. I'm giving these examples because dinosaurs are the very first thing everyone thinks about when they hear the word fossil. Or almost everyone; if you're a Pokémon trainer, you might instantly recall some of the fossil monsters in the game, most likely those from Gen I, Omanyte, Kabuto, and Aerodactyl.

From the first game in the series onwards, there are fossil Pokémon that you can find in rocks (including amber) and then revive in a Jurassic Park-esque style. The player would find such rock (for instance, a Helix Fossil) and then take it to the Pokémon Lab, where the scientists would revive it. In our example, the Helix Fossil would become an Omanyte, which is arguably the best Pokéfossil ever.[1] Every new generation of Pokémon had new fossils, with the exception of Gen VII (*Sun & Moon*).

After the break in Gen VII, Gen VIII (*Sword & Shield*) brought the fossils back, albeit in a nightmarish form. There are four types of fossils to find in the Galar region of *Pokémon Sword* and *Pokémon Shield*: Fossilized Bird, Fossilized Drake, Fossilized Dino and Fossilized Fish. However, you do not use them straightforward to get a Pokémon; a Fossilized Bird will not grant you a cool extinct bird like *Confuciusornis* from the Cretaceous Period of China. Rather, you take two different fossils to a self-entitled Pokémon professor and she will mix them

Figure 1. The fossil Pokémon chimeras from Sword & Shield. From left to right: Dracozolt, Arctozolt, Dracovish, Arctovish. Artwork from the games; images retrieved from Bulbapedia (https://bulbapedia.bulbagarden.net/).

[1] And the only one to ascend to godhood. Read the story of Lord Helix in the article by Salvador (2014).

[2] A Fossilized Bird plus a Fossilized Drake will give you Dracozolt; Bird + Dino = Arctozolt; Fish + Drake = Dracovish; Fish + Dino = Arctovish.

both to create a horrid chimera (Fig. 1).[2] The resulting Pokémon are horrid mixes that will in all likelihood have a miserable existence – just look at them, it's almost as horrible as Nina's story in *Full Metal Alchemist*.

I find it difficult to decide whether this was just some game developers running wild during character creation brainstorming sessions or if said developers knew enough about Paleontology to make a bold statement against the mistakes and the forgeries that pop up in this field every now and then. Given other biological nonsense in the series (for instance, see Tomotani, 2014; Salvador & Cavallari, 2019), I am more inclined towards the first hypothesis. Even so, I would like to explore the second one here.

Below I will delve into mistakes in fossil interpretation, from centuries-old scientific works to the present-day, and will also scrutinize the insidious fakes that people have fabricated for various reasons. But first, let us take a closer look into the fossil record.

THE FOSSIL RECORD

Paleontological science is entirely dependent on the fossil record. In broad terms, a fossil is formed when a living organism dies, get buried in the sediment and, over time, becomes petrified as the sediment turns into a rock. As you can imagine, not every organism will be "lucky" enough to get buried in appropriate sediment. For instance, carcasses might get torn apart and be eaten, plants will be decomposed and "vanish", or the weather and environmental conditions might erode and destroy an organism's remains.

Besides, not all organisms will fossilize. If they have hard parts like bones, teeth or shells, they will more likely become fossils. Mollusk shells and shark teeth are among the most common fossils to find. However, soft-bodied organisms only fossilize when conditions are extremely favorable; think about jellyfish and squid, for example. Thus, only a small fraction of all past life got fossilized. And of that small fraction, we have only found a small portion; we haven't searched all the rocks on the planet – there are several areas out there still to be explored.

As such, in Paleontology we work with very incomplete data. And to add insult to injury, sometimes the conditions of the fossils we find are less than optimal, which will make any research difficult. Just compare the fossils in Figure 2: one is neatly preserved, where all structures can be seen and studied; the other is a complete mess and barely recognizable as a snail.

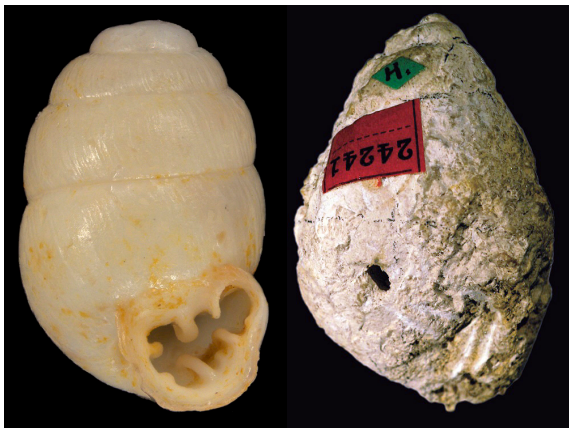

Figure 2. Left: shell of a *Vertigo* land snail from the European Pliocene (33–28 Ma), showing amazing preservation (the shell measures about 1.8 mm); specimen RGM 550.111, from Naturalis Biodiversity Center. Right: shell of an *Eoborus* land snail from the Paleocene of Brazil (roughly 58–55 Ma), showing very poor preservation (the fossil measures 44 mm); specimen AMNH 24241, from the American Museum of Natural History.

All of this makes research in Paleontology heavily dependent on the specimens one has available. Sometimes, poorly-preserved fossils will result in erroneous interpretations. These are honest mistakes that will eventually be corrected when new fossils, new data or new tools come into play. Getting it wrong the first time around is not lame or shameful – careful re-analysis and correction of mistakes is an important way in which scientific knowledge advances. So, let us take a look in some famous examples of honest mistakes.

The reversal of *Hallucigenia*[3]

Hallucigenia is a genus of weird marine worm-like creatures, full of spikes and soft appendages. The first species was discovered from the Burgess Shale, a now-famous fossil deposit in British Columbia, Canada, which dates back to the Cambrian Period (roughly 508 Ma[4]). That is the time known as Cambrian Explosion, when all animal groups were rapidly[5] diversifying into all the different branches that we know today.

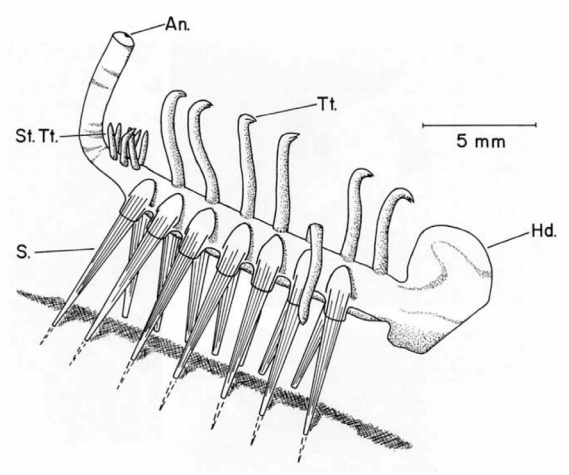

Figure 3. Morris' reconstruction of *Hallucigenia* sparsa from the Burgess Shale. Image extracted from Morris (1977: text-fig. 2A). Abbreviations: An. = anus; S. = spine; St. Tt. = short tentacle; Hd. = head; Tt. = tentacle.

At first, *Hallucigenia* was thought to be a kind of polychaete worm, but it was later interpreted as something different. Morris (1977) proposed it was a distinct branch of the animal evolutionary tree[6], and reconstructed the animal walking on its spikes, with the soft appendages floating in the water (Fig. 3). In retrospect, it is rather silly to suppose an animal would walk on stiff legs and some researchers even pointed that out at the time (Gould, 1989), but it was the only interpretation available.

Only later, researchers working on *Hallucigenia* species from Chinese Cambrian rocks were able to figure out that the spines were protective structures on the animal's back and that it walked with soft legs (Ramsköld & Xianguang, 1991). They basically flipped the animal. Also, those researchers proposed that *Hallucigenia* actually belonged to the phylum Onychophora. Nowadays, we known onychophorans as velvet worms and there are only terrestrial species remaining. The entire marine branch of this phylum (which included *Hallucigenia*) became extinct.

But the story did not end there. Smith & Caron (2015), working with better preserved material from the Burgess Shale, realized that what people thought it was the animal's tail was actually its head (Fig. 4). So *Hallucigenia* was reversed once again, only this time rotated on a different plane. This shows how difficult it is to work with fossils when they are not well-preserved or belong to groups that are entirely extinct.

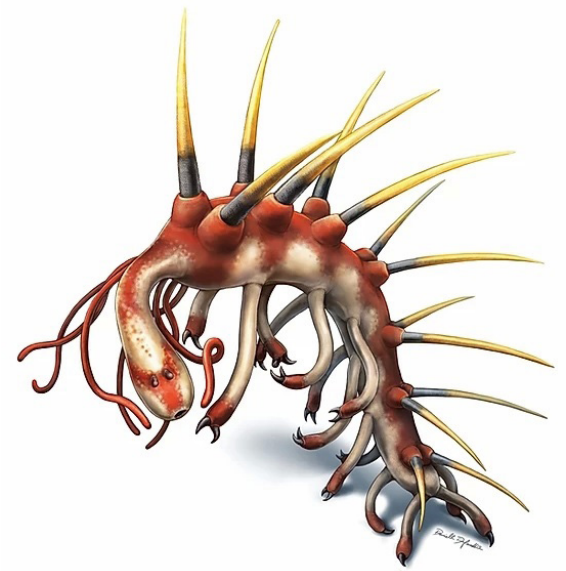

Figure 4. Artistic reconstruction of *Hallucigenia sparsa*. Illustration by Danielle Dufault (https://www.ddufault.com/), extracted from Smith & Caron (2015: fig. 3f).

[3] Yes, I borrowed the title from Steve Gould (1992).
[4] Ma = megaannum, or millions of years.
[5] Rapidly in geological terms, of course. What are 15 to 25 millions of years for a planet that is 4.5 billions of years old?
[6] He was also the one who named it *Hallucigenia*, because it is such a weird-looking beast.

The terror shrimp

The Burgess Shale was the home of a myriad of weird and wonderful creatures. My personal favorite is *Anomalocaris*. When it was first discovered (Whiteaves, 1892), the species *Anomalocaris canadensis* was described based on a fossil like the one shown in Figure 5. The genus name means "anomalous shrimp", because the fossil was deemed to be a weird sort of shrimp (it was thought to be lacking its head).

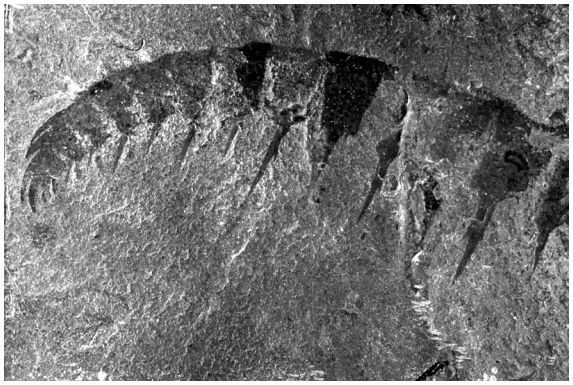

Figure 5. *Anomalocaris canadensis* (circa 8.5 cm long); specimen YPM 35138 from Yale Peabody Museum of Natural History. Image extracted from Wikimedia Commons (James St. John, 2014).

Well, you might be thinking "that's a pretty lame fossil to have as favorite", but please bear with me for a moment. Meanwhile, two other fossils were discovered in the Burgess Shale: the jellyfish *Peytoia nathorsti* (Fig. 6) and the sea cucumber *Laggania cambria*, both described in the same paper (Walcott, 1911).

It took several decades and new fossils (Fig. 7) for paleontologists to realize that *Anomalocaris*, *Peytoia* and *Laggania* were actually just parts of a single animal (Whittington & Briggs, 1985). The bit called *Anomalocaris* corresponds to the frontal appendages of the animal; *Peytoia* is the mouth; and *Laggania* the body.[7] Because *Anomalocaris* was the oldest name (the first one described), it is the one that remains used.

This is an honest mistake, even more than that of *Hallucigenia* above; it is still related to problems of fossil preservation, but in this case, it is an issue of only partial information (and partial fossils) being available.

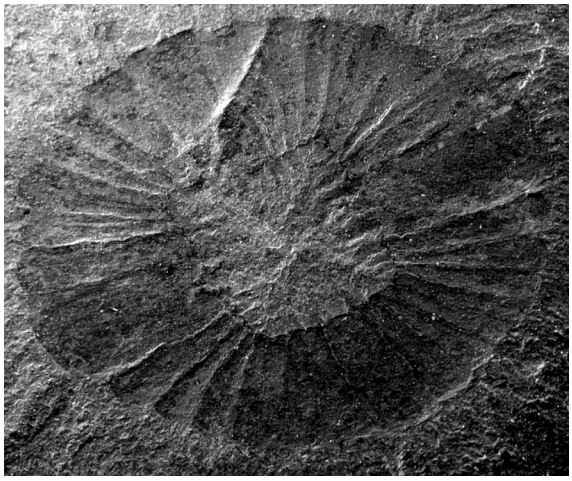

Figure 6. *Peytoia nathorsti* (circa 5.2 x 4.2 cm); specimen YPM 5825 from Yale Peabody Museum of Natural History. Image extracted from Wikimedia Commons (James St. John, 2014).

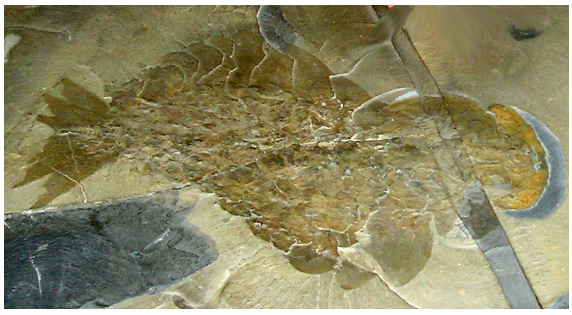

Figure 7. The first complete *Anomalocaris canadensis* ever found; specimen from the Royal Ontario Museum. Image extracted from Wikimedia Commons (Keith Schengili-Roberts, 2007).

Anomalocaris was then reinterpreted as the topmost predator of the Cambrian fauna. It was massive for its time, about 1 meter long, and possessed nasty-looking grasping-&-crunching appendages (Fig. 8) to deal with hard-shelled mollusks and trilobites. As a proficient hunter, *Anomalocaris* had dichromatic color vision and eyes composed of 16,000 lenses, rivalled only by modern dragonflies (Paterson et al., 2011; Fleming et al., 2018). They belong to a branch of the tree of life named Dinocaridida ("terror shrimps"), which is an ancestral

[7] Actually the mouthpart of *Anomalocaris* is different an the fossil known as *Peytoia* belongs to a second species of anomalocaridid.

group of phylum Arthropoda.

Finally, if you are thinking the reconstruction from Figure 8 looks familiar, that's because the Pokémon Anorith (Fig. 9) from Gen III is obviously an *Anomalocaris*.

Figure 8. Artistic reconstruction of *Anomalocaris canadensis*. Image extracted from Wikimedia Commons (PaleoEquii, 2019).

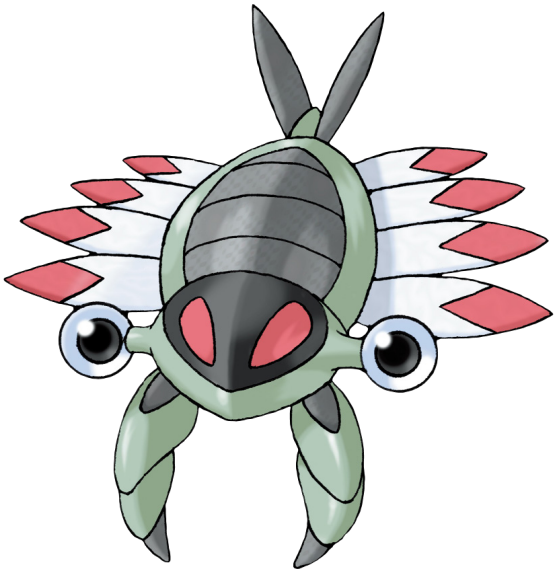

Figure 9. The fossil Pokémon Anorith from Gen III. Artwork from the game; image retrieved from Bulbapedia (https://bulbapedia.bulbagarden.net/).

A falsely accused dinosaur

Oviraptor is a genus of small theropod dinosaurs, of the kind that already looked very bird-like. They lived in Mongolia during the Late Cretaceous (90 to 70 Ma) and received their name means "egg seizer". Osborn (1924) gave them such name because the fossil skull was found lying directly on top of a nest of dinosaur eggs, which "immediately put the animal under suspicion of having been overtaken by a sandstorm in the very act of robbing the dinosaur egg nest" Osborn (1924: 9). Back then, Osborn thought the eggs belonged to another dinosaur, *Protoceratops andrewsi*.

It took a long time for people to realize the skull belonged to a parent sitting on its nest (Barsbold et al., 1990; Norell et at., 1995; Clark et al., 1999, 2001). Contrary to the examples above, the interpretation of *Oviraptor* as a thief was not due to poor fossil preservation or to the fossil belonging to a completely "alien" group. This time the interpretation hinged on a thieving raptor versus a caring parent. So how could Osborn and a whole bunch of early 20th century paleontologists get it so wrong?

In short, it was an obsolete paradigm that prevented them from seeing what is now obvious to us. Back then, dinosaurs were seen as dumb cold-blooded beasts. Only in the 1960's the so-called dinosaur renaissance began, where the paradigm started to shift.[8] A new wave of paleontologists started to understand dinosaurs as warm-blooded and active animals, with complex behavior and social structures. The work of Horner & Makela (1979), showing that *Maiasaura peeblesorum* cared for its young, was a complete breakthrough and changed the way we understand dinosaurs and how they are related to their present-day survivors, the birds.

Cope's *Elasmosaurus*

I will only touch very lightly on this example, because it is so well-know. If you're interested to know more, the book *Dinosaur Bone War* by Kimmel (2006) is a great start.

The first specimen of the giant marine reptile *Elasmosaurus platyurus* was described by paleontologist Edward D. Cope

[8] This renaissance ultimately led to a shift in how the public perceived dinosaurs too, largely due to the film version of *Jurassic Park* (Litpak, 2018; Thomas, 2020).

in 1868. When he reconstructed the skeleton, though, Cope thought the animal had a long tail and a short neck, where he obviously attached the skull. Paleontologists soon realized that the animal actually had a short tail and a very long neck and Cope's skeleton had its head on its ass, so to speak. This caused quite a stir and Cope soon became the butt of jokes by his arch-nemesis Othniel C. Marsh. This fact kickstarted what later became known as Bone Wars.

FORGERIES

All the examples above were honest mistakes. A series of erroneous interpretations were made, but in the end, they were identified and corrected. That's how things work – our scientific literature is only temporary, representing the objective truth we have at a given point in time. But eventually, everything will (or at least should) be checked and corrected or refined as necessary.

Next, we will take a look at the dark side of Paleontology. These are not fossils mistakenly interpreted; rather, these are actual fakes and forgeries made for a series of typically-human reasons.

The Lügensteine

The Würzburger Lügensteinen[9] (German for Lying Stones of Würzburg) is one of the most curious stories in Paleontology, back from a time this whole scientific field was not quite yet formed. In 1725, Johann Beringer, a professor from the University of Würzburg, found several amazing fossils on a mountain near the city: lizards, frogs, arthropods, all extremely detailed and apparently well-preserved. He also found "fossils" of other stuff, like comets and letters spelling out the Tetragrammaton (the Hebrew name of the biblical god).

Do keep in mind that this was a time when the mechanisms of fossilization and evolution were not yet understood, so we should avoid judging it by our modern standards (Gould, 2000). Beringer took these fossils seriously and published a book entitled *Lithographiæ Wirceburgensis* in 1726, describing his finds. Beringer interpreted the animal fossils as, well, fossilized animals, and considered the other stuff as "capricious fabrications of God" (Jahn & Woolf, 1963).

It turns out the "fossils" were sculpted and planted there by two of his colleagues, Ignatz Roderick and Johann von Eckhart, who wanted to discredit Beringer. The duo started to plant fakes that were progressively more absurd, but it went on for so long that they eventually decided that the prank was getting way out of hand. They tried to convince Beringer that the fossils were fake (without implicating themselves, of course), but he dismissed them, feeling he and his work were under attack.

Because of that, Beringer took Roderick and Eckert to court to "save his honor". The duo confessed they were the perpetrators of the hoax and wanted to discredit Beringer because "he was so arrogant and despised us all" (Jahn & Woolf, 1963). The whole deal ended up discrediting Beringer and ruining the reputations of the other two. The fossils became known as Lügensteine, or Lying Stones, and some are still around (Fig. 10).

Figure 10. Three Lügensteinen on display in the Senckenberg Naturmuseum (Frankfurt). Image extracted (and cropped) from Wikimedia Commons (MBq, 2018).

This is a story where everyone was wrong. The duo of forgers, obviously, no matter how much of an "insufferable ped-

[9] Also known as Beringersche Lügensteine, or Beringer's Lying Stones, after their infamous "discoverer".

ant" (Gould, 2000: 21) Beringer was. And Beringer himself, who even by the scientific standards of his day, should have done a better job instead of falling prey to an easy road to fame (Gould, 2000).

But that's all in the past, isn't it? Paleontologists nowadays are great scientists who won't be fooled, right? Well…

Spider-Lobster and the Invisible Hand

In 2019, a group of paleontologists described a giant spider species from the Early Cretaceous of China (Cheng et al., 2009). It was named *Mongolarachne chaoyangensis* (Fig. 11) and was unlike any other spider we knew about. It turns out that was due to quite an obvious reason: it was not a spider. Instead, the fossil was a crayfish with two extra legs painted on it!

Other paleontologists discovered the mistake and corrected it very quickly (Selden, 2019). But why would someone paint those legs to create a fake spider in the first place? According to Paul Selden, who spotted the issue, in China these fossils are "dug up by local farmers mostly, and they see what money they can get for them" (Lynch, 2019).

There is a huge market for embellished fossils and complete fake fossils out there. China, Morocco[10] and Brazil are especially infamous for this (Gould, 2000; Pickrell, 2015; Lynch, 2019). Typically, the fakes are restricted to dinosaurs and other large vertebrates, because that's where the big money is. Most of these "fossils" end up bought by private collectors, but sometimes a "specimen" finds its way to a museum or university and becomes part of the scientific discussion (Lynch, 2019), like the "spider" above.

These forgeries are very skillfully done, often starting with fragmentary fossils and carving out the missing parts from the stone (Pickrell, 2015). So yes, even scientists can be fooled by them, just like art curators and archaeologists are every now and then fooled by "Renaissance" paintings, Van Gogh's "Sunflowers", or a bunch of "Dead Sea Scrolls" (Gould, 2000; Subramanian, 2018; Burk, 2020).

Because of that, several fossil species have been put in check since their description and sadly the field of Paleontology has been marred by an initial feeling of mistrust whenever a new fossil (for instance, a feathered Chinese dino-bird) is discovered (Pickerell, 2015).

Figure 11. Fossil of *Mongolarachne chaoyangensis*. Image extracted from Cheng et al. (2009: fig. 1).

In all cases above (the lying stones and the "embellished" fossils), the fakes were unknown to the scientists involved. But what about forgeries purposefully-built by a researcher? Are there any of those in Paleontology? The answer is, unfortunately, yes.

[10] See Gould's 2000 book *The Lying Stones of Marrakech* for an essay linking the big forgery industry of Morocco with Beringer's Lying Stones.

The Piltdown Man

The next example is strictly speaking paleontological, although many would argue that hominin fossils fall into a particular subset of Paleontology or even into a separate field altogether: Paleoanthropology. The following story, like Cope's *Elasmosaurus*, is very well known, so I'll just touch upon it briefly. There are several books published about the Piltdown Hoax, so if you're interested, a quick search online will give you plenty of options.

To make a long story short, in 1912, a British amateur archaeologist named Charles Dawson claimed that he had discovered a hominin fossil in Piltdown, England, which was the "missing link" between large apes and humans. The species was named *Eoanthropus dawsoni* (popularly known as the Piltdown Man) and the fossils included skull fragments, a jawbone, and a canine tooth. The fossils were a forgery created by Dawson and planted on the "archaeological site" (De Groote, 2016). The jawbone and tooth belonged to an orangutan and were physically and chemically altered and prepared by Dawson. The skull fragments belonged to two humans.

Dawson and his colleagues never let other scientists analyze the actual fossils, just handing out casts of the fossils – like that was not suspicious! Only in 1953, almost 4 decades after Dawson's death, the forgery was discovered (Weiner et al., 1953). And only in 2016 researchers were able to confirm Dawson as the forger (De Groote et al., 2016).[11]

Why did he do it? Clearly for the fame (was he expecting a knighthood, maybe?) and the attention that his "discovery" garnered – it put the UK at the forefront of Paleoanthropology, attracting interest from both scientists and the general public (De Groote, 2016).

BACK TO POKÉMON

All the new fossil Pokémon from the Galar region fall into the second category explored above, that is, of fakes and forgeries. It's not their fault, of course. The fossils could be reconstructed properly; you'd just need two bits from the same species: two Fossilized Drake items, for instance, would result in a complete dinosaur, probably *Stegosaurus*-like. In fact, several fans have recreated what the actual fossil species would look like (*e.g.*, Fig. 12; but you can find more examples online).

The Pokémon "scientist" from Galar is a self-entitled expert, creating fake fossils for her own ends, just like Charles Dawson. The chimeric "species" even have spurious Pokédex entries[12], just like the "facts" about the Piltdown Man were once published in

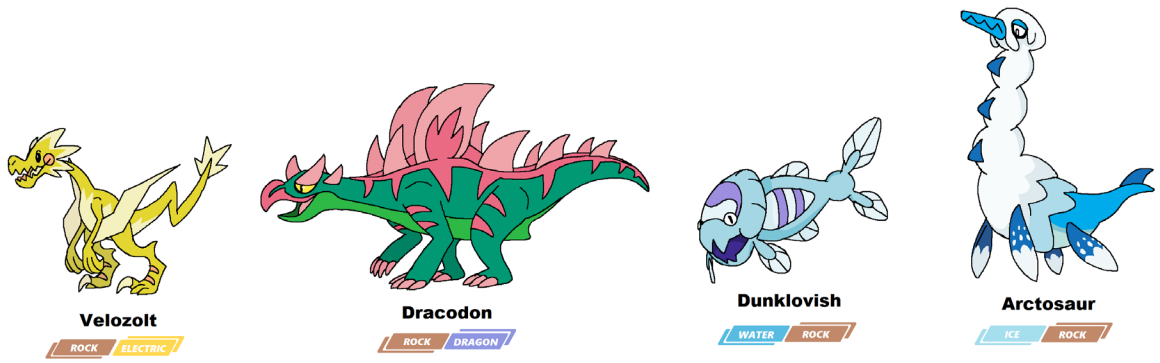

Figure 12. Reconstruction of the complete fossils from Galar region. Artwork by JWNutz (https://www.deviantart.com/jwnutz); used with permission.

[11] The Piltdown Man was not Dawson's only forgery, though; he has tens of others on his portfolio (Walsh, 1996; Russel, 2013).
[12] Granted, several other Pokédex entries seem to have been written by an 8-year-old child. Just look for Ponyta's, Alakazam's and Magcargo's entries, for instance.

actual scientific literature. The Galarian poser "professor" is a dark stain to the honorable profession of Pokémon Professor – and of paleontologists, of course. However, she is surprisingly appropriate for our times, being well in tune with all those "Fox News experts": flat-Earthers, climate change deniers, creationists, and anti-vaxxers. Dark times call for dark Pokémon NPCs, I suppose.

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Acknowledgements

Many thanks to my paleo-colleagues Alan Tennyson and Felix Marx for pointing out some examples and references I had overlooked; and to Jean-Claude Stahl for the beautiful photo of Vertigo.

About the author

Dr. **Rodrigo Salvador** is a paleontologist who studies snails, although he has dabbled a little in dinos and fossil birbs too. His long-time favorite Pokéfossil is none other than Lord Helix, despite the anatomical flaws in comparison with real ammonoids. Rodrigo was eager for the new fossils in *Sword & Shield* but ended up massively disappointed. On the bright side, at least the new horrible Pokéfossils served as a backdrop and excuse to write this article.