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A Collection of Creature Restoration Inaccuracies in the Jurassic Park Franchise and Their Implications

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Abstract

The *Jurassic Park* franchise is one of the highest-grossing media franchises of all time. Here, I show that many representations of dinosaurs and other palaeo-organisms in the franchise are inaccurate, being vastly different from their real-life counterparts in major aspects, and they negatively affect the public's view of palaeo-organisms by imprinting stereotypes. A complete list of inaccuracies that has the potential to deviate the public impression of palaeo-organisms are listed in this article via research, and the implications of these inaccuracies are studied and discussed with an analysis of an online questionnaire.

Keywords

Science Representation, Dinosaur, Stereotype, Film, Media

1. Introduction

The *Jurassic Park* franchise began in 1990 when Universal Pictures and Amblin Entertainment gained the rights to Michael Crichtons's novel *Jurassic Park*. As of right now, it includes two film trilogies with numerous video games, books, and spin-off shows. Starting from the very first film, many creatures are represented with unscientific, speculative features in order to satisfy the visions of the writer (Cummings, 2015; Shay & Duncan, 1993). As time progressed and science marched on, more restorations in the films are proven wrong. However, the more recent films of the franchise, starting from *Jurassic World* (Trevorrow, 2015), retained the inaccurate restorative designs from previous, outdated films and even further modified them, taking them even further from the scientific consensus. Some of these restorations are misleading for the general audience and evidently affected

the representations of these animals in other media, with *Velociraptor* and *Dilophosaurus* among the most apparent (e.g. Del Coro, 2020; *Dilophosaur*, n.d.). The general impressions of these extinct creatures in the public's eyes have deviated from the scientific consensus. A questionnaire investigation is analysed, confirming this hypothesis. A collection of all inaccuracies with the potential to deviate the public impression (*id est* inaccurate restorations, terming, spelling and pronouncing) is arranged and explained in a compendium, revealing the high extent of the inaccuracy of representation in the franchise. This compendium can assist artists and creators in avoiding common prevailing inaccurate stereotypes, and can thus contribute to canceling out the negative effects the films have had on the public's impressions of dinosaurs and other creatures. The implications of the inaccuracies listed are also studied and discussed, including their effects on public interpretation and other media.

2. Methods

2.1. Documentation and Compendium Assembly

Each film in the franchise is rewatched, which each restored extinct creature in the films observed and compared to its respective latest scientific descriptions; characteristics in the film creatures are accepted or repudiated according to the latter. The differences are documented in the compendium, with the related studies cited.

The "Goofs" section of each of the films on IMDb is checked, with the miscellaneous goofs documented and evaluated. Selected "goofs" with the potential to mislead the communal knowledge base are included under the "Miscellaneous" section of the compendium. Other websites, such as fandom.com, are also utilized herein inaccuracy collecting.

Websites such as fandom.com and wikipedia.com are further exploited for additional creature restoration inaccuracies and any non-redundant inaccuracies stated in the said sources regarding creature restoration with the potential to mislead audiences are included in the compendium.

The compendium is made in Pages software by Apple, Inc. All creatures included in the films are recorded and compared to the descriptions in the latest papers (cited in APA format), and all differences are precisely stated in the compendium. Each film is studied and analysed, and the creatures are listed in alphabetical order of their binomial names. Non-restorational innacuracies that have the potential to affect public understanding are included at the end of each category under the caption "Miscellaneous".

2.2. Questionnaire Inquiry and Analysis

A questionnaire is launched in order to inquire the public's interpretation on dinosaurs as a result of the implications of the inaccuracies in *Jurassic Park* films, and a total of 100 people are investigated. Questions focus on some common misconceptions the films have created. All charts are built and edited in

Pages software; the questionnaire is made and conducted on the Wenjuanxing platform.

3. Results and Discussion

Listed below is a compendium of all confirmed inaccuracies in the films with the potential to mislead audiences in the *Jurassic Park* franchise.

Titles involved:

Jurassic Park (Spielberg, 1993);

The Lost World: *Jurassic Park* (Spielberg, 1997);

Jurassic Park III (Johnston, 2001);

Jurassic World (Trevorrow, 2015);

Jurassic World: *Fallen Kingdom* (Bayona, 2018);

Jurassic World Dominion (Trevorrow, 2022).

3.1. Creature Design and Portrayal

Ankylosaurus magniventris (Brown, 1908) was shown with spikes instead of osteoderms on multiple positions, whereas they in reality were much flatter and smoother in shape; the body morphology is unlike the actual animal as being too tall and narrow; the jugal horns were also depicted to be too large and broad in size; and the tail club was portrayed with inaccurate shaping compared to fossil remains of this taxon, which were flatter and more pronounced, with four symmetrical osteroderms (Carpenter, 2004).

Apatosaurus sp. (Marsh, 1877) was portrayed to chew on vegetation with its jaw moving horizontally, similar to a modern cow. However, dental distribution is limited to the front of the skull (Fastovsky & Weishampel, 2009), making chewing unsuitable. The skin of this animal was shown to be wrinkled and scaleless, contrary to available material of sauropod integument (Czerkas, 1994). Elephantine graviportal manus instead of saurpod ones are present on the design.

Atrociraptor marshalli (Currie & Varricchio, 2004) was completely featherless being a dromaeosaurid despite overwheling evidence suggesting otherwise in close relatives and phylogenetic bracketing (Xu, 2020). They had incorrect pronated wrists (Carpenter, 2002) and were oversized; size estimations from fossil evidence suggest 1.8 meters in length (Molina-Pérez & Larramendi, 2019). One of the characters stated that these animals are "pure-bred", making it even more misleading.

Baryonyx walkeri (Charig & Milner, 1997) was shown with incorrectly pronated wrists (Carpenter, 2002), potrayed with a skull lacking or containing contradictory features with the holotype specimen, such as lack of the "triangular crest" on the dorsal part of the nasal, over-broad upper snout, and inaccurately straight, conical dentition (Charig & Milner, 1997). The animal, upon contact with flowing lava, should display traumatism (Mitchell, 2018), which was not the case in the film. The animal was given crocodilian-like dorsal osteoderms; these particular osteoderm structures are not found in any dinosaur and only add to the "cold-blooded reptile" stereotype.

Brachiosaurus sp. (Riggs, 1903) was shown rearing upwards for feeding. Newer research concluded that the limb length ratio, the forward center of mass and the minimal advantage would have made brachiosaurids unsuited for rearing (Mallison, 2011). The only circumstance *B. altithorax* would possibly have reared was during the supposed dominance conflicts (Hallett & Wedel, 2016). The back toes of *B. altithorax* were depicted as similar to elephants, whereas in reality they contain protruding claws (Maltese et al., 2018). The animal was given a whale-like call, which has not yet been scientifically proven and does not make sense for a reptile without a vocalizing larynx. The animal was also portrayed to chew on vegetation with its jaw moving horizontally, similar to a modern mammal. However, brachiosaurid feeding involved simple up-and-down jaw motion (Barrett & Upchurch, 2005) and didn't involve chewing. In all likelyhood, they utilized hindgut fermentation (Sander et al., 2010). The skin of this animal was shown to be wrinkled and scaleless, contrary to available material of sauropod integument, which shows clear preservation of scales (Czerkas, 1994).

Carnotaurus sastrei (Bonaparte, 1985) was shown with incorrectly pronated wrists (Carpenter, 2002); the irregularly arranged, conical feature scales on skin impressions preserved were wrongly depicted to be sharp spikes lining down the torso in the films (Hendrickx & Bell, 2021).

Ceratosaurus nasicornis (Marsh, 1884) was portrayed with incorrect cranial anatomy. The nasal horn was depicted to be excessively sharp, unlike in preserved fossils which were much blunter (Gilmore, 1920), and the lacrimal ridges were undersized, as in juveniles (Britt et al., 1999). Note that branching grooves present on the nasal horn indicate cornified layers, which might result in a slightly more elongated horn in life. The animal was incorrectly pronated (Carpenter, 2002). According to model supervisor Ken Bryan on the DVD commentary of *Jurassic Park III* (Johnston, 2001), the *Ceratosaurus* model was modified from that of *T. rex* instead of being a genuine restoration of the taxon.

Compsognathus longipes (Wangner, 1859) was shown without feathers, however close relatives (albeit more derived), e.g. *Sinosauropteryx prima* (Ji & Ji, 1996) and *Sinocalliopteryx gigas* (Ji et al., 2007) exhibited evidence of feathers (Currie & Chen, 2001; Ji et al., 2007), indicating otherwise. The animal was also incorrectly referred to as "*Compsognathus triassicus*", likely an oversight, confused with *Procompsognathus triassicus* (Fraas, 1913). The creatures in the film travel in herds characteristically, though there is no clear evidence of pack-hunting behaviour in *C. longipes*. The animal was also incorrectly pronated (Carpenter, 2002).

Corythosaurus sp. (Brown, 1914) was portrayed to be mostly bipedal, whereas hadrosaurids most likely turned to quadrupedality along with maturity according to certain allometric changes displayed in *Maiasaura peeblesorum* (Dilkes, 2001). The beak of hadrosaurids were not exactly "duck-billed" (as in most popular media and in the films) with soft tissue taken into account (Morris, 1970), with the keratinous upper beak covering the mouth quite thoroughly.

Dilophosaurus wetherilli (Welles, 1954) was depicted as a 4-foot-long venomous predator with neck frills representative of *Chlamydosaurus* used against prey. In reality, *D. wetherilli* was the largest land animal found in North America at its time (Early Jurassic), with body size comparable to that of a brown bear (Marsh & Rowe, 2020), and that there are no evidence of the presence of a venom disposal in the diastema (which wasn't even depicted in the film design) between the maxilla and the premaxilla. There are no markings for muscle attachments on the skull, therefore the "frill" is not supported by any evidence; even if it did have a frill, it would've used it to intimidate a competitor or a threat rather than prey (Bennington, 1996). The animal was also shown with incorrect pronated wrists (Carpenter, 2002).

Dimetrodon sp. (Cope, 1878) was designed with incorrect cranial anatomy. The skull looks like it was a modified model of *Jurassic Park*'s *T. rex*, lacking the characteristic large caniniforms (Baur & Case, 1899) and instead sprouting much smaller, uniform teeth. The animals are portrayed as cave-dwelling semi-aquatic ambush predators, despite that fact that microanatomy suggests terrestrial lifestyles (Kriloff et al., 2008).

Dimorphodon sp. (Buckland, 1829), these small pterosaurs were depicted with incorrect cranial shape, being significantly angular, whereas the actual animals had relatively rounded crania (Cranfield, 2002). The animal were also incorrectly portrayed to have soared despite the fact that its proportionally short wings and rather robust torso might result in frantic, short bursts of flight, similar to modern fowls and woodpeckers (Witton, 2013). The animal in-film was said to be over 3 metres in wingspan, whereas scientific estimations indicate a wingspan of ~1.5 metres (Cranfield, 2002).

Dreadnoughtus schrani (Lacovara et al., 2014) was shown often resting in water, an outdated view on sauropods prevalent before 1951. Sauropods, similar to extant sauropods, had air sacs, causing them to have very high floatability. Fossil evidence show that sauropods, even in shallow water, would have issues walking on all fours as part of the animal would float (Henderson, 2004). The skin of this animal was shown to be wrinkled and scaleless, contrary to available material of sauropod integument (Czerkas, 1994). Elephantine graviportal manus instead of saurpod ones are present on the design.

Gallimimus bullatus (Osmólska et al., 1972) was depicted without feathers, however specimens of a contemporary relative *Ornithomimus edmontonicus* Sternberg, 1933 exhibited pennaceous feather shafts and hair-like filaments indicate otherwise (Zelenitsky et al., 2012). The animal was incorrectly pronated (Carpenter, 2002). In *Jurassic World* (Trevorrow, 2015), the animals were incorrectly toothed, whilst the actual animals were edentulous (Osmólska et al., 1972).

Giganotosaurus carolinii (Coria & Salgado, 1995) was depicted with large dorsal spikes sprouting from the neck to the tip of the tail, with underlying crocodilian osteodermic armour; crocodilian slip pupils and crocodilian jagged dental structure and crossbite distribution, which are incorrect compared to preserved

material which show an overbite structure with narrow, serrated teeth (Calvo & Coria, 1998) despite the ecological difference in carcharodontosaurids and crocodilians (Hassler et al., 2018). The skull was designed with lacrimal ridges, extending over the nasal, making the head look more triangular. This does not match with available epidermal correlation material, which indicates continuous soft tissue, perhaps a cornified pad, covering the dorsal and lateral parts of the nasal (Witton, 2022). The dentary was straight and featureless at the posterior end, unlike preserved material which presents a downward projection (Calvo & Coria, 1998). The animal was shown encountering and combating with a *T. rex* in a segment stated to be 65 millions years ago. *T. rex* ranged from 68 - 66 Ma in North America exclusively (National Museum of Natural History, 2014). *Giganotosaurus* was discovered in the Candeleros Formation, which ranged from ~100 to 97 Ma in Patagonia of South America (Holtz Jr., 2007). Thus, the two taxa wouldn't be able to encounter one another 65 million years ago.

Mamenchisaurus sp. (Young, 1954) was shown with an over-elongated skull due to the CGI model being a slendered version of the first film's *Brachiosaurus* (Duncan & Crichton, 1997). The rather complete skulls of some *Mamenchisaurus* species have been found, exhibiting more robust cranial structures and relatively shorter snouts than shown in the film (Ye et al., 2001; Zhang et al., 1998; Pi et al., 1996). Elephantine feet and skin are carried over from the *Brachiosaurus* asset.

Mosasaurus sp. (Conybeare, 1822) referred to as "*Mosasaurus maximus*" was oversized (the largest estimates reach about 17 m (Grigoriev, 2014)) and incorrectly had a dorsal fringe dunning down the length of its body. This was due to a faulty reconstruction by S. W. Williston in 1898, when he mistakened the slender cartilaginous rings of the trachea for what he called the "nuchal fringe" (Williston, 1902). The reconstruction in-film also lacked a cresent-shaped caudal fluke despite the evidence for the latter is present in the *Prognathodon* sp. specimen ERMNH HFV 197 (Lindgren et al., 2013). A diploglossan tongue was also not present in the film, despite phylogenetic analysis supporting the presence of the aforementioned structure (Schulp et al., 2005).

Parasaurolophus sp. (Parks, 1922) was portrayed to be mostly bipedal, whereas hadrosaurids most likely turned to quadrupedality along with maturity according to certain allometric changes in *Maiasaura peeblesorum* (Dilkes, 2001). The beak of hadrosaurids were not exactly "duck-billed" (as in most popular media and in the films) with soft tissue taken into account (Morris, 1970), with the keratinous upper beak covering the mouth quite thoroughly.

Pteranodon longiceps (Marsh, 1876) was depicted without fuzz. However, Witton (2013) expressed that most, if not all, pterosaurians possessed pycnofibers (dense filaments) on the head and torso; and that these dense filaments would have assisted thermoregulation by acting as insulators and reducing excessive heat loss, as in the coating of modern mammals (Witton, 2013). Newer research suggests that these structures may be synonymous with feathers (Cin-

cotta et al., 2022). In *Jurassic Park III* (Johnston, 2001), the animals were incorrectly toothed (despite the fact that the term "*Pteranodon*" literally means "wing-without-tooth"), with wrongful bird-of-prey claws instead of pterosaurs' smaller hindlimbs relatively to the wingspan (Witton, 2013). The pterosaurs were depicted with eagle-like behaviour, although there is no evidence of this. In fact, *Pteranodon* is now considered to be mainly piscivorous due to multiple examples of fossilized fish scales and bones fossilzed in *Pteranodon* specimens. This includes a fish bolus in the jaws of AMNH 5098 (Bennett, 1994). The animals shown in-film also lifted humans into aerial locomotion, which is unlikely according to the wing loading and wing area calculations made by Witton and Habib (2010). Using the greatest dataset in their calculations,

$$224.79\ \mathrm{N} \times 1.60\ \mathrm{m}^2 / 9.80665\ \mathrm{m/s}^2 = 36.6755212\ \mathrm{kg}$$

Not enough for the average adult human with an average weight of 62.0 kg (Walpole et al., 2012).

Pyroraptor olympius (Allain & Taquet, 2000) was depicted with rough, random feathering unlike extant theropods and had eyes sunken into the skull and forward placed peculiarly. Despite its feathering, the animal was shown diving into icy water and swimming at high velocity. Modern secondary aquatic theropods adapted for cold environments, like penguins, have thick, smooth plumage to ensure a layer of air for buoyancy; have webbed feet and/or adapted flippers; and layers of blubber for insulation, all of which the film's *Pyroraptor* lacks.

Quetzalcoatlus sp. (Lawson, 1975) was oversized, with a wingspan rivaling that of a Fairchild C-119 Flying Boxcar. In reality, the biggest specimens had wingspans of around 10 - 11 meters (Witton et al., 2010). The animals were shown nesting with sticks on top of buildings, similar to some birds. However, pterosaur eggs were soft shelled (Wang et al., 2017) and thus were more likely covered in moist substrates.

Sinoceratops zhuchengensis (Xu et al., 2010) was depicted with an uncovered parietal fenestrae, contradictory with the signs of blood vessel grooves on the fossil frill (Horner & Goodwin, 2009). The animal was also oversized, being larger than African elephants. In reality, they more likely reached 2 metric tonnes (Paul, 2010).

Spinosaurus aegyptiacus (Stromer, 1915) was shown with over-elongated hindlimbs (Ibrahim et al., 2014). Its keeled tail (Ibrahim et al., 2020) incorrectly is shown to be a generic theropod tail. Hone and Holtz Jr. (2021) proposed a "shoreline generalist" model of behaviour for the animal, unlike the terrestrial and aquatic pursuit predator shown in the film. The cranial anatomy for *Spinosaurus* was also fallaciously depicted, with two lacrimal ridges, similar to that of an *Allosaurus*, whereas the actual animal had a singular crest on the dorsal part of the nasal (Dal Sasso et al., 2005). The animal was incorrectly shown with pronated wrist (Carpenter, 2002).

Stegosaurus sp. (Marsh, 1887) had inaccurate positioning, with the tail drop-

ping below from the sacrum (in *Jurassic World* (Trevorrow, 2015)). The caudal vertebrae articulated so that their centra faces are parallel, therefore the tail is almost at the level of the sacrum throughout its length (Carpenter, 1998). The animals were also oversized, looking about 15 metres in length in-film, howbeit scientific estimations of the largest specimen, YPM 1853, reach up to 9 meters (Holtz Jr., 2007). The restorations in film also had relatively short necks compared to more recently described specimens (Maidment et al., 2015).

"*Stygimoloch spinifer*" (Galton & Sues, 1983) is generally considered to be a junior synonym of *Pachycephalosaurus* (Goodwin & Evans, 2016). However, the taxon was treated as an individual genus in the film.

Therizinosaurus cheloniformis (Maleev, 1954) was depicted with incorrect morphology overall; the cranium is proportionally too big and of incorrect shaping, the torso lacks the signature "large belly" compared the available remains (Hedrick et al., 2015). In *Jurassic World Dominion* (Trevorrow, 2022), the animal is shown using its almost metallic looking claws as weapons, penetrating the bodies of theropods with ease. However, such curved claws are not very resistant to stress and were more likely adaptations for herbivorous foraging (Lautenschlager, 2014).

Triceratops sp. (Marsh, 1889) had horns incorrectly depicted as rough and filled with fossil marks instead of smooth, more lifelike cornified texture (Bennington, 1996), and the skin are not consistent with yet unpublished soft tissue material (Witton, 2015; Manucci, 2021). Ontogeny studies conclude that *Triceratops* lost their triangular epoccipitals as they aged, resulting in smooth frills for adults, unlike the portroyral in the films (Horner & Goodwin, 2006). The animals in the films are designed with elephantine feet, whereas in reality their forearms and manus were more primitive for quadrupedality (Fujiwara, 2009).

Tyrannosaurus rex (Osborn, 1905) was shown with inaccurate forelimb placement, with the volar incorrectly facing backwards towards the legs, a posture deemed impossible in any theropod (Carpenter, 2002). The animal was also stated to be unable to see unmoving objects. However, According to Stevens (2006), *T. rex* had 13 times the optical acuity of a *Homo sapiens*, surpassing the visual sensitivity of an eagle; *Tyrannosaurus* might have had a limiting far point as far as 6 km, exceeding the *Homo* limit of 1.6 km. *T. rex* was shown running in pursuit of a Jeep and caught up, despite the fact that locomotion at such velocity was estimated to be improbable for a large animal like *T. rex* (Hirt et al., 2017) as their hindlimbs would have shattered if the 7 tonne animal reach speeds above 18 km/h (Sellers et al., 2017). The roar of the in-film *Tyrannosaurus rex* was a mixture of the sounds made by a juvenile elephant, a tiger and an alligator. It can be inferred that extinct theropods most likely vocalized with syrinxes, as in modern and primitive birds (Riede et al., 2016). Thus, had dinosaurs possess syrinxes, they would've made avian-like vocalizations rather than roars (or: reptilian hissing from phylogenetic bracketing). The cranial restoration of *T. rex* in *Jurassic Park* (Spielberg, 1993) is, from a modern perspective, lacking from soft tissue (shrink-wrapped), and the lacrimal ornamentations are considered too angular

for the epidermal correlations below: covering the dorsal region are projecting, miniscule spicules that do not have vascular grooves branching off, which are commonly found under cornified sheaths, not angular hornlets. *T. rex* was also shown with inaccurate ontogenesis: a juvenile specimen was depicted with a deep skull, as found in adults, however new studies conclude that the genus "*Nanotyrannus*" (Bakker et al., 1988) was in fact a junior synonym of *T. rex* (Woodward et al., 2020), and that high degree of ontogenic changes can be resultant from age-related niche partitioning (Holtz Jr., 2021). The former had a much more elongated cranium (Carr, 2020). Three adult *T. rex* individuals, one of which upon the first time meeting the other two, are shown interacting peacefully. Such behaviour is considered unlikely due to the amount of evidence found for a high degree of intense intraspecific combat (e.g. Peterson et al., 2009; Brown et al., 2022). The animal was explicitly shown to have not had a nictitating membrane, despite the fact that crocodiles and birds both possess this structure, allowing phylogenetic bracketing. Recent skeletal placement studies of *Tyrannosaurus* show that it had much higher robusticity than previously reconstructed (*A Fresh Science Makeover for SUE*, 2018); gastralia tend to follow the deep pubis which in turn leads to a larger torso.

Velociraptor mongoliensis (Osborn, 1924) was probably the most misleading portrayal in the film; its large, featherless, reptilian appearance contradicting with the actual fossil material. First off, quill knobs were found on a forelimb fossil in Mongolia (Turner et al., 2007), explicitly indicating feathers. The animals shown in the films were >3 meters in length, whereas available fossils indicate otherwise, exhibiting a body length of <2.1 meters (Holtz Jr., 2007; Campione et al., 2014). *V. mongoliensis* was also shown with an inaccurate forelimb position of pronation (Carpenter, 2002). The taxon was portrayed to have hunted in packs, like modern wolves, despite the lack of fossil evidence to support this; no individuals were found in close proximation to one another (Norell & Makovicky, 2004), and desert dwelling predators are more likely solitary (Holtz Jr., 2007). The cranial restoration was overly short and robust, with incorrect shaping; the skull was supposed to be concave on the upper surface and possess a rather elongated and gracile lower jaw (Barsbold & Osmólska, 1999). A *Velociraptor* was shown dug out in a site in Montana, North America, despite the fact that *V. mongoliensis*, as its name suggests, are found in Mongolia (Holtz Jr., 2007; Paul, 2010). In *Jurassic Park III* (Johnston, 2001), the animals were shown as highly intelligent, being able to achieve complex communications with one another and outsmart human characters, which are unlikely; these animals were likely as smart as an "average bird" according to Dr. David Button (Hendry, n.d.). The animals also underwent a cranial redesign in *Jurassic Park III* (Johnston, 2001), as two lacrimal ridges were added onto its skull, which are, again, not represented in fossil remains described by Barsbold and Osmólska (1999). In later films, the teeth are shown extending directly below the orbit, which doesn't make sense anatomically. Compare with description of skull by Barsbold and Osmólska (1999).

3.2. Miscellaneous

1) A character possesses a bottle of *Tyrannosaurus* urine, which looks like typical human urine. Reptiles and birds produce insoluble uric acids instead of soluble urea out of amino acid metabolism, thus their urine are supposed to be whitish, aqueous suspensions of uric acid crystals that are passed into the cloaca and mixed with fecal material before being expelled (The Editors of Encyclopaedia Britannica, 2022).

2) In a segment stated to have taken place 65 million years ago, several species were shown in the same environment. This includes *Dreadnoughtus* (South American Campanian-Maastrichtian (Lacovara et al., 2014)); *Nasutoceratops* (North American Campanian (Getty et al., 2010)); *Giganotosaurus* (South American Cenomanian (Paul, 2010)); *Moros* (North American Cenomanian (Zanno et al., 2019)); *Iguanodon* (European Barremian-Aptian (Paul, 2010)); and *Tyrannosaurus* (Paul, 2010). These animals could likely never encounter one another. In addition, the K/Pg impact was 66.043 ± 0.011 million years ago (Renne et al., 2013), thus "65 million years ago" would be after the extinction of non-avian dinosauriformes.

3) *Baryonyx walkeri* (Charig & Milner, 1997) was stated to be larger than *Suchomimus tenerensis* (Sereno et al., 1998), however scientific size estimates pointed otherwise (Paul, 2010).

4) Diaphysis was referred to as epiphysis on the tibia of the juvenile *T. rex*.

5) *Dilophosaurus* were referred to as poisonous. If it spits and bites its prey with poison, then it is venomous, not poisonous (Rafferty, n.d.).

6) Dinosaurs were referred to as a species. However, the *clade Dinosauria* (Owen, 1842), under current phylogenetic nomenclature, refers to all the descendants of the Most Recent Common Ancestor (MRCA) of *Triceratops horridus*, *Passer domesticus* & *Diplodocus carnegii* (Baron et al., 2017).

7) "Raptor" was explained to mean "bird of prey", whereas it actually means "plunderer".

8) *Tyrannosaurus* was misspelt as Tyranosaurus. *Stegosaurus* was misspelt as Stegasaurus.

3.3. Implications of Inaccuracies

Questionnaire investigation

The effects on the public of the inaccuracies are shown by the results (**Figure 1**) of a very brief questionnaire investigation; 100 sets of data were obtained, and the questionnaire was conducted in July 7, 2021 (Note: this was before the release of *Jurassic World Dominion* (Trevorrow, 2022)):

1) Which following elements of the Jurassic Park™ franchise is your favorite?

Figure 1 shows the percentage array of choices. Note that this is a multiple-answer question, meaning that more than one choice is choosable simultaneously. The most favored element is CGI. Dinosaur reconstruction is only 2% shorter: out of 100 individuals, 63 opted for the said option. 22 people went for plot, setting and characters, and 15 people chose action and thrill.

2) In your opinion, which of the following *T. rex* is the most scientifically accurate? (Do not leave this page before answering. Your initial opinion is of great importance to my research. If you never watched the Jurassic Park™ franchise, please choose "*Not watched yet*".)

Figure 2 shows the choices. Figure 3 shows the percentage distribution of choices. There is a choice for certain individuals who haven't seen the aforementioned films which will redirect them to another question. Thus, all individuals who answered (A), (B) or (C) have watched the films and therefore are our targets of investigation.

(A) is an outdated, thoroughly feathered restoration from 2016, as the *T. rex* specimen HMNS 2006.1743.01, containing tail, hip, and neck scales (Bell et al., 2017), was described one year later.

(B) is the *Jurassic Park* design, has inaccurate forelimb placement, with the volar incorrectly facing backwards towards the legs, a posture deemed impossible in any

Figure 1. Percentage distribution of people's favorite elements of *Jurassic Park* franchise.

(A) (Palmer, 2016) (B) (Kee, n.d.) (C) (Nikodim, 2020)

Figure 2. *T. rex* restorations: An outdated, feathered restoration from 2016 (A), the *Jurassic World* design (B), and a relatively more accurate restoration as of 2020 (C).

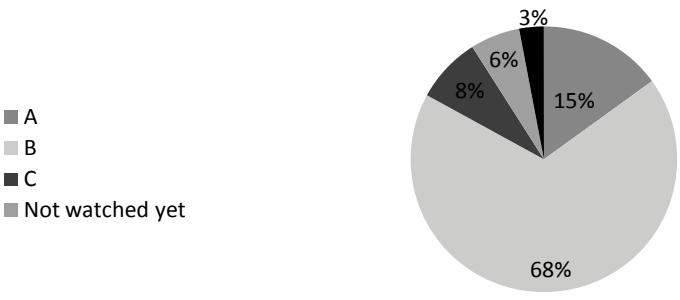

Figure 3. Percentage distribution of choices shown in a pie chart for "In your opinion, which of the following *T. rex* is the most scientifically accurate?".

theropod (Carpenter, 2002).

(C) is the most accurate *T. rex* restoration of the three, with rectified scales matching available soft tissue remains, correct forelimb posture and accurate proportions.

(B) is the affirmative choice here. 68 out of 100 chose this design as the most accurate *Tyrannosaurus rex* impression. The *Jurassic World* design is practically identical in all of *Jurassic Park* films, one who have watched any of the films may be affected accordingly. The *T. rex* designs in *Jurassic Park* plays a fundamental role in the apprehension of how the widespread impressions on palaeo-vertebrates have been deviated by the aforementioned franchise. A, on the other hand, is considerably less considered as accurate; the ones who chose it might have been prevailed by scientific reports before Bell et al. (2017); they may have seen inappropriate "popular science" articles and webpages that divulged outdated material; and so forth. C, the correct answer, is the least chosen option.

3) How "scientific" and how "fantasized" is the Jurassic Park™ franchise?

Two antitheses are noted following the genres in order to grant a more perspicuous view on the question. They are, respectively, *Planet Dinosaur* and *Godzilla*. The selector is able to adjust the ratio between the two.

As seen here in **Figure 4**, the distribution of results is rather balanced, with "fantasy" obscurely transcending "science".

4) How "scientific" and how "fantasized" should the Jurassic Park™ franchise be in your opinion?

Two antitheses are noted following the genres in order to grant a more perspicuous view on the question. They are, respectively, *Planet Dinosaur* and *Godzilla*. The selector is able to adjust the ratio between the two, the results shown in **Figure 5**.

Commensurate with the preceding question, this one enquires the selector's opinion on *how* the franchise should be, thereby revealing their satisfaction on the franchise's scientific-fantasized ratio they decided prior. The results display a general tendency towards a positive rate of satisfaction.

Summary of questionnaire results:

1) Focused on the public's most concurring elements in the franchise, CGI turned out to be highest voted; dinosaur reconstruction is in proximity at second.

2) Listed out 3 divergent restorations of the Maastrichtian theropod *Tyrannosaurus rex* and enquired for the most scientific variation. The *Jurassic World* design was the most affirmative option, being more substantial than all other options combined.

3) Provided an adjustable ratio with two antitheses: "Scientific" and "Fantasized", questioning for the ratio of the two elements in the contemporary franchise. "Fantasized" was slightly higher than "Scientific".

4) Was commensurate to 3), whereas this time enquiring for the answerer's opinion on how the franchise should be. The results were roughly identical to the results in 3), indicating a high satisfactory rate on the current franchise.

According to the questionnaire analyzed above, Audiences are more likely to

Figure 4. Results of "How 'scientific' and how 'fantasized' is the Jurassic Park™ franchise?". The percentage distribution of choices is shown in the pie chart.

Figure 5. "How 'scientific' and how 'fantasized' should the Jurassic Park™ franchise be in your opinion?". The percentage distribution of choices is shown in the pie chart.

consider the incorrect *Jurassic Park* dinosaur restoration as accurate instead of more scientific restorations. They also exhibit a tendency of general satisfaction towards the current state of the films, considering the dinosaur restorations in the films to be likeable.

Apart from the misleading effects the franchise has on the public, the general impressions on these animals also by extension affect the restoration of other media. *Dilophosaurus*, for example, were depicted with a neck frill in the film with venomous feats, and were the size of pigs. In real life, these animals would lack a neck frill, venom disposal and would be as large as brown bears (Marsh & Rowe, 2020). However, the implications of the "neck frill" stereotype established in *Jurassic Park* can be seen in other, unrelated media as well, e.g. *Dilophosaurus* statues in Long Nooch Dinosaur Valley, Thailand (Del Coro, 2020) and the *Dilophosaurus* model from the ARK: Survival Evolved videogame (*Dilophosaur*, n.d.). The frilled restoration of *Dilophosaurus* in *Jurassic Park* may have influenced the creature designers of the aforementioned restorations. By extension, individuals who saw the incorrect restorations caused by the implications of the films may be influenced as well, causing the *Jurassic Park*-caused stereotypes to spread and propagate in the population. The same reason can be attributed to the many widespread stereotypical incorrect dinosaur restorations in media, e.g. pronation of theropods (it wasn't until the early 2000s when scientists started to look at dinosaur pronation and supination (e.g. Carpenter, 2002); filtering all outdated scientific retorations is difficult, thus more people is likely to be misguided); overrated intelligence of *Velociraptor*; whale-like vocalization, elephant-like covering and cow-like grazing movements of sauropods; et cetera.

To improve the situation, more public media can be published featuring and explaining more accurate paleo-organisms. Examples of recent successful accurate paleo-media include the documentary series *Prehistoric Planet* and the videogame *Prehistoric Kingdom*. However, *Jurassic Park*'s monopoly over the dinosaur genre in mainstream media (Morales, 2022), evident as some directors purposefully avoid the genre because "*Jurassic World* owns that" (Pearson, 2017), is a major deterrence to prospering of other paleo-media in mainstream media. The constant lack of attention on the scientific accuracy of the only major medium representing paleontology in mainstream media is a driving force of incorrect public impressions of paleontology science. The compendium listed in this study is a useful tool for allocating stereotypical inaccuracies from paleo restoration, providing an opportunity for artists to course-correct in a world where certain incorrect perceptions predominate.

4. Conclusion

The many restorations of dinosaurs and other palaeo-organisms in the *Jurassic Park* franchise are incorrectly portrayed, as being vastly different from their real-life counterparts. The compendium of inaccuracies and mistakes included in this paper offered insight into how the actual animals may have looked like compared to the film restorations, and the effect of the incorrect restorations in the films is evident in a questionnaire, with the general audience tending to choose the *Jurassic Park* version over scientific ones, and displaying high satisfactory rates towards the current condition. Also, the incorrect reconstructions of the creatures in the films may affect dinosaur restorations in other media, creating a positive feedback loop where incorrect, baseless stereotypes propagate instead of scientific restorations.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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