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Terrestrial Mollusca in *The Legend of Luo Xiaohei*

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Since the beginning of 2019, the web cartoon and flash animation *The Legend of Luo Xiaohei*[1] (in short, *Luo Xiaohei*) has been viewed more than 72 million times on barrage video website Bilibili (https://www.bilibili.com/). It premiered on March 17, 2011, and has since been updated at a very slow pace. Currently, there are only 27 episodes, each lasting a little over five minutes, counting the ending and opening themes.

The low-updating cartoon has wonderful backgrounds and depicts many creatures, some of which are terrestrial Mollusca. The creators of *Luo Xiaohei* are Chinese, so the inspirations for the Mollusca in the cartoon are all from East Asia. The depictions are either directly based on a particular species, or freely created based on a wider group of species. Here I discuss the taxonomic and ecological characteristics of the mollusk species depicted in *Luo Xiaohei*.

TERRESTRIAL MOLLUSCA

Episode 9, 06:28 / Episode 10, 01:07

Taxonomy: Genus *Amphidromus* Albers, 1850.

In Episode 9, two snails can be seen on a tree covered with moss. Based on a recent study by Lok & Tan (2008), the diet of *Amphidromus* is similar to other tree snails such as *Achatinella* Swainson, 1828 and *Partula* Férussac, 1821 (Kobayashi & Hadfield,

Figure 1. Screen capture from Episode 9, 06:28; extracted from Bilibili.

[1] By MTJJ, China (2011–present). Original title: 罗小黑战记

1996). These snails are known to live among moss, their favorite food, and the enviroment depicted in the cartoon is indeed quite realistic.

In fact, the environment shown in this episode seems to be humid, and *Amphidromus* occurs in Northeast Asia (Sutcharit & Panha, 2006), a warm and humid region. Also, since this is a Chinese cartoon, it is worth mentioning that species in this genus are also known to occur in South China (Benson, 1851). These snails are usually found in tree holes (Inkhavilay et al., 2017) and when predators like birds are about, they won't move, which strongly fits the depiction in the cartoon. We can also see the same kind of shell in the background of Episode 10 (01:07 min). The cartoonists are probably hooked on these wonderful snails.

Figure 2. Screen capture from Episode 10, 01:07; extracted from Bilibili.

Figure 3. *Amphidromus roseolabiatus* on a tree trunk; extracted and modified from Wikimedia Commons (Inkhavilay et al., 2017).

Episode 10, 03:38

Taxonomy: Family Cyclophoridae Gray, 1847.

A juvenile shell can be seen on a leaf. Based on the shape of its expanded aperture, it may have an operculum. This is probably an extrapolation by the creator, because terrestrial snails actually do not expand and thicken their aperture when they are young. By the time they expand the shell's outer lip, they should have more whorls. The inspiration for this one may come from the genus *Platyrhaphe* Möllendorff, 1890.

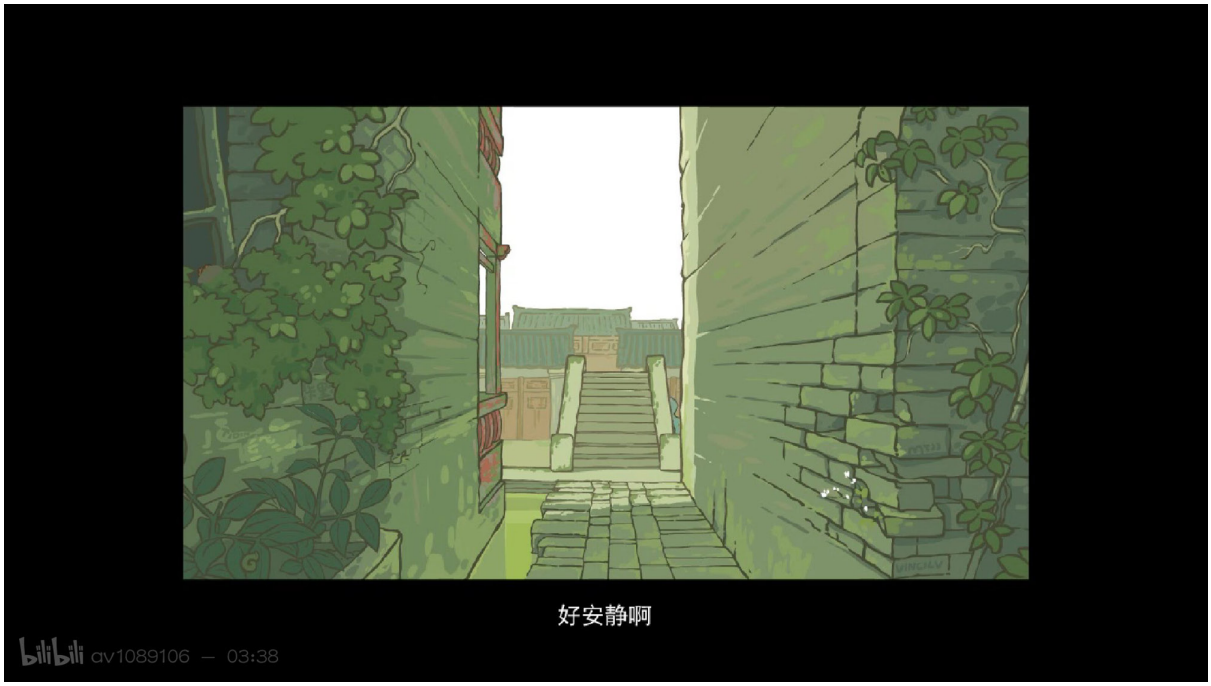

Figure 4. Screen capture from Episode 10, 03:38; extracted from Bilibili.

Figure 5. Holotype of *Platyrhaphe demangei*; extracted from Royal Belgian Institute of Natural Sciences (www.naturalsciences.be).

Episode 15, 02:05

Taxonomy: Genus *Camaena* Albers, 1850.

A broken shell lies on the ground over some moss. We can see the umbilicus directly, which shows that this shell is sinistral (that is, it has a "left-handed" coiling direction). Also, the environment shown is consistent with South China. According to the plot, Luo Xiaohei (the titular character in the cartoon) becomes smaller due to magic, so this is why the shell seems so large. However, in fact, *Camaena* is quite large for a terrestrial snail (Ding et al., 2016).

In China (where the cartoon was produced), the color of the sinistral *Camaena* species is usually brownish and reddish (Ding et al., 2016). In the cartoon, the color is yellowish, but this may be caused by the shell being long exposed to the weather. Usually, shells found in the wild are often weathered and discolored, and the characteristic bands disappear.

Figure 6. Screen capture from Episode 15, 02:05; extracted from Bilibili.

Figure 7. *Camaena cicatricosa*; extracted from Wikimedia Commons (Llez, 2013).

Episode 15, 04:29

Taxonomy: Genus *Meghimatium* Hasselt, 1823.

Identification of slugs depends on the proportional relationship between the mantle and the entire body and the location of the breathing pore (called pneumostome). In the cartoon slug, there is no visible boundary between the mantle and the entire body. Because the slug must match the background color but not lose its color, its body will add a lot of green to integrate to the overall atmosphere and environment and thus, be inconspicuous.

The continuous mantle limits the range of identification options to two slug families: Veronicellidae Gray, 1840 and Philomycidae Gary, 1847 (Wiktor et al., 2000). The mantle of veronicellids does not look so humid (they are called "leatherleaf slugs"), so naturally, it can only be Philomycidae.

In China, a very common genus of slugs belonging to Philomycidae is *Meghimatium*. Some members of this genus vary a lot in color pattern, such as *Meghimatium bilineatum* (Benson, 1842). The common color pattern of *M. bilineatum* is grey with two longitudinal black lines, but also orange individuals without lines can be found (Chen & Gao, 1987; Wiktor et al., 2000). I have also found grey-colored individuals lacking the black lines.

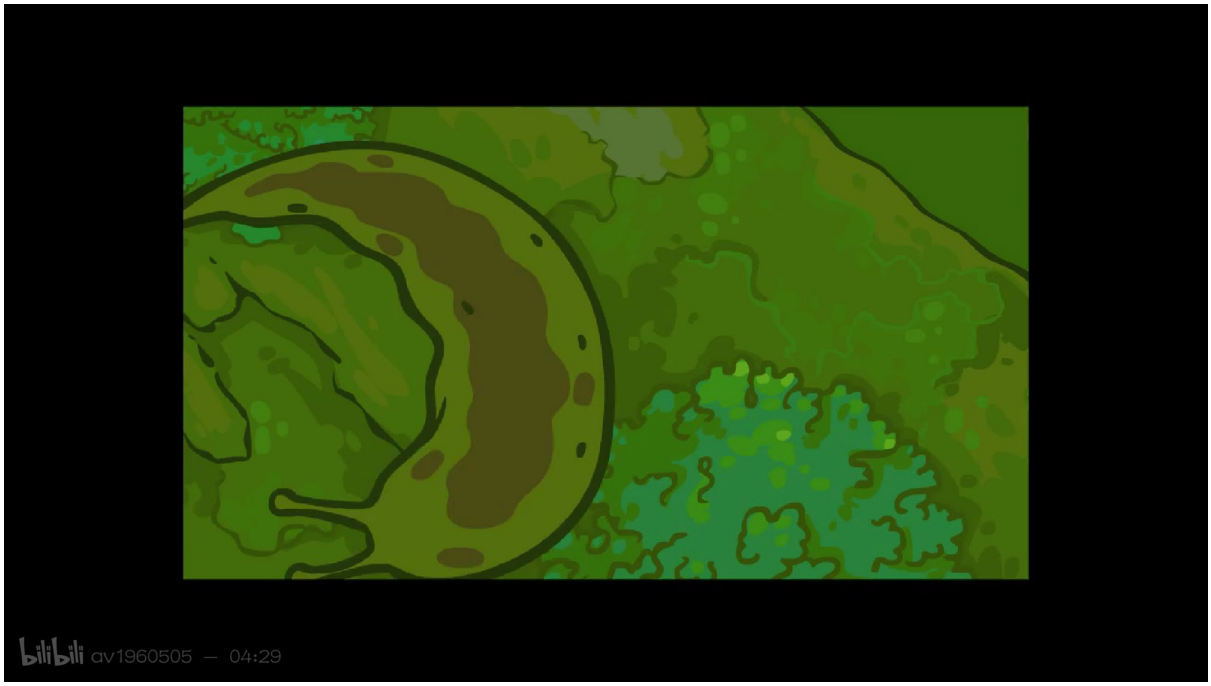

Figure 8. Screen capture from Episode 15, 04:29; extracted from Bilibili.

Figure 9. *Meghimatium bilineatum* from Rizhao, Shandong, China; photo by the author.

Episode 16, 07:55

Taxonomy: Genus *Achatina* Lamarck, 1799.

A shell used as a flower pot seems to have been inspired by snails in the genus *Achatina*. Shells in this genus are very large and have a tall spire. The species kown as African giant snail, *Achatina fulica* (Férussac, 1821), has been introduced to South China before the 1930s (Jarrett, 1931). But the shell in the cartoon has a lower spire and more inflated whorls.

Figure 10. Screen capture from Episode 16, 07:55; extracted from Bilibili.

Figure 11. *Achatina fulica*; extracted from Wikimedia Commons (Eric Guinther, 2004).

CONCLUSION

The terrestrial mollusks in *Luo Xiaohei* are accurately depicted regarding their real-world ecology, habitat, and diet (*e.g.*, Episode 9, 06:28). Some of the depictions show real morphological features of the species they seem to be based on (*e.g.*, Episode 15, 04:29). Nevertheless, terrestrial mollusks are an essential part of natural environments. Much like in nature, they also play an important role in *Luo Xiaohei*, especially in Episode 15, 02:05, when the shell indirectly reflects the fact that Luo Xiaohei has become smaller. In fact, the mollusks depicted in the cartoon may actually help in transmitting the atmosphere of the humid, lush environment where the story takes place.

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About the author

Guoyi Zhang is a student and taxonomist working on the Camaenidae of China. Land snails are Zhang's favorites in life. Zhang also enjoys watching *Luo Xiaohei* and other cartoons on Bilibili as a hobby.

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Inspiration for the character design of *Squids Odyssey*

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Squids Odyssey is a role-playing game by French studio The Game Bakers. It is the latest entry in the *Squids* franchise, released in 2014 for Nintendo 3DS and WiiU, and more recently, in 2018 for PC and Nintendo Switch.

The fun fact about our *Squids* games is that we were actually all fascinated by octopuses and cephalopods in general long before we created the game. We even almost named our game studio "Happy Squids"... It was when we were working on the game mechanics and looking for some characters that could be "stretchable" on an iPhone screen that we thought about "tentacles"[1]. Then we knew it was a perfect fit! We started designing our little heroes inspired by

Clint was inspired on the vampire squid (*Vampyroteuthis infernalis*), a very unique deep-sea species. Source: Wikimedia Commons (C. Chun, 1910: Die Cephalopoden, II. Teil).

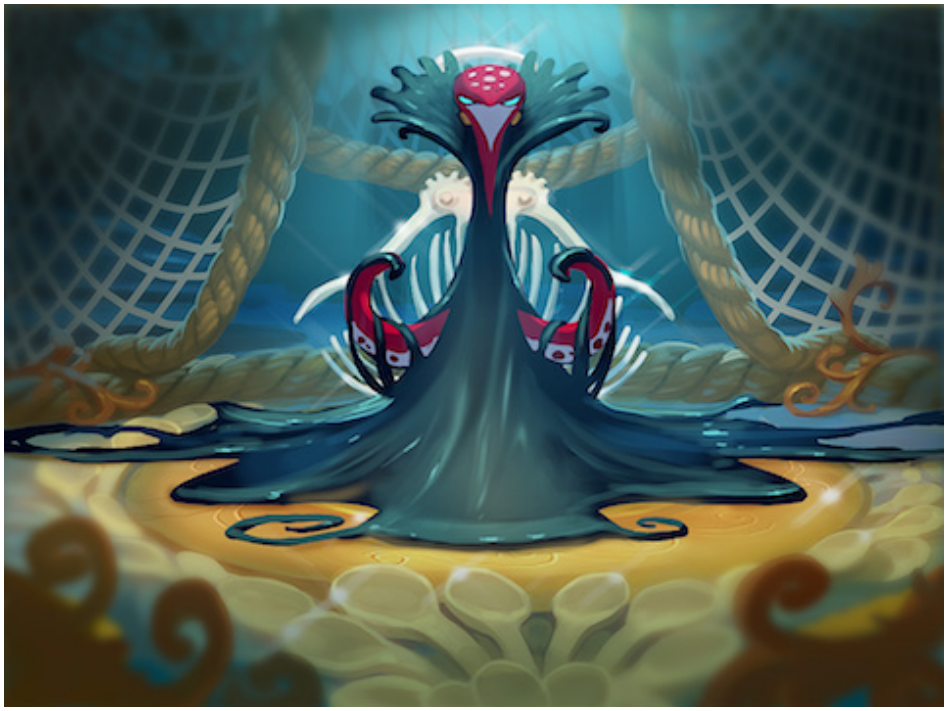
[1] Squids and cuttlefish have 8 arms and 2 tentacles. Octopuses have 8 arms and no tentacles.

real octopuses, squids and other cephalopods.

We did a lot of research to get inspiration on shapes and colors, but of course there is also a lot of redesign in cartoon style so sometimes it might be hard to see the direct reference. But you can still recognize a few: for instance, Clint was inspired on the vampire squid. Baron, the bad guy in the story, is inspired by a more regular octopus.

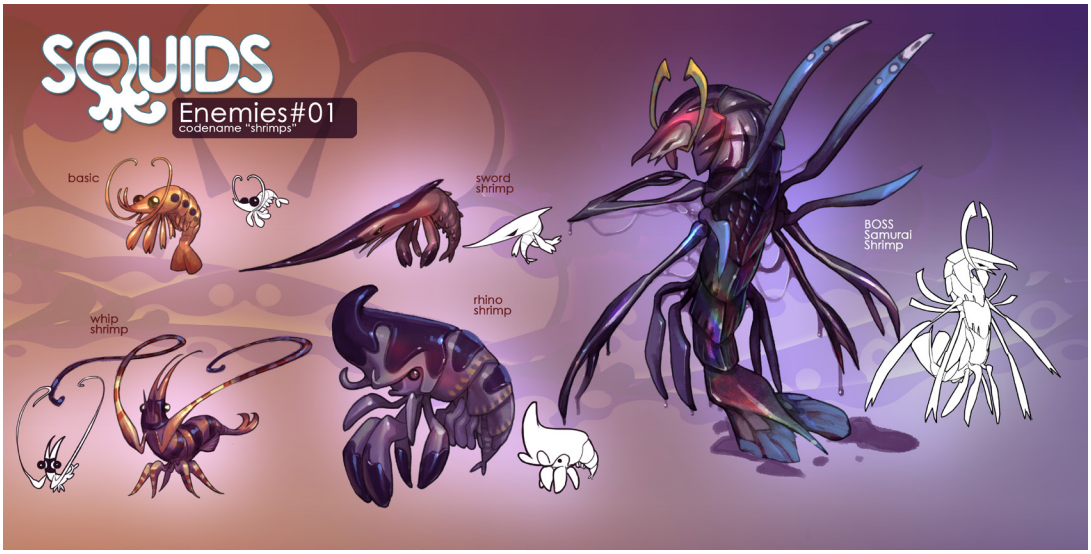
We also looked at shrimps and crabs[2] for the enemies. The big boss of the first game is a coconut crab, while a basic enemy you meet in the game is a hermit crab. You can tell the influences directly from the designs.

We took inspiration from other real underwater fauna and flora for the environment design. Even their habitations or their helmets are inspired by things you can find on the bottom of the sea. And in the com-



Baron was inspired on a more classic octopus, such as the common octopus (*Octopus vulgaris*) – yes, the name says it all. Source: Wikimedia Commons (A. Salo, 2007).

[2] Shrimps, crabs and lobsters are crustaceans and belong to the Phylum Arthropoda, alongside insects and arachnids. They are not related to cephalopods, which belong in the Phylum Mollusca alongside snails and clams.



Design variations of the crustacean enemies.

Coconut crabs (*Birgus latro*) live on coastal areas around the Indian and Pacific Oceans. They are the largest land-dwelling arthropods and may weigh up to 4 kg. Despite their name, coconuts are not a significant portion of their diet. Source: Wikimedia Commons (fearlessRich, 2006).

Hermit crabs belong to the superfamily Paguroidea, which counts with over 1,000 species. They typically inhabit a snail shell, using it for protection. This one is called blueband hermit crab (*Pagurus samuelis*) and lives along the Pacific coast of North America. Source: Wikimedia Commons (Stemonitis, 2011).

ic book, we extended the character design to fish; for instance, one of the characters was inspired on a swordfish. In our game, squids and turtles actually cooperate, even though this might not be the case in real life.

For simplification, our little characters only have 4 arms. It's funny that we've been told by some members of our Japanese audience – experts in octopuses and squids – that our little heroes did not look enough like these animals!

About the team

The Game Bakers is an indie game studio founded by **Emeric Thoa** and **Audrey Leprince**, and based in Montpellier, France. Besides the *Squids* franchise, they are also responsible for the acclaimed *Furi* and the upcoming *Haven*.

Cooperation (mutualism) between squids and turtle. Although uncommon, some sea turtles are known to eat squids!

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Cosplay at Armageddon Expo*

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Cosplay is a performance medium in which embodied textual citation and photographic practices come together and sometimes collide. Moreover, photography both documents and preconditions elements of the cosplay performance, via visual genres typically spanning those of the fashion runway, studio and 'hallway' shoots. This chapter brings these textual and visual analyses together to present a situated photo-essay shot in the candid style. It documents five years of an Australasian-based fan convention that celebrated its twentieth anniversary in 2015, the Auckland Armageddon Expo. In doing so it offers a snapshot, as it were, of a half decade of 'glocalized' cosplay practice. The term 'glocalization' refers to twin processes at work in late capital. Firstly, capital and regulatory frameworks elide from the national upwards to the global scale and reciprocally downwards to the scale of the local. Secondly, economic activities and networks between business entities become simultaneously more localized, regionalized and transnational.[1] This model has been widely applied to the sphere of cultural capital and is of particular relevance to cosplay, which tends to grow by osmosis out of local conditions but owes its provenance to wider networks of cultural production and associated fandoms.

Armageddon is an instance of the organic way in which glocalized conventions develop and proliferate. It began as a comics and trading card event in Auckland, New Zealand, in 1995 with follow-ups in 1997, and within a few short years had spread to the capital city, Wellington (1998), and on to Melbourne, Australia (1999).[2] Starting off in small community venues, progressing to more major urban events centres, and on to large-scale convention spaces, the Expo has evolved into a major regional sci-fi, comics and gaming convention with over 80 events to date, some 70,000 annual visitors in its home city and 130,000 across its Australasian diaspora. In aggregate, it is, therefore, close in scale to San Diego's annual Comic-Con and exhibits a similar mix of cultural and industry practices. While the Auckland Expo has some factors that are specific to its geographic location, genealogy as a gaming and fan con, specifics of the main site and its mix of events, the photos in this chapter could have been taken at almost any con in the western world, both in terms of the diversity of participants and the franchises, storyworlds and other source media texts represented in the costumes on display. The first part of the commentary, which follows, discusses the range of sources being cited—the individual trees amid the forest of citations—along with some identifiable trends in the 50 photographs that comprise this selection.

* This is an extract from Chapter 3 of *Planet Cosplay: Costume Play, Identity and Global Fandom*, by Paul Mountfort, Anne Peirson-Smith and Adam Geczy (Bristol, UK: Intellect Books; Chicago, US: University of Chicago Press, 2018). Reprinted with permission by Intellect Books. Note that this version may display minor editorial differences to the final published version.

Figure 1. Q from [C] *The Money of Soul and Possibility Control* (2011), contest event, Auckland Armageddon Expo 2012. © Paul Mountfort.

Figure 3. Applying prosthetics, Auckland Armageddon Expo 2012. © Paul Mountfort.

Figure 2. 'Heath Ledger's' Joker from *The Dark Knight* (2008), Auckland Armageddon Expo 2012. © Paul Mountfort.

Figure 4. Scene outside the convention space, Auckland Armageddon Expo 2013. © Paul Mountfort.

Figure 5. Bane from *The Dark Knight Rises* (2012) and Harley Quinn from DC universe, Auckland Armageddon Expo 2013. © Paul Mountfort.

Figure 7. Thorin Oakenshield (*left*) from *The Hobbit* (2012–2014) and steampunk cosplayer (*right*), Auckland Armageddon Expo 2013. © Paul Mountfort.

Figure 6. Display mannequin, Auckland Armageddon Expo 2013. © Paul Mountfort.

Figure 8. Namine and Roxas (*left* and *centre*) from *Kingdom Hearts* (2002–), with Korra (*right, background*) from *Legend of Korra* (2012–14), Auckland Armageddon Expo 2013. © Paul Mountfort.

Figure 9. Menma from *Anohana* (2011), Auckland Armageddon Expo 2013. © Paul Mountfort.

Figure 11. Vendor with mood-reading nekomimi (cat ears), Auckland Armageddon Expo 2013. © Paul Mountfort.

Figure 10. Naruto from *Naruto Shippuden* (2007–7), Auckland Armageddon Expo 2013. © Paul Mountfort.

Figure 12. Onision 'I'm a banana' meme cosplay, Auckland Armageddon Expo 2013. © Paul Mountfort.

A cosphoto-essay

With the identity of the cosplayers included in this chapter being anonymous, the focus of discussion here is on the characters and source texts identifiable in the sample of photos on display, and the popular cultural milieu out of which they have arisen. Many of the sources being mined here are comparatively 'timeless,' harking back decades to milestones in their respective media, such as the 2014 San cosplay and crossplay (Figures 23 and 40) inspired by Studio Ghibli's *Princess Mononoke* (*Mononoke Hime*) (1997).[3] Half a decade is long enough, however, for micro-historical forces to operate in fan cultures, wherein recent movies, games and media elements enjoy rapid waves of meme-like popularity. Of course, even the most up-to-the-minute sources being cosplayed may spring from long-lived media franchises. For instance, Marvel or DC's blockbuster transmedia storyworlds have comic book precursors going back to the 1930s and 1940s. However, particular movie or game adaptions are often very specific: for example, a 2012 costume of The Joker (Figure 2) is not any old joker but identifiably Heath Ledger's Joker from Nolan's *The Dark Knight* (2008). Similarly, the 2016 release of the movie *Suicide Squad*, set in the DC Comics universe, indelibly marked the portrayal of Harley Quinn in that year.[4] Nor do new waves of influence always overwhelm old favourites: stormtroopers and even sets from the original *Star Wars* (1977–83) trilogy jostle alongside Sith and other characters from the more recent prequels and sequels (Figures 25, 35 and 36).[5]

Identifying the 'trees' in the forest of citations that comprise even a medium-size convention would prove a challenging, if not impossible, task for even the most pop culturally literate geek or otaku. This is because, as we have seen, cosplay draws on multiple media sources: comics, movies, manga, anime, games, pop idols and other media identities, as well as online memes. Most, though not all, of the costumes in this essay proved readily identifiable.[6] However, others were more elusive, with some cosplay, being, in any case, modelled after what Matthew Hales terms a generic (as opposed to discrete) character type[7] or fashion style rather than a titular protagonist—though these two dimensions (character type and style) often go hand in hand. Common western character types include vampires, zombies and other genera of the undead, who shuffle convention spaces alongside Japanese-inspired samurai, ninjas, *shōnen* (boys) and *shōjo* (girls), including sub-types such as *bishōnen* (beautiful boys) and *mahō shōjo* (magical girls). Among the most important generic styles—which may comprise not just fashion but lifestyles—are Lolita and steampunk. As previously discussed, these styles have often infected source media, such as anime and manga. Furthermore, crossovers and mash-ups abound, especially at larger cons with more established player communities who have the confidence to push cosplaying boundaries. This said, superhero action franchises, sci-fi and fantasy television shows, multi-season anime series and protagonists from popular gameworlds tend to be the dominant fauna at most cosplay cons.

There are identifiable cultural fashions within cosplay, and one of the affordances of an extended photographic study is that we are able to see how the portrayal of certain characters, or iterations of certain characters, spike in relation to recent film, game and other media releases. Photos from Armageddon taken between 2012 and 2016 document a number of character iterations from Marvel and DC. Both are deep-rooted comics franchises from the early twentieth century that have had many iterations, adaptations and spin-offs over the decades, and which are now the subject of multiple big movie and television series versions. Marvel exerts a particularly powerful gravitational pull on western cosplay today, with *Avengers* franchise characters such as Captain America (Figure 32) much in evidence in the wake of the *Captain America: The First Avenger* (2011), *The Winter Soldier* (2014) and *Civil War* (2016) instalments.[8] The interconnected nature of the Marvel universe, where the storylines of characters from discrete shows intersect at various junctures,

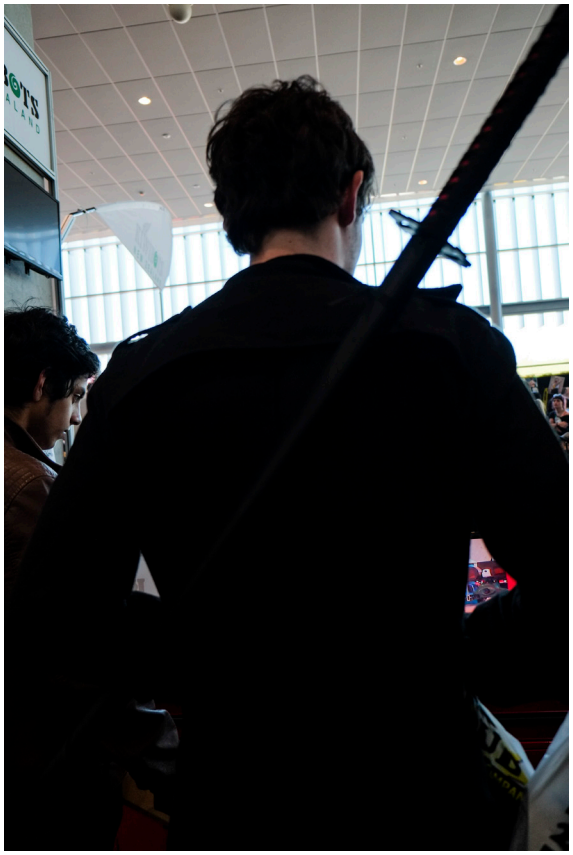

Figure 13. Samurai cosplay, Auckland Armageddon Expo 2013. © Paul Mountfort.

Figure 15. Colossal Titan (*centre, foreground*) from *Attack on Titan* (2009–), Auckland Armageddon Expo 2014. © Paul Mountfort.

Figure 14. Zipper face nurse meme cosplay, Auckland Armageddon Expo 2013. © Paul Mountfort.

Figure 16. Armoured anime cosplay, Auckland Armageddon Expo 2014. © Paul Mountfort.

Figure 17. Horse mask meme cosplay, Auckland Armageddon Expo 2014. © Paul Mountfort.

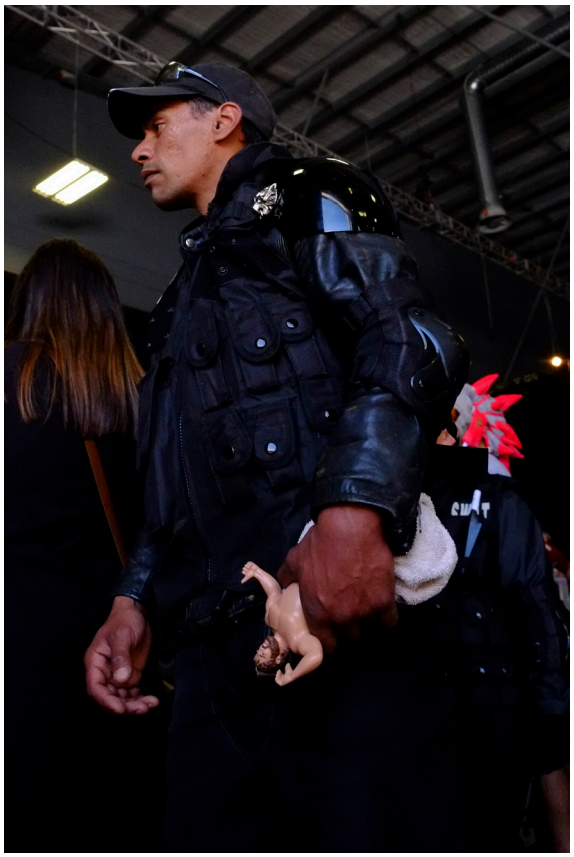

Figure 19. Cosplayer with police jacket, Cloud from *Final Fantasy* (1988) left shoulder plate, and convention merchandise, Auckland Armageddon Expo 2014. © Paul Mountfort.

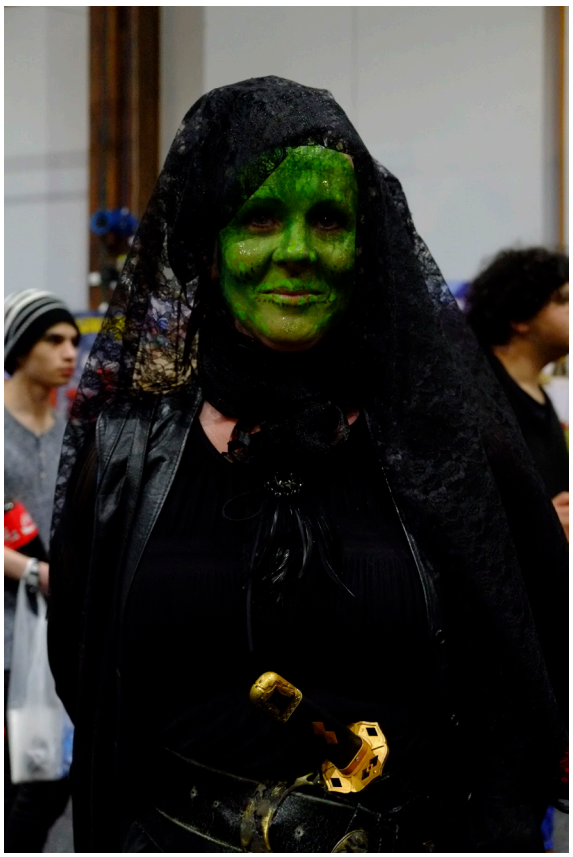

Figure 18. Madame Vastra from *Doctor Who Series 6* (2011), Auckland Armageddon Expo 2014. © Paul Mountfort.

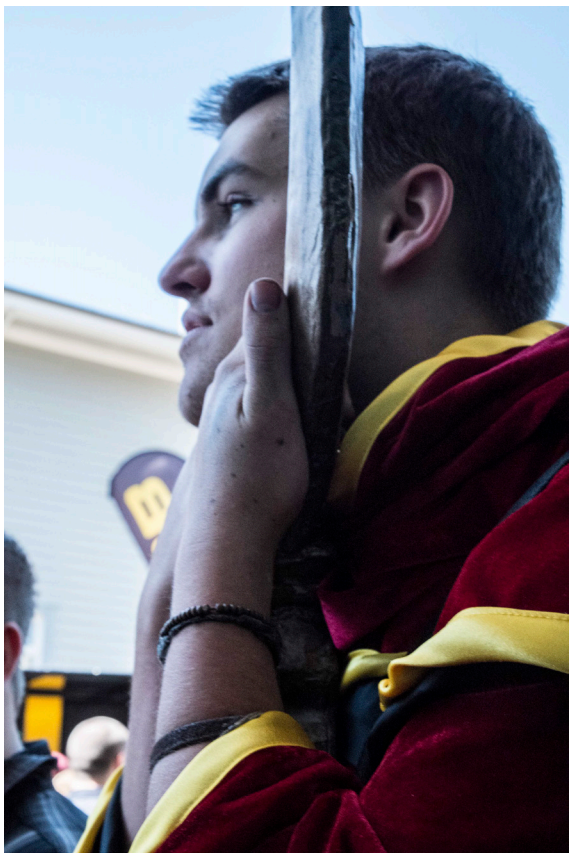

Figure 20. Quidditch player from *Harry Potter* (2001–11) franchise, Auckland Armageddon Expo 2014. © Paul Mountfort.

Figure 21. Ring Wraith from *The Lord of the Rings* (2001–03) movie trilogy, Auckland Armageddon Expo 2014. © Paul Mountfort.

Figure 23. San from *Mononoke Hime* (1997) Auckland Armageddon Expo 2014. © Paul Mountfort.

Figure 22. Titular lead character from DC Comics' *Scarecrow* (1941–), Auckland Armageddon Expo 2014. © Paul Mountfort.

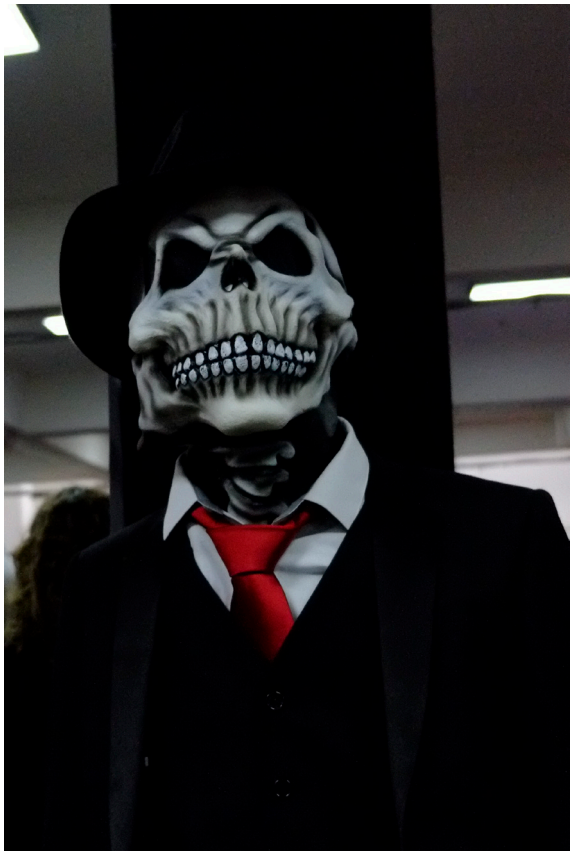

Figure 24. Titular lead character from *Sculduggery Pleasant* (2007–), Auckland Armageddon Expo 2014. © Paul Mountfort.

rewarding fans focused on the detailed timelines and backstories, provides the perfect template for the kind of vast inter-referential networks that operate within the cosphere.

In recent years DC has made serious moves to mimic Marvel's integrated storyworlds in an attempt to establish its own universe, though with mixed success. As mentioned, 'Heath Ledger's' Joker (Figure 2) was cited at Armageddon in 2012, four years after the release of DC's *The Dark Knight* (2008). Ledger's Joker attained iconic status not just through his riveting performance and the relative critical acclaim of Christopher Nolan's *Batman* trilogy[9] but also due to the actor's tragic death in the same year as the movie's release, which cemented his cult following in popular culture and ensured both actor and character iteration a viral afterlife. Nolan's trilogy restored a cachet to the *Batman* storyworld notably lacking for DC in the pantheon of contemporary popular culture, including cosplay circles. Hence characters such as the Scarecrow (Figure 25),[10] who was the only villain of genuine vintage to star in the entire rebooted *Batman* trilogy (2005–12), Bane and Harley Quinn (Figure 5) showing up in cosplaying circles following the 2012 release of *The Dark Knight Rises*, even though Quinn does not appear in this particular trilogy. She has had many iterations and her popularity spiked in 2016's Armageddon in response to *Suicide Squad's* (2016) fishnet stockings and baseball bat toting version (Figure 39, 50), even though the movie itself was ambivalently received. Superman and Wonder Woman undergo periodic revivals, with 2016's Armageddon showcasing both female and crossplaying versions (Figure 48) in anticipation of the *Wonder Woman's* 2017 Warner Brothers' reboot directed by Patty Jenkins, while the Green Arrow (Figure 44) from DC's *The Arrow* (2012–) television series reboot also put in a guest appearance.[11]

While some character iterations clearly follow more or less ephemerally on the heels of a movie or other media release, others enjoy relative longevity. For example, at Armageddon 2014 stormtroopers from the first *Star Wars* (1977) movie (Figure 25), a Ringwraith (Figure 21) and Quidditch player (Figure 20) were in evidence despite the original *Star Wars* trilogy dating back to 1977–83, *Lord of the Rings* from 2001–03 and *Harry Potter* from 2001–11.[12] Of course, like the DC and Marvel storyworlds, these cinematic works have deep and massive roots in popular culture, functioning practically as cultural mythologies in the west, and continue to have currency courtesy of the follow up *Star Wars* prequels, sequels and spinoffs (1999–), *The Hobbit* movie adaptation (2013–14) and *Harry Potter* prequel (2016).[13] The troupe of stormtroopers who posed in 2014 against a lovingly re-created backdrop from the original Death Star returned in 2015 to find themselves joined by a red guard (Figure 35) from *Star Wars II: Attack of the Clones* 2002 and a scruffy 'sandtrooper' from the extended *Star Wars* universe (Figure 36). Characters from the wider *Star Wars* universe may also make cameos, such as the Twi'lek woman from Armageddon 2014 (Figure 27). Although not an identifiable character from the canon, such as Aayla Secura, she is clearly a member of the alien species that figure in the television series *Star Wars: The Clone Wars* (2008–15). Creative adaptations from the storyworld are fairly common in cosplay, and could be described as fan-driven spinoffs, akin to fanfiction's world building.

Legacy movies that are not part of a larger franchise or storyworld can also provide cosplayers with material, especially where the imagery is iconic or has proved to 'have legs' in popular culture. Examples include the ubiquitous *V For Vendetta* (2006) masks that reference not only the film, but the Occupy movement, the cyber-insurgent group Anonymous and, more recently, NBC-Universal hacktivist drama *Mr. Robot* (2015–), in a feedback loop of popular cultural inter-referentiality (Figure 29).[14] Of course, anonymous masks may also be a cheap and easy way to simulate cosplay while retaining an aura of subcultural capital that other mass-produced masks do not convey. A movie's cult status may ensure the relative immortality of its characters in

Figure 25. Stormtroopers with fan-constructed backdrop from *Star Wars IV: A New Hope* (1977), Auckland Armageddon Expo 2014. © Paul Mountfort.

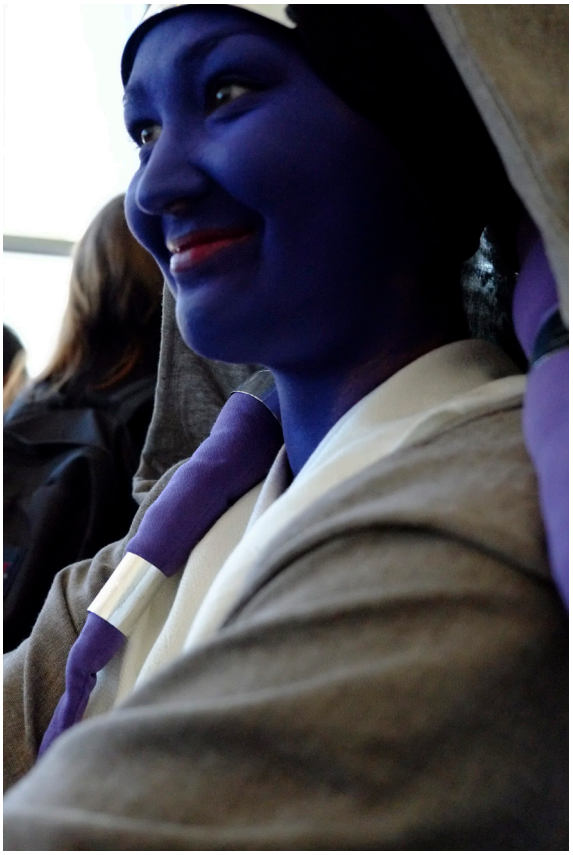

Figure 27. Twi'lek woman from the *Star Wars: The Clone Wars* (2008–15), Auckland Armageddon Expo 2014. © Paul Mountfort.

Figure 26. An Ood from *Doctor Who Series 4* (2006), Auckland Armageddon Expo 2014. © Paul Mountfort.

Figure 28. Fantasy figure, Auckland Armageddon Expo 2014. © Paul Mountfort.

Figure 29. *V for Vendetta* (2006) mask, Auckland Armageddon Expo 2014. © Paul Mountfort.

Figure 31. Zombie nurses cosplay meme, Auckland Armageddon Expo 2014. © Paul Mountfort.

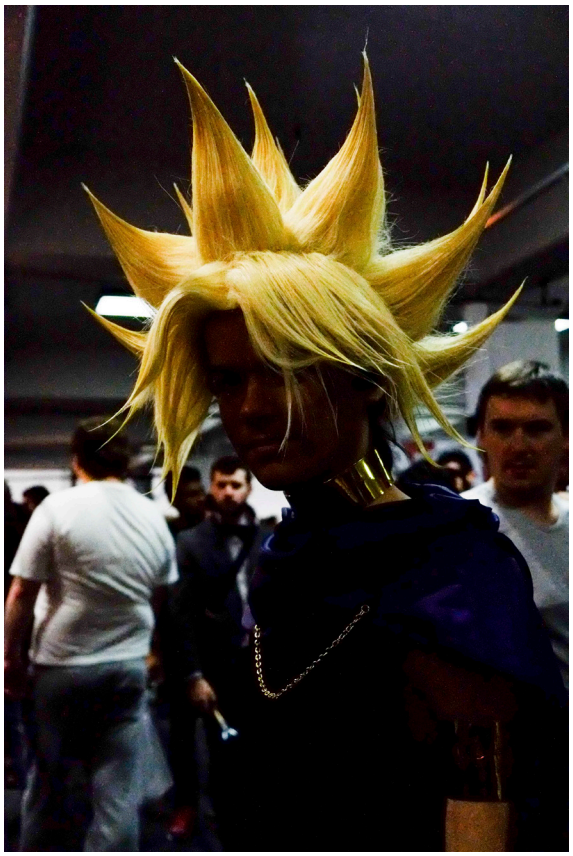

Figure 30. Yami from *Yu–Gi–Oh* franchise (1998–), Auckland Armageddon Expo 2014. © Paul Mountfort.

Figure 32. *Captain America* (2011–), Auckland Armageddon Expo 2015. © Paul Mountfort.

Figure 33. Yukata and kimono cosplaying pair, Auckland Armageddon Expo 2015. © Paul Mountfort.

Figure 34. Sakura kimono cosplay, Auckland Armageddon Expo 2015. © Paul Mountfort.

Figure 35. Red Guard from *Star Wars II: Attack of the Clones* (2002), Auckland Armageddon Expo 2015. © Paul Mountfort.

Figure 36. Sandtrooper from *Star Wars* universe (2015), Auckland Armageddon Expo 2015. © Paul Mountfort.

the cosphere, such as the appearance of the eponymous heroine (Figure 37) from Tim Burton's *Corpse Bride* (2005) coming back to life in 2015.[15] Long running movie series spread out over years mean that the distinction between legacy and current characters is often fluid. *Pirates of the Caribbean*'s (2003-)[16] Jack Sparrow is the source of numerous memes and has been widely cosplayed, there even being a professional cosplayer in Italy who has based his career on cosplaying Sparrow. 'Jack's' appearance at Armageddon in 2016 could be a back reference to instalments 1–4 of the seemingly endless *Pirates* movie franchise mill, or may have anticipated 2017's much dreaded *Dead Men Tell No Tales*.

There are character iterations, and then there are regenerations (when dealing with a certain 2822-year-old Timelord). Among the many television shows that jostle for attention with characters from live action movies, the long-running British sci-fi series *Doctor Who* (1963–) is a particularly popular media source. Contemporary characters (*e.g.* Madame Vastra, Figure 18) rub shoulders with both 'classic' and more recent iterations of the Doctor, as do daleks and newer menaces such as Weeping Angels, the Master in 'his' gender bending guise of Missy and The Ood (Figure 26). Along with sci-fi shows, quasi-historical series such as *Spartacus* (2010–13), represented by a slave gang (Figure 38) and, particularly, fantasy TV shows have massive constituencies, with *Game of Thrones* (2011–) being a major source of cosplay performance.[17] Occasionally, characters from popular novels that are not transmediated, such as the titular hero (Figure 24) from *Skulduggery Pleasant* (2007–), are cosplayed, ostensibly based on book cover and fan art.[18]

Western animation is sometimes adapted for cosplay, notable examples being *Avatar: The Last Airbender* (2005–8) and *The Legend of Korra* (2012–14) (Figure 7). However, Japanese visual media comprise the twin lodestar, along with western live action films and television, around which contemporary cosplay gravitates globally. This is doubtless due to the sheer profusion of visual riches and the subcultural cachet afforded by Japanese manga, anime and gaming. As with live action, characters from classic anime staples continue to appear, such as the face-painted, dagger-wielding San (Figures 23 and 40) from *Princess Mononoke* (*Mononoke Hime*) (1997), along with many other Studio Ghibli characters and those from other anime studios, such as Toei Animation, Sunrise, Production I.G., Madhouse, Manglobe, Studio Pierrot, PA Works, Kyoto Animation and Bones. Characters from anime TV series spotted at Armageddon include Menma (Figure 9) from A-1 Picture's *Anohana: The Flower We Saw That Day* (*Ano Hi Mita Hana no Namae o Bokutachi wa Mada Shiranai*) (2011), Q (Figure 1) from [C] *The Money of Soul and Possibility Control* (2011), Mami Tomo (Figure 42) from *Puella Magi Madoka Magica* (*Mahō Shōjo Madoka Magika*) (2011), along with abundant fauna from big ticket franchises such as *One Piece* (*Wan Pīsu*) (1997–), *Bleach* (*Burīchi*) (2001–) and *Naruto* (1999–) (Figure 10).[20]

Game characters are a widely represented—and perhaps the fastest growing—fictional demographic at cosplay cons, doubtless due to the massively increased penetration of gaming platforms into people's homes in the early twenty-first century. Among the many examples of stand-alone game series characters in 2016, for example, was Shay Patrick Cormack (Figure 49) from *Assassin's Creed* (2007–).[21] However, games are widely transmediated and evince complex relations with other media. There are, of course, the manga/anime/trading game tie-ins, resulting in cons being stacked with endless *Pokémon* (1995–)[22] characters along with identities from other systems such as Yami (Figure 30) from *Yu–Gi–Oh!* (*Yū Gi–Ōh!*) (1996–).[23] These franchises are truly gargantuan, with *Pokémon* alone having grossed close to US $50 billion prior to the release in 2015 of the short-lived augmented reality (AR) craze for Pokémon GO.[24] Their reach and formative influence on Millennials and Generation Z make it unsurprising that they constitute a major source for cosplay performance. Many characters and storyworlds migrate from manga to anime and onto gaming platforms, such as *Naru-*

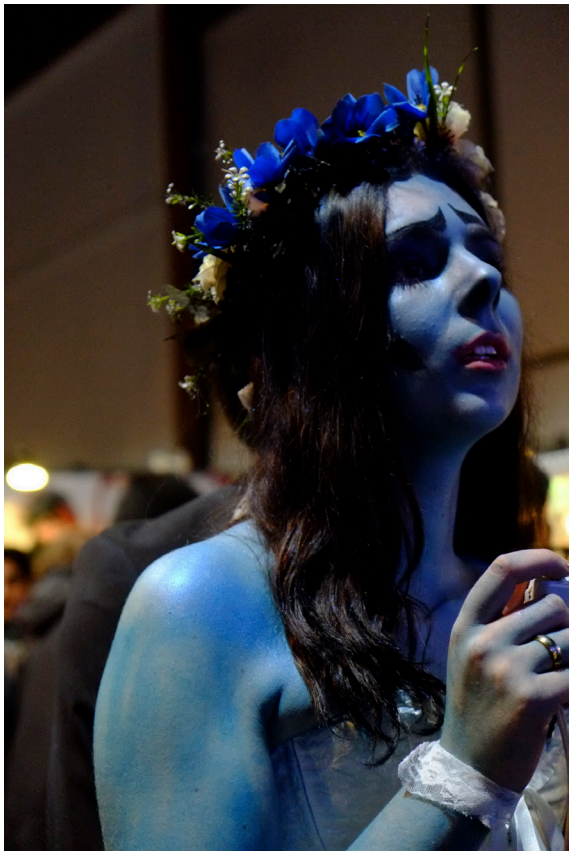

Figure 37. Titular character from *Corpse Bride* (2005), Auckland Armageddon Expo 2015. © Paul Mountfort.

Figure 39. Harley Quinn, *Suicide Squad* (2016) iteration, Auckland Armageddon Expo 2016. © Paul Mountfort.

Figure 38. Slave gang cosplay from *Spartacus* (2010–13), Auckland Armageddon Expo 2015. © Paul Mountfort.

Figure 40. San crossplay from *Princess Mononoke* (1997), Auckland Armageddon Expo 2016. © Paul Mountfort.

Figure 41. Lara Croft from the *Tomb Raider* (1997–) franchise, Auckland Armageddon Expo 2016. © Paul Mountfort.

Figure 43. Hatsune Miku, digital character from Hatsune Miku V4X Bundle (2007) synthesizer application, Auckland Armageddon Expo 2016. © Paul Mountfort.

Figure 42. Mami Tomo from *Puella Magi Madoka Magica* (2011), Auckland Armageddon Expo 2016. © Paul Mountfort.

Figure 44. The Green Arrow from DC's *The Arrow* (2012–) television series reboot, Auckland Armageddon Expo 2016. © Paul Mountfort.

to and *One Piece*. Indeed, the anime/games crossover is a huge subject that could easily comprise a book in itself.

Quite apart from trading games, there is a broad distinction between games that have evolved out of manga/anime source-texts and those that were games first but have subsequently been made into movies or television series. Thus, for example, the Colossal Titan (Figure 15) from *Attack on Titan* (*Shingeki no Kyojin*) (2009–) references an acclaimed series that has also spawned official and unofficial games, while Namine and Roxas (Figure 8) are avatars from *Kingdom Hearts* (*Kingudamu Hātsu*) (2002–), a role-playing action game in the crossover genre—in this case Japanese studio Square Enix's characters occupying a setting from the Disney universe.[25] *Final Fantasy* (*Fainaru Fantajī*) (1987–) is a long-running gaming franchise that was transmediated from the original games into films, while *Tomb Raider* (1996–) started as a game and was adapted to comics and into movies.[26] Lara Crofts of various iterations remain a convention favourite throughout the west (Figure 41), though she is not unknown in Asia. Some game characters riff off anime genres, such as the magical girl anime style of Monimi Usami (Figure 45) from *Danganronpa 2: Goodbye Despair* (*Sūpā Danganronpa Tsū: Sayonara Zetsubō Gakuen*) (2012),[27] despite, or perhaps because of, the game itself being *shōnon* (young male). Indeed, the abstracted look of many avatars and certain generic conventions in the depiction of costuming and weapons both here and in some anime can make identification of such cosplay sources difficult. For example, some Samurai cosplay (Figure 13) and fantasy figures (Figure 28) can be hard to distinguish from the general type. Similarly, it can be difficult without asking to tell at first glance if a particular player is *Game of Thrones*' Jon Snow or *The Hobbit's* (2012–14) Thor Okenshield (Figure 7). There are whole books devoted to making Japanese Kimono-inspired costumes, 'because doing so requires specialized dressmaking skills that are different from western dress-making techniques'[28] and the resulting *kimono* and *yukata* cosplay (Figures 33 and 34) can be hard to distinguish as genera or specific character references.

In Japan, characters from transmedia storytelling franchises are sometimes also pop cultural idol (*aidoru*) figures who may embody, or are embodied by, real-life avatars, from media celebrities to café 'maids' and 'butlers.' Some also may be stand-alone complexes, so to speak. The Hatsune Miku cosplay (Figure 43) at Armageddon 2016 comes from a digital avatar used in a synthesizer application Hatsune Miku (2007–) by Crypton Future Media.[29] As a further complication, there are the previously mentioned generic character types such as zombies (Figure 31) and fashion subcultures, such as Lolita and steampunk (Figure 7) that may or may not allude to films and games in which specific Lolis and steampunk characters figure. In some cases one might initially mistake the sackcloth and noose tooting costume from 2014 that was DC's Scarecrow (Figure 22) as a repurposed Halloween mask. Increasingly prevalent is meme cosplay, which is hard to identify for those not in on the joke, and which tends to have a fairly rapid turnover, though less so perhaps in coser circles than online. Examples of this include the Onision 'I'm a Banana' (Figure 12) meme from 2009 and zipper-face (Figure 14) and zombie nurse (Figure 31) memes observed at Armageddon 2013 and 2014, respectively (the former meme dates back to at least 2011). More generic garb, such as the not-uncommon 'horse head' masks (Figure 17), may be adopted as an easy way to come costumed to a convention and to create dramatic effect on the cheap. Finally, where the current gallery of photographs is concerned, there are shots that document typical kinds of convention activity from milling around outside the convention (Figure 4) to common commercial features of the covered exhibition halls. These include the promotional application of prosthetics (Figure 3), themed mannequins (Figure 6) and sale of merchandise, such as mood-reflecting *nekomimi* (cat ears) sold at booths on the convention floor (Figure 11). These 'costplay' zones await further documentation within the archives of cosphotography, as do many other domains, both physical and virtual, of the ever-expanding cosphere.

Figure 45. Monimi Usami from *Danganronpa 2: Goodbye Despair* (2012), Auckland Armageddon Expo 2016. © Paul Mountfort.

Figure 46. Unidentified cosplay, Auckland Armageddon Expo 2016. © Paul Mountfort.

Figure 47. Captain Jack Sparrow from *The Pirates of the Caribbean* (2003–) movie franchise, Auckland Armageddon Expo 2016. © Paul Mountfort.

igure 48. Eponymous heroes from the long-running *Superman* (1938–) franchise and *Wonder Woman* (2017) reboot (left and right), Auckland Armageddon Expo 2016. © Paul Mountfort.

Figure 49. Shay Patrick from *Assassin's Creed* (2007–) video game series, Auckland Armageddon Expo 2016. © Paul Mountfort.

Figure 50. Another Harley Quinn from *Suicide Squad* (2016), Auckland Armageddon Expo 2016. © Paul Mountfort.

Endnotes

Note: Many comic, film, television and game series have multiple directors and are the result of collaboration between several studios, production houses and distributors. For the sake of brevity, the following references limit credit to the main one or two directors, with additional directors noted by et al. Author's names appearing before titles refer to comics or literary works. Production credit is generally given to the distributor, often a dominant partner in the production, due to many works being the result of collaborations with multiple studios. Readers who wish to know more about the specific commercial and artistic collaborations that give rise to specific productions can find detailed information online.

[1]See Erik Swyngedouw, 'Globalisation or "Glocalisation"? Networks, Territories and Rescaling,' *Cambridge Review of International Affairs* 17, no. 1 (April 2004).

[2]See Anon., 'General-Info/History,' accessed 1 January 2018, https://www.armageddonexpo.com/General-Info/History/

[3]*Princess Mononoke* (*Mononoke Hime*), directed by Hayao Miyazaki (Tokyo: Studio Ghibli, 1997), Anime film.

[4]*Suicide Squad*, directed by David Ayer (New York: Warner Brothers, 2016), Film.

[5]*Star Wars I: The Phantom Menace*, directed by George Lucas (Century City: 20th Century Fox, 1999), Film; *Star Wars II: Attack of the Clones*, directed by George Lucas (Century City: 20th Century Fox, 2002), Film; *Star Wars III: Revenge of the Sith*, directed by George Lucas (Century City: 20th Century Fox, 2005), Film; *Star Wars IV: A New Hope*, directed by George Lucas (Century City: 20th Century Fox, 1977), Film; *Star Wars V: The Empire Strikes Back*, directed by Irvin Kershner (Century City: 20th Century Fox, 1980), Film; *Star Wars VI: Return of the Jedi*, directed by Richard Marquand (Century City: 20th Century Fox, 1983), Film; *Star Wars: The Clone Wars*, produced by Dave Filoni (US: Disney/ABC, 2015), Film; *Star Wars VII: The Force Awakens*, directed by J. J. Abrams (Century City: 20th Century Fox, 2015), Film.

[6]Grateful thanks to Jasmin Darnell, Fin Mountfort, Felix Mountfort and to Sye Johnson and his cosplaying circle, for assistance provided to the authors in the identification of cosplay characters and other story-world, gameworld and media content for this chapter.

[7]Matthew Hale, 'Cosplay: Intertextuality, Public Texts, and the Body Fantastic,' *Western Folklore* 73, no. 1 (2014): 10–14.

[8]*Captain America: The First Avenger*, directed by Joe Johnston (Hollywood: Paramount Pictures, 2011), Film; *Captain America: The Winter Soldier*, directed by Antonio Russo and Joe Russo (Burbank: Walt Disney Studios, 2014), Film; *The Avengers*, directed by Antonio Russo and Joe Russo (Burbank: Walt Disney Studios, 2014), Film; *Captain America: Civil War*, directed by Antonio Russo and Joe Russo (Burbank: Walt Disney Studios, 2016), Film.

[9]*Batman Begins*, directed by Christopher Nolan (New York: Warner Brothers, 2005), Film; *The Dark Knight*, directed by Christopher Nolan (New York: Warner Brothers, 2008), Film; *The Dark Knight Rises*, directed by Christopher Nolan (New York: Warner Brothers, 2012), Film.

[10]*Scarecrow*, Bob Kane and Bill Finger, et al. (Burbank: DC Comics, 1941), Comic book.

[11]*Superman*, Jerry Siegel and Joe Shudter, et al. (Burbank: DC Comics, 1938–), Film; *Wonder Woman*, directed by Patty Jenkins (New York: Warner Brothers, 2017), Film; *The Arrow*, Greg Berlanti, Marc Guggenheim, and Andrew Kreisberg (New York: Warner Brothers, 2012), Film.

[12]*The Lord of the Rings: The Fellowship of the Ring*, directed by Peter Jackson (Wellington, New Zealand: Wingnut Films, 2001), Film; *The Lord of the Rings: The Return of the King*, directed by Peter Jackson (Wellington, New Zealand: Wingnut Films, 2003), Film; *The Lord of the Rings: The Two Towers*, directed by Peter Jackson (Wellington, New Zealand: Wingnut Films, 2002), Film; *Harry Potter and the Philosopher's Stone*, directed by Chris Columbus (New York: Warner Brothers, 2001), Film; *Harry Potter and the Chamber of Secrets*, directed by Chris Columbus (New York: Warner Brothers, 2002), Film; *Harry Potter and the Prisoner of Azkaban*, directed by Alfonso Cuarón (New York: Warner Brothers, 2004), Film; *Harry Potter and the Goblet of Fire*, directed by Mike Newell (New York: Warner Brothers, 2005), Film; *Harry Potter and the Order of the Phoenix*, directed by David Yates (New York: Warner Brothers, 2007), Film; *Harry Potter and the Half-Blood Prince*, directed by David Yates (New York: Warner Brothers, 2009), Film; *Harry Potter and the Deathly Hallows – Part 1*, directed by Mike Newell (New York: Warner Brothers, 2010), Film; *Harry Potter and the Deathly Hallows – Part 2*, directed by Mike Newell (New York: Warner Brothers, 2011), Film.

[13]*The Hobbit: An Unexpected Journey*, directed by Peter Jackson (New York: Warner Brothers, 2012), Film; *The Hobbit: The Desolation of Smaug*, directed by Peter Jackson (New York: Warner Brothers, 2013), Film; *The Hobbit: The Desolation of Smaug*, directed by Peter Jackson (New York: Warner Brothers, 2014), Film.

[14]*V For Vendetta*, directed by James McTeigue (New York: Warner Brothers, 2006), Film; *Mr. Robot*, Sam Esmail (US: NBC/Universal Television, 2015), TV series.

[15]*Corpse Bride*, directed by Tim Burton (New York: Warner Brothers, 2005), Film.

[16]*Pirates of the Caribbean: The Curse of the Black Pearl*, directed by Gore Verbinski (Burbank: Walt Disney Studios, 2003), Film; *Pirates of the Caribbean: Dead Man's Chest*, directed by Gore Verbinski (Burbank: Walt Disney Studios, 2006), Film; *Pirates of the Caribbean: At the World's End*, directed by Gore Verbinski (Burbank: Walt Disney Studios, 2007), Film; *Pirates of the Caribbean: On Stranger Tides*, directed by Rob Marshall (Burbank: Walt Disney Studios, 2011), Film.

[17]*Doctor Who*, created by Sydney Newman, C. E. Webber and Donald Wilson (London: BBC, 1963–), TV series; *Spartacus*, Steven S. DeKnight (Meridian: Starz, 2010–13), TV series; *Game of Thrones*, directed by David Benioff and D. B. Weiss (New York: HBO, 2011–), TV series.

[18]Derek Landy, *Skulduggery Pleasant* (London: Harper Collins, 2007).

[19]*Avatar: The Last Airbender*, Micheal Dante DiMartino and Bryan Konietzko (US: Nickelodeon, 2005–8), Animated TV series; *The Legend of Korra*, Michael Dante DiMartino and Bryan Konietzko (US: Nickelodeon, 2012–14), Animated TV series.

[20]*Anohana: The Flower We Saw That Day* (*Ano Hi Mita Hana no Namae o Bokutachi wa Mada Shiranai*), directed by Tatsuyuki Nagai (Tokyo: A1 Pictures, 2011), Anime film; [C] *The Money of Soul and Possibility Control*, directed by Kenji Nakamura (Tokyo: Fuji TV, 2011), Anime TV series; *Puella Magi Madoka Magica* (*Mahō Shōjo Madoka Magika*), directed by Akiyuki Shinbo (Tokyo: Shaft, 2011), Anime TV series; *One Piece: Defeat Him! The Pirate Ganzack!* (*Wan Pīsu: Taose! Kaizoku Gyanzakku*), directed by Gorō Taniguchi (Tokyo: Fuji TV, 1988), Anime TV film; Eiichiro Oda, One Piece (Wan Pīsu) (Tokyo: Jump Comics, 1997), Manga; *One Piece* (*WanPīsu*), directed by Konosuke Uda et al. (Tokyo: Jump Comics, 2003), Anime TV series; *One Piece: Romance Drawn Story!* (*One Piece: Romansu Dōn Stori*), directed by Katsumi Tokoro (Tokyo: Toei Animation, 2003), Anime film; Tite Kubo, *Bleach* (*Burīchi*) (Tokyo: Jump Comics, 2001), Manga; *Bleach* (*Burīchi*), directed by Noriyuki Abe (Tokyo: TV Tokyo, 2004–12), Anime TV series; *Bleach Nintendo Home Console* (Sega, 2005), Console game; Masashi Kishimoto, *Naruto* (Tokyo: Shōnen Jump, 1999–2014), Manga; *Naruto*, directed by Hayato Date (Tokyo: TV Tokyo, 2002–7), Anime TV series; *Naruto Shippuden*, directed by Hayato Date (Tokyo: TV Tokyo, 2007–), Anime TV series.

[21]*Assassin's Creed* (Carentoir, France: Ubisoft Entertainment SA, 2007–), Computer game.

[22]*Pokémon*, directed by Kunihiko Yuama et al. (Tokyo: The Pokēmon Company International, 1997–), Anime TV series.

[23]Kazuki Takahashi, *Yu-Gi-Oh* (*Yū Gi-Ōh!*) (Tokyo: Weekly Shōnen Jump, 1996–2004), Manga; *Yu-Gi-Oh* (*Yū Gi-Ōh!*), directed by Hiroyuki Kakudō (Tokyo: Toei Animation, 1998), Anime TV series; *Yu-Gi-Oh* (*Yū Gi-Ōh!*) Duel Monsters, directed by Kumihisa Sugishima (Tokyo: TV Tokyo, 2000–4), Anime TV series.

[24]'Pokémon,' accessed 1 January 2018, http://vgsales.wikia.com/wiki/Pok%C3%A9mon

[25]*Attack on Titan* (*Shingeki no Kyojin*), directed by Hajime Isayama (Tokyo: Bessatsu Shōnen Magazine, 2009), Anime TV series; *Kingdom Hearts* (*Kingudamu Hātsu*), Tetsuya Nomura and Shinji Hashimoto (Tokyo: Nintendo Entertainment System, 2002), Anime TV series.

[26]*Final Fantasy* (*Fainaru Fantajī*), created by Hironobu Sakaguchi (Tokyo: Nintendo Entertainment System, 1987), Console game; *Tomb Raider* (London: Eidos Interactive, 2001–), Console game; Tomb Raider (Los Angeles: Top Crow, 1997); *Tomb Raider*, directed by Simon West (Hollywood: Paramount Pictures, 2001), Film.

[27]*Danganronpa 2: Goodbye Despair* (*Sūpā Danganronpa Tsū: Sayonara Zetsubō Gakuen*) (Tokyo: Spike Chunsoft, 2012), Computer game.

[28]Yuniya Kawamura, *Fashioning Japanese Subcultures* (London: Berg, 2012), 79.

[29]*Hatsune Miku V4X Bundle* (Chūōku, SPK, Japan: Crypton Future Media, 2007–), Computer game.

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Bird biodiversity in heavy metal songs

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Birds have fascinated humankind since forever. Their ability to fly, besides being a constant reminder of our own limitations, was a clear starting point to link birds to deities and the divine realm (Bailleul-LeSuer, 2012). Inevitably, these animals became very pervasive in all human cultures, myths and folklore (Armstrong, 1970). In fact, they are so pervasive that they have found their way to perhaps the most unlikely cultural niche: Heavy Metal.

With some exceptions, such as raptors (Accipitriformes) and ravens/crows[1] (Fig. 1), birds are not typically seen as badass enough to feature on heavy metal album covers and songs, even though sometimes they already have the right makeup for it (Fig. 2).

As we highlighted above, the birds' power of flight is their main feature, but they have another power up their feathery sleeves. And this feat is one that people tend to consider one of the most human endeavors of all: music. Most birds are deemed melodious creatures, like the slate-colored solitaire (*Myadestes unicolor*) from Central

Figure 1. Examples of album covers with birds: Devil's Ground, by Primal Fear (Nuclear Blast, 2004), and the fantastic Winter Wake, by Elvenking (AFM, 2006). Source: Caratulas (2019; www.caratulas.com).

[1] We'll solve the raven vs crow problem later.

America and the celebrated nightingale (*Luscinia megarhynchos*), although some might seem almost tone-deaf[2] (Fig. 3).

Figure 2. Pied falconet, *Microhierax melanoleucos*, a species distributed from China to southeastern Asia; photo by Owen Chiang (2007; www.i-owen.com), used with permission. Gene Simmons, bassist and co-lead singer of KISS, with his Demon make up; source: Wikimedia Commons (Alberto Cabello, 2010).

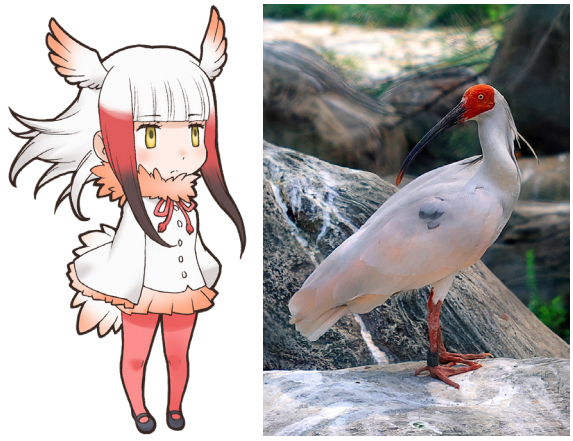

Figure 3. The Crested Ibis, from Kemono Friends (Mine Yoshizaki, 2015), is made fun of in the series because of her awful singing. The character was based on the Japanese crested ibis, *Nipponia nippon*, a species once widespread through eastern Asia, but now severely endangered (BirdLife International, 2017). Sources: Japari Library (2018); Wikimedia Commons (Olyngo, 2017).

Birds (class Aves) can be largely divided in two groups: the order Passeriformes (with circa 6,000 known species) and "the rest" (several orders, totaling around 5,000 species). Members of the order Passeriformes are commonly called "passerines" or "perching birds" and include most of the species that typically comes to mind when we think of birds: sparrows, robins, starlings, blackbirds and crows. Inside Passeriformes, there is a suborder called Passeri[3], the "songbirds", a group with roughly 5,000 species of animals. The vocal organ (called syrinx) of songbirds is modified in comparison to that of other birds and can produce complex sounds (Raikow & Bledsoe, 2000). Typically, these sounds result in bird song, but crows have their own way of communicating.

With all these bird species, some are bound to appear in heavy metal songs, right? We mean, besides eagles and ravens, of course. So, we decided to analyze the lyrics of thousands of metal songs in order to find 'em birds (Fig. 4).

Figure 4. Skarmory, one of the few examples of a literal metal bird; more specifically, a Steel/Flying type. Source: Bulbapedia (2019b; The Pokémon Company, 1998–2019).

Here, we show how many songs talk about birds and which specific birds they mention. We also investigate how each bird groups is represented in the genre and in each subgenre. We will also talk a little bit about the biology of some of these animals to make you, our dear headbanging reader, more acquainted with this fantastic slice of Earth's biodiversity.

[2] If we're being completely honest, some lead singers out there also seem to be somewhat tone deaf, especially in some of the more peculiar subgenres of heavy metal.

[3] The name Oscines was also used for this group and can still be found in the literature.

MATERIAL AND METHODS

Data collection

All lyrics used in this project were collected from Metal Kingdom (www.metalkingdom.net), a web compendium on metal music of diverse genres. To collect this data, we built a custom web crawler that navigated all music pages on the website. This collection yielded us three main datasets:

- Bands: CSV file listing all bands found on the website.
- Genre: CSV file mapping bands to their respective metal genre.
- Lyrics: CSV file which contains the actual lyrics, as well a reference to the artist.

On 07/August/2018, we collected a total of 145,716 songs from 6,359 bands, spanning 368 different metal (sub)genres.

Data pre-processing

When we started going through the data we obviously ran into some problems. (If you're not finding any problems in your data, you're not looking hard enough!) In this section, we present some of the hurdles we had to overcome when working with this dataset.

Language

A quick look into the data showed us a problem for our study: not all lyrics were in English. For example, below are the verses of "*Ohne Dich*" by German band Rammstein (2004):

"*Und der Wald er steht so schwarz und leer,*

Weh mir oh weh,

Und die Vögel singen nicht mehr."

We may have some additional language skills to identify 'die Vögel', but we certainly won't know every language in the dataset. Because of this, we decided to restrict our study only to songs in English. However, this posed another problem: we have no structured data about the language of each song, and this information would need to be inferred from the lyrics themselves.

Fortunately, this was also a problem for Google when deciding in which language you're searching in during your queries, and they were kind enough to opensource their implementation[4]. They used a Naïve Bayes approach, which achieved 99.77% accuracy when classifying news articles in over 49 languages (Nakatani, 2010). Using this approach, we managed to label almost all lyrics by language, identifying 43 different ones in the corpus. The distribution of the languages can be seen in Table 1.

Table 1. Frequency count of languages for lyrics. Languages are represented by their ISO 639-1 codes.[5]

Language	Count	Language	Count	Language	Count	Language	Count
en	125805	pt	584	uk	75	bn	20
ro	4580	ja	562	sk	70	lt	20
de	2555	hu	415	el	70	cy	18
es	2388	cs	412	tr	57	fa	16
ru	1439	it	317	lv	57	tl	14
fr	1156	sw	255	zh-cn	56	af	14
fi	862	id	246	et	53	ar	7
ko	797	da	172	sl	33	mk	6
no	788	nl	139	so	33	sq	3
sv	713	hr	118	bg	31	ur	1
pl	617	ca	101	vi	29	?	12

[4] You can find it here: https://github.com/shuyo/language-detection

[5] Check the Library of Congress for the codes: https://www.loc.gov/standards/iso639-2/php/English_list.php

This method, however, is not without its own problems. We were curious, for instance, as to why there were so many lyrics in Romanian (ro). A more in-depth investigation revealed that instrumental songs would have only the text "(instrumental)" listed as their lyrics –the algorithm struggles when classifying such short words. However, since this problem affected only songs without lyrics (that is, songs that won't mention any birds at all) we opted to just remove them from the dataset.

Homonyms

Another problem we identified was homonyms: words that sound and are written the same, but have different meanings depending on the context. Consider, for example, the following excerpts:

Song: *White Synthetic Noise*
Band: …And Oceans

Sorrow sings of everything but survival doesn't seem to ring
Isolate, contain your pain to outlast the taste of misery
I believe the curse will ***swallow*** *it's*[6] *teeth*
Show the stars and I can clear the air and love the end

Song: *Hourglass*
Band: A Perfect Circle

Red flag red, all the sentinels are damned
The Tokyo kitty, ***swallow****, rose, and canary*
Tick tick tick, do you recognize the sounds as the grains count down
Trickle down right in front of you?

The word 'swallow' has clearly different meanings in these songs. In the former, it is a verb, that is, the act of causing or allowing something to pass down the throat. In the latter, however, we have a reference to a Hirundinidae bird that may or may not be able to carry a coconut.

To address this problem, we must distinguish between the different uses of homonyms. One way of doing this is classifying each word in a text by its Part of Speech. A part of speech is a category in which a word falls given its syntactic function in a sentence. In the first example above, 'swallow' is classified as a verb, while in the second example it is classified as a noun. Since we are interested in identifying mentions of birds in lyrics, knowing that a word function as a noun in the sentence can help us reduce the homonym problem. (Unless, of course, they are nouns for both their meanings. In this case, this approach won't help much.)

The process of classifying words like this is known as Part-of-Speech tagging, or POS tagging in short. POS tagging can be seen as a supervised learning problem, as we can train a classifier to identify these tags given a pre-labeled dataset of token sequences and tags. For this project, we opted to use a pre-trained model available in NLTK. This default English POS-tagger consists of a Greedy Averaged Perceptron implemented by Honnibal (2013).

Let's see how this works for our examples. POS tagging on the first one yields the following result:

Word:	I	believe	the	curse	will	swallow	it	's	teeth	.
Tag:	PRP	VBP	DT	NN	MD	VB	PRP	VBZ	NNS	.

The tags are represented by abbreviations from the Penn Treebank Tagset[7]. In this case, we can see that 'swallow' was assigned the POS tag 'VB' (Verb, Base Form) and as such, should not be counted as a bird. Let's see how this works out with our second example:

Word:	The	Tokyo	kitty	,	swallow	,	rose	,	and	canary	.
Tag:	DT	NNP	NN	,	NN	,	VBD	,	CC	JJ	.

Here, 'swallow' was assigned the POS tag 'NN' (Noun, singular or mass) and as such, should be counted as a bird. However, this example also shows that this meth-

[6] This is not a typo on our part. The lyrics are like this in our source.

[7] You can find it here: https://www.clips.uantwerpen.be/pages/mbsp-tags

od is not perfect, as 'canary' received a 'JJ' tag (Adjective). However, since the alternative would be to manually annotate POS tags for the whole corpus, we decided to proceed with this alternative.

Plurals

With both language and homonyms out of the way (well, sort of), we can finally tackle our last problem: plurals. Consider the following two examples:

Song: *For the birds*
Band: 8 Foot Sativa

To close my eyes
Reduce you to black
Nothing more than an insignificant shadow among the ***vultures***
I will walk away

Song: *Scavenger*
Band: A Static Lullaby

Scavenger, where does the ***vulture*** *sleep?*
And when you speak to him
Will you bring him to me, bring him to me
Scavenger, bring forth the jackals teeth

We can see that both songs mention the bird 'vulture': the first one uses the plural form while the second uses the singular. We wanted to count both references as the same bird, so how could we achieve that?

One solution would be to increment our list of "bird terms" to include all plurals of bird name, as well as a mapping to a root form of the word. This, however, would be a lot of work. This looks like a common problem when doing natural language processing, so we searched for what we could do to address it.

Lemmatization is the process of removing inflectional forms, finding the root word, that is, the lemma, so that they can be analyzed as a single group. It is widely used when running searches for terms in documents as a way to correctly match-related terms. Fortunately, there are various lemmatizers implementations for different languages. For this problem, we will use the WordNet lemmatizer available in the NLTK library.

Lemmatizer usually requires the POS tag of the word, but fortunately, we got that covered. Running the WordNet Lemmatizer in our first example yields the following: "Nothing more than an insignificant shadow among the vulture."

You might be thinking: "Wait. That much work just to take out an 's' from the end of the word?". However, remember that grammatical number can be way more complex than that (e.g., goose and geese), and using a proper lemmatizer takes all that complexity into account.

Data aggregation

OK. We detected the language of our metal songs and filtered only those in English. We tagged the part-of-speech of all our words, and we even lemmatized them to ensure consistency. What is then left to do?

Well, we need to count our birds! For this project, we decided to use a static list of bird names commonly used in cultural works. The list can be seen in Table 2.

We only counted the term in our dataset if the POS tag of it corresponded to a noun. This reduced the likelihood of homonyms such as 'swallow' bird and 'swallow' verb, but unfortunately will do nothing for homonyms such as 'tyrant' flycatcher (Tyrannidae) and 'tyrant' Cersei Lannister. The count was done in two different ways:

- Occurrence counts: This method counts the number of times a word appears, counting multiple repetitions in the same song as distinct occurrences. For example, when counting the word "bird" in the classic song "*Surfin' Bird*", by The Trashmen, this counting method would yield 82 occurrences.
- Song counts: This method counts the number of songs in which a word appear, counting multiple repetitions in the same song as a single occurrence.

Table 2. Common bird names used in this work, arranged alphabetically.

albatross	crossbill	goose	kite	owl	raven	tanager
auk	crow	grackle	kiwi	parakeet	robin	thrush
bird	cuckoo	grouse	lapwing	parrot	roller	toucan
bird of prey	curlew	gull	lark	passerine	rook	trogon
blackbird	dodo	hawk	macaw	peacock	rooster	turkey
buzzard	dove	heron	magpie	pelican	shrike	tyrant
chickadee	duck	hoopoe	manakin	penguin	snipe	vulture
chicken	eagle	hornbill	mockingbird	petrel	sparrow	warbler
chough	egret	hummingbird	nightingale	petrel	starling	waxwing
cockatoos	emu	ibis	nightjar	pheasant	stonechat	wheatear
cockerel	falcon	jackdaw	nutcracker	pigeon	stork	woodpecker
condor	finch	jay	oriole	puffin	swallow	wren
cormorant	flamingo	kestrel	osprey	quail	swan	wryneck
crane	flycatcher	kingfisher	ostrich	raptor	swift	yellowhammer

Keeping with our previous example, "*Surfin' Bird*" would only wield 1 as the count of the word "bird".

To validate our methods, let's take a look at the top 5 most metal birds:

Word	Occurrence count	Song count
bird	2874	2222
eagle	1738	1036
tyrant	1737	1221
raven	1603	1205
vulture	1230	990

That corresponded with our expectations, even though we probably are suffering from a homonym problem with all those tyrants showing up. The tyrant flycatchers are not actually that metal (Fig. 5).

We also grouped our bird count by each metal genre. In this way, we will be able to run an analysis on how different birds relate to different types of metal. Given that we had 368 different metal subgenres, we had to summarize this if we wanted to run any meaningful statistical analyses. We summarized them using the definitions from Wikipedia into "just" 37 categories, listed in Table 3.

Figure 5. Too cute for metal? Left: a tyrant flycatcher, known as western kingbird (*Tyrannus verticalis*), lives in North and Central America; source: Wikimedia Commons (MdF, 2010). Right: the grey-hooded Attila (*Attila rufus*), from southern Brazil, is actually named after a tyrant; source: Wikimedia Commons (D. Sanches, 2010).

Table 3. List of metal genres used in our analyses. Note that: (1) occasionally, a rock genre popped up in the database; (2) the category 'Various' include weird singletons we just could not classify elsewhere, such as "A Capella".

Alternative Metal	Experimental Rock	Industrial Metal	Sludge Metal
Alternative Rock	Folk Metal/Rock	Industrial Rock	Southern Rock
Black Metal	Glam	Melodic Metal	Speed Metal
Christian Metal/Rock	Gothic Metal	Metalcore	Stoner Metal
Crust Punk	Gothic Rock	Pagan Metal	Stoner Rock
Dark Metal	Grindcore	Power Metal	Trash Metal
Death Metal	Grunge	Progressive Metal	Various
Doom Metal	Hard Rock	Progressive Rock	
Electronic	Hardcore	Punk Rock	
Experimental Metal	Heavy Metal	Rock n' Roll	

RESULTS AND DISCUSSION

The word 'bird' appears in 2,222 songs, as we've seen above. It seems quite a lot, but on a closer look, it's not quite: that number represents only about 1.5% of all the songs in the database. We honestly didn't know what to expect when we started this project, so it is hard to decide if that's a lot of birds or too few of them. We are more inclined to the latter, given that birds are such prominent symbols in most worldwide cultures.

But more specific mentions of popular bird names also appear in several songs. Some likely refer to a single species, like 'nightingale' (*Luscinia megarhynchos*) and 'blackbird' (*Turdus merula*). Most common names, however, refer to a whole group of species, like 'eagle' and 'penguin', and not to a particular species in each group. Finally, some common names, like 'dove' and 'swan', while being representatives of larger groups, in this context probably refer to the most common European forms, the rock dove (*Columba livia*) and the mute swan (*Cygnus olor*).

We present below the number of times each type of bird is mentioned in a metal song and we do this in two ways. Table 4 shows the total count (the "occurrence count" from the example above), which includes all the times a particular word pops up in the lyrics. As explained above, this includes repetitions within the same song, such as in chorus sections. For instance, 'eagle' appears several times in Helloween's "*Eagle Fly Free*" (1988). Table 5 shows the counts ignoring all the repetitions (the "song count" from the example above). This way, 'eagle' is counted only once in Helloween's song.

We think the second type of counting (Table 5) is a better representation of bird abundance in metal songs, so we will only refer to this one in our discussion below[8]. However, if should be noted that eagles are the most used bird according to Table 4, but they come in second in Table 5, having switched places with ravens. Even though we knew from simple life experience that these two were the most metal birds, we expected eagles to get the crown in both types of count.

[8] We excluded 'tyrants' from the analysis due to the homonym problem presented above. Likewise, we excluded 'roller', which is typically used in the term 'rock n' roller' rather than referring to the members of family Coraciidae.

Table 4. Total count of common bird names in heavy metal songs.

Bird	Count (total)	Bird	Count (total)	Bird	Count (total)
bird	2874	nightingale	59	thrush	9
eagle	1738	blackbird	55	starling	7
tyrant	1737	condor	50	woodpecker	7
raven	1603	gull	50	shrike	6
vulture	1230	peacock	48	snipe	6
crow	977	goose	37	finch	5
dove	511	lark	34	puffin	5
swan	430	rooster	34	stork	5
roller	324	heron	33	cormorant	4
owl	315	rook	30	nightjar	4
swift	256	magpie	27	chickadee	3
hawk	241	parrot	27	grouse	3
falcon	225	cuckoo	21	ostrich	3
swallow	220	hummingbird	18	penguin	3
chicken	129	mockingbird	18	kestrel	2
duck	119	turkey	18	macaw	2
sparrow	94	buzzard	17	petrel	2
crane	78	quail	17	toucan	2
raptor	78	robin	12	parakeet	1
kite	77	jay	11	wheatear	1
pigeon	75	cockerel	9		
albatross	64	ibis	9		

Figure 6. While we were writing this article, the Gen VIII Steel/Flying Pokémon Corviknight was aptly announced. Gen VIII's Galar region is based in England, birthplace of heavy metal (Allsop, 2011). So thank you, Game Freak Inc.! Source: Bulbapedia (2019a; The Pokémon Company, 1998–2019).

Popular birds

So now we can say with certainty that the most metal bird is the raven (Fig. 6). The word can refer to several species worldwide, but it is logical to assume that people usually think of the common raven (*Corvus corax*; Fig. 9) when using the word. This species is distributed throughout the Northern Hemisphere and is one of the largest passerines alive. Ravens are omnivorous animals, extremely opportunistic and versatile, and their intelligence is well-known to biologists.

Ravens are undoubtedly one of the most common birds in folklore and pop culture but are generally regarded as birds of ill-omen and related to "evil stuff". Thus, they are well-represented in Black and Death Metal, with respectively, 328 and 152 occurrences. However, they are sometimes asso-

Table 5. Count of common bird names in heavy metal songs, avoiding repetitions within the same song (e.g., chorus sections).

Bird	Count (per song)	Bird	Count (per song)	Bird	Count (per song)
bird	2222	raptor	43	cockerel	6
tyrant	1221	gull	37	snipe	6
raven	1205	goose	35	finch	5
eagle	1036	blackbird	34	ibis	5
vulture	990	lark	29	puffin	5
crow	742	peacock	29	starling	5
dove	428	rooster	29	stork	5
swan	313	rook	28	cormorant	4
owl	249	condor	26	shrike	4
swift	229	heron	23	chickadee	3
swallow	183	magpie	20	ostrich	3
hawk	159	parrot	20	penguin	3
roller	148	turkey	18	grouse	2
falcon	137	buzzard	17	kestrel	2
chicken	97	quail	15	macaw	2
duck	81	robin	12	nightjar	2
sparrow	79	jay	11	petrel	2
pigeon	59	hummingbird	10	toucan	2
kite	58	cuckoo	9	parakeet	1
nightingale	53	mockingbird	9	wheatear	1
crane	49	thrush	9		
albatross	44	woodpecker	7		

ciated with nicer things, like the ravens from the Tower of London (Kennedy, 2004) and Nordic mythology. The relationship with the latter is very clear given the 114 times this bird appears in Pagan Metal songs.

In second place, we have the eagle, a staple of Power Metal and original Heavy Metal (Fig. 1), with 197 and 193 counts, respectively. Eagles are very likely the most prominent bird symbol of all in Western culture (Armstrong, 1970): Zeus, the Roman Empire, European heraldry (especially Germany and Austria), and of course, 'Murica. As the "king of birds", the eagle is almost always a symbol of power or leadership. The 'eagle', however, will not be the same bird species for every headbanger: American bands and fans will always think of their national symbol, the bald eagle (*Haliaeetus leucocephalus*), while others will possibly think of the golden eagle (*Aquila chrysaetos*) or other more regional species. Eagles are part of the Accipitridae family, together with hawks, kites and Old world vultures (see below); however, the name 'eagle' is given to several large species that are not actually too closely related to each other (*e.g.*, booted eagles, snake eagles, sea eagles, harpy eagles; Lerner & Mindell, 2005).

The third most used bird is the vulture. This term does not refer to any specific vulture species, but most likely to a sort of over-generalized stereotypical representation of a vulture in popular imagination. Vultures suffer from a bad press, being often mindlessly associated with corpses, death and decay due to their scavenging diet. Unsurprisingly, it is a prevalent bird in Death and Black Metal songs, with 228 and 143 counts respectively. Trash Metal also has a good number of counts (117), but given this genre's more political lyrics, 'vul-

ture' is here often related to bad people or practices.

Figure 7. Examples of Old World vultures. Top: Egyptian vulture (*Neophron percnopterus*). Bottom: griffon vulture (*Gyps fulvus*). Source: Wikimedia Commons (D. Ash, 2013 and S. Krause, 2011, respectively).

Figure 8. Examples of New World vultures. Left: turkey vulture (*Cathartes aura*) and Andean condor (*Vultur gryphus*). Source: Wikimedia Commons (respectively S. Blanc, 2007, and E. del Prado, 2007).

The popular name vulture actually refers to 23 species worldwide, distributed in two distinct yet closely related biological groups (Buechley & Sekercioglu, 2016): the Old World vultures (Fig. 7) and the New World vultures (Fig. 8). Old World vultures belong to the family Accipitridae, the same as eagles and hawks, while the New World ones (which include condors) comprise the family Cathartidae. The scavenging habits of vultures evolved independently in these two lineages and in both cases has led to some common adaptations to this way of life: large bodies and wings, powerful beaks and featherless heads (Buechley & Sekercioglu, 2016).

The fourth bird on our list are the crows. Again, 'crow' can refer to any out of 30-something species. The typical European black crow is called carrion crow (*Corvus corone*; Fig. 10); the hooded crow (*Corvus cornix*) is also very common in the continent, but it is not entirely black and so possibly unsuitable for metal songs. North American headbangers will be typically more familiar with the American crow (*Corvus brachyrhynchos*).

Note that all these species belong to the genus *Corvus* and, in fact, so does the raven (see above). People get confused about these birds all the time and often use the words 'raven' and 'crow' interchangeably. While neither word has any true biological meaning (that's what scientific names are for, after all!), we will give you some pointers as how to differentiate the common raven from those crows. Also, after reading this, try checking all those raven and crow illustrations on heavy metal albums – you'll be surprised how many of them are just plain wrong.

There are several differences to keep an eye out for when trying to identify crows and ravens (BTO, 2013). First off, ravens are huge, with a wingspan similar to a buzzard's and an even larger body. If you're uncertain about the identity of the bird you're seeing, it's probably a crow. When you finally encounter a raven, you'll immediately know it. But there are other features that might help you out if the animals are seen far off, flying or just through photos.

Crows have a rounded head, with the plumage arranged neatly on the body; their beak is deeply curved and stout (Fig. 10). Ravens have very long and heavy beaks, ruffled throat feathers, a barrel-like chest and a long neck, which together gives them a heavy-headed impression (Fig. 9). In

flight, crows beat their wings more heavily and their fan-shaped tail is clearly seen (Fig. 10). Ravens, however, tend to soar more; the feathers on their wing tips looks more like a raptor's when flying and they have a long and wedge-shaped tail (Fig. 9). Finally, crows have a far-carrying "caw" vocalization, while the ravens' calls are a deep and hoarse croak.

Figure 9. Common raven. Source: top: Wikimedia Commons (F. Veronesi, 2016); bottom: iNaturalist (A. Viduetsky, 2019).

Unexpected birds

There are some unexpected results. For starters, we imagined hawks and falcons would rank higher on the list, as well the nightingale, which is typically associated with song and poetry. We also have lots of mentions to ducks, geese and chicken, but a good portion of them refer to expressions (*e.g.*, sitting ducks) or, metaphorically, to people.

Figure 10. Carrion crow. Source: top: Wikimedia Commons ('Loz' L.B. Tettenborn, 2007); bottom: iNaturalist (E. Bosquet, 2019).

However, there were some actual surprises. From the list of bird "species" we initially came up with (Table 2), we had included some oddballs just to be thorough and have all avian orders represented. To our surprise, however, our search came up with some occurrences for them, like penguins, ostriches, macaws and toucans.

The song Ostrich, by American band Gloomy Grim (2000), focuses on the fallacious idea that ostriches (*Struthio camelus*) bury their head in the sand to hide. They do not. What they are doing is inspecting and caring for their eggs; they dig shallow nests and from a distance, it might look like an ostrich has its head buried in the sand (American Ostrich Association, 2019). In fact, ostriches have no need to hide; besides being the largest living dinosaur and having a mean kick, they are the fastest animals on two legs (Donegan, 2002; Stewart, 2006).

All mentions of penguins come from a single Swedish Black metal band called Satan's Penguins. Several of their songs stick to the theme, such as "*Antarctic Winterstorm*", "*Behind Mountains of Ice*", and "*Night of the Penguins*". Despite being thought of

as birds from the icy wastes of our planet, most penguin species live in sub-Antarctic or temperate areas (Davis & Renner, 2003). Actually, the Galapagos penguin (*Spheniscus mendiculus*) is endemic to the Galapagos Islands, very close to the equator.

Battle of the genres

One curious thing to see was how each genre has its own favorite bird (Table 6). However, when we looked more closely at these results, they are entirely expected. Eagles are the stars in genres such as Heavy, melodic, Power and Speed Metal, while ravens dominate the Gothic, Folk and Pagan genres. The preference of owls in Electronic, however, is a mystery to us.

We could also check which genre is the most biodiverse, that is, which genre cites the largest number of bird "species" in its songs (Table 7). The undisputed crown goes to Death metal, with 46 species; after it, we have Power, Black and Heavy Metal all clustered together with 41, 40 and 39 species, respectively. However, this might just be an artifact of the sheer number of Death Metal songs: this genre has twice more songs in the database (a total of circa 46,000 songs) than the second genre (Black Metal, with circa 23,000). So the change of a bird popping up in a Death Metal song is just higher because of this. (Also, several species are mentioned just once and birds are not mentioned that much in their songs; see also Table 8.) The other three genres we mentioned are better balanced: Black Metal has 23,000 songs total, as shown above, while Power Metal has circa 17,000 and Heavy Metal 22,000.

The least ornithological genre is Grunge, but one could rightfully argue that "grunge's not metal" or "who cares about grunge

Table 6. List of metal genres and the most cited bird "species" in their songs.

Genre	Fave birb	Genre	Fave birb
Alternative Metal	vulture	Heavy Metal	eagle
Alternative Rock	crow & vulture	Industrial Metal	vulture
Black Metal	raven	Industrial Rock	dove
Christian Metal/Rock	dove	Melodic Metal	eagle
Crust Punk	vulture	Metalcore	vulture
Dark Metal	swan	Pagan Metal	raven
Death Metal	vulture	Power Metal	eagle
Doom Metal	raven	Progressive Metal	vulture
Electronic	owl	Progressive Rock	crow
Experimental Metal	raven	Punk Rock	swan
Experimental Rock	vulture	Rock n' Roll	eagle
Folk Metal/Rock	raven	Sludge Metal	vulture
Glam	eagle	Southern Rock	eagle & turkey
Gothic Metal	raven	Speed Metal	eagle
Gothic Rock	swan	Stoner Metal	vulture
Grindcore	vulture	Stoner Rock	eagle & vulture
Grunge	vulture	Trash Metal	vulture
Hard Rock	eagle	Various	eagle
Hardcore	vulture		

anyway?" So the least ornithological true genres are Dark Metal and Christian Metal (Table 7).

However, if you take into account the proportion of songs that mention birds (Table 8), Pagan Metal is the true bird-loving (or should we say raven-loving?) genre. Around 13.5% of Pagan Metal songs mention some sort of bird. The second place goes to Folk Metal/Rock, with 11.2% of songs mentioning birds. The least bird-friendly genres are Alternative Metal (1.7%) and Glam (1.9%).

Table 7. List of metal genres and the total number of bird "species" featured in their songs.

Genre	Nr of birds	Genre	Nr of birds
Alternative Metal	19	Heavy Metal	39
Alternative Rock	16	Industrial Metal	13
Black Metal	40	Industrial Rock	9
Christian Metal/Rock	6	Melodic Metal	30
Crust Punk	8	Metalcore	24
Dark Metal	5	Pagan Metal	18
Death Metal	46	Power Metal	41
Doom Metal	33	Progressive Metal	33
Electronic	18	Progressive Rock	23
Experimental Metal	24	Punk Rock	6
Experimental Rock	18	Rock n' Roll	18
Folk Metal/Rock	25	Sludge Metal	26
Glam	12	Southern Rock	8
Gothic Metal	25	Speed Metal	15
Gothic Rock	6	Stoner Metal	18
Grindcore	25	Stoner Rock	12
Grunge	2	Trash Metal	33
Hard Rock	35	Various	20
Hardcore	16		

Biodiversity

And what about the songs that have the most birds? Well, we have two worth mentioning, one from a big name in metal and the other from, well, a rather obscure band. First is "*The Crow, the Owl and the Dove*" by Finnish symphonic metal band Nightwish, from the album Imaginaerum (Nuclear Blast, 2011), later also released as a single (Fig. 11). As expected from the title, there is a good avian diversity in this song: besides the three titular birds, there is also mention of the swan. The second song is "*Proverbs of Hell Plates 7-10*" by Norwegian black metal and avant-garde metal band Ulver[9], from the album Themes from William Blake's the Marriage of Heaven and Hell (Jester Records, 1998). This song mentions the peacock, eagle, crow and owl.

[9] We confess none of us had the slightest idea Ulver even existed.

Table 8. List of metal genres and the total number of bird "species" featured in their songs.

Genre	% of songs with birds	Genre	% of songs with birds
Alternative Metal	1.7%	Heavy Metal	3.9%
Alternative Rock	3.2%	Industrial Metal	2.0%
Black Metal	5.6%	Industrial Rock	3.2%
Christian Metal/Rock	2.1%	Melodic Metal	5.7%
Crust Punk	5.1%	Metalcore	2.2%
Dark Metal	5.6%	Pagan Metal	13.5%
Death Metal	2.9%	Power Metal	4.4%
Doom Metal	5.3%	Progressive Metal	3.8%
Electronic	4.5%	Progressive Rock	5.1%
Experimental Metal	5.2%	Punk Rock	2.6%
Experimental Rock	3.2%	Rock n' Roll	3.4%
Folk Metal/Rock	11.2%	Sludge Metal	4.5%
Glam	1.9%	Southern Rock	4.2%
Gothic Metal	5.7%	Speed Metal	3.6%
Gothic Rock	3.5%	Stoner Metal	5.6%
Grindcore	2.1%	Stoner Rock	6.4%
Grunge	4.5%	Trash Metal	2.6%
Hard Rock	3.1%	Various	3.5%
Hardcore	2.1%		

Figure 11. Album cover of The Crow, the Owl and the Dove by Nightwish (Nuclear Blast, 2012). Source: Wikimedia Commons.

CONCLUSIONS

We have certainly been surprised by some of our findings: from ravens overtaking eagles to the odd penguin and ostrich popping up in some lyrics. As we've argued, birds are very diverse group of animals, and several species are deep-seated symbols in cultures worldwide. So maybe it's about time heavy metal left the tropes of ravens, eagles and vultures on the bench for a while and let other avian stars shine (Fig. 12).

Figure 12. Washimi, the secretarybird from Aggretsuko (2018) seems to enjoy some good old death metal in the karaoke scenes in Netflix's animated series. Yes, secretarybird is an actual thing: the species is called *Sagittarius serpentarius* and it is a terrestrial bird of prey (Accipitriformes) that inhabits the savannah and open grasslands of sub-Saharan Africa.

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About the authors

Henrique Soares is an engineer and machine learning enthusiast, not particularly knowledgeable in either birds or metal. When he is not working on unconventional applications of machine learning, Henrique spends his time wondering how could there be people that don't know about the bird, because everyone knows that the bird is a word! A-well-a-bird, bird, b-bird's a word, a-well-a...

João Tomotani is a mechanical engineer currently working with Supply Chain. Though he is more of a power/melodic metal enthusiast, he agreed to focus on birds instead of dragons in this research.

Dr. **Barbara Tomotani** is a biologist and the only one in this group whose work actually focuses on birds. She is not a big heavy metal fan and does not work with heavy metal birds, preferring the tiny flycatchers. But she has certainly liked the new metal bird Corviknight.

Dr. **Rodrigo Salvador** is a zoologist who lately has found himself working with a lot of bird-related stuff. One of the first songs he remembers ever hearing as a child was *Walk of Life*, by Dire Straits – his sister's "fault" and an influence that eventually led him down the road to metal. He'll quickly tell you his favorite bands are Queen and Avantasia, but he's hard pressed to decide his favorite bird.

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Perceiving the emotions of Pokémon

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The ability to reliably perceive the emotions of other people is vital for normal social functioning, and the human face is perhaps the strongest non-verbal cue that can be utilized when judging the emotional state of others (Ekman, 1965). The advantages of possessing this ability to recognise emotions, *i.e.*, having emotional intelligence, include being able to respond to other people in an informed and appropriate manor, assisting in the accurate prediction of another individual's future actions and additionally to facilitate efficient interpersonal behavior (Ekman, 1982; Izard, 1972; McArthur & Baron, 1983). In the current experiment the consistency with which emotions display by a human female face and a Pokémon character are investigated.

GENERAL METHODS

The current study employed 30 hand drawings of Pikachu, a first generation electric-type *Pokémon* character, depicting a range of emotions (images used with permission from the illustrator, bluekomadori [https://www.deviantart.com/bluekomadori]; based on the video game characters belonging to The Pokémon Company); see Fig. 1a for examples. Also, 30 photo-quality stimuli displaying a range of emotions, expressed by the same female model, were taken from the McGill Face Database (Schmidtmann et al., 2016); see Fig. 1b for examples. Ratings of arousal (*i.e.*, the excitement level, ranging from high to low) and valence (*i.e.*, pleasantness or unpleasantness) were obtained for each image using a similar method to Jennings et al. (2017). This method involved the participants viewing each image in turn in a random order (60 in total: 30 Pikachu and 30 of the human female from the McGill database). After each image was viewed (presentation time 500 ms) the participants' task was to classify the emotion being displayed (*i.e.*, not their internal emotional response elicited by the stimuli, but the emotion they perceived the figure to be displaying).

The classification was achieved via "pointing-and-clicking" the corresponding location, with a computer mouse, within the subsequently displayed 2-dimensional Arousal-Valence emotion space (Russell, 1980). The emotion space is depicted in Fig. 1c; note that the red words are for illustration only and were not visible during testing, they are supplied here for the reader to obtain the gist of the types of emotion different areas of the space represent. Data for 30 observers (14 females) was collected, aged 23±5 years (Mean±SD), using a MacBook Pro (Apple Inc.). The stimuli presentation and participant responses were obtained via the use of the PsychToolbox software (Brainard, 1997).

RESULTS

The calculated standard errors (SEs) serve as a measure of the classification agreement between observers for a given stimuli and were determined in both the arousal (ver-

tical) and valence (horizontal) directions for both the Pokémon and human stimuli. These are presented as the error bars in Fig. 1d and 1e. The SEs were compared between the two stimulus types using independent t-tests for both the arousal and valence directions; no significant differences were revealed (Arousal: t(58)=-0.97, p=.34; and Valence: t(58)= 1.46, p=.15).

Effect sizes, *i.e.*, Cohen's d, were also determined; Arousal: d=0.06, and Valence: d=0.32, i.e., effect sizes were within the *very small* to *small*, and *small* to *medium* ranges, respectively (Cohen, 1988; Sawilowsky, 2009), again indicating a high degree of similarity in precision between the two stimuli classes. It is important to note that the analysis relied on comparing the variation (SEs) for each classified image (reflecting the agreement between participants) and not the absolute (x, y) coordinates within the space.

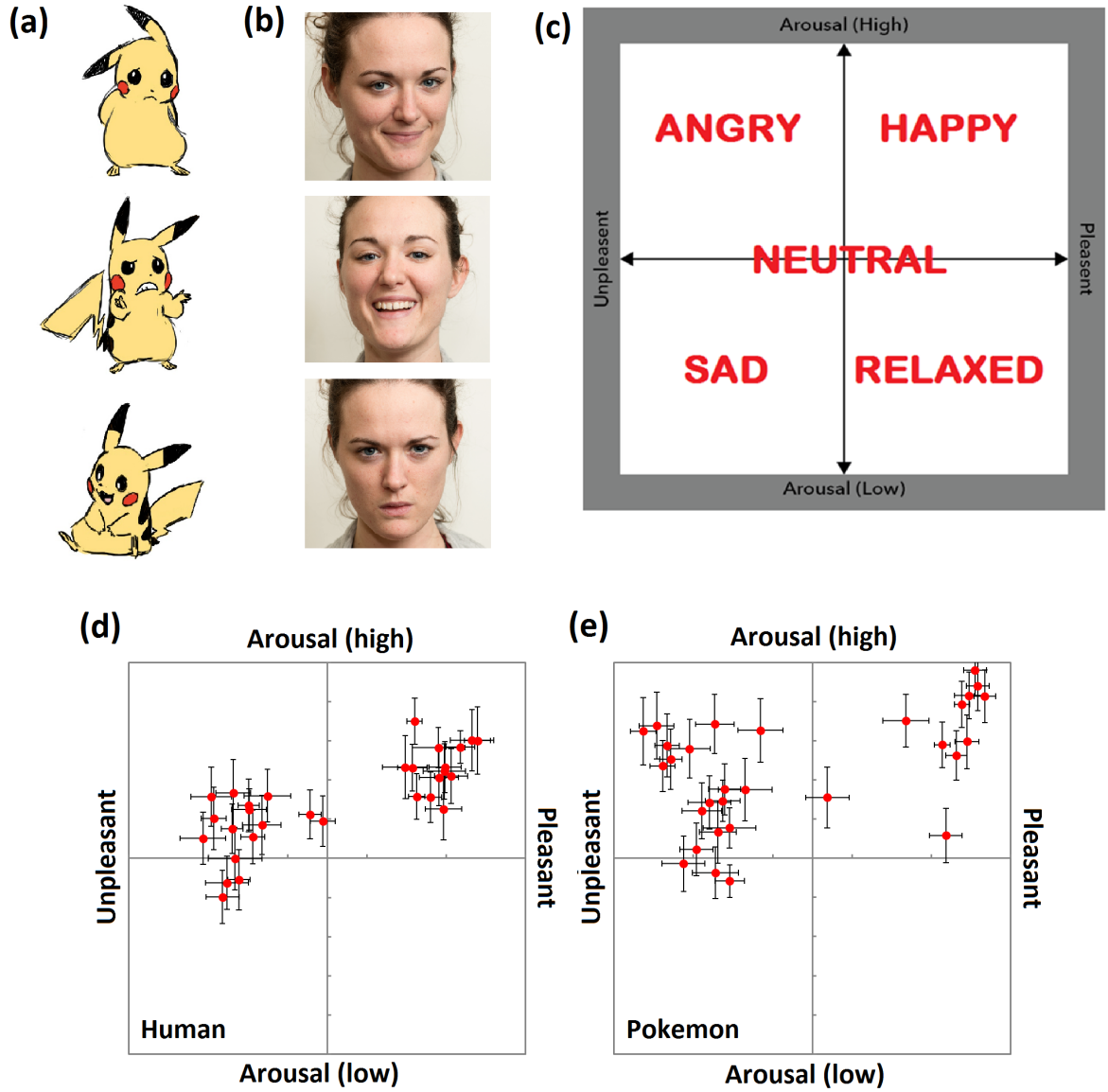

Figure 1. Panels **(a)** and **(b)** illustrate 3 exemplars of the Pokémon and human stimuli, respectively. Panel **(b)** shows the response grid displayed on each trial for classifications to be made within (note: the red wording was not visible during testing). Panels **(d)** and **(e)** show locations of perceived emotion in the human and Pokémon stimuli, respectively. Error bars present one standard error.

DISCUSSION

What could observers be utilizing in the images that produce such a high degree of agreement on each emotion expressed by each stimulus class? Is all the emotional information contained within the eyes? Levy et al. (2012) demonstrated that when observers make an eye movement to either a human with eyes located, as expected, within the face or non-human (*i.e.*, a 'monster') that has eyes located somewhere other than the face (for example, the mythical Japanese Tenome that has its eyes located on the palms of his hands; Sekien, 1776) the observers' eye movements are nevertheless made in both cases towards the eyes, *i.e.*, there is something special about the eyes that capture attention wherever they are positioned. Schmidtmann et al. (2016) additionally showed that accuracy for identifying an emotion was equal when either an entire face or a restricted stimulus showing just the eyes was employed. The eyes of the Pikachu stimuli are simply black circles with a white "pupil", however they can convey emotional information, for example, based on the positions of the pupil, the orientation of the eye lid, and by how much the eye is closed. It is hence plausible that arousal-valence ratings are made on the information extracted from only the eyes.

However, for the Pokémon stimuli Pikachu's entire body is displayed on each trail, and it has been previous shown when emotional information from the face and body are simultaneously available, they can interact. This has the result of intensifying the emotion expressed by the face (de Gelder et al., 2015), as perceived facial emotions are biased towards the emotion expressed by the body (Meeren et al., 2005). It is therefore likely that holistic processing of the facial expression coupled with signals from Pikachu's body language, *i.e.*, posture, provide an additional input into the observers' final arousal-valence rating.

CONCLUSION

Whatever the internal processes responsible for perceiving emotional content, the data points to a mechanism that allows the emotional states of human faces to be classified with a high precision across observers, consistent with previous emotion classification studies (*e.g.*, Jennings et al., 2017). The data also reveals the possibility of a mechanism present in normal observers that can extract emotional information from the faces and/or bodies depicted in simple sketches, containing minimal fine detail, shading and colour variation, and use this information to facilitate the consistent classification of the emotional states expressed by characters from fantasy universes.

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About the Author

Dr. **Ben Jennings** is a vision scientist. His research psychophysically and electrophysiologically investigates colour and spatial vision, object recognition, emotions, and brain injury. His favourite Pokémon is Beldum.

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Mondo Museum: a sim game to build your own world-class dream museum

Interview with Michel McBride-Charpentier

Mondo Museum is an upcoming simulation game developed by Viewport Games where you can build your dream museum. Equipped with dinosaurs, Books of the Dead, classical paintings, and space-age stuff, *Mondo Museum* has something for everyone. The game will be soon published by Kitfox Games and is already listed on Steam.

The Journal of Geek Studies interviewed designer/programmer Michel McBride-Charpentier to understand how such a wonderful game like *Mondo Museum* came to be. You can read the full interview below.

Q: There are lots of sim games around, but as far as we know, there has never been one about curating and running a museum. So how did you get that idea?

A: After the announcement, a few people have said they'd also had the idea of a "SimMuseum", so I don't think it's a wholly original concept. I'm actually really surprised nobody else has made a game like this since the idea first popped into my head over a decade ago and I've spent the last 5 years really expecting one to drop on Steam at any moment.

The idea, like most good ones, came to me through synthesizing a lot of different interests I've developed over my life: visiting a wide variety of museums in school and later as an adult, a love for Maxis and Bullfrog management games, and a person-

al desire to create work that is educational and engages players with systems thinking without being a dry capital-letters Serious Game.

Q: Do you have any particular type of museum you enjoy the most? Or an all-time favourite museum?

A: Museums that contain a wide variety of exhibits that have no apparent relation to each other are always the most fun for me to visit. For example, The Met in NYC which has collections ranging from Ancient Egypt to medieval European armour to Rembrandt paintings. The Royal Ontario Museum in Toronto is also in this vein, with dinosaur skeletons and fossils next to Chinese sculpture.

Asking for my favourite is an impossible question, but I'll use this opportunity to shout out the Noguchi Museum in Queens, NYC. It's entirely focused on the life and work of Japanese-American sculptor/designer/landscape architect Isamu Noguchi. Walking through those galleries and the sculpture garden for the first time sparked a real appreciation for abstract sculpture I never had before, and he instantly became my favourite artist of the 20th century.

Q: Did you bring into *Mondo Museum* some of your personal experience or preferences?

A: Choosing which collections to include at launch was definitely driven by my personal preferences. When I was a kid I wanted to be an Egyptologist and archaeologist, so including an Ancient Egypt collection was an obvious choice. Many of the things that invoke a sense of wonder in kids but are often lost as we become older are represented, such as dinosaurs, space exploration, and the geology of the Earth.

Q: Have you or anyone in the team worked in a museum before?

A: C.J. Kershner is writing the exhibit item descriptions and the few characters who are directors/curators of other museums, and has many years of experience volunteering at the American Museum of Natural History as an info desk attendant (so obviously had to know a lot about the workings of the museum from the visitor's perspective), and as an explainer for a live exhibits team.

Q: So, let's turn to the game now. What is the players' goal in *Mondo Museum*? Are there different scenarios and objectives to be met?

A: There's a sandbox mode where the end goal, or how to achieve the highest prestige ranking, is mostly up to the player to define. There is a task/objective system that provides short-to-medium term goals, such as unlocking new items or receiving more funding.

As for scenarios, the current plan is to have those, though what exactly they will look like is still undecided. A campaign where you move between different museums with unique challenges and constraints is the goal, but will likely only come in an Early Access update.

Q: From what we've seen, the game includes all types of museums: natural history, technology, archaeology, anthropology, art, etc. How did you manage to gather all these different areas of study and interest into a single package?

A: As I mentioned above in what my favourite types of museums to visit are, it's not uncommon for real museums to display a wide variety of collections under one roof. But we go one step further, and let players mix and match items from any collection. The challenge was in selecting items that complement one another and allow players to discover these relationships between items. One example is how in the Ancient Egypt collection there's an astronomical chart, and tools for observing the stars, that

can be combined with items from the Space Exploration collection to create a kind of "Astronomy through the Ages" combo. Right now I'm explicitly defining these combos, but might try out a more free-form tagging system, where for example any item tagged "Tool" could be placed in an exhibit hall with others that share that tag.

Q: And now perhaps the most important question of all: does *Mondo Museum* include exhibits of the giant squid (Architeuthis dux) or the colossal squid (Mesonychoteuthis hamiltoni)?

A: "The Ocean" is on a shortlist for collections to include in a future content update, but if you're really desperate to see some horrors of the deep, mod support means if a player can make a 3D model of one then it will be very easy to put in the game.

Q: Did you bring in any museum staff as consultants while making the game?

A: No real consultants other than C.J., but if anyone is brought in will likely be to review specific collections for cultural sensitivity issues we might have been oblivious to. For example, someone recently brought up the debates museums have around the subject of human remains when making exhibits about ancient burial practices and so on, which I hadn't considered before. That kind of insight is really helpful (in our case, this helped me decide to only have mummified animals because a) they're actually pretty cute while human mummies are pretty gross and b) a human mummy is kind of unnecessary since the real interesting artefact/art is the coffin and sarcophagus).

Q: There is a lot of discussion today around ownership and repatriation of artefacts, especially in archaeology and anthropology . It is a tough subject, but does *Mondo Museum* tackle it in some sense?

A: Absolutely, and it's core to the politics of the game. I didn't want to recreate the systems of colonialism and looting that resulted in many museums in the West originally acquiring their collections. *Mondo Museum* takes place in a more just and utopian world, where all items have been repatriated (or never left in the first place). The way you unlock new exhibit items is by satisfying the conditions of visiting directors/curators from these museums around the world, who will then effectively give you permission to display parts of their col-

lections.

Q: The game focuses on the exhibitions, which are the public face of museums. Will there be any mention to the vast collections of objects and specimens museums have and of all the research (scientific and otherwise) that is done based on these collections?

A: The research and archive aspect of the game is still a work in progress (there are researcher staff you hire who can improve the quality of your items/the understanding visitors get from it in a sort of abstract way), but I like the idea of the item we have created that is on display representing a lot of associated items that don't have 3D models but you need to manage to some extent. I'm trying to keep the scope achievable for the moment, but big updates are planned throughout Early Access.

Q: Do you hope the players will learn something with *Mondo Museum* or maybe spark their interest to visit a museum?

A: I really do hope it encourages players to go to museums if they haven't been in a while, or maybe since a school field trip. Hopefully the game will give everyone a deeper appreciation of the work behind creating an exhibit that makes sense to the public, or consider what curation decisions they might have done differently to tell a different story.

Q: Do you hope museums worldwide might learn something from *Mondo Museum*?

A: The people running modern museums are generally doing a really good job in engaging visitors these days, so I'm not expecting to reveal anything they don't already know. Maybe there could be more museum activities for adults, and not just kids or currently enrolled students. I'm targeting an audience of all ages, and there's been a lot of interest from adults intrigued by the game. Curator talks, seminars, group tours, opening parties, etc., are fairly common, but I'd love to see more creative activities and workshops designed with adults in mind, since there's clearly an adult audience for "playing" with museums.

About the team

Michel McBride-Charpentier is *Mondo Museum's* designer and programmer; the other team members are Genevieve Bachand (artist), Farah Khalaf (producer), C.J. Kershner (writer), and Rhys Becker (artist). Viewport Games is a small studio based on Montréal, Canada. Kitfox Games, also from Montréal, is an independent games studio focused on creating intriguing worlds to explore.

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Vampire Apocalypse Calculator

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Welcome to the Vampire Apocalypse Calculator[1], you lovely, tasty human. This sophisticated tool is based on the **predator –prey model**, a model that successfully describes the dynamics of ecosystems, chemical reactions, and even economics. Now it's time to use it to answer the question: "what if vampires were among us?" You might think we're joking, but the facts are clear. If we compare the actual world's population[2] (Fig. 1: red points) to the exponential growth model[3], it reveals there are some hidden causes preventing the expansion of humanity.

We could theorise all day why this is, but there's one idea we'd like to check and discuss: **vampires**. Are you ready to unveil the ancient mysteries of vampirism?

Figure 1. Earth's population growth: expected logarithmic scale vs actual data. Extracted from Strielkowski et al. (2013).

[1] You can find it at: https://www.omnicalculator.com/other/humans-vs-vampires

[2] World Population Clock, available from: https://www.worldometers.info/world-population/

[3] Exponential Growth Prediction Calculator, by M. Mucha, available from: https://www.omnicalculator.com/statistics/exponential-growth-prediction

WHAT IS VAMPIRISM?

Nearly every culture around the world has its blood-drinking creature. The ancient world had the female demons Lilith (Fig. 2; Babylonia) and Lamia (Greece). In Africa, the Ewe folklore believes in Adze, a vampiric being that can take the form of a firefly. Chilean Peuchen was a gigantic flying snake that could paralyse, and in Asia Penanggal was a woman who broke a pact with the devil and has been forever cursed to be a bloodsucking demon. So, why is it that vampires are known around the globe? Isn't it suspicious?

Figure 2. Lilith, by John M. Collier (1892), oil on canvas. Source: Wikimedia Commons.

What about the vampires themselves? Today, they are usually believed to be undead creatures with supernatural powers: they don't age, can fly, and can fully regenerate from almost any wound. They have a taste for human blood (Fig. 3), but are afraid of sunlight, silver, religious symbols, and garlic. Vampires can be killed by decapitation or a wooden stake through the heart. The last but most important thing is that vampires can't reproduce; they can only turn a human into a vampire.

Figure 3. The Vampire, by Philip Burne-Jones (1897). Source: Wikimedia Commons.

THE CALCULATOR

What if vampires were among us? The Vampire Apocalypse Calculator allows you to check how humanity would fair in some selected scenarios from popular books and movies, as well as creating your own story from scratch. It's your decision!

We present the result in the form of a graph that plots how three populations change: humans (blue points), vampires

(red points), and vampire slayers (yellow points). You can adjust the graph if needed by setting an appropriate time scale (days, weeks, months, years, decades, centuries) and type of chart (linear or logarithmic[4]).

The vampire apocalypse calculator performs real-time numerical calculations that might sometimes be a little demanding, depending on your machine specifications. But, please, be understanding! The algorithm can receive up 13 parameters from the three populations:

- **Humans**: if not interrupted by vampires, their population size will grow exponentially. The available settings are the initial population, the probability of turning into a vampire when attacked, and annual population growth. Humans' unique ability is to **grow faster** when their population becomes smaller than its starting value.
- **Vampires**: bloodthirsty humanoids that hunt people and turn them into new vampires. The available parameters are their initial population and their aggression level towards humans and slayers. You can make vampires smarter with their special ability. When activated, vampires will **refrain from killing** too many humans, so they do not lose their only source of blood.
- **Vampire slayers**: an organization of brave people with one objective: save the world from vampiric domination. The available parameters are their initial population, annual recruitment speed, aggression level towards vampires, and vampire transformation probability. They cannot afford their members' salaries if the entire world population is made up of vampire slayers, so you can turn on the vampire slayers special ability to **limit the maximum size** of the organization.

So, go ahead and test the Vampire Apocalypse Calculator. It's freely available online: https://www.omnicalculator.com/other/humans-vs-vampires. If you find a set of parameters that creates an incredible story, don't hesitate and share it with your friends and us (there is a 'Send this result' on the website). See also the Box 1 below for more information on how the calculator came to be.

PREDATOR–PREY MODEL: LOTKA–VOLTERRA EQUATIONS

Italian astronomer and physicist Galileo Galilei (known for his experiments with falling bodies and inclined planes) once said that "mathematics is the language in which God has written the universe". Indeed, scientists all around the world try to find suitable mathematical equations that describe the natural world properly.

If you consider a simple ecosystem with two species, e.g., foxes and rabbits, the Lotka–Volterra equations[5] generally work just fine. They are also called the predator–prey model. Why? Let's stick with our example. The population of rabbits can peacefully live and reproduce if we assume that they have access to an unlimited source of food in the forest. On the other hand, foxes are carnivorous, so their population size depends on the accessibility of food, i.e., rabbits. Can you see where the problem is? More rabbits mean more foxes, but more foxes mean fewer rabbits.

A similar situation exists with humans (prey) and vampires (predators). Our calculator makes use of the Lotka–Volterra equations, with a few modifications. First of all, we created some vampire slayers that control the population of vampires. Secondly, we gave each group a special ability that is implemented indirectly in the algorithm. Eventually, we came up with the following differential equations:

$$dx/dt = x(k_1 - a_1 y)$$

$$dy/dt = y(b_1 a_1 x + b_2 a_2 y - cz)$$

$$dz/dt = z(k_2 - a_2 y)$$

[4] See also Log Calculator, by Haponiuk & Pal, available from: https://www.omnicalculator.com/math/log

[5] See also Yorke & Anderson (1973).

where:

- x, y, and z are the sizes of the human, vampire, and vampire slayers populations, respectively;
- k_1 and k_2 are the growth rates of the human and vampire slayer populations;
- b_1 and b_2 are the probabilities that a human and a vampire slayer will turn into a vampire;
- coefficients a_1, a_2, and c describe the aggression levels: vampires towards humans, vampires towards vampire slayers, and vampire slayers towards vampires, respectively.

For more explanations, please refer to Strielkowski et al. (2013). We based this calculator on the fourth-order Runge–Kutta method to solve the problem of differential equations.

BLOODSUCKERS - ARE VAMPIRES AMONG US?

There are species in the animal kingdom that suck and feed on their preys' blood. This practice is called **hematophagy**, and many small animals adopt it because blood is basically a fluid tissue rich in nutrients.

So, what's the main difference between animal bloodsuckers and fictitious vampires? The former can't turn their prey into something else by biting it or killing it. Lucky for us!

Some known bloodsucking animals are (Fig. 4):

- **Vampire bats**: they mainly hunt birds and reptiles, but they occasionally turn their fangs on humans. Interestingly, vampire bats often share the blood that they

Box 1. How the Calculator came to be

The Vampire Apocalypse Calculator combines two things that I find fascinating: fiction and science. I love it when we can apply mathematical models to even the most surprising things and describing a vampire apocalypse using differential equations definitely makes the top of my list. I got inspired when I found an interesting paper regarding vampires, where the authors subtly suggested the existence of vampires based on real-life data.

That drew my attention and I decided to test it out in a scientific way with the well-known theory of the predator–prey model, based on game theory. Secondly, I needed to prepare an algorithm itself with adequate populations (humans, vampires, vampire slayers) and to create proper relationships between them. Lastly, the implemented calculations are numerical, so I needed to make them stable, no matter the set-up. That required, for example, setting a time step that on one hand, wasn't too small (to avoid the calculations taking literally forever) and that on the other hand, wasn't large enough to make the algorithm unstable. All of this was challenging and because I focused on the Calculator in my free time, it took me about a month to finish everything.

The last part was the hardest. I wanted my calculator to work with various input parameters so everyone could create their own scenarios. The problem with numerical calculations is their stability and the time required to compute them. A stable algorithm requires more time, but it has to be executed within a finite time, even on mobiles. So, depending on the user's input, I needed to predict the appropriate time-step of consecutive calculations to make sure that everything will be estimated in a reasonable period. Choosing sensible parameters was a challenging task too! I had to give meaning to raw numbers to build the atmosphere of a vampire apocalypse. I'm happy that I built a tool that people find interesting and fun.

Figure 4. Top left: vampire bat *Desmodus rotundus*, from Peru; source: Wikimedia Commons (Acatenazzi, 2005). Top right: medicinal leech *Hirudo medicinalis*; source: Wikimedia Commons (GlebK, 2011). Bottom left: *Aedes* (*Ochlerotatus*) sp.; source: Wikimedia Commons. Bottom right: vampire finch *Geospiza difficilis septentrionalis*; source: Wikimedia Commons (P. Wilton, 2009; cropped).

have sucked with their hungry compatriots. That's a real friendship!

- **Leeches**: bloodsucking annelid worms that live in water. They can be used medicinally, as they can restore blood flow to damaged veins.
- **Mosquitoes**: flying insects that you're probably familiar with. They can be dangerous to humans, since mosquitoes can carry many diseases. An interesting fact is that only female mosquitoes suck blood from their victims (they need it to fuel egg production).
- **Vampire finches**: don't let these lovely looking birds deceive you! When other food sources are scarce, they sometimes feed by drinking the blood of other birds.

Humans also practice hematophagy! There are meals that contain animal blood. For example, many people around the world eat blood sausages – sausages filled with blood that has been cooked or dried. With that, we can conclude that vampires are actually among us! Of course, that's only a half-truth; real bloodsuckers can't turn people into vampires.)

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About the author

Dominik Czernia is a PhD candidate in the Institute of Nuclear Physics of the Polish Academy of Sciences. When he was a child, he really liked mysterious and bloody stories. As an adult, he realized that blood doesn't give you immortality in the literal sense, but it can save someone's life! Since he turned 18, he has been donating blood regularly: 16 liters so far and feeling the need to donate more. One could say he's the perfect prey for vampires! ;)

As part of his involvement with The Omni Calculator Project, Dominik has built a few interesting tools such as The Hot Car Calculator (https://www.omnicalculator.com/health/car-heat), which helps people understand the lethal consequences of leaving kids unattended in cars, and The Coffee Kick Calculator (https://www.omnicalculator.com/food/coffee-kick), in collaboration, which allows you to maximize your caffeinated efficiency. He's also created many more super scientific ones that may not be as fun but are still worth a mention, such as the Space Travel Calculator, the Acceleration Calculator, and a few Velocity tools.

Journal of Geek Studies

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The Climate Trail: how to survive the climate apocalypse

Interview with William D. Volk

The Climate Trail[1] is a new and totally free game for PC and mobiles developed by Willian D. Volk. The game takes place in the in future, when our inaction regarding the climate crisis has rendered much of the world uninhabitable. The player leads climate refugees as they flee from ever worsening conditions, combining adventure, survival and visual novel elements. *The Climate Trail* follows the footsteps of the famous series *The Oregon Trail* (MECC, 1971–2011).

The Journal of Geek Studies interviewed Willian D. Volk to understand how *The Climate Trail* came to be. You can read the full interview below.

Q: Firstly, thank you for making *The Climate Trail*; the world desperately needed it. Being such a hot topic (no pun intended), it's amazing no one in the video game industry has faced it heads on yet. So how did you become the first one to step up to this task?

A: The mainstream video game industry is risk-adverse because unlike film, there is no secondary markets (cable, etc.) for their games. With high budgets, they don't take big risks and rely on franchises (*i.e.*, *Call of Duty*, *Overwatch*, *Grand Theft Auto*) for most of the revenue. There's also an aversion to tackling controversial topics. There

[1] You can find it at https://www.theclimatetrail.com/

are some indie games that have addressed the climate issue, but *The Climate Trail* may be the first to put players into a post climate-apocalypse world.

Q: Before *The Climate Trail*, did you have any experience in communicating about climate change? Or maybe even joining up some marches and protests?

A: I have degrees in Physics, a wife who used to work for the EPA and a brother who is a meteorologist. I've done way too much online debating on the issue, which was one of the motivations for making this game. I have participated in some climate events as well.

Q: As the game's title and website make clear, it has drawn inspiration from *The Oregon Trail*. *The Oregon Trail* series is classified as 'educational games'. Do you see *The Climate Trail* equally as an educational game or more as a call to action?

A: My goal is to add more educational content into the game so it can be a resource for climate information, but I also want it to be a call to action. Both are important.

Q: Would you like to see *The Climate Trail* being used in classrooms?

A: I do. This is why there's no "roving band of cannibals" or other violence in the game. I present information about climate change in the title and expect to have the game serve as a resource for climate education.

Q: To create *The Climate Trail*, did you use models and predictions made by climate scientists? If so, which studies and reports have you used?

A: Yes, here are some studies and information about feedback loops.[2]

- *What Lies Beneath: The Understatement of Existential Climate Risk;*[3]
- *Existential Climate-Related Security Risk* [foreword by C. Barrie];[4]
- *Turn Down the Heat: Why a 4°C Warmer World Must be Avoided;*[5]
- Scientific articles by Farquharson et al. (2019)[6] and Schneider et al. (2019);[7]
- Opinion articles by Hewett (2019)[8] and Kristof (2019).[9]

[2] You can also check Wikipedia's entry on the clathrate gun hypothesis: https://en.wikipedia.org/wiki/Clathrate_gun_hypothesis

[3] Spratt, D. & Dunlop, I. (2018) Available from: https://climateextremes.org.au/wp-content/uploads/2018/08/What-Lies-Beneath-V3-LR-Blank5b15d.pdf

[4] Spratt, D. & Dunlop, I. (2019) Available from: https://52a87f3e-7945-4bb1-abbf-9aa66cd4e93e.filesusr.com/ugd/148cb0_90dc2a2637f348edae45943a88da04d4.pdf

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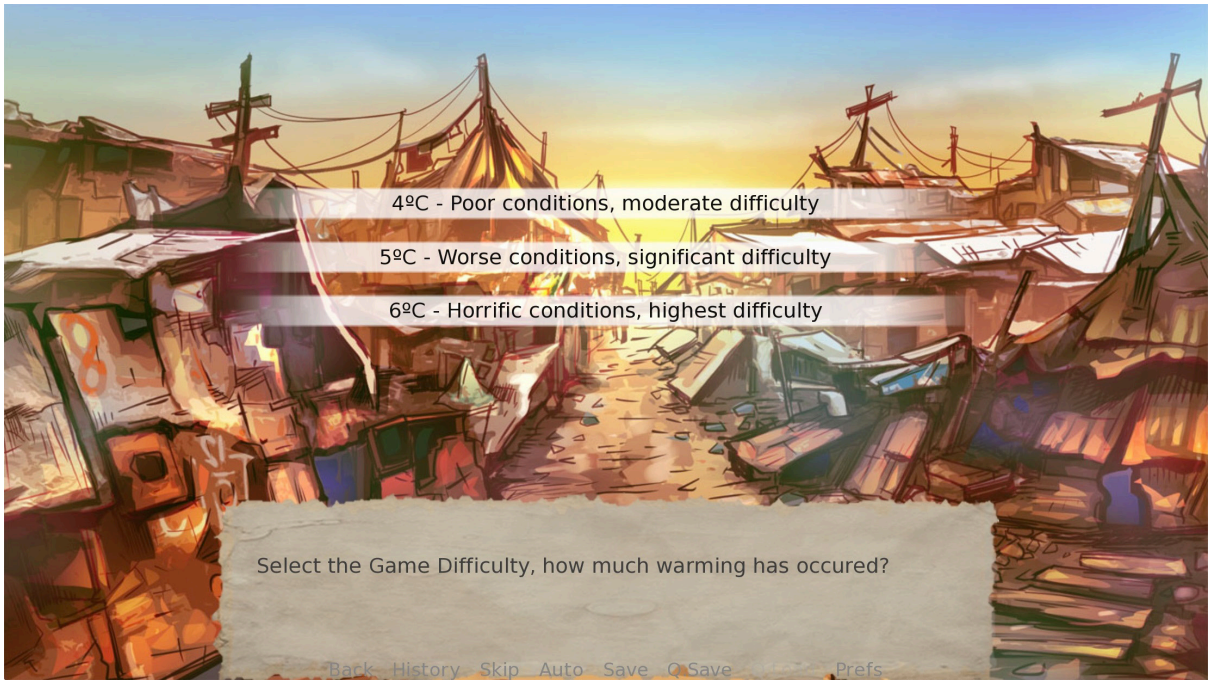

Q: To many (if not most) people, science alone is not enough reason to take action. The emotional impact of a game might be more crucial, and art might play a bigger role here. *The Climate Trail* has all of that, so how did you approach the mix and balance of science and emotion?

A: I've always believed that games can have social value. Chris Crawford's 1985 classic game of geopolitical brinkmanship, *Balance of Power*, showed the futility of nuclear war. There are other examples, the 1997 PlayStation game *Oddworld: Abe's Oddysee* covered the exploration of workers in a moving way. For me the example that best represents a creative effort that moved me to tears is the 1959 film *On the Beach*.

On the Beach scared me and I'm sure many other "cold war children" (and adults). The ending scene of the film shows a deserted world with banners expressing futile hope in a dramatic image. I want to invoke the same feelings about our ever more likely climate apocalypse as *On the Beach* did for nuclear war. As the scientist in that film says: "Who would ever have believed that human beings would be stupid enough to blow themselves off the face of the Earth?"

I simply can't believe we're stupid enough to cook ourselves off the face of the Earth. If I can achieve 1/10th of the emotional impact of *Oddworld* or *On the Beach* I will be happy with the effort.[10]

Q: In *The Climate Trail*, players must survive a journey from Atlanta, USA, to Canada, across a climate-wrecked landscape. Did you choose this area for any particular reason?

A: Single highway route made design easier, all the locations are far enough above sea level to still be passable even if all land ice melts. I've been to that Canadian town as well.

[10] Read more at: https://www.theclimatetrail.com/development-blog/why-am-i-giving-this-game-away-or-can-a-game-make-you-cry and https://www.theclimatetrail.com/development-blog/the-games-the-thing-wherein-ill-catch-the-conscience-of-my-kin-

[11] See also: https://www.theclimatetrail.com/development-blog/why-am-i-giving-this-game-away-or-can-a-game-make-you-cry

Q: The USA in *The Climate Trail* looks terrible. In what year exactly does the game take place?

A: I'm deliberately not specific. Kate (the scientist) mentions Greenland Ice Melt when she was in college (dog sled picture) so the idea is it could be anywhere from 30 to 50 years or more.

Q: We love that the game's difficulty levels are represented by greater increases in global temperature. How do the different temperature increase scenarios change the gameplay?

A: They effect heat wave and storm frequency, how many seeds you have at the start and the odds of finding supplies and capturing rain.

Q: You funded the game yourself and made it available to the public for free. Why did you opt for that approach?

A: It's easier for climate organizations to support a game if it's not a commercial venture. Also want to get it into schools.[11]

Q: Ultimately, what is your hope for *The Climate Trail*?

A: Have it become an educational resource (as we add more climate info) and as with *On the Beach*, create emotional impact that moves people to action. I want to see millions playing it.

About the Team

William D. Volk is a game developer, founder of Deep State Games, and environmental advocate. He began his career in 1979 helping to launch the computer game division of Avalon Hill. He has worked at Activision and Lightspan and produced over 100 educational adventures. **George Sanger**, also known as "The Fat Man", is a musician who has composed music for several video games, including *Wing Commander* and *SimCity 2000*.

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Corsola ecosystems in the Galar region

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To begin this article in the most honest way I can think of, I must state that as a biologist I've always complained about those absurdities in the Pokémon franchise that could have been solved if the designers had taken 10 minutes to Google them. And I'm not alone in this! – There are issues such as mistaken cephalopod anatomy (Salvador & Cavallari, 2019), using Japanese species on a setting that's clearly France (Tomotani, 2014), the impossible water-holding capacity of Blastoise (dos Anjos, 2015), and the skewed biodiversity of the Pokémon world towards cats and dogs (Prado & Almeida, 2017; Kittel, 2018; Salvador & Cavallari, 2019).

Maybe that's why one Pokémon in this new generation (Gen VIII) has caught me so off-guard. Given that the whole franchise is about making monsters beat other monsters, I was not expecting something with an ecological/conservationist edge out of it. I was particularly not expecting a new Pokémon to reflect one of the major environmental problems our planet is facing: coral bleaching. The Galarian form of Corsola was a slap to the face and a brilliant addition to the game, so hats off to Game Freak Inc. and The Pokémon Company in this regard[1].

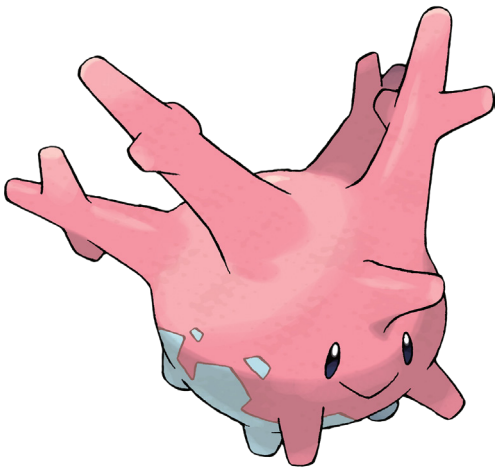

Figure 1. Corsola. Original artwork from the game; extracted from Bulbapedia.

Figure 2. The skeletal remains of a *Corallium rubrum* (Linnaeus, 1758). Extracted from Wikimedia Commons (P. Géry, 2010).

[1] Not in other regards, though. We did not need a new Mr. Mime or a Pokémon who's a walking dollop of whipped cream. Not to mention that the ice cream Pokémon were included in the game, but Abra, Starly and Lord Helix were not.

CORSOLA AND CORALS

Corsola's first appearance on the franchise was on Gen II, the famed *Gold* and *Silver* games (Fig. 1). It is a dual-type Pokémon (Water/Rock) based on a coral, likely the red corals[2], a moniker given to several species in the genus *Corallium* (Fig. 2).

Corals are animals belonging to the phylum Cnidaria, which also includes jellyfish and anemones. Broadly speaking, there are two types of corals: soft corals (Alcyonacea) and stony corals (Scleractinia). The latter, as can be surmised by their name, have hard skeletons made of calcium carbonate (Fig. 2). That explains Corsola's Rock type – or would, because the red corals that are the likely inspiration for Corsola, are not stony corals. Rather, they are soft corals (Alcyonacea) that – atypically for the group – have calcareous structures in their otherwise organic skeleton (Grillo et al., 1993; Debreuil et al., 2011).

The live polyps (Fig. 3), however, look very different from the dead coralline skeleton. But oddly enough, Corsola looks more like a dead coral colony skeleton (Fig. 2) than a living one. Also, Corsola looks like a single creature rather than a colony, as it would be expected of red corals.

Figure 3. Live *Corallium rubrum* (Linnaeus, 1758). Extracted from Wikimedia Commons (P. Géry, 2010).

Despite being colonial, red corals (and other soft corals) are not reef-building corals. Even though, to better explain the issue with coral bleaching and threats to ecosystems, I need to provide a brief explanation on reefs and reef-builders.

Stony corals are often colonial and a group of them known as "hermatypic corals" are reef-builders; that is, their skeletons fuse to become coral reefs (Fig. 4). These corals often have symbiotic zooxanthellae (single-celled photosynthetic algae) embedded in their soft tissues. Since they depend on photosynthesis to acquire nutrients, they are typically found in shallow and clear tropical waters.

Figure 4. Coral reef, Israel. Extracted from Wikimedia Commons (Mark A. Wilson "Wilson44691", 2007).

Coral reefs are hotspots of marine biodiversity. They sustain and shelter a myriad of species: lobsters and shrimps, snails and squids, worms, fishes, turtles, and many others (Fig. 5). So, why does that matter? Simply put, the highest the biodiversity (number and types of different species), the more 'ecosystem services' we can benefit from (CORAL, 2019). Think of these services[3] as everything nature can provide us if we could just take good care of it. To

[2] Also known as 'precious corals' because people like to use its red/pink/orange skeleton for making jewelry.

[3] Ecosystem services are split into four categories: provisioning (*e.g.*, food production); regulating (*e.g.*, climate buffering); supporting (*e.g.*, oxygen production); and cultural (*e.g.*, recreational and spiritual benefits).

help inform decision-makers, many ecosystem services are being assigned economic values. It seems ridiculous that we have to assign an economic value to nature, but unfortunately that's how our short-sighted governments work.

Figure 5. The typical example of coral reef biodiversity is a bunch of colorful fishes. Extracted from Wikimedia Commons (Fascinating Universe, 2011).

Inevitably, coral reefs are extremely threatened by overfishing and pollution (including the now pervasive microplastics) and by climate change, because the increased temperatures lead to coral bleaching and ocean acidification (McClanahan, 2002). But I will come back to this later; first, let's take a look at the Galar region and its Corsola.

GALAR

The Galar region is the setting of the newly released games *Pokémon Sword* and *Pokémon Shield*, the franchise's Gen VIII. Galar is based in the United Kingdom and several locations in the game were inspired by real-world places. Part of the new fauna (but not all of it[4]) is also appropriate to the UK, such as ravens (Corviknight) and cormorants (Cramorant). However, as the game says, Galar is heavily industrialized and this has influenced some Pokémon living there, like Weezing, whose Galarian variant manages to look even more noxious than the original form from Kanto (but see Box 1).

The Galarian variant of Corsola is a Ghost-type Pokémon, clearly indicating it's already dead. It is entirely white (bleached) and has a sad face (Fig. 6). Its Pokédex entry in *Pokémon Shield* bluntly states: "Sudden climate change wiped out this ancient kind of Corsola." In Galar, Corsola also have an evolution, named Cursola (Fig. 6), which is, likewise, a Ghost-type. It is a larger and more branched coral.

Figure 6. Left: Galarian Corsola. Right: Cursola. Original models from the game; extracted from www.serebii.net.

However, contrary to regular Corsola, the Galarian Pokémon are not based on the red coral. Instead, given the shape of their branches, they seem to be based on actual reef-building corals such as *Acropora* spp. (Fig. 7). That is fitting, because *Acropora* are major components of reefs and are one of the most sensitive corals to climate change (Loya et al., 2001). Also, *Acropora* corals are what you usually find when googling for "bleached coral". So it seems *Sword* and *Shield* developers are finally using Google, after all.

CORAL BLEACHING

When ocean temperatures increase[5], the symbiotic zooxanthellae leave the corals. This makes the corals become white (Fig.

[4] For instance, one of the starters is a monkey.

[5] Water pollution can also be a cause for bleaching in some cases.

BOX 1. GALAR/UK AND KANTO/JAPAN

Galar is badly industrialized and that is true for its real-life counterpart too. Great Britain is famous as the starting point of the Industrial Revolution and infamous for social problems associated with it, such as poor working conditions and child labor. But a fact that is often overlooked is the collapse of the English Channel's ecosystem. The Channel separates southern England from France and is one of the busiest fishing areas in the world. The place has been overfished to a scary extent and the habitats on the bottom of the Channel has been destroyed by trawling (Southward et al., 2004; Roberts, 2007). As is, the Channel's ecosystem cannot recovery and the biodiversity in the area has plummeted (Molfese et al., 2014).

Even so, Japan is not truly in a position to point fingers about this topic. The country has one of the most destructive fishing practices in the word, including harvesting shark fins[5] and being one of the only nations that still hunt whales (Clover, 2004; Sekiguchi, 2007; McCurry, 2011). Japan has overfished several, if not most, edible animal species in their EEZ, from the famous bluefin tuna to squids and crabs; as a result, the country's fisheries have witnessed a sharp decline in the past decades (Popescu & Ogushi, 2013; Katsukawa, 2019). Researchers within Japan are now arguing for a change to sustainable and scientifically informed fishing practices (Katsukawa, 2019). We can only hope they will.

7); they "bleach", so to speak. Also, without their photosynthetic "buddies", corals are under more stress, start to starve, and overall have a serious decrease in their chances of survival (Fig. 8). Decline in coral ecosystems have been reported from all over the world: from the Caribbean to the Indo-Pacific, most famously including the Great Barrier Reef (Bruno & Selig, 2007; Edmunds & Elahi, 2007; De'ath[7] et al., 2012). Reports from the Galar region are yet to come.

Decline in coral reefs will start a cascading effect and most other species dependent on them (lobsters, squid, fish, etc.) will decline as well (Jones et al., 2004). This might lead to ecosystems collapses and, needless to say, it will affect all those ecosystems services (including food) we derive from the sea. When corals die, the dead rocky reefs become dominated by low-productivity and non-commercial invertebrate species such as sea urchins, starfish, and small snails (McClanahan, 2002).

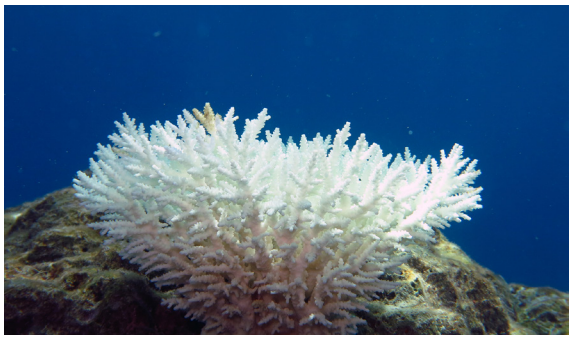

Figure 7. Bleached coral (*Acropora* sp.), Andaman Islands. Extracted from Wikimedia Commons (Vardhanjp, 2016).

[6] Curiously, *Pokémon Moon* (Gen VII) had the following Pokedéx entry for Sharpedo, a shark Pokémon: "It has a sad history. In the past, its dorsal fin was a treasured foodstuff, so this Pokémon became a victim of overfishing." So, the absence of Sharpedo in *Sword* and *Shield* could be explained by an extinction event.

[7] Just using this footnote to point out that this person has a PhD and is thus known as Dr. De'ath. That is one of the coolest Marvel-esque names I've ever seen in academia.

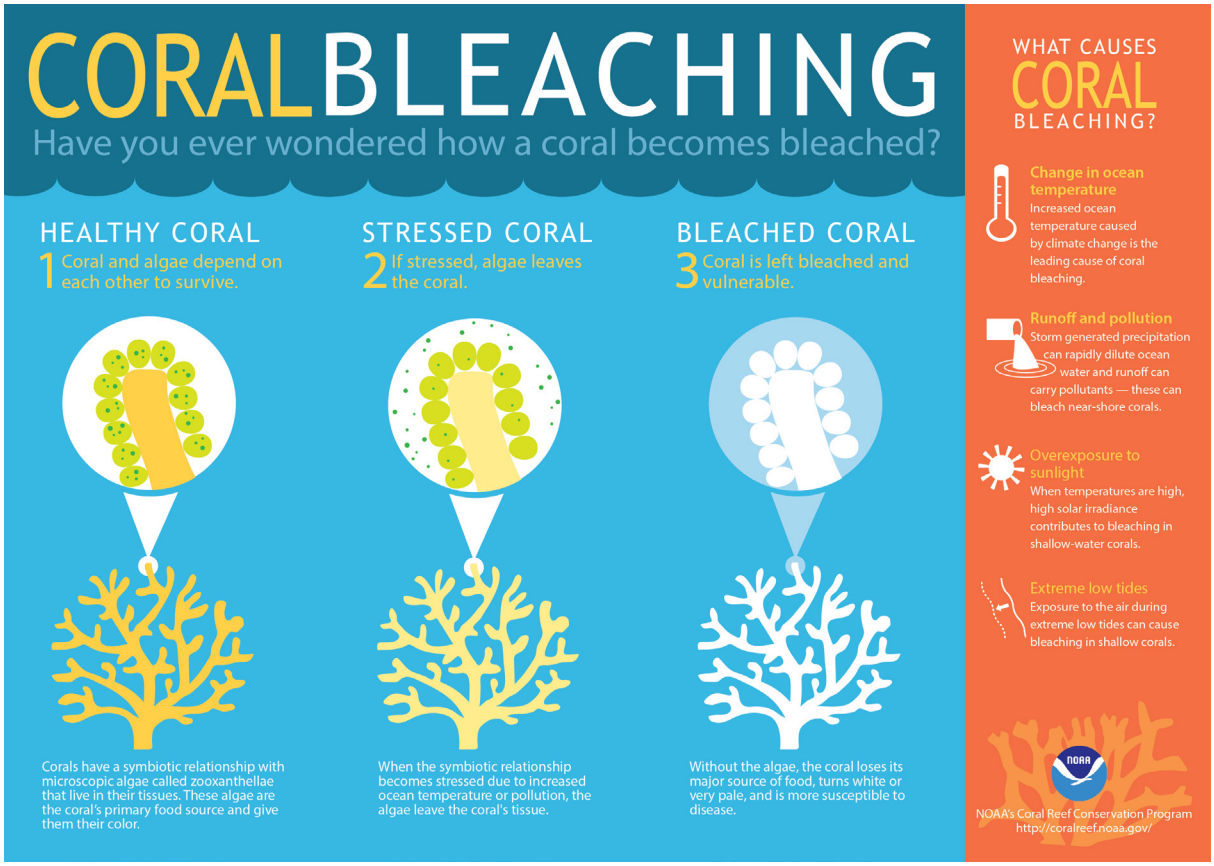

Figure 8. Coral bleaching. Extracted from NOAA (https://coralreef.noaa.gov/); used under NOAA's general usage permission for educational/informational purposes.

OCEAN ACIDIFICATION

Bleaching, however, is not the only threat to corals. Our oceans are acidifying due to increased CO^2 concentrations in the air since the Industrial Revolution. When CO^2 is absorbed into the water, it reacts to become bicarbonate ions, making the water more acidic. This effect is, of course, amplified by higher temperatures (Humphreys, 2017). Acidified waters make it more difficult for corals to produce and deposit calcium carbonate (Albright et al., 2017), which is the substance that makes up their skeleton, as we've seen above.

Unfortunately, corals are not the only animals threatened by rising temperatures in the ocean.

Figure 9. *Limacina* sea butterfly. Because of their diaphanous shells, pteropods are amongst the most threatened animals by ocean acidification[8]. Extracted from Coldwater.Science (http://coldwater.science/), © Alexander Semenov, used with permission.

[8] Phione and Manaphy are Pokémon based on the pteropod species *Clione limacina* (Salvador & Cavallari, 2019). Their absence in *Sword* and *Shield* could be explained by an extinction event due to climate change.

Mollusks have shells made of calcium carbonate and are thus vulnerable to more acidic waters, especially during their larval or juvenile phase. Mollusks such as planktonic sea-butterflies (pteropod snails; Fig. 9) and bottom-dwelling bivalves are as important as corals for ecosystems, and several other animals depend on them, from other mollusks to crustaceans and fish (Manno et al., 2017). Here, the situation might be even worse than with corals: while reefs are restricted to tropical regions, ocean acidification will affect mollusks in temperate regions as well (Soon & Zheng, 2019).

As much as we can protect the natural world by creating nature reserves (including marine ones), unfortunately they will not work in this case (Allison et al., 1998; Jameson et al., 2002). Reserves can protect the reef ecosystem against overfishing and trawling, but it cannot stop ocean acidification. That is linked to climate change and we are already passing the tipping point in which the change could be turned back (Aengenheyster et al., 2018); soon, all we'll be able to do is damage control.

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About the author

Dr. **Rodrigo Salvador** is a biologist who specializes in mollusks; fittingly, his favorite Pokémon is the West Sea Gastrodon. Part of his research is on marine snails and slugs, but he's also interested in other marine animals – except fish maybe, which are mostly boring. He has played *Pokémon* since Gen I, but never really cared about Corsola – until now.

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SuperAves: a collectible card game about bird biodiversity

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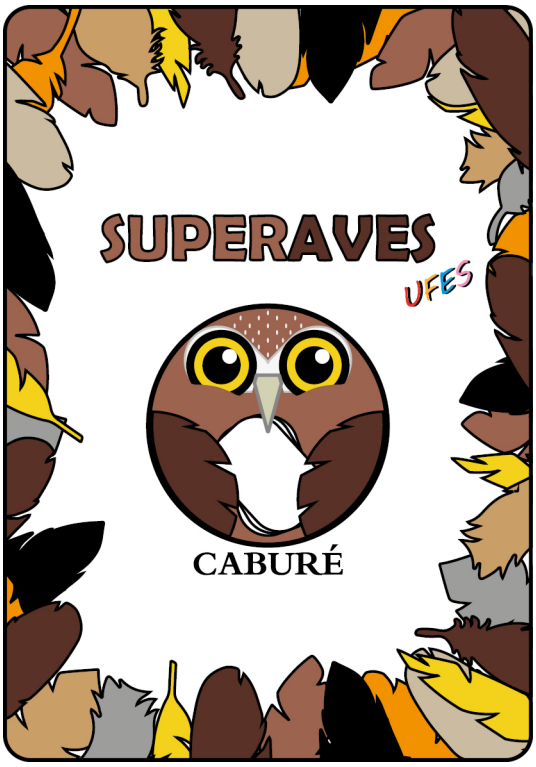
The idea of making a game about the birds of the UFES (Federal University of Espírito Santo, in southeast Brazil) campus was a sum of long-brewing factors. I have always been interested in the souvenirs offered to people at natural parks, zoos, aquariums, shrines and other similar spaces, especially when regarding the biodiversity and the landscapes of the place. It is beautiful? Funny? Cheap? Does it have educational value? I always asked myself these questions in search of a souvenir that pleased my biologist and traveler self.

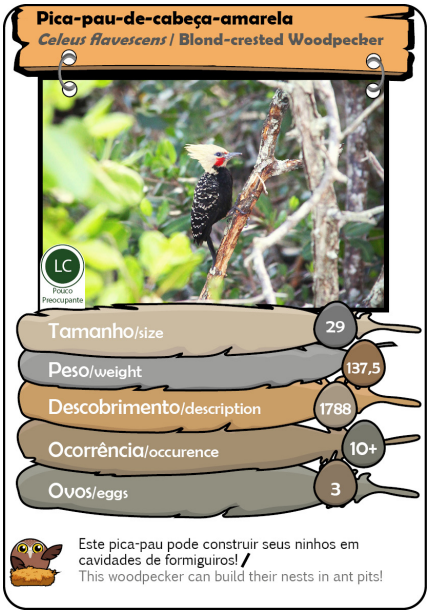
In 2016 I was able to spend a few months in the USA, where I visited several natural parks and of course, brought back many souvenirs and ideas. With the end of my degree in Biology, my advisor Viviana Borges (who had some experience with natural parks in South Africa) and I put the ideas together and decided that I would turn a campus bird survey I had done at the beginning of my degree into a game of collectible cards. Then, *SuperAves*[1] was born.

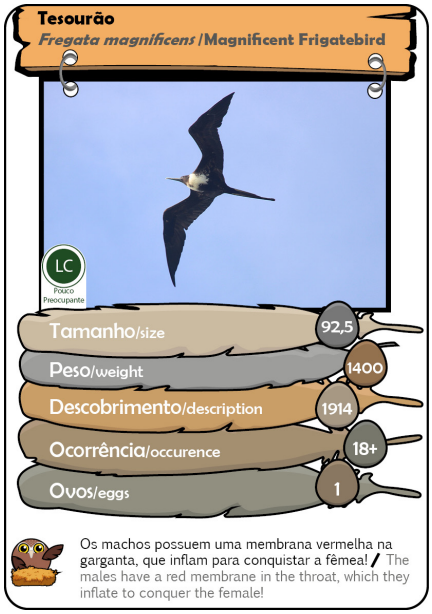
In the game, each card represents a species, containing its popular name, scientific name, and some features of the bird species it represents, such as: weight, size, year of description ("discovery"), number of eggs it usually lays, its geographic distribution in Brazil, and a bit of trivia. The cards are bilingual: in Portuguese and English.

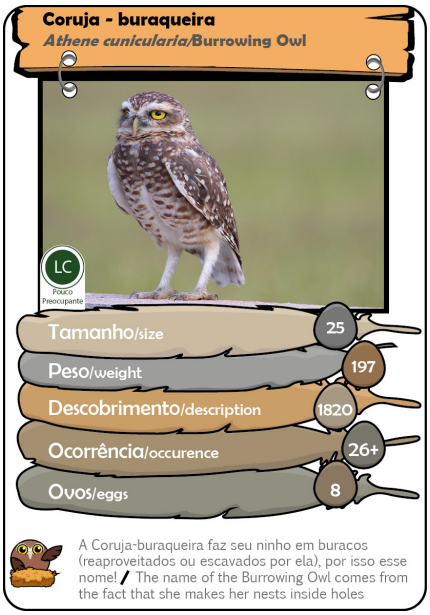
The game starts with all the cards in a pile, and each round all players take one card and keep it to themselves. In each turn, a new player chooses one of the characteristics of the card that he believes to be superior to the card of other players. Whoever has the highest value for that trait wins the round and obtains the other players' cards. In the next round, new cards are taken from the pile, and that's how it goes until the end of the game, where the player who accumulated the most cards is the winner.

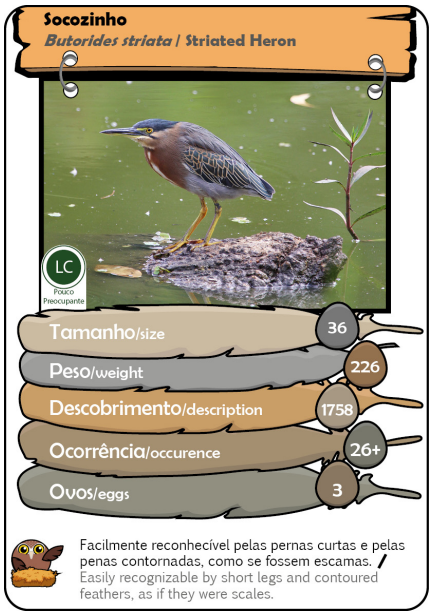


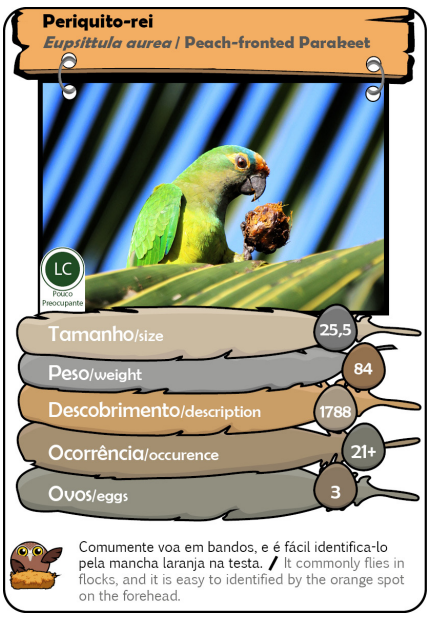
[1] "Aves" is not only a general term for "birds" in Portuguese, but also the scientific Latin name of the group: Class Aves contains all avian dinosaurs.

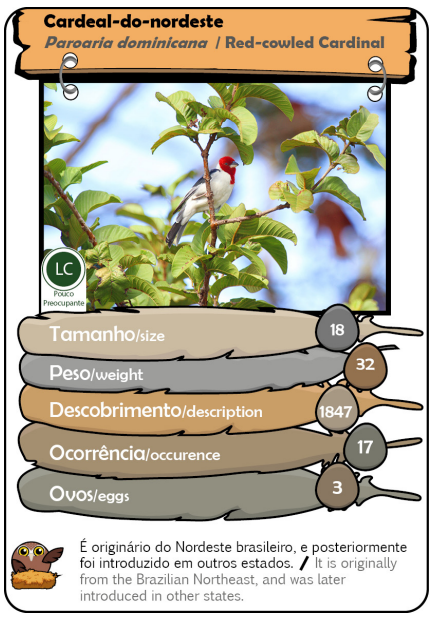

Pica-pau-de-cabeça-amarela
Celeus flavescens / Blond-crested Woodpecker
LC
Pouco Preocupante
Tamanho/size 29
Peso/weight 137,5
Descobrimento/description 1788
Ocorrência/occurence 10+
Ovos/eggs 3
Este pica-pau pode construir seus ninhos em cavidades de formiguiros! / This woodpecker can build their nests in ant pits!


Tesourão
Fregata magnificens /Magnificent Frigatebird
LC
Pouco Preocupante
Tamanho/size 92,5
Peso/weight 1400
Descobrimento/description 1914
Ocorrência/occurence 18+
Ovos/eggs 1
Os machos possuem uma membrana vermelha na garganta, que inflam para conquistar a fêmea! / The males have a red membrane in the throat, which they inflate to conquer the female!

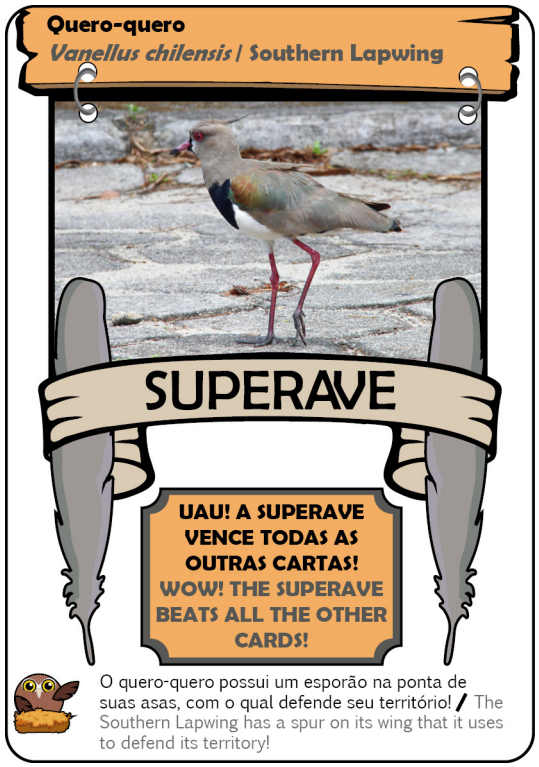

Coruja - buraqueira
Athene cunicularia/Burrowing Owl
LC
Pouco Preocupante
Tamanho/size 25
Peso/weight 197
Descobrimento/description 1820
Ocorrência/occurence 26+
Ovos/eggs 8
A Coruja-buraqueira faz seu ninho em buracos (reaproveitados ou escavados por ela), por isso esse nome! / The name of the Burrowing Owl comes from the fact that she makes her nests inside holes


Socozinho
Butorides striata / Striated Heron
LC
Pouco Preocupante
Tamanho/size 36
Peso/weight 226
Descobrimento/description 1758
Ocorrência/occurence 26+
Ovos/eggs 3
Facilmente reconhecível pelas pernas curtas e pelas penas contornadas, como se fossem escamas. / Easily recognizable by short legs and contoured feathers, as if they were scales.


Periquito-rei
Eupsittula aurea / Peach-fronted Parakeet
LC
Pouco Preocupante
Tamanho/size 25,5
Peso/weight 84
Descobrimento/description 1788
Ocorrência/occurence 21+
Ovos/eggs 3
Comumente voa em bandos, e é fácil identifica-lo pela mancha laranja na testa. / It commonly flies in flocks, and it is easy to identified by the orange spot on the forehead.


Cardeal-do-nordeste
Paroaria dominicana / Red-cowled Cardinal
LC
Pouco Preocupante
Tamanho/size 18
Peso/weight 32
Descobrimento/description 1847
Ocorrência/occurence 17
Ovos/eggs 3
É originário do Nordeste brasileiro, e posteriormente foi introduzido em outros estados. / It is originally from the Brazilian Northeast, and was later introduced in other states.

In addition to the common bird cards, there are two instructional cards (one of rules and one explaining what each bit of information on the cards represents) and one special card that beat the others, called SUPERAVE. Naturally, it is important that, as an educational tool, the teacher or mediator who applies the game clearly explains that one bird isn't better than another



In the Biology events where I presented the game, everyone asked how much it costs! – which makes me very happy, since it means that people liked it so much, they are willing to pay! At the moment, as the initial production demands a certain investment, I only produced a pilot deck, but I am looking for a partnership with the regional public power (so that the game could be distributed in public schools), and with the private sector too (like zoos , aquariums, etc.), proposing customized versions of the game for each of these locations, while I continue to improve the layout of the game.

We hope this game will increase students' interest in science and biology, facilitate learning about biological diversity, zoology and even ecology, and bring back some interest in the natural world from the lay public, which seems to have decreased over time. The game can be easily played (and collected) by children from 10 years old, or when they become able to read well, as well as by teenagers and adults, students or not. The important thing is to want to have fun and to get to know a little more about nature (in this case, birds).

About the author

Luis F. Gonzaga is a recently graduated Brazilian biologist who enjoys birds, teaches, photographs, organizes events, pies, and more recently, science outreach events. He believes in the power of partnerships to get further and better!

Dr. **Viviana B. Corte** is a professor in the Biological Sciences Department at UFES and supervised the *SuperAves* project.

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The author L.F. Gonzaga presenting his work during the IV Colloquium of Cultural Zoology. Photo by Vinícius M. E. Santiago.