Journal of Geek Studies

Vol. 11(2): 2024.

ISSN 2359-3024

Journal of Geek Studies

The Journal of Geek Studies is a non-peer-reviewed, open-access, non-profit, online biannual publication devoted to the popularization of science.

Journal of Geek Studies
http://jgeekstudies.wordpress.com/
http://jgeekstudies.org /

ISSN: 2359-3024 (online).
Vol. 1 (2014) – present.
São Paulo, SP, Brazil.

1. Science; 2. Technology; 3. Geek Culture.

Information for authors can be found at http://jgeekstudies.org/guidelines/

Cover art: Promotial art of *Senua's Saga: Hellblade II* (Ninja Theory, 2024), available from the game's Press Kit.

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What's the deal with the blue "robins" in gacha games?

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It seems *Honkai: Star Rail* (miHoYo/HoYoverse, 2013) is set to keep baffling me with its choices of birds. Last year there were the tree sparrows (*Passer montanus*, which are great birds by the way), in Sushang's splash art. So, I wrote a bit about them and then digressed about the Four Pests campaign and the Great Famine in China (Salvador, 2023).

This time it's the splash art of a new character that caught my eye (Fig. 1). Robin is a singer and her in-game lore and design contain many bird-related elements. A bit cliché for a singer, of course, but hey, it's a gacha game and by this time in its life cycle their focus is on making people spend money trying to get new (and often power-crept) characters. Anyway, she is a singer

Figure 1. Robins's splash art. Source: Honkai: Star Rail Wiki.

Cite this article as: Salvador, R.B. (2024) What's the deal with the blue "robins" in gacha games? Journal of Geek Studies 11(2): 69-73. https://doi.org/10.5281/zenodo.12637401

named Robin and her splash art features a bird. A bird that one would expect to be a robin. As you might have already figured out, if I'm writing this article that means the bird is most certainly not a robin.

Figure 2. Close-up of Fig. 1 showing Robin's non-robin bird.

WHAT IS A ROBIN?

There are several types of birds that can be called robin (Tomotani, 2014). The "original" one is the European robin, *Erithacus rubecola*, also known as robin redbreast (Fig. 3). And I say original not because it was the first species of robin to appear, but because it is what has been traditionally called robin in English. The European robin belongs to a group called Saxicolinae, which is a sub-family inside the family Muscicapidae (old-world flycatchers). Birds in the Saxicolinae sub-family as a whole can be referred to as 'chats' (Winkler et al., 2020a; Gill et al., 2024), but there are some species within this group that are called robins. Besides the European robin, one example is the Japanese robin (*Larvivora akahige*), which you might know as the Pokémon Fletchling (Tomotani, 2014). The Saxicolinae robins also includes some birds with blue plumage, like the Siberian blue robin (*Larvivora cyane*) and the Sumatran blue robin (*Myiomela sumatrana*). Notably, Saxicolinae also includes the nightingale (*Luscinia megarhynchos*), which is perhaps the bird most commonly associated with a beautiful song.

Figure 3. A European robin, *Erithacus rubecola*. Source: Wikimedia Commons (Arjan Haverkamp, 2009).

Outside the "true robins" of the Saxicolinae sub-family, there are other birds that also bear that name. These are animals that the British found when colonizing other people's lands and which reminded them of the European robin – mostly by having a red breast or by being a cute little ball of fluff. Among those, we have the American robin (*Turdus migratorius*), which is actually a true thrush (genus *Turdus*), and the many Australasian robins (family Petroicidae). The latter include absurdly adorable species such as the pink robin (*Petroica rodinogaster*) from southeastern Australia.

ROBIN'S "ROBIN"

Robin's bird in Star Rail is a bluebird, which is not a robin but a thrush. Bluebirds belong to the genus *Sialia* in the thrush family Turdidae (same as the American robin). There are three species of them (Winkler et

al., 2020b): the western bluebird (*Sialia mexicana*), the eastern bluebird (*Sialia sialis*), and the mountain bluebird (*Sialia currucoides*).

The western bluebird lives in western USA and Mexico, while the eastern bluebird lives in areas stretching from central/eastern Canada to Nicaragua. They are rather similar in appearance, but the males of the western bluebird have a blue throat, while male eastern bluebirds have an orange-coloured throat (Cornell Lab of Ornithology, 2024). Females of both species have a less colourful plumage. Robin's bird is thus, a male western bluebird (Fig. 4).

Figure 4. A male western bluebird, *Sialia mexicana*. Source: Wikimedia Commons, cropped (Gregory "Slobirdr" Smith, 2007).

Now why, with so many options available, they chose a bluebird for Robin instead of an actual robin? Was it the blue colour? Perhaps, but there are options of real robins that are blue as I mentioned above. In fact, the red-flanked bluetail, a.k.a. the orange-flanked bush-robin (*Tarsiger cyanurus*) from Asia, looks rather similar to bluebirds (Fig. 5) and belongs to the Saxicolinae. Thus, the choice was perhaps not entirely related to design.

Figure 5. A male red-flanked bluetail, *Tarsiger cyanurus*. Source: Wikimedia Commons, cropped (Imran Shah, 2019).

What about geography then? In *Star Rail*, Penacony is clearly based in the United States' Roaring Twenties, so the artist possibly wanted a North American species instead of a Eurasian one. But then again, why not go for the safest choice, the American robin? Perhaps then design choices came into play, including the colour palette and the fact that the bluebird is somewhat cuter than the American Robin. Either way, the end result is that Robin's robin is not an actual robin.

WHAT ABOUT THE OTHER ROBIN?

I must talk about another gacha game and the only one I play rather religiously. In *Fate/Grand Order* (Delightworks/Lasengle, 2015) – or FGO for short – Robin Hood has a bird called Robin (Figs. 6, 7). This particular bird is originally from *Witch on the Holy Night* (or *Mahoutsukai no Yoru*; TYPE-MOON, 2012), and now it can also be seen in FGO together with the recently-released character Kuonji Alice, its original owner.

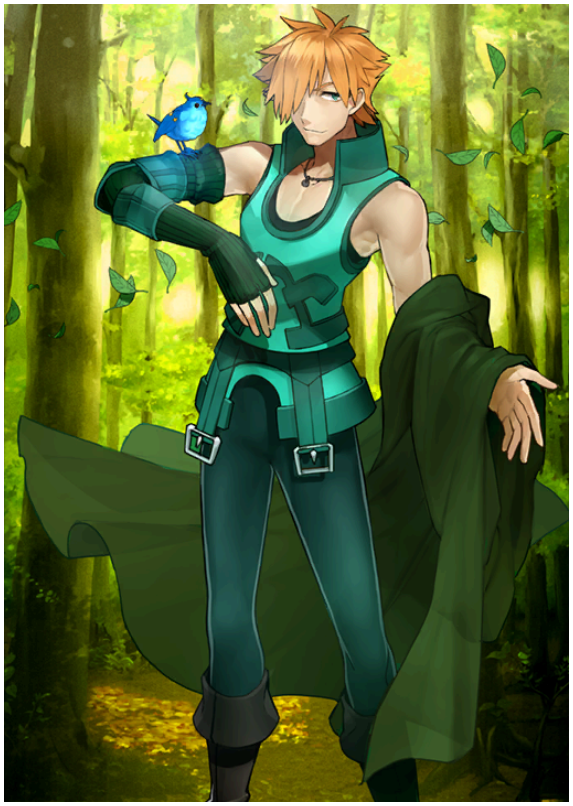

Figure 6. Robin Hood, 3rd ascension (illustrated by Wada Arco). Source: Fate/Grand Order Wiki.

Figure 7. Robin. Source: TYPE-MOON Wiki.

Considering the English background lore, we could legitimately expect the bird to be a European robin. Instead, we got a bluebird again. This Robin's plumage colour pattern is very reminiscent of male mountain bluebirds (Fig. 8), which can be found in central and western North America, ranging from Alaska to Mexico. But contrary to *Star Rail*'s bird above, this Robin is not an exact match to the bluebird, as some artistic liberties were taken. But yet again, the end result is that Robin's robin is also not an actual robin.

Figure 8. A male mountain bluebird, *Sialia currucoides*. Source: Wikimedia Commons, cropped (Great Sand Dunes National Park and Preserve, 2016).

CONCLUSION

So, what's the deal with all the (two) blue robins in gacha games? It might be an actual context+design choice in *Star Rail*, but I don't think *Witch on the Holy Night* and FGO really have an excuse here – it could be simple lack of information on birds by the artists and/or developers. After all, most people are rather unfamiliar with bird species, even the ones in their own backyards, to the extent that they actually don't even take notice of the birds around them every day. And there are plenty of birds around us, even in our concrete jungles.

So, when next walking across a park – or even smack dab in the middle of town – try to pay attention to the birds. Keep your eyes (and ears) peeled and you'll be surprised at the variety of birds you'll find. From the conspicuous doves/pigeons, gulls and crows to the smaller (and often shier) songbirds. You can find sparrows and swallows nesting on buildings and all sort of human-

made structures (traffic lights, cameras, you name it), thrushes rummaging through freshly-cut grass looking for insects and earthworms, and parents of various species gathering food on their beaks to bring back to their nestlings. Watch them for a little while, what they are doing, how they behave. I don't expect you to become an avid birdwatcher, but I do hope this exercise will give you a bit of extra appreciation towards the other species that share the planet with us.

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About the author

Dr. Rodrigo B. Salvador is curator at Luomus, the Finnish Museum of Natural History. He is a biologist specialized in the study of snails but is often involved in bird research too. He spends perhaps too much time on gacha games, but managed to remain F2P so far – alright, alright, except for a few lucky bags in FGO, but that's it!

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Understanding Senua's psychosis in *Hellblade*

Interview with Paul Fletcher

In 2017, *Hellblade: Senua's Sacrifice*, by Ninja Theory, was released for PC and PlayStation 4, later making its way to Xbox One, Nintendo Switch and Xbox Series X/S. The game was remarkable for dealing masterfully with a difficult topic, psychosis. It was made by a relatively small team that counted with advice from specialists in mental health and by people living with the condition to properly represent it. The game received wide acclaim for its portrayal of psychosis, the acting of Melina Juergens (who plays Senua), and also technical aspects (notably, the voices or "Furies").

This year saw the release of the sequel *Senua's Saga: Hellblade II* for PC and Xbox Series X/S. This new game continues Senua's story and her struggle with psychosis and, once again, the team at Ninja Theory (now part of Xbox Game Studios) relied on a group of experts offering advice and their experiences.

Among the experts was Dr. Paul Fletcher, a Professor of Health Neuroscience at the Department of Psychiatry, University of Cambridge, UK. Dr. Fletcher was part of the team in the development of both games and kindly agreed to an interview. So, we took the opportunity to learn more about his participation in game development, the medical understanding of psychosis and its in-game depiction, and much more.

Cite this article as: Journal of Geek Studies. (2024) Understanding Senua's psychosis in Hellblade. Journal of Geek Studies 11(2): 75-79. https://doi.org/10.5281/zenodo.12637459

So please read ahead. But do keep in mind that, while we do not have any major spoilers here, this interview is best enjoyed after playing at least the first game.

Before we start talking about games, would you kindly give our readers some background on your academic and clinical work?

I trained in medicine and then specialised in psychiatry, practising as a full-time clinician in north London before becoming involved in research. My current role is a mixture of clinical and research work and I also do some teaching. My main interest has always been in trying to understand the brain processes that are necessary to perceiving and making sense of reality and, in particular, how alterations in those processes might lead to psychosis.

As a university professor, it must have been rather surprising to be contacted by a video game company – and to act as an advisor in a very complex matter on top of that. How did that happen exactly?

Yes – it happened almost exactly a decade ago (2014) when the Ninja Theory team were just beginning to develop what would become Hellblade: Senua's Sacrifice. They wanted to begin by understanding more about it and came across my name as someone in the vicinity who does clinical work and research in the condition. So, they just sent me a short email asking if we could talk a bit and I came along to their studio. I was impressed straightaway by what they were trying to do and the care that they wanted to put into it. So, it grew and developed out of that.

What kind of advice and information were you providing during game development?

To begin with, we organised a few meetings in which I talked about the basic neuroscience of psychosis, what the symptoms are and so forth. That led on to more in-depth discussions about how, for all of us, with or without psychosis, the experience of reality is constructed from within. It's not just through the evidence of our sense that we comprehend the world around us. We also use our past knowledge to shape reality to our expectations. Recognising this – and the processes by which the brain constructs our model of reality – we can begin to get closer to understanding what happens when people experience an unshared reality, which is what psychosis is.

The term used to refer to Senua's experience in the game materials is 'psychosis', but that term encompasses lots of different things. Would you be able to give us a quick primer on what is psychosis and what are its most common causes and symptoms?

In some ways, psychosis is a loose descriptive term. It basically refers to the experience of an unshared reality – one that other people don't concur with and may not understand because it can seem so bizarre and lacking in evidence. Importantly, it's not just some vague or faint imaginary experience but it can feel absolutely real and unquestionable. Doctors typically think of psychosis as having two main components: *hallucinations*, which are altered perceptions (perceiving, hearing seeing, touching, tasting, smelling) things when there is no external cause, and *delusions*, which are unusual beliefs, sometimes bizarre and frightening, which seem to arise without good evidence and which can be very much out of keeping with what the person would normally believe. So, for example, a hallucination might consist of one or more voices talking to the person and a delusion might be the belief that they are being hunted or persecuted by neighbours.

It's a description, not a diagnosis, and it can have many different causes. Typically, people think of it occurring in the context of a serious mental illness like schizophrenia. But it can also be found in neurological and physical illnesses. Isolated symptoms of psychosis (like hallucinations) are thought

to occur, in relatively mild forms, in healthy people under certain conditions (stress, trauma, sleep deprivation, sensory deprivation) and, of course, it can occur due to drugs.

Besides yourself, there were also further advisors who brought in their personal experiences with psychosis. So, there was an interplay of both science and lived experience informing game development, plus all the narrative and gameplay aspects, and actors. How was your experience in working with that group?

From a very early stage, the Ninja Theory team wanted to involve people with experience of psychosis, and this has been a commitment that they have honoured throughout the past 10 years. We ended up having fascinating meetings in which personal experience, neuroscience, clinical experience and art, acting and gameplay were all brought together. These meetings would lead to design and creation by the Ninja Theory team, which would then be shown and discussed at subsequent meetings. The whole process was iterative, and the lead designers made sure that everyone had a voice that was listened to.

It is clear that everyone involved put in a lot of effort and attention in the games and treated the topic with care and respect. So, how good a representation of psychosis does *Hellblade* offer?

From my perspective, the games have deeply embedded certain principles of understanding how we make sense of the world and construct our own realities into the story, gameplay, and audiovisual design. They have also done some truly remarkable things in representing individual symptoms (like auditory and visual hallucinations), to the extent that I have found them enormously helpful in communicating my work to students and the public. More than that, and viewing the games as a whole, they have created a deeply empathic representation of what it might be like to live in an uncertain, unreliable, frightening and confusing world and to have to battle through it, which is what the individual with psychosis may have to do every day. More importantly, the people who contributed their own experiences of psychosis to the game have been explicit that the game really does convey the experiences in a way that is compelling, honest, and respectful. That means a huge amount and it's been incredible to see this view echoed by those who weren't involved in game design but have their own experiences of mental illness and distress, in themselves or in loved ones.

In *Senua's Saga*, it feels like Senua is on another "stage" of dealing with her psychosis in comparison to the first game. Is that something real, in the sense that is based on real-world data?

Yes. One of the earliest principles of the story was that there would be no "miracle" recovery but, at the same time, Senua would come to terms with her experiences and learn to live with them and manage them, just as people may have to do in real life. As the story moves into *Senua's Saga*, there has been a change in her outlook. She still has the voices ("the Furies") with her and she is still experiencing a reality that differs from the ones experienced by those around her. But she has more agency. She isn't deeply enveloped by the Darkness that she was forced to battle through in *Senua's Sacrifice*. She can recognise and integrate with the realities of others around her. This is a known experience in the evolving experience of psychosis. People may come to inhabit a dual reality and to have to somehow balance what they experience with the idea that others may reject that reality and may have very different perspectives on the world. This can be uncomfortable and difficult, and I think that *Senua's Saga* has done some very interesting things to represent that and explore it. For example, at a simple level, sometimes Senua's voices will challenge or argue with the voices of the people around her, urging her to distrust them. This is a very real experience in psychosis and can be very hard to deal with.

The two *Hellblade* games reached a wide audience and brought people in contact with several aspects of psychosis. Do you think Senua's story might help the public to understand better what psychosis entails and perhaps remove the stigma and prejudice from it?

That has been our hope throughout. It's important to know that the initial aspiration of the game, as I understood it, was not to serve as some documentary or "edutainment". Rather it evolved to represent an unusual and frightening experience as truthfully and respectfully as the medium and the art could allow. I think that, in telling a story with these principles in mind, Ninja Theory have created an experience that offers a powerful urge towards empathy for people in the throes of psychosis. By treating Senua as a complex, frightened and confused, but ultimately heroic character, they've created a perspective on psychosis that resonates with my clinical experience of the courage, grace and dignity of people dealing with this condition. Telling stories in this way and with this level of care seem to me crucial in fostering empathy and ultimately challenging stigmatising attitudes.

Has people dealing with psychosis contacted you because of the *Hellblade* games? And if so, do you know if the games have helped them to understand themselves better?

Yes – people have contacted me and, in much greater numbers, have directly contacted the studio. I have been really touched by how positive they have been about the validating effect the game may have on their views of themselves and their experiences. People have spoken of having experienced a sense of shame and of trying to keep things secret and have found that the game challenges that by recognising and representing their struggle. One of the very consistent messages is that, by creating this representation, and representing inner experiences and struggles in a way that can be seen, heard and shared, they have experienced a sense of relief in being able to show it to others and say, "this is what it can be like for me".

Now going the other way around, what do you think about using video games as part of the treatment of mental health issues?

I think there is a huge, and as yet largely untapped, potential in what video games can bring to clinical sciences. We could use games to replace the standard (and boring) psychological tasks that measure cognitive function, we could develop much more sophisticated and precise measures of how people approach problems and challenges in different ways. Ultimately, gameplay has a big learning component and I envisage that games can provide a setting in which psychotherapeutic tools could be offered in ways that are creative and effective. Indeed, I have been working with Ninja Theory to look at ways in which gameplay could help people to learning to regulate their responses to stress and this is an exciting possible avenue.

Besides raising awareness, do you think *Hellblade* is a good tool in teaching? Do you use it in your classes?

In the past, my lectures tended to be restricted to describing psychosis and giving examples of first-person written accounts. Over the last decade, my teaching has much improved by incorporating segments from *Hellblade* to convey much more vividly what the auditory and visual experiences might be like. It has been extraordinarily useful to me in my classes.

Do you have any final words for the gamers out there who want to learn more about the topic?

With the release of *Senua's Saga*, Ninja Theory created a 20-minute video documentary talking about psychosis. It includes the voices of people who have experienced psychosis as well as of the artists and writers who worked so hard to incorporate these experiences into the game. I would strongly recommend it. In it, I talk about the neuroscience of psychosis and of how we construct our reality all the time – you can always fast forward through those bits but make sure you listen to the artists and those with experience of psychosis as that is really powerful and interesting.

About the interviewee

Dr. Paul C. Fletcher lives in Cambridge and spends his spare time reading novels and poetry, playing video games, and long distance running with a ridiculously fit Springer spaniel called Idris and an even fitter wife called Nicky – both of them can run further and faster than he can. He used to play a lot of football (the British kind) but is getting too old now, so he watches it and pretends that he used to be better at it than he actually was. He's played both *Hellblade: Senua's Sacrifice* and *Senua's Saga: Hellblade II* and finds them immensely powerful and emotional experiences. He feels incredibly fortunate to have been a tiny part of a team that is so incredibly talented, motivated and inspired.

Image usage

The images used in this article are from the Press Kit of *Senua's Saga: Hellblade II* (Ninja Theory, 2024) or screen captures taken from the game.

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The birds of *Fate/Grand Order*

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As biologists, birdwatchers, and gamers, it is a common practice for us to take note of all birds that we see and hear in the games we play. Sometimes we even write about those birds, like we did for *Overwatch* and *Honkai: Star Rail* (Tomotani & Salvador, 2016; Salvador, 2023, 2024). Thus, it's past time we write something about the birds in *Fate/Grand Order*.

Fate/Grand Order (2014–present; henceforth FGO) is a mobile gacha game by Delightworks and now, Lasengle, belonging to the larger *Fate* franchise. Put simply, in the game you summon heroic spirits known as 'Servants' to help you fight and save the world. Servants are typically taken from the real world, and they can be historical people (like Florence Nightingale and Charlemagne), legendary/mythological beings (like King Arthur and Heracles), or literary characters (like Moriarty and Astolfo). A few Servants are summoned together with bird familiars/pets, are bird-themed, or just include birds in their artwork. Those are the Servants we are going to take a closer look at – or rather, we will take a look at their birds.

PARROTS

Kama, in her summer Avenger incarnation, is accompanied by rose-ringed parakeets (*Psittacula krameri*), also known as ring-necked parakeets or ringneck parrots. It is a popular species to have as a pet and Kama seems to have a whole flock of them (Fig. 1). Besides, and perhaps more importantly, the Hindu god Kamadeva rides a parrot or a parrot-powered chariot (though no one ever bothered to say which species of parrot that is and depictions vary).

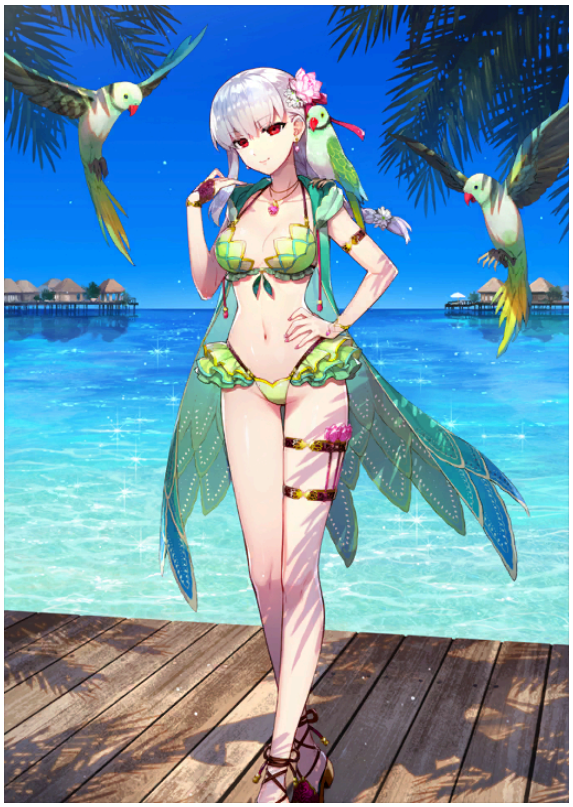

Figure 1. Stage 2 ascension artwork of Kama (Avenger) (illustrated by ReDrop). Source: Fate/Grand Order Wiki.

Cite this article as: Salvador, R.B. & Tomotani, B.M. (2024) The Birds of Fate/Grand Order. Journal of Geek Studies 11(2): 81-95. https://doi.org/10.5281/zenodo.13238979

The rose-ringed parakeet is an interesting species, as its geographical distribution is split in two isolated areas: there are two subspecies in Africa and another two subspecies in the Indian subcontinent (Russello et al., 2021). The two Asian subspecies even have common names of their own; there is the Indian rose-ringed parakeet (*Psittacula krameri manillensis*) from southern India and the boreal rose-ringed parakeet (*Psittacula krameri borealis*) from northern India and neighbouring countries (Fig. 2).

Figure 2. A male boreal rose-ringed parakeet. Source: Wikimedia Commons (Charles J. Sharp, 2019).

The Asian subspecies have been introduced to several other countries worldwide, including many European nations, the USA, Australia, New Zealand, and Japan (Jackson, 2021), leading to parrot sightings in otherwise parrotless lands (Mandelbaum, 2023).

These birds were (and still are) targeted by the pet trade and many were released or escaped, and populations of these parakeets eventually managed to establish themselves in foreign lands (Cassey et al., 2004; Jackson, 2021). Genetic studies have shown that the parakeets in Europe originate mostly from northern India and Pakistan (Jackson et al., 2015; Russello et al., 2021). That led scientists to hypothesize that birds from the northern Indian populations were more tolerant to colder climates, which helped them to settle down in Europe. In Japan, the populations of parakeets are presently small in comparison to other countries. Still, it is predicted that these birds will increase their range in the countries where they have been introduced to thanks to climate change (Strubbe & Matthysen, 2009) – winters are becoming shorter, with fewer frost days, and overall temperatures are increasing, making the foreign environments more welcoming to the parakeets.

Only adult male rose-ringed parakeets have the dark ring around their necks, so all of Kama's birds are males. The females (and juvenile males) lack the ring or have a very faint shadow-like one. But in captivity, they have been bred to display a variety of colour mutations: there are yellow, white, grey, and blue birds. But a word of caution is needed here. While rose-ringed parakeets have been successfully bred in captivity and are popular pets, the pet trade and poaching of wild birds are leading many other parrot species worldwide towards extinction (Olah et al., 2016; Martin, 2018).

Parakeets and parrots belong to the order Psittaciformes, alongside the macaws and a few fun oddities like the cockatoos, kea, and kākāpō. Thus, there are other psittaciform birds in FGO. Blackbeard, in his summer attire, is shown with three macaws (Fig. 3), following the pop-culture trope that pirates must have a parrot. Not that we're complaining, Blackbeard and his macaws are great! Besides, the link between pirates and parrots is apparently grounded in reality, as these animals were good pets to have on board a ship and could also be traded for a fair sum (Nosowitz, 2015).

Figure 3. Blackbeard in his summer attire (illustrated by B-suke). Source: Fate/Grand Order Wiki.

Macaws are a type of parrot; there some six genera inside the parrot family (Psittacidae) that are commonly referred to as macaws (Fig. 4). All macaws are neotropical birds, which means they inhabit the tropical areas of the Americas. That is, of course, in line with Blackbeard's uh… workplace.

Figure 4. A scarlet macaw (*Ara macao*), photographed at Wilhelma, Stuttgart. Photo by BMT (2016).

The design of Blackbeard's macaws is simplified and generalized in some parts (e.g., fewer colours), and exaggerated in others (e.g., crests and ahoge). No known species of macaws is a perfect match to Blackbeard's birds. Thus, the artist likely based the illustrations on more than one species; also, colour mutations and hybrids bred in captivity were likely used as references. For instance, the orange and blue bird on Blackbeard's left shoulder looks like a 'Maui Sunrise Macaw', which is a hybrid of two other hybrids!

Figure 5. Final ascension artwork of Beni-Enma (illustrated by Harada Takehito). Source: Fate/Grand Order Wiki.

SPARROWS

Tree sparrows (*Passer montanus*) are common birds in Japan, where they are known as *suzume* (スズメ). They are common in the sense that you can see the actual birds everywhere in cities and villages, and they are also commonly represented in artwork and in everyday items. They are rea-

sonably beloved birds deeply ingrained in Japanese culture and, from their many appearances in literature and folklore, perhaps the best example is the fable *The Tongue-Cut Sparrow* (舌切り雀, *Shita-kiri Suzume*). In FGO, Beni-Enma (Fig. 5) is based on the titular sparrow of that fable. We will not spoil the fable's story here, so look it up if you have some time. We promise that Beni-Enma's abilities and backstory will make a bit more sense after you read it.

Beni-Enma is always accompanied by regular tree sparrows and by her fluffy giant sparrow attendants (Fig. 6). They are the most adorable critters in FGO – sorry, Fou & Steggy, but we think at least Marie and Nagiko would agree with us (Fig. 7). As a matter of fact, in *The Pillow Book* (枕草子, *Makura no Sōshi*), Sei Shōnagon includes "sparrows feeding their young" under "Things that make one's heart beat faster". Accordingly, tree sparrows can be seen in the artwork of Sei Shounagon's final ascension in FGO.

Figure 6. Beni-Enma's sparrow attendants shown in the Christmas-themed "Enma-tei's Appren-chirps" Command Code (illustrated by logA). Source: Fate/Grand Order Wiki.

Figure 7. Top: The moment Marie Antoinette sees a sparrow attendant for the first time. Bottom: Nagiko (Sei Shounagon) making a comment about sparrow chicks in line with *The Pillow Book*. Source: screen capture from the game.

Tree sparrows can be recognized from other species of sparrows by the black markings on their "cheeks" (Fig. 8). Males and females look the same, contrary to what is observed in other sparrow species, in which females have an attenuated brown plumage (Clement et al., 1993). Tree sparrows feed on seeds and grain throughout the year, but also capture small invertebrates, mostly insects, when they have chicks to feed (Summers-Smith, 1995, 2016). They build their nests in cavities in trees and rocks, but also in buildings and traffic lights, making full use of the urban environment. When establishing their nests, they might choose to do so in close proximity to other sparrows, forming a loose type of colony (Hegyi & Sasvári, 1994; Summers-Smith, 1995).

Researchers consider that the tree sparrow originated in Asia – potentially in China – around 5 million years ago (Summers-Smith, 1995; Päckert et al., 2021). Today, it is a widespread species, being present all over Eurasia and even on some of the Atlantic and Pacific Islands (Summers-Smith, 1988, 1995, 2016). The species has also been introduced to countries like Australia, the Philippines, and the USA. In their home range in Asia, the tree sparrow is an urban species, while its "cousin" the

house sparrow (*Passer domesticus*) sticks to more natural areas. In Europe, however, it is the other way around: tree sparrows are a rural species, preferring more natural habitats, while house sparrows are urbanites.

Figure 8. A tree sparrow photographed in Osaka, Japan. Tree sparrows, like most other passerines, has the potential to be classified as birbs, borbs, and floofs (see Elbein, 2019, 2020 for a serious scientific definition of those terms). Source: Wikimedia Commons (Laitche, 2015), image cropped.

Both tree and house sparrows evolved alongside our own species as our commensals (Summers-Smith, 1988, 1995). They have adapted to live in our settlements, villages, and now cities. This topic has been studied in greater depth in house sparrows; their thicker skulls and a greater capacity to digest starch are both features linked to a diet based on grains that humans cultivate (Ravinet et al., 2018).

We have another article about sparrows (Salvador, 2023) using the birds in *Honkai: Star Rail* as a basis for discussion of this animal's biology and the ecological disaster that took place in China in the 20th century. So, please feel free to take a look at it if you're interested.

JAPANESE CRANE

Apart from Benni-Enma, there is another Servant based on a bird-themed fable, Miss Crane (Fig. 9). She is the crane from the fable *Crane's Return of a Favour* (鶴の恩返し, *Tsuru no ongaeshi*). As its title implies, the tale is about a crane who returns a favour and we won't spoil the story for you; so, as we mentioned for *The Tongue-cut Sparrow* above, do look it up.

Figure 9. Stage 3 ascension artwork of Miss Crane (illustrated by Shaka P). Source: Fate/Grand Order Wiki.

Figure 10. Japanese cranes in Hokkaidō, Japan. Source: Wikimedia Commons (Alastair Rae, 2011).

Miss Crane's colour palette and aspects of her design are, expectedly, based on the titular bird, the Japanese crane or red-

crowned crane (*Grus japonensis*) (Fig. 10). It is called *tanchō* (タンチョウ) in Japanese (or, more strictly, タンチョウヅル, *tanchōzuru*).

The Japanese crane is a large bird (about 1.5m in standing height and 2.2–2.5 m of wingspan) that can lead long lives of 30–40 years in the wild, with some captive birds growing to be 75 years old (Archibald & Meine, 1996). They form long-lasting breeding pairs and are thought to mate for life (Masatoni & Kitagawa, 1975; Takeda et al., 2018). Their courtship duets are famous from nature documentaries, even attracting birdwatchers and "normal tourists" alike to places like Hokkaidō.

CROWS

Kiichi Hogen is a Servant based on a legendary Japanese monk who is often considered to be a tengu. Thus, their design in FGO obviously brings in some tengu themes, particularly the crows. In the game, Kiichi Hogen is accompanied by crows in their artwork and battle animations, but the birds undeniably look their best in Riyo's April Fool's illustration (Fig. 11).

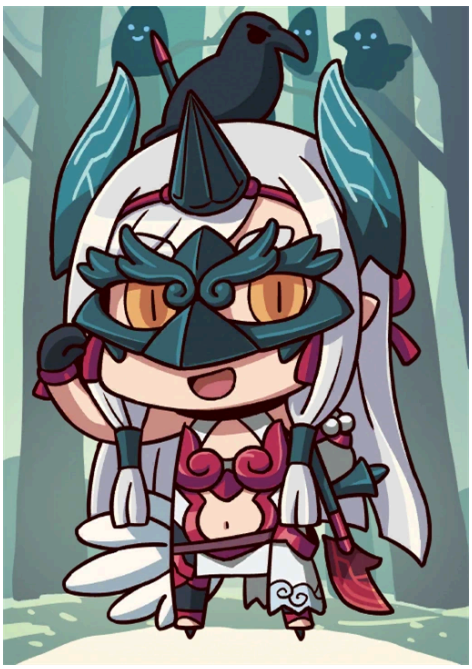

Figure 11. April Fool's artwork of a nice crow perched on Kiichi Hogen's head (illustrated by Riyo). Source: Fate/Grand Order Wiki.

In Japanese, the word *karasu* (カラス) can refer to either the large-billed crow (*Corvus macrorhynchos*), sometimes also called jungle crow, or the carrion crow (*Corvus corone*). Nevertheless, considering the thickness and curvature of the beak, the species in FGO is in all likelihood the large-billed crow (Fig. 12), a staple of the Japanese bird fauna. These crows are large animals, with a wingspan of impressive 1.1–1.3 m. They can live for around 10 years in the wild but can reach 20 years in captivity. Large-billed crows live in closer proximity to humans in Japan than anywhere else (Matsubara, 2007) and you can often hear them on the background of games, anime, and movies.

Figure 12. A large-billed crow, photographed in Aomori Prefecture, Japan. Source: Wikimedia Commons (あおもりくま [Aomorikuma], 2017).

Crows belong to the corvid family (or family Corvidae to use its Latin name), an ensemble of over 120 species that include crows, ravens, jays, and magpies, among others. Corvids in general are recognized as some of the most intelligent animals around and, alongside parrots, are considered to be cognitively superior to other birds and, in many cases, to apes (Emery, 2005). Both carrion crows and large-billed crows are good examples of this, being quick learners, having great memory and displaying behaviour of play (Matsubara, 2007). In Japan,

Figure 13. Mysterious Alter Ego Λ: ascension Stage 1 (left) has penguins, including a chick, and Stage 3 (middle) has gulls (illustrated by Wada Arco). Final ascension artwork of Nemo (right), with some fabulous gulls (illustrated by DANGERDROP). Source: Fate/Grand Order Wiki.

carrion crows display a unique behaviour in urban environments: they drop hard-shelled nuts on roads and wait for cars to run over them and break them open; when the traffic light turns red, the crows sweep in to get the nuts (Nihei, 1995).

In Western cultures, crows and other corvids are generally represented negatively, though there are a few notable exceptions, like Huginn and Muninn. In Japan, they have a more positive place in myths and folklore, including fantastic beasts based on crows such as Yatagarasu and Yogen no tori – not to mention some of the coolest Pokémon (Gómez-Martínez & García-Arroyo, 2023).

PENGUINS & GULLS

Meltryllis, in her Mysterious Alter Ego Λ form, is penguin-themed (or Leviathan-themed according to her). In her artwork, battle animations and Noble Phantasm, she is accompanied by emperor penguins, *Aptenodytes forsteri* (Fig. 13). Her birds seem a bit small for an emperor penguin though, which average around 1.08 m in standing height (Prévost, 1961). As emperor penguins already receive a lot of attention in documentaries and so on, we will not go into details about them here.

Melt is also accompanied by gulls in another ascension (Fig. 13) and Nemo is also shown alongside gulls in his artwork (Fig. 13) and in battle animations. There are over 50 species of gulls worldwide and they are notoriously difficult to identify in real life (Olsen, 2018). So, trying to pinpoint which species the artist used as reference would be unfruitful, particularly in more cartoonish renderings such as Melt's gulls. We could make some educated guesses, but any verdict we reached would be at best debatable.

Thus, we will refrain from identifying the species and simply take the opportunity to say that gulls are awesome animals despite all the bad press they get. They are curious birds and rather apt in problem solving, which has allowed them to thrive in urban environments (Lamarre & Wilson, 2021). But yes, they are watching you and your chips! A study has shown that they observe human behaviour in relation to food to inform their approach to unknown items that are a potential meal (Goumas et al., 2020). If they see humans eating something, they will more likely go for it too.

Figure 14. Stage 2 ascension artwork of Huang Feihu (illustrated by Araya). Source: Fate/Grand Order Wiki.

GREEN BIRD & BLUE BIRD

Huang Feihu is accompanied by the so-called "Golden-eyed Divine Warbler" (Fig. 14), a green songbird with golden eyes. It is a magical creature, capable of scarring the fox Daji. The bird's design in Huang Feihu's ascension art and battle animations is a rather simplified take on a bird, but the art of his Bond 10 Craft Essence gives us a better look at it (Fig. 15). Still, it is not a 100% match to any actual bird.

But we have some additional information to work with. First, it is identified as a warbler. We can interpret that as meaning an "Old World warbler", an assortment of bird species that look rather similar and were once all lumped in family Sylviidae (though we now known that they are not strictly related to one another). Secondly, it is said Huang Feihu found the bird in the northern seas, which we take is the coast of northern China and likely refers to Manchuria (which today is split between Russia and China) or perhaps to the Yellow Sea.

Figure 15. "Golden-Eyed Divine Warbler" Craft Essence (unknown illustrator). Source: Fate/Grand Order Wiki.

Now, our knowledge of kanji is very precarious, so we might be off here, but the kanji used for Huang Feihu's bird in FGO is 鶯, which tends to refer to the *uguisu* (ウグイス), that is, the Japanese bush warbler (*Horornis diphone*). It is a year-round resident in most of Japan (and one of the three most prominent songbirds in that country) and Philippines, and migratory elsewhere, spending the summers in Hokkaidō, the Korean Peninsula, Manchuria and central China, and wintering in southern China and Taiwan. That is certainly a good start. But this bird looks like a generic warbler (Fig. 16) and is only borderline green. Besides, Huang Feihu's bird has a much stouter beak than a regular warbler.

Figure 16. A Japanese bush warbler. Source: Wikimedia Commons (M. Nishimura, 2008). The song of this bird is very characteristic and well known in Japan. Because of that, it appears in several anime and games. Bird song in anime/games is a topic that deserves its own article one day.

So, what other options do we have? The kanji 鶯 seems to have been applied in Chinese poetry to the black-naped oriole (*Oriolus chinensis*) (Wikipedia, 2024), which is a yellow and black bird and certainly not a warbler. Also, it's nowhere close to Huang Feihu's bird in FGO.

But there seems to be some confusion today among the (non-birder, non-ornithologist) public in Japan, mixing up the Japanese bush warbler with the warbling white-eye (*Zosterops japonicus*) or *mejiro* (メジロ) (Wikipedia, 2024; we could not find the original source for this). This species lives in Japan, the Korean Peninsula, eastern China, Taiwan, the Philippines, and Indonesia. This could be a possibility for FGO's mystery bird, as the plumage of members of this species is a brighter shade of green (Fig. 17). Still, the Japanese white-eye has a darker and slenderer beak than Huang Feihu's bird, not to mention the white circle around its eyes that gives the species its name. The latter, though, could be the reason for the large "golden eyes" of Huang Feihu's bird.

What about other Chinese stories then? The Qingniao (青鳥) are "blue/green birds" that appear in some stories. But despite the coincidence of colour, the Qingniao are supposed to be much larger birds. In the end, we don't think we can identify Huang Feihu's bird as an actual bird species and must just accept it is a fantastical species.

Figure 17. A warbling white-eye. Source: Wikimedia Commons (su neko, 2009).

But speaking of blue birds, Robin Hood has a lovely little bird with him. We know from the visual novel *Witch on the Holy Night* (Type-Moon, 2012: original; Aniplex, 2022: enhanced ed.) that the bird is called Robin. But, contrary to expectations, it is not a robin (*Erithacus rubecula*), which is a common species in England and has a conspicuous orange breast.

Figure 18. Stage 3 ascension artwork of Robin Hood (illustrated by Wada Arco). Source: Fate/Grand Order Wiki.

Figure 19. A male mountain bluebird (females are brown with blue wings). Source: Wikimedia Commons (Great Sand Dunes National Park and Preserve, 2016), image cropped.

Instead, Robin Hood's bird in FGO is blue, with a darker shade on its head and back and a lighter shade on its breast and belly, and black legs and beak (Fig. 18). The pattern is very reminiscent of males of the mountain bluebird (*Sialia currucoides*) (Fig. 19), which is a North American species and, thus, a very weird choice for a British hero. We have already covered this robin in another article (Salvador, 2024), focusing on *Honkai: Star Rail*'s Robin and her bird (also not a robin). In that article we cover all sorts of robins, so take a look at it if you want to know more.

BIRDS OF PREY

There are a few birds of prey represented in FGO. The term "birds of prey" is not an actual biological group (like, say, penguins are); rather, it is just a convenient label used to refer to a variety of animals from different families that feed on other land vertebrates. These include the "classics" (eagles, hawks, falcons, owls, and vultures) alongside some other lesser-known animals such as condors, secretarybirds, and seriemas.

Let's start with one of our favourites, the legendary pharaoh Nitocris (see Salvador, 2020 for a full analysis of the Ancient Egyptian themes in her design). In one of her attack animations, Nitocris summons a bird that is drawn in a style that is supposed to be reminiscent of Ancient Egypt (Fig. 20). That bird is in all likelihood a falcon, considering the shape of its wings and Nitocris' (and all pharaohs') ties with the god Horus. Horus' falcon iconography is something that people today easily recognize as belonging to Ancient Egypt alongside Anubis' jackal. Horus' falcon is most likely the lanner falcon (Fig. 20), *Falco biarmicus* (Salvador, 2016).

Figure 20. Top: Nitocris' bird. Source: Fate/Grand Order Wiki. Bottom: A lanner falcon in flight. Source: Wikimedia Commons (A. Manson, 2010), image cropped.

Popess Johanna is accompanied by a lovely snowy owl (*Bubo scandiacus*) in her first ascension (Fig. 21). This owl species is native to the northern reaches of Eurasia and North America and thus someone would need to have brought it to Rome as a

Figure 21. Left: Stage 1 artwork of Johanna (illustrated by Takenashi Eri). Middle: Final ascension artwork of Dark Koyan (illustrated by Wada Arco). Right: Stage 1 artwork of Munenori (illustrated by Furumi Showichi). Source: Fate/Grand Order Wiki.

gift to the Popess. Gifting exotic animals (including birds of prey) to rulers has been a common practice throughout human history all around the world, from the time of the Egyptian pharaohs to the present-day "panda diplomacy" of China (Bedini, 2000; Buckingham et al., 2013). Snowy owls are commonly seen in media, particularly after since *Harry Potter*'s Hedwig, so we won't go into many details here.

Koyanskaya of Darkness also has an owl in her final ascension art (Fig. 21), which we believe is supposed to be the Eurasian eagle-owl (*Bubo bubo*). Considering Koyan's relation to Tunguska, we could further extrapolate that it is the subspecies known as eastern Siberian eagle-owl (*Bubo bubo yenisseensis*). Still, it looks a bit small for this species and its plumage is, in some points, also reminiscent of the Japanese scops-owl (*Otus semitorques*), a much smaller species native to the oriental reaches of Russia, the Korean Peninsula, eastern China, and Japan. So, the artist could have used (knowingly or unknowingly) more than one species an owl as reference. Either way, it's no small feat to hold a 4 kg owl the way Koyan is doing in her final ascension art (Fig. 21).

Yagyū Munenori appears alongside an eagle in his second ascension's artwork (Fig. 21). Considering it's a Japanese servant, that bird is likely the Japanese golden eagle (*Aquila chrysaetos japonica*), which is a subspecies of the golden eagle. The Japanese subspecies has a smaller body size than their continental Eurasian cousin but can still reach an impressive 2-meters wingspan (Kojima, 2022). These eagles live in densely forested mountainous areas and are considered an endangered species in Japan (Ogden et al., 2020). The good news is that there are ongoing programs dedicated to its conservation, including breeding it in zoos for release in the wild (Ogden et al., 2020; Kojima, 2022).

OTHER BIRDS IN FGO

A few other birds that pop up in FGO are also worth mentioning.

Semiramis has a black rock dove/common pigeon (*Columba livia*) in her skill animation. Some of her legends say she was fed by doves as a baby and some of her representations include doves. Since the rock dove is the most common everyday bird,

we will not talk much about their biology here. But we will take the opportunity to make a public service announcement: the "fact" that doves/pigeons transmit diseases and are a public health risk is a myth started by careless journalism of the New York Times and a stupid term coined by a random New York City parks commissioner (Jerolmack, 2008). This myth has been perpetrated to this day by lazy media outlets and even lazier school textbooks, to the point that even some fellow biologists believe it and further reproduce it. So, let's fully state it here: there is no evidence of people getting sick from casual interactions with pigeons (Soniak, 2016) and the risk is very low even for people working jobs that bring them into close contact with these animals and their nesting sites (Haag-Wackernagel & Moch, 2004). From the times of the legendary Semiramis to the beginning of the 20th century, people had a much nicer relationship with pigeons (Mosco, 2021).

Figure 22. Leucistic male blackbird. Source: New Zealand Birds Online (Duncan Watson, 2015).

Tristan, in his newest summer incarnation, is accompanied by chickens, while his Round Table fellow Percival has a white bird that pops up and sings during his skill's animation. There is no completely white songbird in Britain except for the eventual leucistic or albino individuals. Both albinism and leucism are genetic variations: albino animals show a complete (or partial) absence of the dark pigment called melanin in their feathers, scales, and irises (the latter means that the eyes are red); in leucistic animals, broadly speaking, there is only partial loss of pigmentation (with no changes to the eyes) and it can also affect pigments other than melanin. People sometimes refer to a white (leucistic) version of the blackbird (*Turdus merula*) as a "white-bird" (Fig. 22). Percy's bird does resemble the blackbird in size and overall shape, but who knows if that's just a coincidence or if a white blackbird was really the inspiration for Percival's bird.

Yamanami Keisuke appears together with a swallow (ツバメ, *tsubame*) in his final ascension (Fig. 23). Only the bird's back is shown in the illustration, but considering the long outer tail feathers it is likely the barn swallow (*Hirundo rustica*), the most widespread swallow species in the world. These swallows, more specifically the subspecies *Hirundo rustica gutturalis*, are present in Japan during spring and summer for breeding and, as in many places around the world, they are culturally associated with the arrival of spring.

Figure 23. Final ascension artwork of Yamanami Keisuke (illustrated by Kibadori Rue). Source: Fate/Grand Order Wiki.

In the 'Arctic Summer World' event, many thick-billed murres (*Uria lomvia*; also known as Brünnich's guillemot) are seen visiting the areas. This species can be found across the polar and sub-polar regions of the Northern Hemisphere and four subspecies exist; the one in the game is likely *Uria lomvia lomvia* from the North Atlantic and Arctic Oceans. The game's depiction of the animals (Fig. 24) is spot-on.

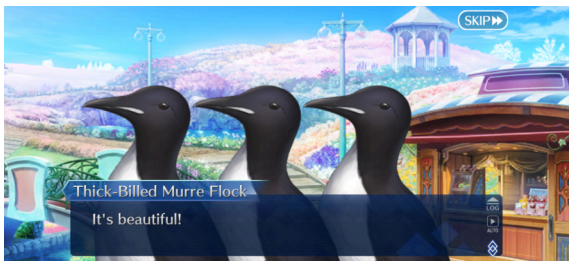

Figure 24. Thick-billed murres enjoying a stroll in Merlin's… uh, Merlin's little sister's flower garden. Source: screen capture from the game.

Finally, there are some not-quite-birds that deserve a brief mention here as well: Da Vinci has mechanical birds in all her incarnations; Astolfo has Hippogriff, which is arguably half-bird (though it "officially" belongs to Ruggiero and Bradamante); and Artoria Caster (Berserker) has a bird-like Pokémon/Pal.

If we missed some birds, do let us know. While we tried to cover content still available only in Japan, we play the global/NA version of the game, so we haven't played through the Japan-only chapters and events yet. Besides, we have never used Eric Bloodaxe, so we don't know if he has a bird or not.

CONCLUSION

Putting aside the two Servants based on actual bird stories, Benni-Enma and Miss Crane, the other Servants are divided in two groups. Some have familiars/pets based on real birds (e.g., Kama and Melt), while others have birds that show a generalized or cartoonish design (e.g., Percival and, again, Melt). It is possible that it all boils down to the artists who drew each character and if they are choosing a real species or not when drawing their birds – or perhaps sometimes using as basis a mish-mash of photos from a Google search representing more than one species. The only certain thing is that, looking at the list of Servants and birds above, it is clear that we need more birbs in FGO.

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Dr Rodrigo B. Salvador is a biologist researching land snail biodiversity, but he often gets involved in bird research too. He has suffered at the hands of the gacha gods and lost count of all the min rolls and unfortunate spooks. Still, he perseveres and hopes that more birds (and more of Charlemagne's crew) will make their way into the game.

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Euarthropod diversity in *Pokémon*: searching for the ancestral type

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Euarthropoda, including living (extant) groups like insects and arachnids, extinct groups like trilobites, and stem-group taxa (species diverging earlier on the evolutionary tree), is the most diverse animal group on the planet. Since the early Cambrian, Euarthropoda has been the most diverse and abundant group of animals ever to have lived (Giribet & Edgecombe, 2019). They have fundamentally impacted the evolution of Earth's environments and of other animal groups, and remain crucial for healthy ecosystem-functioning and to human societies. Given their importance, it is no surprise that euarthropod taxa are frequently represented in human culture. This extends to their representation in video games, and, in particular, their diversity of forms found within the *Pokémon* biosphere (The Pokémon Company, 1996–present).

Here, I present a taxonomic assessment of the euarthropod Pokémon up to the most recent generation (Gen. IX), place them in a cladistic framework based on real-world euarthropod phylogenetic analyses (that is, analyses about their evolutionary history and relationships), and reconstruct the ancestral primary type of euarthropod Pokémon. This allows for comparison to the biodiversity and morphological disparity of real-world Euarthropoda, and for demonstration of how we reconstruct ancestral characteristics using the fossil record.

METHODOLOGY

Taxonomic assignments were made to order-level based on observations of the morphological characteristics of the Pokémon using their official game models, the descriptions on Bulbapedia (https://bulbagarden.net/), and the taxonomic assignments presented in Prado & Almeida (2017). Some groups were not represented at the order-level; for trilobites (class Trilobita) and centipedes (class Chilopoda) the only representative Pokémon were not assignable to orders. Several assignments were changed from Prado & Almeida (2017), and new taxa were added from subsequent Pokémon generations. Additionally, Celebi and Pupitar were removed from the Euarthropoda – the former because only its wings suggest a euarthropod association (with wing structures being polyphyletic in animals) and it has an otherwise mythical 'fairy-like' appearance, and the latter because its pre- and post-evolutions are both reptilian, with Pupitar thus being apparently a reptilian animal irrespective of its arthropod-like exoskeleton.

The cladogram topology (that is, the diagram showing evolutionary relationships) was extracted from phylogenetic analyses of real-world euarthropods (Misof et al., 2014; Giribet & Edgecombe, 2019). Due to high levels of uncertainty around the broader evolutionary relationships of trilobites (e.g., Lieberman & Karim, 2010; Chip-

Cite this article as: Drage, H.B. (2024) Euarthropod diversity in Pokémon: searching for the ancestral type. Journal of Geek Studies 11(2): 97-102. https://doi.org/10.5281/zenodo.13242809

man, 2015; Scholtz et al., 2019), the position of Trilobita reflects just one hypothetical placement. The tree was drawn using *iTOL: Interactive Tree of Life* (Letunic & Bork, 2024), with the tree topology defined in Newick format as:

> *((((Pedunculata, Decapoda), ((((((Diptera, Lepidoptera), (Coleoptera, Neuroptera)), Hymenoptera), Hemiptera), (((Blattodea, Mantodea), Phasmatodea), Orthoptera)), Odonata)), Chilopoda), ((Araneae, Scorpiones), Xiphosura)), Trilobita), Radiodonta);*

Ancestral state reconstructions were based on the primary type of each Pokémon. An assessment of ancestral state hypotheses was made using parsimony principles (i.e., based on the least number of evolutionary changes required given the cladogram's topology).

TAXONOMIC DIVERSITY AND MORPHOLOGICAL DISPARITY

107 euarthropod taxa are currently represented in the Pokémon global biodiversity, out of a total of 1025 taxa at writing (=10% of taxa). This is highly unrepresentative of Earth's extant animal biodiversity, with an estimated ~80% being arthropodan; there are 1,214,295 (Zhang, 2011) or 1,240,007 (IUCN, 2024) described arthropod species versus 1,565,919 described animal species in total (IUCN, 2024). Additionally, most arthropod species are undescribed, with estimates of living terrestrial arthropod biodiversity suggesting around 7 million taxa total (Stork, 2017). Although a Pokédex comparable to Earth's biosphere would lead to an 'insect Poké-world' with rather less morphological disparity, and this underrepresentation likely results from the low popularity of most euarthropodan Pokémon (see Le Vaillant, 2020). Within *Pokémon*, most euarthropod taxa are hexapods (more specifically, insects; Fig. 1), which corresponds with real-world diversity studies and estimates. Liria et al. (2020) found hexapods represent 92% of global terrestrial arthropod occurrences, while Zhang (2011) noted hexapods are 84% of described arthropod taxa total.

Amongst hexapod Pokémon, Lepidoptera (butterflies, moths) are overrepresented at 27% of taxa. Coleoptera (beetles)

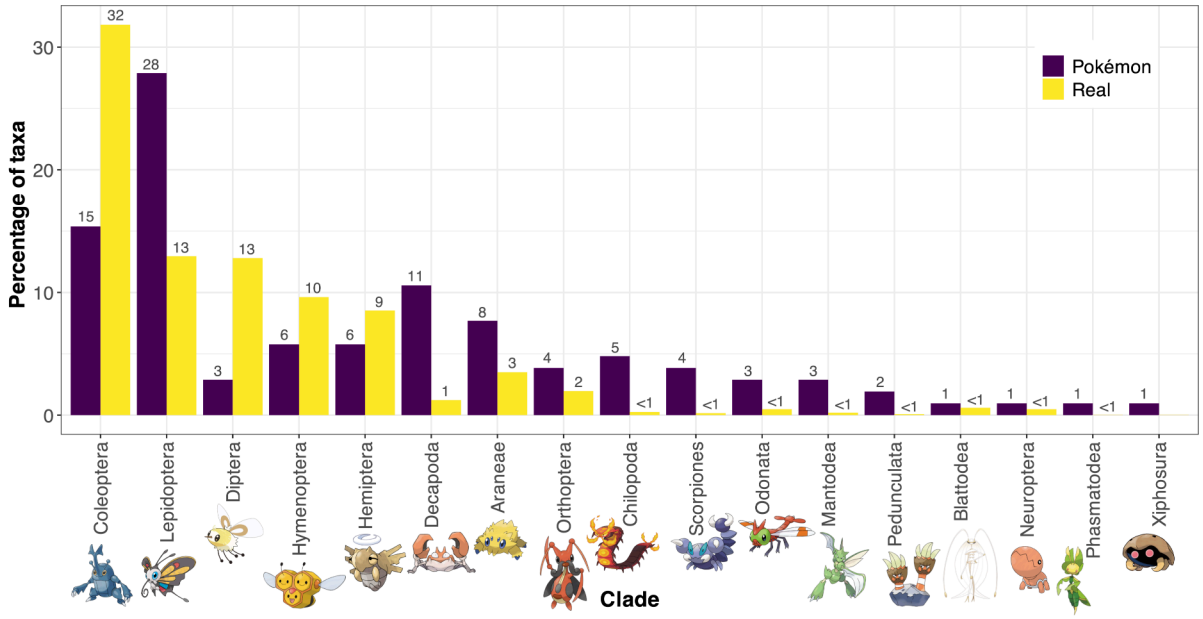

Figure 1. Comparison of the real-world (yellow) and Pokémon (purple) diversity for the different euarthropod groups represented amongst Pokémon taxa. Diversity is calculated as being the percentage of taxa the group represents out of the total of all Euarthropoda; rounded percentages are given above each bar. Images represent one Pokémon taxon for each group. The Pokémon images, extracted from Bulbapedia, are official artworks employed here under fair use.

are the second most diverse Pokémon group at 15% of taxa, with Decapoda (crabs, lobsters) third at 10% (Fig. 1). However, in terms of their real-world diversities, the numbers of lepidopteran and coleopteran Pokémon should be reversed, with Coleoptera being the most diverse real-world arthropodan group at 32% of taxa (386,500 species, Zhang, 2011) and lepidopterans at 13% (157,338, Zhang, 2011) (Fig. 1). This imbalance presumably reflects the greater appeal of butterflies and moths to beetles in the public eye. The Decapoda are also overrepresented in the Poké-world at 10% of taxa compared to ~1% of real-world species (14,898 species; Ahyong et al., 2011); this may result from the important role ascribed to decapod crustaceans in many cultures (e.g., as a food source), particularly in Japan. The other hexapod groups (Diptera, flies; Hymenoptera, bees, wasps, ants; Hemiptera, true bugs) are, like the Coleoptera, underrepresented in the Pokémon world (Fig. 1); all have >100,000 species (13%, 10%, 9% of euarthropod taxa respectively) in the real world (Zhang, 2011). In comparison, many non-hexapod groups are, like Decapoda, overrepresented amongst Pokémon; Araneae (spiders) are 8% of Pokémon euarthropods (42,473 species real-world; Zhang, 2011), Scorpiones 4% (1947 species; Zhang, 2011), and Chilopoda (centipedes) 5% (3100 species; Zhang, 2011). From the perspective of the fossil record, trilobites are massively underrepresented in the Pokémon world, having >20,000 described real species (Adrain, 2011), with many more still undescribed. Perhaps this is because their single representative, Kabutops, is intended to represent a fictional survival of trilobites hanging on to the modern day (a 'Dead Clade Walking'; Barnes et al., 2021).

Certain Pokémon taxa were more problematic in terms of their taxonomic assignments. Trapinch and Vibrava are clearly arthropods (Neuroptera, the antlions, and Odonata, dragonflies, respectively), though their final evolutionary form, Flygon, has an overwhelmingly reptilian morphology, with one pair of wings and four limbs in an overall dragon-like appearance. In comparison, the prior form Vibrava is classically dragonfly-like with two pairs of wings, paired antennae, insectoid limbs, and a segmented body. Pineco is a bagworm moth larva (Lepidoptera) in light of its morphology and behaviour of agglutinating bark and hanging from tree branches, mimicking the appearance of a pinecone, though its subsequent form Forestress has a less-euarthropodan appearance resulting from external plates and spines with a morphology unlike that of an exoskeleton. However, with no internal anatomical information available, we can assume Forestress is also a bagworm made of different agglutinated materials. Gligar and Gliscor are scorpion-like based on their limb morphology and stinger tails, though represent a novel life mode and adaptations for Scorpiones in being able to fly. This characteristic is presumably homoplasic, that is, evolved independently to flight in other euarthropodan groups. Fomantis and Lurantis are not considered euarthropodan based on their morphologies, descriptions, and names. 'Fomantis' seems to originate from the words 'faux' (false) and 'mantis', while Lurantis evokes either a 'lure' or 'fleur' (flower). Both appear to be comprised of plant material that mimics the look of mantids, are able to photosynthesise, and are single-type Grass Pokémon.

An interesting feature is the lack of morphological disparity within certain euarthropod Pokémon groups, particularly the Decapoda. Taking this representation to be a result of the way decapod crustaceans are viewed in the public eye, these Pokémon are all generically crab- or lobster-like, with a very limited colour palette – most decapod taxa are orange, with two being shades of blue. This strongly contrasts the real-world scenario, in which decapods are morphologically disparate and found in all manner of colour palettes. Similarly, Myriapoda is represented in the Pokémon universe by only centipede-like forms (Chilopoda) with a single pair of legs per body segment; no millipede (Diplopoda) forms seem to exist, despite being more diverse in the real-world (Zhang, 2011). The Pokémon chilopods also reflect only a sin-

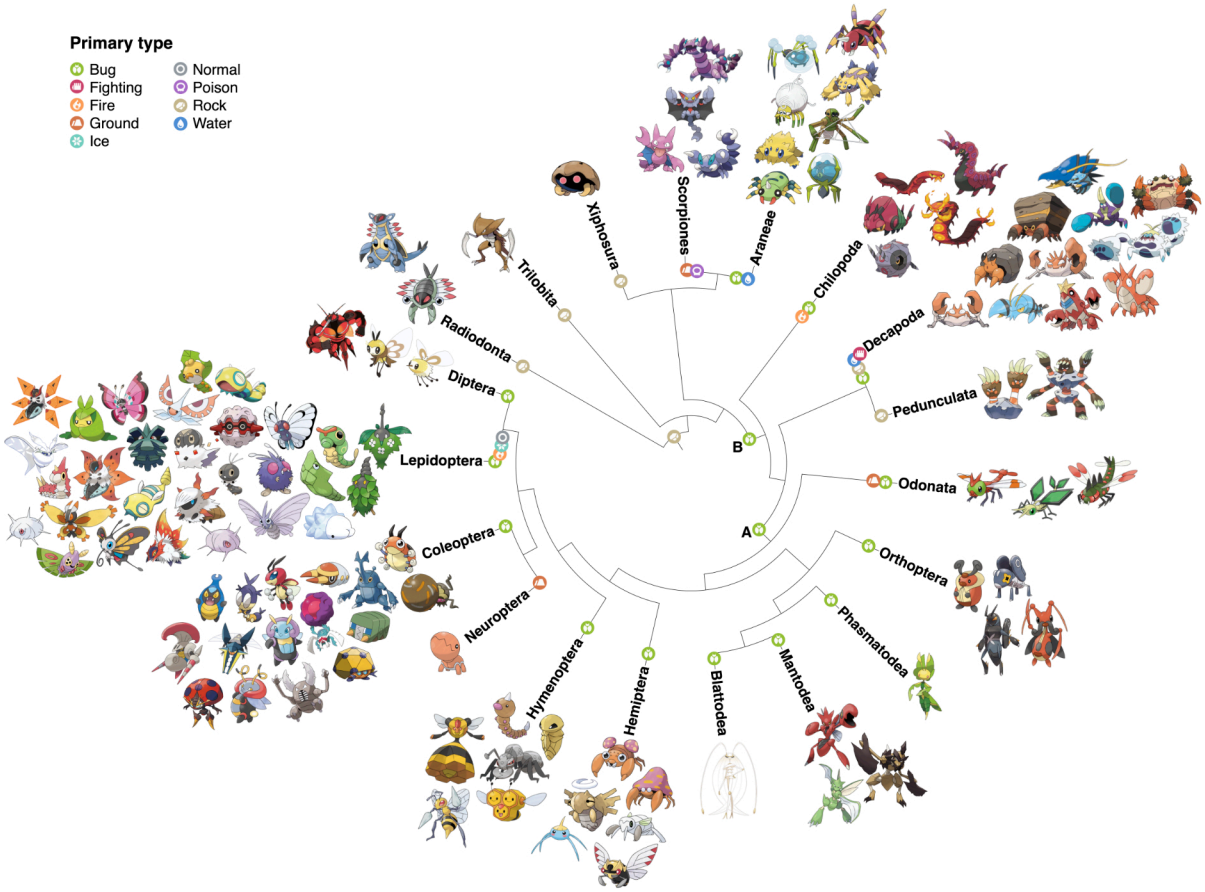

Figure 2. Cladogram of euarthropod Pokémon, with their evolutionary relationships derived from phylogenetic analyses of real-world taxa (see Misof et al., 2014; Giribet & Edgecombe, 2019). Images represent all Pokémon taxa present in each group. All group primary types are also displayed (see legend), and ancestral type state changes displayed at key nodes. A and B represent the two hypotheses for the shift to Bug-type, requiring an identical number of total step changes across the cladogram. The Pokémon images and Type symbols, extracted from Bulbapedia, are official artworks employed here under fair use.

gle colour palette, being predominantly red. Pokémon Scorpiones also reveal the public view of real-world scorpions, being purple-coloured and usually poison-type. We can thereby glean insights from cultural properties like Pokémon into the public perception of euarthropods in our living world (for a more detailed study of Pokémon perceptions and preferences, see Le Vaillant, 2020).

ANCESTRAL TYPE RECONSTRUCTION

Bug is by far the most common type for euarthropod, and particularly hexapod, Pokémon. This is somewhat circular, with the bug-type presumably originating in the Pokémon biosphere as a way of describing the morphologies and behaviours of the Gen. I hexapods (e.g., Caterpie). It is therefore likely that the earliest hexapod Pokémon were bugs, with Bug type being ancestral to the group and the occurrences of other types (Ground, Fire, Ice, and Normal) representing singular autapomorphies (Fig. 2). Based on it being the most common type, the decapods seem to be predominantly Water-types, though crustaceans may be ancestrally Rock-type as the Pedunculata are also Rock-type (Fig. 2). The Chelicerata (Xiphosura, Scorpiones and Araneae) are notably variable in their type designations (Fig. 2).

Of particular interest is the ancestral (original) type of Euarthropoda Pokémon. Owing to the inclusion of Radiodonta and Trilobita (both real-world extinct groups), the tree suggests the evolution of arthropod taxa from a Rock-type ancestry (Fig. 2), which is conducive with the next diverging group likely being Xiphosura, also Rock-type (horseshoe crabs, with their earliest real-world representatives roughly contemporaneous with trilobites and radiodonts; see Lamsdell, 2019). Given the type of Xiphosura and reasonably certain stem-euarthropod position of Radiodonta (Zheng et al., 2020), this result seems robust to whether Trilobita are in this position in the tree or closer to Mandibulata (i.e., Chilopoda to Hexapoda). However, this may also represent an instance of circularity ('circular evolution'?), as the 'fossil' Pokémon (i.e., trilobites and radiodonts) are presumably Rock-type owing to their original resurrection in-game from actual fossil specimens, *Jurassic Park*-style.

Importantly, this finding mirrors the importance of including extinct taxa in real-world studies of ancestral state reconstructions (e.g., Joy et al., 2016). Without the extinct Radiodonta and Trilobita, it would be more parsimonious to conclude that the ancestral type of euarthropod Pokémon was Bug, with one fewer type-change required on the resulting tree than for a Rock-type origin. With the inclusion of these fossil groups, the tree reveals that euarthropod Pokémon likely diverged from a Rock-type ancestor (Fig. 2).

Following their probable Rock-type origin, there are two hypotheses for the euarthropod Pokémon transition to predominantly Bug-type: (1) the ancestral Rock-type lingered until the split within Pancrustacea between Hexapoda and all other groups (Fig. 2: node A); and (2) Bug-type originated earlier at the divergence between Chelicerata (arachnids, etc.) and Mandibulata (Fig. 2: node B). Both hypotheses require 15 type changes along the tree presented in Figure 2, and so are equally plausible under a parsimony assessment.

SUMMARY

10% of Pokémon taxa clearly represent morphological and behavioural characteristics of real-world extant and fossil Euarthropoda. As such, these taxa can be taxonomically classified using our existing nomenclature and placed on a cladogram representing their hypothetical evolutionary relationships. In this way, we can reconstruct ancestral states of euarthropod Pokémon, such as their primary type, and better understand the evolutionary patterns inherent in the Pokémon world, understanding that the methods and problems involved mirror those for the biosphere of our natural world.

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Scarlet Rot: a biological exploration of *Elden Ring*'s decaying disease

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FromSoftware's 2022 seminal work *Elden Ring* explores themes such as war, betrayal, and moral confrontations with the status quo in the Lands Between. These conflicts are deeply influenced by divine entities, specifically the Outer Gods, who seek to impose their will upon the continent. Their influence extends beyond shaping the social dynamics of the townsfolk and their leaders, affecting even their mental and physical health.

One such manifestation of divine interference is the Scarlet Rot, a persistent affliction that ravages all living beings. Not limited to humans, the Scarlet Rot also permeates the ecosystem, corrupting other animals and flora alike. This ailment has been spreading for an untold length of time, reaching every corner of the Lands Between, even forming landmarks characterized by oozing rot. Despite its catastrophic consequences, the disease has been neglected, leaving entire towns derelict and their inhabitants unattended. Furthermore, with its varied clinical manifestations and cosmic origins, treating and curing those afflicted is an immense challenge. However, we can infer the disease dynamics by drawing parallels between the Scarlet Rot and real-world pathogens, offering insight into its destructive power in the Lands Between.

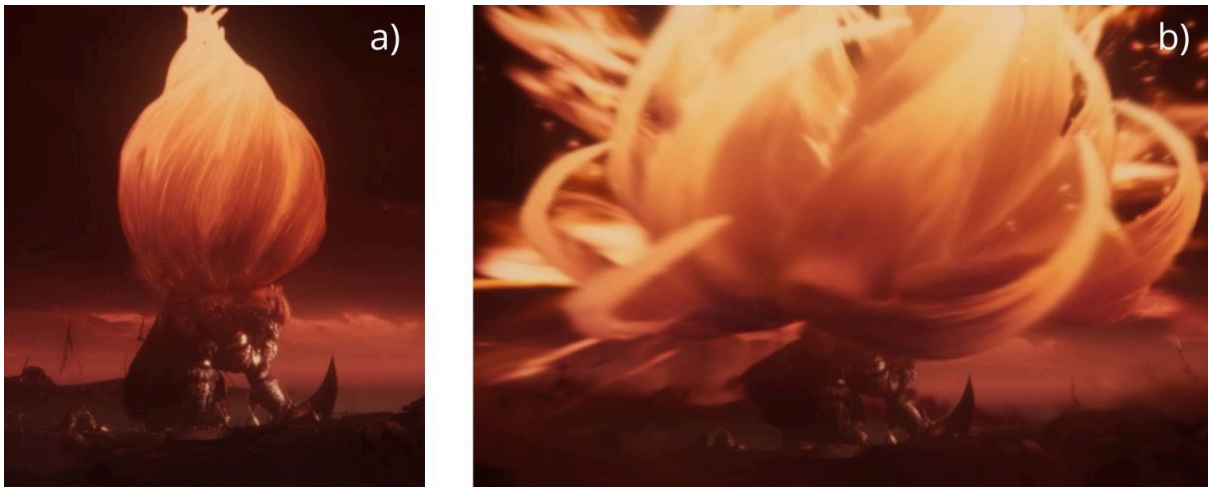

Figure 1. Malenia's blooming. During her battle against General Radahn, Malenia unleashes the Scarlet Rot upon Caelid by transforming into a flower. **a)** The petal-like structure at the top twists and compresses before **b)** blooming in an explosive release, spreading the Scarlet Rot. These images were extracted from the *Elden Ring* Story Trailer (https://www.youtube.com/watch?v=K_03kFqWfqs) under fair use.

Cite this article as: Morales-Primo, A.U. (2024) Scarlet Rot: a biological exploration of Elden Ring's decaying disease. Journal of Geek Studies 11(2): 103-114. https://doi.org/10.5281/zenodo.13889427

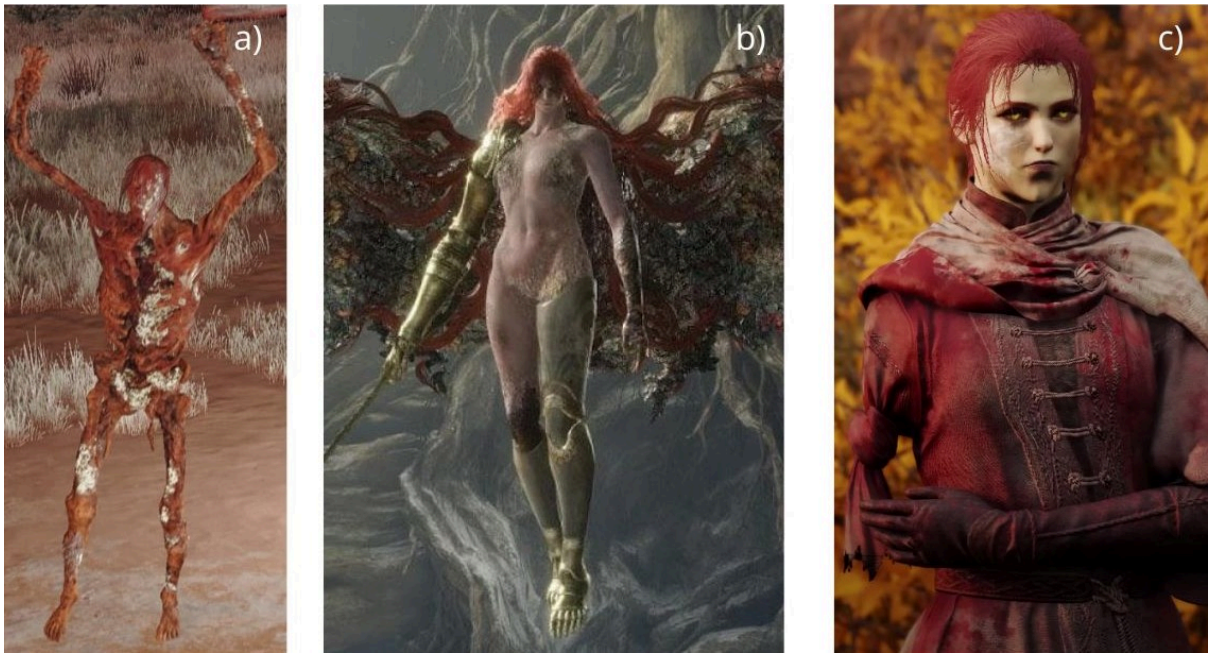

Figure 2. Symptoms of Scarlet Rot. In humans, Scarlet Rot manifests as **a)** gangrenous and necrotic lesions, often leading to **b, c)** the loss of limbs and the need for prosthetics. Images were extracted under fair use from the Elden Ring Wiki (https://eldenring.wiki.fextralife.com/) and VaatiVidya's "An Elden Ring Movie: Children of the Scarlet Rot" video (2024; https://www.youtube.com/watch?v=VscKtjLG9XU).

ETIOLOGY AND PATHOLOGY OF THE SCARLET ROT

The Scarlet Rot is the physical manifestation of the Outer God of Rot's will upon the Lands Between, a force that transcends mere diseases. While its presence is most notably felt during the events of Elden Ring, its influence stretches back to ancient times. Historically, the Scarlet Rot was not always viewed as purely destructive. In some cultures, the bodily decay caused by the rot was considered a sacred process, integral to rituals of rebirth and transformation. Although there are no clear examples of diseases being revered in human history, they were often interpreted as divine intervention or retribution (Krzysztofik, 2022).

The Scarlet Rot's infamous reputation intensified when the demigod Malenia, Blade of Miquella, cursed with the Scarlet Rot from birth, spread the miasma throughout the region of Caelid. She accomplished this by blooming into a gigantic scarlet flower, unleashing the Rot across the land (Figure 1). This eruption of Scarlet Rot caused devastating symptoms in the population, including open skin wounds, gangrenous and necrotic lesions, the loss of limbs, and ultimately, death (Figure 2).

Some animals exhibited gigantism, as evidenced by the enormous dogs, crows, and scorpion-spider chimeras roaming the affected lands. Additionally, fungi sprouts and other vegetal growths began to emerge from the bodies of the afflicted. Even the flora was not spared, as the same fungus-like growths appeared on plants and trees, emphasizing the destructive nature of the Rot. Finally, as their minds and bodies succumbed to the ailment, the sick descended into madness, exhibiting violent, erratic behavior until they were completely overtaken. The following sessions explain how the Scarlet Rot affects humans, plants, and arthropods.

HUMANS

In biological terms, Scarlet Rot is a disease that is transmitted by direct contact with an affected individual, for example

through physical damage, by airborne transmission via inhalation of the miasma or spores, and by waterborne transmission, as it can contaminate bodies of water such as lakes or rivers. This multifaceted method of transmission highlights the difficulties of containing such a prevalent disease.

Empirical observations suggest that the Scarlet Rot may possess a plant or fungal origin. Both plants and fungi release compounds as defense mechanisms against pathogens and predators or to aid in colonization and infection (Kocyigit et al., 2023). Fungi, in particular, produce secondary metabolites called mycotoxins, which can cause serious health conditions, while plants produce similar compounds known as phytotoxins (Kocyigit et al., 2023). Phytotoxins are commonly ingested for them to cause symptoms in a patient, also known as plant poisoning (Abhilash et al., 2021; Kerchner & Farkas, 2020).

Given that the Scarlet Rot is spread through the blooming of a flower, pollen may be a potential causal agent. Pollen is a well-known allergen that triggers conditions such as allergic rhinitis, asthma, conjunctivitis, and dermatitis (Guryanova et al., 2022). While these allergies can be life-threatening in extreme cases, their symptoms are not as severe or grotesque as those observed with the Scarlet Rot. However,

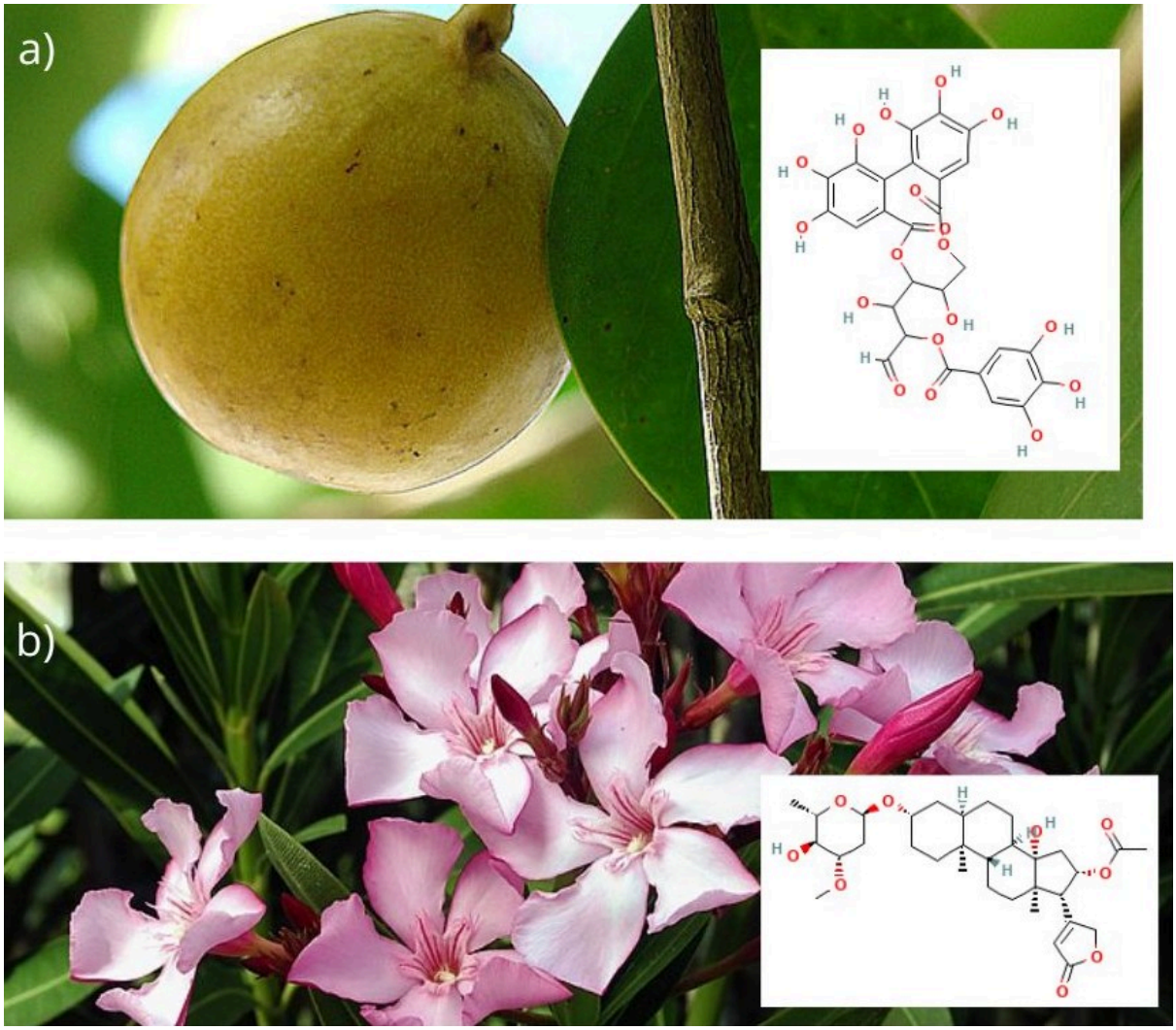

Figure 3. Potential toxic plants and their toxic compounds. **a)** *Hippomane mancinella* and its toxic compound, hippomanin A (NCBI, 2024a). Image source: Wikimedia Commons (H. Hillewaert, CC BY-SA 3.0). **b)** *Nerium oleander* and its toxic compound, oleandrin (NCBI, 2024b). Image source: Wikimedia Commons (Alvesgaspar, CC BY 2.5).

pollen from certain poisonous plants may provide a closer analogy to the dramatic effects of the Scarlet Rot. *Hippomane mancinella* (commonly known as the manchineel tree) and *Nerium oleander* (known as oleander or rosebay) are prime examples of plants with highly toxic properties (Figure 3). *H. mancinella* produces toxins such as phorbol esters and terpenoids, which can cause severe skin irritation, blistering, and even respiratory issues when inhaled or contacted (USDA, 2004; Andreu & Friedman, 2012). Similarly, *N. oleander* contains potent cardiac glycosides like oleandrin, which can cause arrhythmias, nausea, and fatal heart conditions if ingested or inhaled in significant quantities (Anadón et al., 2018). Though the pollen of these plants is less commonly studied as a direct vector of poisoning, any contact with these plants, including inhaling the air around them, can provoke serious allergic or toxic reactions.

Pollen is also capable of carrying mycotoxins and mycotoxin-producing fungi (Kostić et al., 2019). Some mycotoxins found in pollen, such as aflatoxins, ochratoxins, and fumonisins, are known to cause kidney and liver failure, hypersensitivity, muscle pain, respiratory impairment, and, in some cases, neurological symptoms such as difficulty with movement, delirium, or dementia (Kraft et al., 2021; Kostić et al., 2019). These mycotoxins are primarily produced by opportunistic species of the genera *Aspergillus*, *Penicillium*, and *Fusarium*, which can cause various diseases in vertebrates and plants (Kostić et al., 2019). Additionally, pollen can harbor toxic and opportunistic fungi species from the genera above, as well as *Mucor*, *Cladosporium*, *Alternaria*, and *Trichoderma*, which are primarily plant pathogens but can infect immunocompromised people (Kostić et al., 2019). This exemplifies how pollen not only acts as an allergen but also as a vector for mycotoxins and a carrier for harmful fungi, potentially mirroring the spread of the Scarlet Rot, as it infiltrates both the environment and living organisms through airborne and contact-based transmission.

On the other hand, some fungi utilize pollination as a means of dispersal and infection. *Claviceps purpurea*, commonly known as ergot, is a species of Ascomycota fungus that causes ergotism, a disease resulting from the ingestion of contaminated grains, particularly rye (Webster & Weber, 2009) (Figure 4). The life cycle of *C. purpurea* (Figure 4b) begins when a spore germinates in the flower's ovary, replacing it with a

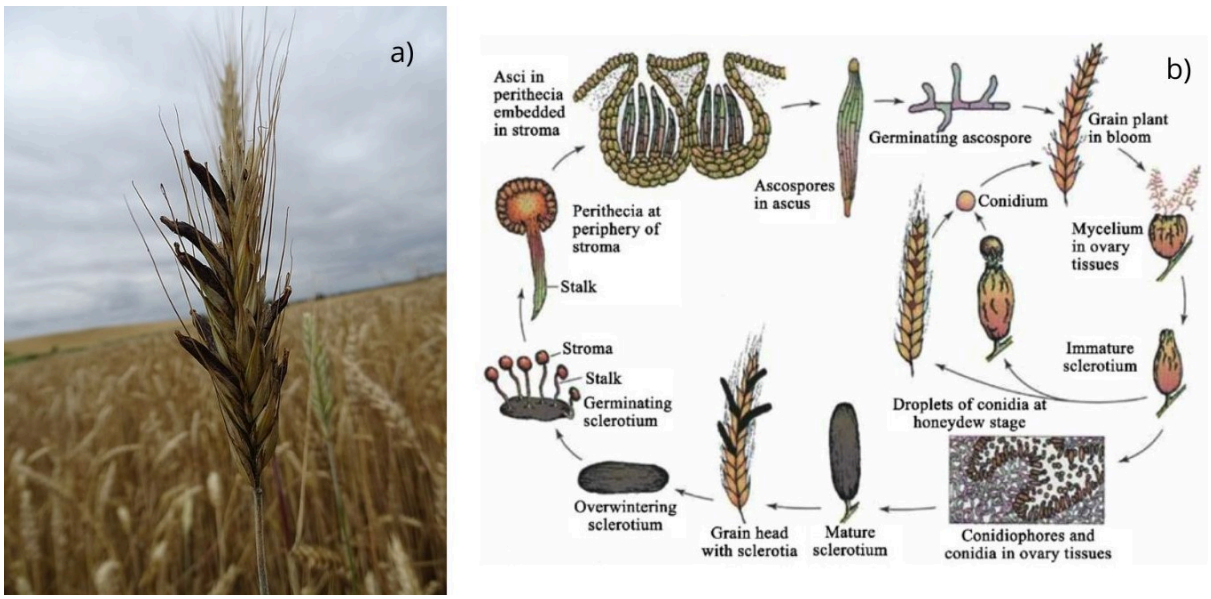

Figure 4. *Claviceps purpurea* and its life cycle. **a)** *C. purpurea* ergots growing in rye (Wikimedia Commons; G. Grzejszczak, CC BY 4.0). **b)** *C. purpurea* life cycle (image reproduced from Schumann & Uppala, 2000).

fungal structure known as a stroma that produces haploid cells called conidia (Miedaner & Geiger, 2015). This stroma secretes a syrup-like substance, or honeydew, which attracts insects that transfer the fungus to other plants, helping to preserve and spread the infection (Miedaner & Geiger, 2015). Additionally, water droplets aid in fungal dispersion. Once the stroma dries and darkens, it matures into a structure called a sclerotium or ergot, which, under optimal conditions, produces new fruiting bodies that continue the fungus's life cycle (Miedaner & Geiger, 2015).

Ingestion of the sclerotium via contaminated cereals will lead to the development of ergotism. Historically, ergotism, previously known as St. Anthony's fire, has had a close relationship with humans, with cases reported as early as 600 BC, causing epidemics in the Middle Ages (Cervellin et al., 2021). St. Anthony's fire manifests in two clinical forms: (1) Gangrenous ergotism, characterized by burning sensations in the limbs (hence the name), followed by desensitization, edema, drying and blackening of affected areas, and in severe cases, loss of the limb without bleeding; and (2) Convulsive ergotism, where patients exhibit twitching, spasms, hallucinations, paranoia, and convulsions (Cervellin et al., 2021; Haarmann et al., 2009).

The main source of toxicity of *C. purpurea* lies in the alkaloids found in the ergot. These ergot alkaloids, such as ergotamine, ergocryptine, and related ergopeptine alkaloids, are responsible for the vasoconstrictive and neurotoxic effects that lead to the symptoms of ergotism (Haarmann et al., 2009). These compounds interfere with neurotransmitter systems and blood flow, particularly affecting the extremities and nervous system, causing the gangrenous and convulsive manifestations of the disease (Cervellin et al., 2021; Liegl & McGrath, 2016). The gangrenous tissue damage and erratic behavior bear a striking resemblance to the symptoms caused by the Scarlet Rot, linking the two conditions in terms of their debilitating impact on the human body.

PLANTS

The Scarlet Rot's effects on the landscape and vegetation are displayed in the environments of Caelid, the Lake of Rot, and the Church of Bud (Figure 5). The land in Caelid appears arid and lifeless, characterized by desiccated trees, eroded soil, and a notable absence of healthy plant life (Figure 5a). Instead, fungi thrive ubiquitously, with some gigantic flower buds growing from the dead vegetation. At the heart of this blighted region lies a contaminated body of water, precisely where Malenia's bloom occurred. The Lake of Rot, where the God of Rot is sealed, bears similar signs of fungal infestation, with the added feature of a vast, corrupted lake and cascading water (Figure 5b). The Church of Bud and its surroundings display the same devastating patterns, though with a peculiar twist: flower buds of varying sizes carpet the floor of the church's hall (Figure 5c).

Regarding fungi, we observe four distinct kinds of fruiting bodies that resemble real-life organisms (Figure 6). (1) Clusters of gray/red apothecia, similar to ascomycete fungi from the genus *Sarcoscypha* (Figure 6a). (2) Aggregates of flat-capped mushrooms that resemble *Laetiporus* (Figure 6b). (3) Pinecone-like structures that grow near or on top of mushrooms that share similarities with the fruiting bodies of *Arcyria* slime molds (Figure 6c), though slime molds are not technically fungi. (4) Long, single stems covered in capped-ended, branch-like projections, resembling an uncapped *Dendrocollybia* fruiting body (Figure 6d). All of these organisms are saprophytic, which is fitting given the degraded state of these lands and the themes of rebirth from dead organic matter (Arora, 1986). Furthermore, given the enormous size of the fungi, it is easy to infer that the weakened flora succumbed to the fungi's nutritional demands, much like how many fungal diseases can ultimately kill their hosts (Jain et al., 2019). Interestingly, the sclerotium of *C. purpurea* resembles the structures previously described, solidifying the possibility that the Scarlet Rot shares similar traits with this group.

Figure 5. Scarlet Rot affected landmarks. **a)** Top of a dead tree in Caelid. **b)** Lake of Rot shore. **c)** Church of Bud hall. The Tarnished is used for scale although no official data of their height exists. Screenshots from the game, captured on a PS5.

Lastly, the flower buds appear as large and bulbous with overlapping, thick, petal-like scales or tepals. They have green, sharp-edged bracts, giving the flowers an overall armored appearance, and the reddish-pink hue suggests a mature bloom ready to open. This description aligns with flowers of the *Protea* genus (Figure 6e). However, unlike *Protea* plants, which have a bushy growth habit, these Scarlet Rot buds appear epiphytic (SANBI, 2024).

Additionally, certain fungi can alter plant physiology to facilitate their own reproduction. *Gibberella fujikuroi* is a parasitic fungus that alters the growth of infected rice plants by producing gibberellins, a growth hormone, causing the plants to grow taller than others, which aids in the fungus's spread (Cuali-Álvarez et al., 2011). *Puccinia monoica*, a parasitic rust fungus of mustard plants, dramatically alters plant physiology. It induces the formation of pseudoflowers that bear the fungal reproductive cells. These pseudoflowers produce nectar that attracts pollinators, which transfer the cells to a recipient fungal hypha on another infected plant, thus maintaining the fungus's life cycle (Roy, 1994). These examples suggest that similar mechanisms could be at play in the context of the Scarlet Rot, where fungal strategies may be driving abnormal growth and reproduction in the affected flora, paralleling real-world biological interactions.

ARTHROPODS

Although the Scarlet Rot is harmful to vertebrates and plants, arthropod-like crea-

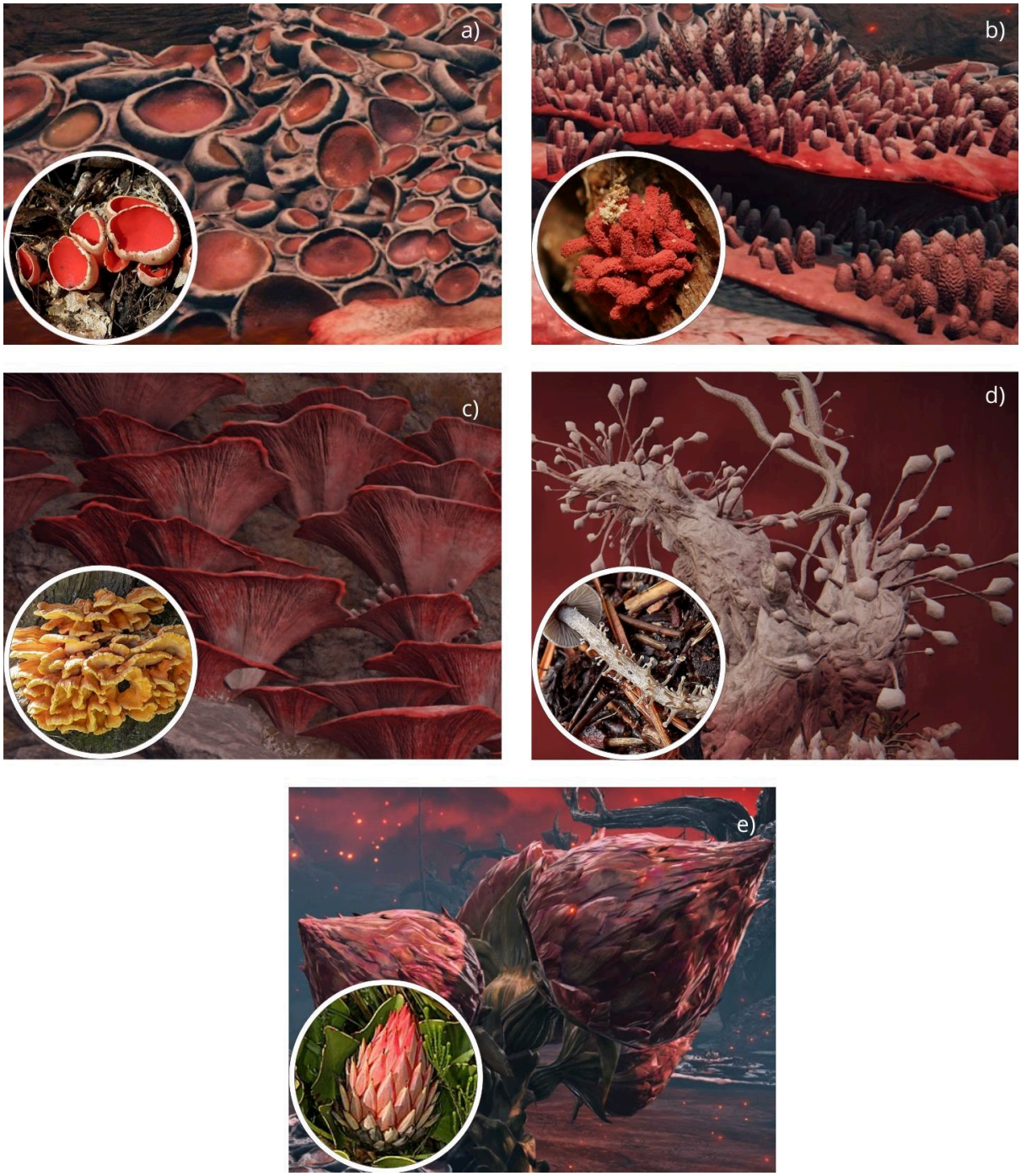

Figure 6. Fungi and flora in Scarlet Rot-afflicted landmarks and their real-life counterparts. **a)** *Sarcoscypha* (Wikimedia Commons; Epegeiro, CC BY-SA 4.0). **b)** *Laetiporus* (Wikimedia Commons; P. van de Velde, CC BY 2.0). **c)** *Arcyria* (Wikimedia Commons; D. Bowman, CC BY 2.0). **d)** *Dendrocollybia* (Wikimedia Commons; Laurel, CC BY-SA 3.0). **e)** *Protea* (Wikimedia Commons; SAplants, CC BY 4.0). Screenshots from the game, captured on a PS5.

tures appear immune, even forming symbiotic relationships with the rot. The Kindred of Rot, a race of anthropomorphic, centipede-like beings, praise the Rot, believing themselves to be its offspring (Figure 7a).

It is suspected that before the arrival of the God of Rot, they were mere bugs, elevated to their current form through a deep connection with the Rot. Entomopathogenic fungi from the *Ophiocordyceps* genus are well-known for altering insect behavior, although being detrimental to the host. For instance, infected ants expe-

Figure 7. Scarlet Rot and arthropods. **a)** Spear-wielding Kindred of Rot in Caelid. **b)** Tarnished casting the Rotten Butterflies incantation. **c)** Romina, Saint of the Bud, at the Church of the Bud. Images were extracted under fair use from a) Elden Ring Creatures Reviews, Entry 27 (https://bogleech.com/souls/er27-pests), b) *Elden Ring: Shadow of the Erdtree* Official Gameplay Reveal Trailer (https://www.youtube.com/watch?v=qLZenOn7WUo), c) Elden Ring Wiki (https://eldenring.wiki.fextralife.com/).

rience spasms and are forced to leave their nests, climbing vegetation and clamping their jaws onto high surfaces to facilitate spore dispersal (de Bekker, 2019).

Conversely, some insects have developed mutualistic relationships with fungi. One such phenomenon is known as fungiculture. Attine ants and ambrosia beetles, for instance, depend on this relationship. These insects "farm" the fungus, spreading and caring for it (even secreting antibiotics to protect it), while the fungus concentrates nutrients from wood to nurture the arthropods (You et al., 2015; Currie et al., 2006). These examples show how fungi form symbiotic relationships with arthropods, improving their fitness, similar to how the Scarlet Rot benefits certain arthropod-like creatures.

Butterflies also symbolize the Scarlet Rot's presence. Although butterflies are found in every biome across the Lands Between, the Aeonian and Scarlet butterflies thrive in Scarlet Rot-affected lands. These butterflies are believed to have been part of the God of Rot wings. The Rotten Butterflies incantation even uses these butterflies to cause Scarlet Rot buildup, suggesting these arthropods are vectors for the disease (Figure 7b). Members of the order Lepidoptera (butterflies and moths) are not considered a threat to human health like other insects. Toxicity in Lepidoptera depends on various factors such as the stages of development (some larvae have urticant hairs) and the source food (ingestion of some compounds such as alkaloids from plants, which are then stored in the insect's tissues), however

only direct contact or ingestion triggers symptoms (Rothschild et al., 1970). Interestingly, some butterflies can carry fungi as part of their microbiome in every stage of their life cycle, granting them a role as fungi spreaders (Harrison et al., 2016). Indeed, some butterflies are vectors for fungal plant diseases such as *Ustilago maydis*, also known as corn smut or *huitlacoche* (Jennersten, 1983).

These mutualistic relationships may be explained by the belief that the God of Rot possesses arthropod-like characteristics, specifically resembling a scorpion, solidifying the bond between the rot and arthropod life. Interestingly, it appears that the host's willingness to receive the Scarlet Rot significantly influences the outcomes of the affliction. Romina, Saint of the Bud, who was once human, embraced the rot fully, resulting in her transformation into a chimera. While retaining her human appearance, she grew butterfly wings from her back, with a giant centipede and a scorpion tail protruding from her waist (Figure 7c). Even though some mycotoxins are mutagenic, such as the aflatoxin from *Aspergillus*, none cause such dramatic changes in the host (McCullough et al., 2019). Nonetheless, this transformation reinforces the powerful connection between arthropods and the Scarlet Rot, while also highlighting the thematic elements of rebirth and metamorphosis that the Rot conveys.

TREATMENTS

Despite the severe consequences of the Scarlet Rot on a patient, the disease can be resolved if treated quickly. Therefore, Scarlet Rot can be classified into acute and chronic stages. For the Tarnished (the playable character) to become afflicted with the Rot, they must come into contact with a source of Scarlet Rot and exceed a resistance threshold. Once afflicted, the Tarnished's health points will rapidly decrease until either they succumb to the rot or use one of the tools available to cure it. To treat Scarlet Rot, the Tarnished have several options (Figure 8): consuming "Preserving Boluses", inserting an unalloyed gold needle into their body, or casting the "Flame, Cleanse Me" incantation.

Magic or mystical techniques to treat sickness lack reproducibility and scientific evidence. However, in the case of the flame incantation (Figure 8a), fire — or more specifically, heat — has been used in various treatments throughout history. Cauterization is an ancient technique involving the direct application of heat through fire or heated materials to close wounds or remove undesired skin (Nayab, 2017). Similarly, hyperthermia is an adjuvant cancer treatment that involves applying heat (40–48 °C) to kill cancerous cells and reduce tumor size, locally or systemically, depending on the cancer stage (Behrouzkia et al., 2016). Addi-

Figure 8. Scarlet Rot treatments in *Elden Ring*. **a)** "Flame, Cleanse Me" incantation, it "creates a fire within that burns away toxins" (FromSoftware, 2022). **b)** Preserving boluses that "alleviates scarlet rot buildup and cures rot aliment" (FromSoftware, 2022). **c)** Miquella's needle that "ward away the meddling of outer gods" (FromSoftware, 2022).

tionally, some researchers have proposed using hyperthermia to treat infections, as it can deactivate pathogens and enhance immune responses, though with the risk of harming the patient (Markota et al., 2023).

Preserving boluses are a consumable item that alleviates the Scarlet Rot buildup and cures the rot (Figure 8b). They are crafted from natural ingredients such as buds, herbs, and moss. Natural remedies and traditional medicine have long been seen as potential treatments for various afflictions, including infections. Since we infer that the Scarlet Rot is similar to fungal diseases, plant derivatives such as eucalyptol, camphor, and tea tree oil exhibit fungicidal properties alone or in combination with other compounds (Stojković et al., 2022).

Finally, inserting an unalloyed gold needle (also known as Miquella's needle; Figure 8c) not only cures Scarlet Rot but also severs any connection with the Outer Gods. This mechanism is similar to implantable drug delivery systems used in diabetes and cancer treatments (Greatbatch & Holmes, 1991). These devices are surgically placed in the patient's tissue to control the timing, rate, and location of drug release (Fayzullin et al., 2021). Additionally, antibiotic-coated implants have been used to treat infections during orthopedic procedures (Gimeno et al., 2015). These modern implants are made from biodegradable materials and metals that, with the aid of antibiotics, prevent pathogen growth (Xi et al., 2021).

CONCLUSION

Scarlet Rot is an insidious disease that plagues the world of *Elden Ring*, akin to real-world fungal diseases, particularly those belonging to the Ascomycota phylum. Its characteristics resemble the fungus *Claviceps purpurea* (ergot), as the Rot causes symptoms similar to ergotism, characterized by gangrenous decay and hallucinations. Moreover, the fruiting bodies that emerge from Rot-infected plants are reminiscent of the fungal growths seen in ergot infections and other colonizing fungi. However, unlike ergot's detrimental impact on plants and animals in the real world, the Scarlet Rot has a unique, symbiotic relationship with certain arthropods. Creatures such as the Kindred of Rot not only appear immune to the Rot's effects but have adapted to thrive alongside it, elevating their in-game status and forming a mutualistic bond with the disease.

Scarlet Rot treatments also echo real-world medical practices. For example, consuming Preserving Boluses, crafted from natural ingredients, mirrors the use of plant-derived compounds that exhibit antifungal properties. The "Flame, Cleanse Me" incantation, while mystical, emulates the historical use of heat in medical treatments to combat infections. Meanwhile, Miquella's needle evokes modern implantable drug delivery systems.

In summary, the Scarlet Rot can be interpreted through the lens of both fungal biology and medical science, blending real-world principles of disease, symbiosis, and treatment with the rich lore of *Elden Ring*.

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Acknowledgments

This work was partly supported by using OpenAI's GPT for drafting and editing assistance, and Grammarly for grammar and style suggestions. The author reviewed, edited, and revised the AI-generated texts and suggestions to his liking and takes ultimate responsibility for the content of this publication.

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On the influence of Japanese archaeological heritage on *The Legend of Zelda: Breath of the Wild*

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A THICK LAYER OF TIME

In the realm of Nintendo's *Zelda* franchise, time is more than a narrative tool: it shapes the player's experience and connection to its expansive worlds. In *Ocarina of Time* (1998), time is an effective gameplay element, and the player can travel through two different timelines, separated by seven years during which crucial events occur, but out of the player's sight. As a result, the player alternates between embodying young Link and adult Link, each with a distinct perspective. The world of Hyrule mirrors this transformation: lush and innocent for the young, grim and desolate for the adult. In *Majora's Mask* (2000), time travel is restricted to three critical days, which you can relive as many times as necessary to prevent the moon from crashing into the Earth at the end of the third day.

In *Breath of the Wild* (2017), time no longer plays a central role in gameplay mechanics, except for brief interruptions like the Stasis rune. Instead, it serves as a backdrop, with constant references to events from the distant past, from the very beginning of the game when you wake up from a hundred-year artificial sleep, with little information about what happened during this gap. This century-long time span focuses on personal memories and political events: Link can't remember what happened before his sleep, creating a tension between personal memory and collective history, pushing the player to explore the remnants of a world that has moved on without them. Fragments of the past are in fact materially dispersed in Hyrule, and the player seeks to find them to understand both Link's and Hyrule's fate. Fortunately, Impa the old Sheikah lady of the Kakarico village witnessed the disastrous events and will help him to recover memories from that time.

If most of us are able to understand what a hundred years ellipse means, there is another timescale in the game, and once again it is Impa who tells the player the tale of what happened 10,000 years ago, the epic struggle between the forces of good and evil, and the constitution of modern-day cosmogony ("with the passage of time, each conflict with Ganon faded into legend"). The recurrence of this type of conflict is a commonplace of fantasy worlds, and a convenient way to turn the lore of these games into repeated iterations of commercial successes (Sangster, 2023), developing a stereotypical "stock of characters and devices […] into a predictable plot in which the perennially understaffed forces of good triumph over a monolithic evil" (Attebery, 1992). This definition fits perfectly to the *Zelda* series, as each opus is a reinvention of the Link/Zelda/Ganon trio. Here the game somewhat breaks the fourth wall, as Impa describes a previous battle between the protagonists, suggesting the existence the other

Cite this article as: Cudennec, J.-F. (2024) On the influence of Japanese archaeological heritage on The Legend of Zelda: Breath of the Wild. Journal of Geek Studies 11(2): 115-123. https://doi.org/10.5281/zenodo.13988333

episodes of the series in a delightful *mise en abyme*, even for those who are not accounted with the intricated official timeline, a curious mixing of both linear and circular times (Aonuma, 2020).

But 10,000 years — one hundred centuries, a timespan longer than most human civilizations — is harder to grasp for the public. Here, the game enters the realm of geological time. Our current geological epoch, the Holocene, started 12,000 years ago, and even if the modern human species is far older, it is during the Holocene that humans developed agriculture, settled communities, and advanced technologies, multiplying the global population by about 8,000, from one million to eight billion. An opposite trajectory is portrayed in *Breath of the Wild*, Hyrule being a world in decline, echoing a distant golden age marked by Sheikah technological marvels.

This duration of ten millennia therefore constitutes a specific timespan: longer than any human oral tradition or heritage, but short enough to stay in a familiar world, with biogeographic contextual changes rather than evolutionary ones, which are perceived as immutable and essentialist by most individuals.

This evocation of a deep past thus inevitably evokes prehistoric periods, and 10,000 BCE (Before Common Era) constitutes the beginning of a crucial transition between the two main prehistoric economies and lifestyle (in the Fertile Crescent at least), from the Palaeolithic (small, mobile hunter-gatherer groups) to the Mesolithic and finally Neolithic (large sedentary farmer groups). This simplistic and finalistic vision of a glorious march of humanity from short-lived and miserable cavemen toward thriving villages of politically-organised and socially complex communities of farmers and craftsmen is completely outdated from an academic point of view (Sahlins, 1976; Graeber & Wengrow, 2021), but it is still commonplace among the public, as exemplified by the famous illustration "Road to *Homo sapiens*" presenting modern-day humans as the pinnacle of evolution.

THE JŌMON PERIOD IN *BREATH OF THE WILD*: A LINK TO THE PAST?

At first glance, the 10,000-year time interval in *Breath of the Wild* might seem like a narrative device to add epic grandeur to the tale Impa is telling Link, without deeper significance. But it happens that the art director of *Breath of the Wild*, Satoru Takizawa, specifically mentioned the use of Japanese historical and archaeological heritage for the design of the game, namely the Jōmon period, as an inspiration for most of the ancient ruins and artifacts of the game (Nintendo of America, 2017).

Figure 1. A Jōmon *kaen doki* (flame pot). Source: The Metropolitan Museum of Art, New York (public domain).

The Jōmon period (縄文時代, Jōmon jidai), is a pre- and protohistoric period specific to Japan, and even if it is a well-known period for Japanese, it remained until recently poorly known outside the archipelago. This culture goes from 14,000 BCE to 400 BCE (Habu, 2004), so a little more than the 10,000 years represented in Breath of the Wild. The term Jōmon means "cord-marked", as the pottery from this period

Figure 2. *Breath of the Wild* sanctuaries are inspired by Jōmon pottery. Screenshot from the game.

shows specific ornaments made by imprinting different objects on the clay, including ropes but also marine shells, nails, etc. This kind of decorations are not unique in prehistory, and Europe also has a neolithic culture called "Corded ware" (Beckerman, 2015), but the Jōmon pottery reached a peak of intricated and exuberant ornamentations during the Middle Jōmon period (3,500–2,000 BCE; Ghobadi, 2015). These specific and heavily decorated pots are called '*kaen doki*', or 'flame pots' (Fig. 1).

Even if they represent only a fraction of the diversity of Jōmon pottery, these *kaen doki* are unique and easily recognisable items, making them a typical representation of the Jōmon culture. They are so iconic that the design of several of the Jōmon-inspired elements in *Breath of the Wild* are directly coming from the design of these pots. Sanctuaries and guardians of the ancient Sheikah culture are the most striking examples, as they are essentially upside down *kaen doki* (Fig. 2).

The second most evident example of Jōmon artifact in the game is the presence of Cherry in the Akala Ancient Tech Lab (Fig. 3). This robot (also called 'Ancient Oven') displays several characteristics of the *dogū* figurines (土偶, literally 'earthen figures'), which appear during the Middle Jōmon and persist through Late and Final Jōmon (from 3,000 BCE to 400BCE; Kaner & Bailer, 2009).

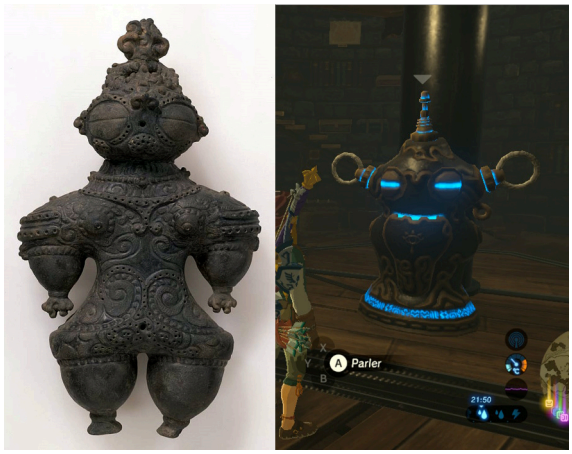

Figure 3. Left: Dogū from Tajirikabukuri, Ebisuda, Miyagi Prefecture (1,000–400 BCE). Source: Tokyo National Museum, Digital Research Archives (item J-38304). Right: Cherry the robot in *Breath of the Wild*. Screenshot from the game.

More than 20,000 dogū have been uncovered, and even if they show a wide range of styles, shapes, and decorations, the typical figurine has a "goddess" shape and large prominent eyes (frog-type or snow-goggles-type). In game, Cherry will craft Sheikah items for the player in exchange for materials collected on Sheikah ruins, therefore maintaining a link with the past. It is not the first time that dogū appears in a *Zelda* game though; the ancient robot of the Lanyaru desert in *Skyward Sword* (2011) can also be seen as reinterpretation of dogū. The explicit reference to Jōmon artifacts within the design of *Breath of the Wild* not only enriches the game's cultural depth but also aligns with broader trends in Japanese media to reinterpret historical and archaeological heritage in a positive way (Tamaki, 2019).

JŌMON CONNECTION

While many Western players may have overlooked the connection between the Jōmon period and Breath of the Wild, it holds different significance for Japanese audiences. The Jōmon period is an integral part of Japan's national history and cultural heritage that percolated into the arts and popular culture of Japan long before this 2017 Nintendo game.

A pivotal moment in postwar Japan's awareness of the Jōmon period was the publication of the article "On Jōmon Pottery", by artist Okamoto Tarō, in the magazine *Mizue* (Okamoto, 1952, translation by Reynolds, 2009). In this strange but influential piece, Okamoto discusses the apparent discord between the complexity, irregularity, and alien beauty of the Jōmon style and the "harmony and refined elegance associated with Japanese tradition" (Reynolds, 2009). Having studied oil painting at the Tokyo School of Fine Arts, he stayed in Paris for several years, where he studied literature, philosophy, ethnology and anthropology, under the supervision of Marcel Mauss. These different approaches, and the sharp analysis of the Japanese culture he engaged when he came back to Japan after the war certainly helped in his fascination for the Jōmon: "The powerful movement and the tenacious sense of equilibrium manifested on these ceramics cannot possibly be gasped by traditional aesthetics. I believe that it should be our great task to study this cold asymmetry and bold, inharmonious balance through Jōmon ceramics" (Reynolds, 2009). His famous *Tower of the Sun*, created for the Japan World Exposition in 1970 (Fig. 4), is a synthesis of two ancient Japanese artistic traditions: the dogū figurines with round faces and large eyes, and the bottle-like bodies and outstretched arms of the *haniwa* figurines from the later Kofun period (which we will revisit shortly).

Figure 4. Okamoto Tarō's *Tower of the Sun* in Osaka. Source: Entire Landscapes (https://entirelandscapes.space/Tower-of-the-Sun/).

Another characteristic feature of Okamoto's work is the large, stylised eye, incarnated by his "*alien named PAIRA*" of 1956, which inspired the eye on the Sheikah slate, the player's tool for altering the environment and interacting with gameplay elements (Fig. 5).

Okamoto influenced the Japanese pop culture long before *Breath of the Wild* though. One of the most direct examples is the character of Deidara, in Masashi Kishimoto's manga *Naruto* (1999–2014). Deidara uses explosive clay figurines to fight against one of the main characters and repeats Okamoto's famous mantra: "art is an explosion!" (Winther-Tamaki, 2011). Even if it

Figure 5. Left: Okamoto Tarō's *alien named PAIRA*. Source: WikiArt (https://www.wikiart.org/en/taro-okamoto/alien-named-paira-1956). Right: Sheikah slate. Screenshot from the game.

might not come directly to the western public's mind, the use of the specific Jōmon aesthetic is relatively common in Japanese popular video games. Representations of dogū figurines can be found in games like *Atomic Runner Chelnov* (Data East, 1988), *Pokémon* (Baltoy/Claydol; Game Freak, 2002) and *Digimon* (Shakkoumon; Bandai, 2000), or the *Shin Megami Tensei* and *Persona* series (Fig. 6).

Beyond the Jōmon period, other periods of Japan's pre-historic past have influenced video game aesthetics. Centuries after the end of the Jōmon, during the Kofun period, people crafted specific funerary figures known as haniwa (Fig. 7), which are also commonly featured in modern games. These haniwa inspired the gyroids in the *Animal Crossing* series, where players unearth them from the ground suggesting, given their archaeological origins, that the

Figure 6. Left: Aharabaki from *Shin Megami Tensei III: Nocturne* (Atlus, 2003; remastered version 2020). Source: (https://megamitensei.fandom.com/wiki/Arahabaki). Right: *Atomic Runner Chelnov*. Source: Atomic Runner (https://playatomicrunner.com/).

game is set on an ancient necropolis. Similarly, haniwa figures have influenced the design of the Earthenwarrior in the *Dragon Quest* series, the Cactuar in the *Final Fantasy* series, and the Haniwa Nobbu in *Fate/Grand Order* (Delightworks, 2015).

Figure 7. Haniwa figures excavated from the Nohara Tumulus, Kumagaya-shi, Saitama, Kofun period, 6th century CE, ceramic. Source: Tokyo National Museum (https://webarchives.tnm.jp/).

BEYOND THE AESTHETIC: WHAT COULD POSSIBLY HAPPEN IN 10,000 YEARS?

In the lore of *Breath of the Wild*, we learn how the Sheikahs, a technologically advanced culture, sought to mitigate the threat posed by Ganon: constructing gigantic "divine" creatures, powerful guardians, and meshing the territory with observation towers. The political stability of the region was thus maintained by materialistic features, but the use of these technologies slowly faded. So, when the prophecy announced that Ganon was about to come back, King Rhoam, father of Princess Zelda, seeks solution in the past, literally using archaeology to save the world against evil: "We decided to heed the prophecy and began excavating large areas of land. It wasn't long before we discovered several ancient relics made by the hands of our distant ancestors. These relics, the Divine Beasts, were giant machines piloted by warriors" (*Breath of the Wild*: end of the Great Plateau cutscene). Thus, towers, shrines, and mechanical creatures had remained untouched, merely waiting for the Sheikah slate's activation, suggesting an almost unnatural stasis.

While the Jōmon people were not technologically advanced in the way the Sheikah were, their 10,000-year period allows for interesting parallels, especially in terms of societal and environmental change. The Holocene is a period of dramatic climatic and geographic shifts (Ryu et al., 2005): the Earth gradually switched from the dry and cold climate of the Younger Dryas (12,850–11,650 BP, Before Present), the last cold spell of the Ice Age, to the warmer and wetter climate of the Holocene Climatic Maximum (9,000–5,000 BP, the famous "green Sahara" period), to finally stabilize near modern-day climates. During this period, the huge amounts of melted ice provoked a 40 m sea level rise along the Japanese coasts, an episode known as the Holocene marine transgression (Umitsu, 1991).

With these more clement climatic conditions, agriculture could develop gradually and independently in several regions of the world: the Middle East, south-east Asia, South America, and Africa (Gupta et al., 2004), ultimately leading neolithization, sedentary lifestyle, the appearance of cities, states, etc. These periods are rich in events, with complete civilisations gradually thriving and declining over the millennia. However, Jōmon people followed their own path, and did not develop agriculture but instead relied on a very specific lifestyle, based on the exceptionally rich ecosystems of the archipelago (Matsumoto et al., 2017). There are endless typologies of Jōmon ceramics that testify the temporal and re-

gional evolution of the different populations in the Japanese archipelago, and it is possible to distinguish different adaptations to changing environments. For example, littoral groups were "maritime foragers", and maximised their use of marine resources, building large shell middens (domestic wastes mainly composed of marine molluscs), while other hinterland groups stored mainly acorn and chestnuts. However, the core of their societies kept its Mesolithic features, at a time when most of the world was marching toward neolithization (or to be precise, Neolithic people were marching to conquer the world, see for example Brace et al., 2019).

This "garden of Eden" theory was initially developed upon North American societies that rely on intensive hunting, fishing and foraging strategies, but which also developed sedentism, "complex" cultural traits and high population density (Cannon & Yang, 2006). These populations notably stored seasonal resources like salmon, a trait which is also present among certain Jōmon groups (Okada, 1998), hence the importance of ceramics to preserve food through the periods of scarcity. Even if the Jōmon population fluctuated steadily over the millennia, it may have reached a peak of 260,000 people during the Middle Jōmon (Habbu, 2004). Likewise, we might wonder how Hyrule's societies evolved — or perhaps failed to evolve — during its own long stretch of history, with technological remnants persisting despite evident population changes. Link, as most of other Hyrule inhabitants, is an Hylian, not a Sheikah, suggesting a form of population replacement. Hylians' white skin and artifacts evoke European medieval periods and are depicted as positive imperial forces, while the Gerudos are portrayed as stereotypical easterners dwelling in the desert, in an idealistic colonial scheme (Kimball, 2018).

Jōmon people presents here different characteristics that interrogate classical concept of anthropology, like the opposition between Palaeolithic hunter-gatherers and Neolithic farmers, in the exact same way Alain Testart did in his article "Of hunter-gatherers or on the origins of social inequality" (Testart, 1982). The sedentism and the use of ceramics to store food are generally considered neolithic features, but they are present here in Jōmon societies. Testart was also a convinced cultural evolutionist, for whom the concept of state was already present in early societies (Testart, 2004). Despite the length and the relative stability of the Jōmon period, there is no evidence of the formation of any centralised authority. In his famous essay "*La société contre l'État*" ("Society against the State"), Pierre Clastres (1974) argues that the societies without centralised authorities are not primitives, quite the contrary: they have succeeded in inventing a politics which is not obliged to resort to coercion. Could the Jōmon have invented a "society against the Neolithic"?

Despite the geographic and climatic fluctuations of the Holocene, the Jōmon culture is a remarkably stable one, achieving a sustainable lifestyle over 10,000 years (Watanabe, 2004), once again echoing the artificial immutability of Hyrule. This is particularly true compared to other regions of the world: over the same Holocene period, the Middle East saw the appearance and spreading of Neolithic cultures, invention of irrigation and it corollary the environmental collapse and desertification of the Tigre and Euphrates River system, the rise and fall of Mesopotamian, Assyrian, and Egyptian empires. Under this aspect, the Jōmon appears as a steady example of long-term, harmonious relationship of a relatively dense human population with its environment.

Conclusion

The game developing team's careful integration of Japanese archaeological and historical heritage, especially from the Jōmon period, into *Breath of the Wild*, reflects the enduring influence of the Japan's ancient past on contemporary culture. The incorporation of 10,000-year-old narratives in the game, rooted in Japan's prehistory, not only adds a layer of immersive lore but also

reflects Japan's societal connection to ancient times. By drawing from the Jōmon period's artifacts' unique aesthetic, such as the *kaen doki* flame pots and dogū figurines, the game goes beyond pure entertainment, inviting players —particularly those familiar with Japanese history — into a dialogue between the past and present. The main protagonist's name is Link, after all (Audureau, 2012).

This connection between archaeology and national heritage is not unique to *Breath of the Wild*. However, this title marks a departure from the *Mukokuseki* (無国籍) — the "stateless" or "ethnically neutral" characters of its predecessors — aligning instead with the "Cool Japan" policies promoted by the Japanese government, which emphasizes cultural exportation and soft power. Some authors go even further in the nationalist intentions of the game designers and interpret the Sheikahs as a wise and ancient Japanese race from which Link, the western medieval Hylian, seeks advanced technologies (Herfs, 2020). In this perspective, *Breath of the Wild* represents the first episode of a new conception of Zelda games, using different world regions and cultures as a support to explore new gameplay experiences, in a similar approach as Ubisoft has made with the *Assassin's Creed* series. The following opus, *Tears of the Kingdom* (2023), jumped from prehistoric Japan to the pre-Columbian world, reinterpreting the Nazca's geoglyphs of Chala's region in Peru (Verdier, 2023).

In this context, the developing team's thoughtful design goes beyond gameplay, offering players a profound exploration of Japan's historical consciousness — an intricate tapestry of time, memory, and artifacts. *Breath of the Wild* becomes an interactive journey through both Hyrule and the deep layers of Japanese identity and national heritage.

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Acknowledgments

The author would like to thank Bruno de Figueiredo for his knowledge about Jōmon references in video games, and the Journal of Geek Studies editorial panel for their helpful suggestions.

About the author

Dr Jean-François Cudennec is a postdoctoral researcher with a background in marine biology, a PhD in archaeology of shell middens (hence the passion for the Jōmon), and is now working as a palaeontologist, using marine molluscs' shells to investigate past climates and environments at the University of Derby (UK). The interdisciplinary aspect of his research probably twisted his mind enough to push him to dig in this very specific rabbit hole. He grew up with *Zelda* games, from *Link's Awakening* on the venerable Game Boy to the most recent opus on Switch, and struggle every day to maintain a balanced relationship with the virtual world.

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Xenomorphia ex machina: the zoology and biochemistry of xenomorphs from the *Alien* franchise

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In science fiction, the xenomorph emerges as a creature that transcends the boundaries of traditional extraterrestrial movie knowledge (Fordham, 2023). From the corridors of the spaceship *USCSS Nostromo* to the haunting silence of the primordial exoplanet Acheron LV-426 (Flowers, 2020), the creature created by Ridley Scott and H.R. Giger has become the symbol of alien terror in movies and in collective imagination (Domino, 2019).

Beyond the movies, xenomorphs can also be seen as a zoological and biochemical scientific challenge (Chemist, 2017). The cinematic universe of *Alien* introduces the xenomorph as an alien force, both literally and metaphorically (Feel No Pain, 2023). Our exploration begins with an examination of their hypothetical taxonomic classification, an attempt to place these creatures within the framework of known biological diversity (Pratt, 1972).

TAXONOMY

Taxonomic levels presented in this paragraph are based only on morphological features not considering genomic analysis due to the absence of DNA sequences for fictional creatures. Some characteristics are shared between the various classification levels of living organisms and can be used as comparative parameters for our speculation.

The xenomorph's multicellular structure serves as a cornerstone for its classification within Animalia (Ros-Rocher et al., 2021). Its intricate organization of cells, tissues, and organs reflects a level of biological complexity commonly associated with animals. Xenomorphs can be included into the Arthropoda phylum due to the morphological similarities shared with certain terrestrial arthropods such as an exoskeletal structure, a segmented body plan, the presence of hemolymph, etc. (Akam, 2000). Xenomorphs and chelicerates can be morphologically connected, justifying its classification within the class Chelicerata (Sharma, 2018). Similarities are shared in limb structure and mouthparts, aligning the xenomorph with arachnids. The chelicerate-like tail, i.e., the telson, is a distinctive hallmark of the xenomorph, further reinforcing this classification (Howard et al., 2019). In recognition of the xenomorph's unparalleled morphology and extraterrestrial origin, a novel taxonomic order,

Cite this article as: Tonietti, L. & Gargallo, G.C. (2024) Xenomorphia ex machina: the zoology and biochemistry of xenomorphs from the Alien franchise. Journal of Geek Studies 11(2): 125-132. https://doi.org/10.5281/zenodo.14218797

Xenomorpha, is proposed. This order serves as a specialized category crafted to accommodate the unique characteristics exhibited by the xenomorph. The family Xenomorphidae emerges as the categorization that embraces the diverse variations among different xenomorph species depicted in cinematic portrayals. This taxonomic family acknowledges the variability within the xenomorph lineage, providing a framework to encapsulate the differences observed in various cinematic depictions such as the dog-xenomorph in *Alien 3* or the neomorph in the new franchise. The family is also based on the original host of the facehugger. At the genus level, the overarching features shared among diverse xenomorph variants coalesce under the name *Xenomorphus*. This taxonomic designation emphasizes the exoskeleton, the scorpion-like tail, the acidic blood, and all the characteristics of some arthropods, as a central unifying trait among different xenomorph manifestations. The species name, *Xenomorphus extraterrestris*, encapsulates the xenomorph's extraterrestrial origin. While maintaining a taxonomically specific identity, this nomenclature acknowledges the unique evolutionary path and biological distinctiveness of the xenomorph within the proposed taxonomic framework.

MORPHOLOGICAL FEATURES

Xenomorphs are extraordinary animals with unique characteristics that let them be able to colonize extreme environments, occupying every single niche. As for some living organisms on our planet, xenomorphs can be considered extremophiles; particularly, they can be defined as polyextremophiles as shown in the different movies. They are able to survive in many different environments spanning from the cold interstellar space to the extremely hot furnace in *Alien 3* (1992). Their ability to thrive and hunt in extremely harsh conditions could be due to their morphological features such as the robust exoskeleton, the scorpion-like tail and some biochemical adaptations, e.g., the acidic blood.

Exoskeleton. The xenomorph's exoskeleton is a structure composed probably of a unique amalgamation of chitin and other resistant organic compounds, and stands as the main characteristic of resilience. As depicted in *Aliens* (1986), it not only serves as a protective barrier against flamethrowers and bullets but also showcases an adaptability akin to the exoskeletons found in Earth's terrestrial arthropods (Giribet & Edgecombe, 2019). The cinematic narrative mimics the real-world resilience observed in beetles, renowned for their robust exoskeletons that withstand different adversities (Nagasawa, 2012; Stamm et al., 2021).

Cephalothorax. A defining feature inspired by arachnid anatomy is the xenomorph's cephalothorax that takes a focal point in its anatomical design, as observed in *Alien: Resurrection* (1997). The emphasis on the xenomorph's cephalothorax reveals a carapace that not only shields vital sensory organs but also integrates with the creature's sensory systems as shown by the tube-like structures on the back that are probably chemo-sensors or the breathing system, similar to the book-lungs of arachnids (Machalowski et al., 2020).

Figure 1. The whip spider *Heterophrynus* sp. (Amblypygi). The chelicerae and the sensory appendages of the xenomorphs are similar to the ones found in whip spiders. Source: Wikimedia Commons (G. Wise, 2014).

Chelicerae. The xenomorph's chelicerae are a captivating feature, as shown in *Alien* (1979), offering a glimpse into their preda-

tory arsenal. Chelicerae are probably reminiscent of the efficient mouthparts seen in arachnids, horseshoe crabs, and sea spiders, unfolding as multifunctional tools that play a pivotal role in the xenomorph's hunting and defensive strategies (Sharma, 2017). In the whole series of movies, it is evident that the fangs, pincers, or jaws of the xenomorphs are transparent, maybe suggesting that they are hollow and they can contain some venomous glands. In addition to the arachnid-like chelicerae, xenomorphs also present a predator inner jaw that mimics the one found in moray eels (Johnson, 2019).

Figure 2. Moray eel (Muraenidae). With the inner jaw the moray eel inspired the mouth of the xenomorph in all the franchise. Source: Wikimedia Commons (M. Ströck "Mstroeck", 2006).

Limbs. Prominently featured in *Alien 3*, the xenomorph's segmented limbs can be seen as scythe-like talons contribute to a predatory adaptation (Panganiban et al., 1995). The segmented structure of the limbs offers both flexibility and strength (Gao et al., 2012), allowing the xenomorph to transition between stalking its prey and executing lethal strikes. A behavior that we can also find in some animals such as mantis shrimps (Stomatopoda). The dynamic mobility enables the xenomorph to move in different environments with agility, from the confined spaces of spacecraft to the corridors of alien worlds.

Figure 3. *Odontodactylus scyllarus*, the mantis shrimp that inspired the exoskeleton and limb morphology of the xenormophs. Source: Wikimedia Commons (National Science Foundation, 2004–2008).

Scorpion-like tail. The xenomorph's elongated segmented tail, featured in all the franchise, emerges as one of the most fascinating morphological characteristics with a multifaceted purpose. This tail, complete with a stinger or a telson that serves as offensive and defensive roles, aligns with the multifunctional tails observed in scorpions (Lourenço, 2018; Carmichael, 2022). Differently from them, the tail of xenomorphs does not seems to contain a venomous substance.

Figure 4. *Centruroides sculpturatus* with its typical telson and tails. Source: Wikimedia Commons (A. Meeds, 2022).

Extraterrestrial ovipositor. The extraterrestrial ovipositor (seen only for xenomorph queens) facilitate the precise implantation of embryos into host organisms. The xenomorph's ovipositor showcases reproductive adaptations reminiscent of certain wasps (Quicke & Fitton, 1995). In the movies, the massive tube-jelly-like organ that composes the whole ovipositor is

evident. It seems that the queen is not able to move freely when connected to this structure, which can be removed when necessary.

XENOMORPH BIOCHEMISTRY

Acidic hemolymph

The acidic hemolymph of xenomorphs is a hallmark of their unique biochemistry. Hypotheses surrounding the origins of acidity point towards an unconventional enzymatic cascade within the xenomorph's hemolymph, potentially involving hyper-reactive acid-base equilibria (Grifoni et al., 2019). We can hypothesize the presence of specialized enzymes capable of generating highly acidic intermediates during metabolic processes.

Thus, we could hypothesize, for instance, the presence of organic acids such as thioacids and haloacids in xenomorph hemolymph, which would raise questions about the biochemical pathways responsible for their synthesis and their specific roles in maintaining the acidic milieu (Dong et al., 2018). Thioacids, known for their strong acidic properties, present a fascinating topic for exploration (Ulrich & Jakob, 2019; Wang et al., 2022). The reactivity of these thioacids could serve dual purposes, acting both as defensive agents against external threats and as key components in the xenomorph's metabolic processes.

The possible presence also of haloacids, featuring halogen atoms such as chlorine, would introduce another layer of complexity to xenomorph biochemistry (Su et al., 2016). The incorporation of haloacids into the acidic hemolymph could enhance corrosive properties, potentially explaining the rapid degradation observed in xenomorph blood interactions with various materials (e.g., HF if able to corrode glass). Drawing inspiration from terrestrial haloacid-tolerating organisms (Wang et al., 2021), the xenomorph's ability to synthesize and deploy these acids unveils a biochemical strategy that extends beyond conventional defensive mechanisms.

Determining the acidity of the xenomorph hemolymph involves making several assumptions due to the speculative nature of the creature and its fictional biochemistry. However, we can discuss a hypothetical scenario. Sulfuric acid is a strong acid, and its derivatives could contribute to the xenomorph hemolymph acidity. If we consider a concentration of 1 M sulfuric acid, the pH would be approximately 0 (all the protons of the acid are released into the solution). The xenomorph's hemolymph may contain a mixture of acids, such as thioacids and haloacids. We can assume a collective concentration of these acids equivalent to a 1 M solution of hydrochloric acid. Using the Henderson-Hasselbalch Equation:

$$pH = pKa + \log([A^-]/[HA]),$$

we can assume a pKa of -log(1), and a 1:1 ratio of dissociated (A-) to undissociated (HA) acid, giving a pH result of approximately 0.

Chemist (2017) suggested that the acidic composition of the hemolymph could be the superacid $HF \cdot SbF_5$ or a mixture between minor components, such as hydrofluoric acid (HF), sulfuric acid (H_2SO_4), hydrochloric acid (HCl), and nitric acid (HNO_3).

The purpose of xenomorph blood is also explored through comic book lore, particularly from Lasalle Bionational's research in the *Aliens vs Predator* series (Xenopedia, 2024). According to this lore, xenomorph blood serves as a biological battery, generating a powerful bio-electric charge through a chemical reaction. This unique energy source replaces the need for traditional respiration and digestion, which raises questions about how xenomorphs might recharge this energy source, leading to the eventual death of the creatures in case it is not renewable (Chemist, 2017).

The concept introduces an intriguing idea that xenomorphs have evolved a more efficient energy source than humans. While humans rely on consuming food for energy

through oxidation/reduction reactions, xenomorphs use a stream of electrons as a power source, similar to recently discovered organisms on Earth, e.g., chemolithophilic organisms. This alternative energy pathway suggests a unique evolutionary path for the xenomorphs, making them "cosmically tenacious".

Exoskeletal resilience

Unlike typical corrosive substances, the xenomorph's acidic hemolymph displays a specificity in its corrosive action. Hypotheses propose the presence of molecular inhibitors within the exoskeleton, forming a protective barrier against the acid's corrosive effects (e.g., Wang et al., 2018). One potential candidate is a class of chelating agents that selectively bind to metal ions, preventing them from participating in the acid-base reactions responsible for corrosion (Gulcin & Alwasel, 2022). To resist the extremely acidic conditions of the hemolymph, the exoskeleton could be composed by anti-corrosive substances such as fluoropolymers. Polytetrafluoroethylene (PTFE) stands out as one of the best molecular candidates for composing the exoskeleton of xenomorphs, owing to several distinctive characteristics. Firstly, it is renowned for its extreme chemical inertness and high-temperature resistance. Being a fluorine-based compound, it does not react with hydrofluoric acid, showcasing resistance to chemical agents. It is well-documented that xenomorph chitin-like structure (Elieh-Ali-Komi & Hamblin, 2016) retains its resistance to acid even after the creature's demise or the removal of its exoskeleton as shown in *Alien vs Predator* (2004). The chemical inertness of PTFE would be crucial in ensuring the durability and resilience of the xenomorph exoskeleton. The high-temperature rating of PTFE would also allow xenomorphs to operate in extremely hot environments without compromising their physical abilities as shown in *Alien 3* when molten metallic substances are poured onto xenomorph's body.

The fluorescent color

The vivid fluorescent green/yellow shade of xenomorph hemolymph introduces another layer of mystery to its biochemistry. Fluorescence in biological systems often stems from the presence of specific molecules, and in the case of xenomorphs, hypothetical bio-fluorophores would contribute to this glow. One plausible candidate is a family of polyaromatic hydrocarbons (PAHs) with extended conjugated systems (Zhang et al., 2020). These molecules, absorbing light at one wavelength and re-emitting it at a longer wavelength, could be responsible for the xenomorph's fluorescent coloration. PAHs are generally known for their stability and resistance to acidic conditions, particularly in comparison to more reactive compounds (Abdel-Shafy & Mansour, 2016). The aromatic nature of PAHs, characterized by a stable ring structure, contributes to their overall resistance to chemical degradation under acidic conditions (Patel et al., 2020). This structural robustness is a key factor in explaining how the xenomorph's fluorescent biochemistry maintains its luminosity even within the context of its acidic hemolymph.

On the other hand, one typical solution in terrestrial organisms for bioluminescence is the luciferin pathway. A phenomenon that occurs in species belonging to very distant phyla, the emission of light plays an important role in the life cycle of the involved organisms (Syed & Anderson, 2021; Ke & Tsai, 2022). By oxidizing luciferins, the enzyme luciferase is able to produce an intermediate excited state oxyluciferin that will later decay to a ground energy state by emitting photons. Given such an ominous name, it is not unlikely that the creators of the xenomorph could have engineered a similar mechanism to that of the luciferase pathway, thanks to their natural prowess in genetic engineering as featured in both *Prometheus* (2012) and *Alien: Covenant* (2017). Special attention must have been paid to stabilize the tertiary structure under such acidic conditions, notably the binding site and the corresponding luciferin sub-

strate, a feat that is more than extraordinary given our current means and knowledge in bioengineering.

PARASITOID BEHAVIOR

It is evident from the movies that there are many different stages in the organism's growth. Beginning with the parasitoid implantation of embryos, a biological relationship is established as the xenomorph utilizes host organisms as incubators for its progeny. This parasitoid interplay is exemplified in *Alien*, where a facehugger marks the initiation of the xenomorph's life cycle (Kuris & Luo, 2023).

As the xenomorph's life cycle progresses, the chestburster emerges. The xenomorph's ability to change different host species emphasizes its parasitoid versatility (e.g., Manwell, 1957). This flexibility is exemplified in *Alien 3*, which showcased the infection of the dog in the facility by a facehugger, and in *Alien: Covenant*, which introduced the neomorph, a variant of the xenomorph species displaying distinct parasitic characteristics. Thus, the seed of the xenomorph, the "black goo" (Chemical A0-3959X.91–15), serves to illustrate the skills of the extraterrestrial creators of the xenomorph. Not only they engineered a lethal weapon, but managed to bypass all the extant species barriers successfully targeting all animal-like life-forms.

Figure 5. *Ampulex compressa*, also known as the emerald jewel wasp, which in comparative biology is connected with the parasitic strategy of xenomorphs. Source: Wikimedia Commons (M.M. Karin, 2009).

Giving some real-world analogs, the xenomorph's tactics aligns with those of parasitic wasp, such as species of *Glyptapanteles*, which lays eggs inside caterpillars; the chestburster's emergence mimics the invasive nature of parasitoids in terrestrial environments (Surridge, 2008). Species of the ichneumonid wasp genus *Megarhyssa* use its long ovipositor to deposit eggs deep within wood-boring insects, which is also a striking parallel to the xenomorph's ovipositor and its precise implantation of embryos into host organisms (Crankshaw & Matthews, 1981). In *Alien: Covenant* it is evident the common features between the neomorphs and the parasitic fungi of the genus *Ophiocordyceps*, which manipulate the behavior of their insect hosts (Araújo et al., 2021).

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Acknowledgements

We would like to thank all the people involved in these kinds of scientific speculation and we are grateful to the ExoBioNapoli group, the ExoPlaNats group, and the GiovannelliLab for their support. We thank MUR (Ministero dell'Università e della Ricerca) for the PhD program PON "Ricerca e Innovazione" 2014–2020, DM n.1061 (10/Aug/2021) and n. 1233 (30/Jul/2020). We would like to thank Ridley Scott for the big inspiration in this work. Lastly, we would also like to add this last comment — "Sometimes science inspires science fiction. Sometimes it does not."

An AI tool (ChatGPT, GPT-4, OpenAI) was used to refine the writing style of this article. The authors reviewed, revised, and edited the AI-generated text to their own liking, taking full responsibility for the final content, which reflects a collaboration between humans and machines. To L.T. integrating AI into creative processes is not only a step forward in efficiency but also a glimpse into a future where full AI assistance becomes a reality.

Nomenclatural disclaimer

The taxonomy in this paper is entirely fictional and does not adhere to the rules of the International Code of Zoological Nomenclature (ICZN). The names and classifications used are created for narrative and entertainment purposes only and have no scientific or official value.

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Journal of Geek Studies

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Studying religion in video games: rationale, research approaches, and theory

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Sociological analyses of video game media have accelerated over the past twenty years on the grounds that these creations, like other popular mass entertainment media (movies, TV shows, novels, etc.), are lucrative, popular products of twenty-first century Western culture[1] that embody and express ideas.

Religion is one such form of common expression. Numerous respected anthropologists, sociologists, and religion and media scholars have provided arguments in favor of critically examining how religions are portrayed in video games and how their viewers interpret those representations.

Building on this basis and through my own video gaming experiences and doctoral research, I introduce readers to the critical analysis of video game "texts", why video games have significance for the study of religion, and discuss research approaches for data acquisition and methods for analyzing this data in order to yield data pertinent to broader theory deliberation in the study of religion. These discussions and arguments have been directed toward answering my paper's primary research question: How is religion represented in secular fantasy-fiction video game and film media, and does its interpretation by audiences indicate a pursuit for re-enchantment?

VIDEO GAMES AS LUCRATIVE PRODUCTS OF CONTEMPORARY CULTURE

Video games are a very visible and important part of contemporary culture today (Berger, 2002; Muriel & Crawford, 2018; Cerezo-Pizarro et al., 2023) and incredibly popular. The video gaming industry has evolved into an economic juggernaut in general and in comparison to other lucrative entertainment industries (Bachynski & Kee, 2009; Testa, 2014; de Wildt & Aupers 2017), bringing in an annual global revenue of USD 396.2bn (statista, 2023a), evidently higher than the film ($136bn) and literature ($78bn) industries combined (statista, 2023b). Today there are a staggering 3.09 billion gamers worldwide (statista, 2024b).

The most sold video game globally is *Minecraft* (Mojang Studios, 2011), boasting a

[1] I restrict the scope of my paper to the "West" even though China (statista, 2023d), Japan (statista, 2024c) and other Asian countries have very large gaming markets. This is because North American and North and Western European countries have been the case studies for important theoretical discussions in the sociology and study of religion for several decades on issues of secularization and post-secularization, modernity and post-modernity, and mediatization theory. These topics are directly relevant to my paper's analysis of religion in video game media, its expression therein, and audience interpretations.

Cite this article as: Bishop, J.A. (2024) Studying religion in video games: rationale, research approaches, and theory. Journal of Geek Studies 11(2): 133-146. https://doi.org/10.5281/zenodo.14218885

total of 300 million sales (statista, 2023b). There were 141 million active players monthly in 2021 (statista, 2021) and, in 2024, according to Player Count (2024), 253,188 active players online concurrently. Second in the global ranking is *Grand Theft Auto V* (Rockstar North, 2013) and its impressive 200 million sales figure (statista, 2024a).

In the United States, there are 212 million gamers in total (Statista 2024e), 666 million in China (statista, 2023d), and more than half of Europe's population regularly plays video games (European Commission, 2024). The European Video Games Society 2023 study recognizes video games as "an important part of Europe's cultural landscape, as their artistic and creative dimension distinguish them from other technological products. This growing recognition is clear in terms of policymaking as video games become prevalent in key cultural and creative policy documents" (European Commission, 2024). One of several recommendations is to "[f]acilitate the safeguarding of video games as cultural heritage".

These sales and figures demonstrate that video games cater for a large contemporary audience. Jesper Juul acknowledges the omnipresence of video games: "To play video games has become the norm; to not play video games has become the exception" (Juul 2009: 8).

Eric Zimmerman (2013) refers to a "ludic century". Whereas in the twentieth century linear, non-interactive information with the moving image (film and video) was the dominant cultural form, transformations have led the present century to be one that "has been put at play… The rise of computers has paralleled the resurgence of games in our culture… Increasingly, the ways that people spend their leisure time and consume art, design, and entertainment will be games -- or experiences very much like games" (Zimmerman, 2013: 1–2).

According to scholar and game designer Ian Bogost, "[No] video game is produced in a cultural vacuum" (cited by Trattner 2017: 11). Theologian Kutter Callaway, who has studied the representation of religious ideas in various popular entertainment media, describes video games as "a pervasive cultural form that both reflects and constructs the contemporary cultural imagination, serving as a primary locus of meaning making and identity formation" (Callaway, 2010: 76).

Figure 1. Photo of the panel of speakers at the Digital Games Research Association (DiGRA) Conference in 2018 at the University of Turin (Institute of Digital Games, 2018).

VIDEO GAME STUDIES

The field of video game studies has grown significantly. The organizers of the first international academic journal of computer game research, *Game Studies*, identified 2001 "as the Year One of Computer Game Studies as an emerging, viable, international, academic field" (Aarseth, 2001). Academic journals became dedicated to the study of video games, notably *Game Studies* (2001), *Games and Culture* (2006), and *Eludamos* (2007). Methodological frameworks for analyzing video games were conceptualized (Konzack, 2002; Aarseth, 2003).

The Digital Games Research Association (DiGRA) conference emerged in 2003, appearing first in Utrecht, the Netherlands, followed by conferences in Vancouver, Canada (2005), Tokyo, Japan (2007), and then in Brunel, West London (2009). A series of local DiGRA conferences were established in the likes of DiGRA Australia, DiGRA Nordic, and Chinese DiGRA conferences (Mäyrä, 2021: 536–537).

In December 2007, the University of Potsdam became the first German university institution to study computer games on an interdisciplinary basis after media philosopher Dieter Mersch founded The Digital Games Research Center (DIGAREC) (Günzel et al., 2021: 533). Its work focused on several features of video games, including the structural, aesthetic, technical, and performative aspects. The center continues to host international lectures, workshops, and conferences on the topics of ludic boredom, serious games, in-game photography, and gamification. Having now moved into the 2020s, video game studies has become one of the "fastest-growing branches of media studies" (Wolf & Konzack, 2021: 2180).

INTEREST IN THE REPRESENTATION OF RELIGION IN VIDEO GAMES

Researchers of religion wished not to be left out of the vibrant discussions on the nature of video games. Religion in video games has been a relatively recent yet lively domain of investigation by game theorists and religion scholars. In particular, this topic has enjoyed serious academic attention in the sociology of religion over the last few decades (Partridge, 2004; Possamai, 2005; Cusack, 2010; Davidsen, 2014).

The premise upon which this area of study, whether in game studies generally or by sociologists, theologians, media scholars, or scholars of religion, stands is that "digital games now depict the religious within the twenty-first century," therefore rendering them an important site for critical exploration into the intersection of religion and contemporary culture (Campbell & Grieve, 2014: 14–15).

The "finest games draw from substantive wells in philosophy, mythology, and theology" (Detweiler, 2010: 4). According to the game theorist Mark J. P. Wolf (2018), "[R]eligious and theological ideas can be made manifest in video games, including the appearance of religion and religious iconography within video games and through the playing of video games as a potentially religious activity, especially contemplative ones that vicariously place the player in a different environment".

Peter Molyneux, a well-known game designer, explains that "Clearly God, the divine as a concept, plays a huge role in modern gaming. Virtually every fantasy role-playing game… explicitly includes the divine in the form of priests calling down healing prayers or smiting evil foes" (Murdoch, 2010). According to the academic contributors to an online series on this topic by the Berkley Center for Religion, Peace & World Affairs, "the human construct with which video games have most in common isn't television or literature or warfare but religion… It is a practice in rituals, ethics, moralities, and metaphysics" (Berkley Forum, 2019).

Sociologist William S. Bainbridge, who has spent considerable time studying video games sociologically, says that through them the player "experiences a marvelous world, often for many hundreds of hours, frequently encountering religious symbolism" (Bainbridge, 2013: 3). These gaming virtual spaces allow players to experiment with new worldviews in which gods from diverse religious and mythological traditions coexist. They appeal to the "*homo* [sic] *fantasia*", the fantasizing and imaginative human (Morehead, 2010: 183).

Around the same time, many researchers acknowledged the lack of critical analysis of religion in video games and the need for more scholarly attention (Campbell & Grieve, 2014; Vallikat, 2014: 9), and presented *apologia* for why scholars interested in religion or theology should take video games seriously (Detweiler, 2010; Corliss, 2011; Campbell & Grieve, 2014; Vallikat, 2014; Campbell et al., 2015; Bosman, 2019).

In 2007, in a panel entitled "Born Digital and Born Again Digital: Religion in Virtual Gaming Worlds", scholars presented their work on religiously themed games, the problematic appearance of violent narratives in religious gaming, and the rise of the Christian gaming industry. The following

year, the panel "Just Gaming? Virtual Worlds and Religious Studies" discussed the use and presence of religious rituals and narratives in mainstream video gaming.

The need for a more focused study of religion in gaming and virtual worlds led to the release of a slew of landmark publications, notably *Halos & Avatars: Playing Video Games with God* (Craig Detweiler, 2010), *Godwired: Religion, Ritual and Virtual Reality* (Rachel Wagner, 2011), *eGods: Faith versus Fantasy in Computer Gaming* (William S. Bainbridge, 2013), *Of Games and God: A Christian Exploration Of Video Games* (Kevin Schut, 2013), *Playing with Religion in Digital Games* (Heidi A. Campbell & Gregory P. Grieve, 2014), and *Methods for Studying Video Games and Religion* (Vít Šisler, Kerstin Radde-Antweiler & Xenia Zeiler, 2018).

Journals, such as *Gamenvironments* (2014–present) and *Online - Heidelberg Journal of Religions on the Internet* (2004–2010 and 2014–present), continue providing substantive critical analyses of religion in video games, while many researchers have made this the central topic for their dissertations (Corliss, 2011; Kim, 2012; Perreault, 2015; Tregonning, 2018; Bishop, 2022–).

Figure 2. Top left: The fiery symbol of The Golden Order, a philosophical and theological movement in *Elden Ring* (Bandai Namco Entertainment, 2022), symbolizing the reign of Queen Marika the Eternal and the removal of the Rune of Death from the Elden Ring (Microsoft, 2024). Top right: A digital rendition of Notre-Dame (Beck, 2019), a fully explorable location in *Assassin's Creed Unity* (Ubisoft, 2014). Bottom left: Also known as "The Father", Joseph Seed, a messianic-like figure who is the main antagonist of *Far Cry 5* (Ubisoft, 2018) and founder of the fictional Hope County-based extremist religious cult called Project at Eden's Gate. Bottom right: *Call of Duty: WWII* (Activision, 2017) depicts a battle in the French town of Marigny, which requires players to capture the local church that functions as a German stronghold (UnseeableNinja, 2022: 2:43 min).

ENCOUNTERING RELIGION IN VIDEO GAMES

A number of scholars and researchers have articulated the ways in which religion is expressed by and encountered in video games (Love, 2010; Ferdig, 2014; Bosman, 2019).

In my view, religion features in most video games in some way, to varying degrees, and arguably across almost all genres ranging from first-person shooters to real-time strategy, action-adventure, survival horror, the walking simulator, high fantasy role-playing, and so on. Some genres evidence a greater level of expression, particularly high fantasy role-playing games where mythological themes, creatures and stories, and magic and supernaturalism are particularly frequently encountered (Aupers et al., 2018: 2).

Yet, even in video games in which religion is unlikely the first idea to come to mind, religious imagery and themes are observed and encountered by players; for example, a segment in *The Last of Us Part II* (Sony Interactive Entertainment, 2020) that takes place in a synagogue in Seattle that, in real life, is the Daniels Recital Hall, or the unhinged religious zealot Longinus from *Far Cry 4* (Ubisoft, 2014), who offers a unique spin on some major biblical texts while supplying the player with useful armaments needed for surviving the fictional setting of Kyrat.

In addition, religious controversies may erupt around video games, which some might argue do not intentionally emphasize religion at all. Notably, the combat that takes place inside a digital version of the Manchester Cathedral in *Resistance: Fall of Man* (Sony Computer Entertainment, 2006), a video game attentive primarily to an alien invasion of Earth, led to the Church of England to publicize its disapproval of a purported act of desecration, as well as copyright infringement (Fernández-Vara, 2019).

Walking simulators are particularly known for their ability to tell stories (Carbo-Mascarell, 2016; Catalan et al., 2024), literally having players "walk" through a narrational script. *Everybody's Gone to the Rapture* (Sony Computer Entertainment, 2015) evokes the Christian eschatological concept of "rapture" while also containing religious images and locations, such as a quaint church and balls of light reminiscent of spirits existing after the death of the physical body.

Figure 3. Side-by-side representations of the Manchester Cathedral (Bhasin, 2016). The top is a photo of the inside of the cathedral. The bottom image is the artistic rendition of it in *Resistance: Fall of Man* (Sony Computer Entertainment, 2006).

In such cases, compared to what many might think, religion is more present in video game material than perhaps realized. This is not lost on researchers themselves. According to culture scholar Mark C. Love, the ways "religion is used in video games are legion" (Love, 2010: 208).

It is used creatively, serving existential, experiential, narratological, and ludological purposes: [1] Functionally, as a gaming mechanic, to serve as "tool [that] one [the player] uses to suppress dissent, put down rebellions, gain bonuses (items and stats), and accomplish goals"; [2] narratologically, it "improves the fiction by making for a

great story… [and] a believable world"; [3] elucidating the driving motives and moral backgrounds for in-game avatars or characters that players control; [4] utilized creatively by game developers in the form of "clever puns" or included merely as "trite throwaway allusions"; [5] experientially for players, religion gives a numinous/Gnostic/mysterious aura to the video game; and [6] existentially/reflexively, religion in a video game can be a way for a player to express identity, as well as a "tool players use to fantasize and deal with the lack of certainty and efficacy in the real world".

Theologian Frank G. Bosman (2019) offers a typology of five "shapes" referring to ways in which religion is encountered by players: [1] material (religious artefacts, buildings, clothes, items, and so on); [2] referential (implicit or explicit references to an existing religious tradition existing externally to it); [3] reflexive (the video game uses existential ideas traditionally associated with religion); [4] ritual religion (when players engage with in-game activities that are traditionally associated with religion, which can be either intended by the developers or happen spontaneously); and [5] gaming as religion or as a religious act (the experience of gaming itself being identified as religious, by developers and/or players).

Another helpful perspective is given by Richard Ferdig, in which he outlines four areas where one may study the relationship between religion and video games (Ferdig, 2014: 71–77): [1] Game content: content explicitly related to religion; [2] Game context: story, environments, and situations within the game that explicitly or implicitly refer to religion; [3] Game challenge: actual goals and presupposed outcomes of the game that are connected to religion; and [4] Player capital: the religious element introduced by the gamer himself or herself.

APPROACHES FOR STUDYING RELIGION IN VIDEO GAMES

We now shift focus to the appropriate ways the researcher might approach his object of study. In video game research, two major approaches are apparent: the actor-centered and game-immanent (Heidbrink et al., 2014; Bosman, 2016). Both follow naturally from the perspective that video games, being products of culture, can be critically studied as "textual material" or "texts", availing themselves to researchers. Religious and spiritual concepts and themes within them are open for exploration (Campbell, 2012).

The actor-centered approach places focus not on the researcher but on the experiences of other players, typically involving interviewing and/or observing a certain number of players engaging in the designated game or game sequence. The researcher can learn and understand the emotions, cognitions, and/or notions of the player and to what degree games influence players' religious beliefs.

The game-immanent approach, moreover, entails the researcher playing the video game being studied. This approach emphasizes the interactive experience of playing. The researcher must think carefully about how he is to understand himself as a player and how to acquire pertinent data for analysis,

> *"What type of player am I? Am I newbie, casual, hardcore? Do I know the genre? How much research should I do prior to playing? Do I take notes while playing? Keep a game-diary, perhaps? Or do I just go ahead and immerse myself, and worry about critical analysis later? Some games are fast, some are slow; should we approach them differently? Should we record ourselves while playing? How do we analyze a game we are not very good at?"* (Aarseth, 2003: 3).

These two approaches should not be considered contradictory or mutually exclusive (Aarseth, 2003), as both have academic validity and should ideally be combined (Bosman, 2016: 37). Espen Aarseth considers both being required, although clearly underscores the game-immanent approach,

> *"Firstly, we can study the design, rules and mechanics of the game, insofar as these are available to us, e.g. by talking to the developers of the*

game. Secondly, we can observe others play, or read their reports and reviews, and hope that their knowledge is representative and their play competent. Thirdly, we can play the game ourselves. While all methods are valid, the third way is clearly the best, especially if combined or reinforced by the other two." (Aarseth, 2003: 3).

William Bainbridge (2013), in *eGods*, emulated an internal or game-immanent approach, spending a sizeable 2,400 hours in *World of Warcraft* (Blizzard Entertainment, 2004–), during which he experimented with twenty-two avatars[2] of every class and race and participated in player guilds. Bainbridge planned exactly what his avatars would do in World of Warcraft's virtual world to gain relevant data. His research built upon the idea that through the user-controlled avatar, the player experiences religion and engages in meaning making that occurs in the digital space. One should agree with Aarseth that "if we [as researchers] have not experienced the game personally, we are liable to commit severe misunderstandings, even if we study the mechanics and try our best to guess at their workings" (Bainbridge, 2003: 3).

METHODOLOGIES

Various research methodologies are suitable in video game studies. Critical discourse analysis (Trattner, 2017: 11–25), surreal impersonation (Bainbridge, 2017: 50–77), phenomenological hermeneutics (Fiadotau, 2017: 77–89), empirical triangulation (Gandolfi, 2017: 89–115), normalized social distance (Šlerka & Šisler, 2017: 129–143), and socio-phenomenological (Waltemathe, 2014) methods have yielded valuable insights (refer to Heidbrink & Knoll, 2015, for critical analyses of some of these methodologies).

For my dissertation, I am using thematic analysis. It is a useful method because of its inclusivity, allowing one to derive data from a range of sources, including texts, 'traditional' face-to-face data collection methods such as interviews, and focus groups (Terry et al., 2017: 10). The question for the researcher is then which method of data acquisition is best suited for answering his primary research question.

In many instances where the subjective views of individuals participating in the study are concerned, qualitative interviews are required. The minimum number of qualitative interviews is roughly twelve to obtain data saturation.

I view text as broad. Although traditionally understood as referring to "any discourse fixed by writing" (Ricoeur, 1981: 14, cited by Bosman, 2016: 31), texts' arsenal also includes films, paintings, clothes, architecture, and video games (Buerkle, 2008: 26–35). Many researchers consider it appropriate to perceive or define video games as "texts" (Beavis et al., 2009; Apperley & Beavis, 2013; Beavis, 2014; Mummart, 2014; see Cox's [2014] four-part series).

The approximately 100 hours I spent in The Lands Between of *Elden Ring* (Bandai Namco Entertainment, 2022) as both a player and a researcher assisted me in making progress toward answering my main research question, though my research is still ongoing. It has been some time since I have been in its inspired luminous and bricolage virtual world, so The Lands Between call to me again.[3]

Using thematic analysis to analyze data derived from internal and external readings, I can discover dominant themes in the data, which are then explained in greater detail (Terry et al., 2017: 6). This requires sifting through data and looking for pat-

[2] A player-controlled character is called an avatar. It serves as a tool of digital visualization and representation that allows the player to interact with the virtual world or environment of a video game. Scholars have not overlooked the phenomenological importance of player-controlled avatars (Bessière et al., 2007: 540; Livingston et al., 2014; Vallikatt, 2014: 25).

[3] I decided to take a temporary break from my research since relocating to a new country in recent months of 2024.

terns of meaning and common themes, such as repeated ideas, perspectives, and topics (Terry et al., 2017). I can subsequently theorize why these themes are prevalent and why they are so meaningful for some players.

By examining the subjective, phenomenological perspectives of gamers, researchers have discovered some interesting findings.

Sociologists Julian Schaap and Stef Aupers examined players' phenomenological understandings and interpretations of religion through 22 qualitative interviews, based on player engagement with the religious or spiritual aspects of *World of Warcraft*. I find inspiration in their qualitative, phenomenological analysis for my own study.

Phenomenologically, as Schaap and Aupers describe, player engagement could evoke a search for "ultimate meaning" (Schaap & Aupers, 2017: 16). As a result, based on their gaming experiences, a number of players talked about their exploration of real-world religions, including Buddhism, Confucianism, Daoism, and Hinduism, based on in-game interactions with factions and cultures like the Tauren and Pandarian.

Inversion, or the propensity for certain players to build avatars that convey worldviews that differ from their own, was also encouraged by engaging with *World of Warcraft*'s religious features (Schaap & Aupers, 2017: 12). Deviant, controversial, marginalized, or even immoral behaviors could thus be creatively experimented with by players. Christian players, for example, could "create stories in which belief in god(s) and supernatural influence is denied and by focusing a character's powers on nature's potential or physical strength" (Schaap & Aupers, 2017: 12). An example of this could be the expression "of the self that they [players] have found necessary to suppress or efface in the offline world" (Robinson, 2007: 98), as in a Catholic player who experimented with an atheist identity as a "guilty pleasure" (Schaap & Aupers, 2017: 13).

A number of players chose avatars that reflected or mirrored their own worldviews and life experiences. For example, one player's avatars depicted the religious struggles she had as a teenager, and Lance, who suffered trauma from a negative religious experience as a child and commands an avatar that harbors a deep hatred for the gods (Schaap & Aupers, 2017: 14).

Furthermore, some players' perspectives toward religion were altered by their interactions with religion in *World of Warcraft*. Colin, a self-described materialist, claimed that he was "always open to things" after coming across supernatural beliefs and forces in the game's universe (Schaap & Aupers, 2017: 15). In their interviews, a number of players also noted that they felt more at ease with the supernatural beings in *World of Warcraft* because they were real and visible in the game, which they contrasted with their offline encounters with religious people when talking about theological ideas (Schaap & Aupers, 2017: 15).

Through my own research, one interviewee, Tom[4], who is an avid fan of the *Dark Souls* franchise, evidently held strong feelings about the nefarious use of religion for power and its ability to engender madness in important characters. He pointed out Pontiff Sulyvahn, the penultimate boss of the Anor Londo castle, in *Dark Souls 3* (Bandai Namco Entertainment, 2016). He feels that "the whole series is meant to leave you depressed".

> *"I feel sad when I see it, as someone who appreciates the good that religion can create in a society, I feel sad when I see people abandon religious or spiritual views out of fear for their status in society. One also needs to know that systemic corruption was present in the royal*

[4] This particular interview with Tom will not be included in my final paper; rather, it served as a mock trial using qualitative interview questions that I created. I plan on doing another interview with Tom later.

family and how they ran Anor Londo and Lothric Castle, so seeing how corruption has destroyed corrupt people can create a feeling of justice. But mostly it's just sadness."

Yet, why this issue specifically? As a former anti-theist turned devout Christian who has worked in the ministerial sphere tasked with sharing the gospel with unbelievers in his sociocultural context, Tom realizes how the evils perpetuated in the name of religion can prove disastrous for these efforts. Critics of religion frequently point this out in their discussions with the religious.

Further, he observes fellow Christian believers abandoning their faith in their society, although he does not describe what type of society this is. Rather than being a source of corruption and embarrassment, religion has, in his view, significant good to offer society. For Christians, this goodness lies in what Tom says is the heart of the Gospel, namely the salvific work God has done through Jesus Christ's sacrifice on the cross and sharing this good news through deeds of charity and support for the poor, ill, and vulnerable. Tom is therefore particularly upset when fellow believers abandon Christianity, which, he believes, negates doing good for society's most vulnerable and needy.

As these examples show, qualitative interviews can draw out the real feelings that players have when encountering and reflecting on religious themes in their favorite video games.

THEORY IN THE STUDY OF RELIGION AND MEDIA STUDIES

Theory depends on data. Since hypotheses cannot be developed, tested, revised, or abandoned in the service of knowledge advancement without evidence, data is essential to comprehending social phenomena.

In the sociology of religion, debates have raged for decades, perhaps even centuries, over the role and influence of religion in modern Western societies. In this case, secularization and modernity occupied central roles and each boast notable supporters and detractors, all of whom derive and/or vigorously advocate and defend their views based on sociological data (Casanova, 1994; Lambert, 1999; Stark, 1999; Bruce, 2002; Dobbelaere, 2006; Berger, 2011; Clark, 2012; Gauthier, 2021).

The argument over the role of religion in society has persisted well into the twenty-first century (Dobbelaere, 2006; Clark, 2012; Flanagan, 2017; Obirek, 2019), particularly in the wake of the popularization of the "post-secular" by social theorist and philosopher Jürgen Habermas (Habermas, 2008), as well as debates about the Weberian notion of disenchantment (Weber, 1948; Aupers et al., 2018: 4) and the concept of post-modernity (Furseth & Repstad, 2017: 77).

The hypothesis I attempt to test, which has pertinence to these discussions, is the mediatization of religion, considered by Mia Loveheim and Stig Hjarvard (Loveheim & Hjarvard, 2019) to be a modern, secularization process occurring in contemporary industrial Western societies.

Mediatization is when "core elements of a social activity (for example, politics, teaching, religion, and so on) assume media form", which gives media significant power and influence over society (Hjarvard, 2008: 6). Media not only become progressively more autonomous and independent, whereas they previously served other social institutions, but also advocate a logic increasingly adapted by other institutions.

Given the potential changes the media may bring about in religion, called the mediatization of religion, the dependence on and portrayal of religion in the media is of significant interest to researchers and scholars.

The use of religion in the secular media produces a paradox (Hjarvard, 2016). On the one hand, secular mass media have given public visibility to religion and sustained religion's public presence (Hjarvard, 2012: 35). In some cases, media have even

provided cosmologies, rituals, practices, and frameworks for interpreting the world, inspiring new forms of religion in secular societies. Jediism (Possamai, 2011: 245–262; Lyden, 2012: 775–786), Matrixism (Laderman, 2009; Morehead, 2012; Maćkowiak, 2016), Snapeism (Alderton, 2014), and Tolkienism (Davidsen, 2014) are a few examples of new forms of modern religions, which might be called "invented religion" (Cusack, 2010), "hyper-real religion" (Possamai, 2005, 2012), or "fiction-based religion" (Davidsen, 2013) that are based on and/or draw substantially from diverse fantasy-fiction media.

Yet, on the other hand, as a tenet of secularization, media have progressively taken over the functions of traditional religious institutions, thus pushing those institutions closer to the margins of societies. In addition, media is now the primary means by which some Western audiences encounter religion, while traditional institutionalized religious texts have a more limited role (Hjarvard, 2012: 27). So, translating this to my research, a Danish player of the latest edition of *World of Warcraft* or *Valheim* (various publishers, 2021) is much more likely to be exposed to, learn, and reflect about religious and metaphysical themes and concepts while venturing across these digital, virtual worlds than she is from "real-life" religious institutions or sacred texts present in her society.

Natural questions arise: How is religion being represented in secular fantasy-fiction media? Why and how does fantasy media serve as an inspiration for the religious imagination? And does this indicate a desire and longing for re-enchantment in a disenchanted world?

By strategically continuing to participate and inhabit the marvelous virtual worlds of specifically selected fantasy-fiction video games as a researcher (i.e., applying an internal or game-immanent approach), collecting and interpreting information from various sources, such as merchandise, fandom websites and wikis, social media pages, blogs, official developer and publisher websites, novels, and comic books (i.e., an external approach), and interviewing and/or observing the players themselves (i.e., an actor-centered approach), I will go a long way to learning how religion is represented in secular fantasy-fiction media, in particular video games, and how it is being interpreted by audiences, therefore contributing to the evolving academic debate on this fascinating topic. The Lands Between await.

POSTSCRIPT

Since having once again plunged into my research following the aforementioned temporary hiatus, a part 2 will follow this article for the Journal of Geek Studies.

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About the author

James A. Bishop is a PhD student at the University of Cape Town's Department for the Study of Religions. He researches religion and media, with a focus on new religious movements. His interests are diverse, including debates over secularization and post-secularization theories, religious apologetics and legitimation, world religions, fantasy-fiction religions, religious theories, and religious history. James also possesses an inkling of creativity, having earned a degree in Creative Brand Communication, Marketing, and Multimedia Design (CBC), followed by a degree in Theology (majoring in Psychology) (BTH, Community Leadership). James has had a fondness for video games since he got his hands on *Resident Evil* at the tender age of eight, and has expanded his tastes to an array of genres, especially high fantasy.

Journal of Geek Studies

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A history of geek studies

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The past few years of pandemic and deleterious social media have shown us many things about our societies and our species. Among them, one that struck us particularly hard is how misinformation was spread and how the public's trust in science – and most other types of research – eroded. We've seen anti-maskers and anti-vaxxers, often propped up by asinine and/or unethical leaders telling them to drink bleach or that vaccines could turn people into alligators, and we've suffered 7 million deaths due to COVID-19, a grim number that is likely an underestimate. There are complex layers of causes and ramifications surrounding this issue, including the difference between trust in science and trust in science-led policy, but there is one area that we as ordinary researchers can act on – and that is science communication. Engaging with people is one way to build (back) trust in science and experts.

Communicating science to the public is, and has always been, an important part of a researcher's job. Unfortunately, it is also one that is often neglected. Not out of ill will or lack of interest, mind you, but because researchers are stretched thin by the relentless demands of their core responsibilities of conducting research, mentoring students, and teaching, and also by the time they lose to the Kafkaesque bureaucracy and paperwork that permeates academic life. To many researchers (ourselves and several of our colleagues included), sci-comm often happens in whatever free time is left, making it more of a side task than a priority. That is problematic for many reasons, but we won't dwell on that because this introduction has already gotten too depressing. What's undeniable is that, to many researchers, doing sci-comm feels great despite everything else.

Back in 2014, three nerdy graduate students saw the need to start doing some sci-comm of their own. So, we (BMT, RBS, and JVT) got together to write about science in a fun and engaging way. Not just fun for our readers but also fun for us. We felt like simply talking about our own research, or other general new research being published then, things would get very boring really fast. We decided instead that we would bring a pinch of science into our readers' lives through topics that we love and care about:

Cite this article as: Salvador, R.B.; Tomotani, B.M.; Tomotani, J.V.; Soares, H.M.; Cavallari, D.C.; Nagai, M.H. (2024) A history of geek studies. Journal of Geek Studies 11(2): 147-150. https://doi.org/10.5281/zenodo.14251931

games, anime, manga, D&D, sci-fi, and anything and everything geeky out there.

So, we started a blog, with simple and short articles. But we quickly realized that it could become something else. The blog was quickly put in the incinerator, and we reshaped our initial idea into an online magazine. Our articles evolved into more than just the quick reads they were and that we usually find online; they became real (and sometimes long) essays, carefully researched, and written with a general audience in mind. As the final touch, we stole the looks and feels of academic journals, and we became the *Journal of Geek Studies*.

Our first official volume was published on December 10, 2014, with five (and we must confess, rather raw) articles, all written by ourselves. From our second volume onwards, we began to reach out to other experts to write for us. Slowly throughout the years, we managed to attract authors from several corners of the planet and achieved a reasonable diversity. To us, a significant achievement was to attract many people from outside the Anglosphere. Our content is, of course, entirely in English, even though we are not native speakers ourselves. English is, whether we like it or not, the lingua franca of science and the way we had to reach as many people as possible around the globe.

Along the way, we also started to conduct interviews with game developers, as well as other scientists somehow involved in geek stuff. We also brought in three new members to our editorial board at different times (HMS, DCC, and MHN) who increased our overall geekiness level and (fictional) impact factor to over nine thousand.

We've had some very interesting stories to tell from those ten years of spreading knowledge and geekiness (not necessarily in that order!). For instance, we were contacted by people that worked in the movie industry because of our *Ant-Man* and "zombie model" articles. The results from our "metal birds" article were featured on *Nature*'s website – that is one of the most prestigious scientific journals out there! We coined and defined the term "Astolfo Effect", which is becoming more well known on the Internet, even outside the *Fate* community. Other curiously popular articles in terms of access were the one telling the story of how the Ancient Egyptian god Medjed became popular in Japan, and the one discussing whether mechas (Japanese giant robots) are isometric or allometric.

And we've come a long way. So far, we published 129 articles (okay, perhaps with one easter egg among them), contributed by 93 authors based on 23 different countries, representing over 70 universities and research institutions worldwide. Our articles have been accessed over a half a million times by people from 214 different countries. Most of our readers are based in: (1) the USA; (2) Brazil; (3) UK; (4) Canada; (5) Australia; (6) Philippines; (7) Germany; (8) India; (9) Indonesia; (10) Japan.

Among our published articles, most, by far, belong to Biology. More than half of our articles (70 to be more precise) are related to the biological sciences and the majority of those belong more specifically to the field of Zoology. History and Archaeology combined are a distant second place, with 26 articles. The most discussed geek "area of knowledge", also with more than half our articles, is Video Games, summing up to a whopping 74 articles. Once again, a distant second is Cinema, with 29 articles. Among the most specific topics, the first place belongs to *Pokémon*, with 22 articles. We think it's safe to say we probably became the biggest authority on "Pokémon taxonomy" thanks to that.

The day this article is being published marks the 10th anniversary of the *Journal of Geek Studies*. We have come quite far since our humble beginnings and we have only you to thank for, our readers, our authors, and our interviewees. Thank you for sticking with us. It doesn't matter if you have just discovered the Journal, or if you knew us before we were cool; either way, we are sincerely grateful. You folks are the reason we do this, so we hope you had some fun reading our articles – and maybe (why not?) also learned something new along the way.

If we managed to garner a little more trust in science, even better. So, let us celebrate our anniversary and wish for another 10 years of geeky sci-comm.

EDITOR'S CHOICE ARTICLES

Below we present our Editor's Choice Articles. Each editor picked one article from the entirety of the Journal's archives – that was not their own, of course. The choice was not based on scientific merit or anything serious like that – they're just our favourite articles, for personal and perhaps unexplainable reasons.

RBS's choice: *Frankenstein, or the beauty and terror of science* – by van den Belt, 2017.

BMT's choice: *An unexpected bird in Honkai: Star Rail and China's war on sparrows* – by Salvador, 2023.

JVT's choice: *Playing with the past: history and video games (and why it might matter)* – by McCall, 2019.

HMS's and DCC's choice: *The Astolfo Effect: the popularity of Fate/Grand Order characters in comparison to their real counterparts* – by Tomotani & Salvador, 2021.

MHN's choice: *Cicadas in Japanese video games and anime* – by Salvador, 2022.

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The editorial team

Dr Rodrigo B. Salvador is a biologist and curator at the Finnish Museum of Natural History and current editor-in-chief of the JGS. He specializes in biodiversity research of land and freshwater snails and spends a good portion of his time thinking up geek culture-based scientific names for the new species he discovers, such as *Gallirallus astolfoi*, *Halystina umberlee*, and *Idiopyrgus meriadoci*.

Dr Barbara M. Tomotani is a biologist, bird fanatic, and researcher at the Arctic University of Norway. She is living in the Arctic and studies how animals adapt to the weird (lack of) daylight in the region, while at the same time, tries to adapt to it herself. In the present, she has way less time than she wished for geek stuff, but she tries to compensate that by sneaking *Pokémon* quizzes in her teaching and exam questions whenever she can.

João Vitor Tomotani, MSc, is an engineer that currently works with Data Analytics applied to Supply Chain. When he is not busy building and analysing dashboards, he is thinking of how he could apply all that to more interesting themes or running while listening to geeky podcasts. He is also kind of a weeb, being a manga and JRPG enthusiast.

Henrique M. Soares is an engineer applying machine learning and data engineering in the industry. He is fascinated by applications such as computer vision and language processing and has a rather mixed view on how artificial intelligence will impact society. When he is not fretting over thoughts about doomsday machines ending society as we know it, he likes to play all kinds of RPGs and tactics-style games accompanied by his dog, Kepler.

Daniel C. Cavallari, MSc, is a biologist and lab technician at FFCRLP, University of São Paulo, Brazil, with a passion for studying molluscs, especially gastropods, whether they call the sea or land their home. When he's not busy with research, Daniel is deep into RPGs of all kinds. As a dedicated DM, he has a particular fondness for naming his most extravagant NPCs after famous taxonomists. After all, why not bring a bit of scientific flair into the fantasy world?

Dr Maira H. Nagai is a biologist and scientist at Columbia University, currently contemplating the beauty of the development of epithelial airways. Her mind is constantly (and sometimes unbearably) filled with thoughts on how things come about, no matter whether it is for work, for fun, or to ease her plaguing existential questions. She is proof that you don't necessarily need to be a geek to be amused by geek stuff – just need some appreciation of wit, respect for fastidiousness, and curiosity about the world.