

Journal of Geek Studies

Vol. 6(1): 2019.



ISSN 2359-3024



Journal of Geek Studies

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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.

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Cover art: Screen capture from the game Valleys Between, by Little Lost Fox (Wellington, New Zealand). Image is a courtesy of the studio; used with permission.



Valleys Between: bringing environmental issues to games

Niamh Fitzgerald

Little Lost Fox. Wellington, New Zealand.

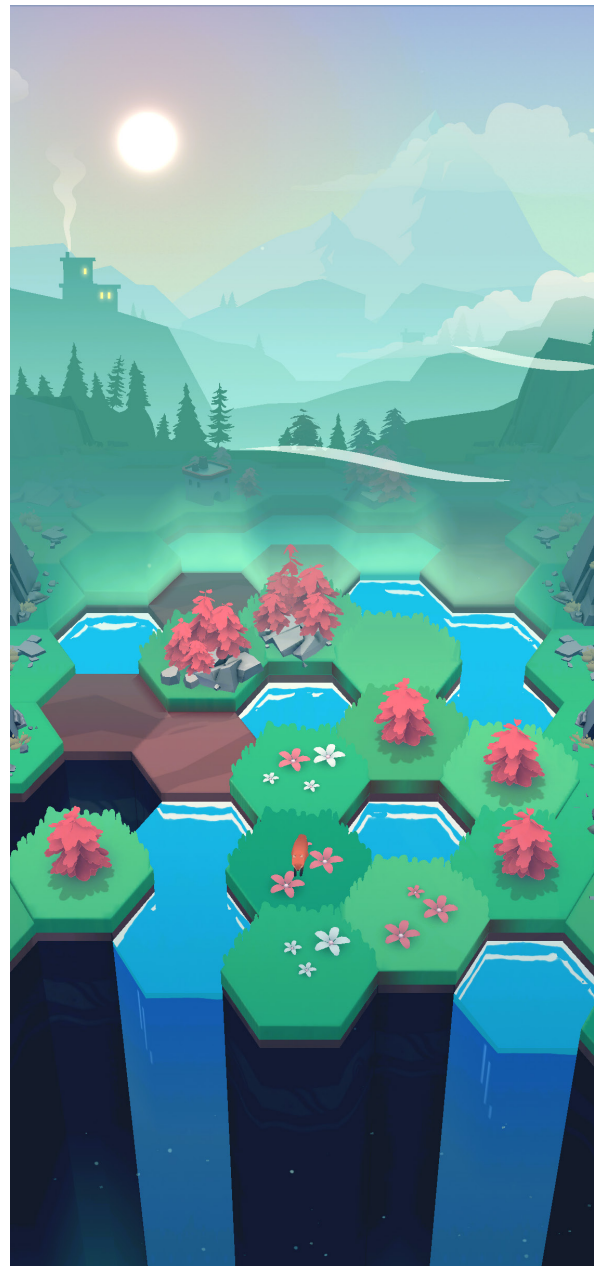
Email: niamh@littlelostfox.com

*Valleys Between*¹ is an environmental puzzle game, where your goal is to grow your world for as long as you can while protecting it from threats that will damage its health.

When we started designing *Valleys Between* we wanted to explore ways to get people thinking about environmental issues, and while the game has evolved during the game development cycle, the core themes of the game are still there. While we considered real world ecology and nature, we realised early on that to create a fun and engaging game we would need to take inspiration from them without being too literal.

One of our goals is to create a strong bond between the player and the world they've created, and one of the ways we do this is by allowing you to literally shape the world with your fingertips. Players only have the ability to swipe up or down to interact with the world, but small actions such as pulling a tree up out of the ground can actually have a big impact. Much like the real world, one action isn't always enough to solve larger problems but a group of small actions can result in a big change.

Many of the games mechanics are inspired by nature, though in a simplified or abstract way. This allows us to craft gameplay that's enjoyable and relatable without ever straying too far into something that feels completely at odds with reality (at least in most cases). With that in mind we had two important rules that guided our design:



The beautiful hexagonal environments of *Valleys Between*.

¹ Released in 2018 by Little Lost Fox. Currently available for iPhone/iPad and coming soon to Android. Learn more at <http://littlelostfox.com/>

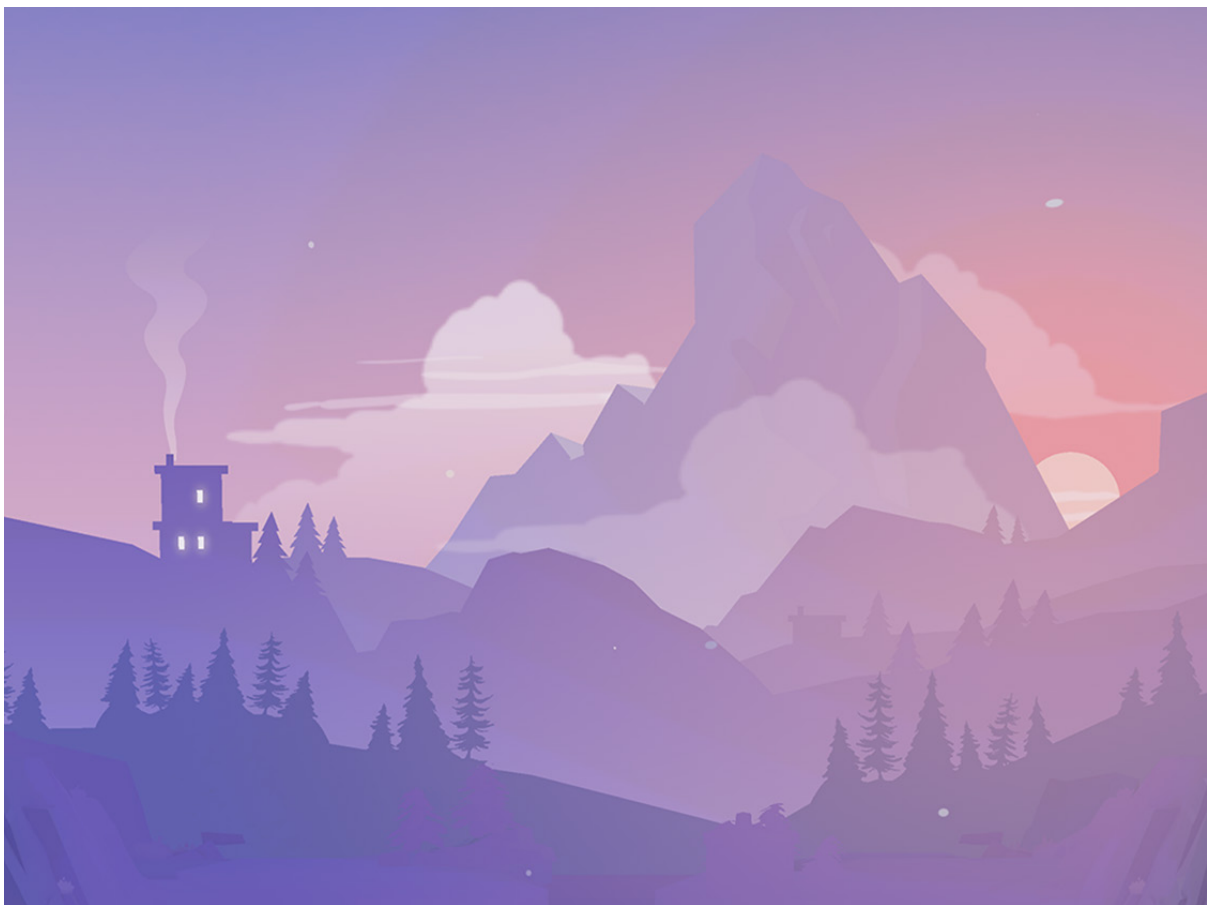
1. The game is inspired by nature, so the environmental theme should always be present while never overpowering or distracting the player from the gameplay.
2. We won't sacrifice enjoyable gameplay for the sake of keeping something too realistic or similar to how our real world works.

These rules allowed us to find a balance between fun and relatable mechanics that are easy for the player to understand. When designing mechanics we often started from an ecological concept and explored how we could distill it down to base elements to see how they could work well within the game. The best way to illustrate this is to look at the primary mechanics in *Valleys Between*.

At its core, *Valleys Between* is about creating a thriving world. The first step to doing this is to create an environment where things can grow, so the first move a player makes is to create water tiles in their new

world. Water makes all dirt tiles around it turn into grass, and trees can only be planted on grass. To plant a tree, the player pulls up on a grass tile and essentially plucks a fully-grown tree out of the ground. While this is clearly a few steps removed from reality, it feels close enough, and this familiarity helps create a stronger connection between the nature presented in the game and what the player expects from nature in the real world.

Trees that are next to each other can be combined to make a forest, which grows your world by adding a new row of land. In this way, the base relationship between water and trees are shown as being critical to growing a world. Groups of forests can be further combined to make a house, which introduces humans as part of the ecosystem in *Valleys Between*. While this is an incredibly simplified representation of nature to a few small mechanics in *Valleys Between*, it's part of what makes it feel environmentally rich.



Grow a thriving world and find the balance sustain it.



Animals are the protectors of your world.

The game wouldn't be very fun without something challenging you, so we decided to introduce the two sides of human influence on the environment. The first is a positive influence of creating a house by combining trees which helps your world grow and expand. However, as your world grows, we also introduce a negative influence in the form of factories and other man-made objects. Factories threaten the health of your world and they can spill oil to surrounding tiles if you leave them for too long. While there isn't necessarily an easy action to fix things these things in our

world, we wanted players to want to protect their world from these threats even if they can't stop them from occurring. We also found in early playtests that people became very attached to the animals that wander their world, and this helped them feel connected to it, so we decided to tie these concepts together and have animals act as the primary protectors of your world. Animals wander throughout your world, and while you can influence their path, you aren't able to control them directly. You can choose to use them to nurture and enhance a specific area, or use them to convert a factory to

something that won't damage the health of your world. Once you've used an animal, they fall asleep for a period of time so the player has to choose when to nurture and when to protect their world. While these mechanics may seem to be quite a stretch from the real world, we've found that by taking inspirations from nature rather than literal representations, we've been able to craft an enjoyable game.

ABOUT THE AUTHOR

Niamh Fitzgerald is a producer and game designer at indie studio Little Lost Fox, based in Wellington, New Zealand. She organised the New Zealand Game Developer Conference in 2017 and 2018, and likes to combine her love of travel with game development by getting involved in game developer events around New Zealand and internationally.



Wingspan: how birds colonized board games

Interview with Elizabeth Hargrave

Wingspan is a game entirely about birds and it has been a wonderful surprise, being considered one of the hottest titles for 2019¹. This is the first game from designer Elizabeth Hargrave, published by Stonemaier Games, and will be available in March this year.

In this game, the players take the role of bird enthusiasts (researchers, birdwatchers, and ornithologists) and must discover and attract birds to their wildlife preserves. In board game terms, *Wingspan* is an engine-building game, that is, a game in which you have to establish an effective system to generate and accumulate points.

There are 170 unique bird cards in the game and, as you add them to your nature preserve, they help you do more and more on each subsequent turn. In general, forest birds make you better at getting food, wetland birds help you get more cards, and grassland birds make you better at laying eggs.

The Journal of Geek Studies interviewed Elizabeth Hargrave to understand how ornithology and ecology made their way into a board game. You can read the full interview below.



¹ McLaughlin, S. 2019. Birds star in one of this year's hottest board games. National Audubon Society. Available from: <https://www.audubon.org/news/birds-star-one-years-hottest-board-games> (Date of access: 19/Feb/2019).

Q: To come up with a game based on birds, you must be a birdwatcher or an ornithologist, is that right?

A: Yes, I'm an amateur birder.

Q: When did your interest in birds begin?

A: I've always been a nature lover and appreciated birds in general when I saw them, the same way I appreciated any other wildlife. I've always had a bird field guide and a pair of binoculars around. But I didn't really start intentionally birding – like, going out with birds as my primary purpose – until maybe 6 or 7 years ago.

Q: What gave you the idea for a bird ecology game?

A: I felt like there were too many games about castles and space, and not enough games about things I'm interested in. So I decided to make a game about something I cared about.

Q: Did you bring into *Wingspan* some of your experience with birds? Your favorite species, maybe?

A: I tried to get a diverse set of birds from North America into the game, and a lot of the common ones. But some species definitely got a push just because I like them. Roseate spoonbills² are only in a tiny corner of North America, but it's the corner of North America that I grew up in, and I love them, so they're in. There's a lot of room with 170 cards – but it's still only a fraction of all of the species that live in North America³.

Q: So, let's turn to the game now. What is the players' goal in *Wingspan*? How does one win in a bird game?

A: You win by having the most points.

² *Platalea ajaja* Linnaeus, 1758 (family Threskiornithidae).

A lot of your points will come from playing the birds themselves, but you can also get points by laying eggs or by using certain bird powers. And then there are specific goals and bonuses that change from game to game. You might have the "photographer" card that will give you bonus points for birds with colors in their name, or the "falconer" that gives points for predator birds. And then there are shared goals that you can compete for, like having the preserve with the most eggs in it at the end of a round.

To win, you usually have to choose to focus on some of those things over others. And you need to think about how the different powers on the bird cards could help you get there.





Q: The game's strategy is spun around a lot of ecology. What sort of information have you brought from the real world into *Wingspan*? Or, better put, how much scientific data have you included in the game?

A: There is a ton of real-world information on each card. Birds get played into certain habitats on your player mat, based on their real-world habitat. And each card's cost is food, based on some very simplified categories of the food that the birds actually eat. And each bird's nest type could play into the end-of-round goals.

When I could, I tried to work in real-life bird behavior for the powers on each bird. For example, predator birds go hunting by looking at the top card in the deck: if the bird has a small enough wingspan that the predator could eat it, you get to keep that card and score a point for it. Nest parasites like brown-headed cowbirds get to lay an egg on another bird's nest when another player lays eggs. That kind of thing.

And finally, each card has a little factoid on it about the bird, and a very simplified map of which continents it is native to. Those don't actually come into play on the game, but sometimes they might explain why a bird's power is what it is.

Q: Do you hope the players will learn something about the birds by playing *Wingspan*?

A: I hope that it's a game that you can play primarily as a game, without feeling like you're supposed to be learning anything... and then maybe accidentally pick some things up along the way. A lot of educational games feel very preachy to me, and that's not my intention. But I do hope that as players interact with the birds in the game, some of the real-world information that's there is interesting to them.

³There are circa 760 bird species that breed in the USA and Canada, according to the Cornell Lab of Ornithology (<https://birdsna.org/Species-Account/bna/home>).

Q: Suppose a player is inspired by *Wingspan* to do some birdwatching of their own. Would you have some tips to offer to this fledgling birder?

A: Find a list of common birds for your area, and look for them right around where you live. Once you have a few birds that you can reliably identify, things get easier.

A pair of binoculars makes a huge difference. You don't have to spring for a super-expensive pair right away – there are decent starter pairs for the cost of a board game. But it's incredibly frustrating to try to ID birds without being able to see all their markings.

Find a local birding club, or hit up a birder friend – most people are happy to share their knowledge, and to have you along as an extra pair of eyes. I once caused a major freak-out in a group of more-knowledgable birders by saying “hey, what's that one?” – it turned out to be a golden-winged warbler, a beautiful bird that very rarely visits our area.

Download the eBird app⁴ and keep lists of the birds you see. If you're anything like me, growing your personal list will be addictive – but you'll also be contributing to a worldwide database that ornithologists use to track trends in bird populations.

Q: Do you think ultimately *Wingspan* can help with bird conservation efforts?

A: As much as the industry is growing, board games are still a pretty niche hobby. But every little bit helps! I have definitely heard from gamers who have started paying attention to birds in real life because of *Wingspan*.

Q: Is there any takeaway message you'd like the players to get from *Wingspan*?

A: I always set out to make it a fun game first, about something that I love. If you have fun playing *Wingspan*, my mission is accomplished. If you can see why people love birds – or get interested in them yourself – after playing, even better.

ABOUT THE TEAM

This is the first published game from designer **Elizabeth Hargrave**. Bird art is by Natalia Rojas and Ana Maria Martinez Jaramillo, while art for the player mats and birdhouse dice tower is by Beth Sobel. Christine Santana did the graphic design. David Studley designed the solo version of the game, with help from the Automa team. Jamey Stegmaier managed the whole team, and worked with Elizabeth to develop the gameplay.

⁴eBird (<https://ebird.org/home>) is a project of the Cornell Lab of Ornithology.



You're an oegopsid now: the phylogeny of squid kids from the future

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The main characters of Nintendo's 2015 video game *Splatoon* and its 2017 sequel *Splatoon 2* are Inklings, a species of sapient cephalopod with the ability to transform between a humanoid form and a more traditional coleoid form. Also present are the Octarians: octopus descendants that take the role of enemies. Since the release of the

Octo Expansion for *Splatoon 2*, the Octoling, a subspecies of Octarian with similar appearance and abilities to Inklings, has become playable. Both Inklings and Octolings are hyper-evolved descendants of modern cephalopods, having evolved after sea level rise drives humanity to extinction 12,000 years in the future.



Figure 1. Comparison between the cephalopods of *Splatoon* and real cephalopods. Clockwise from top left: an Inkling in squid form; a female Inkling in humanoid form; a male Octoling in humanoid form; an Octoling in octopus form; *Ommastrephes bartramii*; *Todarodes pacificus*; *Octopus vulgaris*; *Abralia veranyi*; *Thysanoteuthis rhombus*. (Inklings' and Octolings' official renders are a courtesy of Nintendo; other images are public domain, retrieved from Wikimedia Commons.).

Exactly which cephalopods Inklings and Octolings descended from is unknown. In-game lore posits that Inklings are descended from squids and Octolings are descended from octopuses. A previous article covering the cephalopods of *Splatoon* has suggested links to Ommastrephidae or Thysanoteuthidae for Inklings (Salvador & Cunha, 2016). Here, I set out to resolve the relationships of these cephalopods with phylogenetic analysis.

Usually, scientists would use molecular data, *i.e.*, DNA or protein sequences, to determine relationships among recent taxa. There have been numerous recent studies on the relationships of coleoid cephalopods based on molecular data (*e.g.*, Sanchez et al., 2018). However, since video game characters have no DNA, this cannot be applied here. Thus, only morphological and behavioral data can be used. Luckily, there have

been morphological phylogenies of cephalopods in the past to build off of.

METHODS

To answer this question that nobody was really asking, I constructed a morphological dataset of cephalopods. This combines four previously-published morphological datasets (Young & Vecchione, 1996; Voight, 1997; Lindgren et al., 2004; Sutton et al., 2016), as well as additional characters. I also added Inklings, Octolings, and nine extant squid genera to the dataset (Table 1): *Dosidicus*, *Eucleoteuthis*, *Hyaloteuthis*, *Lampdoteuthis*, *Lycoteuthis*, *Mesonychoteuthis*, *Todarodes*, *Todaropsis*, and *Watasenia*. “*Palaeoctopus pelagicus*” was removed because it isn’t a cephalopod at all, but fragments of a fossil coelacanth (Schultze et al., 2010).

Table 1. List of OTUs and sources of data. Extinct taxa are denoted by the symbol (†) before the species name. New data is marked in bold. Note that inklings and octolings are fictional taxa.

Taxon	Source of morphological data
<i>Abralia trigonura</i>	Young & Vecchione, 1996; Sutton et al., 2015
<i>Abraliopsis pfefferi</i>	Lindgren et al., 2004
† <i>Actinosepia canadensis</i>	Sutton et al., 2015
<i>Allonautilus scrobiculatus</i>	Lindgren et al., 2004 [as <i>Nautilus scrobiculatus</i>]
<i>Amphitretus pelagicus</i>	Voight, 1997; Sutton et al., 2015
<i>Ancistrocheirus lesueurii</i>	Lindgren et al., 2004
<i>Architeuthis dux</i>	Lindgren et al., 2004; Sutton et al., 2015
<i>Argonauta</i> spp.	Voight, 1997 [<i>A. argo</i>]; Lindgren et al., 2004 [<i>A. nodosa</i>]; Sutton et al., 2015 [<i>A. nodosa</i>]
<i>Bathypolypus arcticus</i>	Voight, 1997; Lindgren et al., 2004
<i>Bathyteuthis abyssicola</i>	Young & Vecchione, 1996; Lindgren et al., 2004; Sutton et al., 2015
<i>Batoteuthis skolops</i>	Lindgren et al., 2004
† <i>Belemnoteuthis antiquus</i>	Sutton et al., 2015
<i>Bolitaena pygmaea</i>	Voight, 1997 [as <i>Eledonella pygmaea</i>]
† <i>Boreopeltis sagittata</i>	Sutton et al., 2015
† <i>Boreopeltis smithi</i>	Sutton et al., 2015
<i>Brachyteuthis</i> sp.	Lindgren et al., 2004
<i>Callistoctopus ornatus</i>	Voight, 1997 [as <i>Octopus ornatus</i>]
<i>Chiroteuthis veranyi</i>	Lindgren et al., 2004
<i>Chtenopteryx sicula</i>	Lindgren et al., 2004; Sutton et al., 2015
<i>Cirroteuthis muelleri</i>	Voight, 1997
<i>Cirrothauma murrayi</i>	Lindgren et al., 2004; Sutton et al., 2015

Table 1. (cont.)

Taxon	Source of morphological data
<i>Cistopus</i> sp.	Voight, 1997
<i>Cranchia scabra</i>	Lindgren et al., 2004; Sutton et al., 2015
<i>Cycloteuthis sirventi</i>	Lindgren et al., 2004; Sutton et al., 2015
<i>Discoteuthis laciniosa</i>	Lindgren et al., 2004
† <i>Dorateuthis syriaca</i>	Sutton et al., 2015
<i>Doryteuthis pealeii</i>	Young & Vecchione, 1996 [as <i>Loligo pealei</i>]; Lindgren et al. 2004 [as <i>L. pealei</i>]; Sutton et al., 2015
<i>Dosidicus gigas</i>	new data (tolweb.org)
<i>Eledone cirrhosa</i>	Voight, 1997; Lindgren et al., 2004
<i>Enoploteuthis</i> spp.	Young & Vecchione, 1996 [<i>E. anapsis</i>]; Lindgren et al., 2004 [<i>E. leptura</i>]
† <i>Eoteuthoides caudata</i>	Sutton et al., 2015
<i>Eucleoteuthis luminosa</i>	new data (tolweb.org)
<i>Filippovia knipovitchi</i>	Lindgren et al., 2004 [as <i>Moroteuthis knipovitchi</i>]
FMNH 278064	Voight, 1997 [as FMNH 278064]
† <i>Geopeltis simplex</i>	Sutton et al., 2015
† <i>Glyphidopsis waagei</i>	Sutton et al., 2015
† <i>Glyphiteuthis abisaadiorum</i>	Sutton et al., 2015
† <i>Glyphiteuthis freijii</i>	Sutton et al., 2015
† <i>Glyphiteuthis libanotica</i>	Sutton et al., 2015
† <i>Glyphiteuthis minor</i>	Sutton et al., 2015
† <i>Glyphiteuthis ornata</i>	Sutton et al., 2015
† <i>Glyphiteuthis rhinopora</i>	Sutton et al., 2015
<i>Gonatus antarctus</i>	Young & Vecchione, 1996; Lindgren et al., 2004; Sutton et al., 2015
<i>Graneledone</i> spp.	Voight, 1997 [<i>G. pacifica</i>]; Lindgren et al., 2004 [<i>G. verrucosa</i>]
<i>Grimpoteuthis bathynectes</i>	Voight, 1997
<i>Haliphron atlanticus</i>	Voight, 1997; Lindgren et al., 2004; Sutton et al., 2015
<i>Hapalochlaena lunulata</i>	Voight, 1997
<i>Heteroteuthis hawaiiensis</i>	Lindgren et al., 2004; Sutton et al., 2015
† <i>Hibolithes semisulcatus</i>	Sutton et al., 2015
<i>Histioteuthis celetaria</i>	Sutton et al., 2015
<i>Histioteuthis corona</i>	Lindgren et al., 2004; Sutton et al., 2015
<i>Histioteuthis reversa</i>	Lindgren et al., 2004
<i>Hyaloteuthis pelagica</i>	new data (tolweb.org)
<i>Idiosepius pygmaeus</i>	Lindgren et al., 2004; Sutton et al., 2015
<i>Illex</i> spp.	Young & Vecchione, 1996 [<i>I. illecebrosus</i>]; Lindgren et al., 2004 [<i>I. coin- deti</i>]
<i>Japetella diaphana</i>	Young & Vecchione, 1996; Voight, 1997; Lindgren et al., 2004; Sutton et al., 2015
<i>Japetella heathi</i>	Young & Vecchione, 1996
† <i>Jeletzkyia douglassae</i>	Sutton et al., 2015
† <i>Jeletzkyteuthis coriaceus</i>	Sutton et al., 2015
<i>Joubiniteuthis portieri</i>	Lindgren et al., 2004
† <i>Keuppia hyperbolaris</i>	Sutton et al., 2015

Table 1. (cont.)

Taxon	Source of morphological data
† <i>Keupia levante</i>	Sutton et al., 2015
<i>Lampadioteuthis megaleia</i>	new data (tolweb.org)
<i>Leachia atlantica</i>	Lindgren et al., 2004
<i>Lepidoteuthis grimaldii</i>	Lindgren et al., 2004; Sutton et al., 2015
† <i>Leptoteuthis gigas</i>	Sutton et al., 2015
† <i>Loligosepia aalensis</i>	Sutton et al., 2015
† <i>Loliogsepia bucklandi</i>	Sutton et al., 2015
<i>Lolliguncula brevis</i>	Young & Vecchione, 1996
<i>Lycoteuthis</i> sp.	new data (tolweb.org)
<i>Macrotritopus horridus</i>	Voight, 1997
† <i>Marekites vinarensis</i>	Sutton et al., 2015
<i>Mastigoteuthis agassizi</i>	Lindgren et al., 2004; Sutton et al., 2015
† <i>Muensterella scutellaris</i>	Sutton et al., 2015
<i>Muusoctopus hokkaidensis</i>	Voight, 1997 [as <i>Benthoctopus hokkaidensis</i>]; Lindgren et al., 2004 [as <i>Benthoctopus</i> sp.]
<i>Nautilus pompilius</i>	Young & Vecchione, 1996; Lindgren et al., 2004; Sutton et al., 2015
<i>Neoteuthis thielei</i>	Lindgren et al., 2004
<i>Octopoteuthis sicula</i>	Lindgren et al., 2004; Sutton et al., 2015
<i>Octopus</i> spp.	Young & Vecchione, 1996 [<i>O. vulgaris</i>]; Voight, 1997 [<i>O. bimaculatus</i>]; Sutton et al., 2015 [<i>O. vulgaris</i>]
<i>Ocythoe tuberculata</i>	Young & Vecchione, 1996; Voight, 1997; Sutton et al., 2015
<i>Ommastrephes bartramii</i>	Young & Vecchione, 1996; Lindgren et al., 2004; Sutton et al., 2015
<i>Onychoteuthis banksii</i>	Young & Vecchione, 1996; Sutton et al., 2015
<i>Opisthoteuthis agassizi</i>	Young & Vecchione, 1996; Voight, 1997; Sutton et al., 2015
<i>Opisthoteuthis californiana</i>	Young & Vecchione, 1996; Voight, 1997
<i>Opisthoteuthis</i> sp.	Lindgren et al., 2004
<i>Ornithoteuthis antillarum</i>	Lindgren et al., 2004
† <i>Palaeoctopus newboldi</i>	Sutton et al., 2015
† <i>Palaeololigo oblongata</i>	Sutton et al., 2015
† <i>Parabelopeltis flexuosa</i>	Sutton et al., 2015
<i>Pareledone charcoti</i>	Voight, 1997
† <i>Phragmoteuthis bisinuata</i>	Sutton et al., 2015
† <i>Plesioteuthis prisca</i>	Sutton et al., 2015
† <i>Plesioteuthis subovata</i>	Sutton et al., 2015
† <i>Pohlsepia mazonensis</i>	Sutton et al., 2015
<i>Psychroteuthis</i> sp.	Lindgren et al., 2004
<i>Pteroctopus tetracirrhus</i>	Voight, 1997
<i>Pterygioteuthis gemmata</i>	Lindgren et al., 2004
<i>Pyroteuthis margaritifera</i>	Lindgren et al., 2004
† <i>Rachiteuthis donovani</i>	Sutton et al., 2015
<i>Robsonella fontanaia</i>	Voight, 1997
<i>Rossia</i> spp.	Young & Vecchione, 1996 [<i>R. pacifica</i>]; Lindgren et al., 2004 [<i>R. palpebro-sa</i>]; Sutton et al. 2015 [<i>R. pacifica</i>]

Table 1. (cont.)

Taxon	Source of morphological data
<i>Scaevargus unicolor</i>	Voight, 1997
† <i>Senefelderiteuthis tricarinata</i>	Sutton et al., 2015
<i>Sepia officinalis</i>	Young & Vecchione, 1996; Lindgren et al., 2004; Sutton et al., 2015
<i>Sepiella inermis</i>	Lindgren et al., 2004
<i>Sepiola</i> spp.	Young & Vecchione, 1996 [<i>S. atlantica</i>]; Lindgren et al., 2004 [<i>S. affinis</i>]
<i>Sepioteuthis</i> spp.	Young & Vecchione, 1996 [<i>S. sepioidea</i>]; Lindgren et al., 2004 [<i>S. lessoniana</i>]
<i>Spirula spirula</i>	Young & Vecchione, 1996; Lindgren et al., 2004; Sutton et al., 2015
<i>Stauroteuthis syrtensis</i>	Young & Vecchione, 1996; Lindgren et al., 2004; Sutton et al., 2015
<i>Sthenoteuthis oualaniensis</i>	Lindgren et al., 2004
<i>Stigmatoteuthis hoylei</i>	Lindgren et al., 2004 [as <i>Histioteuthis hoylei</i>]
<i>Stoloteuthis leucoptera</i>	Lindgren et al., 2004
† <i>Styletoteuthis</i> aff. <i>annae</i>	Sutton et al., 2015
† <i>Styloteuthis convexa</i>	Sutton et al., 2015
<i>Tetracheledone spinicirris</i>	Voight, 1997
† <i>Teudopsinia haasi</i>	Sutton et al., 2015
† <i>Teudopsis bollensis</i>	Sutton et al., 2015
† <i>Teudopsis bunellii</i>	Sutton et al., 2015
† <i>Teudopsis jeletzkyi</i>	Sutton et al., 2015
† <i>Teudopsis subcostata</i>	Sutton et al., 2015
<i>Thaumeledone guntheri</i>	Lindgren et al., 2004
<i>Thysanoteuthis rhombus</i>	Young & Vecchione, 1996; Sutton et al., 2015
<i>Todarodes</i> spp.	new data (tolweb.org)
<i>Todaropsis eblanae</i>	new data (tolweb.org)
† <i>Trachyteuthis bacchiae</i>	Sutton et al., 2015
† <i>Trachyteuthis covacevichi</i>	Sutton et al., 2015
† <i>Trachyteuthis hastiformis</i>	Sutton et al., 2015
† <i>Trachyteuthis nusplingensis</i>	Sutton et al., 2015
† <i>Trachyteuthis teudopsiformis</i>	Sutton et al., 2015
<i>Tremoctopus violaceus</i>	Voight, 1997
<i>Uroteuthis chinensis</i>	Lindgren et al., 2004 [as <i>Loligo formosana</i>]
† <i>Vampyronassa rhodanica</i>	Sutton et al., 2015
<i>Vampyroteuthis infernalis</i>	Young & Vecchione, 1996; Voight, 1997; Lindgren et al., 2004; Sutton et al., 2015
<i>Velodona togata</i>	Voight, 1997
<i>Vitreledonella richardi</i>	Voight, 1997
<i>Watasenia scintillans</i>	new data (tolweb.org)
Inkling	new data (Nintendo, 2015, 2017, 2018)
Octoling	new data (Nintendo, 2018)

A few species in the same genera were lumped due to either having identical codings or in the name of having more complete Operational Taxonomic Units, or OTUs (several were coded in one dataset and not the others). Most Octarians have highly unorthodox morphology compared to Inklings or Octolings, and were excluded because how do you code a tentacle with a face? The resulting dataset has 283 characters and 139 OTUs.

I ran analyses in TNT (Goboloff & Catalano, 2016) using equal weighting methodology for 2000 replicates, producing 10 trees each. I ran one analysis with no constraints and one with a “molecular backbone” – forcing the analysis to fit a certain topology corresponding to what molecular phylogenies tell us. The framework of Sanchez et al. (2018) was used for the backbone analysis. This way, the trees can be built around how certain taxa are related, while the morphological data plots where those without molecular data would be. The outgroup taxon was *Nautilus pompilius*.

RESULTS AND DISCUSSION

Surprisingly, *contra* in-game lore, Inklings and Octolings are consistently recovered as sister taxa. The two species are united by numerous features, mostly having to do with living on land and shooting ink everywhere. Feasibly, these could have evolved independently, but compared to other NPC species in the game, the similarities between these two are striking. If this is true, this may make their rivalry analogous to that which may have occurred between Neanderthals and anatomically modern humans in the Pleistocene (Finlayson & Carrión, 2007) in response to environmental change (changing sea levels and climate change, respectively). This may also ex-

plain why most Octarians are so different from Octolings – they may have *actually* descended from octopuses, and gone down a completely different evolutionary path towards sapience and land-living. It is canon that Octolings were brainwashed into serving the Octarian army, so this might imply that the Octarian-Octoling link is largely fabricated. Of course, that adds a layer of in-game cultural implications that is out of the scope of this paper.

In all analyses, both species ended up well inside Ommastrephidae, the flying squids. This fits with what we know of Inklings biology. As previously noted by Salvador & Cunha (2016), the leaping ability of Inklings in squid form (“super jump”), demonstrated in *Splattoon*, *Splattoon 2*, and *Super Smash Bros. Ultimate*, may be exapted from the tendency of flying squids to jump above the surface of water. Inklings are also bioluminescent, a trait shared with certain members of Ommastrephidae, including *Ommastrephes* itself. The unusual octopus-like form of the Octoling may be convergent evolution with Octopoda; Octolings display the same “super jump”, not known in any octopods, and similar awkward terrestrial locomotion in coleoid form (in contrast to the Octarians).

But aside from being a fun and way too time-consuming exercise in phylogenetics, what does this tell us? Our results echo the suggestions of Salvador & Cunha (2016) that the design of Inklings was likely heavily influenced by ommastrephid squids that live in Japanese waters, such as *Todarodes pacificus* and *Ommastrephes bartramii*. This shows that the designers of the *Splattoon* franchise likely deliberately modeled this game’s characters after specific cephalopod species (echoed in the fact that the Japanese names of several characters reference specific real-world species). Nintendo certainly knows their squids.



Figure 2. Strict consensus tree of the “spineless” analysis, with *Pohlsesia* removed *a posteriori* because it was unstable.

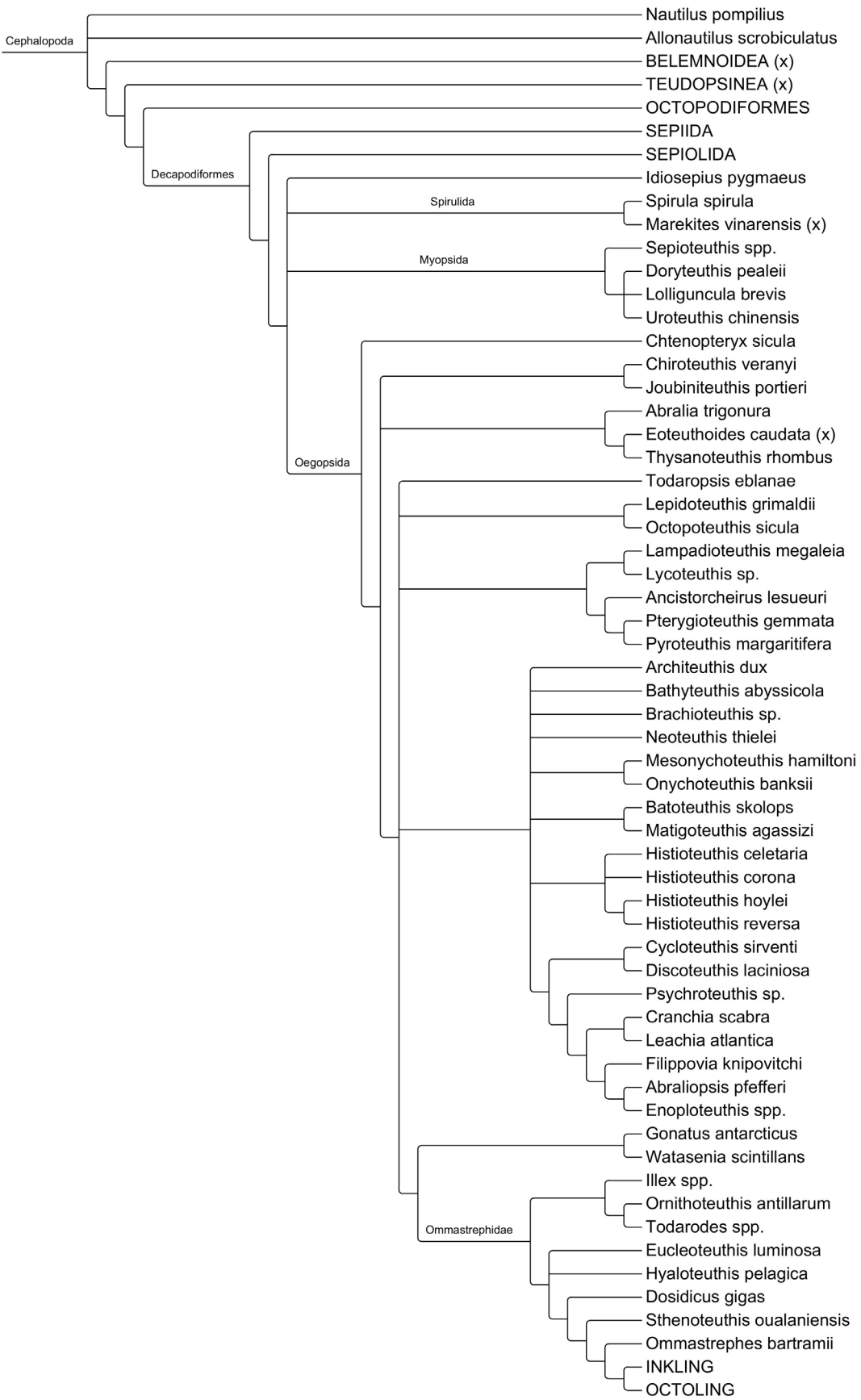


Figure 3. Strict consensus tree of the analysis with a molecular backbone constraint applied.

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MATERIALS AND DATA

Because the author lives approximately 10,000 years before the evolution of either Inklings or Octolings, he was unable to access any for study. However, he was able to access relevant game models and amiibos in private collections for the collection of morphological data. He also adopted a Sanei Inkling boy plush during the preparation of this manuscript.

ACKNOWLEDGEMENTS

Props to Nintendo for making this awesome franchise in the first place, and to an anonymous friend/reviewer for trying to dissuade me from doing this silly project.

ABOUT THE AUTHOR

Henry Thomas is a biology student at the University of California, Berkeley. He mostly studies pterosaurs, but also dabbles in the phylogeny of other creatures, regardless of whether or not they exist.



The scientists of *Assassin's Creed* Part 1: James Cook and Charles Darwin

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It feels like a long time since Altair first adventured through the Holy Land. Now *Assassin's Creed*, by Ubisoft, became one of the highest selling video game franchises of all time. It is even bigger if you consider the novels, comic books, animations, and well... that movie-thing. It is also one my top 3 favorite game series, so no wonder it would pop up on one of my articles eventually.

Besides the nice action and beautiful historical settings of *Assassin's Creed* games, my favorite moments are when I suddenly stumble upon one of my real-life heroes. I enjoy talking to their in-game reconstructions and to see how they match both my expectations and the historical accounts of their real-world counterparts. Most of these people are, of course, scientists, even though some lived in a time where the word "scientist" was yet to be coined.

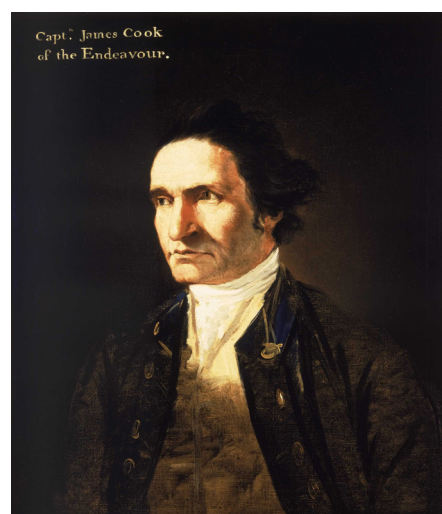
So, my goal here will be to show how these people are portrayed in *Assassin's Creed* and how this matches reality. I will also explain their major achievements and their importance to science. But with so many games in the franchise, it would be a monumental task to write a single article with every scientist; thus, I decided to present this in parts. The first one, as you might have surmised from the title, will be about James Cook and Charles Darwin.

At first sight, this might seem a strange pairing, but it has its reasons. I've chosen to start with them because this year marks some anniversaries – and us humans just can't help but be attracted to round num-

bers and meaningful dates. The year of 2019 marks 250 years from Cook's historical first visit to New Zealand and 240 years from his death. It is also Darwin's 210th would-be-birthday and the 160th birthday of the most groundbreaking book ever written: *On the Origin of Species*.

CAPTAIN JAMES COOK

James Cook was born on 7 November 1728 in Marton, in North-East England. He attended local school, apprenticed as a shop boy, and in his late teens became a merchant navy apprentice. During that time, he learned navigation skills and a healthy dose of algebra, geometry, trigonometry, and astronomy. In 1755, he joined the Royal Navy, just when Britain was preparing for the Seven Years' War.



Portrait of James Cook, oil on canvas, 1775-1776, by William Hodges (extracted from Wikimedia Commons).



Captain James Cook, oil on canvas, 1775-1776, by Nathaniel Dance-Holland (extracted from Wikimedia Commons).

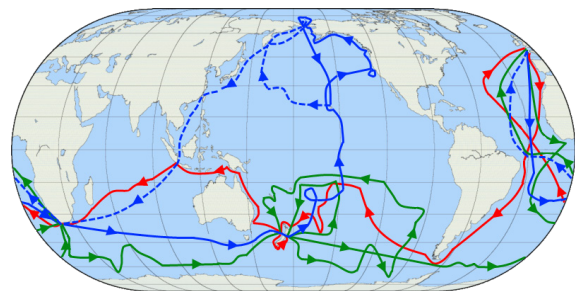
Cook served aboard several ships; most remarkably, he was part of the HMS *Pembroke* crew when the British captured the Fortress of Louisbourg from the French in 1758, during the Seven Years' War. Due to his talent as a cartographer, he was put to good use during that time, mapping several parts of Canada in the late 1750's and early 1760's (then aboard the HMS *Grenville*). This is the part of his life seen in *Assassin's Creed*, but he is most famous for what came afterwards; so let us take a look at that before turning to the game.

In 1768, the Admiralty made Cook lieutenant and put him in command of the HMS *Endeavour* on a scientific voyage to the Pacific Ocean. His main goal was to observe the transit of Venus¹ in Tahiti in 1769, which would help to determine the distance of the Earth to the Sun (the solar parallax). After that was out of the way, Cook opened an envelope with further orders: to navigate the South Pacific in search of the hypothetical continent Terra Australis and to find New Zealand's eastern shores. He set off to the south and then westwards, reaching New Zealand and precisely mapping its

entire coast. He also took the opportunity to record the transit of Mercury. Cook also needed to document the flora and fauna and establish a relationship with native people; in the long term, the goal was to acquire their consent to take the land for His Majesty. That was the beginning of the British history of New Zealand.

Once back in England, Cook was promoted to commander and sent on a second voyage in search of Terra Australis, which everyone now knew was not New Zealand. Cook took the HMS *Resolution*, with the HMS *Adventure* serving as its companion ship, and navigated the southern oceans. He almost reached Antarctica, but his "failure" to find land put an end to the Terra Australis myth.

Back in England once again, he was made captain and soon became involved in a third voyage, commanding the HMS *Resolution* once again (the companion ship this time was the HMS *Discovery*). His goal was to find a northern passage, through the Arctic, from the Pacific to the Atlantic. He couldn't do it, of course, and became frustrated with the voyage. During a prolonged stay in Hawaii to fix the ship, tensions began to rise with the locals. Cook tried to kidnap the Hawaiian king to put an end to it; the Hawaiians naturally didn't like that and Cook was killed.



Map showing Cook's three voyages: first voyage (1768-1771) in red, second (1772-1775) in green, third (1776-1780) in blue (becomes a dashed line after his death in 1779). Map by J. Platek (2008; extracted from Wikimedia Commons).

¹ Herdendorf (1986) argued that the Transit of Venus, first in 1761 and then in 1769, was the first international collaborative effort in science, including dozens of observers in tens of stations spread worldwide. He considered it as the establishment of the modern scientific international community.

Box 1. THE DISCOVERY AND NAMING OF NEW ZEALAND

Despite what might be assumed, Cook did not discover New Zealand. Polynesian settlers arrived there between 1200 and 1300 CE and became known as the Māori. They called their new home Aotearoa.

The first non-Polynesian person to arrive in New Zealand was Dutch explorer Abel J. Tasman, who first sighted the shores of South Island in December 1642. Tasman's crew would have landed there, but were driven off by the Māori. They assumed that land could be the western shore of the imaginary continent Terra Australis. In any event, Tasman named the "new" land Staten Landt, which is a straightforward horrible choice. Dutch cartographers recognized this and renamed the place Nova Zeelandia in 1645, after the province Zeeland in the Netherlands. This name stuck, even under later British control.

Even though he did not stay long, Tasman literally put New Zealand on the map and right under the radar of European colonial efforts. His name lives on today in the Tasman Sea (separating Australia and New Zealand), in Tasmania (Australia's southern island), and in the Abel Tasman National Park (in northwestern South Island, New Zealand).



Portrait of Abel J. Tasman, 1903, by J. M. Donald (extracted from Wikimedia Commons).

Captain Cook was responsible for mapping large parts of the world, as well as for several astronomical observations and for collecting dozens of ethnographic artifacts. He might not convey the impression of the typical scientist, but can and should be counted as one.

He was not the only scientifically-inclined person on his expeditions, though. During his voyages, Cook counted with botanists Joseph Banks and Daniel C. Solander, astronomers Charles Green, William Wales and William Bayly, and naturalists Herman Spöring, Johann R. Forster, Georg A. Forster and David Nelson. There were also artists to illustrate the new lands, their people, flora and fauna.

Cook features in *Assassin's Creed: Rogue* (henceforth ACR), released in 2014 for the Xbox 360 and PlayStation 3 (2015 for Microsoft Windows) and remastered for the Xbox One and PlayStation 4 in 2018. This game is different from the others in the series in that you play as a Templar instead of an Assassin. The game follows Shay Cormac in his convoluted journey from Assassin apprentice to senior Templar.

Cormac first encounters Cook towards the middle of the game's story. By that time (June 1758) Cook was master of the HMS *Pembroke*. Even though he appears several times, his presence is not as well-marked as one would hope. Cormac and his crew go after him due to his "mathematical mind" and expertise in deciphering secret codes. They comment that Cook's "seamanship is second-to-none" and that he had a self-policy of strict honesty. Cormac and his colleague Gist discuss how Cook would be a good addition to the Templars, but in the end decide that his total lack of guile would be bad for the Order: the man would not be able to keep the secret.

The presentation of Cook's character and personality is in line with contemporary sources and his many later biographies, which paint him as intelligent, honest and driven. However, he faced many trials during his voyages and sometimes dealt with them using more brutality (towards his crew or the native people of the Pacific) than we can now accept. Furthermore, he seemed to have had a drastic change of personality on his third voyage. In any event, the depiction of young James Cook in ACR is very compelling.



Concept art from ACR, by D. Atanasov (©Ubisoft Entertainment; extracted from *Assassin's Creed* Wiki).



Captain Cook (left) meeting ACR's protagonist; screenshot from the game (©Ubisoft Entertainment; extracted from *Assassin's Creed* Wiki).

The first mission in ACR involving Cook is very straightforward: to beat the French. Cormac takes the helm of the HMS Pembroke to aid Cook in turning the tide of the battle and finally, capturing the Fortress of Louisbourg. This aligns rather nicely with the historical record.

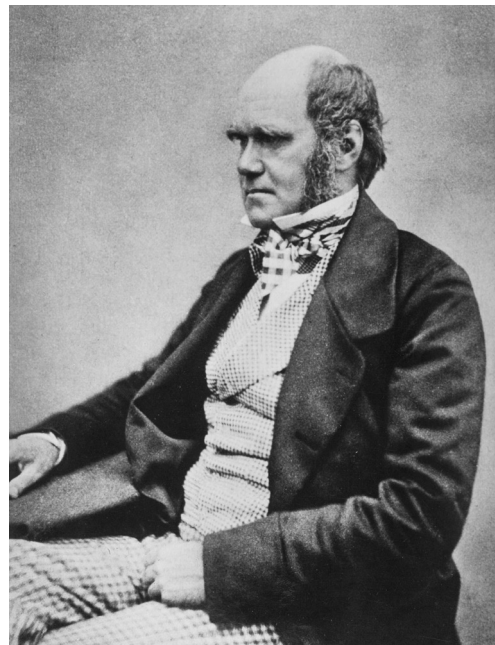
Cormac meets Cook again in Percé, in 1759, and asks him to decipher some encrypted maps. Cook also helps in tracking down a French-Canadian Assassin, after which he asks Cormac whether he belonged to a larger organization. After getting a reply in the lines of "we couldn't say even if we were", Cook then assumes Cormac and his crew were under direct orders of the King. The Templars seem satisfied with this and do not correct Cook. Instead, they say their group will contact him about sponsor-

ing future voyages.

The last bit is a clear reference to Cook's three exploration voyages to the Pacific. What interest the Templars might have there remains unknown for the moment, but it could definitely involve Terra Australis. In any event, real-life Cook indeed got the attention of the Admiralty and the Royal Society during his years in Canada, especially because of his incredible work mapping Newfoundland; indeed, this latter led to his appointment as commander of the first Pacific voyage.

CHARLES R. DARWIN

Darwin (1809–1882) needs no introduction – but here's one anyway. He is THE most important figure in Biology and of the most important scientists of all time. He is most famous for his book *On the Origin of Species* (henceforth *Origin*), first published in 1859, but his contributions to the natural sciences extend beyond that. As late American paleontologist Stephen J. Gould argued, Darwin's ideas rank with Copernicus in the way they revolutionized not only science but also the very way our silly species sees itself.



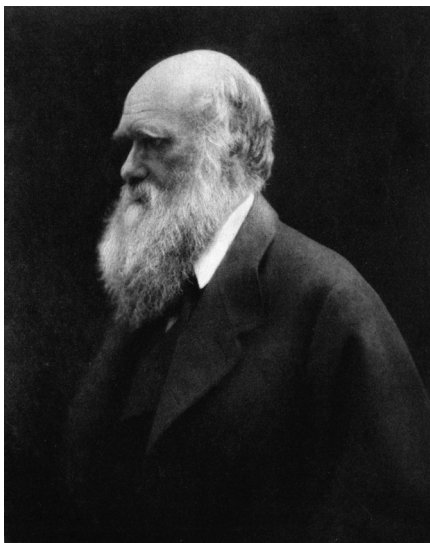
Photograph of Charles Darwin, possibly from 1854 (extracted from Wikimedia Commons).

There is simply way too much to write about Darwin: his early life, his voyage, his books, his garden experiments, his immense legacy, etc. There are dozens of books written about him and, if I start writing all the things I find interesting here, I might just end up with a whole book. Since I do not want that, I will focus here on very small parts of his life that are related to what happened in the game.

Darwin features in *Assassin's Creed: Syndicate* (henceforth ACS), released in 2015 for the Xbox One, PlayStation 4 and Microsoft Windows. The game takes place in London, starting in 1868, and revolves around the brother and sister pair of Assassins, Jacob and Evie Frye.



Charles Darwin, from ACSR (©Ubisoft Entertainment; extracted from *Assassin's Creed* Wiki).



Photograph of Charles Darwin from 1868, when ACS takes place (by J.M. Cameron; extracted from Wikimedia Commons).

In the game, you first meet Darwin investigating a factory that produced an opium-based drug called "Soothing Syrup". It was made by the Templars, of course, and Jacob decided to help Darwin in his investigation. They find out that Richard Owen (see Box 2), who was responsible for an article defaming Darwin, knew something about the syrup. Jacob interrogates Owen and discovers the name of the doctor who was behind the new drug, confronting and killing him in an asylum.

Back to the real world, first I should point out that Darwin was somewhat of a hermit. He lived in the countryside near London since 1842 and his home was known as Down House. Darwin reportedly did not enjoy going into town that much, so you would be hard pressed to find him in London as the Frye twins did. But that is totally excusable, as a game set in Victorian London must include Darwin somehow. Also, by that time Darwin already had his share of adventures during the voyage of H.M.S. Beagle around the world, so you would be even more unlikely to find him poking around criminal activities in London. Thus, the whole "Soothing Syrup" quests would be very unlikely, especially because they involve more medicine and chemistry than actual biology.

Later on in ACS, the Frye twins meet Darwin again, who says that his critics were threatening him and his colleagues with violence. He was waiting for a certain German colleague of his, identified in the game simply as Dr. Schwartz, who was bringing an important fossil to London. Darwin asks the Fries to protect Schwartz, but they discover that the German scientist was intercepted and killed by Templars. Even so, they manage to recover the fossil and deliver it to Darwin.

This mission is simply perfect for the setting, even though it is slightly historically inaccurate. The mission is called "The Berlin Specimen", which is a name that can only refer to one thing: the fossil specimen of *Archaeopteryx lithographica* from the Natural History Museum (Museum für Naturkunde) of Berlin. This species is one

BOX 2. SIR RICHARD OWEN

Owen is clearly linked with the bad guys in ACS. He was a controversial figure indeed, hated by his adversaries, but maybe not quite the “video game villain” kind. Sir Richard Owen (1804–1892) was a brilliant naturalist and authored outstanding works in animal anatomy and paleontology. In fact, he is the one who coined one of the most important words in our vocabulary, “dinosaur”. He is also responsible for the magnificent Natural History Museum in London, built as a cathedral of Nature.

However, Owen opposed Darwin’s idea of evolution by natural (and sexual) selection. Owen was well aware of the anatomical features that established lines of descent and relatedness among animals. Still, his belief in human uniqueness, immersed in what he saw as “natural order” arranged by a creative power, escalated his quarrel with Darwin and his followers, mainly Thomas H. Huxley and Joseph D. Hooker. He could not agree with humans being “just” a weirdly naked species of ape.

In ACS, Darwin even says to Owen: “Mr. Owen, you are truly the most insufferable fellow I have ever had the misfortune to count among my acquaintances!” In real life, after Owen’s involvement in an event that undermined one of his colleagues, Darwin wrote in a letter: “I used to be ashamed of hating him so much, but now I will carefully cherish my hatred & contempt to the last days of my life.”



Photograph of Richard Owen with a crocodile’s skull, 1856 (extracted from Wikimedia Commons).



Richard Owen, from ACS (©Ubisoft Entertainment; extracted from Assassin’s Creed Wiki).

of the most important in the world from a historical perspective: its first fossil was discovered in southeastern Germany just two years after *Origin* was published and was a major evidence in favor of Darwin’s work, showing that the origin of modern birds lays within the group of theropod dinosaurs.

The Berlin specimen is the most famous (and most complete) of all the fossils of *Archaeopteryx lithographica*; we typically see a replica of it in exhibition in museums worldwide. However, it was only discovered somewhere in 1874–1876, some years after the setting of ACS, but still reasonably close. Curiously, a man named Schwartz, from Nuremberg, tried to buy the actual fossil before it was bought by the Berlin museum (funded by Werner von Siemens, founder of Siemens AG).



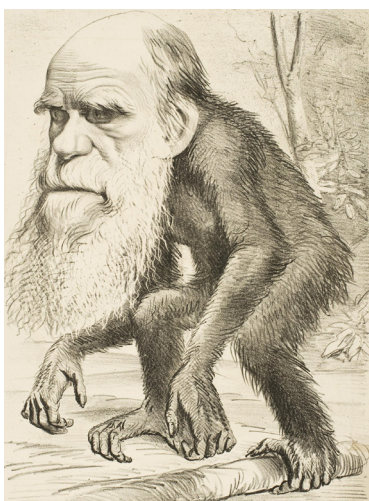
The Berlin specimen of *Archaeopteryx lithographica* (photo by E. Willoughby, 2014; extracted from Wikimedia Commons).

There is in fact a “London specimen” of *Archaeopteryx*, discovered in 1861 and bought by none other than Richard Owen for the Natural History Museum in January 1863. Perhaps this fossil would have been more appropriate for ACS; especially given that Owen is already in the game.



Replica of the London specimen of *Archaeopteryx lithographica* (photo by H. Zell, 2010; extracted from Wikimedia Commons).

Back to ACS, Darwin first asks the Fries to investigate a plant that can make people delirious and then to secure him a copy of that day’s newspaper, which had a rebuttal to Owen’s defamation mentioned above. The Fries then discover a Templar plot to spread newspaper articles with anti-Darwin propaganda, epitomized as a caricature.



This caricature, entitled “A Venerable Orang-outang” is seen in ACS and it was a real thing, published by The Hornet magazine in 1871, after Darwin published his book *The Descent of Man* (extracted from Wikimedia Commons).

In fact, Darwin was constantly under the radar of the Templars in ACS, who tried to buy him (and his research) out. Darwin answered that “[s]cientific knowledge cannot be bought, it belongs to everyone.” The Fries, of course, would come to his aid. They discover who was behind the caricature (spread through London as posters) and sabotage the printer shop.

Darwin’s ideas of evolution by natural and sexual selection and their implications for our own species were the cause of many heated debates during his lifetime. In fact, to this day many people are still in denial regarding his ideas (especially in religious countries like the US and Brazil), despite the massive amount of evidence in his favor. Darwin knew this would happen and that is basically why he took so long to publish his main book: he needed to amass as much supporting evidence as he possibly could. In ACS, Darwin says to Evie that “I am used to people challenging my ideas”.

The last mission involving Darwin in ACS is called “A Struggle for Existence” and alludes to the full title of his main book: “*On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*”. But the mission is not as poetic as it sounds; rather it is very literal.

It begins with Florence Nightingale telling the Fries that Darwin had been arrested and that she feared that “Mr. Darwin is no longer the fit, young man who once traveled the world.” The Fries then rescue him from a Templar base and Florence suggests that Darwin retired with his family to the Isle of Wight to recuperate in peace. Darwin, though, argues that “[t]he acquisition of knowledge is in itself sufficiently recuperative.” Real-world Darwin actually spent a holiday with his family on the Isle of Wight during 1868; the latter of the photos shown above was taken there.

ASSASSIN/TEMPLAR SCIENTISTS

As I said in the beginning, Cook and Darwin (and Owen, I suppose) are hopefully just the first on a series I intend to write exploring all the real-world scientists that feature in the many *Assassin's Creed* games. (I'll definitely include Florence Nightingale at some point, in case you were wondering.) Also, since several games take place before the establishment of modern science, you'll also see some philosophers and historians around here. Until next time!

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ABOUT THE AUTHOR

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Playing with the past: history and video games (and why it might matter)

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HISTORYING, PUBLIC HISTORY AND HISTORICAL VIDEO GAMES

While traditional history, as a discipline, is important, that should not obscure the fact that doing history, sometimes called “historying,” is something everyone does. For history is fundamentally just the communication of the past through a medium (Denning, 2006; Chapman, 2016). That is certainly the case when the most traditional forms of history are crafted by academic historians: books and textbooks. The dominance of text and speech in history classes should not mislead us: they are not the only media for

communicating the past and certainly not the only legitimate media (McCall, 2012b). There are many more, and once we leave the realm of academic historians, it’s easy to find pretty much everyone doing history in some form. They do this when they tell a story about their day, draw a picture about their vacation, or debate something that happened in their peer group. Film, painting, theater, sculpture, toys, music, even social media can and often do communicate aspects of the past and, when they do, they are history.¹ So, historical video games certainly qualify as a medium that can do history, that can communicate aspects of the



Figure 1. Historying. Collage of several images; sources: *Revolution* (cravengames.com); Delacroix's *La Liberté guidant le peuple* (Wikimedia Commons); Metropolitan Museum of Art (screen capture from their website: metmuseum.org); East India Company (screen capture from their website: theeastindiacompany.com); *Clan Fabius*, book cover (amazon.com); Cincinnatus Statue (S Kaya: flickr.com); Cincinnatus Pig Statue (waymarking.com); *Hamilton* (broadway.org); *Assassin's Creed Origins* (screen capture from the game, Ubisoft); Playmobil History set (toptoyusa.com); *Evil Empire*, album cover (Rage Against the Machine); *Dirt*, album cover (Alice in Chains).

¹ History and accurate/authentic history are not the same, and a work that qualifies as history can still be a very flawed communication of the past, whether a monograph, a lecture, a visual artwork, a film, a game, etc.

past. To use a more formal term, historical video games are a form of public history. Because the term's meaning varies widely, for purposes of this article, let's define public history as any communication of the past crafted outside traditional academia with little or no involvement of academic historians. This includes games whose designers read published histories and even games where an academic historian was on board as a consultant but did not make the driving decisions in the design process (McCall, 2018).

So, what makes a video game count as historical? This is another area of debate, but a useful broad definition runs like this: a historical game "has to begin at a clear point in real world history, and that history has to have a manifest effect on the nature of the game experience" (MacCallum-Stewart & Parsler, 2007). This definition works for most commercial games set in the past: the big budget titles *Call of Duty: World War II*, *Total War: Rome 2*, and *Battlefield One*; *Sid Meier's Civilization* series (now for almost

three decades with *III*, *IV*, and *V* still sold and *VI* released in late 2016); *Assassin's Creed Origins* and *Odyssey* (and many earlier entries in the series); the favorite games of last decade like *Stronghold*, *Sid Meier's Pirates*, and even *Age of Empires*; and hosts of recent games by independent developers such as *Field of Glory II*, *Egypt: Old Kingdom*, *Bomber Crew*, *Nantucket*, and *The Curious Expedition*.

Some games that connect to the past, however, are more difficult to categorize. *Wolfenstein: New Order*, for example, imagines a counterfactual history where Nazi Germany conquers the United States in 1948. The game begins in 1960. Not a historically documented world of 1960, but a counterfactual United States ruled by Nazis. Though *Wolfenstein* deals with important historical topics like the Holocaust, it does not neatly fit the definition of a historical game noted above (McCall & Chapman, 2017, 2018).

Games in *Assassin's Creed* series, on the



Figure 2. *Wolfenstein: The New Order*, screen capture from the game (Bethesda Softworks, 2014).

other hand, do begin at a clear point in real world history but focus on player characters that did not exist (Altair, Ezio, Bayek, Kassandra) occupying roles (Assassins and Templars in cabals) that did not exist his-

torically – at least not according to the best evidence and analysis. It's best to remember that, ultimately, categories like "historical games" are useful not for their rigid application but only insofar as they help

us focus on what is essential. Accordingly, this article is concerned primarily – but not exclusively – with exploring those games that fit the narrower definition of historical games most neatly: large-budget games like *Civilization*, *Total War*, *Crusader Kings*, *Europa Universalis*, *Call of Duty*, *Battlefield*, and countless independent games like *Field of*

Glory and *Bomber Crew*. Despite their many differences, these games have real-world historical settings and have player agents that – generally speaking – either existed historically or take on roles that existed historically (McCall, 2019).



Figure 3. *Assassin's Creed Odyssey*, screen capture from the game (Ubisoft, 2018).

HISTORICAL VIDEO GAMES: WHAT KIND OF HISTORY?

There are a great many kinds of these historical games: shooters, strategy games, adventure games, city builders, management sims, and so on. These games take two main approaches to representing the past: realist and conceptual (Chapman, 2016). Three-dimensional first- and third-person shooter games like *Call of Duty*, *Battlefield One*, and the *Assassin's Creed* series take the realist approach to representing the past. Their designers present a visually verisimilar environment, the past as it arguably appeared and as a world the player can navigate through the game's protagonist. Much like historical novels, these games center on fictitious characters who act in historically documented setting but do not alter conventionally accepted larger historical narratives. So, for example, the *Assassin's Creed* protagonists in the *Assassin's Creed* series do not alter the outcome of the French Revolu-

tions in *AC Unity* or negate Cleopatra's alliance with Julius Caesar in *AC Origins* as they have their adventures. Protagonist Red Daniels' actions in *Call of Duty: World War II* do not spawn an alternate history without the Allied Push through western France. Rather, the player character develops their own fictitious narrative within the backdrop of the more-or-less documented historical setting. Players decide some of the in-game protagonist's actions but do not change the larger historical narrative.

The other main approach to historical games is the conceptual simulation approach. Games like those in the *Civilization* series, *Total War* series, and Paradox's grand strategy games like *Europa Universalis IV*, *Crusader Kings II*, and *Hearts of Iron IV* focus not on showing how the past looked but telling how the systems and processes of the past functioned. They do this, not through immersive visually realistic environments, but through underlying rule sets



Figure 4. *Call of Duty: WWII*, screen capture from the game (Activision, 2017).

and systems, communicated to the player through stylized and sometimes abstract symbols and graphics (Chapman, 2016). So, *Civilization*, for example, does not show what ancient civilizations looked like so much as tell, among other things, how geography shapes the development of civilizations. *Crusader Kings II* does not show how medieval barons lived but tells about the political fragmentation of medieval Europe. In these games, players can make choices that have a grand impact on historical outcomes: managing ancient Egypt to

become the dominant world power by the time of the Renaissance, preventing Rome from falling, fending off the Crusaders, etc. These are approaches are not mutually exclusive, however, and many games have elements of both, such as the *Total War* games that combine the conceptual-style large-scale grand strategy of campaign maps and city-management screens with the more realist verisimilitudinous representations of individual soldiers and battlefields rendered in 3D.



Figure 5. *Europa Universalis IV*, screen capture from the game (Paradox Interactive, 2013).

What kind of histories are these historical video games? The vast majority whether their approaches to the past are realist, conceptual, or some combination, present that past as one or more historical problem spaces (McCall, 2012a, 2012b, 2016a, 2018). That is, they present the past in terms of:

- A primary agent, the player character of the game, with one or more roles and goals, operating within
- a physical space, a virtual world with an environment and geography that includes

- any number of elements, including other agents modeled by the AI as non-player characters, that can afford and assist player actions, constrain player actions, or both depending on the situation; and so, the player crafts

- strategies and makes decisions to take advantage of available affordances, work within or around constraints, and achieve their goal.

This certainly can be a problematic way to approach the past: It can over-emphasize

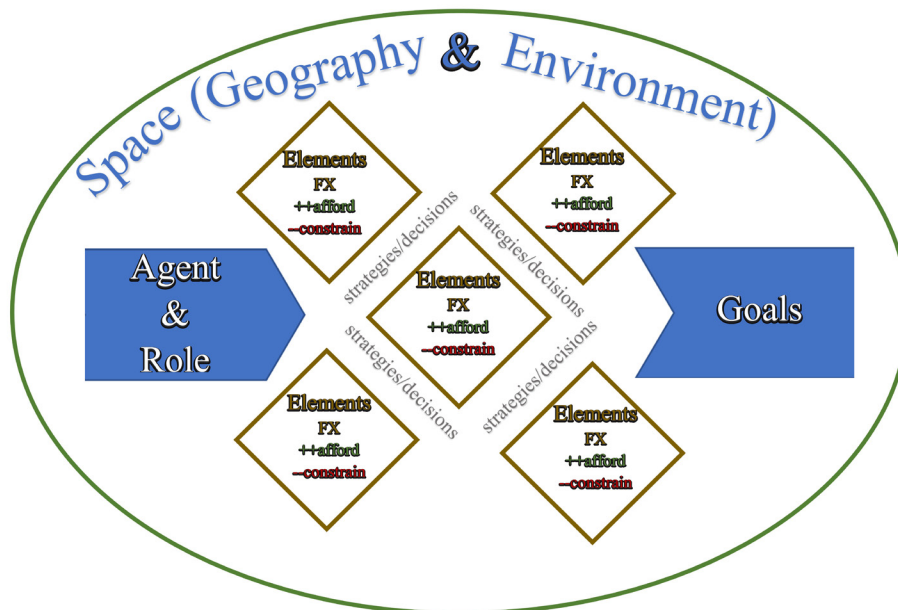


Figure 6. Diagram of a Historical Problem Space.

agents' conscious goal-oriented behavior and cause humans other than the primary agent to be cast as instruments (McCall, 2012b: 16–19). When applied specifically to the study of agents making decisions in systems like politics, trade, management, construction, battle and so on, however, the historical problem space approach of video games works reasonably well. For in these and other spheres, there was a great deal of conscious goal-oriented behavior, taking place in a physical geography containing elements and agents that could afford and constrain actions – terrain, weather, the physical condition of agents, their morale, and so on. Merchants and revolutionaries, soldiers and farmers, all formed strategies and made choices to reach their short- and long-term goals within their environment, their space.

Historical games model historical problem spaces in significantly different ways from narrative historical texts (McCall, 2012b: 13–21, 2016a: 8–10). The basic distinction is that games are interactive where text-narrative histories are fixed. Texts are fixed by the author and though, of course they can be interpreted in many ways by readers, the reality of the actual letters on the actual pages is objective and fixed and the narrative outcome of the text is fixed. For example, every reader that reads the book as designed will experience the same words in the same order. To that extent, the narrative outcomes of the text are fixed. Videogames (and boardgames for that matter) are interactive. The player is faced with meaningful choices and a variety of possible narrative outcomes based on those choices. Different players playing the game as designed will

experience different scenes and episodes in different orders, a different narrative overall. In practice, this means historical games will necessarily include counterfactual history, events and outcomes that did not hap-

pen, but might have.

Crusader Kings II, for example, allows a player to start their games at various times in the 9th to 15th centuries CE. At any giv-

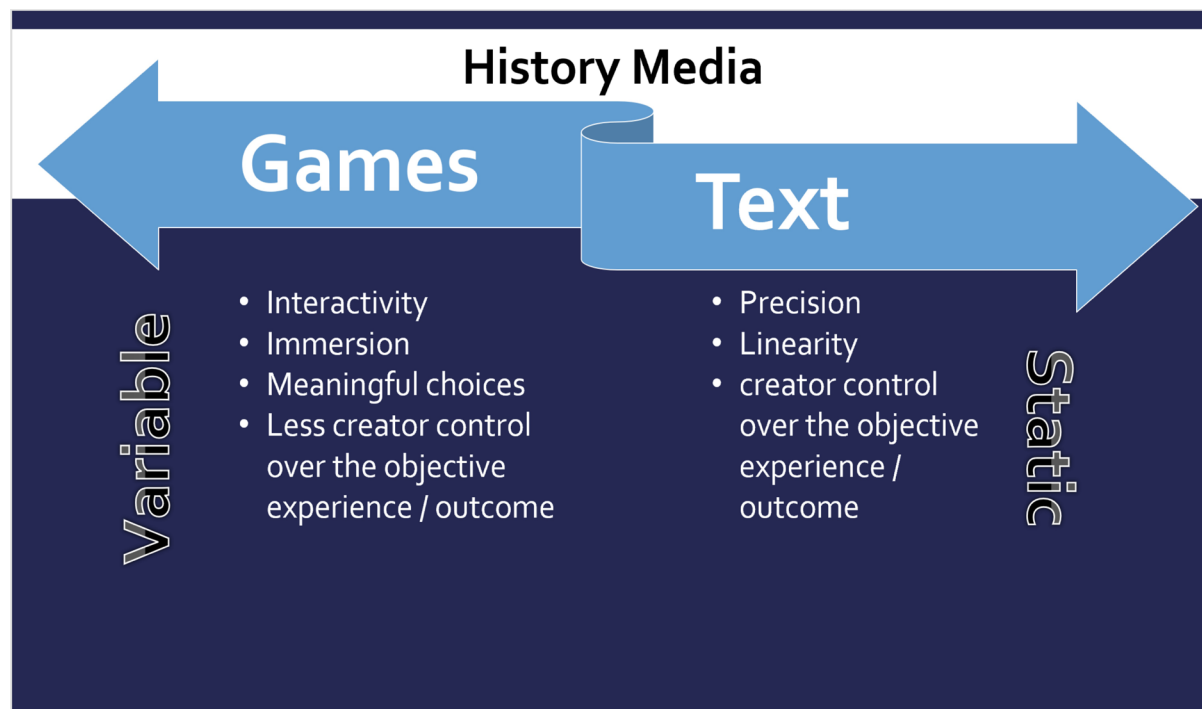


Figure 7. History media.

en date, the world map is divided into territories under the control of historical local rulers according to the historical evidence the game developers have been able to find. So, to use the European Middle Ages as an example, starting the game in late 1066, the player finds William of Normandy as the new king of England. The game designers did not stop with historical monarchs; lesser nobles generally correspond to historically documentable agents when that information is known, and the political boundaries of the world map change to match the history of the time and place. Thus, to a certain extent, *Crusader Kings II* accurately simulates the political geography of the time period in its various starting points. Once the player selects a dynasty to control and starts to play, however, the game simulates the actions of all the lords great and small in the game that the player does not control. Each lord operates according to the rules and priorities established in the game code. The player's freedom of choice and the fact that artificial intelligence (AI) agents' choic-

es are coded as probabilities, not certainties, means that the narrative of gameplay will bear similarities to the broader historical context of the period and place but almost certainly not match the specific historical chronology. So, one can centralize eleventh-century England under King Harold instead of William the Conqueror, lead a Mongol king to conquer all of Eurasia, and so on (McCall, 2012b: 12–16, 2016a: 8–10, 2018: 408–409).

This key feature of historical games, interactivity and, as a result, counterfactual outcomes, makes games potentially a very powerful medium for exploring the past. Historical games, in short, can do a very good job presenting the past in terms of systems and interactions, the causal connections that made past societies and people act the way they did. They can also represent the past, to a certain extent, as it seemed to agents at the time, as a contextualized world of possibilities where agents make choices in the hopes of achieving or avoiding certain outcomes, without any



Figure 8. A counterfactual history: Norwegian control of England in *Crusader Kings II* (screen capture from the game; Paradox Interactive, 2012).

certainly how everything will come out in the end. Indeed, this is how life is experienced for most of us, past and present. Interestingly, however, as Coppstone (2017) noted, the standard form of representing the past, textual history, tends to present the past as anything but open-ended, as simply a linear set of events destined to turn out the way they did. Games offer a sense of exploration, of control, of possibility, possibly a sense of sober consideration, not just passive determinism. As such they can helpfully move history education beyond the archetypal monotony of “one damned thing after another.”

Historical games generally make two kinds of claims to being historical, to conforming with evidence and scholarship

about the past: implicit and explicit. Essentially, all historical games make implicit claims to having at least some accurate historical detail. Consider this: When designers craft a historical game, they can choose to make it about a historical topic and world – *Civilization* or *Call of Duty* or *Assassin's Creed* – or not – *Scrabble*, *Super Mario Odyssey*, and so on. By opting to connect the game to a historical world with historical names, visuals, symbols, and rules, the designers implicitly suggest the game is historical to some extent and has some level of accurate portrayal of the past – though of course that level can vary widely within and between games.

Many historical game publishers go beyond these implicit claims to claim explicit-



Figure 9. Implicit claims to historical accuracy: *Scrabble* and *Super Mario Odyssey* vs *Call of Duty* and *Assassin's Creed*. Sources: *Scrabble* (boardgamegeek.com); *Super Mario Odyssey* (screen capture from the game; Nintendo, 2017); *Call of Duty: WWII* (screen capture from the game; Activision, 2017); *Assassin's Creed Origins* (screen capture from the game; Ubisoft, 2017).

ly that their games are historically accurate. “Historical accuracy” is a problematic term in-and-of itself and means different things to different people. Coppleson (2017) found in her research that many video game designers understood “accuracy” in terms of verisimilitude, correctly portraying architecture and material culture. Many players, on the other hand, considered accuracy to be judged in the degree to which a game matched something they had read (Coppleson, 2017). Gilbert (2019), however, found some players judged games to be more accurate than history texts to the extent that the games seem to espouse more diverse points of view than standard historical textbooks or teachings. Those investigating the connections between video games and history have their different definitions too and some advocate distinguishing between accuracy, defined as exact capturing of historical factual details, and authenticity, a more systems-based general feel that may err on details but gets an overall valid impression (Chapman, 2016; McCall & Chapman, 2017, 2018). Still, many would recognize historically accurate or even historically authentic representations of the past must conform to some debatable extent to sound historical evidence. In other words, they are consistent with at least some of the evidence. And this is what some game developers explicit-

ly claim. The manual for *Civilization IV*, for example, boldly proclaims:

“*Civilization IV* is the latest iteration of Sid Meier’s *Civilization*, first released in the early 1990’s. From its inception the *Civilization* series has been acknowledged as the first and best world history simulation, lauded for its incredible depth of play and its extraordinary addictive nature.” – (2K Games, 2005)

And Paradox Interactive claims its game, *Europa Universalis IV* allows one to “Rule [their] nation through the centuries, with unparalleled freedom, depth and historical accuracy” (in store.steampowered.com; accessed on 04/Apr/2019). Activision, publishers of the 2017 World War II shooter, *Call of Duty: WWII*, crowed, “our teams at Sledgehammer and Raven (...) captured the epic scale and authentic atmosphere of the most brutal war ever fought” (Jones, 2017). Creative Assembly, makers of the historical *Total War* series, played with definitions some, but still claimed their historical games conform to historical evidence when a spokesperson noted, “Authenticity is probably a better word than accuracy, and that’s what we aim for” (Brown, 2013).

Historical games not only promise to connect players to a real past, however; they promise all the traditional appeals of video games, elements that shape the type of history these games deliver. Beyond the



Figure 10. *Total War: Rome 2*, screen capture from the game (Sega, 2013).

tendency to cast players as goal-oriented agents within a problem space, video games often seek to indulge power fantasies where players have not just choices, but interesting and important choices that determine the fate of the game world. And because games try to satisfy this desire to make important decisions, they tend to be made about topics that seem more readily cast in heroic terms. This is at least part of the reason why there are very few peasant agriculture history games or games about herding flocks – despite the importance of these activities in human history – but there are myriad games about battles and politics.

Several other common biases of the medium are worth noting. Beyond presenting agents as empowered goal-seekers who face interesting choices, historical games also tend to simplify and streamline the topics they cover to make them more readily graspable, and, as a result, more appealing to consumers. Converting the health of soldiers into hit-points, calculating the ex-

perience of a player agent in terms of levels, treating all the nutritional requirements of humans as a simple all-purpose food commodity, expressing diplomatic relationships as positive or negative numbers. These are all examples of simplification and abstraction (McCall, 2012b).

On top of designers' goals to craft engaging gameplay, and the historical problem space framework, game histories – like indeed all historical media – are also shaped by their designers' understandings of the past. At a basic level, when a designer attempts to model the past, the elements in a game function according to that designer's understanding of the past. To give some recent examples, the *Civilization* series continues to emphasize the designers' understandings that advantageous geography and the development of Western arcs of technology are primary determinants in a civilization's success, a quantifiable success often expressed in militaristic terms. The Roman city-builder game from last decade,



Figure 11. *CivCity: Rome*, screen capture from the game (2K Games, 2006).

CivCity: Rome, has a happiness level that is essentially a material comfort level, and this measures the success of the player. In other words, the game promotes the “bread and circuses” approach to government – give the people material gifts and entertainment, and they will be happy. The popular *Total War* series suggests that morale is a critical part of battles, because soldiers fight not until they die, not always anyway, but until their morale dips too low and they flee in fear. None of these understandings are necessarily in conflict with historical evidence. They simply illustrate that designer’s understandings of the past shape their games (McCall, 2010; McCall, 2014).

GAMING THE PAST: VIDEO GAMES AND HISTORICAL THINKING INSIDE AND BEYOND THE CLASSROOM

Designers do a considerable amount of history when crafting their historical games, and this alone suffices to make them an interesting manifestation of public history for historians to explore. These games also have great potential to inspire and enhance all sorts of historical inquiries in and outside of the classroom. Since 2005, I have advocated that historical games’ ability to:

- immerse and engage through choice and multi-modal channels,
- provide systems-based interpretations that emphasize causal connections, and
- offer historical problem space approaches to understanding the past,

makes them useful tools for formal history education. Treating games as historical interpretations to critique, not as factual accounts, is critical to this approach. In other words, teachers and students should approach historical video games critically, study historical evidence, discuss ways the games simulate the past effectively and ways that they misrepresent it. This ap-

proach integrates reading historical sources, having discussions, direct instruction segments, and gameplay in class, and engaging in activities ranging from discussion to critical analytical writing, all designed to get students thinking about the historical claims of game models, and thereby, hopefully, developing a greater understanding of the past by assessing the strengths and weaknesses of the game versions. At the same time, I have explored the flip side of the coin, students crafting historical simulations as a way to practice the craft of historians, think carefully about cause and effect, and explore the choices of historical agents in the past. Most recently that has manifested itself in research and work on *Twine*, the choice-based interactive text tool, that allows students to research and craft interactive historical texts, allows them, in short, to do interactive digital history (McCall, 2016b, 2016c). The powerful potential of historical video games as pedagogical tools for history education is just starting to be realized.²

Even when not used in class as part of well-crafted learning environments, however, historical video games are an important medium of participatory public history. Players do history just by playing, for they interact with the game and engage in play that leads to historical narratives. Theorists about public history talk about the idea of shared authority, that non-academic historians, the public, can share authority for reconstructing and interpreting the past with academic historians. Game players and designers also share authority for reconstructing the past in video games. The game does nothing without a player, and so the act of playing is, in a very real sense, a dialogue between player and designer about what the past was like and how it functioned (McCall, 2018).

There is some research in this area, trying to understand what players think about as they play and reflect upon a historical game, though more is needed (Gilbert, 2019). Internet game forum discussions

²For my work in the field, see McCall, 2011: *Gaming the Past: Using Video Games to Teach Secondary History* (Routledge) and visit my work page on Gaming the Past (<https://gamingthepast.net/theory-practice/my-work/>).

offer an important and largely untapped resource for investigating the historical reasoning and journeys of game players. True, most game players likely never post on game forums. So, one can rightly question how representative forum posts are of game-players' thoughts in general. Still, they are an important resource for understanding some of the possibilities for players' historical thinking: since the forums allow essentially any gamer to participate in them, they publicize players' ideas ranging from support to analysis and criticism of their games. Forum threads, therefore, illustrate some of the types of experiences and understandings players *can have* interacting with these games. This is a critical point: the forums show a range of possible interactions with games available to anyone who wants to share their thoughts, and these interactions are no less possible for those who choose never to post. In short, the forums tell us what kind of reasoning can happen, a critical data point for those investigating historical games as media for learning history (McCall, 2018).

Forum posts suggest that some players engage in considerable amounts of historical reasoning as they reflect upon and discuss their gameplay. Discussion topics include:

- the difference between a fixed representation of the past and a simulation;
- the tensions that often exist between historical accuracy and engaging gameplay;
- the role of counterfactual history in games;
- how accurately games simulate elements of world history ranging from a historical state's political and military power, to the role of women in the politics of a period, a religion's characteristics, and to institutions of slavery.

Sometimes posters just assume the truth of their historical claims. Other times they provide reasonable historical statements ("facts") to back their assertions. Occasionally, they refer to a historian's work or text to back up their claims. In these ways, posters clearly engage in significant historical thinking on varied important topics and

also think about the accuracy of the games (McCall, 2018)

In short, historical video games have an impact on how players approach and understand the past (McCall, 2018; Gilbert, 2019). Indeed, they can serve as foils for important arguments about past and present. It's time to consider this final point in our exploration of historical video games as means of encountering, learning, and thinking about the past.

WHEN GAMES ABOUT THE PAST TROUBLE THE PRESENT

Far from desiccated topics of debate only of interest to antiquarians, video games histories inspire intense, sometimes inflammatory debates about past, how it is portrayed, whether those portrayals are historically accurate, and how those portrayals affect the present. This final section will examine a few cases where contemporary controversies have arisen about how accurately certain video games represent the past.³

Some video games have proven to be politically charged in how they represent military and political powers in the past, causing some to challenge their historical accuracy. *Assassin's Creed Unity* (2014), for example, places the player in control of a fictional Assassin based in Paris during the French Revolution. The game, developed by French company Ubisoft, sparked criticism from some French politicians, most notably former presidential candidate Jean-Luc Melenchon. He challenged the seemingly bourgeois depictions of Louis XVI and Marie Antoinette as honorable victims of revolution, the radical Maximilien Robespierre, author of the Terror, as a vicious despot, and the Parisian working class as a bloodthirsty mob. Debates about these and other actors in the Revolution have existed since the time of the Revolution itself and continue to take place, now around video games (Chibber, 2014).

Company of Heroes 2, a real-time strategy game about the Eastern Front in World War

³I gave a talk on this at Cincinnati Country Day School in October 2018, available on the school's Facebook page (www.facebook.com/CincinnatiCountryDaySchool/videos/280069235998930/).



Figure 12. *Assassin's Creed Unity*, screen capture from the game (Ubisoft, 2014).

II, was released in 2013, causing an uproar among some in Eastern Europe and Russia. Some of those upset signed a digital petition, hoping to block the sale of the game in the Russian Commonwealth. Critics "review-bombed" the game, flooding a videogame review site, in this case Metacritic, with negative reviews to lower dramatically its overall review scores. At issue was the depiction of the Soviet Army and war effort in the Second World War. At different times

in the game, the Soviet army is depicted as sending soldiers into battle without rifles, ordering officers to shoot any soldiers who retreated, and fielding battalions of convicted criminals. Critics suggested that these elements caricature Eastern Europeans as violent and obedient to the point of self-destruction and the Soviet state as evil. Relic defended its history and noted that there is enough evidence to suggest that two totalitarian states were brutal in their clashes on



Figure 13. *Company of Heroes 2*, screen capture from the game (Sega, 2013).

the Eastern Front and soldiers there were often caught between a rock and a hard place, between their enemies on the battlefield and their own states (Campbell, 2013).

The *Civilization* series, created by Sid Meier back in 1991 and now in its sixth iteration, has received significant criticism not only for its questionably accurate portrayals of the past but also the problematic messages those portrayals send to players. In this extremely popular strategy game franchise, players take on the role of leader of a “civilization.” These are ostensibly historical national leaders, but functionally deities, the guiding intelligence for their civilizations. Starting with the foundation of their first city in about 4000 BCE on a world map of earth-like or random geographic features, players navigate geography, and compete, collaborate, and fight with rival civilizations in a race to create the best civilization. Some have objected to the game’s caricature of historical figures and cultures. Other have criticized that the surest path to victory, to having the “best” civilization, is following the historical imperialist trajectory of technological and military development found in Western Civilization (Poblocki, 2002). Still others have pointed to the game’s problematic presentation of techno-

logical and industrial growth. In most play-throughs, a civilization can truly expand to all the corners of the world, exploiting ever more land and resources, without any problematic effects on the environment. Interestingly enough, anthropogenic global warming and its effect on sea levels were built into the earliest games of the series, *Civilization I* (1991) and *Civilization II* (1996), and not seen as particularly controversial. The phenomenon disappeared from *Civilizations III* through *V* (Tharoor, 2016). Most recently the developers of *Civilization VI* (2016) have released an expansion, *Gathering Storm* (2019), that adds, among other human made crises, anthropogenic climate change.

Still others have questioned how *Civilization* portrays certain historical leaders and cultures. Recently the Cree Nation criticized *Civilization VI* for including the Cree, without their consultation, as a historical civilization along with their historical chief Poundmaker. Said Cree Head Milton Tootoosis, “It perpetuates this myth that First Nations had similar values that the colonial culture has, and that is one of conquering other peoples and accessing their land” (Chalk, 2018). Tootoosis further opined, “That is totally not in concert with

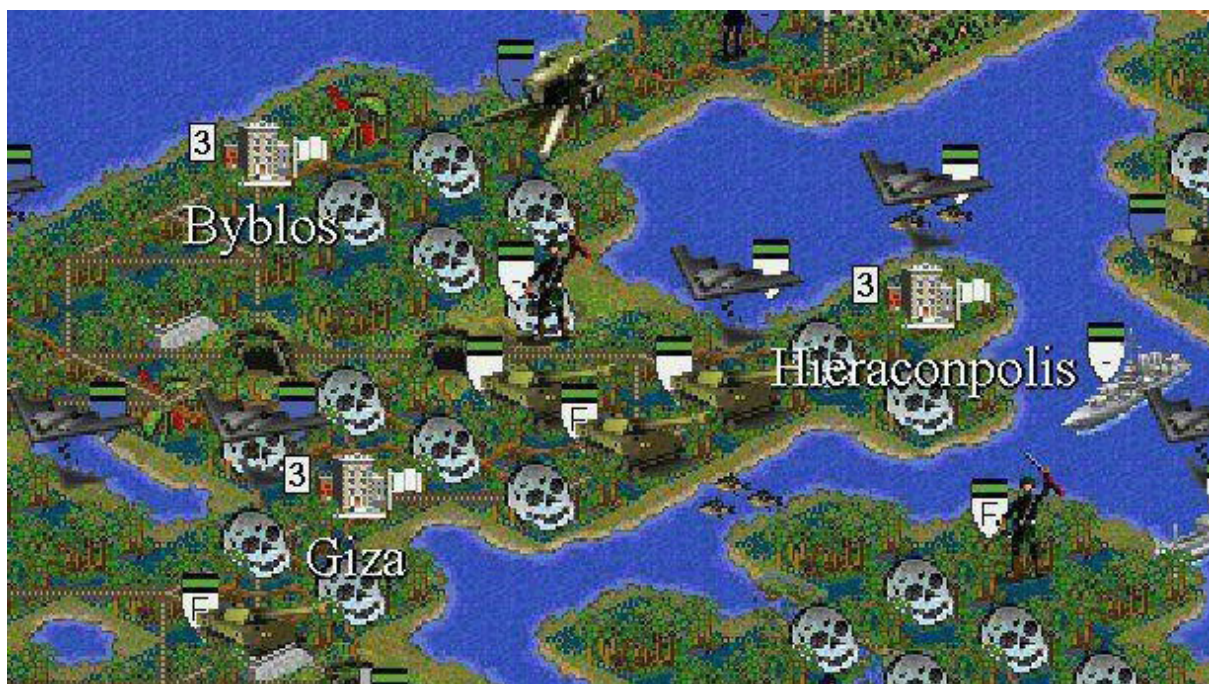


Figure 14. A 10-year (real world years!) game of *Civilization II*, screen capture from the game (MicroProse, 1996). Image extracted from Biessener (2012).

our traditional ways and world view (...) It's a little dangerous for a company to perpetuate that ideology that is at odds with what we know. [Chief Poundmaker] was certainly not in the same frame of mind as the colonial powers" (Chalk, 2018).

This concern about historical accuracy takes a grim turn when some argue, even

against the historical evidence, that a game obscures the reality of the past in order to be "politically correct" and inclusive of diversity. *Assassin's Creed Origins* (2017), for example, since its unveiling, has sparked debate and a considerable amount of racist rant and memes on Steam forums and elsewhere about the skin tones of ancient Egyptians, ancient Mediterranean peoples, and



Figure 15. Chief Poundmaker, from *Civilization VI*, screen capture from the game (2K Games, 2005).

so on. Much of this discussion focused on whether Ubisoft was historically accurate in its racial portrayals of ancient Egyptians. Though not always, much of this discussion reeked of blatant efforts to promote racist ideology in the present by attempting to apply it to the past (as a search in the Steam forums under *Assassin's Creed Origins* will illustrate) (Tamburro, 2017).

Similar debates about including women as protagonists in historical video games have surfaced in recent years. Creative Assembly's *Total War: Rome 2*, a strategy game in which players command an ancient state and its armies, received an update in March of 2018 that increased slightly the chances of certain states to receive female generals as potential recruits. These adjustments corresponded with Creative Assembly's release of the Desert Kingdoms Culture Pack that added Kush and Nabataea, among oth-



Figure 16. *Assassin's Creed Origins* screenshots (top; Ubisoft, 2017), compared to some Roman Period Fayum mummy portraits (bottom; Wikimedia Commons).



Figure 17: *Total War: Rome 2*, Desert Kingdoms Culture Pack, screen capture from the game (Sega, 2013).

er new playable states (Grayson, 2018; Lukomski, 2018; Scott-Jones, 2018).

Ultimately, the changes assigned some ancient states in the game a 10–15% chance to receive female generals as potential recruits. A few received greater chances. The ancient Nubian state of Kush, for example, received a 50% chance to reflect the greater frequency of women in political and military roles there. The most historically patriarchal societies – Rome, Greece, and Carthage – had no chance of recruitable female generals ap-

pearing.

Several months later, in September 2018, Creative Assembly released a tweet to respond to forum posters⁴ who did not condone the inclusion of women. The developers spoke in terms that demonstrated their interest in history and in representing the past in fairly viable, broad strokes. They stood by the changes.

Almost immediately after the tweet, negative reviewers review-bombed *Total War:*

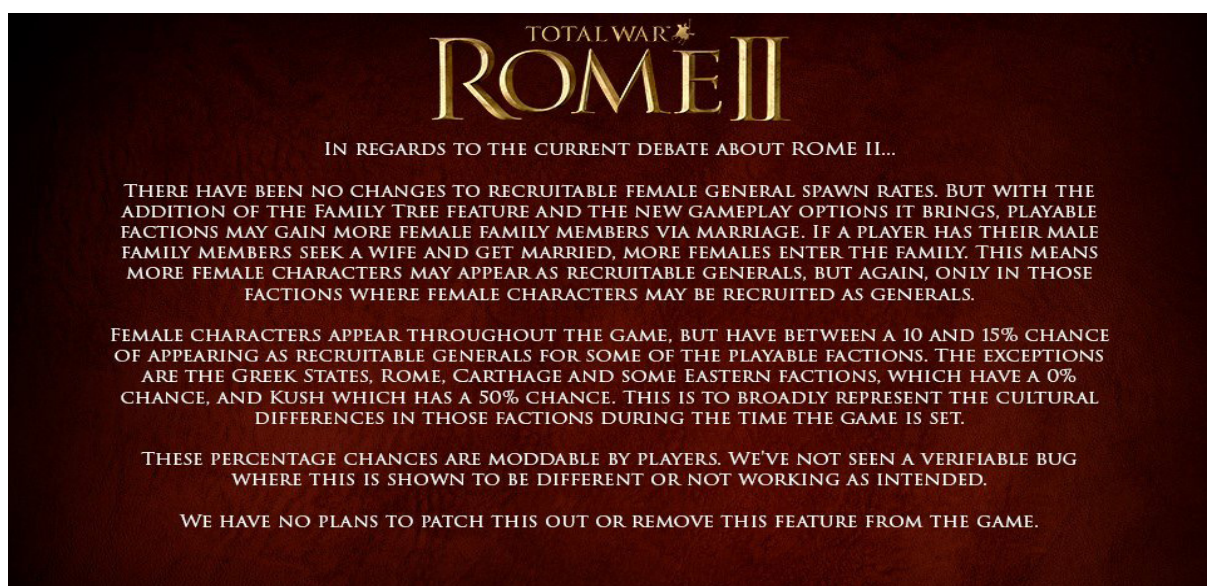


Figure 18. Creative Assembly's tweet from 25/Sep/2018.

⁴ To read reviews, go to: [https://store.steampowered.com/app/792520/Total War ROME II Desert Kingdoms Culture Pack/](https://store.steampowered.com/app/792520/Total_War_ROME_II_Desert_Kingdoms_Culture_Pack/)

Rome 2 in the Steam reviews section for the game.⁵ Many of the protests claimed that the game was historically inaccurate in its inclusion of women in the game. Much of the criticism also suggested that Creative Assembly was pandering to the so-called “SJWs”, or Social Justice Warriors, a label of derision often applied in forums to designate those who are too interested in sup-

porting diversity and inclusion (Grayson, 2018; Lukomski, 2018; Scott-Jones, 2018).

Battlefield V, a popular first-person shooter game focused on World War 2, became the topic for a similar debate. A trailer⁶ launched for the game in May 2018 included a female sniper with a prosthetic arm engaged in a pitched skirmish. Critics, often



Figure 19. Steam customer-review graph for *Total War: Rome 2*.

in volatile misogynistic terms, protested the game’s inclusion of playable women characters as historically inaccurate (Plunkett, 2018).

The striking feature of the *Total War: Rome 2* and *Battlefield 5* controversies is not so much that the critics of these aspects of the game – the inclusion of more women characters in political and militaristic historical contexts – often use inflammatory language calling out “the politically correct” and “Social Justice Warriors,” as interesting as that is. What is truly striking is that these critics levy the at-first-glance-more-objective claim that Creative Assembly and EA DICE are in the wrong because these features make their games “historically inaccurate.” In reality, however, there are any number of basic features of these games and indeed the larger *Total War* and *Battlefield* series that fail the test of historical accuracy, if that means consistency with the critically researched available historical evidence. This was pointed out by Lukomski (2018) in an insightful essay titled: “Accuracy” vs

Inclusivity: Women in Historical Games. And, in fact, there is ancient evidence that, in some cultures, women indeed participated in the political and military conflicts of their states as rulers, generals, and even just combatants. The same is true for World War II where women did play combat roles, especially in the Soviet forces, legendary for lethal women snipers and an air unit, the Night Witches, composed entirely of women pilots (Arbuckle, 2016; Holland, 2017). In short, it appears a number of posters have appealed to historical accuracy to support what essentially are racist and sexist arguments to limit diversity and representation in games.

The case of *Kingdom Come: Deliverance* (2018, henceforth *KC:D*) is a particularly interesting one to end this exploration with, because of a role reversal: instead of a game developer, as in the case of Ubisoft, Creative Assembly, and EA DICE including diverse people, increasing representations of diversity, and sparking cries of historical inaccuracy, the developers of *KC:D* presented

⁵ Search for reviews from September 2018 on Steam (https://store.steampowered.com/app/214950/Total_War_ROME_II_Emperor_Edition/ and https://store.steampowered.com/app/792520/Total_War_ROME_II_Desert_Kingdoms_Culture_Pack/).

⁶ You can find it on YouTube (<https://www.youtube.com/watch?v=a7ZpQadiyqs>).



Figure 20. Cover art for *Battlefield 5* (EA DICE, 2018).

a largely monolithically white, patriarchal, Catholic vision of Medieval Bohemia that pushed some to question how historically accurate this un-diverse vision of the Middle Ages was. In response to a query from a reader, the blogger at People of Color in European Art History investigated the game's Kickstarter and raised questions about the game's very un-diverse portrayal of medieval folk in Bohemia.⁷ Angry Internet sparring followed, and ultimately *KC:D* lead designer, Daniel Vávra, tweeted, "would you please explain to me whats [sic] racist about telling the truth? There were no black people in medieval Bohemia. Period," a problematically binary and ill-defined statement.⁸ In response to this doubling down, considerable debate has spawned on the Internet over whether indeed there were people of color in this small section of Medieval Bohemia.

In response to the ensuing flame war, blogger Robert Guthrie noted Vávra's claims were misleadingly selective. There are many elements in *KC:D*, Guthrie (2015) notes, that are not historically accurate, but ignored in the game designers' claims to accuracy. And so, it is difficult to avoid

the conclusion captured in Guthrie's title: "When historical accuracy is used to deny agency" (Guthrie, 2015). By insisting this exclusion of people of color and women in anything other than stock subordinate roles is required of a historically accurate game, *KC:D* essentially erases these groups from history, at least from the audiences of their game.

All of this raises interesting questions for historians and history teachers who hope to leverage historical video games that are, like all historical sources, limited in their scope and representation of issues and people. Historical accuracy certainly seems to be a reasonable value for history educators, and reasonably accurate history by game designers seems to be a positive goal. But what happens if the claim of historical accuracy is used, not as the basis for civil discussion about the past and how it is represented but as a way to exclude others? There is, indeed, a critical point here. When whole groups of people are left out of historical narratives and analysis, whether in a history book, class lecture, or video game, the effect is to almost erase those peoples from the record. This is not a problem

⁷ You can see it on their website (<http://medievalpoc.tumblr.com/post/75252294049/hi-ive-been-looking-at-a-kickstarter-for-a>).

⁸ To see Vávra's tweet, go to: <https://twitter.com/DanielVavra/status/569686445344079872>

that is unique to historical video games, of course. Even the best historians must be selective in their treatments and topics and will have their own biases. Thoughtful and reasoned debate and discussion are critical to navigating the often-muddy waters of historical accuracy in video games.

And those thoughtful and reasoned debates can certainly take place in the classroom. When it comes to use in history classes, the learning experience enhanced by games will be successful to the extent educators and students ground their discussion and analysis in historical evidence. After all, a game that is largely historically inaccurate – however one wants to measure that – can still be useful for learning history because the flaws in the game provide grist for the mill of critique (McCall, 2010, 2011).

Historical games, accurate or loose, exclusive or inclusive, problematic or purposeful are history. They communicate their designers' understandings of the past, not only in terms of what the designers think about the past, but also in terms of what they think is important to know, engage, and remember. They offer the possibility to game the past, to immerse oneself in historical problem spaces, seek out goals, make choices, and see the impact of those choices in a causally-connected systems. Accordingly, they offer significant possibilities for learning history whether it comes to students honing their abilities to critique modern media or developing their appreciation of systems and problem spaces. Regardless of whether they are leveraged in formal history education, they communicate messages about the past that reach considerable numbers of people. They should not be ignored by anyone concerned with how the past is perceived, portrayed, and played.

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ABOUT THE AUTHOR

Dr. **Jeremiah McCall** is an historian who writes about the political and military culture of the Roman Republic and about videogames as a form of history. He teaches high school history, quite likely his true calling, at Cincinnati Country Day School, where he has been for most of the past two decades. For more details on his work, please visit [Gamingthepast.net](#).



Through the Darkest of Times: life as the resistance during the Third Reich

Interview with Jörg Friedrich

Through the Darkest of Times is a historical strategy video game taking place in Berlin during the Third Reich, from Hitler's seizure of power in 1933 to Germany's surrender in 1945. The player leads a civilian resistance group fighting off the new regime how they can. The resistance is made up of common people, from all walks of life, so it's the leader's job to win hearts and minds and hold the group together. The player will be responsible for planning the group's activity and survive by avoiding the Gestapo. All of this while actual history unfolds outside: the game follows the actu-

al historical time-line, which influence the player's options. The game is under development by Berlin-based studio Paintbucket Games¹, made up by the duo Jörg Friedrich and Sebastian Schulz. It will be published by HandyGames in the near future and is already listed on Steam.

The Journal of Geek Studies interviewed Jörg Friedrich to understand how such a unique game like *Through the Darkest of Times* came to be. You can read the full interview below.



¹ Be sure to check out their website (<http://paintbucket.de/>).

Q: On your website, you mention that a game focusing on the civil resistance during Third Reich Germany just had to be made. We agree, of course, but would you care to elaborate a little more on this?

A: The story of civilian resistance fighters in Germany is a story that people must learn about – these normal people with families, with normal jobs, saw what was going on the world and decided they had to do something against it. They went underground and risked their lives to stop an inhumane regime.

We think this is a story that must be told.

As political people, certain developments in the world, the fact that we see fascists rise again, here in Germany but also in many more countries in Europe and in the US, worries us a lot. In 2017 we wondered what we could do about this and the only thing we are good at is making games, so we thought “hey let’s make a game that takes an anti-fascist stance and maybe it will make the world a better place!”

As game developers and artists, we like to push the boundaries of the medium. Sebastian and I met when we were working for YAGER, where we made a game called

Spec Ops: The Line – an AAA shooter that asked players to shoot people and blamed them when they did. It was supposed to make players feel bad.

Back in 2012 this was special. It felt like a game that needed to be made. We felt like pioneers, we felt like we tried something new by taking a new stance on war and on war in games.

Making *Through the Darkest of Times* feels similar – we try to find a new way on how games treat Nazism.

Q: Do you believe game developers have a responsibility when representing History? Should this come before artistic freedom?

A: We learn history not only at school, but also from the stories told to us by movies, books and well – video games.

But if someone would learn everything he knows about Nazism from games, he might conclude that Nazis are villains like the Empire in *Star Wars*: somewhat evil, but they have cool uniforms and tanks and are in the end just a faction like any other.

I find it problematic, that most games





with Nazis don't even mention the murderous anti-Semitism, the slow rise of Fascism or the Shoa.

I know that these games usually have no bad intention by omitting these facts, they often do it to avoid controversy. But honestly: if you think mentioning the historical crimes of the Nazis is inappropriate for your game, maybe picking Nazis as a faction or theme for your game is what is inappropriate here.

Q: Nazism seems to have become just another Hollywood trope nowadays. Are you concerned about how Nazi Germany is depicted in current games?

A: Here is the problem: if your game is about Nazis, but in your game, they do not commit any war crimes, there is no Auschwitz, no Shoa, then you create a historical narrative in which the Nazis didn't commit these crimes.

And that's the narrative that is told by Neo-Nazis who try to white-wash historical Nazism, so people are less hesitant to open for far-right ideologies.

Video games is the most important nar-

rative medium of our time – as developers we must take responsibility and tell things the way they happened just as movies did a couple of decades ago.

Q: Current gaming culture is often referred to as toxic, where sexist, racist, homophobic behavior unfortunately abound. Do you believe that might be related to the ideals that games historically presented? Can game developers help change this culture?

A: Yes, I think so. The way games were marketed since the 1990's until recently, towards young men, featuring the ideal of tough white guys who like hot girls and solve problems with their guns, appealed to a specific type. And this type feels now entitled to games. They think it is their medium and that developers need to create games for them and only for them.

This was never true, because of course there were always all kinds of people playing video games, but we now have this extremely entitled, extremely loud and toxic bunch of guys who yell the loudest and think they can dominate the Internet and our medium.



We must not let them. We must not listen to their demands; leave them stew in their own juice and just ignore them. Let's make games that are open and inclusive, for an open and diverse audience instead of making games for the Christchurch killer².

Q: So, let's turn to the game now. What exactly is the players' goal in *Through the Darkest of Times*?

A: You play a leader of a civilian resistance group in Berlin in 1933 when Hitler becomes chancellor. You try to fight the regime with acts of sabotage and later attacks, educate people and let them know the truth about the Nazis' plans and their doings, and help the persecuted, by hiding them or getting them out of the country.

Your goal is to persist as a group until the end of the war and do as much of the three things mentioned as possible without being caught by the Gestapo.

In order to achieve this you need to send your members on missions and organize re-

sources necessary for your fight.

The group members are civilians, who are suddenly thrown into a situation where they must do something illegal and risk their life to resist the regime. Members have different biographies and political views, which can lead to conflicts within the group and keeping up morale and members from simply giving up can be tough.

So you try to do as much good as you can and lead you and your group through the darkest of times.

Q: There are some games out there with a healthy dose of historical backgrounds, such as Ubisoft's *Valiant Hearts* and *Assassin's Creed*. How does *Through the Darkest of Times* approach History?

A: Every turn in the game is one historical week. At the beginning of each turn you get the news with what happened in that week – based on the historical events of that week. But history influences the game mechanics too: at the beginning you don't

²The Christchurch mosque shootings were two terrorist attacks conducted by an Australian alt-right white supremacist in Christchurch, New Zealand, on 15 March 2019. Over 50 people were killed and another 50 were injured. New Zealand's Prime Minister Jacinda Ardern described the event as "one of New Zealand's darkest days." (Source: Wikipedia)

need to be too worried, there are even public protests against the regime happening in the streets where you and your group can join. But over time, the repression increases; after the Reichstag fire, the city is full of SA and things are dangerous; and once the Gestapo is founded and the first concentration camp is built, things are dangerous.

There are also big historical events that you witness through narrative sequences to give you more a feeling of being there, than just in the strategy mode.

History also influenced the looks of the game. Sebastian was inspired by German expressionists of the 1920's who were later banned by the Nazis as un-German art. He tried to create a look that the Nazis would have banned.

So I would say, history plays a very important role in *Through the Darkest of Times*.

Q: What kind of source material did you use while building the game? Books, historical documents, interviews?

A: All of this. We read a lot, we went to places and museums – luckily, as we are in Berlin and the game takes place in Berlin,

there are a lot of memorial sites and local annalists we got in touch with. We read interviews of course and we talked to descendants of civilian resistance fighters.

Q: How faithfully does the game follow real-life events of the Third Reich? Can the players expect to “change the course of history”?

A: In the main game, the historical events and what you read in the news all follow the actual historical timeline. Your character, the members of the group and your supporters are fictional though, and so are their actions against the regime.

But characters and actions are inspired by real civilian resistance groups that were active in Berlin at that time, such as the Schulze-Boyssen/Harnack group or the Jochen-Baum group.

Most of the missions wouldn't have an impact on grand politics – if this is what you mean by “changing history”. However, the way we see it, history is not only changed by generals and leaders but by all of us.

Who saves people drowning in the Mediterranean Sea today is changing history –



more than most politicians and in a better way if you ask me.

But since we have all these rogue-like elements in the game and since we like the idea, we are thinking about a second mode – a “New Game+” if you want – in which events happen less predictably and you might be able to stop the regime before the end of the war.

Q: Do you hope players will learn something about German and World History by playing *Through the Darkest of Times*?

A: When I talk to people about the Nazi time they often have the idea that it started with war and holocaust right away. But it didn't. Hitler got elected. He became chancellor in a legal way, because we had conservatives who thought that they could handle a fascist in power and that this would still be better than the left – 12 years later half of Europe was destroyed and millions of people had died.

I hope people might be able to recognize the patterns when playing *Through the Darkest of Times* when they look at what is going on in the real world.

Q: Is there any takeaway message you'd like the players to get from your game?

A: It would be great if our players took away the same message that we took away when we started to learn about civilian resistance fighters: some developments are so wrong, they are so evil, that we have to overcome our day to day disputes, unite and fight for the fundamental human rights even if it means taking a risk.

ABOUT THE TEAM



Paintbucket Games is a Berlin-based indie game studio founded by two ex-AAA developers. **Jörg Friedrich** does design and code and **Sebastian Schulz** does art and design. They have been making games for more than 13 years each and worked on 10 of those together. Among the several titles they worked on are: *Spec Ops: The Line*, *Dead Island 2*, *Albion Online*, and *Desperados 2*.



Pokémollusca: the mollusk-inspired Pokémon

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The phylum Mollusca appeared during the Cambrian Period, over 500 million years ago, alongside most other animal groups (including the Chordata, the group we belong to). There are even some older fossils that could be mollusks, although their identity is still hotly debated among scientists.

Mollusks are a very biodiverse group. We do not yet know the precise number of species, since many are still unknown and being described every year. However, estimates go from 70,000 to 200,000 (Rosenberg, 2014). And that's just for the living species. As such, mollusks have long been considered the second most diverse group of animals – the first place belongs to arthropods.

Mollusks can be found in almost all sorts of habitats: land, freshwater and marine, including the deep sea and hot vents. The only thing they can't do is fly.

They are also a very unique group in terms of body shapes (morphology), including extremely disparate forms: snails, slugs, clams, mussels, squids, octopuses, nautilus, chitons, tusk shells, and the odd worm-like aplousobranchs. And there were other forms yet, which are now extinct: ammonoids, belemnites and rudists. Mollusks go from tiny snails less than a millimeter long to giant squids, almost 20 meters long and the largest known invertebrates.

The main groups of mollusks, however, are just three: Gastropoda, or gastropods, which include snails and slugs; Cephalopoda, or cephalopods, which include squids and octopuses; and Bivalvia, or bivalves,

which include mussels and clams.

Curious creatures that they are, mollusks make nice “monsters” and are constantly being featured in video games (Cavallari, 2015; Salvador & Cunha, 2016; Salvador, 2017). One very famous game that features mollusks is *Pokémon*, a franchise that started with two games released by Nintendo for the Game Boy in 1996. More than 20 years later, the series is still strong, currently on the so-called seventh generation of core games, but counting with several other video games, an animated series, films, a card game, and tons of merchandise. Also, there's an eighth generation of games on the horizon.

Most monsters in *Pokémon* are based on real animals (see, for instance, Tomotani, 2014; Mendes et al., 2017; Kittel, 2018), so the goal of this article is to present those based on mollusks. Some of them were just broadly based on a larger group of mollusks, such as ‘octopuses’, while others seem to have been inspired by particular species. Thus, we indicate the real species or group that served as inspiration for the monsters and explain a little bit about their biology. Whenever possible, we outline specific features of the real animals that were transported to the games (such as types, moves, abilities, etc.).

LIST OF MOLLUSK POKÉMON

We analyze each mollusk Pokémon below; they are listed in the same order as in

the National Pokédex (this number is given with a “#” on each entry). All the illustrations of the Pokémon reproduced here are the official art by Ken Sugimori and were extracted from *Bulbapedia* (<https://bulbapedia.bulbagarden.net/>). Likewise, all information on the Pokémon (size, weight, and description of abilities and moves) were taken from their entries in *Bulbapedia*, considering only the game’s current generation (Gen VII).

The systematic classification of the mollusks used here follows Bouchet et al. (2010, 2017) and WoRMS (World Register of Marine Species). Images of real mollusks were extracted from Wikimedia Commons, except where otherwise noted; credits are given in each figure’s caption.

Shellder
(#090; Type: Water)



Class: Bivalvia (bivalves)

Order: Pectinida (scallops and oysters)

Family: Pectinidae (scallops)

With its googly eyes and what seems to be a hanging tongue, Shellder looks somewhat scared or mesmerized (or perhaps both). This small shell-bearing fellow is surely designed after a bivalve mollusk. And, curiously enough, the large eyes are actually not out of character: even though most bivalves have no eyes, the Pectinida, a.k.a. the scallops and their allies, are an amazing exception. These animals are found in all of the planet’s oceans and the family Pectinidae is in fact one of the largest marine bivalve families, including over 300 living species belonging to 60 genera (Waller,

2006). They do have incredible eyes with a very intricate structure that allows them to measure amounts and intensity of light coming from different directions (Morton, 2008). As far as we know, scallops can discriminate light from dark, spot surrounding algae, and perceive moving objects or obstacles (and react accordingly). Judging by its real-world counterparts, Shellder shouldn’t necessarily have a hard time aiming its “Clamp” or “Razor Shell” attacks, hiding from someone else’s attacks, or swimming away from menacing foes. And yes, scallops also have awesome swimming abilities, which are also not common among bivalves in general. Most bivalves are very good swimmers during their early days as planktonic larvae (known as veligers), but become sessile when adults, spending their lives burrowed in the sand or attached to a rock or other hard surface.



Top: Scallops on the seabed (CSIRO, 2001). Bottom: Close-up of the blue eyes (M. Krummins, 2014).

As for the shell itself, Shellder seems to belong to the family Pectinidae because of its overall shape. Even so, Shellder’s tongue, in particular, is a very interesting topic. It looks very similar to a bivalve’s foot, a bulky, muscular structure that allows it to burrow itself into the sand, among other things. However, though the foot is

very conspicuous in most bivalve lineages, it is reduced in pectinids (Shumway & Parsons, 2011). At the same time, though they are never protruded, some of the animal's organs such as the gonads are often visible from the outside in real world bivalves, and they can resemble a tongue hanging between open lips. We do, however, prefer to think of Shellder's tongue as a foot for obvious reasons. Pectinids usually don't grow up to the huge proportions of 0.3 m and 4 kg informed by the Pokédex, but other real-world clams can become even larger (see Cloyster below).

Cloyster
(#091; Type: Water / Ice)



Class: Bivalvia (bivalves)

Order: Pectinida (scallops and oysters)

Family: Spondylidae (thorny oysters)

Genus: *Spondylus* Linnaeus, 1758

A rather fierce-looking version of its pre-evolved state, Cloyster sports a larger, thicker and rougher shell, complete with spikes/thorns, which are typical features of the bivalve family Spondylidae. Commonly known as thorny or spiky oysters (they are not part of the so-called “true oysters”, which belong to the family Ostreidae), spondylids are close relatives of the common scallops (Matsumoto & Hayami, 2000). Among many other striking morphological characters, such as their many eyes spread along the animal's mantle, pectinids and spondylids share an overall similar shell outline but the latter are usually bulkier and spikier.

As for being bulkier, Cloyster is many

times larger and heavier than Shellder, spanning up to 1.5 m wide and weighing over 130 kg, a size unattainable for any real-world spondylid, but still not entirely fictional: some bivalves in the family Tridacnidae (a.k.a. giant clams) can weight over 200 kg (Knop, 1996). Nevertheless, even though spondylids certainly do not grow to such humongous proportions, the increased size and the prominent, more numerous spikes make up for a more menacing and stronger version of the childly-looking Shellder, with a malicious look as a bonus.



Top: *Spondylus regius* Linnaeus, 1758 (D. Descouens, 2009). Bottom: *Spondylus* sp. (F. Ducarme, 2018).

The attacks are all very similar to Shellder's, with the addition of a “Spike Cannon” move (yet another reference to the thorny *Spondylus* shells). Likewise, if Shellder is based on pectinids and Cloyster on spondylids, the “close” relationship between the two Pokémon thus elegantly (though hardly intentionally) reflects their real-world

kinship.

Of course, spondylids are not the only spiky bivalves out there. The Japanese spiky oyster, *Saccostraea kegaki* Torigo & Inaba, 1981 (family Ostreidae), for example, also has a spiky shell that seems quite uninviting to the touch. But spikes aside, it lacks some other traits observable in Cloyster that indicates it was probably inspired by real-world spondylids, e.g., the bulkier shell. Besides, true oysters have very variable shape, not very similar to Cloyster's symmetrical, scallop-like profile. Its shell also includes wing-like or ear-like projections located at the rear (called auricles), which also appear in some spondylid species (Shumway & Parsons, 2011).

Omanyte
(#138; Type: Rock / Water)



Class: Cephalopoda (squid, octopuses and nautiluses)

Subclass: Ammonoidea (ammonoids)

Omanyte and its evolved form, Omasstar (see below), are based on a generalized ammonoid. Ammonoids¹ are cephalopod mollusks who once crowded the seas, with an astounding diversity of species. Unfortunately, they went extinct together with non-avian dinosaurs during the great extinction event in the end of the Cretaceous period. True to its roots, Omanyte is not found alive in the game: it is found as a fossil (called "Helix Fossil") on a rocky matrix. The player must then "resurrect" it in a very Jurassic Park manner. As all fossils in the *Pokémon* franchise, Omanyte and Omas-

star are Rock-type. On a side note, the Helix Fossil recently spun its own mythology on *Twitch Plays Pokémon*, where it acted as a sort of oracle to the players (for the whole story, see Salvador, 2014).

Despite being very similar to a real ammonoid fossil, Omanyte bears a huge flaw in its design. The soft body is positioned in an inverted manner in relation to the shell. That is, Omanyte's body is positioned like the body of a snail (a gastropod), rather than like the body of a cephalopod (Salvador, 2014). Omanyte is depicted with 10 arms, but the real numbers an ammonoid would actually have is unknown because other living cephalopods have a variable number (Monks & Palmer, 2002): nautiluses have 50 to 90 arms, squids and cuttlefish have 10 (two of which are called tentacles) and octopuses have 8.



Top: *Asteroceras* sp. (Daderot, 2012). Bottom: Reconstruction of *Asteroceras* sp. (N. Tamura, 2009).

Omanyte can have the ability called "Shell Armor" (see above), which makes

¹ In common parlance, they are known as "ammonites", but from a more strict scientific perspective, ammonites (order Ammonitida) is a smaller group inside the ammonoids (subclass Ammonoidea).

sense, and can learn the move “Withdraw”. Although no living ammonoid exists, they were thought to be able to withdraw into their shells for protection like their present-day “cousins”, the nautilus (Monks & Palmer, 2002). It can also learn the move “Shell Smash”, which does not make sense: why would a mollusk break its only means of protection?

Omastar

(#139; Type: Rock / Water)



Class: Cephalopoda (squids, octopuses and nautiluses)

Subclass: Ammonoidea (ammonoids)

Omastar is very similar in design to Omanyte (even retaining the gastropod-like position of the body), with a few important differences. (1) Beak: Omastar has a tetrapartite beak. Living cephalopods have a parrot-like beak made up of two interlocking jaws, and ammonoids thus probably also had a beak (Engeser, 1996; Monks & Palmer, 2002). We say “probably”, because features of the soft body hardly ever are preserved in the fossil record. In any case, a beak made up of four parts such as Omastar’s is a bit of an overkill.

(2) Spikes: Omastar’s shell is lined with spikes. It can learn the move “Spike Cannon”, which means it supposedly can shoot them as projectiles. Needless to say, ammonoids species that were ornamented with spikes (for instance, *Apoderoceras* spp. and *Euhoplites* spp.) would not be able to do that. Even so, the function of shell spikes in ammonoids is thought to be defensive, to discourage potential predators of taking a bite (Ward, 1981; Monks & Palmer, 2002).

(3) Size: while Omanyte measures 0.4 m and weighs 7.5 kg, Omastar reaches 100 cm and 35 kg. Of course, every player worth their salt knows that these Pokédex entries are just plain crazy, but it can serve here to illustrate how awesome ammonoids were. A 1 m high Omastar might seem too large to be possible, but one ammonoid species could reach up to 2 m in shell diameter (estimated 2.5 m or even 3.5 m if the largest known fossil was complete; Teichert & Kummel, 1960). This species is called *Parapuzosia seppenradensis* (Landois, 1895) and is known from the Cretaceous Period of Germany. Its shell is estimated to have weighed circa 750 kg in life and this value would increase to 1,400 kg with the animal’s soft body (Teichert & Kummel, 1960).



Euhoplites armatus Spath, 1928 (courtesy J.-S. David; www.jsdammonites.fr).

Curiously, *Bulbapedia* states that the shell of Omastar was too heavy to move and this led to the species extinction (they died out from starvation). This type of view about extinction, which supposes that the animals were somehow inept and unable to survive, is completely outdated – not to say completely ridiculous. The same story was told

long ago about the extinction of the “slumbering dinosaurs”, but this is now known to be false. Extinction can have many causes, including environmental changes, competition with other species, predation, calamitous events, and, of course, irresponsible humans.

Slugma
(#218; Type: Fire)



Class: Gastropoda (snails and slugs)

Superorder: Eupulmonata (pulmonate snails and slugs)

Order: Stylommatophora (terrestrial snails and slugs)

Slugma was clearly based on slugs, but not on any particular species: rather, its design is broadly generalized. The superorder Eupulmonata (earlier known as order Pulmonata) within the gastropods contain the highest diversity of terrestrial forms (over 20,000 species of land snails and slugs; Rosenberg, 2014). The “slug” body shape is a modification of the typical snail body in which the members of the lineage go through shell reduction, shell internalization (it becomes a small piece within the animal’s body) and sometimes the complete loss of the shell (Barker, 2001). This process, called “limacization” (or “transformation-into-a-slug”), happened separately several times within Eupulmonata, in many distinct families (Veronicellidae, Rathouisiidae, Arionidae, Limacidae, etc.). Is it though that losing its shell increases the mobility of the animal and capacity to explore and hide in smaller spaces (Cameron, 2016). However, the absence of the shell means that the animal is more vulnerable to predators and to the worst enemy of terres-

trial gastropods: evaporation.

Terrestrial gastropods have soft moist bodies and are constantly losing water to the environment by evaporation. A very large portion of these animals’ evolutionary history is related to mechanisms and strategies to decrease or avoid losing precious water (Barker, 2001). Also, slugs cannot be too large, because of water loss and the lack of a skeletal structure to sustain the body. Of course, the 0.7 m tall Slugma is basically a *Dungeons & Dragons* fire elemental, so water loss is not even in question.



Top: *Arion rufus* (Linnaeus, 1758) (H. Hillewaert, 2008). Bottom: *Limax* cf. *dacampi* Menegazzi, 1854 (Hectonichus, 2005).

Slugs are worm-like creatures that crawl horizontally, but Slugma has a somewhat upright posture, with its head permanently reared up. Although slugs can sometimes strike such a pose (when trying to climb something, for instance), they do not spend their whole time nor do they move around like this.

Magcargo
(#219; Type: Fire / Rock)



Class: Gastropoda (snails and slugs)

Superorder: Eupulmonata (pulmonate snails and slugs)

Order: Stylommatophora (terrestrial snails and slugs)

The evolved form of the slug Pokémon Slugma is Magcargo, a snail. As explained above, biological evolution has always worked the other way around, with slug species arising within snail lineages. In any event, it is evident that “evolution” in Pokémon has absolutely nothing to do with biological reality – and we hope we do not need to explain here that it is impossible for an animal to transform into another after it has gained enough XP. That’d be cool, though.

Like Slugma, Magcargo has a generalized design but this time around, based on a snail. In fact, its name is a combination of the words magma and escargot (French for snail). Curiously, Magcargo has a planispiral shell, meaning that its shell is coiled on a single plane, resulting in a flat appearance. Planispiral shells are very rare in land snails, presumably because carrying a shell shaped like this on land is rather clumsy. However, planispiral shells are very common in freshwater snails, where the water helps to sustain it; there is a whole family with planispiral shells, aptly named Planorbidae (from the Superorder Hygrophila, the sister-group of Eupulmonata). Typically, the shells of land snails are more globose or more elongated. In any event, land snails carry their shell a little tilted to the side, not upright as Magcargo.



Top: *Planorbis corneus* (Linnaeus, 1758) (C. Ableiter, 2007); Mid: *Cepaea nemoralis* (Linnaeus, 1758) (D.G.E. Robertson, 2008); Bottom: *Drymaeus papyraceus* (Mawe, 1823) (courtesy of L. Charles).

Magcargo is huge for a snail, measuring 0.8 m in height and weighing 55 kg. As explained above for Slugma, this size would pose problems regarding water loss, but a more pressing issue is body weight: a snail cannot sustain such a heavy body on land, nor hold up and carry around a rock-like

shell. The largest land snail species is the fossil *Pebasiconcha immanis* Wesselingh & Gittenberger, 1999 (from the Miocene of Colombia and Peru), but its shell is “light-weight” in comparison to Magcargo, reaching up to “meager” 26 cm in length (Wesselingh & Gittenberger, 1999).

Bulbapedia states that Magcargo could be based on the Cherufe, a volcano-dwelling creature from Argentinean and Chilean folklore. However, this is extremely unlikely for two reasons: (1) Cherufe is typically a gigantic humanoid monster, albeit with some dragon-like features such as a predilection for meals including young girls (Lurker, 1987; Rose, 2001), with no mention of molluscan features. (2) More to the point, the people responsible for *Pokémon* only rarely look outside of Japan (or Japanese zoos) for influences; for instance, even Generation VI, which is supposedly based on France, has a very Japanese fauna (Tomotani, 2014).

Octillery
(#224; Type: Water)



Class: Cephalopoda (squids, octopuses and nautilus)

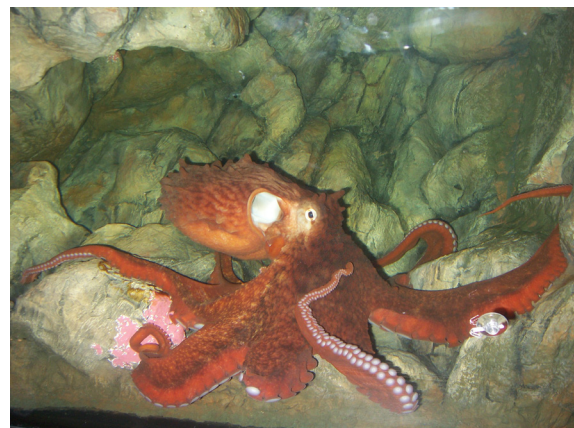
Subclass: Coleoidea (octopuses, squids, and cuttlefish)

Order: Octopoda (octopuses)

Octillery has a generalized cartoon-octopus look and, thus, not much can be said about its morphology. However, there is one feature that is clearly mistaken (as in numerous other cases in Japanese games and anime/manga): the structure that is depicted as Octillery’s mouth is actually the

funnel. To breathe, cephalopods bring water into a chamber inside their body called the “mantle cavity”, where the gills are located. Then, the water is expelled through the funnel; this can be done quietly or in a more powerful gush of water, enabling the animals to move by jet propulsion. The mouth of a cephalopod is located where all the arms meet, facing “downwards” and hidden from view, and the funnel is located laterally (not in front, like in Octillery).

While most octopuses are not very large, Octillery can reach a respectable size: 0.9 m high, weighing 28 kg, according to its Pokédex entry. The largest octopus alive is the giant Pacific octopus, *Enteroctopus dofleini* (Wülker, 1910). Large adults can reach 6 m in radial “arm span” and weigh about 50 kg, but some records increase the span to somewhere between 9 and 10 m (High, 1976; Hartis, 2011).



Enteroctopus dofleini (Wülker, 1910) (Bachrach44, 2008).

One of Octillery’s in-game abilities is called “Suction Cups”; its description says: “This Pokémon uses suction cups to stay in one spot to negate all moves and items that force switching out.” This is a very pertinent ability, as the arms of octopuses (and squids and cuttlefish) are covered with suction cups (also called “suckers”) on their inner surface. These suction cups are used in locomotion and to manipulate objects and prey. The cups are astonishingly strong, and the animals can control each of them independently.

Octillery’s signature move is called “Octazooka”, the description of which says:

"The user attacks by spraying ink at the target's face or eyes. This may also lower the target's accuracy." This is likewise a very pertinent move, as cephalopods are famous for their ability to squirt dark ink. These animals have an organ called "ink sac" and can expel the ink lodged inside it – through the funnel – as a dark smoke-screen-like cloud. When cephalopods are attacked, this strategy confuses the predator and allows them to escape (Sato et al., 2016). Moreover, recent studies suggest that ink clouds may also be used to confuse prey, allowing a sneak attack bonus (Sato et al., 2016).

As a last note, Octillery is the evolution of Remoraid, which is a remora, a type of fish (Mendes et al., 2017). Again, we know that "evolution" in Pokémon bears no resemblance to biological reality, but this might be taking the craziness a tad bit too far.²

Clamperl
(#366; Type: Water)



Class: Bivalvia (bivalves)

Order: Heterodonta

Family: Tridacnidae (giant clams)

Genus: *Tridacna* Bruguière, 1797

Species: *Tridacna gigas* (Linnaeus, 1758) + fish egg of an unknown species

Appearances can often be deceiving in the *Pokémon* world. Though Clamperl may look like and is certainly named after a mollusk, the pinkish "pearl" inside its shell is actually a fish egg – or rather, roe. Roes are egg masses of fish and certain marine ani-

mals, such as urchins, shrimp, and even scallops. Even though some mollusks produce eggs, both of Clamperl's evolved forms, Huntail and Gorebyss, are actually fish-like Pokémon (Mendes et al., 2017), which clarifies its true nature. This pink egg rests on what seems to be a soft, bluish pillow with stubby projections. It is as if a random giant clam is offering its body as protection for the fish egg – and so, Clamperl is actually composed of two different organisms in association – or symbiosis, if you may. In fact, this is not unheard of in the *Pokémon* franchise, and some cases also involve mollusk-inspired Pokémon (we're looking at you, Slowbro and Slowking).

Nevertheless, its shell seems to be based on real-world giant clams, a.k.a. bivalves in the family Tridacnidae and genus *Tridacna*. Its overall size and weight (0.4 m and 52 kg) are also not out of this world: as we mentioned before, species such as *Tridacna gigas* (Linnaeus, 1758) are huge and can measure as much as 137 cm and weight 230 kg (Knop, 1996). Clamperl's abilities and attacks also refer to and reinforce the relevance of its shell: Shell Armor, Shell Smash, and, of course, the signature attack Clamp.



Tridacna gigas (Linnaeus, 1758) (Liné1, 2008).

Curiously, getting a leg or arm clamped by a giant clam is actually the stuff of legend: giant clams were called "killer clams" and "man-eating clams" in the past due to having allegedly drowned divers that got stuck between their valves (each individual piece of a bivalve shell is a valve).

² Recently, some of the preliminary sprites for Gen II were found by dataminers (<https://mobilesyrup.com/2018/05/31/unreleased-pokemon-sprites-gold-silver/>), showing that proto-Remoraid was a gun-shaped Pokémon and proto-Octillery was a tank-shaped Pokémon. We had a really hard time deciding which option makes less sense and ended up abandoning this question.

This rumor probably originated in Wilburn Dowell Cobb's romanticized article on the discovery of the "Pearl of Allah" (or Pearl of Lao Tzu) published on the *Natural History* magazine in 1939. One of the largest pearls ever found, with 24 cm in length and weighing ca. 6.4 kg, it was retrieved from a giant clam that, according to Cobb's (1939) dramatic description, ended up "slaying a native diver trapped when its great jaws snapped shut". And by jaws, he probably meant the valves. Cobb went as far as calling the clam a "deep sea murderer".

Both things are strictly wrong: giant clams are not a deep-sea species, nor murderers of any kind: they have a symbiotic relationship with algae, which use sunlight (not present in the deep sea) to synthesize their food supply. Influenced by such dramatic descriptions, even scientific and technical manuals once claimed that clams had caused deaths, and even gave instructions on how to release yourself if you were stuck. Nowadays, we know this reputation is rather underserved: not a single human death by giant clam has ever been reported (scientifically, that is). Moreover, the adductor muscles in giant clams, which are responsible for closing their shells, move rather slowly (Fredericks, 2014). Hence real-world clams are, in fact, quite gentle giants.

Shellos
(#422: Type: Water)



Class: Gastropoda (snails and slugs)

Order: Nudibranchia (sea slugs)

Family: Chromodorididae

Genus: *Chromodoris* Alder & Hancock, 1855

and *Hypselodoris* Stimpson, 1855



Top: *Chromodoris lochi* Rudman, 1982 (A.R. Jenner, 2009). Bottom: *Hypselodoris apolegma* (Yonow, 2001) (C. Ordelheide 2011).

Nudibranchia is a peculiar group within the Opisthobranchia, a.k.a. the sea slugs. Well-known because of their vivid colors and extravagant forms, nudibranchs (or nudis, if you wish) are among the most beautiful and popular sea creatures out there. They live pretty much everywhere, inhabiting the seas worldwide from arctic to temperate and tropical regions (but unlike Shellos, definitely not on land). Shellos's design seems to be clearly based on nudis – it has a long and somewhat flat, colorful body, with flappy lateral expansions, and the head appendages are very similar to rhinophores, which are characteristic sensory structures of nudibranchs. The color patterns are very similar to nudibranchs belonging to the family Chromodorididae found in Japan such as *Chromodoris lochi* Rudman, 1982, *Hypselodoris festiva* (A. Adams, 1861), and *Hypselodoris apolegma* (Yonow, 2001). Moreover, Shellos's proportions (0.3 m and 6.4 kg) are actually not exaggerated: nudibranch spe-

cies such as *Hexabranhus sanguineus* (Ruppell & Leuckart, 1828) can grow as long as 52 cm (Double, 1992).

Remarkably, Shellos was one of the first attempts of the franchise at introducing the concept of regional variants back in Pokémon Diamond and Pearl (Gen IV) in 2006–2007. This would become a central theme in Pokémon Sun and Moon (Gen VII), ten years later. Nevertheless, back then, Shellos presented two forms corresponding to two distinct regions: the blue form inhabits the East Sea, and its pink “cousin” lives in the West Sea. This is clearly a nod to the phenomenon of geographic (a.k.a. allopatric) speciation: it happens when populations of the same species become isolated due to geographical barriers, forming two or more new populations that evolve independently in different forms.

One curious thing about Shellos (and its evolution Gastrodon, see below) is the fact that it can learn some pretty nasty poison abilities, even though it is not a Poison-type Pokémon. In the real world, some nudibranchs store toxins and other unpleasant or harmful substances/structures they get from other organisms they feed on such as algae, anemones, and coral. They effectively use these substances as a defense mechanism. Sometimes, their striking colors, which may be especially vivid in the parts of the body where the harmful substances are stored, serve as a warning for visually oriented predators: a phenomenon known as aposematism (Aguado & Marin, 2007). As pretty as Shellos may look, its bright colors could signal danger.

Gastrodon

(#423; Type: Water / Ground)



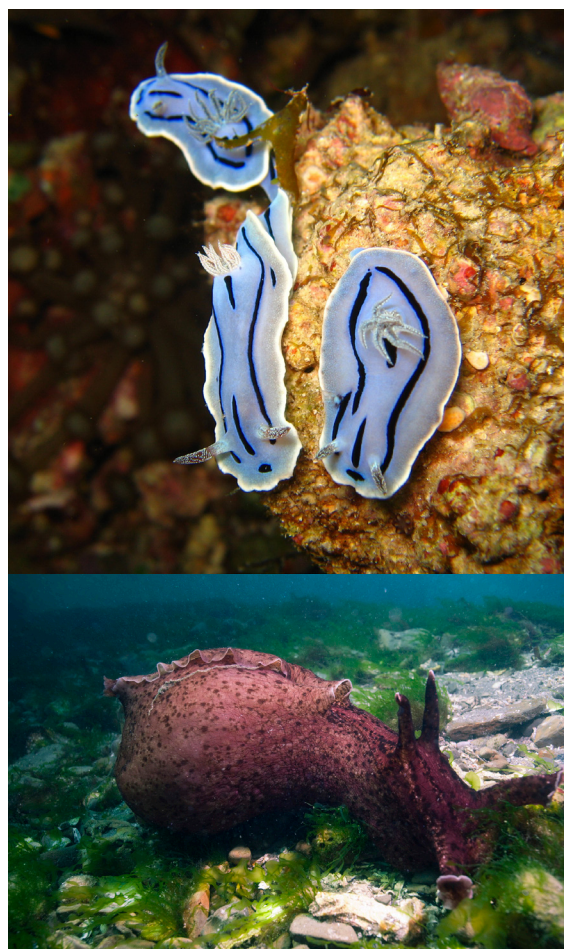
Class: Gastropoda (snails and slugs)

Order: Nudibranchia (sea slugs)

Family: Chromodorididae

Genus: *Chromodoris* Alder & Hancock, 1855 and *Hypselodoris* Stimpson, 1855 (and maybe *Aplysia* Linnaeus, 1767)

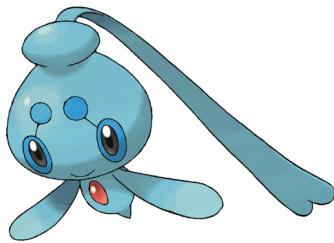
Much like its pre-evolution Shellos, Gastrodon’s design is largely based on nudibranchs or other related marine slugs. Our considerations about Shellos also apply to Gastrodon, with a few exceptions. Gastrodon is quite larger than Shellos, measuring as long as 90 cm and weighing up to 30 kg. This is way too large for real-world nudibranchs, but not entirely disproportionate: a species of sea hare, *Aplysia vaccaria* Winkler, 1955 can measure up to 99 cm long and attain a total weight of 14 kg (Behrens, 1992).



Top: *Chromodoris willani* Rudman, 1982 (J. Tanaka, 2006). Bottom: *Aplysia californica* (Cooper, 1863)(C. King, 2011).

In fact, *Bulbapedia* claims the East Sea variant of Gastrodon was designed after sea hares. Nevertheless, sea hares are not nudibranchs but belong to a group called Anaspidea, one of the many lineages within the Heterobranchia, a natural group of gastropods that also includes Nudibranchia. You could think of them as distantly related “cousins”. In any event, the design of East Sea Gastrodon is only remotely alike sea hares and much more closely resembles chromodoridid nudibranchs, being very similar to the species *Chromodoris willani* Rudman, 1982, from the Western Pacific.

Phione
(#489; Type: Water)



Class: Gastropoda (snails and slugs)
Order: Pteropoda (sea butterflies)
Suborder: Gymnosomata (sea angels)
Family: Clionidae
Genus: *Clione* Pallas, 1774
Species: *Clione limacina* (Phipps, 1774)

The so-called sea angels are actually free swimming (pelagic) sea slugs scientist collectively call Gymnosomata (from the Greek, meaning “naked body”, a direct reference to their shell-less bodies). They belong to a group called Pteropoda, the sea butterflies, which means “wing-foot”. Pteropods use their wing-like flaps, known as parapodia, to swim about searching for prey. Yes, prey: they are voracious predators of planktonic invertebrates, including other pteropods

(Hermans & Satterlie, 1992). While most pteropods have shells, the lineage of the Gymnosomata lost it during its evolution.

Elegant and somehow intimidating (if you’re just small enough), sea angels in the genus *Clione*, especially *Clione limacina* found in Hokkaido, are quite popular in Japan (Hutcheon, 2010). The in-game region Sinnoh is reportedly based on Hokkaido, which makes *Clione limacina* the obvious inspiration for Phione. Even their names are almost the same.



Clione limacina (Phipps, 1774) (NOAA, 2005).

It is no surprise that Phione, the single mythical³ molluscan Pokémon alongside Manaphy, was based on sea angels, whose name is already kind of mythical. Measuring 40 cm long (weight ~4 kg) according to the Pokédex, it is a little too large for a sea angel: they never grow past a few centimeters. However, even though it is somewhat stylized, Phione’s (as much as Manaphy’s) appearance is that of a sea angel with the signature wing-like parapodia, a well-marked head, and tail-like body. We can see some attention to detail has been paid, as the red gem on Phione’s “chest” resembles

³The mythical status of Phione is highly debated within the community – yes, those are debates that actually happen – since official sources are ambiguous and contradictory (see *Bulbapedia* for more info). Manaphy, on the other hand (or should we say foot?), is indeed mythical.

the large, reddish-orange digestive gland seen in sea angels, which is roughly located at the same place in the real-world slug bodies (although internally, of course).

Manaphy
(#490; Type: Water)



Class: Gastropoda (snails and slugs)

Order: Pteropoda (sea butterflies)

Suborder: Gymnosomata (sea angels)

Family: Clionidae

Genus: *Clione* Pallas, 1774

Species: *Clione limacina* (Phipps, 1774)

Manaphy is very similar in appearance to Phione and should also have been inspired by *Clione limacina*. So pretty much everything that was said about Phione also applies to Manaphy.

One thing tough, is the Tail Glow move: “The user stares at flashing lights to focus its mind, drastically raising its Sp. Atk stat.” This move is a possible nod to the phenomenon of bioluminescence, which consists on the production and emission of light by living organisms. Although widespread among marine invertebrates, like jellyfish, bioluminescence is known from very few nudibranchs: just the genus *Plocamopherus* Rüppell & Leuckart, 1831 and the species *Phylliroe bucephalum* Peron & Lesueur, 1810 (Herring, 1987; Lalli & Gilmer 1989; Haddock et al., 2010). Bioluminescence has never been documented in *Clione*.

Shelmet
(#616; Type: Bug)



Class: Cephalopoda (squid, octopuses and nautilus)

Order: Nautilida (nautilus)

Family: Nautilidae

Genus: *Nautilus* Linnaeus, 1758 or *Allonautilus* Ward & Saunders, 1997

With a very characteristic spiral shell-like armor, Shelmet is at least partly based on cephalopods, more specifically those in the family Nautilidae, like the living genera *Nautilus* and *Allonautilus*. As tragic as it may sound, the three living nautilus species are the only survivors of a once thriving group (Dunstan et al., 2011). The fossil record shows us that nautilus were much more diverse and a multitude of genera existed a few hundred million years ago. This diversity suffered its ups and downs, with a strong decline in the Miocene (roughly 23 to 5 million years ago) and Pliocene (5 to 2.5 million years ago), and most lineages did not survive to this day.



Nautilus sp. (J. Baecker, 2007).

Nevertheless, Shelmet is very akin to living nautilus, starting with the shell: it is tubular and coiled in a single horizontal plane (planispiral), and bears a triangular knight's helmet visor that is very similar to the hood nautilids have (also called aptychus). The position of the body in relation to the shell is correct in Shelmet, contrary to Omanyte/Omastar seen above (nautiloids and ammonoids are closely related, sharing a basic body plan).

The angry cartoonish eyes with vertical pupils also appear to have been inspired by real-world nautilid eyes. The vertical pupils are, in fact, holes: nautilus have pinhole eyes which lack the solid lens that squid and octopuses (as well as humans) have. Shelmet's funny looking puckered-up mouth is also reminiscent of the real animal's funnel (hyponome), even though the real-world structure is used for propulsion, and not for kissing. On the other hand, Shelmet lacks the numerous small, smooth tentacles (called cirri) that are very striking in the real-world nautilids – our guess is that they would probably make the design messy or simply too hard to draw/animate.

At 0.4 m length and 7.7 kg, Shelmet is also way larger than any living nautilid species, which reach up to 0.25 m in width at most (Pisor, 2008). Extinct species of the family Endoceratidae (of uncoiled nautiloids) though, might have reached more than 3 m in shell length (Flower, 1955; Teichert & Kummel, 1960; Teichert, 1964; Frey, 1995).

Naturally, Shelmet has the ability “Shell Armor” and this is rather literal for this Pokémon: its shell was clearly inspired by the armors of medieval knights, as can be seen by its visor and its evolution. Shelmet's evolution is very complicated in-game: when traded with Karrablast, Shelmet evolves into Escavalier, which looks like a bug wearing Shelmet's shell and “visor” (or perhaps a hermit crab?). Meanwhile, Karrablast evolves into Accelgor, which looks like an insect pupa with a slightly coiled (shell-like) head. This mix-up of insectoid features explains why Shelmet is a Bug type. In any case, any mollusk resemblance is (sadly)

lost in the evolutions, so we won't consider them here.

Inkay
(#686; Type: Dark / Psychic)



Class: Cephalopoda (squid, octopuses and nautilus)

Subclass: Coleoidea (octopuses, squids, and cuttlefish)

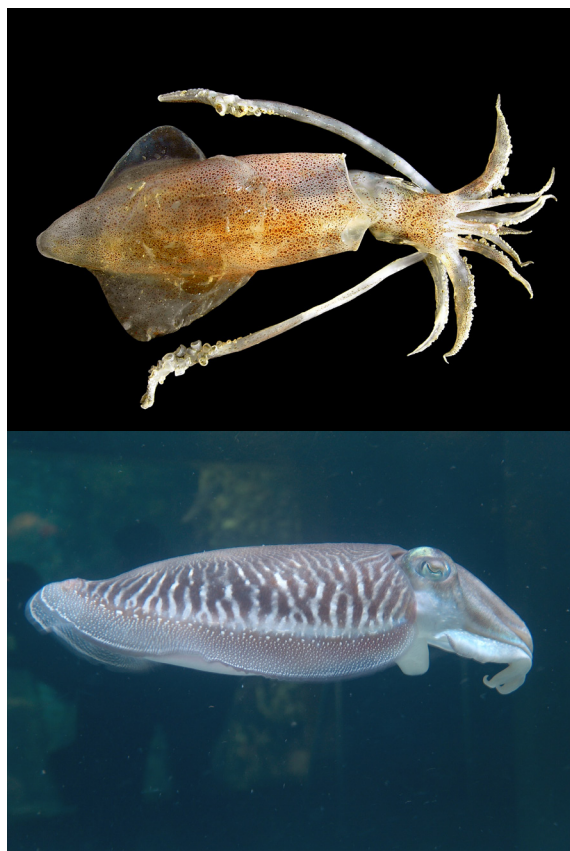
Order: Teuthida (squids) or Sepiida (cuttlefish)

Inkay seems to be a very stylized teuthid or sepiid cephalopod: respectively a squid or a cuttlefish. We do believe it is more of a squid than a cuttlefish, however: Inkay has a very characteristic squid-like figure, with a triangular body (mantle), a somewhat discernible head, arms and stylized tentacles. Moreover, the tentacles of real-world cuttlefish, are “hidden” inside the 8 arms, which is not the case of Inkay – like real-world squids, the tentacles are showing, though their lateral position is odd (they are centralized in real-world squids).

The size informed by the Pokédex is well within the real-world range at 0.4 m length and weighing up to 3.5 kg. Squids can go from millimeters to several meters long: the giant squid, *Architeuthis dux* Steenstrup, 1857, can reach 18 m (Clarke, 1966; Roeleveld & Lipinski, 1991; Salvador & Tomotani, 2014), while the colossal squid, *Mesonychotheuthis hamiltoni* Robson, 1925, can weigh whopping 500 kg (Salvador, 2019).

The designers deserve some praise for actually making the mouth look like a beak for this Pokémon, like in real-world cephalopods. Unfortunately, they put it on the

wrong place. Real-world cephalopods have their mouth (and beak) sheltered in the middle of the arms and tentacles.



Top: *Loligo vulgaris* Lamarck, 1798 (H. Hillewaert, 2005). Bottom: *Sepia officinalis* Linnaeus, 1758 (J. Carvalho, 2006).

Inkay's abilities and moves were also clearly inspired by cephalopod biology. The "Suction Cups" ability is a nod to cephalopod suckers (see Octillery above), which are normally arranged in rows along their arms and at the tip of their tentacles (for differences between arms and tentacles, see Salvador & Cunha, 2016). Though the move "Constrict" may seem logical at first sight, it is actually erroneous: contrary to popular myth, cephalopods cannot constrict something with their tentacles as if they were snakes (Roper & Boss, 1982). The move "Peck" is a reference to a cephalopod beak, although they cannot peck their prey like birds would. Rather, they use the beak to tear small chunks of their prey.

⁴Shamefully, neither Inkay/Malamar nor Octillery have the ability "Color Change". The only Pokémon with this ability is Kecleon, which is based on a chameleon. Just for the record, a chameleons' ability to change color is laughable when compared to cephalopods.

⁵Even though octopuses are the masters of camouflage, Octillery does not learn the move "Camouflage". Inkay, however, can learn it through the intricate (and rather annoying) process of Pokémon breeding.

The move "Hypnosis" employs hypnotic suggestion to make the target fall into a deep sleep. This is a reference to real-world cuttlefish. Coleoid cephalopods can change their body color and color patterns using specialized skin cells called chromatophores. They can change color almost instantly and can produce patterns as if their skin were a TV screen.⁴ The animals use this ability to camouflage⁵ themselves (either to evade predators or to ambush prey), to communicate with their kin, or to scare off predators (Hanlon & Messenger, 1996; Hanlon, 2007; Mäthger et al., 2012). However, some scientists suggest a fourth kind of use for the color-changing ability: the patterns produced would mesmerize prey and make them easier to catch, which could be interpreted as a kind of hypnosis (Mauris, 1989; Mather & Mather, 2006; Thomas & MacDonald, 2016). This ability in real cephalopods, however, remain far from proven.

Malamar

(#687; Type: Dark / Psychic)



Class: Cephalopoda (squid, octopuses and nautilus)

Subclass: Coleoidea (octopuses, squids, and cuttlefish)

Order: Teuthida (squids)

More so than Inkay, Malamar's design is clearly based on a squid, with an elongated body with triangular wing-like fins, and two long well-defined tentacles. The fierce, evil look is just a bonus. Oddly though, Malamar

is basically upside down. Real-world squids do not swim in this position; they are usually horizontally or vertically oriented with the arms and tentacles pointing downward. However, some squids (e.g., family Cranchiidae) do remain on this upside-down position with the arms held upwards: this is known to scientists as the “cockatoo position.” This inversion in position is linked to the way Inkay evolves into Malamar: the player must hold the Nintendo 3DS system upside-down for Inkay to evolve.

In any case, everything else that was said about Inkay applies to Malamar, including the moves/abilities (which are identical), the beak-like mouth (and its odd placement), and the size range (1.5 m, 47 kg; respectable, but much smaller than some real-world squids).

Goomy
(#704; Type: Dragon)



Class: Gastropoda (snails and slugs)

Order: Nudibranchia (sea slugs)

Family: Chromodorididae

Genus: *Goniobranchus* Pease, 1866

Goomy is yet another Pokémon probably designed after sea slugs⁶ (most likely Nudibranchia), though it is neither a Water-type nor marine. Goomy’s “antennae” are very similar to structures of sea slugs called rhinophores, which are scent or taste receptors

(chemosensory structures) situated on the dorsal surface of the animal’s head (Wertz et al., 2007; Cummins et al., 2009). The overall shape of its body is a very generic design of a sluggish creature, and the color pattern is somewhat reminiscent of species such as *Goniobranchus kuniei* (Pruvot-Fol, 1930) or *Goniobranchus geminus* (Rudman, 1987).

Interestingly, Goomy (and its evolved forms) are Dragon-type Pokémon. This is a possible reference to the so-called blue dragon sea slug, *Glaucus atlanticus* Forster, 1777, though the design is not even vaguely similar to it. Goomy’s size (0.3 m, 2.8 kg) is well within that of real-world sea slugs (see Gastrodon’s entry above).



Goniobranchus kuniei (Pruvot-Fol, 1930) (S. Childs, 2006).

Goomy’s abilities are clearly inspired by mollusk physiology. The “Gooey” ability lowers the attacker’s Speed stat upon contact, a nod to the mucus production that is typical of snails and slugs, but usually more conspicuous in terrestrial species (Cameron, 2016). Despite being based on sea slugs, Goomy is fully terrestrial and accordingly gooey. “Hydration” is an ability that heals status conditions when it’s raining. Conserving water in terrestrial environments is hard for moist-bodied creatures like snails and slugs and a good deal of their evolutionary history has to do with this (Barker, 2001). The relationship between snails/slugs and the rain is very clear, as they will be found out and about after a good rain.

⁶ *Bulbapedia* indicates the fossil *Wiwaxia* Walcott, 1911 as a possible inspiration. However, there are very strong arguments against this: (1) These fossils are widely unknown. If *Pokémon* designers can’t even place the mouth of an octopus in the right place (see Octillery, Inkay and Malamar), they likely didn’t know about this animal. (2) *Wiwaxiids* might not actually be mollusks; their position in the tree of life is still hotly debated by scientists. All of Goomy’s abilities, Pokédex entries, moves, etc. point towards a mollusk. (3) The morphology is completely different: *wiwaxiids* were covered by hard plates and spines, like a medieval-looking tank. Likely no soft portion of their body was visible from the outside. Goomy is all soft and cute.

Sliggoo
(#705; Type: Dragon)



Class: Gastropoda (snails and slugs)

Superorder: Eupulmonata (pulmonate snails and slugs)

Order: Stylommatophora or Ellobiida



Top: *Eucobresia diaphana* (Draparnaud, 1805) (J. Grego, 2004; www.animalbase.uni-goettingen.de). Bottom: *Omalonyx convexus* (Heynemann, 1868) (courtesy of L. Charles).

Contrary to Goomy, Sliggoo seems fully based on a terrestrial snail, though it retains some of the characteristics of sea slugs (e.g., the “rhinophores” on the dorsal surface of the head) and is thus, kind of a gestalt. These rhinophores, however, can now also be interpreted as the sensory tentacles of land snails. If that is the case, we can see that Sliggoo’s eyes are positioned on the base of the tentacles. Most eupulmonates

have the eyes on top of the eyestalks (order Stylommatophora), with only a few (order Ellobiida) having eyes on the base of the stalks. However, no ellobiid is known to be semi-slug or slug-like, as Sliggoo is (see below). Once again, this Pokémon seems to be a mixture of forms.

Sliggoo has a spiral “hump” of sorts, which resembles a vestigial shell found in the so-called semi-slugs. These gastropods are, so to speak, halfway through the process of limacization.

The name seems to be derived from words such as slippery, slimy and goo, which is yet another reference to the mucus produced by mollusks in general. In any case, compared to real-world snails and slugs, its erect posture is wrong (see Slugma above). Likewise, its large size (0.8 m, 17.5 kg) is problematic (see Magcargo and Goomy above). Sadly, Sliggoo does not become a slug or a snail later on: it evolves into Goodra, which completely loses its resemblance to mollusks, looking more like a cartoonish dragon/dinosaur creature. It is still slimy, though.

MOLLUSK OR NOT?

There is one Pokémon that is not a mollusk, but which deserves a brief mention here: Dwebble (#557; Type Bug / Rock).



This Pokémon is based on a hermit crab. This group of crustaceans, the superfamily Paguroidea, is typically marine, although there are some terrestrial forms (Dwebble itself is terrestrial). Hermit crabs are remarkable for using the empty shells of gastropods as protection: they choose their shell

carefully, carry them around and change shells when they grow and/or when they find a better one.

Dwebble, however, does not use a gastropod shell; it uses a piece of rock. Curiously, some terrestrial hermit crabs use fossilized gastropod shells (Haas, 1950) and that is as close to a rock as one can get. Dwebble, though, does not have that many options: the only gastropod shell available to it would be that of a Magcargo, which is way too large. Other options would be the shells of the ammonoid-Pokémon Omanyte/Omastar, but they are fossils that need to be “resurrected”, which would make Dwebble’s life much more difficult. Although hermit crabs using ammonoid shells may sound strange, there is evidence that fossil hermit crabs from the early Cretaceous period (circa 130 million years ago) actually used them (Fraaije, 2003).

On a similar case, there is a report of a hermit crab, called *Diogenes heteropsammicola* Igawa & Kato, 2017, using a coral instead of a shell. This species lives in southern Japan (Igawa & Kato, 2017) and it actually looks rather similar to Dwebble. That, however, would be a large coincidence, as this species was only discovered after Gen V had been released.



Diogenes heteropsammicola (Igawa & Kato, 2017).

Awkwardly, Dwebble is called “Rock Inn Pokémon” and that’s likely because the official “Hermit Crab Pokémon” is Slowbro

(#080; Type Water / Psychic), from Gen I.



The problem is, Slowbro is not a crab: its design is clearly based on a mammal. It does have a shell-like structure attached to its tail, though, which is (according to lore) a living Shellder. There are some further problems with this: first, that “Shellder” is still alive, so it would be a case of symbiosis, not of a crab using an empty shell. Secondly, the “Shellder” is now arranged spirally, like if he transformed from a bivalve into a gastropod. However, if one looks closely, the shell is not actually a spiral, but just a hollowed-out structure that looks like a chocolate cornet. In fact, the cornet-thing has a pair of angry eyes, so it is definitely neither a shell nor a mollusk. Thus, Slowbro is just a pile up of mistakes: a crab that’s a mammal carrying a mollusk that’s at best a sentient pastry.⁷



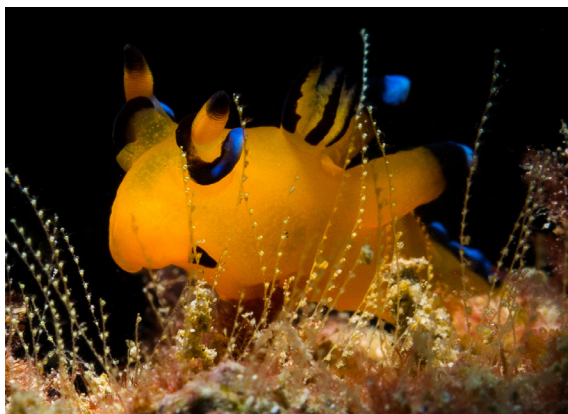
Cornet (Ayy753771, 2017; Cooking Mama Wiki).

REAL LIFE POKÉMON?

There is one notable rea-life mollusk whose name was inspired by *Pokémon* – its

⁷ If you think sentient desserts are too wacky, even for *Pokémon*, please refer to Vanillite, Vanillish, Vanilluxe, Swirlix, and Slurpuff.

popular name, at least. The “Pikachu slug” is a nudibranch from the Indian Ocean and Western Pacific that got the attention of the Japanese public on the Internet. It is a tiny yellow/orange-ish creature with black tips on its rhinophores and gills. It is virtually impossible not to think of Pikachu when looking at it. Even though its popularity is quite recent, the species was discovered and described in the late 19th century; its scientific name is *Thecacera pacifica* Bergh, 1883 (family Polyceridae).



Thecacera pacifica (Olakhalaf, 2017).

CONCLUSIONS

Most of the Pokémon designs are in line with real-world mollusks, although there are some cringeworthy mistakes, like Omanyte/Omastar’s body position, Octillery’s mouth/funnel controversy, and Inkay/Malamar’s beak position. The moves and abilities nicely reflect some mollusk features and, well, abilities, but there is also some crazy stuff added on the mix, like “Shell Smash” and “Spike Cannon”.

As we highlighted in the beginning of this article, there are between 70,000 and 200,000 species of mollusks (Rosenberg, 2014). In comparison, there are only circa 6,000 species of mammals (Burgin et al., 2018). Overall, there are 17 molluscan Pokémon among the current 809 monsters. This number clearly does not reflect true animal biodiversity, similar to other misrepresented invertebrates in the franchise, such as arthropods (Prado & Almeida, 2017; Kittel, 2018). Obviously, people prefer to see cats

and doggos so there are plenty of Pokémon based on them, domestic or otherwise. Even so, there are some animal groups, mollusks or otherwise, that deserve better representation in *Pokémon*, such as velvet worms (Onychophora) and bristle worms (Polychaeta). They would make much more interesting monsters than yet another lion.

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Daniel Cavallari is a taxonomist and marine biologist who loves mollusks and their shells. He's been collecting seashells and playing Pokémon games since he was a small boy. Though he prefers Pokémon of the older generations (I–III), he finds the newest mollusk-based Pokémon really amazing.

- **Fitzgerald, N.** – *Valleys Between* _____ Pp. 1–3.
- **INTERVIEW** – *Wingspan* _____ Pp. 5–8.
- **Thomas, H.N.** – Phylogeny of squid kids _____ Pp. 9–17.
- **Salvador, R.B.** – The scientists of *Assasin`s Creed* _____ Pp. 19–27.
- **McCall, J.** – History and video games _____ Pp. 29–48.
- **INTERVIEW** – *Through the Darkest of Times* _____ Pp. 49–54.
- **Salvador, R.B. & Cavallari D.C.** – Pokémollusca _____ Pp. 55–75.