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The snails of *Super Mario Bros. Wonder*

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Nintendo has recently released a new Mario game, *Super Mario Bros. Wonder*, a multiplayer platformer involving a good dose of mushrooms, both in-game and presumably during development. But psychedelic trips aside, in the first few stages of the game we are introduced to a completely new (and arguably the best) "enemy" in Mario games: a snail with a fabulous pink shell.

Figure 1. Snail (©Nintendo, 2023; fair use). Source: Super Mario Wiki (https://mariowiki.com/).

So far, this critter remains unnamed, but the Super Mario Wiki refers to it as Snail, with a capital S. So, I will use this name throughout this article. It's not very creative, I agree, but maybe safer than risking a bad pun like in some Pokémon names.

The Snail has a pink shell and a green soft body. Its tentacles are striped and its eyes are located below the tentacles. Overall, it is a cartoonish design – as it should be – but an interesting one nevertheless. First, it's kinda cute. Secondly, it has some curious features that are an excuse for me to discuss a little bit about real-world biology. So, let's get down to the snail science.

SNAIL BIOLOGY

Mario Wonder's Snail is a land snail. Land snails are part of the Class Gastropoda, alongside freshwater snails, marine snails, terrestrial slugs, sea slugs, and an assortment of other animals often referred to by more specific terms such as abalones and sea butterflies. Gastropods, in turn, belong to the Phylum Mollusca (the mollusks), together with squids, octopuses, clams, oysters, mussels, and many other shelled and shell-less animals.

Besides the regular Snail in *Mario Wonder*, there is also a large version of it, dubbed Big Snail. It is a magnificent beast larger than the human characters in the game. Its design is exactly the same as the small Snail, although it looks like it's deeply annoyed by your presence – which is understandable, as anyone would be annoyed by an Italian-American plumber running around your place, jumping, and damaging the brickwork.

In nature, a snail unfortunately cannot grow to a large size for two main reasons: (1) the shell would be very expensive to

Figure 2. A giant tiger land snail, *Achatina achatina*, from Ghana. Source: Wikimedia Commons (C.J. Sharp, 2017).

produce in terms of calcium carbonate (and energy) and it would become too heavy to carry around. Typically, aquatic animals are larger because water partially sustains their body weight. Life on land is not so easy. And (2), snails need to stay hydrated. They lose water to the environment through their skin, via evaporation. A larger body would mean more surface for water to evaporate from. Besides, they use a lot of water to produce mucus, which we will come back to in a minute.

Still, some snails in tropical habitats can attain respectable sizes. One species of African giant snail, *Achatina achatina* (Fig. 2), holds the Guinness World Record, with a shell measuring 27 cm in length (see Salvador et al., 2021, for more on giant snails). But there is an extinct species whose shell is estimated to have reached 30 cm. It is called *Pebasiconcha immanis* and it lived in the area that is now the Colombian and Peruvian Amazon during the Miocene epoch, from circa 16 to 10 million years ago (Wesselingh, 2006).

But are Big Snails the adult version of the small Snail? It doesn't look like it, because the shells of both the small and Big Snails have the exact same number of whorls (two). When a young snail grows, its shell grows along with it by slowly adding more material to its edge; thus, the number of whorls slowly increases. For instance, certain African giant snails (genus *Achatina*) are born with around 2 whorls on their shells, but the adults can have up to 7 or 8 whorls. So, could the small Snail and Big Snail be two different species then? Perhaps, but regrettably we don't have enough evidence to answer that question yet.

In *Mario Wonder*, you can find Snails crawling around on the ground and vertical surfaces (but not the ceiling as far as I could tell from my playthrough). Real snails can do that – and even hang upside down – because the slime (or mucus) they produce has adhesive properties. In fact, snails produce slimes with various purposes: (1) for movement, as they "glide" atop it; (2) for hanging on to surfaces, as we've seen above; (3) for "hygiene", as the slime can have antibacterial properties; and (4) for protection, as some types of slime can be used to ward off predators. When moving, a snail leaves a trail of slime behind it (Fig. 3), though this cannot be seen in *Mario Wonder*. Their ability to move vertically on pipes and other surfaces implies that they also produce mucus.

In the game, the Snail can go inside pools made of poison. Needless to say, real snails cannot do that (although some species of

Figure 3. A *Cochlicella barbara* snail leaves a silvery slime trail as it moves. Source: Wikimedia Commons (snail ho, 2007).

land snails can venture into shallow water) and are not immune to poison. On the contrary, most species of snails do not cope well with pollution. Therefore, these animals make good bioindicators, that is, species that researchers can use to assess the health (or lack thereof) of an ecosystem (Gerlach et al., 2013). Regular presence of those snail species would mean a healthy ecosystem, while reduced numbers or absence of snails would indicate a polluted environment.

SNAIL MORPHOLOGY

The in-game design of the Snail's shell is stylized: it is a very rotund shell (Fig. 1) with an aspect that looks a bit "off" when compared to real-world land snail shells. Round shells like that are more commonly found in aquatic environments. But I'm not going to get too hung up on that as it is a cartoonish design. However, the shell color was an interesting – if weird – choice, and perhaps can be explained with a real-world example.

Figure 4. Shells of the grove snail *Cepaea nemoralis*, from Europe. This species is very variable in terms of coloration and lots of shell colors and patterns are known. Some of the red shells can attain a more pinkish tone. Source: Helmholtz-Centre for Environmental Research, UFZ (A. Künzelmann, 2011).

The shell is vivid pink. There are several real-life species with red to pinkish-red tones on their shells (for example, Fig. 4), but actual pink is not really a thing.

But there's a catch. If you search online for "pink snail" you'll run across one species called *Calocochlea festiva*. Sometimes you'll find it under the outdated names *Calococh-*

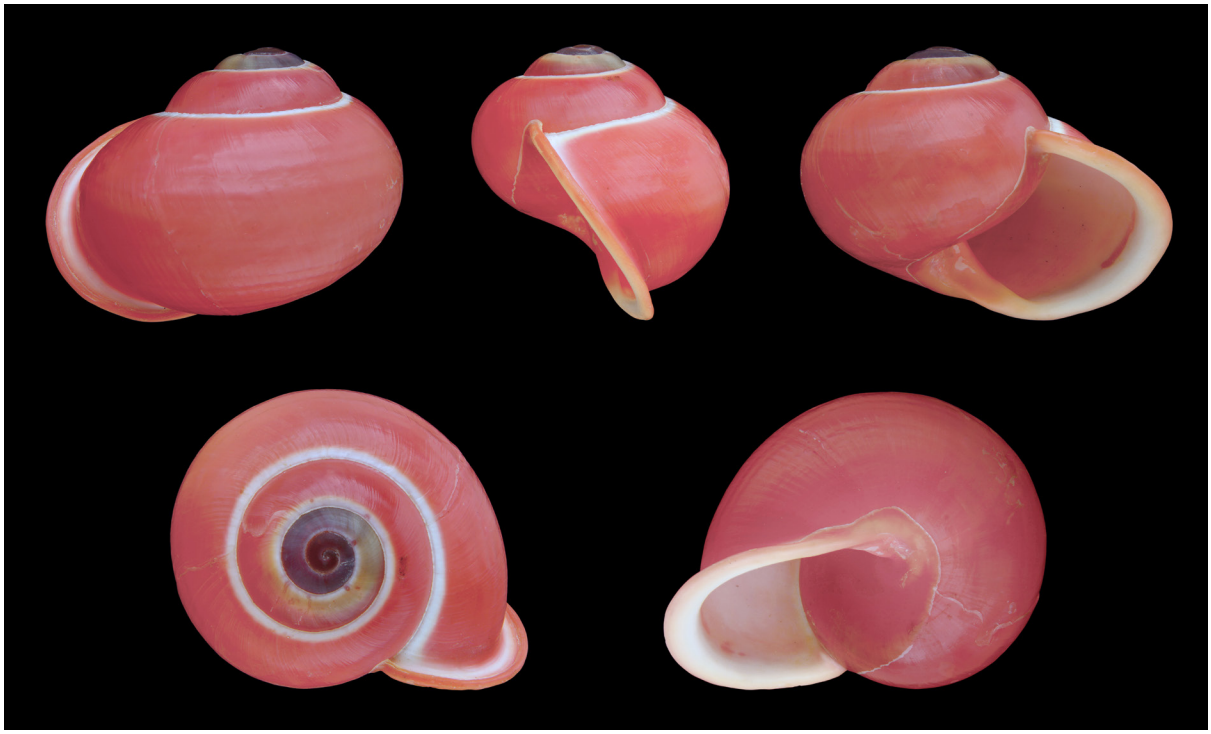

Figure 5. A shell of *Calocochlea festiva* seen from various angles. The shell is about 40 mm wide. Source: Wikimedia Commons (H. Zell, 2011).

lia festiva or *Helicostyla festiva*. It is from the Philippines – a country which has some of the most beautiful snails in the world – and it is fabulously pink indeed (Fig. 5).

The shell of *Calocochlea festiva* is a favorite among shell collectors due to its color. But that color is actually kind of a lie. The pink color is not visible on a live animal, because it is covered (like in all snails) by a protein layer called 'periostracum'. In nature, you'll find out that *Calocochlea festiva* has an orangish-brown color (Fig. 6), with some white stripes. In Figure 7 you can see a specimen with part of the periostracum remaining (on the top half of the shell) and part scrapped clean (the bottom half). Although many collectors prefer to have specimens that really represent the animal as it is in nature (in this case, brown), some will go for the showy (and often artificially modified) specimens.

In all likelihood, the designers of *Mario Wonder* based their Snail on periostracum-less shells of *Calocochlea festiva.* Note that the "border" of the shell that comes in contact with the Snail's soft body is white (Fig. 1), the same as in *Calocochlea festiva* (Figs. 5–7).

That "border" of the shell is known as the 'lip' (or 'peristome', to use the more scientific term). It is indeed quite common for the lip to be of a different color from the rest of the shell; white, soft pink, dark brown, and black, are common colors for the lip.

Figure 6. Shells of *Calocochlea festiva* showing intact shells. Source: Wikimedia Commons (Naturalis Biodiversity Center, 2015, cropped).

Now, let us move on to the flashy green soft body of *Mario Wonder*'s Snail. A green

body is rather uncommon in nature, but there are a handful of examples of it where varying tones of green are represented. For instance, the soft body of *Leiostracus perlucidus* from Brazil is light green (Fig. 8; its shell is actually whitish and translucent), while that of *Rhinocochlis nasuta* from Borneo has a more vivid green color (Fig. 9) that is more similar to *Mario Wonder*'s Snail.

Figure 7. A shell of *Calocochlea festiva* seen from various angles. The brownish periostracum layer has been scrapped off in half the shell to show the pink color underneath. Source: Forum Francophone des Collectionneurs de Coquillages (©KhanShells, 2012).

The eyes of *Mario Wonder*'s Snail are positioned below the head tentacles (Fig. 1). The position of the eyes is a very important feature in distinguishing between the main kinds of land snails. Land snails are not a single cohesive biological group like, for instance, birds (Class Aves). Rather, there are several different and unrelated lineages of gastropods that independently colonized land during their evolutionary history. Thus, the term 'land snail' actually designates a mix of biological groups, like, for instance, the artificial group of 'flying animals', which would contain most but not all birds, bats, pterosaurs, and insects.

Figure 8. *Leiostracus perlucidus*. We can see the green color of the soft body through its translucent shell. Source: iNaturalist (observation #12194810; ©F. Mendes, 2015, CC BY-NC 4.0, cropped).

Figure 9. *Rhinocochlis nasuta*. Source: iNaturalist (observation #22647153; ©N.L. Finley, 2019, CC BY-NC 4.0, cropped).

There are about 25,000 species of terrestrial gastropods living all around the world except Antarctica (Rosenberg, 2014). These species belong to the three largest subclasses of Gastropoda: Neritimorpha, Caenogastropoda, and Heterobranchia. Members of each lineage are only remotely related to those of another lineage (such as ourselves in relation to frogs, for example). Inside the latter subclass (Heterobranchia), there is a

group called Stylommatophora.

The Latin names do not matter much, but it is important to know that Stylommatophora contains over 80% of all terrestrial gastropod species in the world. Thus, they are typically what people are thinking about when they use generic terms such as "land snails/slugs". A distinguishing feature of Stylommatophora is that they have two pairs of tentacles on their head. The topmost pair are actually eyestalks, with the eyes positioned on the tip of the tentacles (by the way, that is the meaning of the Latin name Stylommatophora). The bottom pair of tentacles is responsible for the senses of smell and touch. If you take a closer look at the green snail in Figure 9, you can see the eyes (tiny black dots) on the very tips of the tentacles.

Figure 10. An example of an operculate snail: *Aperostoma blanchetiana*, from Brazil. Note that there is a lid-like structure atop the animal's "tail" – that is the operculum. When the animal retracts its soft body into the shell (bottom image), the operculum closes the shell aperture, offering extra protection against predators and desiccation. The shell is about 23 mm wide. Source: Salvador et al. (2018: fig. 4C, D).

All the other land snails (not Stylommatophora) have a single pair of tentacles and their eyes are positioned on the base of those tentacles (Fig. 10). Thus, we could surmise that *Mario Wonder*'s Snail is not a Stylommatophora. However, it could be interpreted as a terrestrial Heterobranchia that is more closely related to pulmonates but definitely not a pulmonate. That is because members of the other subclasses (Neritimorpha and Caenogastropoda) have an operculum, which is a structure that serves as a lid to close the shell when the animal retracts inside (Fig. 10). *Mario Wonder*'s Snail clearly does not have an operculum (Fig. 1), so it cannot be one of those.

SNAIL SHELLS

A recurrent issue with 2D and 2.5D games is mirror images. Take the most common example: when a character turns around to face the other direction, its sprite or model gets mirrored, making weapons or other items switch hands. So, a character might be right-handed while facing the right side of the screen and left-handed while facing leftward.

The same happens with the Snail. Snails are rather unique in nature in that their body is not symmetrical. The shell coils around while growing and the end result is clearly asymmetrical. The vast majority of shells in nature are right-handed (or dextral), meaning that when we look at a shell while facing its opening (aperture), we can see the opening to our right side (Fig. 11: top). Some species, however, have left-handed (sinistral) shells (Fig. 11: bottom). Try taking a look at all the photos in this article so far and figuring out if the shells are right- or left-handed.

Sometimes, a left-handed snail can even be found in a species that is typically right-handed. For instance, the garden snail Jeremy (Fig. 12) made the news a while ago for being left-handed and even got its own Wikipedia page. Left-handedness can either be genetically determined or, as in Jeremy's case, due to an accident during its early development.

Figure 12. Jeremy (top) and Bree (bottom). Jeremy is a rare left-coiling garden snail (*Cornu aspersum*). Notice how Jeremy's shell is a mirror image of Bree's typical right-handed shell. *Cornu aspersum* is a Stylommatophora snail, by the way, and all animals in this group are hermaphrodites. Source: Wikimedia Commons (Angus Davison, 2016).

When Snail or Big Snail turns around in the game, the handedness of the shell changes from left to right and vice-versa. Granted, most people will not even realize this, but for me, that is rather unsettling. I hope you will now notice this in the game and join me in becoming uncomfortable with it. By the way, when the Snail is seen from above (like when they are crawling on a pipe or other surface), their shells seem to have two spires, one to each side of the body, which is physically impossible in a natural shell. So, I'll just ignore that and pretend it never happened.

Still on the topic of shells, when Mario, or one of his heartless companions, stomps a Snail, the soft body of the animal is launched out of the shell. The Snails in the game survive this gruesome violence and then pitifully try to get back to their shells, as a last and feeble attempt at survival. Mario and company can use Snail shells like Koopa shells to rain more violence upon the local fauna and flora.

Now, I am aware that what I am about to say is obvious to most, but I feel like I need to address it here because many people (including other scientists) have asked me this. So here it goes. No, a snail cannot remove its own shell and then put it back on again. Both the shell and the soft parts make up the snail's body; the shell is the snail's skeleton. If, for any reason, the soft body is separated from the shell, the animal will not survive.

Honestly, I am not sure where the idea that the shell is a removable "accessory" comes from. Could it be from cartoons we watched as kids? Or maybe people are just mixing up snails (a mollusk, Phylum Mollusca) with hermit crabs (a crustacean, Phylum Arthropoda)? Hermit crabs, like all crabs, have a carapace (exoskeleton) made of chitin. However, hermit crabs seek out empty shells that once belonged to (that is, were part of the body of) a snail, which is typically a marine snail. When the crab finds a shell of suitable size and sturdiness, it wears the shell as an armor, so to speak (Fig. 13).

Figure 11. Top: The right-handed shell of *Satsuma longkiauwensis*, from Taiwan, seen from different angles. The shell is about 40 mm wide. Source: Wu et al. (2007: fig. 2, cropped). Bottom: The left-handed shell of *Satsuma squamigera*, from Taiwan, seen from different angles. The shell is about 20 mm wide. Source: Hwang & Wu (2018: fig. 2, cropped).

But you might say "Okay, but what about slugs? They have no shells." That's true, simply put, the definition of a slug is that they lack shells. I have often heard that "a slug is a snail who lost its shell." Taken literally, that is incorrect, as we have seen above. Slugs are born like that; they never had shells. Still, in evolutionary terms, that sentence has a kernel of truth behind it.

Slugs belong to the Stylommatophora group that I mentioned above or to families closely related to them. They descend from lineages of snails in which the shell was gradually lost throughout the course of their evolutionary history. A snail shell protects the animal's internal organs and it is a defense against predators and the environment (mostly water evaporation).

Figure 13. The armed hermit crab, a.k.a. black-eyed hermit crab, *Pagurus armatus*. Hermit crabs hide the softer part of their bodies inside a snail shell for protection. Source: Wikimedia Commons (NOAA Fisheries, 2021).

Figure 14. The European black slug *Arion ater*. Source: Wikimedia Commons (Prashanthns, 2008).

However, Evolution can work some weird stuff. In some cases, it might be advantageous for individuals to have smaller shells; for instance, that might make them more mobile, agile or faster (comparatively, of course), and thus give them an edge in escaping and hiding. Natural selection can act upon that and those individuals survive more and reproduce more, passing on their small-shell genes to the next generation. Over millions of years, the shells become so tiny that they are internalized into the body or altogether lost. That evolutionary

process resulted in the slugs we see today (Fig. 14). Many (but not all) slugs still have vestiges of the shell, like a small shield-like structure located inside the body.

ZOMBIE SNAILS

There is one feature of *Mario Wonder*'s Snail that I have not addressed yet: its striped tentacles. That one is a bit disturbing, so I left it for last. Striped tentacles are not a natural thing in real-world land snails. Rather, they indicate that the poor snail is infected by one of the most horrible parasites known.

It is a flatworm called *Leucochloridium paradoxum*, a.k.a. the green-banded broodsac, a name that reflects its striped color pattern. This flatworm species lives in Europe, Russia and Japan and infects snails exclusively belonging to the amber snail family (Succineidae). Further species in the genus *Leucochloridium* are also snail parasites, but they have different colors and patterns (see Nakao et al., 2019 for some examples).

The snails are intermediate hosts of these parasites. That means that the parasite undergoes its development inside the snail, but will then infect another animal (the definitive host), inside whom they will reproduce.

Like many parasitic infections, it all starts with the snails inadvertently ingesting worm eggs. Inside the snail's body, the eggs hatch into "larvae" called miracidia. The miracidia move to the snail's hepatopancreas (an organ that is more or less like a liver and pancreas put together), where they develop into their next life stage, called sporocyst. The sporocyst, in turn, will develop a green-banded broodsac that occupies the interior of the snail's eyestalks.

The broodsac is a flashy pulsating thing that looks like a caterpillar (Fig. 15). And who loves caterpillars? Birds. Thus, the parasite manipulates the snail's behavior, making it crawl towards places where it is more conspicuous – and hence, more easily snatched by birds. Birds are the definitive host of *Leucochloridium* and become infected after eating a parasitized snail. The adult flatworms live in the bird's cloaca and release their eggs together with the bird's feces, starting the cycle anew.

Figure 15. An amber snail (*Succinea* sp.) from Japan, infected by *Leucochloridium paradoxum*. You can clearly see the pulsating green-banded broodsac inside the right eyestalk. Source: Nakao et al. (2019, cropped).

If that sounds like the plot of a horror movie to you, it's because lots of B- sci-fi and horror involve "zombifying" parasites. *Leucochloridium* is just one of many such parasites. Most horror and sci-fi favor viruses as their "stars", but sometimes we see parasitic animals too, albeit typically fictional like the arthropod-like 'plagas' in *Resident Evil 4*. We can find a good example of a sci-fi parasite based on a real organism in *The Last of Us*. In that case, the zombifying parasite is neither a virus nor an animal, but a fungus belonging to the genus *Cordyceps* (see Villa & del Negro, 2022 for a nice biological overview).

So, is *Mario Wonder*'s Snail parasitized? I certainly hope not. It doesn't look even remotely similar to an amber snail, so it should not become infected by *Leucochlo-*

ridium. Still, I have to admit that the Snails do crawl around very conspicuous places, which makes them more likely to be stomped. That begs the question: if there is a parasite involved, are plumbers its definitive host?

FINAL THOUGHTS

In conclusion, the Snail is now my favorite enemy critter in Mario games (sorry, Chomp). But jokes aside, it is always good when animals that are not mammals are featured in games and other media. Putting them just a little bit in the spotlight allows people to see that the diversity of life is truly wondrous – and that it goes well beyond the usual boring stuff like lions and pandas that we are accustomed to seeing on the TV or at the zoo. Having more contact, even if virtual, with those fascinating creatures might lead some of us to try and save what's left of nature.

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FURTHER READING

Here are some approachable books for anyone interested in snails. They do not require any background in biology, so they are great starting points.

- Brooks, R. (2013) A Slow Passion. Snails, my garden, and me. Bloomsbury, London.
- Gordon, D.G. (2010) The Secret World of Slugs and Snails. Life in the very slow lane. Sasquatch Books, Seattle.
- van Dooren, T. (2022) A World in a Shell. Snail stories for a time of Extinctions. MIT Press, Cambridge.

And for the budding snail aficionados, the book *Slugs and Snails* by Robert Cameron (2016, Willian Collins, London) is an excellent and more technical introduction to this amazing group of animals.

About the author

Dr **Rodrigo B. Salvador** is a malacologist, that is, a researcher specialized in the study of mollusks. Given his fondness for land snails, most of his research centers on them. He was playing *Mario Wonder* despite the amount of unwarranted violence against the snail fauna the game contains, but put that on hold when *Persona 5 Tactica* was released.