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From reality to fiction: cnidarians that inspire the Pokémon world

C. Odette Carral-Murrieta[1], Mariae C. Estrada-González[2] & María A. Mendoza-Becerril[3]

[1]*Centro de Investigaciones Biológicas del Noroeste, S.C., Inst. Politécnico Nacional 195, La Paz, Mexico.*
[2]*Medusozoa México, La Paz, Mexico.*
[3]*El Colegio de la Frontera Sur (ECOSUR), Chetumal, Quintana Roo, Mexico.*
Emails: odettecarral@gmail.com; mc.estradaglz@gmail.com; maria.mendoza@ecosur.mx

Pokémon is a franchise that has taken inspiration from inanimate objects and living things to design a variety of creatures. Among those living beings are the cnidarians, very peculiar animals that have inspired the design of the coral and jellyfish Pokémon, which represent 1.44% of the 1,008 creatures created for the franchise so far (The Official Pokémon Website, 2023).

The phylum Cnidaria is composed of 13,300 species of invertebrate animals (Kayal et al., 2018), characterized by specialized cells that produce poison inside of minuscule capsules, known as cnidocysts (Tardent, 1995). Cnidarians are mostly aquatic and live in the sea, rivers, or lakes (Slobodkin & Bossert, 2010). Their body plan can manifest as polyps (mostly sessile phase) or jellyfish (mostly motile phase) (Slobodkin & Bossert, 2010). This phylum is divided into three large taxonomic groups (or subphyla) and, according to their order of appearance in the evolutionary time, are: Anthozoa, Endocnidozoa, and Medusozoa (Daly et al., 2007; Kayal et al., 2018).

WHO ARE THE CNIDARIANS?

The subphylum Anthozoan (Fig. 1) is composed only of polyps, that is, animals that usually live attached to a substrate and never produce jellyfish during their life cycle (Otero et al., 2017). The anthozoan polyps can remain solitary or live in colonies (Daly et al., 2007).

This subphylum is divided into three classes: Hexacorallia, Octocorallia, and Ceriantharia (Kayal et al., 2018; Ceriello et al., 2020). Hexacorallia comprises scleractinian corals (order Scleractinia) and anemones (order Actinaria). Scleractinian corals, also known as stony corals, have a skeleton made of calcium carbonate and are quite relevant as reef-building corals, while anemones have a disc bottom to attach themselves to several kinds of substrates and have a wide array of colorations (Daly et al., 2003).

Octocorals, on the other hand, do not have a calcium-carbonate skeleton, and for this, they are called soft-corals (order Alcyonacea). Species in this group form colonies, and one important characteristic is that their tentacles are always arranged in groups of eight, hence their name (Fabricius & Alderslade, 2001). Lastly, tube-dwelling anemones of the subclass Ceriantharia are solitary animals that bury themselves in sediments and live inside tubes for protection (Daly et al., 2007).

Endocnidozoa comprises parasites, with approximately 2,200 species belonging to the taxonomic classes Myxozoa and Polypodiozoa (Kayal et al., 2018). Myxozoans are ameboid parasites of both invertebrates and vertebrates, characterized by the presence of polar capsules, which contain an extrudable filament with an anchoring function, similar to nematocysts (Lom & Dyková, 2006). *Polypodium hydriforme* is the only species included in Polypodiozoa; it is adapted to intracellular parasitism in the oocytes of fishes and affects commercially important fish species such as black caviar (Raikova, 1994).

Some species of Medusozoa may exhibit the polyp life stage (Pantin, 1960). However, this subphylum is characterized by the

Figure 1. Cnidarian diversity. Subphylum Anthozoa: **A.** Hexacorallia hard-corals of Scleractinia (T. Hudson; CC BY-SA 3.0). **B**. Hexacorallia anemone (N. Hobgood; CC BY-SA 3.0). **C.** Octocorallia soft-corals (A.M. Gabriela, J.K. Belén & R.J. Antonia; CC BY SA 4.0). **D.** Octocorallia sea pen (S. Shebs; CC BY-SA 3.0). **E.** Cerianthiaria solitary anemones (L. Ilyes; CC BY 2.0). Subhylum Endocnidozoa: **F.** Polypodiozoa (E.V. Raikova; CC BY 2.0). G. Myxozoa (M. Ahn, H. Woo, B. Kang, Y. Jang & T. Shin; CC BY 4.0). **H.** Myxozoa (public domain). Source of all images: Wikimedia Commons.

jellyfish stage (Marques & Collins, 2004) (Fig. 1). Generally representing the mobile life stage, jellyfish tend to be free-swimmers (e.g., cannonball jellyfish *Stomolopus meleagris*; Shanks & Graham, 1987). The jellyfish body plan is made up of three main parts: the umbrella, named like that because it resembles one; the manubrium, constituted by a tube under the umbrella in which the mouth is located; and the tentacles, which are long and very flexible appendages arising from the edge of the umbrella or the mouth of the jellyfish, the latter known as oral arms (Russell, 1953). Among jellyfish, there is a diversity of sizes, some species can be a few millimeters long, while others reach up to 36 meters (Larsen, 2016).

The subphylum Medusozoa is divided into four taxonomic classes: Staurozoa, Cubozoa, Scyphozoa, and Hydrozoa. Stauromedusae (Staurozoa) are characterized by being sessile organisms fixed to a substrate through a peduncle (Miranda et al., 2016). Box jellyfish (Cubozoa) are characterized by complex eyes (e.g., *Tripedalia cystophora*; Coates, 2005), high toxicity, and a highly acute sense of direction (e.g., the sea wasp *Chironex fleckeri*; Kintner et al., 2005; Gordon & Seymour, 2009). Scyphomedusae (Scyphozoa) are the most widely known jellyfish; some species can reach large sizes, and their agglomerations can alter the marine environment and negatively impact activities of economic relevance (Purcell et al., 2007). Finally, hydromedusae (Hydrozoa) are distinguished from other jellyfishes due to their small size and the presence of the velum, a structure located within the umbrellar margin (Genzano et al., 2014). Furthermore, an additional life stage called siphonophore is present, which is a combination of polyps and modified jellyfish (Mapstone, 2015).

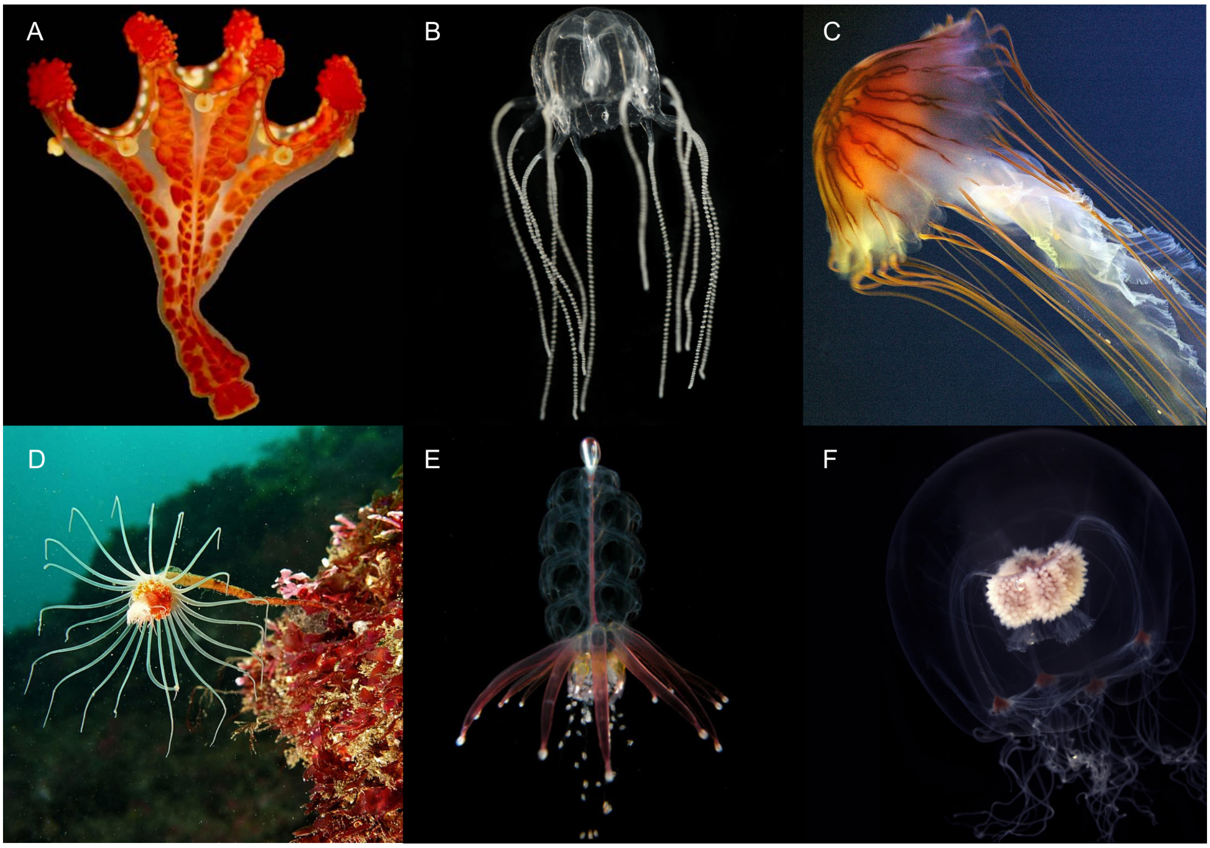

Figure 2. Cnidarian diversity. Phylum Medusozoa: **A.** Staurozoa jellyfish (C. Allen; CC BY-NC 4.0). **B.** Cubozoa jellyfish (J. Bielecki; Smithsonian Science Public Domain). **C.** Scyphozoa jellyfish (F. Degli Angeli; CC BY-SA 2.0). **D.** Hydrozoa polyp (J. Turnbull; CC BY-SA 2.0). **E.** Hydrozoa Siphonophorae (C.W. Dunn; CC0 1.0). **F.** Hydrozoa jellyfish (Pinetreella; CC BY-SA 4.0). Source of all images: Wikimedia Commons.

CNIDARIAN POKÉMON

Corals

There are two Pokémon that are inspired by real corals (Fig. 3). Corsola (#222), from the Johto region, is a Water/Rock Pokémon with regenerative abilities that inhabits warm sea waters. Another version of Corsola is the one from Galar, a ghost-type Pokémon that evolves into Cursola (#864). Galarian Corsola is Ghost-type because it became fossilized due to the impact of a meteorite in the Galar region (The Official Pokémon Website, 2023).

The morphology of Corsola is reminiscent of the Anthozoa group, particularly the corals. Corsola's design is likely inspired by the order Scleractinia, which is known for its stony or hard corals (Otero et al., 2017), furthermore it could resemble branches of the longhorn hydrocoral (*Janaria mirabilis*), a polyp that belongs to Medusozoa and each colony has a hermit crab of the family Paguridae as a symbiont (Cairns & Barnard, 1984). The regenerative capacities of Corsola are a characteristic shared among cnidarians, which is possible thanks to tissue plasticity and the presence of multi- and pluripotent cells (Luz et al., 2021). Examples of highly regenerative corals among the scleractinians are the species *Tubastraea coccinea* and *T. tagusensis* (Luz et al., 2018). Being distributed in warm waters, Corsola can be considered a hermatypic stony coral, which forms coral reefs in symbiosis with photosynthetic dinoflagellates called zooxanthellae, so its distribution is limited to the photic zone of tropical areas (Cairns & Stanley, 1982; Veron, 1995).

The appearance of Galarian Corsola and Cursola can be associated with three biological processes. Fossil corals remain as white-like calcareous structures. On the other hand, living representatives of hermatypic corals can lose their zooxanthellae algae, therefore the pigments that give them color, due to bleaching phenomenon associated with fast changes in temperature, salinity, and light exposure, as well as diseases, and the coral could perish (Brown, 1997), just as Cursola. Also, as a counterpart for hermatypic corals, there are the so-called ahermatypic corals distributed in cold waters between 4 and 20°C and at depths from zero to 6,200 m (Cairns & Stanley, 1982), which tend to look colorless. Some ahermatypic corals, such as the white coral species *Lophelia pertusa*, are reef-building and form associations with many marine species (Rogers, 1999).

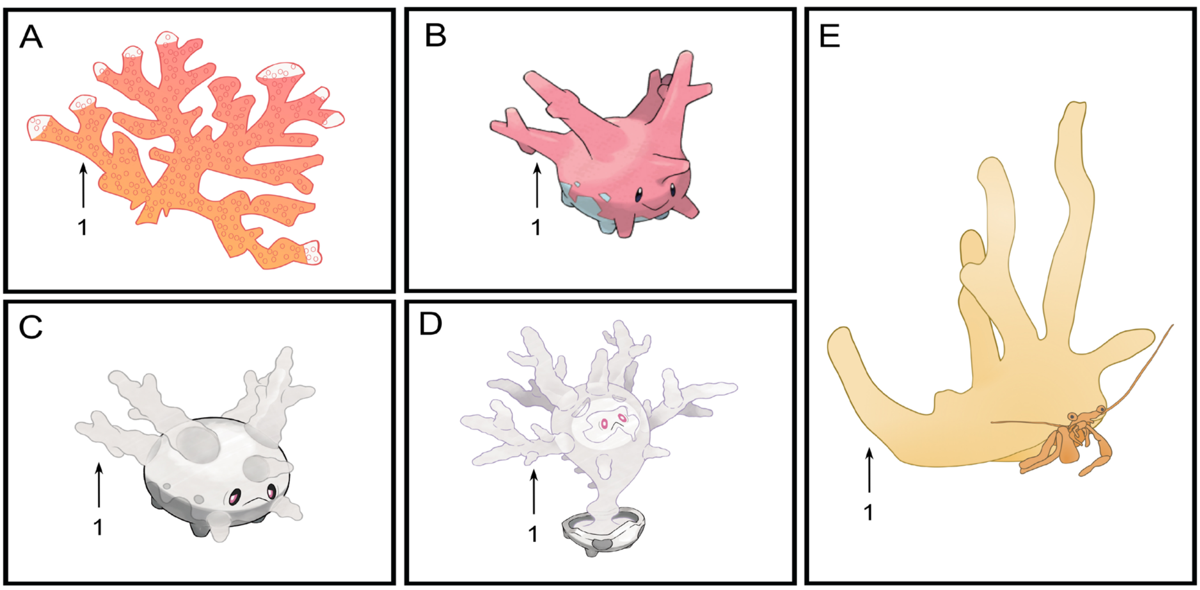

Figure 3. Corals and the Pokémon inspired by them. **A.** Anthozoa: hard branched coral. **B.** Corsola. **C.** Galarian Corsola. **D.** Cursola. **E.** The longhorn hydrocoral *Janaria mirabilis* living on a hermit crab (illustration inspired on O. Aburto; CC BY-NC 3.0). Pokémon designs are official artwork from the franchise (The Pokémon Company, 1996–2023).

Jellyfish

Currently, there are five Pokémon that resemble jellyfish (Fig. 4). The first jellyfish Pokémon introduced in the franchise were Tentacool (#072) and its evolution Tentacruel (#073), from the Kanto region. Tentacool and Tentacruel are Water/Poison Pokémon, which are consistent with the biology of jellyfish since they are aquatic and have nematocysts that inject poison and whose function is defense and capturing prey (Tardent, 1995).

The Pokédex indicates that Tentacool has two tentacles and is not a formidable swimmer, drifting in shallow water while capturing prey. On the other hand, Tentacruel has eighty tentacles that can stretch and shrink freely, trapping prey in a web of extended tentacles while delivering poisonous stings to its preys (The Official Pokémon Website, 2023). Several jellyfish species spend most of their lives floating horizontally near the ocean surface and can actively change their orientation according to ocean currents, as in the case of the barrel jellyfish (*Rhizostoma octopus*), while there are species that live at depths of up to 7,000 meters, such as the helmet jellyfish (*Periphylla periphylla*) (Jarms et al., 1999; Fossette et al., 2015). There are also jellyfish that can remain attached to a variety of surfaces, such as the clinging jellyfish (*Gonionemus vertens*), which can adhere to phytal substrates by means of its tentacles (Bakker, 1980).

Concerning the number of tentacles, jellyfish such as the purple sail *Velella velella*, has two tentacles (Brinckmann-Voss, 1970), and the small hydrozoan *Proboscidactyla flavicirrata* is known for having between 40 and 80 tentacles and its feeding strategy is to remain motionless in the water column with its tentacles extended (Mills, 1981). However, prey capture strategies vary between jellyfish species, and their effectiveness may be determined by factors such as the number of tentacles, musculature, jellyfish speed, swimming patterns, size, and prey speed, among others (Mills, 1981; Katsuki & Greenspan, 2013).

Tentacruel has red spheres on its head that glow brightly when it wants to attack, launching ultrasonic waves (The Official Pokémon Website, 2023). Tentacruel's ability to glow may be inspired by bioluminescent jellyfish, such as the helmet jellyfish (*Periphylla periphylla*) and the crystal jelly (*Aequorea victoria*), belonging to the classes Scyphozoa and Hydrozoa, respectively (Jarms et al., 2002; Haddock et al., 2010). The shiny version of Tentacruel has green spheres instead of red, such as the crystal jelly, a hydromedusa with medical relevance because GFP (green fluorescent protein) is obtained from it (Chalfie, 1995), facilitating the study of neural networks and synaptic connections (Zimmer, 2002).

Frillish (#592) and its evolution Jellicent (#593), from the Unova region, are Water/Ghost Pokémon composed entirely of seawater that catch prey with their tentacles (Pokémon official website, 2022). The water content in jellyfish is extremely high, reaching more than 95% of their total body weight, while less than 1% of their weight is carbon (Lucas et al., 2011).

Both Frillish and Jellicent have sexual dimorphism, which means that males and females of the same species have a different appearance, the most obvious example is the blue and pink colors distinctive for males and females. Nevertheless, dimorphism is not an easily distinguishable trait in jellyfish: their gonads exhibit slight variability in shape and color that could go unnoticed to the human eye (e.g., box jellyfish *Copula sivickisi*) (Lewis et al., 2008). The appearance of Frillish and Jellicent is reminiscent of the so-called common jellyfish of the class Scyphozoa, particularly the Ulmariidae family, to which the common moon jellyfish (*Aurelia* spp.) belongs.

An interesting feature of Jellicent is that during the full moon, it forms groups on the sea surface, waiting for its prey (The Official Pokémon Website, 2023). Around the world, species of box jellyfish belonging to the genus of sea wasps *Alatina* (e.g., *Alatina moseria*, *A. mordens*, and *A. alata*) have been observed forming aggregations of hundreds to thousands of individuals during reproductive events, appearing between 8 and 10 days after the full moon (Lawley et al., 2016).

Another jellyfish Pokémon is the mysterious Nihilego (#792) from Gen. VII, a Rock/Poison Ultra Beast that has an extremely powerful neurotoxin used to control people and Pokémon (The Official Pokémon Website, 2023). Jellyfish venom does contain neurotoxins that can damage the functioning of the nervous system (Liao et al., 2019). Some species, particularly those belonging to the Cubozoa group, such as the wasp jellyfish (*Chironex fleckeri*), are so dangerous that they can kill humans. However, most jellyfish species are harmless to people (Barnes, 1966; Cegolon et al., 2013).

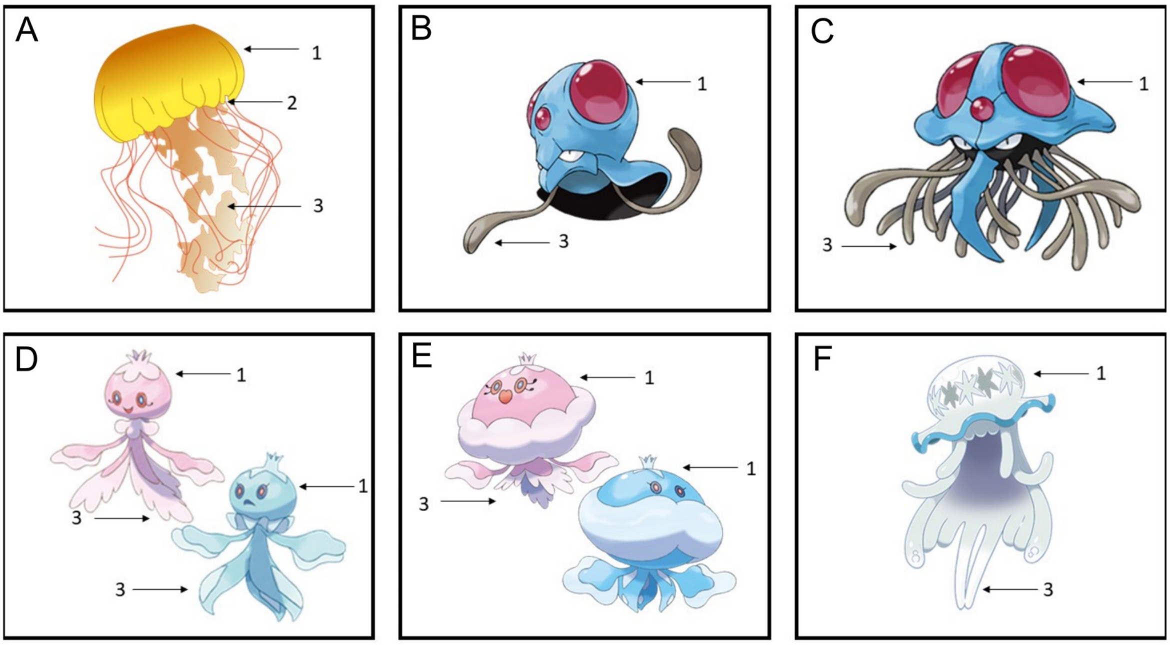

Figure 4. Jellyfish Pokémon. A. Scyphozoan jellyfish with some of its morphological characteristics. B. Tentacool. C. Tentacruel, D. Female and male Frillish. E. Female and male Jellicent. F. Nihilego. Structures: 1= umbrella, 2= margin, 3= oral arms. Pokémon designs are official artwork from the franchise (The Pokémon Company, 1996–2023).

CNIDARIAN CHARACTERISTICS THAT THE FRANCHISE COULD EXPLORE

The Pokémon species Remoraid (#223) and Mantine (#226) represent a mutualist interaction, as Mantine does not mind that Remoraid attaches to its fin to eat its leftovers (The Official Pokémon Website, 2023). On the other hand, Parasect (#47) is completely controlled by the fungus attached to its back (The Official Pokémon Website, 2023), showing an example of a parasitic interaction. Endocnidozoans could be an interesting addition to the Pokémon world, particularly Myxozoan parasites found in the brain of species like the mole *Talpa europaea* (Friedrich et al., 2000).

The abilities of Pokémon that resemble jellyfish are directed toward attack. In reality, the interaction of cnidarian venom and humans goes beyond sting poisoning and could be explored as potential drugs for parasitic and fungal diseases (Morales-Landa et al., 2007) and their compatibility for creating skin grafts (Fernández-Cervantes et al., 2020). This idea could be exploited in the franchise within Pokémon hospitals.

As mentioned above, the cnidarian life cycles are unique and could inspire the creation of new striking evolutionary lines. An example is the knotted thread hydroid (*Obelia geniculata*), where the larval stage (planula) generates a polyp. This polyp forms a colony (several individuals with different functions that work as an integrated organ-

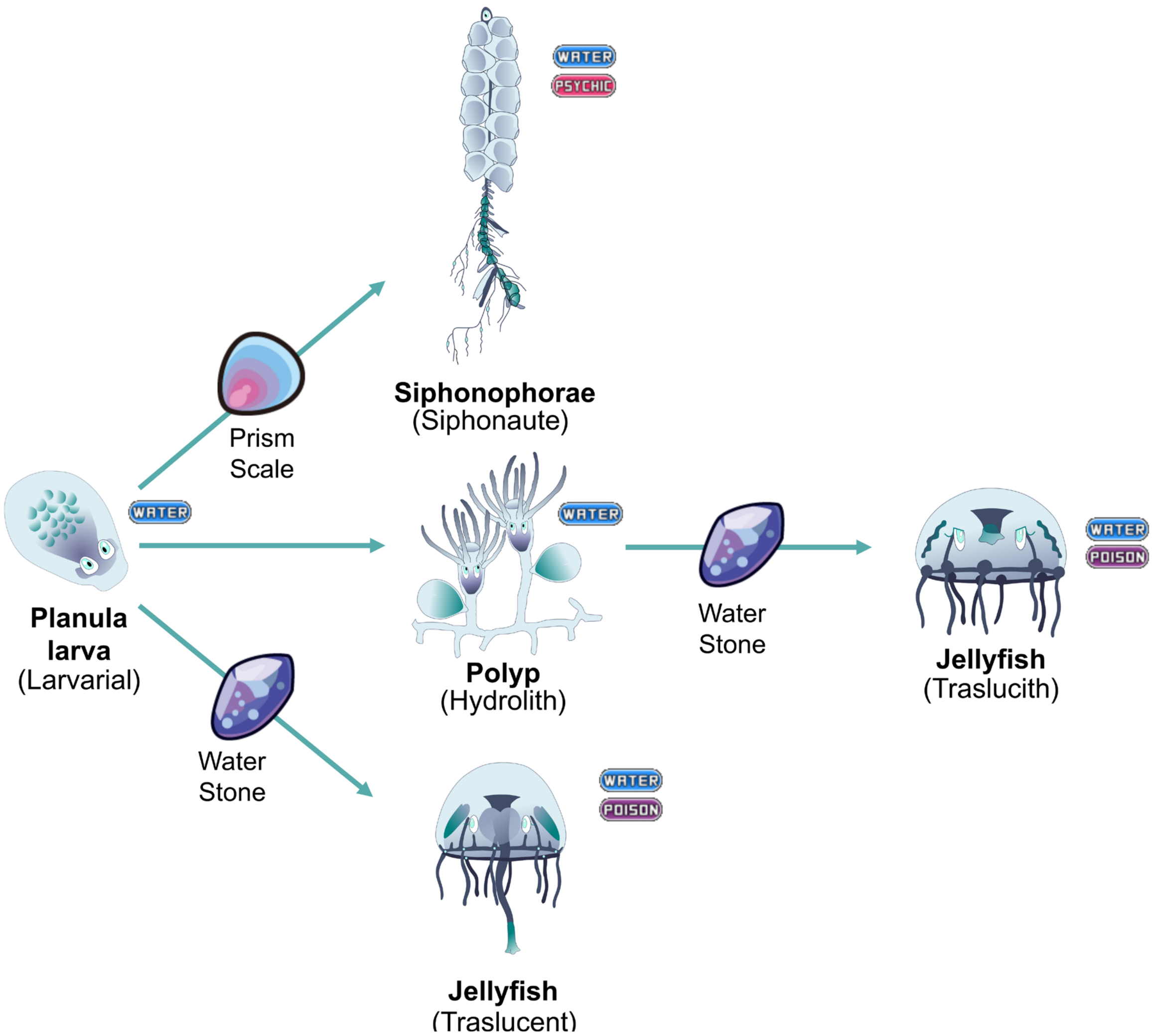

Figure 5. Proposed Pokémon designs based on the complex life cycles and phases of medusozoan cnidarians. Suggested character names are indicated in parentheses. The evolution items and Pokémon Type symbols are official artwork from the franchise (The Pokémon Company, 1996–2023).

ism) that can release jellyfish; then, each individual jellyfish reproduces sexually with another jellyfish, generating a larva, thus repeating the cycle (Slobodov & Marfenin, 2004). Other fascinating medusozoans that could be considered are siphonophores, colonial organisms composed of polypoid and medusoid forms (Mapstone, 2015).

Because we are fascinated by cnidarian life cycles and morphologies, we offer an example of how facts from real-world biology could be incorporated in the design of new Pokémon (Fig. 5): Larvarial, a Water-type Pokémon larval stage that evolves (by levelling up) into Water-type Hydrolith, the polyp representation. If Larvarial is exposed to a Water Stone, it evolves into the dual-type Water/Poison Translucent, a jellyfish, while a Prism Scale transforms it into the mesmerizing dual-type Water/Psychic Siphonaute, a siphonophore. Also, when Hydrolith is given a Water Stone, it evolves into the dual-type Water/Poison Traslucith, another jellyfish form.

CONCLUSIONS

Of the 13,300 cnidarian species known worldwide, there are similarities between structures such as the tentacles, the bell, the oral arms, and calcified branches of seven Pokémon (Corsola, Cursola, Tentacool, Tentacruel, Frillish, Jellicent, and Nihilego) and the real-world cnidarians. Nevertheless, there are still many different species of coral, endocnidozoans, and jellyfish waiting to be adapted to the Pokémon world.

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ABOUT THE AUTHORS

MSc. **C. Odette Carral-Murrieta** is a doctoral student and a cnidarian enthusiast. She loves Pokémon GO but knows that reaching level 50 will take her at least 10 years. Trainer code: 2339 2760 7055.

MSc. **Mariae C. Estrada-González** is a marine biologist and a specialist in medusozoans. She enjoyed Pokémon during her childhood when the anime was broadcasted on television, and on the year of 2016 rediscovered her love for the franchise thanks to the release of Pokémon GO.

Dr **María A. Mendoza-Becerril** has a PhD in Zoology from the University of São Paulo, Brazil. María works at El Colegio de la Frontera Sur, Chetumal, where she develops studies that involve medusozoans. Also, she is the coordinator of Medusozoa México. She is not from the Pokémon GO generation, but she marvels at the idea of bringing medusozoans to fiction and video games so that everyone can know them.