



Turritopsis dohrnii

Primarily from Wikipedia, the free encyclopedia
(https://en.wikipedia.org/wiki/Dark_matter)

Mark Herbert, PhD

World Development Institute
39 Main Street, Flushing, Queens, New York 11354, USA, ma708090@gmail.com

Abstract: *Turritopsis dohrnii*, also known as the **immortal jellyfish**, is a species of small, biologically immortal jellyfish found worldwide in temperate to tropic waters. It is one of the few known cases of animals capable of reverting completely to a sexually immature, colonial stage after having reached sexual maturity as a solitary individual. Others include the jellyfish *Laodicea undulata* and species of the genus *Aurelia*.

[Mark Herbert. **Turritopsis dohrnii**. *Stem Cell* 2020;11(4):111-114]. ISSN: 1945-4570 (print); ISSN: 1945-4732 (online). <http://www.sciencepub.net/stem>. 5. doi:[10.7537/marsscj110420.05](https://doi.org/10.7537/marsscj110420.05).

Keywords: *Turritopsis dohrnii*; immortal jellyfish, biologically immortal; animals; sexual maturity

Turritopsis dohrnii, also known as the **immortal jellyfish**, is a species of small, biologically immortal jellyfish^{[2][3]} found worldwide in temperate to tropic waters. It is one of the few known cases of animals capable of reverting completely to a sexually immature, colonial stage after having reached sexual maturity as a solitary individual. Others include the jellyfish *Laodicea undulata*^[4] and species of the genus *Aurelia*^[5]

Like most other hydrozoans, *T. dohrnii* begin their life as tiny, free-swimming larvae known as planulae. As a planula settles down, it gives rise to a colony of polyps that are attached to the sea-floor. All the polyps and jellyfish arising from a single planula are genetically identical clones.^[6] The polyps form into an extensively branched form, which is not commonly seen in most jellyfish. Jellyfish, also known as medusae, then bud off these polyps and continue their life in a free-swimming form, eventually becoming sexually mature. When sexually mature, they have been known to prey on other jellyfish species at a rapid pace. If *T. dohrnii* jellyfish are exposed to environmental stress, physical assault, or is sick or old, it can revert to the polyp stage, forming a new polyp colony.^[7] It does this through the cell development process of transdifferentiation, which alters the differentiated state of the cells and transforms them into new types of cells.

Theoretically, this process can go on indefinitely, effectively rendering the jellyfish biologically immortal,^{[3][8]} although in practice individuals can still die. In nature, most *Turritopsis dohrnii* are likely to succumb to predation or disease in the medusa stage

without reverting to the polyp form.^[9]

The capability of biological immortality with no maximum lifespan makes *T. dohrnii* an important target of basic biological, aging and pharmaceutical research.^[10]

The "immortal jellyfish" was formerly classified as *T. nutricula*.^[11]

Description

The medusa of *Turritopsis dohrnii* is bell-shaped, with a maximum diameter of about 4.5 millimetres (0.18 in) and is about as tall as it is wide.^{[12][13]} The mesoglea in the walls of the bell is uniformly thin, except for some thickening at the apex. The relatively large stomach is bright red and has a cruciform shape in cross section. Young specimens 1 mm in diameter have only eight tentacles evenly spaced out along the edge,^[14] whereas adult specimens have 80–90 tentacles. The medusa (jellyfish) is free-living in the plankton. Dense nerve net cells are also present in the epidermis in the cap. They form a large ring-like structure above the radial canal commonly presented in cnidarians.^[15]

Turritopsis dohrnii also has a bottom-living polyp form, or hydroid, which consists of stolons that run along the substrate and upright branches with feeding polyps that can produce medusa buds.^[16] These polyps develop over a few days into tiny 1 mm medusae, which are liberated and swim free from the parent hydroid colony.

Images of both the medusa and polyp of the closely related species *Turritopsis rubra* from New Zealand can be found online.^[17] Until a recent genetic study, it was thought that *Turritopsis rubra* and *Turritopsis nutricula* were the same.^[11] It is not known

whether or not *T. rubra* medusae can also transform back into polyps.

Distribution and invasion

Turritopsis is believed to have originated in the Pacific, but has spread all over the world through trans-Arctic migrations, and has speciated into several populations that are easy to distinguish [morphologically](#), but whose species distinctions have recently been verified by a study and comparison of mitochondrial ribosomal gene sequences.^{[11][18]} *Turritopsis* are found in temperate to tropical regions in all of the world's oceans.^[13] *Turritopsis* is believed to be spreading across the world through [ballast water discharge](#).^[13] Unlike other species invasions which caused serious economic and ecological consequences, *T. dohrnii*'s invasion around the world was unnoticed due to their tiny size and innocuity.^[19] "We are looking at a worldwide silent invasion", said [Smithsonian Tropical Marine Institute](#) scientist Dr. Maria Miglietta.^[18]

Life cycle

The eggs develop in [gonads](#) of female medusae, which are located in the walls of the manubrium (stomach). Mature eggs are presumably spawned and fertilized in the sea by sperm produced and released by male medusae, as is the case for most [hydromedusae](#). However, the related species *Turritopsis rubra* seems to retain fertilized eggs until the planula stage.^[17] Fertilized eggs develop into [planula](#) larvae, which settle onto the sea-floor (or even the rich marine communities that live on floating docks), and develop into polyp colonies ([hydroids](#)). The hydroids bud new jellyfishes, which are released at about one millimetre in size and then grow and feed in the plankton, becoming sexually mature after a few weeks (the exact duration depends on the ocean temperature; at 20 °C (68 °F) it is 25 to 30 days and at 22 °C (72 °F) it is 18 to 22 days).^[3] Medusae of *T. dohrnii* are able to survive between 14 °C and 25 °C.^{[3][14]}

Biological immortality

Most jellyfish species have a relatively fixed life-span, which varies by species from hours to many months (long-lived mature jellyfish spawn every day or night; the time is also fairly fixed and species-specific).^[20] The medusa of *Turritopsis dohrnii* is the only form known to have developed the ability to return to a polyp state, by a specific transformation process that requires the presence of certain cell types (tissue from both the jellyfish bell surface and the circulatory canal system).^[21]

Experiments have revealed that all stages of the medusae, from newly released to fully mature individuals, can transform back into polyps under the conditions of starvation, sudden temperature change, reduction of salinity, and artificial damage of the bell with forceps or scissors.^[3] The transforming [medusa](#) is

characterized first by deterioration of the bell, mesoglea, and tentacles. All immature medusa (with 12 tentacles at most) then turned into a [cyst](#)-like stage and then transformed into [stolons](#) and polyps. However, about 20%-40% of mature medusa went into the stolons and polyps stage without passing the cyst-like stage. Polyps were formed after 2 days since stolons had developed and fed on food. Polyps further multiply by growing additional stolons, branches, and then polyps to form colonial [hydroids](#). In the experiment, they would eventually transform into stolons and polyps and begin their lives once again, even without environmental changes or injury.^[3] A diagram of the transformation procedure can be found at the [further reading section in this article](#).

This ability to reverse the biotic cycle (in response to adverse conditions) is unique in the [animal kingdom](#). It allows the jellyfish to bypass death, rendering *Turritopsis dohrnii* potentially [biologically immortal](#). The process has not been observed in their natural habitat, in part because the process is quite rapid and because field observations at the right moment are unlikely.^[3] Regardless, most individual medusae are likely to fall victim to the general hazards of life as [mesoplankton](#), including being eaten by predators or succumbing to the disease.

The species' cell development method of transdifferentiation has inspired scientists to find a way to make stem cells using this process for renewing damaged or dead tissue in [humans](#).^[10]

Ecology

Diet

Turritopsis dohrnii are a carnivorous species that commonly feed on zooplankton.^[22] *T. dohrnii* ingests food and excrete any waste through the mouth. *T. dohrnii* hunts by using its tentacles as it drifts through the water. It's tentacles, which contain stinging cells called nematocysts, spread and sting its prey.^[23] The tentacles can then flex to direct its prey to the mouth. *T. dohrnii*, like other jellyfish, may use its bell to catch its prey. *T. dohrnii*'s bell will expand, sucking in water, as it propels itself to swim. This expansion of the bell brings potential prey in closer reach of the tentacles.^[24]

Predation

Turritopsis dohrnii, like other jellyfish, are preyed on most commonly by other jellyfish. Other predators of *T. dohrnii* include, sea anemones, tuna, sharks, swordfish, sea turtles, and penguins.^[25] Many species prey on *T. dohrnii* and other jellyfish due to their simple composition. They are only approximately 5% matter, and the remaining part is composed of water.^[26] They are composed of three layers. An outer layer (the epidermis), a middle layer (mesoglea; a thick, jelly-like substance), and an inner layer (gastrodermis).^[27]

Habitat

Turritopsis dohrnii was first discovered in the Mediterranean Sea, but has since spread worldwide.^[28]

T. dohrnii generally found living in temperate to tropic waters. They can be found in marinas or docks, vessel hulls, and the bottom (ocean floor). They typically live in a salinity range of polyhaline (18-30 PSU) and euhaline (30-40 PSU).^[29]

Genomic analysis

Genomic analyses such as [sequence analysis](#) on [mRNA](#) or [mitochondria](#) DNA have been employed to investigate its lifecycle. mRNA analysis of each life stage showed that a stage-specific gene in the medusae stage is expressed tenfold more than in other stages. This gene is relative to a [Wnt signal](#) that can induce a regeneration process upon injury.^{[30][31]}

Analysis of [nucleotide sequence](#) homologs and protein homologs identified [Nemopsis bachei](#) as the species' closest relative. None of the closely related species display biological immortality.^[32]

Culturing

Keeping *T. dohrnii* in captivity is quite difficult. Currently, only one scientist, Shin Kubota from [Kyoto University](#), has managed to sustain a group of these jellyfish for a prolonged period of time. The plankton must be inspected daily to ensure that they have properly digested the [Artemia cysts](#) they are being fed.^[7] Kubota reported that during a two-year period, his colony rebirthed itself 11 times.^[33] Kubota regularly appears on Japanese television to talk about his immortal jellyfish and has recorded several songs about them.^[7]

References

1. ^ Schuchert P, ed. (2012). "*Turritopsis dohrnii* (Weissmann, 1883)". *World Hydrozoa database. World Register of Marine Species*. Retrieved November 29, 2012.
2. ^ Bavestrello, Giorgio; Christian Sommer; Michele Sarà (1992). "Bi-directional conversion in *Turritopsis nutricula* (Hydrozoa)". *Scientia Marina*. 56 (2–3): 137–140.
3. ^ Jump up to:^{a b c d e f g} Piraino, Stefano; F. Boero; B. Aeschbach; V. Schmid (1996). "Reversing the life cycle: medusae transforming into polyps and cell transdifferentiation in *Turritopsis nutricula* (Cnidaria, Hydrozoa)". *Biological Bulletin*. 190 (3): 302–312. doi:10.2307/1543022. JSTOR 1543022. PMID 29227703.
4. ^ De Vito; et al. (2006). "Evidence of reverse development in *Leptomedusae* (Cnidaria, Hydrozoa): the case of *Laodicea undulata* (Forbes and Goodsir 1851)". *Marine Biology*. 149 (2): 339–346. doi:10.1007/s00227-005-0182-3.
5. ^ He; et al. (2015-12-21). "Life Cycle Reversal in *Aurelia sp.1* (Cnidaria, Scyphozoa)". *PLOS ONE*. 10 (12): e0145314. Bibcode:2015PLoSO.1045314H. doi:10.1371/journal.pone.0145314. PMC 4687044. PMID 26690755.
6. ^ "Jellyfish and Comb Jellies | Smithsonian Ocean". *ocean.si.edu*. Retrieved 2020-10-19.
7. ^ Jump up to:^{a b c} Rich, Nathaniel (November 28, 2012). "Can a jellyfish unlock the secret of immortality?". *The New York Times Magazine*. Retrieved October 22, 2017.
8. ^ Gilbert, Scott F. (2006). "Cheating Death: The Immortal Life Cycle of *Turritopsis*". Archived from the original on 2010-04-02. Retrieved 2009-03-22.
9. ^ Ker Than (January 29, 2009). "'Immortal' Jellyfish Swarm World's Oceans". *National Geographic News*. Retrieved 2010-06-16.
10. ^ Jump up to:^{a b} Dimberu, Peniel M. (2011-04-25). "Immortal Jellyfish Provides Clues for Regenerative Medicine". *Singularity Hub*. Retrieved 26 October 2011.
11. ^ Jump up to:^{a b c} Miglietta, M. P.; S. Piraino; S. Kubota; P. Schuchert (November 2006). "Species in the genus *Turritopsis* (Cnidaria, Hydrozoa): a molecular evaluation". *Journal of Zoological Systematics and Evolutionary Research (published February 2007)*. 45 (1): 11–19. doi:10.1111/j.1439-0469.2006.00379.x.
12. ^ Kramp, P. L. (1961). "Synopsis of the medusae of the world". *Journal of the Marine Biological Association of the United Kingdom*. 40: 1–469. doi:10.1017/s0025315400007347.
13. ^ Jump up to:^{a b c} Mintowt-Czyz, Lech (26 January 2009). "*Turritopsis nutricula*: the world's only 'immortal' creature". *Times Online*. Archived from the original on February 3, 2009. Retrieved 2009-03-22.
14. ^ Jump up to:^{a b} Martell, L.; Piraino, S.; Gravili, C.; Boero, F. (2016-07-02). "Life cycle, morphology and medusa ontogenesis of *Turritopsis dohrnii* (Cnidaria: Hydrozoa)". *Italian Journal of Zoology*. 83 (3): 390–399. doi:10.1080/11250003.2016.1203034. ISSN 1125-0003.
15. ^ Koizumi, Osamu; Hamada, Shun; Minobe, Sumiko; Hamaguchi-Hamada, Kayoko; Kurumata-Shigeto, Mami; Nakamura, Masaru; Namikawa, Hiroshi (2015). "The nerve ring in cnidarians: its presence and structure in hydrozoan medusae". *Zoology*. 118 (2): 79–88. doi:10.1016/j.zool.2014.10.001. PMID 25498132.
16. ^ Fraser, C. McLean (1937). *Hydroids of the Pacific Coast of Canada and the United States*.

- University of Toronto Press. pp. 201 plus 44 plates.
17. ^ Jump up to:^{a b} Schuchert, Peter. "Turritopsis rubra". Archived from the original on September 12, 2009. Retrieved 23 January 2010.
 18. ^ Jump up to:^{a b} "'Immortal' jellyfish swarming across the world". Telegraph Media Group. January 27, 2009. Retrieved 2010-06-16.
 19. ^ Govindarajan, Annette F.; Carman, Mary R. (2016-02-01). "Possible cryptic invasion of the Western Pacific toxic population of the hydromedusa *Gonionemus vertens* (Cnidaria: Hydrozoa) in the Northwestern Atlantic Ocean". *Biological Invasions*. 18 (2): 463–469. doi:10.1007/s10530-015-1019-8. ISSN 1387-3547.
 20. ^ Mills, C. E. (1983). "Vertical migration and diel activity patterns of hydromedusae: studies in a large tank". *Journal of Plankton Research*. 5 (5): 619–635. doi:10.1093/plankt/5.5.619.
 21. ^ Mihai, Andrei (December 5, 2008). "Meet the world's only immortal animal". ZME Science. Retrieved January 10, 2015.
 22. ^ "NEMESIS Database Species Summary". *invasions.si.edu*. Retrieved 2020-10-21.
 23. ^ "jellyfish | Characteristics, Habitat, Diet, Anatomy, & Facts". *Encyclopedia Britannica*. Retrieved 2020-10-21.
 24. ^ "jellyfish | Characteristics, Habitat, Diet, Anatomy, & Facts". *Encyclopedia Britannica*. Retrieved 2020-10-21.
 25. ^ "jellyfish | Characteristics, Habitat, Diet, Anatomy, & Facts". *Encyclopedia Britannica*. Retrieved 2020-10-21.
 26. ^ US Department of Commerce, National Oceanic and Atmospheric Administration. "What are jellyfish made of?". *oceanservice.noaa.gov*. Retrieved 2020-10-21.
 27. ^ US Department of Commerce, National Oceanic and Atmospheric Administration. "What are jellyfish made of?". *oceanservice.noaa.gov*. Retrieved 2020-10-21.
 28. ^ AMNH, American Museum of Natural History (May 4, 2015). "The Immortal Jellyfish". *American Museum of Natural History*. Archived from the original on October 21, 2020. Retrieved October 21, 2020.
 29. ^ "NEMESIS Database Species Summary". *invasions.si.edu*. Retrieved 2020-10-21.
 30. ^ Logan, Catriona Y.; Nusse, Roel (2004-10-08). "The wnt signaling pathway in development and disease". *Annual Review of Cell and Developmental Biology*. 20 (1): 781–810. Cite Seer X 10.1.1.322.311. doi:10.1146/annurev.cellbio.20.010403.113126. ISSN 1081-0706. PMID 15473860.
 31. ^ Hasegawa, Yoshinori; Watanabe, Takashi; Takazawa, Masaki; Ohara, Osamu; Kubota, Shin (2016-08-01). "De Novo Assembly of the Transcriptome of *Turritopsis*, a Jellyfish that Repeatedly Rejuvenates". *Zoological Science*. 33 (4): 366–371. doi:10.2108/zs150186. ISSN 0289-0003. PMID 27498796.
 32. ^ Devarapalli, Pratap; Science, Department of Genomic; Kerala, Central University of; Campus, Riverside Transit; Science, Opp: Nehru College of Arts and; 17, NH; Padanakkad; Nileshtwer; Kasaragod (2014). "The conserved mitochondrial gene distribution in relatives of *Turritopsis nutricula*, an immortal jellyfish". *Bioinformatics*. 10 (9): 586–591. doi:10.6026/97320630010586. PMC 4209368. PMID 25352727.
 33. ^ S Kubota (2011). "Repeating rejuvenation in *Turritopsis*, an immortal hydrozoan (Cnidaria, Hydrozoa)" (PDF). *Biogeography*. 13: 101–103. ISSN 1345-0662. Archived from the original (PDF) on 2014-10-29.