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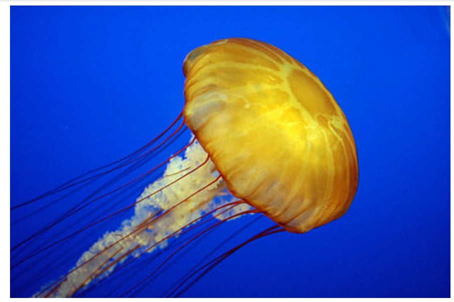
Jellyfish

Jellyfish and **sea jellies** are the informal common names given to the medusa-phase of certain gelatinous members of the subphylum Medusozoa, a major part of the phylum Cnidaria. Jellyfish are mainly free-swimming marine animals with umbrella-shaped bells and trailing tentacles, although a few are not mobile, being anchored to the seabed by stalks. The bell can pulsate to provide propulsion and highly efficient locomotion. The tentacles are armed with stinging cells and may be used to capture prey and defend against predators. Jellyfish have a complex life cycle; the medusa is normally the sexual phase, the planula larva can disperse widely and is followed by a sedentary polyp phase.

Jellyfish are found all over the world, from surface waters to the deep sea. Scyphozoans (the "true jellyfish") are exclusively marine, but some hydrozoans with a similar appearance live in freshwater. Large, often colorful, jellyfish are common in coastal zones worldwide. The medusae of most species are fast growing, mature within a few months and die soon after breeding, but the polyp stage, attached to the seabed, may be much more long-lived. Jellyfish have been in existence for at least 500 million years,[1] and possibly 700 million years or more, making them the oldest multi-organ animal group.[2]

Jellyfish are eaten by humans in certain cultures, being considered a delicacy in some Asian countries, where species in the Rhizostomae order are pressed and salted to remove excess water. They are also used in research, where the green fluorescent protein, used by some species to cause bioluminescence, has been adapted as a fluorescent marker for genes inserted into other cells or organisms. The stinging cells used by jellyfish to subdue their prey can also injure humans. Many thousands of swimmers are stung every year, with effects ranging from mild discomfort to serious injury or even death; small box jellyfish are responsible for many of these deaths. When conditions are favourable, jellyfish can form vast swarms. These can be responsible for damage to fishing gear by filling fishing nets, and sometimes clog the cooling systems

Jellyfish



Pacific sea nettle (*Chrysaora fuscescens*)

Scientific classification

Kingdom:	Animalia
Phylum:	Cnidaria
Subphylum:	Medusozoa

Groups included

- Acraspeda
  - Cubozoa—box jellyfish
  - Scyphozoa—true jellyfish
  - Staurozoa—stalked jellyfish
- some Hydrozoa—small jellyfish

Cladistically included but traditionally excluded taxa

- some Hydrozoa, such as *Hydra*

of power and desalination plants which draw their water from the sea.

Play media

Spotted Comb Jelly

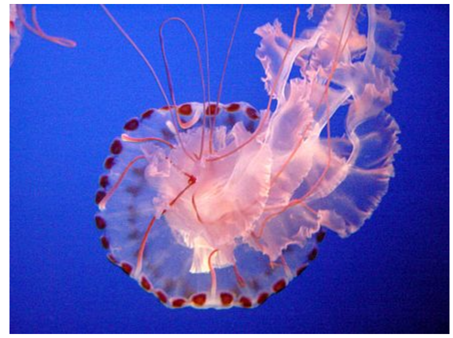
Contents

Names

The name jellyfish, in use since 1796,[3] has traditionally been applied to medusae and all similar animals including the comb jellies (ctenophores, another phylum).[4][5] The term *jellies* or *sea jellies* is more recent, having been introduced by public aquaria in an effort to avoid use of the word "fish" with its connotations of an animal with a backbone, though shellfish, cuttlefish and starfish are not vertebrates either.[6][7] In scientific literature, "jelly" and "jellyfish" have been used interchangeably.[8][9] Many sources refer to only scyphozoans as "true jellyfish".[10]

Mapping to taxonomic groups

Phylogeny



A purple-striped jellyfish at the Monterey Bay Aquarium

Definition

The term jellyfish broadly corresponds to medusae,[3] that is, a life-cycle stage in the Medusozoa. The American evolutionary biologist Paulyn Cartwright gives the following general definition:

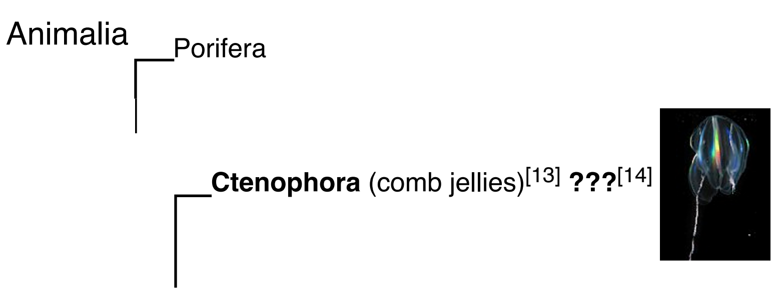
> Typically, medusozoan cnidarians have a pelagic, predatory jellyfish stage in their life cycle; staurozoans are the exceptions [as they are stalked].[11]

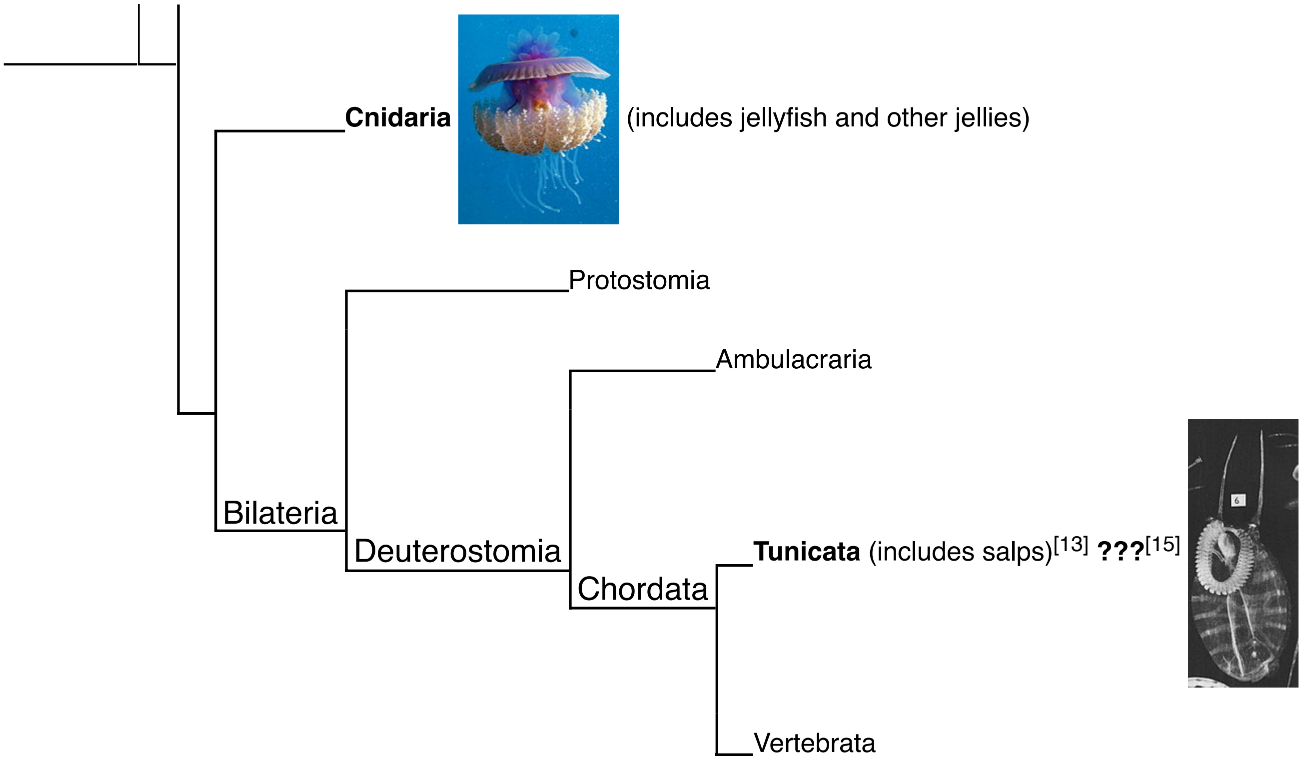
The Merriam-Webster dictionary defines jellyfish as follows:

> A free-swimming marine coelenterate that is the sexually reproducing form of a hydrozoan or scyphozoan and has a nearly transparent saucer-shaped body and extensible marginal tentacles studded with stinging cells.[12]

Given that jellyfish is a common name, its mapping to biological groups is inexact. Some authorities have called the comb jellies[13] and certain salps[13] jellyfish, though other authorities state that neither of these are jellyfish, which they consider should be limited to certain groups within the medusozoa.[14][15]

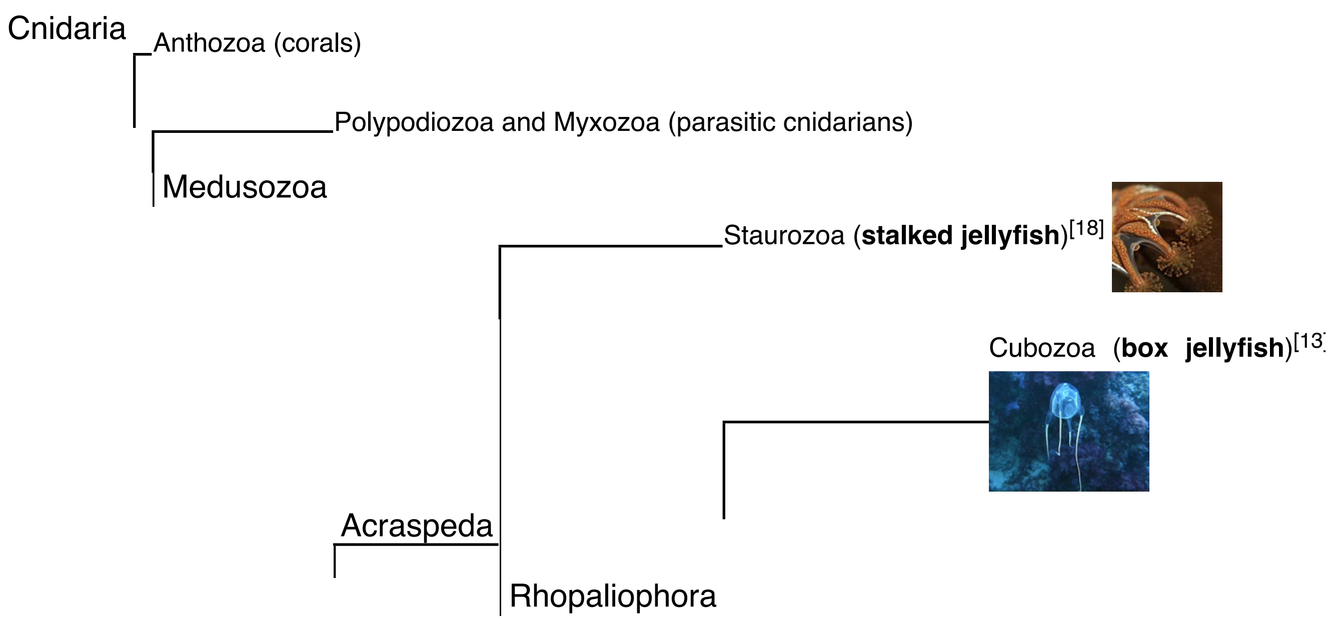
The non-medusozoan clades called jellyfish by some but not all authorities (both agreeing and disagreeing citations are given in each case) are indicated with "**???**" on the following cladogram of the animal kingdom:

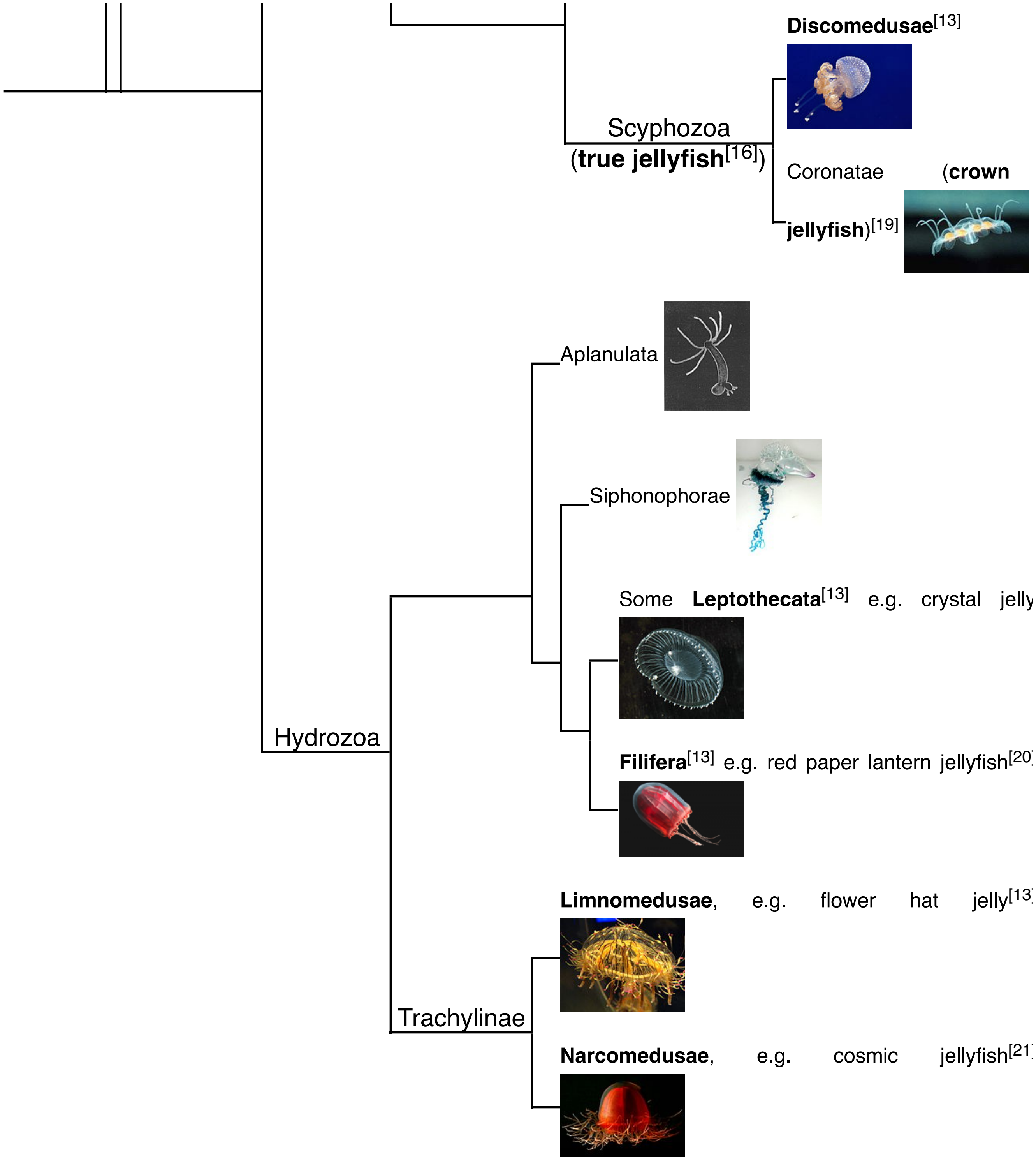




Medusozoan jellyfish

Jellyfish are not a clade, as they include most of the Medusozoa, barring some of the Hydrozoa.[16][17] The medusozoan groups included by authorities are indicated on the following phylogenetic tree by the presence of citations. Names of included jellyfish, in English where possible, are shown in boldface; the presence of a named and cited example indicates that at least that species within its group has been called a jellyfish.





Taxonomy

The subphylum Medusozoa includes all cnidarians with a medusa stage in their life cycle. The basic cycle is egg, planula larva, polyp, medusa, with the medusa being the sexual stage. The polyp stage is sometimes secondarily lost. The subphylum include the major taxa, Scyphozoa (large jellyfish), Cubozoa (box jellyfish) and Hydrozoa (small jellyfish), and excludes Anthozoa (corals and sea anemones).[22] This suggests that the medusa form evolved after the polyps.[23] Medusozoans have tetramerous symmetry, with parts in fours or multiples of four.[22]

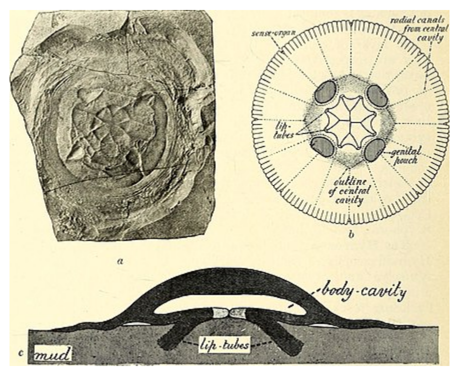
The four major classes of medusozoan Cnidaria are:

- Scyphozoa are sometimes called true jellyfish, though they are no more truly jellyfish than the others listed here. They have tetra-radial symmetry. Most have tentacles around the outer margin of the bowl-shaped bell, and long, oral arms around the mouth in the center of the subumbrella.[22]
- Cubozoa (box jellyfish) have a (rounded) box-shaped bell, and their velarium assists them to swim more quickly. Box jellyfish may be related more closely to scyphozoan jellyfish than either are to the Hydrozoa.[23]
- Hydrozoa medusae also have tetra-radial symmetry, nearly always have a velum (diaphragm used in swimming) attached just inside the bell margin, do not have oral arms, but a much smaller central stalk-like structure, the manubrium, with terminal mouth opening, and are distinguished by the absence of cells in the mesoglea. Hydrozoa show great diversity of lifestyle; some species maintain the polyp form for their entire life and do not form medusae at all (such as Hydra, which is hence not considered a jellyfish), and a few are entirely medusal and have no polyp form.[22]
- Staurozoa (stalked jellyfish) are characterized by a medusa form that is generally sessile, oriented upside down and with a stalk emerging from the apex of the "calyx" (bell), which attaches to the substrate. At least some Staurozoa also have a polyp form that alternates with the medusoid portion of the life cycle. Until recently, Staurozoa were classified within the Scyphozoa.[22]

There are over 200 species of Scyphozoa, about 50 species of Staurozoa, about 20 species of Cubozoa, and the Hydrozoa includes about 1000–1500 species that produce medusae, but many more species that do not.[24][25]

Fossil history

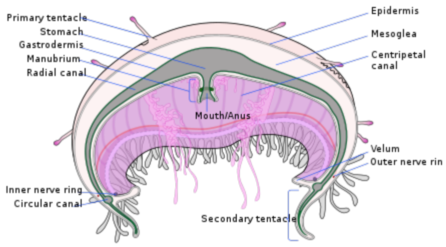
Since jellyfish have no hard parts, fossils are rare. The oldest conulariid scyphozoans appeared between 635 and 577 mya in the Neoproterozoic of the Lantian Formation in China; others are found in the youngest Ediacaran rocks of the Tamengo Formation of Brazil, c. 505 mya, through to the Triassic. Cubozoans and hydrozoans appeared in the Cambrian of the Marjum Formation in Utah, USA, c. 540 mya.[26]



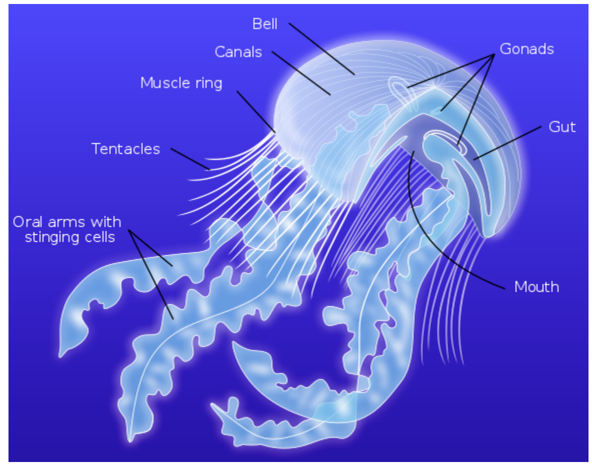
Fossil jellyfish, *Rhizostomites lithographicus*, one of the Scypho-medusae, from the Kimmeridgian (late Jurassic, 157 to 152 mya) of Solnhofen, Germany

Anatomy

The main feature of a true jellyfish is the umbrella-shaped bell. This is a hollow structure consisting of a mass of transparent jelly-like matter known as mesoglea, which forms the hydrostatic skeleton of the animal.[22] 95% or more of the mesogloea (the tissue that functions as a hydro-static skeleton) consists of water,[27] but it also contains collagen and other fibrous proteins, as well as wandering amoebocytes which can engulf debris and bacteria. The mesogloea is bordered by the epidermis on the outside and the gastrodermis on the inside. The edge of the bell is often divided into rounded lobes known as lappets, which allow the bell to flex. In the gaps or niches between the lappets are dangling rudimentary sense organs known as rhopalia, and the margin of the bell often bears tentacles.[22]

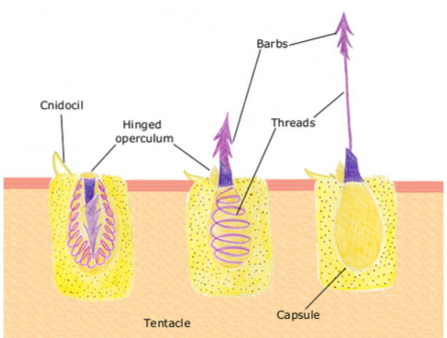


Labelled cross section of a jellyfish



Anatomy of a scyphozoan jellyfish

On the underside of the bell is the manubrium, a stalk-like structure hanging down from the centre, with the mouth, which also functions as the anus, at its tip. There are often four oral arms connected to the manubrium, streaming away into the water below.[28] The mouth opens into the gastrovascular cavity, where digestion takes place and nutrients are absorbed. This is subdivided by four thick septa into a central stomach and four gastric pockets. The four pairs of gonads are attached to the septa, and close to them four septal funnels open to the exterior, perhaps supplying good oxygenation to the gonads. Near the free edges of the septa, gastric filaments extend into the gastric cavity; these are armed with nematocysts and enzyme-producing cells and play a role in subduing and digesting the prey. In some scyphozoans, the gastric cavity is joined to radial canals which branch extensively and may join a marginal ring canal. Cilia in these canals circulate the fluid in a regular direction.[22]



Discharge mechanism of a nematocyst

The box jellyfish is largely similar in structure. It has a squarish, box-like bell. A short pedalium or stalk hangs from each of the four lower corners. One or more long, slender tentacles are attached to each pedalium.[29] The rim of the bell is folded inwards to form a shelf known as a velarium which restricts the bell's aperture and creates a powerful jet when the bell pulsates, allowing box jellyfish to swim faster than true jellyfish.[22] Hydrozoans are also similar, usually with just four tentacles at the edge of the bell, although many hydrozoans are colonial and may not have a free-living medusal stage. In some species, a non-detachable bud known as a gonophore is formed that contains a gonad but is missing many other medusal features such as tentacles and rhopalia.[22] Stalked jellyfish are attached to a solid surface by a basal disk, and resemble a polyp, the oral end of which has partially developed into a medusa with tentacle-bearing lobes and a central manubrium with four-sided mouth.[22]

Most jellyfish do not have specialized systems for osmoregulation, respiration and circulation, and do not have a central nervous system. Nematocysts, which deliver the sting, are located mostly on the tentacles; true jellyfish also have them around the mouth and stomach.[30] Jellyfish do not need a respiratory system because sufficient oxygen diffuses through the epidermis. They have limited control over their movement, but can navigate with the pulsations of the bell-like body; some species are active swimmers most of the time, while others largely drift.[31] The rhopalia contain rudimentary sense organs which are able to detect light, water-borne vibrations, odour and orientation.[22] A loose network of nerves called a "nerve net" is located in the epidermis.[32][33] Although traditionally thought not to have a central nervous system, nerve net concentration and ganglion-like structures could be considered to constitute one in most species.[34] A jellyfish detects stimuli, and transmits impulses both throughout the nerve net and around a circular nerve ring, to other nerve cells. The rhopalial ganglia contain pacemaker neurones which control swimming rate and direction.[22]

In many species of jellyfish, the rhopalia include ocelli, light-sensitive organs able to tell light from dark. These are generally pigment spot ocelli, which have some of their cells pigmented. The rhopalia are suspended on stalks with heavy crystals at one end, acting like gyroscopes to orient the eyes skyward. Certain jellyfish look upward at the mangrove canopy while making a daily migration from mangrove swamps into the open lagoon, where they feed, and back again.[2] Box jellyfish have more advanced vision than the other groups. Each individual has 24 eyes, two of which are capable of seeing colour, and four parallel information processing areas that act in competition,[35] supposedly making them one of the few kinds of animal to have a 360-degree view of its environment.[36]

Largest and smallest

Jellyfish range from about one millimeter in bell height and diameter,[37] to nearly 2 metres (6.6 ft) in bell height and diameter; the tentacles and mouth parts usually extend beyond this bell dimension.[22]

The smallest jellyfish are the peculiar creeping jellyfish in the genera *Staurocladia* and *Eleutheria*, which have bell disks from 0.5 millimetres (0.02 in) to a few millimeters in diameter, with short tentacles that extend out beyond this, which these jellyfish use to move across the surface of seaweed or the bottoms of rocky pools.[37] Many of these tiny creeping jellyfish cannot be seen in the field without a hand lens or microscope; they can reproduce asexually by fission (splitting in half). Other very small jellyfish, which have bells about one millimeter, are the hydromedusae of many species that have just been released from their parent polyps;[38] some of these live only a few minutes before shedding their gametes in the plankton and then dying, while others will grow in the plankton for weeks or months. The hydromedusae *Cladonema radiatum* and *Cladonema californicum* are also very small, living for months, yet never growing beyond a few mm in bell height and diameter.[39]

The lion's mane jellyfish, *Cyanea capillata*, was long-cited as the largest jellyfish, and arguably the longest animal in the world, with fine, thread-like tentacles that may extend up to 36.5 metres (120 ft) long (though most are nowhere near that large).[40][41] They have a moderately painful, but rarely fatal, sting.[42] The increasingly common giant Nomura's jellyfish, *Nemopilema nomurai*, found in some, but not all years in the waters of Japan, Korea and China in summer and autumn is another candidate for "largest jellyfish", in terms of diameter and weight, since the largest Nomura's jellyfish in late autumn can reach 2 metres (6 ft 7 in) in bell (body) diameter and about 200 kilograms (440 lb) in weight, with average specimens frequently reaching 0.9 metres (2 ft 11 in) in bell diameter and about 150 kilograms (330 lb) in weight.[43][44] The large bell mass of the giant Nomura's jellyfish[45] can dwarf a diver and is nearly always much greater than the Lion's Mane, whose bell diameter can reach 1 metre (3 ft 3 in).[46]

The rarely encountered deep-sea jellyfish *Stygiomedusa gigantea* is another candidate for "largest jellyfish", with its thick, massive bell up to 100 centimetres (39 in) wide, and four thick, "strap-like" oral arms extending up to 6 metres (20 ft) in length, very different from the typical fine, threadlike tentacles that rim the umbrella of more-typical-looking jellyfish, including the Lion's Mane.[47]

The lion's mane jellyfish (*Cyanea capillata*) is one of the largest species.

Life history and behavior

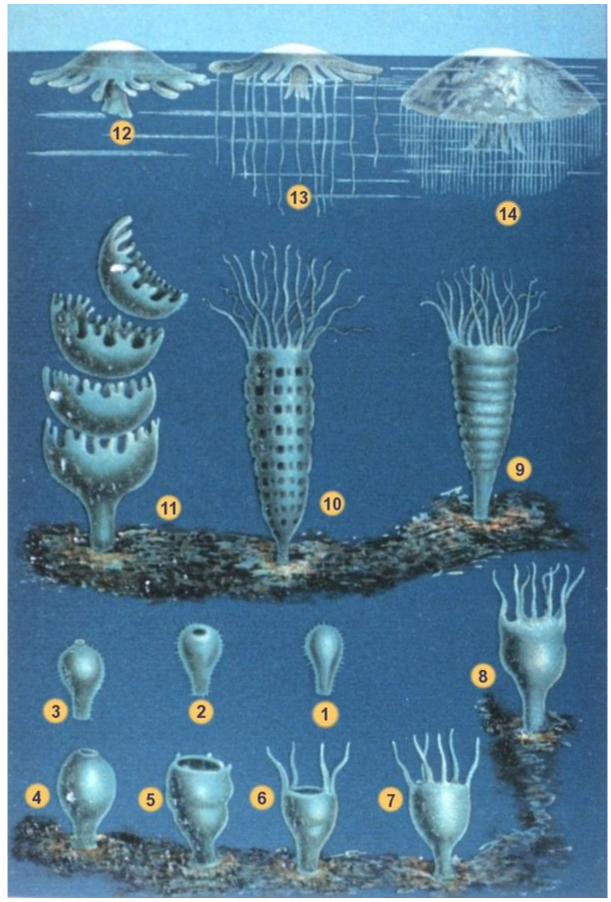
Life cycle

Jellyfish have a complex life cycle which includes both sexual and asexual phases, with the medusa being the sexual stage in most instances. Sperm fertilize eggs, which develop into larval planulae, become polyps, bud into ephyrae and then transform into adult medusae. In some species certain stages may be skipped.[48]

Upon reaching adult size, jellyfish spawn regularly if there is a sufficient supply of food. In most species, spawning is controlled by light, with all individuals spawning at about the same time of day, in many instances this is at dawn or dusk.[49] Jellyfish are usually either male or female (with occasional hermaphrodites). In most cases, adults release sperm and eggs into the surrounding water, where the unprotected eggs are fertilized and develop into larvae. In a few species, the sperm swim into the female's mouth, fertilizing the eggs within her body, where they remain during early development stages. In moon jellies, the eggs lodge in pits on the oral arms, which form a temporary brood chamber for the developing planula larvae.[50]

The planula is a small larva covered with cilia. When sufficiently developed, it settles onto a firm surface and develops into a polyp. The polyp generally consists of a small stalk topped by a mouth that is ringed by upward-facing tentacles. The polyps resemble those of closely related anthozoans, such as sea anemones and corals. The jellyfish polyp may be sessile, living on the bottom, boat hulls or other substrates, or it may be free-floating or attached to tiny bits of free-living plankton[51] or rarely, fish[52][53] or other invertebrates. Polyps may be solitary or colonial.[54] Most polyps are only millimetres in diameter and feed continuously. The polyp stage may last for years.[22]

After an interval and stimulated by seasonal or hormonal changes, the polyp may begin reproducing asexually by budding and, in the Scyphozoa, is called a segmenting polyp, or a scyphistoma. Budding produces more scyphistomae and also ephyrae.[22] Budding sites vary by species; from the tentacle bulbs, the manubrium (above the mouth), or the gonads of hydromedusae.[51] In a process known as strobilation, the polyp's tentacles are reabsorbed and the body starts to narrow, forming transverse constrictions, in several places near the upper extremity of the polyp. These deepen as the constriction sites migrate down the body, and separate segments known as ephyra detach. These are free-swimming precursors of the adult medusa stage, which is the life stage that is typically identified as a jellyfish.[22][55] The ephyrae, usually only a millimeter or two across initially, swim away from the polyp and grow. Limnomedusae polyps can asexually produce a creeping *frustule* larval form, which crawls away before developing into another polyp.[22] A few species can produce new medusae by budding directly from the medusan stage. Some hydromedusae reproduce by fission.[51]



The developmental stages of scyphozoan jellyfish's life cycle:
1–3 Larva searches for site
4–8 Polyp grows
9–11 Polyp strobilates
12–14 Medusa grows

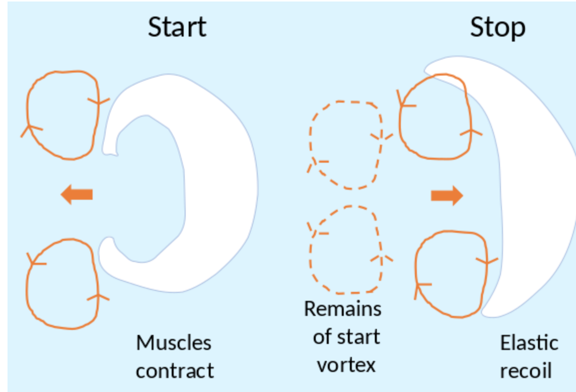
Lifespan

Little is known of the life histories of many jellyfish as the places on the seabed where the benthic forms of those species live have not been found. However, an asexually reproducing strobila form can sometimes live for several years, producing new medusae (ephyra larvae) each year.[56]

An unusual species, *Turritopsis dohrnii*, formerly classified as *Turritopsis nutricula*,[57] might be effectively immortal because of its ability under certain circumstances to transform from medusa back to the polyp stage, thereby escaping the death that typically awaits medusae post-reproduction if they have not otherwise been eaten by some other ocean organism. So far this reversal has been observed only in the laboratory.[58]

Locomotion

Using the moon jelly *Aurelia aurita* as an example, jellyfish have been shown to be the most energy efficient swimmers of all animals.[59] They move through the water by radially expanding and contracting their bell-shaped bodies to push water behind them. They pause between the contraction and expansion phases to create two vortex rings. Muscles are used for the contraction of the body, which creates the first vortex and pushes the animal forward, but the mesoglea is so elastic that the expansion is powered exclusively by relaxing the bell, which releases the energy stored from the contraction. Meanwhile, the second vortex ring starts to spin faster, sucking water into the bell and pushing against the centre of the body, giving a secondary and "free" boost forward. The mechanism, called passive energy recapture, only works in relatively small jellyfish moving at low speeds, allowing the animal to travel 30 percent farther on each swimming cycle. Jellyfish achieved a 48 percent lower cost of transport (the amount of food and oxygen consumed, versus energy spent in movement) than other animals in similar studies. One reason for this is that most of the gelatinous tissue of the bell is inactive, using no energy during swimming.[60][61][62]



Jellyfish locomotion is highly efficient. Muscles in the jellylike bell contract, setting up a start vortex and propelling the animal. When the contraction ends, the bell recoils elastically, creating a stop vortex with no extra energy input.

Ecology

Diet

Jellyfish are like other cnidarians generally carnivorous (or parasitic),[63] feeding on planktonic organisms, crustaceans, small fish, fish eggs and larvae, and other jellyfish, ingesting food and voiding undigested waste through the mouth. They hunt passively using their tentacles as drift lines, or sink through the water with their tentacles spread widely; the tentacles, which contain nematocysts to stun or kill the prey, may then flex to help bring it to the mouth.[22] Their swimming technique also helps them to capture prey; when their bell expands it sucks in water which brings more potential prey within reach of the tentacles.[64]

A few species such as *Aglaura hemistoma* are omnivorous, feeding on microplankton which is a mixture of zooplankton and phytoplankton (microscopic plants) such as dinoflagellates.[65] Others harbour mutualistic algae (Zooxanthellae) in their tissues;[22] the spotted jellyfish (*Mastigias papua*) is typical of these, deriving part of its nutrition from the products of photosynthesis, and part from captured zooplankton.[66][67]

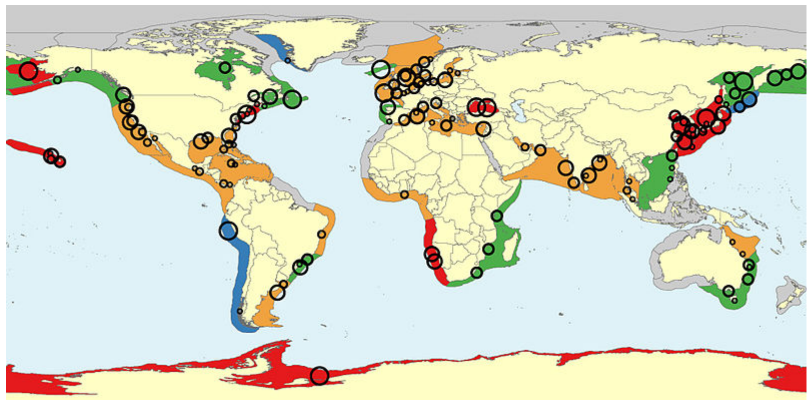
Predation

Other species of jellyfish are among the most common and important jellyfish predators. Sea anemones may eat jellyfish that drift into their range. Other predators include tunas, sharks, swordfish, sea turtles and penguins.[68][69] Jellyfish washed up on the beach are consumed by foxes, other terrestrial mammals and birds.[70] In general however, there are few animals preying on jellyfish. Jellyfish can broadly be considered to be top predators in the food chain. Once jellyfish have become dominant in an ecosystem, for example through overfishing which removes predators of jellyfish larvae, there may be no obvious way for the previous balance to be restored: they eat fish eggs and juvenile fish, and compete with fish for food, preventing fish stocks from recovering.[71]

Symbiosis

Some small fish are immune to the stings of the jellyfish and live among the tentacles, serving as bait in a fish trap; they are safe from potential predators and are able to share in the fish caught by the jellyfish.[72] The cannonball jellyfish has a symbiotic relationship with ten different species of fish, and with the longnose spider crab, which lives inside the bell, sharing the jellyfish's food and nibbling its tissues.[73]

Blooms



Map of population trends of native and invasive jellyfish.[74] Circles represent data records; larger circles denote higher certainty of findings.

- Increase (high certainty)
- Increase (low certainty)
- Stable/variable
- Decrease
- No data

Jellyfish form large masses or blooms in certain environmental conditions of ocean currents, nutrients, sunshine, temperature, season, prey availability, reduced predation and oxygen concentration. Currents collect jellyfish together, especially in years with unusually high populations. Jellyfish can detect marine currents and swim against the current to congregate in blooms.[75][76] Jellyfish are better able to survive in nutrient-rich, oxygen-poor water than competitors, and thus can feast on plankton without competition. Jellyfish may also benefit from saltier waters, as saltier waters contain more iodine, which is necessary for polyps to turn into jellyfish. Rising sea temperatures caused by climate change may also contribute to jellyfish blooms, because many species of jellyfish are able to survive in warmer waters.[77] Increased nutrients from agricultural or urban runoff with nutrients including nitrogen and phosphorus compounds increase the growth of phytoplankton, causing eutrophication and algal blooms. When the phytoplankton die, they may create dead zones, so called because they are ahypoxic (low in oxygen). This in turn kills fish and other animals, but not jellyfish,[78] allowing them to bloom.[79][80] Jellyfish populations may be expanding globally as a result of land runoff and overfishing of their natural predators.[81][82] Jellyfish are well placed to benefit from disturbance of marine ecosystems. They reproduce rapidly; they prey upon many species, while few species prey on them; and they feed via touch rather than visually, so they can feed effectively at night and in turbid waters.[83][84] It may be difficult for fish stocks to reestablish themselves in marine ecosystems once they have become dominated by jellyfish, because jellyfish feed on plankton, which includes fish eggs and larvae.[85][86][87][80]

Some jellyfish populations that have shown clear increases in the past few decades are invasive species, newly arrived from other habitats: examples include the Black Sea, Caspian Sea, Baltic Sea, central and eastern Mediterranean, Hawaii, and tropical and subtropical parts of the West Atlantic (including the Caribbean, Gulf of Mexico and Brazil).[88][89]

Jellyfish blooms can have significant impact on community structure. Some carnivorous jellyfish species prey on zooplankton while others graze on primary producers.[90] Reductions in zooplankton and icthyplankton due to a jellyfish bloom can ripple through the trophic levels. High density jellyfish populations can out compete other predators and reduce fish recruitment.[91] Increased grazing on primary producers by jellyfish can also interrupt energy transfer to higher trophic levels.[92]

During blooms, jellyfish significantly alter the nutrient availability in their environment. Blooms require large amounts of available organic nutrients in the water column to grow, limiting availability for other organisms.[93] Some jellyfish have a symbiotic relationship with single-celled dinoflagellates, allowing them to assimilate inorganic carbon, phosphorus, and nitrogen creating competition for phytoplankton.[93] Their large biomass makes them an important source of dissolved and particulate organic matter for microbial communities through excretion, mucus production, and decomposition.[94][95] The microbes break down the organic matter into inorganic ammonium and phosphate. However, the low carbon availability shifts the process from production to respiration creating low oxygen areas making the dissolved inorganic nitrogen and phosphorus largely unavailable for primary production.

These blooms have very real impacts on industries. Jellyfish can out compete fish by utilizing open niches in over-fished fisheries.[96] Catch of jellyfish can strain fishing gear and lead to expenses relating to damaged gear. Power plants have been shut down due to jellyfish blocking the flow of cooling water.[97] Blooms have also been harmful for tourism, causing a rise in stings and sometimes the closure of beaches.[98]

Jellyfish form a component of jelly-falls, events where gelatinous zooplankton fall to the seafloor, providing food for the benthic organisms there.[99] In temperate and subpolar regions, jelly-falls usually follow immediately after a bloom.[100]

Habitats

A common Scyphozoan jellyfish seen near beaches in the Florida Panhandle

Most jellyfish are marine animals, although a few hydromedusae inhabit freshwater. The best known freshwater example is the cosmopolitan hydrozoan jellyfish, *Craspedacusta sowerbii*. It is less than an inch (2.5 cm) in diameter, colorless and does not sting.[101] Some jellyfish populations have become restricted to coastal saltwater lakes, such as Jellyfish Lake in Palau.[102] Jellyfish Lake is a marine lake where millions of golden jellyfish (*Mastigias* spp.) migrate horizontally across the lake daily.[67]

Although most jellyfish live well off the ocean floor and form part of the plankton, a few species are closely associated with the bottom for much of their lives and can be considered benthic. The upside-down jellyfish in the genus *Cassiopea* typically lie on the bottom of shallow lagoons where they sometimes pulsate gently with their umbrella top facing down. Even some deep-sea species of hydromedusae and scyphomedusae are usually collected on or near the bottom. All of the stauromedusae are found attached to either seaweed or rocky or other firm material on the bottom.[103]

Some species explicitly adapt to tidal flux. In Roscoe Bay, jellyfish ride the current at ebb tide until they hit a gravel bar, and then descend below the current. They remain in still waters until the tide rises, ascending and allowing it to sweep them back into the bay. They also actively avoid fresh water from mountain snowmelt, diving until they find enough salt.[2]

Parasites

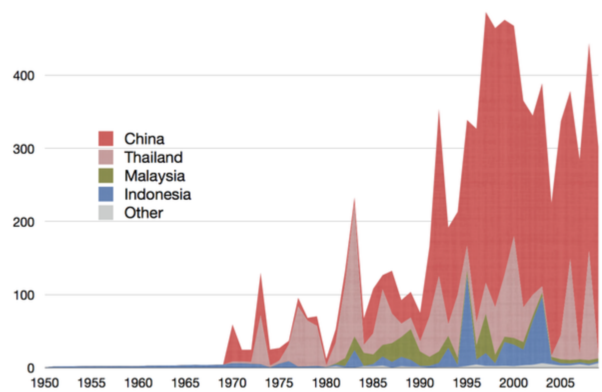
Jellyfish are hosts to a wide variety of parasitic organisms. They act as intermediate hosts of endoparasitic helminths, with the infection being transferred to the definitive host fish after predation. Some digenean trematodes, especially species in the family Lepocreadiidae, use jellyfish as their second intermediate hosts. Fish become infected by the trematodes when they feed on infected jellyfish.[104][105]

Relation to humans

Fisheries

Fisheries have begun harvesting the American cannonball jellyfish, *Stomolophus meleagris*, along the southern Atlantic coast of the United States and in the Gulf of Mexico for export to Asia.[107]

Jellyfish are also harvested for their collagen, which is being investigated for use in a variety of applications including the treatment of rheumatoid arthritis.[108]



Global harvest of jellyfish in thousands of tonnes as reported by the FAO[106]

Products


Rehydrated jellyfish strips with soy sauce and sesame oil

Aristotle stated in the *Parts of Animals* IV, 6 that jellyfish (sea-nettles) were eaten in winter time in a fish stew.[109]

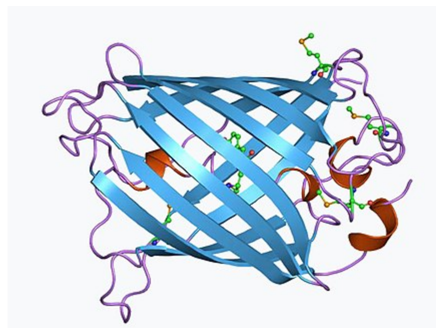
In some countries, such as China, Japan, and Korea, jellyfish are a delicacy. The jellyfish is dried to prevent spoiling. Only some 12 species of scyphozoan jellyfish belonging to the order Rhizostomeae are harvested for food, mostly in southeast Asia.[110] Rhizostomes, especially *Rhopilema esculentum* in China (海蜇 *hǎizhé*, "sea stingers") and *Stomolophus meleagris* (cannonball jellyfish) in the United States, are favored because of their larger and more rigid bodies and because their toxins are harmless to humans.[107]

Traditional processing methods, carried out by a jellyfish master, involve a 20- to 40-day multi-phase procedure in which, after removing the gonads and mucous membranes, the umbrella and oral arms are treated with a mixture of table salt and alum, and compressed. Processing makes the jellyfish drier and more acidic, producing a crispy texture. Jellyfish prepared this way retain 7–10% of their original weight, and the processed product consists of approximately 94% water and 6% protein. Freshly processed jellyfish has a white, creamy color and turns yellow or brown during prolonged storage.[107]

In China, processed jellyfish are desalted by soaking in water overnight and eaten cooked or raw. The dish is often served shredded with a dressing of oil, soy sauce, vinegar and sugar, or as a salad with vegetables. In Japan, cured jellyfish are rinsed, cut into strips and served with vinegar as an appetizer.[107][111] Desalted, ready-to-eat products are also available.[107]

Biotechnology

Pliny the Elder reported in his *Natural History* that the slime of the jellyfish "Pulmo marinus" produced light when rubbed on a walking stick.[112]



The hydromedusa *Aequorea victoria* was the source of green fluorescent protein, studied for its role in bioluminescence and later for use as a marker in genetic engineering.

In 1961, Osamu Shimomura extracted green fluorescent protein (GFP) and another bioluminescent protein, called aequorin, from the large and abundant hydromedusa *Aequorea victoria*, while studying photoproteins that cause bioluminescence in this species.[113] Three decades later, Douglas Prasher sequenced and cloned the gene for GFP.[114] Martin Chalfie figured out how to use GFP as a fluorescent marker of genes inserted into other cells or organisms.[115] Roger Tsien later chemically manipulated GFP to produce other fluorescent colors to use as markers. In 2008, Shimomura, Chalfie and Tsien won the Nobel Prize in Chemistry for their work with GFP.[113] Man-made GFP became widely used as a fluorescent tag to show which cells or tissues express specific genes. The genetic engineering technique fuses the gene of interest to the GFP gene. The fused DNA is then put into a cell, to generate either a cell line or (via IVF techniques) an entire animal bearing the gene. In the cell or animal, the artificial gene turns on in the same tissues and the same time as the normal gene, making GFP instead of the normal protein. Illuminating the animal or cell reveals what tissues express that protein—or at what stage of development. The fluorescence shows where the gene is expressed.[116]

Aquarium display

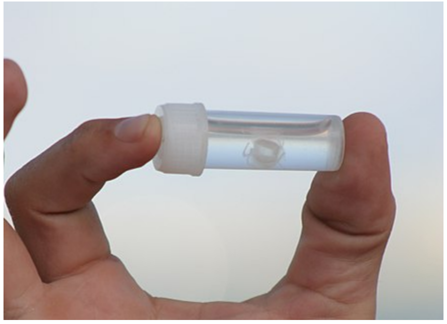
Jellyfish are displayed in many public aquariums. Often the tank's background is blue and the animals are illuminated by side light, increasing the contrast between the animal and the background. In natural conditions, many jellies are so transparent that they are nearly invisible.[117] Jellyfish are not adapted to closed spaces. They depend on currents to transport them from place to place. Professional exhibits as in the

Monterey Bay Aquarium feature precise water flows, typically in circular tanks to avoid trapping specimens in corners. They have a live "Jelly Cam".[118] The outflow is spread out over a large surface area and the inflow enters as a sheet of water in front of the outflow, so the jellyfish do not get sucked into it.[119] As of 2009, jellyfish were becoming popular in home aquariums, where they require similar equipment.[120]

Pacific sea nettles (*Chrysaora fuscescens*) in an aquarium exhibit

Stings

Jellyfish are armed with nematocysts. Contact with a jellyfish tentacle can trigger millions of nematocysts to pierce the skin and inject venom,[121] but only some species' venom causes an adverse reaction in humans.[122] The effects of stings range from mild discomfort to extreme pain and death.[123] Most jellyfish stings are not deadly, but stings of some box jellyfish (Irukandji jellyfish), such as the sea wasp, can be deadly. Stings may cause anaphylaxis (a form of shock), which can be fatal. Jellyfish kill 20 to 40 people a year in the Philippines alone. In 2006 the Spanish Red Cross treated 19,000 stung swimmers along the Costa Brava.[123][124]



Box jellyfish are small and venomous.

Vinegar (3–10% aqueous acetic acid) may help with box jellyfish stings,[125][126] but not the stings of the Portuguese man o' war.[125] Salt water may help if vinegar is unavailable.[125][127] Rubbing wounds, or using alcohol, ammonia, fresh water, or urine is not advised as they can encourage the release of more venom.[128] Clearing the area of jelly and tentacles reduces nematocyst firing.[128] Scraping the affected skin, such as with the edge of a credit card, may remove remaining nematocysts.[129] Once the skin has been cleaned of nematocysts, hydrocortisone cream applied locally reduces pain and inflammation.[130] Antihistamines may help to control itching.[129] Immunobased antivenins are used for serious box jellyfish stings.[131][132]

Mechanical issues

Jellyfish in large quantities can fill and split fishing nets and crush captured fish.[133] They can clog cooling equipment, disabling power stations in several countries; jellyfish caused a cascading blackout in the Philippines in 1999,[123] as well as damaging the Diablo Canyon Power Plant in California in 2008.[134] They can stop desalination plants and ships' engines.[133][135]

See also

- Jellyfish dermatitis
- List of prehistoric medusozoans
- Ocean sunfish, a significant jellyfish predator

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Further reading

- Juli Berwald (2017). *Spineless: The Science of Jellyfish and the Art of Growing a Backbone*. Riverhead Books. ISBN 978-0735211261.

External links

Jellyfish travel guide from Wikivoyage

- Jellyfish and Comb Jellies – Smithsonian Ocean Portal (http://ocean.si.edu/jellyfish-and-comb-jellies)
- Jellyfish Facts – Information on Jellyfish and Jellyfish Safety (http://www.jellyfishfacts.net/)
- "There's no such thing as a jellyfish (https://www.youtube.com/watch?v=3HzFiQFFQYw)" from The MBARI YouTube channel
- "Vicious beauties – Jellyfish" (https://www.youtube.com/watch?v=AT4RAb2zrOk) – a documentary about jellyfish
- They're Taking Over! (http://www.nybooks.com/articles/archives/2013/sep/26/jellyfish-theyre-taking-over/) nybooks.com September 26, 2013. Tim Flannery

Photos

- Media related to Cnidaria at Wikimedia Commons
- Media related to Jellyfish at Wikimedia Commons
- Jellyfish Exhibition At National Aquarium, Baltimore, Maryland (USA) – Photo Gallery (https://archive.is/20130102224831/http://picasaweb.google.com/sridhar.saraf.pictures/JellyfishExhibitionAtNationalAquariumBaltimoreMarylandUSA/)