JELLYFISH

A NATURAL HISTORY

LISA-ANN GERSHWIN

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THE UNIVERSITY OF CHICAGO PRESS
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INTRODUCING THE JELLYFISH

Jiggly, flowing, mesmerizing, alien, delicious, stingy, lethal—jellyfish are many things to many people. To the fisherman, they may be a nuisance, sometimes a costly one. To the swimmer, they mean painful and even dangerous stings. To the artist, they may stimulate and inspire. To certain entrepreneurs, they are promising sources of innovation and profit. To the curious, they are endlessly weird and fascinating.

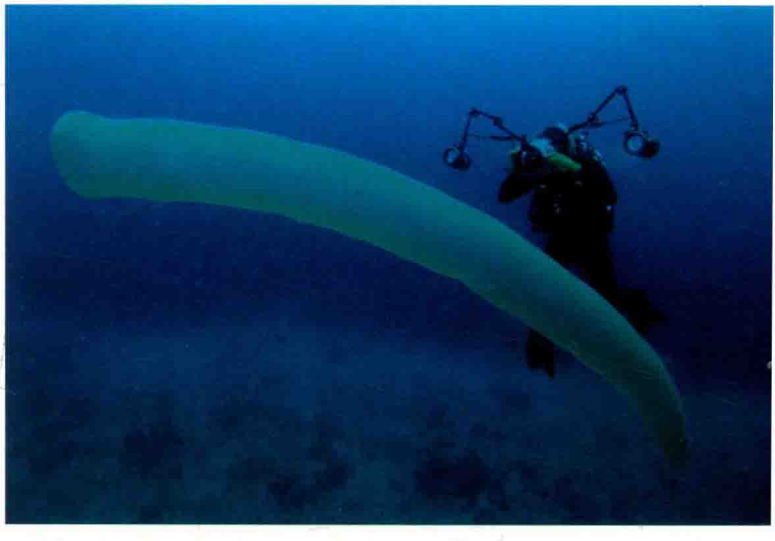
JELLYFISH AS A GROUP hold some astonishing records. The world's most venomous animal is a jellyfish, the Australian Deadly Box Jellyfish (*Chironex fleckeri*, page 50). The largest invertebrate discovered in the twentieth century is a jellyfish, the so-called Black Sea Nettle (*Chrysaora achlyos*, page 114)—though it is practically a toy compared to the lion's mane jellies of the North Atlantic (*Cyanea* spp., page 52), which can reach three meters (ten feet) across the body and drag tentacles nearly 30 meters (100 feet) long. One jellyfish helped scientists win the Nobel Prize (page 198). Another grows ten percent of its body length *per hour* (page 208). And the world's first known case of true biological immortality was discovered in the diminutive and aptly named Immortal Jellyfish (*Turritopsis dohrnii*, page 74).

The Problem with Jellyfish

We have always been put off jellyfish by their stings, and these creatures have long drifted under the radar scientifically and industrially. But a couple of decades ago, jellyfish started becoming harder to ignore. People began reporting problems, which often interfered with human enterprise, and as the frequency of these reports increased it led to further attention and thus even more reports.

Most of the problems involve jellyfish blooms, or large, concentrated swarms. Jellyfish bloom as a natural part of their life cycle. But increasingly, it appears, some blooms are lasting far longer than normal, or are covering vastly larger areas, or are considerably denser than usual. It can be challenging to tease apart what is happening in these cases. Are the jellyfish simply misbehaving, or is human activity impinging on their turf and stimulating rambunctious reactions? Regardless, jellyfish are a problem when they threaten lives or livelihoods.

Below Jellyfish run the full gamut from beauty to beast, from lovely to lethal. They are united by their gelatinous bodies, drifting lifestyle, simple organ systems, and ability to bloom prolifically. Jellyfish come in an array of shapes and sizes, from those barely larger than a grain of sand to others longer than a blue whale. Some, like *Pyrosoma* (left), are herbivores, eating phytoplankton. Others, like the Flower Hat Jelly *Olindias* (center), are carnivores, eating zooplankton. And some, like the blubbers (right), are both.



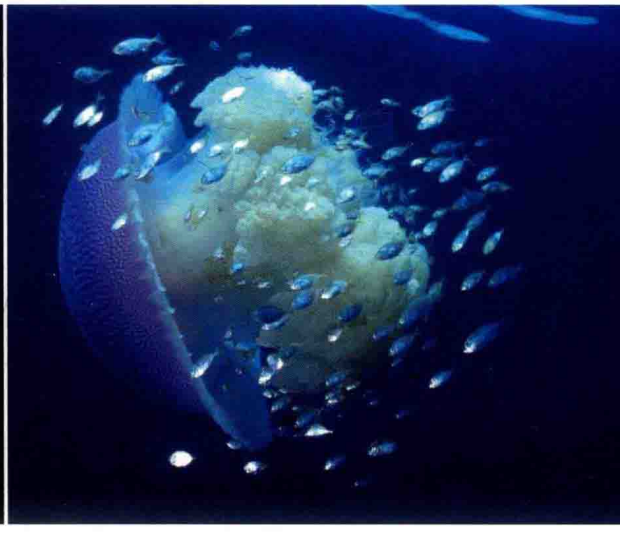
What Is a Jellyfish?

Despite the sensational attention given to jellies in the media, many people are still not sure what, exactly, jellyfish are. They are animals, though they lack recognizable body parts like faces and bones and, in most, a brain and a heart. They are invertebrates, which means they have no vertebral column, or spine, but they belong to different invertebrate groups. Some are in the same category as the corals, sea anemones, and sea fronds; others belong to the lineage that eventually gave rise to humans, and even possess a rudimentary heart and brain but are so primitive evolutionarily that we bear few features in common.

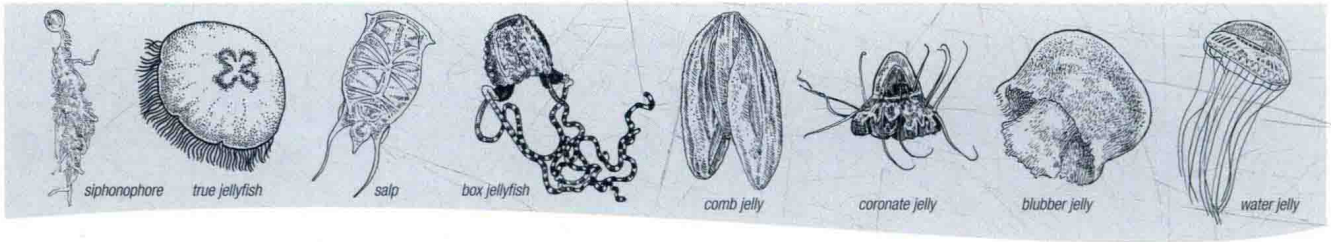
It is also important to keep in mind that not all squishy, drifting, transparent aquatic creatures are jellyfish. Many species of squid and even a few octopus species, for example, are transparent and squishy, and some even drift on the currents. Some fish, particularly the larvae of eels, are transparent and gelatinous (jelly-like). Certain drifting, gelatinous sea cucumbers look more like jellyfish than many jellyfish do. Even the minuscule, spherical Sea Sparkle (*Noctiluca scintillans*), an algae-like organism, could be mistaken for a jellyfish. But none of these creatures are jellyfish. This means the answer to the question "what is a jellyfish?" is as slippery as jellies themselves: Jellyfish are squishy aquatic creatures, some drifting and some transparent, that span different animal groups. But even the experts cannot agree on the group as a whole: some exclude pelagic tunicates (salps and their kin), while others include them, as we do in this book (pages 70–71).

Despite their strangeness, jellyfish, like all animals, must catch food, reproduce, move around, and protect themselves—and they do so without brains, bones, or blood. Jellyfish have been making do for hundreds of millions of years, since before brains, bones, and blood evolved, and their simplicity works for them. They can subsist on a broad variety of food—or even no food at all—and they can reproduce in an exciting variety of ways, with or without a mate. And in their different life stages, they can move or not move, and they get along just fine. It is no wonder they have persisted for so long. They have mastered the art of survival.

The weird and wonderful world of the jellyfish contains many splendid surprises, from their remarkable ability to clone replicates of themselves that are so unlike one another that they have been classified as different creatures, to their tenacious persistence in conditions that most other animals find utterly unlivable, to their delightful shapes and color patterns and mesmerizing movements. The strange otherworldliness of jellyfish makes them simply fascinating.



Group	Examples	Main impacts
True Jellyfish Cnidaria: Scyphozoa: Semaeostomeae	Sea nettles, moon jellies, Purple People Eater	Clogging intake pipes of power plants and ships; stinging
Blubber Jellies Cnidaria: Scyphozoa: Rhizostomeae	Bazinga, barrel jellies, sea blubbers, cabbage jellies, Sea Tomato	Clogging fishing nets and intake pipes of power plants and ships
Coronate Jellies Cnidaria: Scyphozoa: Coronatae	Santa's Hat Jelly, Flying Saucer Jellyfish, thimble jellies	Shifting ecology of Norwegian fjords; consume larvae and plankton
Box Jellyfish Cnidaria: Cubozoa	Box jellies, Irukandjis	Stings very painful and may be lethal or cause severe illness
Water Jellies Cnidaria: Hydrozoa: Hydroidomedusae	Bell jellies, Nobel Jelly	Predation on and competition with fish eggs, larvae, and plankton
Siphonophores Cnidaria: Hydrozoa: Siphonophora	Long stingy stringy thingies, Portuguese Man-of-war	Stinging; strong predation on and competition with other species
Comb Jellies Ctenophora	Sea walnuts, sea gooseberries	Predation on and competition with fish eggs, larvae, and plankton
Salps and Their Kin Chordata: Tunicata	Salps, pyrosomes, doliolids	Grazing on phytoplankton; compete with other species



INTRODUCING THE OCEAN

It has been said that our planet should actually be called Ocean rather than Earth, because nearly three-quarters of it is covered in water. This aquatic portion (72 percent of the planet's surface) is the domain of the jellyfish, which are found from pole to pole, from the surface to the depths. Scientists have developed terminology to describe the multitude of different oceanic zones that exist. Some of these terms are used throughout the book, including in the fact panel that accompanies each species account.

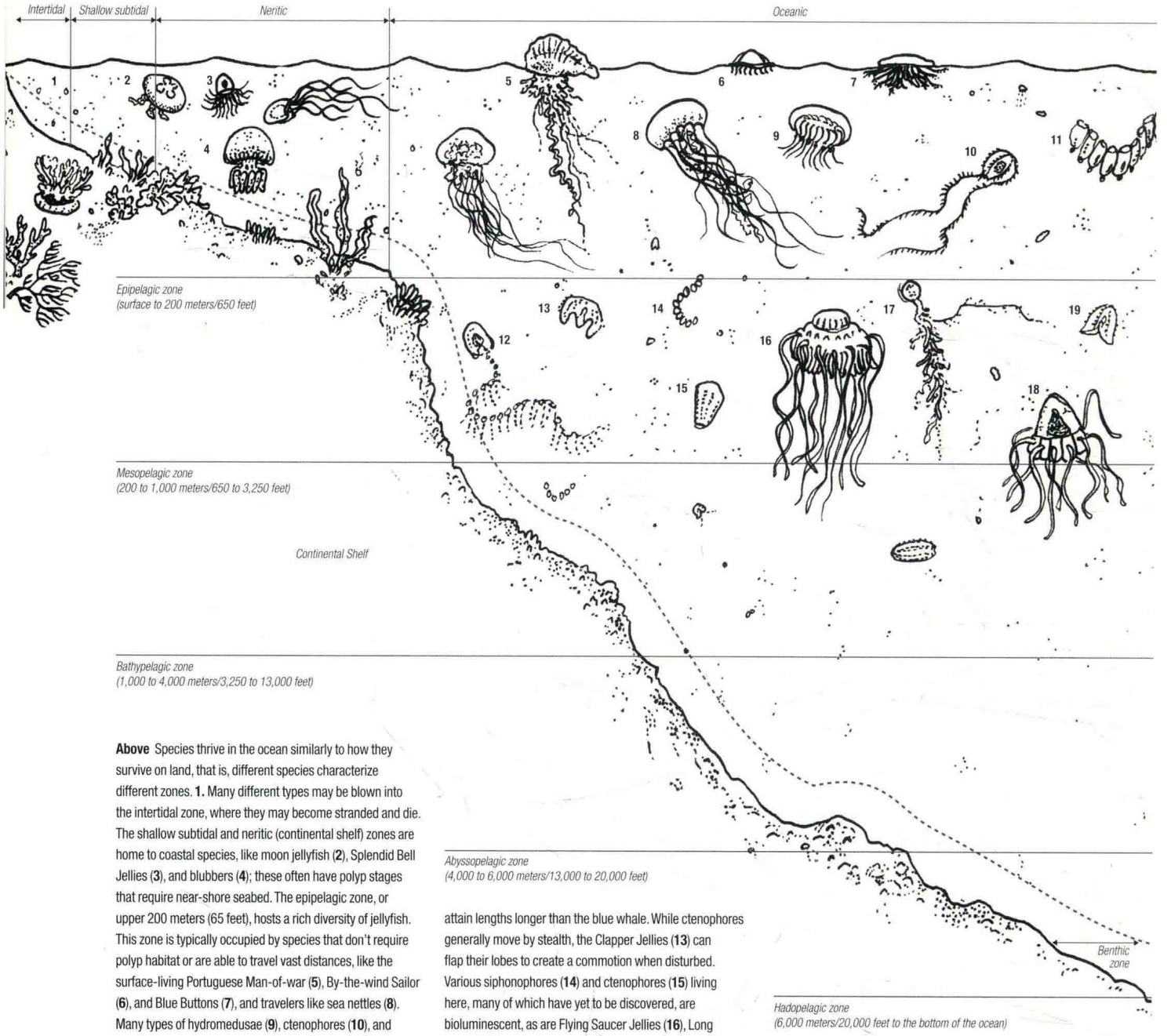
In general, we divide the ocean into zones guided by either vertical position in the water column or horizontal coverage based on relationship to landforms. Within these zones, numerous habitats characterize different ecosystems and define the flora and fauna that live there. These zones are similar in function to the mountains, deserts, rivers, and lakes that divide up the three-dimensional habitats on land and define the ecospace in which certain organisms can thrive.

Horizontal Ocean Zones

The "horizontal" ocean zones begin at the coast, where land and water meet. The area of the shoreline that is traversed by the tide each day is called the intertidal zone; only the hardiest organisms generally survive here, due to the extreme temperature, salinity, and wet/dry and motion pressures associated with the incoming and outgoing tide. Jellyfish sometimes become stranded in the intertidal zone

Right The Great Barrier Reef in Australia is famous for its corals. The mesmerizingly clear blue water that entices us so, is generally low in nutrients. This type of ecosystem is one of the types of habitat where jellyfish flourish.

OCEANIC ZONES



Above Species thrive in the ocean similarly to how they survive on land, that is, different species characterize different zones. **1.** Many different types may be blown into the intertidal zone, where they may become stranded and die. The shallow subtidal and neritic (continental shelf) zones are home to coastal species, like moon jellyfish (**2**), Splendid Bell Jellies (**3**), and blubbers (**4**); these often have polyp stages that require near-shore seabed. The epipelagic zone, or upper 200 meters (65 feet), hosts a rich diversity of jellyfish. This zone is typically occupied by species that don't require polyp habitat or are able to travel vast distances, like the surface-living Portuguese Man-of-war (**5**), By-the-wind Sailor (**6**), and Blue Buttons (**7**), and travelers like sea nettles (**8**). Many types of hydromedusae (**9**), ctenophores (**10**), and salps (**11**) are also found in epipelagic waters. The deeper mesopelagic zone (200 to 1,000 meters/650 to 3,250 feet) requires special adaptations for survival; fewer species live here but they tend to have fascinating aspects to their biology or ecology. Siphonophores like the Giant Heart Jellies (**12**) can attain lengths longer than the blue whale. While ctenophores generally move by stealth, the Clapper Jellies (**13**) can flap their lobes to create a commotion when disturbed. Various siphonophores (**14**) and ctenophores (**15**) living here, many of which have yet to be discovered, are bioluminescent, as are Flying Saucer Jellies (**16**), Long Stingy Stringy Thingies (**17**), Santa's Hat Jellies (**18**), and Sea Walnuts (**19**). The bathypelagic zone is even deeper (1,000 to 4,000 meters/3,250 to 13,000 feet), with much fewer species still, which are often smaller. Jellyfish do inhabit the deepest oceans but are generally poorly known.

when the tide goes out; more often than not, this is lethal to them. By the time the beach floods again with the incoming tide, they are already too overheated and dehydrated to survive.

Offshore of the intertidal zone is the subtidal zone, which begins at the point along the shoreline that is always underwater, regardless of high or low tide. The subtidal is loosely divided into shallow subtidal, which is within diving depths; neritic, which is the water that lies over continental shelves; and oceanic, or open ocean, which is off the shelf. Jellyfish occupy all these biomes, but different species characteristically occupy different zones.

Vertical Ocean Zones

The water column—which extends vertically from the surface to the bottom—is called the pelagic realm. The creatures that live here, including many jellyfish, are said to have a pelagic lifestyle. The bottom, or seabed, is the benthic zone. Starfish, clams, and burrowing worms are examples of benthic species. Many benthic species have pelagic larvae, and some pelagic creatures, including many jellyfish, have benthic stages. There are even jellyfish, such as stauromedusae and platyctene ctenophores (page 18), that are primarily benthic rather than pelagic.

Within the pelagic realms, creatures may specialize in a particular lifestyle. Those that drift on the currents are referred to as planktonic (from *planctos*, Greek for "drifter"), whereas those that swim strongly enough to fight a current are called nektonic. Tuna and swordfish are good examples of nekton, whereas most jellyfish are plankton. The term plankton is a catchall grouping for adult and larval organisms at the mercy of the currents.

The pelagic realm is not uniform, and the creatures that live within it vary as well. Working downward from the ocean surface, the epipelagic zone occupies the top layer of water to the depth to which light penetrates sufficiently to allow photosynthesis, about 200 meters (650 feet) down. From there to about 1,000 meters (3,280 feet) deep is the mesopelagic zone—also called the twilight zone—where light reaches only faintly. Mesopelagic organisms often have peculiar adaptations for coping with small amounts of light, such as bioluminescence, large eyes, or vertical migration behavior.

From 1,000 meters to 4,000 meters (13,000 feet) is the bathypelagic zone; from 4,000 to 6,000 meters (13,000 to 20,000 feet) lies the abyssopelagic zone; and below that the hadopelagic zone drops to the greatest depths. These deeper zones are in permanent darkness, and the organisms that live in them are often blind. Fewer jellies live in these zones than the ones above.

Habitats

Within the ocean's horizontal and vertical zones are numerous habitats, some of which are commonly inhabited by jellyfish. The dangerous box jellies and Irukandjis (pages 50 and 154), for example, are often encountered along sandy beaches, where they hunt for food. The upside-down jellyfish (*Cassiopea*, page 48) is often found in shallow subtidal lagoons between coral reefs; reefs can also help form eddies in which jellies become entrained. Estuaries—areas where rivers and creeks flow into the ocean—often host vast blooms of jellies. Water flows more slowly in estuaries than it does along open coastlines, and this slower turnover time helps jellies stay inside their boundaries. Industries, ports, and urban areas are often clustered at estuaries, and they may contribute to these blooms and suffer their effects.

Perhaps the strangest habitats of all are at the surface of the water: The neuston zone is the top few inches of the water column, where the surface acts as an uncrossable barrier, concentrating planktonic organisms just below it. The pleuston zone is right at the air-water interface (pages 148–49). Here some organisms live on top of the water, others live by clinging to the underside of the air, and the majority have body parts in both realms. The Portuguese Man-of-war (page 34), with its float in the air and its tentacles in the water, is a familiar example of a pleustonic organism.

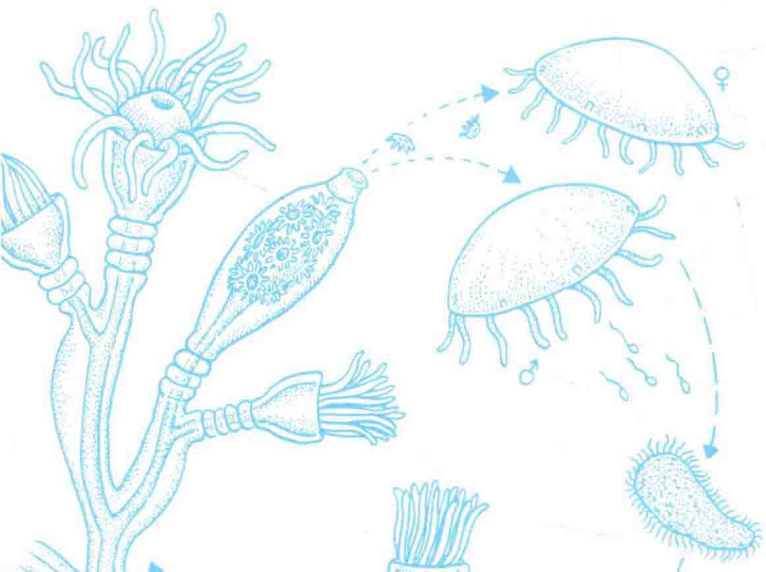
Finally, not all jellyfish are found in marine environments. Some species live exclusively in freshwater habitats such as lakes and reservoirs, which lack tides and are generally too shallow to have complex horizontal and vertical zones.

ABOUT THIS BOOK

This book is divided into five chapters, which cover the primary themes of jellyfish biology and ecology. Organizing the material this way invites us to understand these splendid creatures through features that unite them as well as those that divide. Each chapter examines nine concepts that illustrate each theme and profiles 10 jellyfish species that help bring to life these features.

Chapter One

In the first chapter, "Jellyfish Anatomy," the emphasis is on the functional morphology or functional structure of each body part. As we explore the variety of structures used for defense, locomotion, food capture, and so on, we learn how jellies accomplish the basic tasks of eating, moving, and reproducing. We get to know food-capturing structures that range from tentacles bearing piercing, venomous harpoons, to curtains of entangling, sticky threads, to highly modified lures that mimic other creatures. We also look at the different parts of the jellyfish. For example, we look into their eyes, which run the gamut from completely absent, to light-sensing organs that see only brightness and darkness, to complex visual structures with lenses, retinas, and corneas—similar to our own human eyes—that may discern shapes and colors.

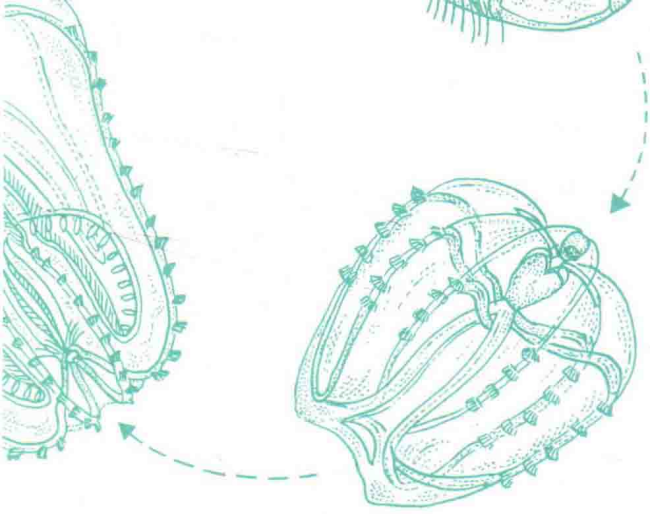


Chapter Two

"Jellyfish Life History" compares and contrasts the developmental aspects of the different types of jellies, which typically share within their group similar developmental pathways. For example, jellies of one major grouping (the phylum Cnidaria) typically have a complex life cycle with two major stages, polyp (a budlike form) and medusa (the familiar floating bell or umbrella shape). They are literally shape-shifters, assuming different forms at different times of their lives that do not look remotely alike. We also look at some of the ways jellyfish produce medusae: some involve a highly complex segmenting process called strobilation, while others simply bud new medusae, and still others undergo total metamorphosis. In this chapter we also examine such curious transformations as cloning and immortality.

Chapter Three

Moving on to "Jellyfish Taxonomy and Evolution," we delve into the extraordinary world of jellies throughout time. We typically view jellies as so completely foreign that we may even wonder whether they are indeed animals or how they came to be so strange. In this chapter we explore how scientists have come to understand jellies' evolutionary history through fossils left behind in ages past and through the relationships revealed by their unusual genetics. We also compare the different species concepts—changes in the ways scientists have considered what a "species" is and how it should be studied—that underlie how we have viewed jellyfish over time.

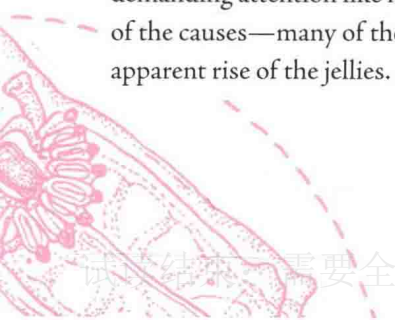


Chapter Four

In "Jellyfish Ecology," we explore how jellies interact with neighboring species and with the physical features of their environment. The name of the game in the ocean is "eat or be eaten"—and live long enough to reproduce. Over millions of generations jellies have mastered the art of survival, persisting long after most other species have come and gone. Through studying their ecology, we can learn how their relationships with the physical and biological features around them shape their bodies and behaviors. From predation to defense to locomotion to migration, these simple creatures use a variety of ways to survive in a complex world.

Chapter Five

The final chapter, "Our Relationship with Jellyfish," profiles the main human-caused stressors that are reshuffling our oceans' ecosystems and opening up ecospace for opportunistic species. As their predators and competitors struggle, jellies flourish. In many disturbed areas, jellyfish provide a visible indicator that the ocean is out of balance. Whether they are causing emergency shutdowns of power plants, clogging fishing nets and capsizing fishing trawlers, or creating profound changes in the food chain, jellies are demanding attention like never before. We examine some of the causes—many of them human-generated—of the apparent rise of the jellies.



Species Accounts

The species accounts that accompany each chapter offer the reader an opportunity to get to know a few of the more interesting jellyfish.

Many species do not have common names and are usually referred to by their scientific names. For a few, the common names in standard use have been confusingly applied to numerous species or are so generic as to be unhelpful (for example, bell jelly, water jelly, box jelly); some of these species have been given revised common names in this book.

One may wonder why so many jellyfish lack common names, but it is simply because jellies have not gotten the widespread attention afforded to commercial species, such as fish, or aroused popular interest or the studied curiosity of naturalists that birds and mammals enjoy.

Where an account features multiple species, the information panel and map at the bottom of the page cover all the species. Distribution data is limited for many species, so the ranges on some maps are estimates.