

"An awe-inspiring journey."

—People

For all of human history, the deep ocean has been a source of wonder and terror, an unknown realm that evoked a singular, compelling question: What's down there? Unable to answer this for centuries, people believed the deep was a sinister realm of fiendish creatures and deadly peril. But now, cutting-edge technologies allow scientists and explorers to dive miles beneath the surface, and we are beginning to understand this strange and exotic underworld. Far from a dark void, the deep is a vibrant realm that's home to pink gelatinous predators and shimmering creatures a hundred feet long and ancient animals with glass skeletons and sharks that live for half a millennium.

Susan Casey is our premier chronicler of the aquatic world. For *The Underworld* she traversed the globe, joining scientists and explorers on dives to the deepest places on the planet, interviewing the marine geologists, marine biologists, and oceanographers who are searching for knowledge in this vast unseen realm. She takes us on a fascinating journey through the history of deep-sea exploration, from the myths and legends of the ancient world to storied shipwrecks we can now reach on the bottom of the ocean.

Throughout this journey, she learned how vital the deep is to the future of the planet, and how urgent it is that we understand it in a time of increasing threats from climate change, industrial fishing, pollution, and the mining companies that are also exploring its depths. *The Underworld* is Casey's most beautiful and thrilling book yet, a gorgeous evocation of the natural world and a powerful call to arms.

"A fine tour of the history and challenges of exploring this most fantastical and forbidding of earthen worlds."

—The Washington Post

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NEW YORK TIMES BESTSELLER

"Casey's descriptions of the shimmeringly strange life teeming below the waves capture her wonder and ravishment in prose that morphs into poetry . . . enthralling." —The Boston Globe

THE UNDERWORLD

JOURNEYS TO THE DEPTHS OF THE OCEAN

SUSAN CASEY

BESTSELLING AUTHOR OF *THE WAVE*

SUSAN CASEY THE UNDERWORLD



Vintage



Susan Casey

The Underworld

Susan Casey is the author of the *New York Times* bestsellers *Voices in the Ocean*, *The Wave*, and *The Devil's Teeth* and is the former editor in chief of *O, The Oprah Magazine*. She is a National Magazine Award–winning journalist whose work has been featured in the *Best American Science and Nature Writing*, *Best American Sports Writing*, and *Best American Magazine Writing* anthologies; and has appeared in *Esquire*, *Sports Illustrated*, *Fortune*, and *Outside*.

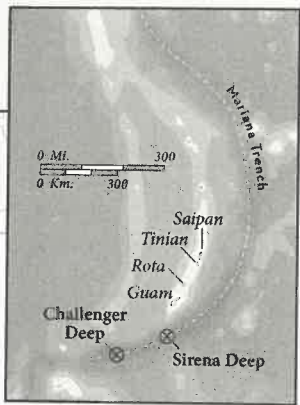
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We must go and see for ourselves.

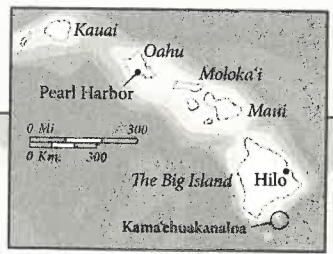
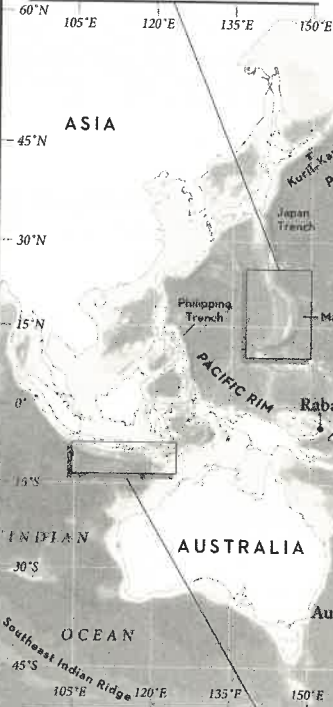
—JACQUES-YVES COUSTEAU

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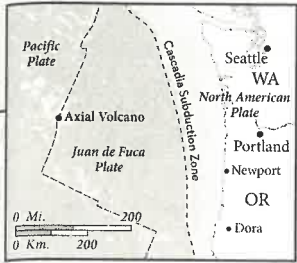
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MARIANA TRENCH



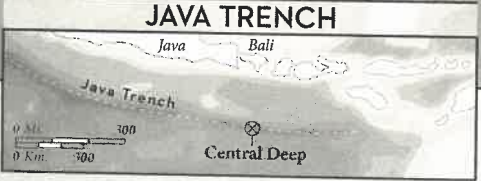
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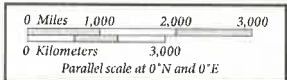
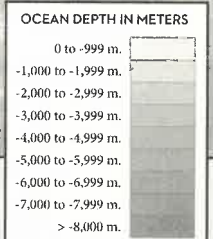
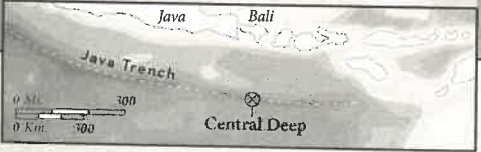
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Author's Note

When writing about the deep ocean, the first question that arises is: What is it? At what point does the ocean become the *deep* ocean? It may be surprising to learn that even deep-sea scientists don't fully agree on how to define the various depth zones. Typically, however, the deep ocean is considered to comprise the waters below two hundred meters, or approximately six hundred feet—the point at which sunlight essentially disappears. In this book, I have defined the deeper layers as the twilight zone (six hundred to thirty-three hundred feet), the midnight zone (thirty-three hundred to ten thousand feet), the abyssal zone (ten thousand to twenty thousand feet), and the hadal zone (twenty thousand to thirty-six thousand feet). These names and measurements are commonly used, although there are other ways to delineate the deep's regions, particularly within its vast mid-waters.

The abyssal zone is known in short as *the abyss*, but the word *abyss* also has a broader meaning as a deep and seemingly bottomless chasm: it's often used when referring generally to the ocean's great depths. You'll find both usages in these pages, with the distinction evident in context.

You could travel through the abyssal zone in a submersible (though few vehicles in the world can venture that deep), but if you were traveling in a submarine you wouldn't have that

option. Submarines are capable of sustained, independent undersea operations, but their diving range is relatively shallow. The deep-sea vehicles I describe in these pages are all submersibles. There are two types: manned and unmanned. Manned submersibles carry passengers, who sit within a dry, pressure-controlled atmosphere equipped with life-support systems. These compact subs can descend, ascend, and fly around beneath the surface independently, but they require a support vessel and crew for transport, launch, and recovery. Their power supplies come from batteries, so they can't remain submerged for weeks the way a submarine can.

Unmanned submersibles are robots, and include remote operated vehicles (ROVs) that are tethered to a ship and driven remotely by a human pilot; and autonomous underwater vehicles (AUVs) that may also be launched from a ship, but are preprogrammed to dive, collect data, and return to their base without real-time human input.

In casual usage the words *submarine* and *submersible* are sometimes used interchangeably, referring generally to an underwater vehicle. Both submarines and submersibles share an abbreviation: subs.

The deep ocean occupies 95 percent of the ocean's volume, and you'll notice that both terms are singular. The earth possesses one ocean, though it's traditionally recognized as having five major regions: the Pacific, Atlantic, Indian, Arctic, and Southern Oceans. Whenever possible, I refer to the ocean as a single entity.

The science of measuring the seabed terrain is known as bathymetry—the submarine version of topography. Bathymetric maps chart the depths and contours of the seafloor in three-dimensional relief, revealing its mountains, valleys, canyons, plains, rifts, trenches, and other undersea features.

American and British readers are accustomed to thinking in miles, feet, tons, degrees Fahrenheit, pounds per square inch. Science uses metric measurements. Mariners use nautical miles and fathoms. Here, I'm defaulting to the imperial system of measurement, but when it is helpful for clarity I've cited metric figures. Metric usage in quotes is verbatim.

CHAPTER 1

Magnus's Monsters

Indeed, I should also add that monsters, some long-familiar, some unprecedented, are sighted off Norway, and this is due particularly to the unfathomable depth of the waters . . .

—OLAUS MAGNUS

UPPSALA, SWEDEN

If you were searching for world-famous deep-sea monsters, a stately building at the top of a hill in Uppsala, Sweden, is not the first place you'd look. But the monsters are here, behind the butter-colored façade and tall windows of Uppsala University's oldest library, an institution known as Carolina Rediviva. The university was established in 1477. Uppsala, a charming city about an hour north of Stockholm, has been around for even longer. It was a Viking stomping ground in the first millennium, a hub of feisty Norse pagans who worshipped the gods of thunder and wind and war, while enjoying the odd human sacrifice, before Christianity moved in. There's a lot of history in Uppsala, but I had come to see one particular relic: the *Carta Marina*, a sixteenth-century illustrated map that depicts the North Atlantic, North Sea, and Norwegian Sea regions—and the fiendish creatures that, according to the map's author, lived in those waters.

For as long as people have gazed out at the ocean, they've shiv-

ered at the thought of its silent inhabitants. The word *abyss*, translated from its Greek roots, means “without bottom.” What kind of ungodly beast would find such a place hospitable? It was hard to imagine what such a thing might look like, though religion and mythology offered chilling descriptions and comparisons to Satan. So when someone created a map of the sea that featured portraits of these residents, it was sure to attract attention.

The *Carta Marina* was printed in 1539, and at a glance it was no boring document. Every inch of its twenty-three-square-foot surface was covered with intricate drawings, landmarks, labels, directions, and notes written in a cramped Latin script. The map was packed with its era's latest intelligence about natural history, geography, marine life, ocean conditions, navigation, shipping routes, and local customs. It charted Scandinavia—an isolated part of the world at that time—with unprecedented accuracy. But the reason I flew to Sweden to see the *Carta Marina* is because it's a 480-year-old snapshot of the prevailing fears and beliefs about the deep ocean. Beyond its cartography, it's a map of perceptions.

In an age before science, before deep-sea exploration, before high-definition underwater cameras, what people overwhelmingly believed about the deep was that it was filled with monsters—and the *Carta Marina* made their presence official. It portrayed their malice in striking detail. From Greenland all the way to Norway, menacing creatures are shown lolling in the water, wreaking havoc on ships, devouring sailors, and in general behaving badly, having risen from the hellish pit of the abyss, and intent on dragging their victims back down there.

Adding to the map's authority, it came from a trustworthy source. Its creator, a Catholic priest and historian named Olaus Magnus, was born in Linköping, Sweden, in 1490. Magnus led a cosmopolitan life, attending university in Germany and traveling widely throughout Europe. For a while he was based in Poland. He roamed the northern countries as a papal ambassador, collecting fees for the Church and soaking up information: firsthand observations, stories from villag-

ers, maritime insights from fishermen and sailors, and regional gossip seasoned with a dash of medieval superstition.

People have always been scared of the deep, but in Magnus's time it evoked an extra degree of terror. In the moody North, the ocean was often visibly furious, and from shore it would've appeared endless, its edges unknown. Ships would leave and never come back. Mariners vanished into its maw, sinking into an underworld that was crawling with demons like Leviathan and the Kraken. Aside from the unlucky souls who'd visited the abyss on a one-way trip, no one had ever seen it; no one knew anything about it. To the average person it was a tabula rasa of doom. But even back then, how could anyone not wonder what was hidden there?

*

We'll never know when or where the earliest efforts to learn more about the deep occurred—somewhere in ancient Oceania would be my guess—but in Western culture, the Greek philosopher Aristotle is credited as the first marine biologist. He dissected any aquatic creatures he could get his hands on in the fourth century BCE, spent years studying their behavior in a lagoon, and presented his findings in a book called *Historia Animalium* (*History of Animals*). Among other observations, Aristotle noted that cuttlefish change color when they're startled, and that female sharks tend to be larger than male sharks. He figured out how lobsters copulate. He also discerned that whales and dolphins are mammals, classifying them in a group he named *Cetacea*, from the Greek word *kētōs*, or sea monster.

The Roman historian Pliny the Elder followed in 77 CE, publishing a thirty-seven-volume encyclopedia that contained notes, musings, and wild conjecture about marine life. Unlike Aristotle, who relied on empirical evidence, Pliny spouted sea monster lore, holding forth about three-hundred-foot-long eels, man-eating octopuses, and fish the size of islands. In fact, he declared, most of

the deep's inhabitants were "of monstrous form." He wrote of submarine hurricanes that stirred up the ocean "from the very bottom, and the monsters are driven from their depths and rolled upwards on the crest of the billow." Aristotle's work was substantial and rigorous, but Pliny's tall tales were more popular. Throughout the Middle Ages, while Aristotle's anatomical diagrams were mostly forgotten, Pliny was considered the main authority.

But still the deep remained far out of reach. It was shrouded in mystery, a veiled supernatural realm. With the *Carta Marina*, Magnus intended to illuminate it. He began with a conclusion, gleaned from his research: "Inside this broad expanse of fluid Ocean, which admits the seeds of life with fertile growth, as sublime Nature ceaselessly gives birth, a conglomeration of monsters may be found."

Magnus's timing was excellent. It was the Age of Discovery and Europeans were curious about everything, especially if it was unusual or ferocious or exotic. There was a hunger for astonishment: wonders, marvels, and terrors were the order of the day. Ships sailed to far-flung shores and sent news of remarkable sights. The unexplained, the awesome, the magnificent, the freakish; rumors of a lion with a man's face in India, of babies born with inverted feet; reports of pygmies, werewolves, and an assortment of what one book, *Marvels Described*, written by a French monk named Friar Jordanus, referred to as "sundry monstrous appearances"—all of these riveted the public. ("If there were cats with wings in Malabar, as he had seen, why should there not be people with dogs' heads in the Islands of the Ocean?" Jordanus's translator asks, somewhat defensively, in the foreword.) The world was expanding—helped along by Johannes Gutenberg's invention of the printing press—and apparently it was a colorful place. In Italy, the Renaissance was in full bloom; Leonardo da Vinci had drafted designs for an underwater breathing apparatus. He was cagey about the details: "I do not wish to publish this because of the evil nature of men, who might use it for murder on the seabed."

As a cleric and a scholar, Magnus took everything he learned and

filtered it through the Bible, Aristotle, Pliny, and Ptolemy's *Geographia*, a second-century CE stab at a global atlas that included calculations of latitude (not bad) and longitude (way off: it would take until the mid-eighteenth century to get that right). He also digested classical texts, with their vivid descriptions of Scylla, Charybdis, and the Hydra, before beginning his twelve years of work on the *Carta Marina*. And though Magnus couldn't have foreseen it, his map would become iconic. It would reign as the gold standard for sea monsters long after he was gone, reflecting our dread of the deep back at us in the most delightfully frightful way.

*

I walked up the hill to Carolina Rediviva on a flawless September morning, to view one of the two original prints of the *Carta Marina* that have survived the centuries. (The other one is in Munich.) On the way there, I wound through cobblestone streets and weaved among students wearing Fjällräven backpacks and passed by rune stones that were taller than me, carved with mystical shapes and inscriptions from the eleventh century. "The stone in memory of . . . soul," explained one translation placard. Trees with silvery leaves rustled and shushed in the breeze.

I was excited to see the map in person so I'd arrived at the library early, ten minutes before it opened. I stood on the front steps and looked around. In this low-slung town you couldn't miss the Gothic spires of the Uppsala Cathedral: they speared four hundred feet into the sky. This hulking redbrick building had played a bitter role in Magnus's life. It was the seat of the archbishop of Uppsala, a post bestowed on him by Pope Paul III in 1544. But it was merely an honorary title: Magnus would never occupy the office. By then he had been exiled in Italy for seven years. The Reformation had turned Sweden into a Protestant country.

He'd finished the *Carta Marina* in Venice. It was a supersize map, measuring four feet tall by five and a half feet wide, printed crisply

on nine woodcut blocks. Nobody knows how many first-edition prints were made—probably not many, because after 1574 the originals had all but vanished. Fortunately, the map's popularity had spawned a smaller-scale copy in 1572, and that version stayed in circulation. (No original was seen again until 1886, when one turned up in a German library's cache of old maps. In 1961, a second original was found in Switzerland and acquired by Uppsala University.)

Magnus had also written lengthy treatises in German and Italian about the *Carta Marina*'s contents, and a handy reference key to its nine panels—but he still had more to say. He spent the next sixteen years completing a 778-chapter doorstop of a book called *A Description of the Northern Peoples* that elaborated on the map's drawings, and included a long, exhaustively footnoted section devoted to its sea monsters. Magnus died in Rome in 1557, two years after the book's publication, so he never witnessed its afterlife: twenty-two editions were published in six languages. It was a hit, a Renaissance bestseller that's still in print today.

Carolina Rediviva's doors opened, and I made my way into the entrance hall. Inside, there was a quiet grandeur: soaring ceilings and windows, catwalks linked by spiral staircases, crown moldings done in Swedish neoclassical style. The reading rooms were spacious and warmly lit, their shelves lined with hardcover volumes bound in muted colors. The effect was sophisticated, as though an art director had stopped by to organize the books.

The *Carta Marina* is on permanent display in a rare manuscripts exhibit off to the side of the entrance. Sunshine is no friend to antique paper, so the room was as dark as a cave. Spotlights were trained on the individual pieces: Mozart's handwritten musical scores, first editions of Newton's *Principia Mathematica* and Darwin's *On the Origin of Species*, Galileo's letters defending his theory of sunspots. I stopped for a moment to let my eyes adjust. Then, at the back of the room, I saw Magnus's monsters.

Mounted in its frame and sheathed by protective glass, the *Carta Marina* takes up an entire wall. I'd seen reproductions of it, but I

was still stunned by the intensity of its detail. The map is printed in black ink on thick ivory paper without any addition of color, and its lines are so finely rendered they seem to have been drawn with a pin. Everywhere you look the map is buzzing with activity, but Magnus clearly wanted to make a point. On land the action is orderly: tiny figures are farming, hunting, skiing, playing the violin. By contrast, the ocean is in chaos, awash in dangers and tragedies, livid with waves and currents flowing, swirling, pooling, seething. Amid the tumult, twenty-five sea monsters make their appearance.

At eye level near the Faroe Islands, and almost as big as them, a monster with a round face, a daggerlike dorsal fin, and spiky claws is frowning as it gobbles a seal. Magnus had labeled it "the Ziphius." "It has a ghastly head, like that of an owl; a very deep mouth, like some vast chasm, with which it terrifies and puts to flight anything that sees it; dreadful eyes; a back that is tapering, or rather, raised into the form of a sword; and a sharply-pointed beak," he explained in his book. Beside it, another monster with a prominent snout and what looks like a bad case of acne is sinking its hooked teeth into the Ziphius's flanks. "These creatures frequently approach northern coasts like sea-robbers or ill-disposed visitors, and purpose harm to all who cross their path," Magnus warned.

Off the coast of Norway, a grizzled beast with a hump on its back grapples with a mutant lobster, while above them a hapless ship is being squeezed to splinters by the "Sea Orm," one of Magnus's most daunting specters. This is "a serpent of gigantic bulk, at least two hundred feet long, and twenty feet thick," he'd noted, and in case that doesn't sound awful enough: "It has hairs eighteen inches long hanging from its neck, sharp, black scales, and flaming red eyes."

Magnus stresses repeatedly that he's relaying eyewitness accounts, and that one of his sources, another archbishop, had even obtained a sea monster's head, preserved it in salt, and sent it to the pope: "The whole head of this creature, which is like very hard leather studded round with horns, is extremely heavy, perhaps because Nature has so designed it for quicker submersion."

Throughout his writings Magnus comes across as meticulous, and his book is stuffed with citations to underpin his claims, so it's likely that the head of *some* large marine beast was delivered to the papal residence. On the other hand, Magnus also reported that in Iceland the streams run with beer.

I was standing so close to the map that I'd fogged the glass, so I stepped back and regarded it from a distance, only to be drawn right back in. Magnus's descriptions may be outlandish, but the *Carta Marina* is no cartoon. Its monsters were rooted in reality—and then subjected to an epic version of the telephone game during which they morphed into bigger, meaner, and more fantastical versions of themselves, until finally the garbled, exaggerated story reached Magnus, who committed it to print: "Paulus Orosius declares in his life of Caligula that in the fifth year of his reign a monster extending to a length of nearly four miles sprang from the sea's abyss . . ."

Many of Magnus's monsters resemble whales—albeit more diabolical looking—and it's obvious from his texts that he was familiar with the animals. He knew they gave birth to live young, breathed air "through tubes," and contained oil "most abundant in the head." But there seems to have been some confusion about which creatures were whales and which were another breed of monster. Magnus believed, for instance, that the male narwhal—a shy, deep-diving Arctic whale with a protruding spiral tooth—was the "Unicorn-Fish . . . a sea-monster with a huge horn on its forehead; with this it can pierce and wreck oncoming ships and kill a large body of men."

During his travels, Magnus would have met coastal villagers who'd encountered stranded whales and other denizens cast up from the deep, bloated and bedraggled and bitten and, in all fairness, looking pretty sinister. What was a medieval farmer supposed to think when he stumbled across the body of a fifty-foot sperm whale, with its boxcar head full of seven-inch teeth? Without context or knowledge there would've been horror. Magnus cited one onlooker's impression of a stranded baleen whale: The "monster"

was ninety feet long, with “thirty throats” and “stupendously large” genitals, the man reported. “Attached to its palate were what looked like countless horny plates, hairy on one side . . . and no teeth, a fact which leads people to conclude that it was *not* a whale.”

*

Fear can take strange forms, so it’s not surprising that our fear of the ocean abyss—a realm that Carl Jung compared to the madhouse of the subconscious mind—has produced some of the strangest forms of all. From the start, we’ve imagined the worst. In the absence of any personal experience with the deep, we’ve stocked it with apparitions from our minds’ darkest corners. It’s the oldest archetype in the human storybook: the monsters, the freaks, the *others*—the beings we don’t recognize, so we react to them by recoiling. Aristotle set out to demystify them; Pliny was determined to amplify them. Magnus’s genius was to get them all down on paper.

It was hard for me to tear myself away from the *Carta Marina*, even though I’d been staring at it, in the dark, for two hours. What I loved most about the map was its exuberance. Even as he was adding horns, fangs, and scowling expressions to make his sea monsters look more fearsome, Magnus couldn’t disguise his enthusiasm for them. “Such great wonders have their position in the huge extent of Ocean that even a person with surpassing talent can hardly describe them,” he raved. It was that ageless mix of fear and fascination; that clash of attraction and repulsion. The biologist Edward O. Wilson summed it up in a sentence: “Even the deadliest and most repugnant creatures bring an endowment of magic to the human mind.”

I left Carolina Rediviva with a handful of *Carta Marina* postcards and a *Carta Marina* coffee mug and the *Carta Marina* seared into memory, and I wished I could tell Magnus that his visions were still mesmerizing, almost five centuries later. For decades after Magnus’s death, his monsters were copied extensively on other maps. But as seafaring became more common, and colonies cropped up on

foreign shores, it occurred to European monarchies that the ocean was something more than a den of trouble—it was a seemingly limitless place to make money. By the mid-seventeenth century, drawings of horrible whalelike predators threatening ships were replaced by images of ships engaged in whaling. Sperm whales no longer had tusks and blazing eyes: they had harpoons stuck in their backs. The monsters were gone, reduced to candle wax and lamp oil. The ocean still commanded respect, but our relationship with it was changing.

To time-travel through the seventeenth and eighteenth centuries—and their seismic shifts in our understanding of the natural world—all I had to do was walk a few blocks around Uppsala. From Carolina Rediviva’s front lawn I could see the Gustavianum, a four-hundred-year-old museum that’s a quirky shrine to the Enlightenment. Among its collections are the version 1.0 tools of the Scientific Revolution: microscopes and telescopes, medical instruments, Anders Celsius’s first thermometer. There are barometers (invented in 1643), and sextants (1731), and chronometers (1735), and beneath a domed roof on the top floor, the world’s second-oldest anatomical operating theater, a standing-room-only gallery where medical students and steel-stomached citizens could watch surgeries performed on convicted murderers.

If you were a budding natural scientist, eighteenth-century Uppsala was a lively place to be. In 1728, there was a new arrival at the university: Carl Linnaeus. Aside from the fact that he was broke, Linnaeus wasn’t your average student. At the university’s botanical garden—right around the corner from the Gustavianum—he distinguished himself as a prodigy of plants. In childhood he’d memorized their Latin names, which at the time were long, baffling mouthfuls based on subjective descriptions. (A cactus, for example, was “the large melon-thistle with fifteen angles and broad recurved thorns, which are of a red color”—and it was even more convoluted in Latin.) Linnaeus became a professor of botany and medicine, and then vaulted into history by establishing the taxonomic system that is still used today to classify living things—a universal for-

mat that allows anyone, anywhere, to pinpoint where an organism belongs on the tree of life, and to identify its origin by genus and species. Over the years, taxonomy has been honed into ever more exact distinctions, and genomic sequencing has advanced the whole game, but thanks to Linnaeus we now know the orca, for instance, as *Orcinus orca*, from the family Delphinidae in the suborder Odontoceti of the order Cetacea, and not by Magnus's preferred name, "the Grampus," or Pliny's description: "an enormous mass of flesh with savage teeth."

All of this represented a great leap forward, a sea change that shunted hearsay and wacky ramblings about monsters off to the side, and replaced them with cool, rational assessment. Although science was still entangled with religion—nasty battles with the Church lay ahead—and the word *scientist* wouldn't even come into use until 1834, the post-Magnus era was a time of measuring, debating, questioning, and reasoning; of developing theories and proving them. It was a heady time of figuring things out.

As the afternoon sun glinted through a scrim of clouds, I left what is now called the Linnaeus Garden—an assemblage of plants identified by his handwritten labels—and headed back into town to check out a Viking-themed pub where you could drink a horn of mead and eat roasted deer meat with your bare hands. As I passed the Uppsala Cathedral, I realized that I'd come full circle. When Linnaeus died in 1778 he was buried here, and his tombstone, set into the church's floor, marks the spot where Magnus's career was thwarted. The last archbishop of Uppsala had never taken the helm in this cathedral, and ultimately it would be scientists armed with new technologies—not priests toting sketchbooks—who were destined to uncover the ocean's secrets. Magnus, it seems, had been aware of his own limitations. "In the deeps of the sea there are species of fish which never, or very rarely, reveal themselves to men's eyes," he wrote, sounding disappointed.

The next wave of ocean investigators had no intention of waiting for these shadowy deep-sea life-forms to reveal themselves. They

wanted to hunt through the depths and find them. It wasn't enough to gawk at marvelous, monstrous creatures that happened to expire on a beach. Nineteenth-century naturalists wanted to collect specimens from their habitats, place them under a microscope, understand their life histories, how they functioned, what they ate. And they wanted to conduct physical experiments that would answer some basic yet confounding questions. How deep was the ocean anyway? What was the seafloor made of? What were conditions like at the very bottom? Was it even possible to methodically examine a realm that existed entirely in the dark? Under miles of water? The abyss was unknown—but was it unknowable?

*

There was no question that studying the deep would be vexingly difficult. Anyone hoping to pry knowledge from the ocean's underworld would need to spend months, even years, at sea, eating hard-tack biscuits and drinking lime juice to avoid scurvy, wedging themselves into tight bunks aboard ships that pitched and rolled and occasionally sank. They would have to endure cabin fever, tropical diseases, heavy weather, and everything else fate could dish out. Accidents and injuries were a given; deaths were to be expected. On his voyage aboard the HMS *Beagle*, Charles Darwin suffered through five years of seasickness. "It is no trifling evil which may be cured in a week," he advised. Darwin disliked maritime life for other reasons, too. He complained of "the want of room, of seclusions, of rest; the jading feeling of constant hurry; the privation of small luxuries, the loss of domestic society and even of music . . ." The ocean, he concluded, was "a tedious waste."

There was also the issue of equipment: easy-to-use, reliable gear was nonexistent. Soundings to gauge depths were taken regularly from ships, but the devices were primitive and the method was inexact. Mariners would drop a weight attached to a long line, watch as it plummeted into the darkness, and try to detect when it

hit the bottom. Then they'd slowly recover it, marking the distance in fathoms—a unit of measurement based on the length of a man's outstretched arms (about six feet). Some sounding devices were designed to grab sediment samples when they touched down, but the only way to obtain a larger hunk of the seafloor—and have any chance at catching animals—was by dredging with an iron-jawed scoop or trawling with a weighted net, both of which also had to be lowered on a line from an unsteady ship in an environment that was constantly moving. These contraptions couldn't be maneuvered with any kind of finesse. They failed often: lines got snagged and tangled and snapped. Their operations demanded hours of monotonous labor even in shallower waters. Working below three hundred fathoms would be a backbreaking production for anyone masochistic enough to try. In its 1823 edition, the *Encyclopaedia Britannica* threw in the towel, declaring that: "Through want of instruments, the sea beyond a certain depth has been found unfathomable."

But the story of human ingenuity always demands a next chapter, and by the mid-nineteenth century there was a pressing reason to learn more about the seafloor: so we could lay telegraph cables across it. Once again the deep was commercially important; sending messages by homing pigeon and packet ship wouldn't do in the age of electricity. Faster communications would also mean military advantage, not to mention bragging rights, for any nation that managed to install a live electrical wire under fifteen thousand feet of salt water. What followed was a decade-long technological experiment at the bottom of the Atlantic Ocean, as Great Britain and the United States collaborated (and competed) to run a two-thousand-mile cable from Europe to America. Where to put it? How to secure it? What might gnaw through it in the depths? Would currents sweep it away? Expertise was urgently needed.

As deep-sea research evolved from a pipe dream into a reality, the typical person who would light out on a seafloor surveying expedition was a European man—women need not apply—from a

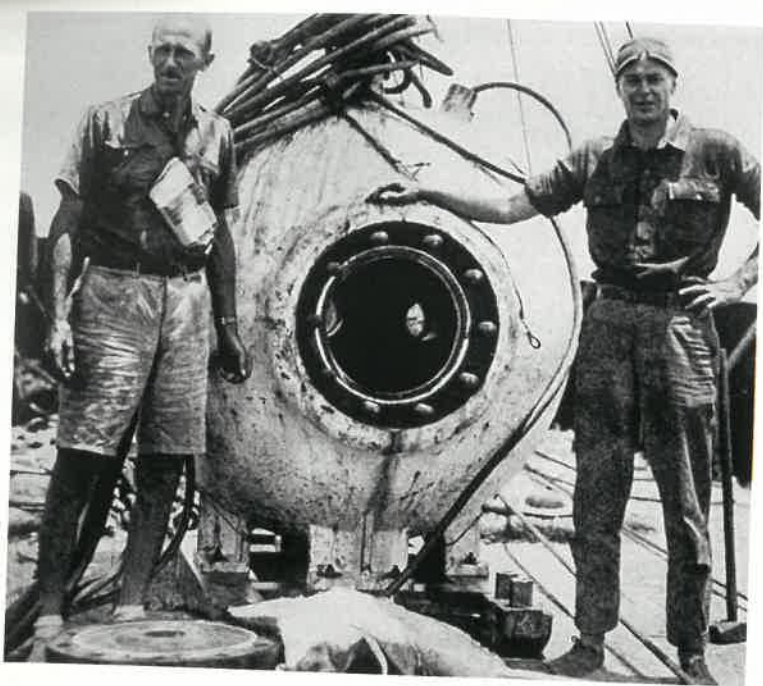
privileged background, with a polished education, academic ambitions, and connections to similarly pedigreed men. The fledgling field of marine science was a gentlemen's club, and unlike sailors, its members were not known for their high tolerance of misery. But the abyss was a wide-open frontier, a bonanza of opportunity. *Everything* in the deep was new to science; careers could be made on a single voyage. It was, in one naturalist's words, "the only remaining region where there were endless novelties of extraordinary interest ready to the hand which had the means of gathering them."

Meanwhile in nature-crazed Victorian England, people were enthralled by any aquatic discovery. Collecting seashells was considered a stylish hobby. Home aquariums, known as "ocean gardens," were a status symbol among the upper classes. "The wonders of the ocean floor do not reveal themselves to vulgar eyes," sniffed a how-to book for setting one up. Marine life transcended the ordinary, even when confined to a tank. Sea anemones were like "rare exotic flowers," the book's author waxed, before injecting a darker note: "Yet they are not flowers, but animals—sea monsters, whose seeming delicate petals . . . seize the unconscious victim as he passes near the beautiful form—fatal to him as the crater of a volcano, in which he is soon engulfed by the closing tentacles." The last chapter was an impassioned pitch for a new form of entertainment, "a Titanic Aquarium" measuring "hundreds of feet in depth," in which sharks would be "exhibited in deadly conflict with human divers, armed with net and trident."

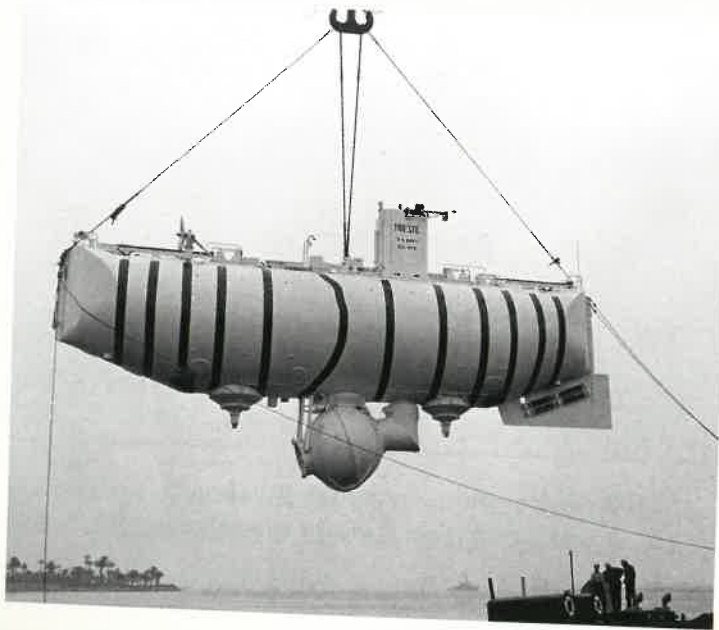
In this go-go time of ocean enterprise, there were some notable ironies. For one thing, even as marine science was flourishing, sea monsters made a strong comeback. Suddenly, it seemed, everybody had seen one—especially in Gloucester, Massachusetts, where more than a hundred people claimed to have watched a "sea-serpent" capering in the town's harbor. Boaters and fishermen also encountered it offshore. Sightings were so frequent that the Linnaean Society of New England launched an official inquiry, taking



“A conglomeration of monsters may be found”:
an inset from the *Carta Marina* by Olaus Magnus, 1539.



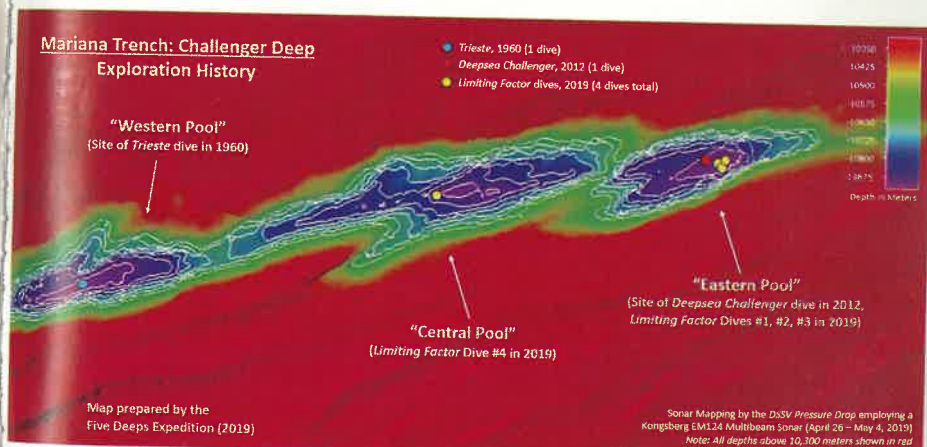
William Beebe (*left*) and Otis Barton (*right*) with the *Bathysphere*, Bermuda, 1934 (*above*). The bathyscaphe *Trieste*, 1959 (*below*).



“Was it sheer madness to dive seven miles into the sea under such conditions?”: Don Walsh (*right*) and Jacques Piccard (*inside*) the pressure hull of the *Trieste*.



“A yawning crevasse in the bowels of the Pacific”: the bathymetry of the Mariana Trench’s Challenger Deep, the ocean’s absolute nadir (*below*).





“Because nobody had done it before”: Victor Vescovo prepares to board his sub in Tonga, on his run of history-making dives.



The *Limiting Factor*: a revolutionary deep-sea submersible that can dive repeatedly to the greatest depths (*left and above*).



"A species known unpoetically as the robust assfish": amphipods, assfish (*above*, *below*), and white supergiant amphipod (*below*) at a hadal lander.

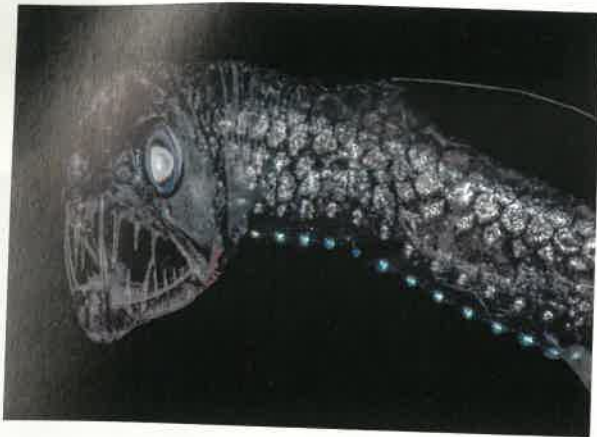


A Dumbo octopus, robust assfish, and red prawn approach a baited lander in the Java Trench (*above*).



Hadal snailfish (*above* and *right*), the world's deepest fish. Alan Jamieson and Tim Macdonald in the *Limiting Factor* (*below*).





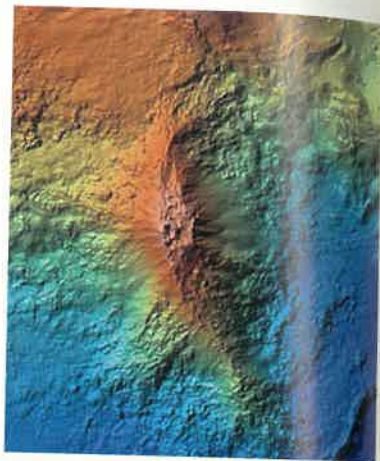
Toothy, glittery predators: a Sloane's viperfish (*top*), elongated bristlemouth (*center*), and luminous lanternfish (*bottom*). They may have fearsome teeth and scary faces, but many twilight zone fish are surprisingly small.

A cosmopolis of creatures: a glass squid (*top*), a tiny, exquisite jelly (*center*), and a ctenophore, or comb jelly (*bottom*). In the deep's midwaters, bioluminescence is a central fact of life and the key to survival.





Vescovo and Casey in the *Limiting Factor*, diving into the abyss, January 31, 2021 (*left*); the bathymetry of Kama'ehua (*below*); pillow lava in Pele's house (*below, left*); a jelly blinking a greeting (*bottom, right*).



Notes

PROLOGUE

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- 4 “a sort of delightful horror”: *Ibid.*, 60.
- 7 “Who has known the ocean?”: Rachel Carson, “Undersea,” in *Lost Woods: The Discovered Writing of Rachel Carson*, ed. Linda Lear (Boston: Beacon Press, 1998), 4.
- 7 Yet the deep ocean: Roberto Danovaro, Cinzia Corinaldesi, Antonio Dell’Anno, and Paul V. R. Snelgrove, “The Deep-Sea Under Global Change,” *Current Biology* 27, no. 11 (June 2017): R461–R465.
- 7 The Pacific alone: The Pacific’s immensity is hard to visualize, especially when you consider that it’s also the deepest ocean basin, with a maximum depth of 10,935 meters, or 35,876 feet—nearly seven miles at its nadir. My back-of-the-envelope calculation of how many continents would fit into the Pacific is based on its area of 64 million square miles; a measurement for the earth’s continental landmass of 57 million square miles; and South America’s footprint of 7 million square miles. (Obviously, to be accurate, cubic miles would be preferable as a basis for measurement.) In any case, the Pacific is *big*.
- 9 I pored over any deep-sea news: Ean Higgins, “Search for MH370 Unveils a Lost World Deep Beneath the Ocean,” *The Australian*, July 21, 2017.
- 10 more like estimates than facts: Larry Mayer, Martin Jakobsson, Graham Allen, Boris Dorschel, Robin Falconer, Vicki Ferrini, Geoffrey Lamarche, Helen Snaith, and Pauline Weatherall, “The Nippon Foundation–GEBCO Seabed 2030 Project: The Quest to See the

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- 10 crisply detailed three-dimensional maps of the deep: To see a graphic representation of the newly revealed Indian Ocean seafloor detail: "The Data Behind the Search for MH370," <https://geoscience-au.maps.arcgis.com/apps/Cascade/index.html?appid=038a72439bfa4d28b3dde81cc6ff3214> (accessed January 4, 2023).
- 10 the *West Ridge*: Ross Anderson, *Maritime Archaeological Analysis of Two Historic Shipwrecks Located During the MH370 Aircraft Search*, Report No. 322, Department of Maritime Archaeology, Western Australian Museum (April 2018), <https://museum.wa.gov.au/maritime-archaeology-db/sites/default/files/no-322-mh370-shipwreck-analysis.pdf>.
- 10 A hundred million years ago: K. Picard, B. Brooke, and M. F. Coffin, "Geological Insights from Malaysia Airlines Flight MH370 Search," [eos.org, https://eos.org/science-updates/geological-insights-from-malaysia-airlines-flight-mh370-search](https://eos.org/science-updates/geological-insights-from-malaysia-airlines-flight-mh370-search) (accessed January 4, 2023).
- 11 a huge mass of igneous rock: Kim Picard, Walter Smith, Maggie Tran, Justy Siwabessy, and Paul Kennedy, "Increased-Resolution Bathymetry in the Southeast Indian Ocean," [hydro-international.com, https://www.hydro-international.com/content/article/increased-resolution-bathymetry-in-the-southeast-indian-ocean](https://www.hydro-international.com/content/article/increased-resolution-bathymetry-in-the-southeast-indian-ocean) (accessed January 4, 2023).
- 11 In one adjacent area: Kim Picard, Brendan P. Brooke, Peter T. Harris, Paulus J. W. Siwabessy, Millard F. Coffin, Maggie Tran, Michele Spinoccia, Jonathan Weales, Miles Macmillan-Lawler, and Jonah Sullivan, "Malaysia Airlines Flight MH370 Search Data Reveal Geomorphology and Seafloor Processes in the Remote Southeast Indian Ocean," *Marine Geology* 395 (January 2018): 301–19, <https://doi.org/10.1016/j.margeo.2017.10.014>.
- 12 If all 3.6 nonillion marine microbes: These estimates come from the International Census of Marine Microbes (ICoMM), a project that was part of the International Census of Marine Life, a global initiative to assess the diversity and abundance of marine life, conducted from 2000 to 2010, <http://www.coml.org/international-census-marine-microbes-icommm/> (accessed January 4, 2023). Also: <https://www.calacademy.org/explore-science/microbe-census>.
- 12 new diagnostic tests: Elise Hugus, "Finding Answers in the Ocean," <https://www.who.edu/oceanus/feature/finding-answers-in-the-ocean/> (accessed January 4, 2023).
- 12 "To sense this world of water": Carson, "Undersea," 4.
- 13 the foundation of the planet: A. R. Thurber, A. K. Sweetman, B. E. Narayanaswamy, D. O. B. Jones, J. Ingels, and R. L. Hansman, "Eco-

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CHAPTER I: MAGNUS'S MONSTERS

- 16 "Indeed, I should also add": Olaus Magnus, *A Description of the Northern Peoples*, vol. 3, trans. Peter Fisher and Humphrey Higgens, ed. Peter Foote (London: The Hakluyt Society, 1998), 1089.
- 16 a hub of feisty Norse pagans: Joshua Mark, "Temple at Uppsala," [worldhistory.org, https://www.worldhistory.org/Temple_at_Uppsala/](https://www.worldhistory.org/Temple_at_Uppsala/) (accessed January 5, 2023).
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- 19 "sundry monstrous appearances": Friar Jordanus, *Mirabilia Descripta: The Wonders of the East*, trans. Colonel Henry Yule (London: The Hakluyt Society, 1863), 1–3.
- 19 "murder on the seabed": Walter Isaacson, *Leonardo* (New York: Simon & Schuster, 2017), Chapter 20, iBooks.
- 20 The other one: In Munich, the original print of the *Carta Marina* is in the Bayerische Staatsbibliothek's map collection.

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