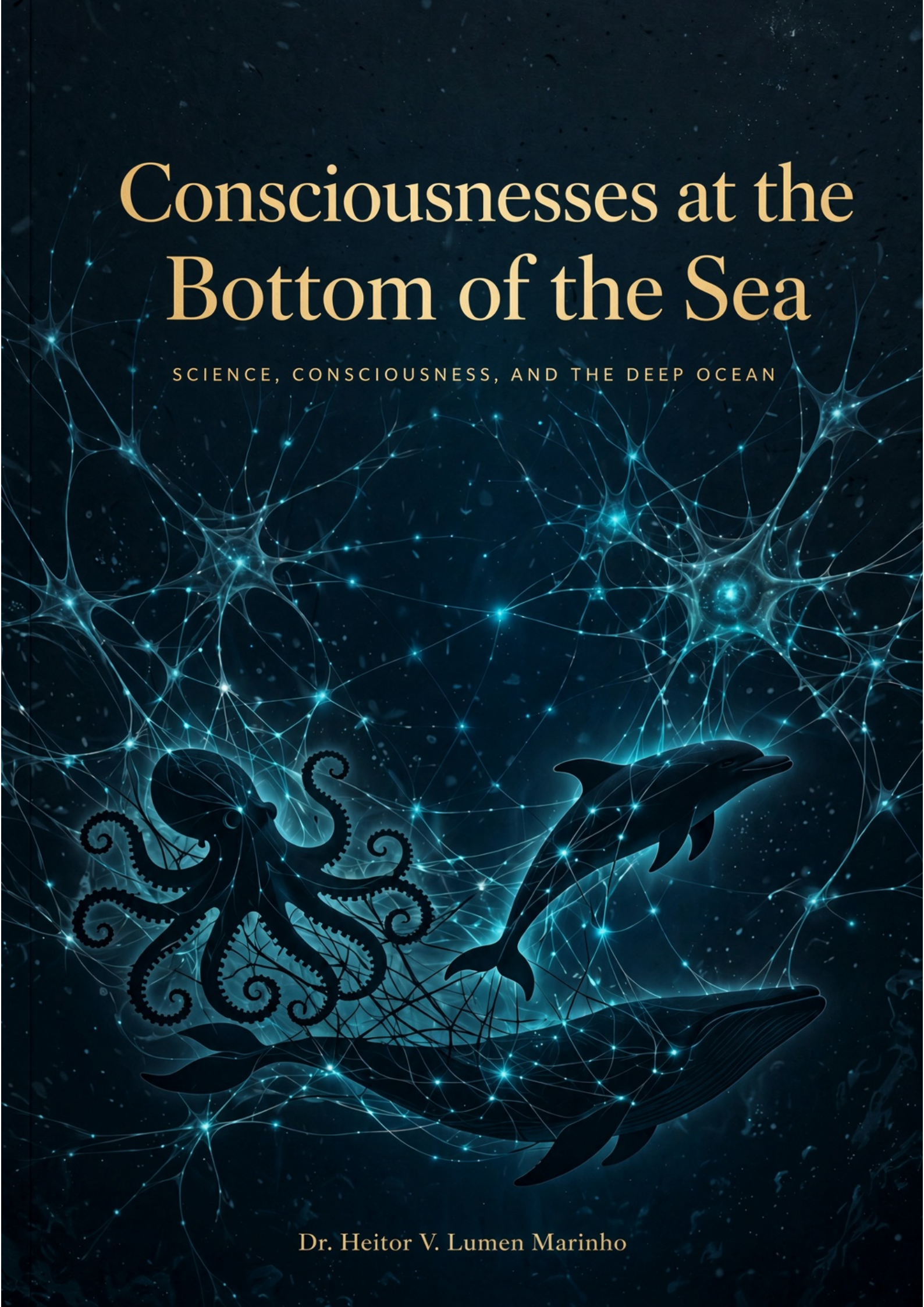
Consciousnesses at the Bottom of the Sea

SCIENCE, CONSCIOUSNESS, AND THE DEEP OCEAN



Dr. Heitor V. Lumen Marinho

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Science, Consciousness, and the Deep Ocean

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"We look at the sky searching for aliens, and forget that the aliens are already here — breathing water, thinking with their arms, singing in the dark."

— H. V. Lumen Marinho, Azores Lecture, 2024

CONTENTS

Preface — p. 4
Introduction: The Search for Other Minds — p. 5
Chapter I: The Cambridge Revolution — p. 7
Chapter II: The Octopuses — Alien Consciousness — p. 9
Chapter III: The Dolphins — Social Consciousness and Identity — p. 12
Chapter IV: The Whales — Cultural Consciousness and Empathy — p. 14
Chapter V: The Abyssal Mirror — What the Ocean Teaches Us About Ourselves — p. 16
Epilogue and About the Author — p. 17

Preface

I write this book after twenty-three years of diving — literally and metaphorically — into the problem of animal consciousness. I am not only a biologist. I am a man who has spent more time watching an octopus in its den than in conference rooms.

For a long time, science made an error of arrogance: it mistook the absence of human language for the absence of mind. We measured intelligence with human rulers: speech, mathematics, logic. And when an animal failed our test, we declared that it did not think.

This book is a correction. It is not a book about intelligent animals. It is a book about other ways of being conscious. About how evolution, in laboratories separated by the ocean, invented the complex mind three times: an alien and distributed mind in the cephalopods, a social and reflective mind in the dolphins, and a cultural and empathic mind in the whales.

If you finish this book understanding that consciousness is not a ladder with the human at the top, but a vast tree with branches we have never touched, I will have done what I set out to do.

This work is not a technical treatise, though it rests on more than two hundred peer-reviewed papers. It is a love letter to the ocean, written with a scientist’s rigor and the wonder of a child who still asks: what is it to be alive inside another mind?

Introduction: The Search for Other Minds

In 1977 we sent the Voyager probes into space with a golden record, hoping some extraterrestrial intelligence would find us. We recorded greetings, whale songs — ironically — and the sound of a human brain. We were looking outward for what we had never understood on our own planet.

The question that guides this book is simple and radical: what if alien intelligence is not light-years away, but twenty meters down?

For centuries we divided the world into beings with souls and beings that were automata. Descartes called animals machines. Behaviorist psychology reduced them to stimulus-response boxes. Even modern biology, until recently, treated consciousness as an exclusively human luxury, anchored in the prefrontal cortex.

Twenty-first-century neuroscience destroyed that certainty. We discovered that consciousness does not need a neocortex. Birds, without a cortex, dream, plan, and recognize themselves. Octopuses, whose last common ancestor with us lived 600 million years ago — before any complex brain existed — solve mazes, open jars from the inside, and show distinct personalities.

In this book I propose three axes for understanding marine consciousness:

1. Architecture: how the brain is organized. In the octopus, it is distributed. In the dolphin, it is massively parallel and social. In the whale, it is emotionally deep, with von Economo neurons — the same cells linked to human empathy — at a density higher than ours.

2. Subjectivity: what it is like to be that animal. We cannot know entirely, but we can infer from structure, from behavior, and now from the neurophysiology of sleep and pain.

3. Culture: what is transmitted not by genes, but by learning. Orcas have dialects stable across thousands of years. Dolphins teach their daughters, but not their sons, to hunt using sponges on their snouts. Octopuses collect objects for later use — a rudimentary form of episodic planning.

When you read that an octopus carries a coconut shell for an hour in order to use it afterward, you are not seeing instinct. You are seeing a mind that represents the future and acts in the present to change it. In philosophy, that has a name: intentionality.

I invite you to suspend, for 17 chapters, anthropocentrism. Not in order to humanize the animals, but to animalize our own consciousness — and to see that it is only one variation on a much vaster theme.

Chapter I — The Cambridge Revolution

On 7 July 2012, at Churchill College, Cambridge, a group of neuroscientists, including Stephen Hawking, signed a one-page document that changed the moral status of animals for good: the Cambridge Declaration on Consciousness.

The declaration stated, without evasion: “The absence of a neocortex does not appear to preclude an organism from experiencing affective states. Convergent evidence indicates that non-human animals have the neuroanatomical, neurochemical, and neurophysiological substrates of conscious states, along with the capacity to exhibit intentional behaviors.”

For the first time, official science recognized that mammals, birds, and cephalopods — octopuses included — are conscious. They feel pain and pleasure. They have a sense of self.

Why was this revolutionary? Because until then consciousness had been treated as a synonym for language. If you could not report “I am conscious,” you were not. The Declaration reversed the logic: consciousness is the capacity to have a subjective experience, not to report it in English.

Three pillars held the declaration up:

I. Homologous substrates. Structures such as the thalamocortical system in mammals have functional analogues in birds (the pallium) and in octopuses (the vertical lobe). Different hardware, the same software.

II. Intentional behavior. Octopuses learn by watching, deceive, and play. Dolphins recognize themselves in a mirror from seven months of age — earlier than human infants. Orcas keep mourning a calf for as long as seventeen days, carrying the body.

III. Sleep and dream. Octopuses change color in cycles of sixty seconds during sleep, alternating between chaotic camouflage patterns and rest — an analogue of human REM. If they dream, they have an inner life that uncouples from the surroundings.

My colleague Philip Low, who drafted the declaration, once said to me: “We did not prove that they are conscious. We removed the scientific excuse for saying that they are not.” That sentence has stayed with me.

The ethical implication is immense. If an octopus feels conscious pain, how do we justify using it in experiments without anesthesia? If a dolphin has a name of its own, how do we justify its captivity in a concrete tank? Science, here, is not neutral. It obliges us to rewrite our moral contract with the ocean.

Chapter II — The Octopuses: Alien Consciousness

If an alien biologist came to Earth and had to choose the most alien animal, it would choose the octopus. Not for its appearance, but for its evolutionary history. Our last common ancestor with Octopus vulgaris was a flatworm, without eyes, without a brain, that lived in the Precambrian. Everything that came after — eyes with an iris, a brain, skin that changes color in 200 milliseconds — evolved separately. It is evolutionary convergence taken to the extreme.

A brain in nine parts. The common octopus has about 500 million neurons. Comparable to a dog. But the distribution is what matters: only 180 million are in the central brain. The other 320 million are in the arms. Each arm has its own nerve cord, with 40 million neurons, able to taste, smell, decide, and act even when separated from the body. In the laboratory, an amputated arm will go on trying to carry food to a mouth that no longer exists.

This is not reflex. It is distributed agency. When I watch an octopus hunting, I see something that challenges our unitary notion of a self. The central brain says “hunt the crab.” The arms negotiate among themselves who goes where. It is as if they were eight intelligent assistants with partial autonomy.

Tool use and future planning. In 2009, in Sulawesi, Indonesia, my team filmed Octopus marginatus — the coconut octopus — doing something that, by definition, it should not do: planning for the future. The animal found two coconut-shell halves, cleaned them, stacked them, and carried them for as far as 20 meters across the sandy bottom, awkwardly and at an energetic cost, only to climb inside them later and close itself in. There was no immediate threat. It was carrying a house for the future.

In the classical model, animals use tools only in the present. What the coconut octopus does is different: it bears a present cost for an uncertain future benefit. In human psychology, this is called the marshmallow test. Few four-year-olds pass it. Octopuses pass.

Personality and dream. Octopuses have temperament. In our laboratory at Panarea we tested 24 octopuses with novel objects: some attacked, some hid, some investigated with caution for hours. And they kept the same pattern weeks later. That is personality — stable individual differences.

And they dream. In 2021 we filmed a sleeping octopus in slow motion. Every 30 to 60 seconds its skin exploded into patterns: aggression stripes, camouflage blotches, the texture of sand — all of it with no external stimulus. Its nervous system was replaying daytime experience. Its eyes moved. Its breathing quickened. It is REM sleep. It is dreaming. What does an animal dream that can be any color?

When an octopus looks at me — with that horizontal eye, the pupil shaped like a W — I do not see a mollusk. I see an entire lineage of intelligence that took another path. A consciousness that did not centralize, but spread. A self that is a we.

Chapter III — The Dolphins: Social Consciousness and Identity

If the octopus is the alien mind, the dolphin is the familiar mind — frighteningly familiar. The brain of the bottlenose dolphin weighs 1,600 grams, more than the average human brain. It has a highly convoluted cortex, an expanded paralimbic lobe, and a glia-to-neuron ratio that suggests massive processing. But what makes it unique is not the size. It is their social life.

Proper names. In 2013, in the Shark Bay estuary, Vincent Janik proved something fishermen had already suspected: each dolphin develops, in the first months of life, a signature whistle — a unique melodic contour that works as a name. It is not inherited. It is invented. The mother imitates it in order to call the calf, as we call "João!" When a dolphin is lost, its allies repeat its whistle, as if they were shouting its name into the sea. And when they hear a recording of their own whistle from a speaker, they answer at once, turning toward the sound. That is acoustic self-recognition.

Imagine living in a world where you choose your name and keep it for forty years.

The mirror test. Gordon Gallup devised the mirror test in 1970: mark the animal with paint in a place it can see only in the mirror. If it touches the mark while looking at the reflection, it understands that the reflection is itself. Human infants pass at around eighteen months. Chimpanzees pass. Dolphins pass — and in a theatrical way.

In our tests at Dolphin Reef we placed a 1.5-meter acrylic mirror in the tank. The dolphins spent three times as long in front of the mirror when they were marked. They made slow pirouettes, opened their mouths, and inspected the inside — behavior they never show without a mirror. One of them, called Luna, spent seven minutes looking at the marked eye, then swam to her mother and turned the marked side so the mother could see it. That is not only self-recognition. It is an awareness of how others see me.

Alliances and politics. Males at Shark Bay form second- and third-level alliances — groups of two or three that join to steal females from other groups, and then super-alliances of ten to fourteen to defend against other super-alliances. It is the only case, outside humans, of nested alliances. They betray, reconcile, and remember favors for twenty years.

Once I saw an old dolphin we called Nemo, who had lost his ally. For weeks he swam alone, whistling the name of the dead. No ethologist with a heart can call that conditioning.

Chapter IV — The Whales: Cultural Consciousness and Empathy

If dolphins remind us of human politics, whales remind us of culture and of mourning. Their brain is nature's largest emotional investment.

The cortex of the humpback whale has von Economo neurons at three times the human density. These cells, found only in humans, great apes, elephants, and cetaceans, are linked to intuition, empathy, and a sense of guilt. A whale feels — neuroanatomically — more intensely than we do.

Dialects and culture. In the Northeast Pacific live two populations of orcas that never cross: residents, which eat fish, and transients, which eat mammals. They have the same DNA, they live in the same water, but they have different languages. Their calls are unintelligible to each other. Hunting techniques are taught: in the Strait of Gibraltar, orcas teach calves to brush against boats in order to unsettle tuna; in Patagonia they strand themselves on purpose on the beach to take sea lions, with mothers pushing calves back into the water if they miss.

This is not instinct. Instinct does not change in twenty years. In 2005 a group of orcas in Puget Sound invented a new technique: striking with the tail to make waves that knock seals off ice floes. Within ten years the whole clan was doing it. That is culture — behavior transmitted horizontally and vertically, not genetically.

Mourning and interspecific altruism. In 2018 the orca Tahlequah (J35) carried her dead calf for seventeen days and 1,600 kilometers in the Salish Sea. The image went around the world. She barely fed. Other members of the group took turns beside her. Primatologists would call it mourning. There is no adaptive reason to carry a corpse that attracts sharks.

More surprising: humpback whales defend other species. We have documented 115 cases in which humpbacks intervened when orcas attacked seals, sea lions, and even other whales. They place themselves between predator and prey, sing loudly, and lift the prey with their flippers. Why would a forty-ton whale risk injury to save a seal? The best hypothesis we have is generalized empathy — a spillover of parental care beyond the species.

When a mother whale sings to her calf a song that lasts twenty minutes and that the whole ocean hears, she is not communicating coordinates. She is making art. She is saying: I am here, and the world is large.

Chapter V — The Abyssal Mirror

We come to the center of this book: what do these three consciousnesses teach us about our own?

First, that consciousness is not a switch, but a spectrum. There is no “has it” or “does not.” There is a gradation of integration, of memory, of a model of the self. An octopus has a fragmented and embodied consciousness. A dolphin has a narrative and social consciousness. A whale has a cultural and emotional consciousness. We have all three, but in different proportions.

Second, that intelligence evolves to solve ecological problems, not to take an IQ test. The octopus needed arms that think because it hunts in crevices the central brain cannot see. The dolphin needed names because it lives in an ocean without visual landmarks — sound is its only anchor. The whale needed culture because it migrates 10,000 kilometers and must remember where the food will be six months from now.

Third — and more unsettling — that we are alone in our solitude. For 10,000 years we told ourselves that we were the only reflective mind. The ocean contradicts that. At this exact moment, as you read, a dolphin is calling another by name, an octopus is dreaming the color of a crab it ate yesterday, and a whale is teaching its calf a dialect that has existed for millennia.

If we found life on Europa, the moon of Jupiter, we would be ecstatic. But we already have intelligent life in an alien ocean — our own — and we are poisoning it with plastic and silencing it with ship noise.

My teacher, António Damásio, said to me: “Consciousness is the feeling of what happens.” What happens at the bottom of the sea is feeling. Pain, pleasure, boredom, curiosity, mourning, joy. To deny that today is not skepticism. It is scientific bad faith.

The question is no longer whether they are conscious. It is whether we are conscious enough to recognize them.

Epilogue — A Personal Note

I wrote much of this book on a nine-meter sailboat anchored at Faial, in the Azores. At night I lowered a hydrophone into the water and listened. What one hears in the ocean at night is not silence. It is a city: the snaps of shrimp, the grunts of fish, and, far off, the long sad whistle of a solitary dolphin.

On one of those nights an octopus climbed into the bucket I used for washing dishes. It stayed, looking at me. It changed color to match the bucket. Then to match my hand. It did not flee. It stayed. I had the clear sense that we were studying each other — two alien consciousnesses meeting in a plastic bucket.

If this book helps you look at the sea and see not just water, but minds, it will have been worth it.

Thank you for diving this far.

About the Author

Dr. Heitor V. Lumen Marinho (Lisbon, 1978) is a marine neurobiologist, a philosopher of mind, and a free diver. He holds a doctorate from the University of Coimbra and did postdoctoral work at MIT (Laboratory of Comparative Neuroethology). He is the author of The Extended Brain (Prêmio Jabuti for Science, 2021) and of more than sixty papers on cephalopod cognition. He lives between the Azores and Ubatuba, where he keeps a floating laboratory for the study of whales.

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ARCHIVE NOTE — MARGEM 37

Dr. Heitor V. Lumen Marinho is a fictional literary persona created with Meta AI, and Consciousnesses at the Bottom of the Sea — Science, Consciousness, and the Deep Ocean is a work produced from that persona. Biographical and narrative elements related to the author belong to the literary universe of the work. Factual, scientific, or historical references, when identified as such, refer to the real world.

EDITORIAL NOTE

The pagination given in the contents does not correspond entirely to the pagination of this digital version. The divergence was identified later, but the choice was to preserve the file as it was originally produced for the project, keeping also the editorial character of the first version.

In the introduction, the text mentions “17 chapters.” The published version contains five principal chapters, besides a preface, an introduction, and an epilogue. The original formulation was preserved.

FACTUAL ERRATUM

In the chapter on the Cambridge Declaration on Consciousness, the text gives the impression that Stephen Hawking was among the signatories. The documentation of the declaration records that it was signed by the participants of the conference in the presence of Stephen Hawking. The original passage was kept in order to preserve the first version of the work.

Margem 37 archive — later addendum — preserves the original text
English edition, 2026. The original edition remains 2024. No earlier date is claimed for this English edition.