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# current conservation

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**Current Conservation** carries the latest in research news from natural and social science facets of conservation, such as conservation biology, environmental history, anthropology, sociology, ecological economics and landscape ecology.

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Cover art **Keya Lall**

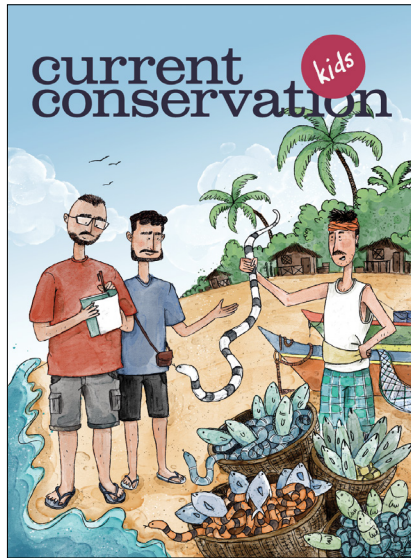
For our marine issue this year, we wanted a set of articles about many, lesser known marine critters. Tanvi Vaidyanathan writes about the trade in seahorses, a fish which has 'a head like a horse, tail like a monkey, a kangaroo-like pouch, and eyes that move independently like a chameleon'. Seahorses are also remarkable because the male carries the eggs around in his pouch till the young ones hatch, a rare instance in nature where males give birth. Mahima Jaini tells us about her journey from studying lobsters in Maine to larvae under microscopes in the Andaman Islands. She uncovers 'bizarre looking' and 'alien like' creatures from her plankton nets. And Kristin Hultgren gives us a glimpse into the lives of snapping shrimp, which produce some of the loudest sounds in the ocean with their oversized claw. These are also the only marine animals that show advanced social behaviour like ants, bees, and wasps. If these weren't enough, Vikas Nair's black water photographs offer a window into just how weird and wonderful marine organisms are.

Bookending the stories about fantastic beasts are two articles that delve in different ways into our relationship with nature. At one end, Rohan Arthur recounts his long running love affair with the reefs in the Lakshadweep, and reflects on the role of symbiosis in our lives. At the other, Caitlin Kight's essay provides insights into our physiological and psychological responses to nature and reveals the many benefits it has for our health and wellbeing.

—**Kartik Shanker**

In this issue of CC Kids' we have two articles from Indian seaside town of Malvan, Maharashtra. Each year huge numbers of tourists come to this beach to enjoy the sun and sea. But alongside these vacations there is a busy fishing industry supported by a vibrant marine ecosystem. In both the articles in this issue, the interactions between people and marine wildlife are explored—food for thought next time you are at the beach or have fish on your dinner plate.

—**Matthew Creasey**

Cover art **Tara Sunil Thomas**

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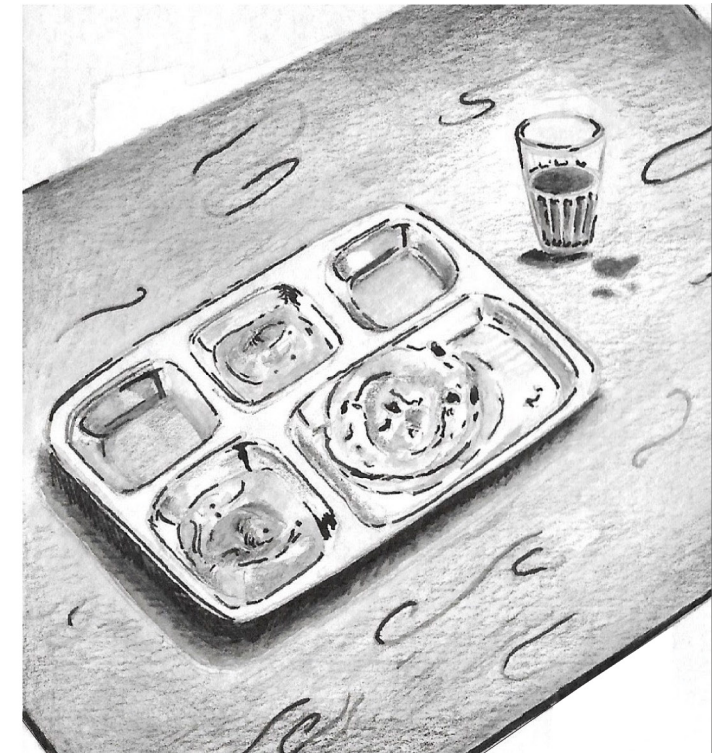
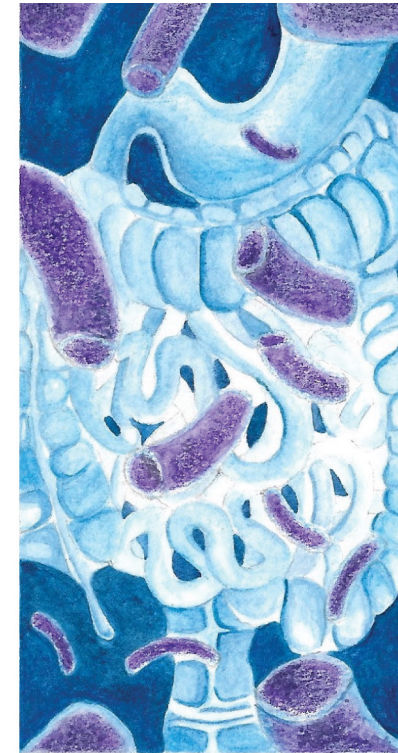
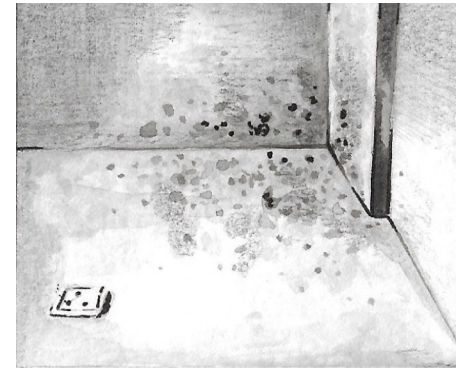
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## Symbiosis

Author **Rohan Arthur** | Illustrator **Adira Andlay**

There is nothing heroic about turning 47. It has none of the transitional status of 40 nor is it a milestone like 50. If it represents anything, it is one more annual reminder of the general accretion of the past, you eroding gradually under its crust. You stare at the growing damp fungus on the ceiling of this tired hotel. Brief body scan from toe to head. Everything aches. That's normal. It has been normal for a while. Inside, your gut microbiome is in turmoil. You've read somewhere that, cell-for-cell, this swirling community of bacteria, protists, and viruses constitute more of you than you yourself. And they are clearly not happy. They have been living on a diet of parotta, fish curry, and sugary tea far too long, and it is only a matter of time before they mount a proletarian protist revolution from within. One more day, you urge. One more day and you are out of these islands. Uncheery thoughts to start the morning. Happy birthday to you.

After twenty two years of being here, you think you are finally spent. The reefs have gone through one major upheaval, then another, and then another. With every one, your hopes fail, then rise, grow exuberant, then crash yet again. The fate of the reef is linked to yours, and after so many repeated batterings you seem both to be waving the flag of surrender. This time around, you promise, you will not rise again, if it will only make the pain go away. Twenty two years. Inside you, your microbiome remind you, a trifle peevishly, that they have been at it for 47. To their credit, it has been a mostly uncomplaining symbiosis, and you cannot really tell where they end and you begin. In reality, until a few years ago, you did not even know they existed, processing your foods, keeping you healthy, keeping you sane.



“Chalo”, you retreat to the cheery vernacular, “let’s head out to sample”. The boat will be waiting at the western jetty. The morning quickly coalesces around the familiar routine. Mask: bifocals for ageing eyes. Fins: quirky duck-shaped ones that have accompanied you all your life. Booties, weight belt, blank slate, pencil, camera in housing, PVC quadrat. Load the net bag and four tanks into the rickshaw. Ride the short distance to jetty. Unload. Load again. Consider a spritely hop on to the boat but remember that you are 47 now. You accept the outstretched hand of the boat captain and climb more gingerly on, suppressing a grunt of effort as your feet hit the deck. Start engines. Chug out of the western lagoon. You chomp a few glucose biscuits before you roll backward into the water. Give the protists something to keep them going through the dive.

You know this site well. You have come here every year for 20 years. It has had a troubled history, like most western reefs in this archipelago. This site was teeming once. Handsome stands of colourful *Acropora* fought bitterly for space in the light. Now the shallows are a vast rubble field, brown with turf, left to the skulkers and scrapers of the reef. It has been like this for many years now. You try not to look as you head further down to get the deeper transects done first. 14 meters. We’ll start here. Place the quadrat. Rise with a breath and hover motionless. Click. Swim ten meters. Repeat. In these deeper waters, the reef is doing better and it does not hurt as much to look. There is even beauty here among these living rocks. Transect one done. You set your mind in neutral and get ready to start the next.

The reef looks unfamiliar. You have swum slightly further than you normally do, slightly deeper. There is something large in the distance. You feel it before you see it. Damn this bifocal mask, you curse, as your eyes struggle to make sense of the shape in the blue. When your eyes finally focus, you see it in all its impossible majesty. It is a giant. A coral, but in all your years of diving these reefs, rarely have you encountered an individual so massive.

It has a gravity all of its own and you are drawn to her, almost afraid to exhale should you wake her from some ancient slumber. At 30 meters away, she fills your vision, a shuddering, living ecosystem all to herself. She wears an iridescent veil of tiny anthias and chromis. Three consorting green turtles rest on her surface, one exhaling quiet bubbles through his nostrils. Below, in the shadowy crannies she creates, large groupers lurk with other regular cave dwellers - wide-eyed squirrels, deep-bodied sweepers, the inevitable banded shrimps.







You lose all sense of her size. Your vision is coral. You are on your knees before her. Porites, possibly lutea. At this distance, you can see the polyps on her surface. At this time of day, most have retired after a night-time of feeding but a few still have their tentacles out. Impossibly, your 47-year old eyes focus in on a single polyp. It is lazily filtering the water for invisible zooplankton to crunch on. Green, but you know that, in reality, each polyp is pale transparent tissue. Inside each, an army of hundred thousand zooxanthallae are busy at work, painting the coral green but doing so much more. They are processing the sunlight that streams down to this depth through the clear waters. Impossibly, you see them through your bifocals, picking up little packets of light in their little dinoflagellate arms, mixing them up in their tiny photosynthetic kitchens, churning out food to feed the insatiable appetite of this Leviathan.

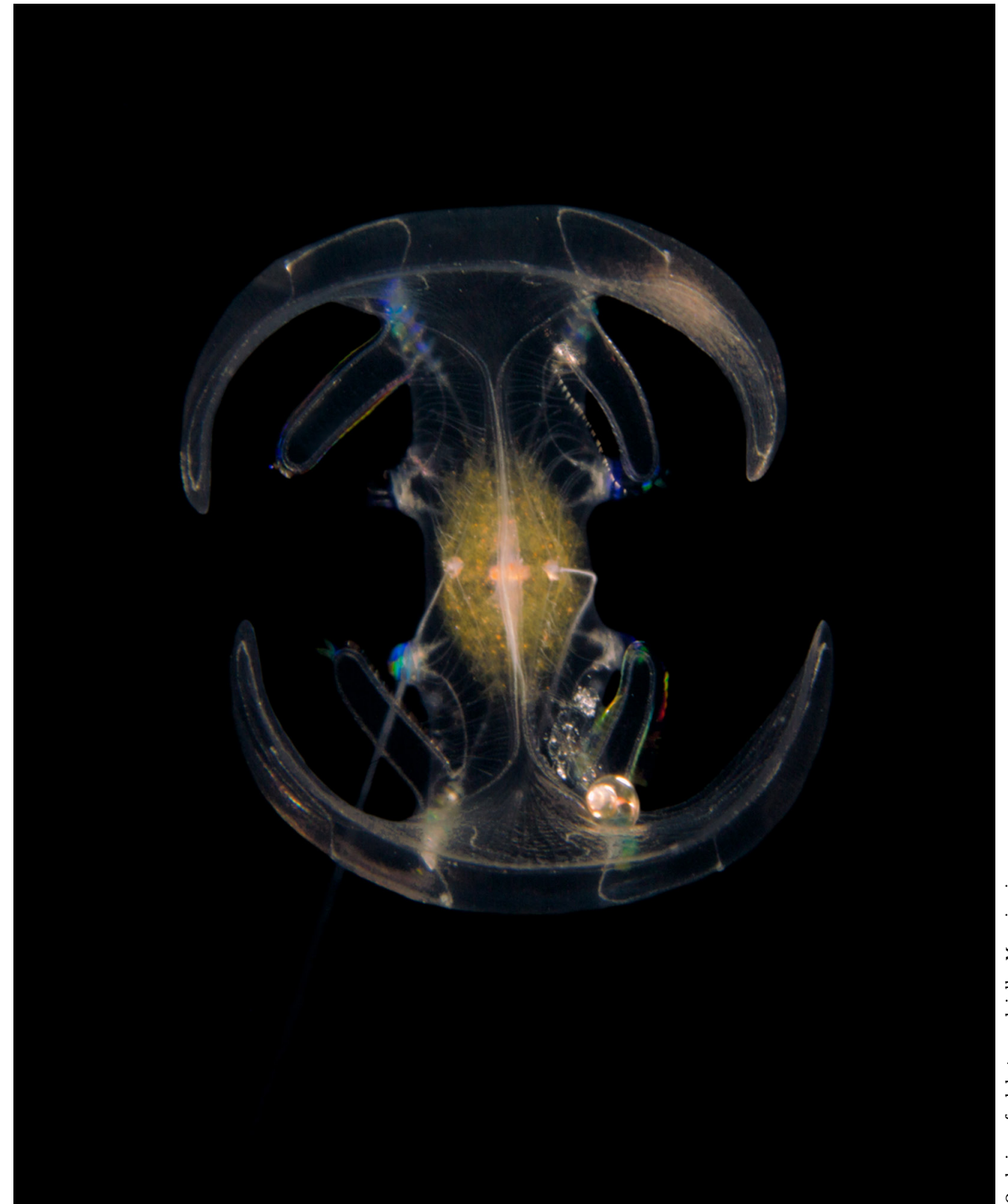
The protist in the coral speaks to the protist in you. There is a quiet movement in your tummy, but it is not a complaint. A silent communion of shared understanding. Comparing notes, you imagine. Two thousand years. Forty seven. When you first came to this island, the zooxanthallae seem to say, we were here already some 1978 years. Your entire 'long term monitoring programme' barely registers in our growth. Before you there were others of course, but we were here before. Cast your mind back, further back. When the first explorers, stragglers, all lost wanderers on their way to India, drifted on these shores, we were here, a mere 500 years old, but here. Further still. Deep in our protist past, dimly remembered now, for an oh-so-brief few hours, we once traveled the waters free, hitching a ride on a tiny planua, less than a millimeter across, that is now the Leviathan you kneel before. We have stayed. Through all the turbulence of the last two decades, through all the rising and falling of our cousins in the shallows, we remain, unmoved. Our history is the history of this reef, our future is its future. And by the way, happy birthday to you, young neonate.

The moment passes. An eternity. Barely breathing, you rise and collect your things. You hover over her, unwilling to leave. The veil of anthias part briefly to let you pass. You have transects to complete. You have corals to count. Your protists are digesting their biscuits.

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**Rohan Arthur** is a scientist with the Nature Conservation Foundation. He works on ocean and coastal systems in the Indian Ocean and (on occasion) in the Mediterranean

**Adira Andlay** is an illustrator who works with hand-done mixed media. She explores visual narratives as a means of sharing perspectives and has an affinity for making watercolour paintings of flora-fauna. Her area of practice is in the field of Social and Communication Design.



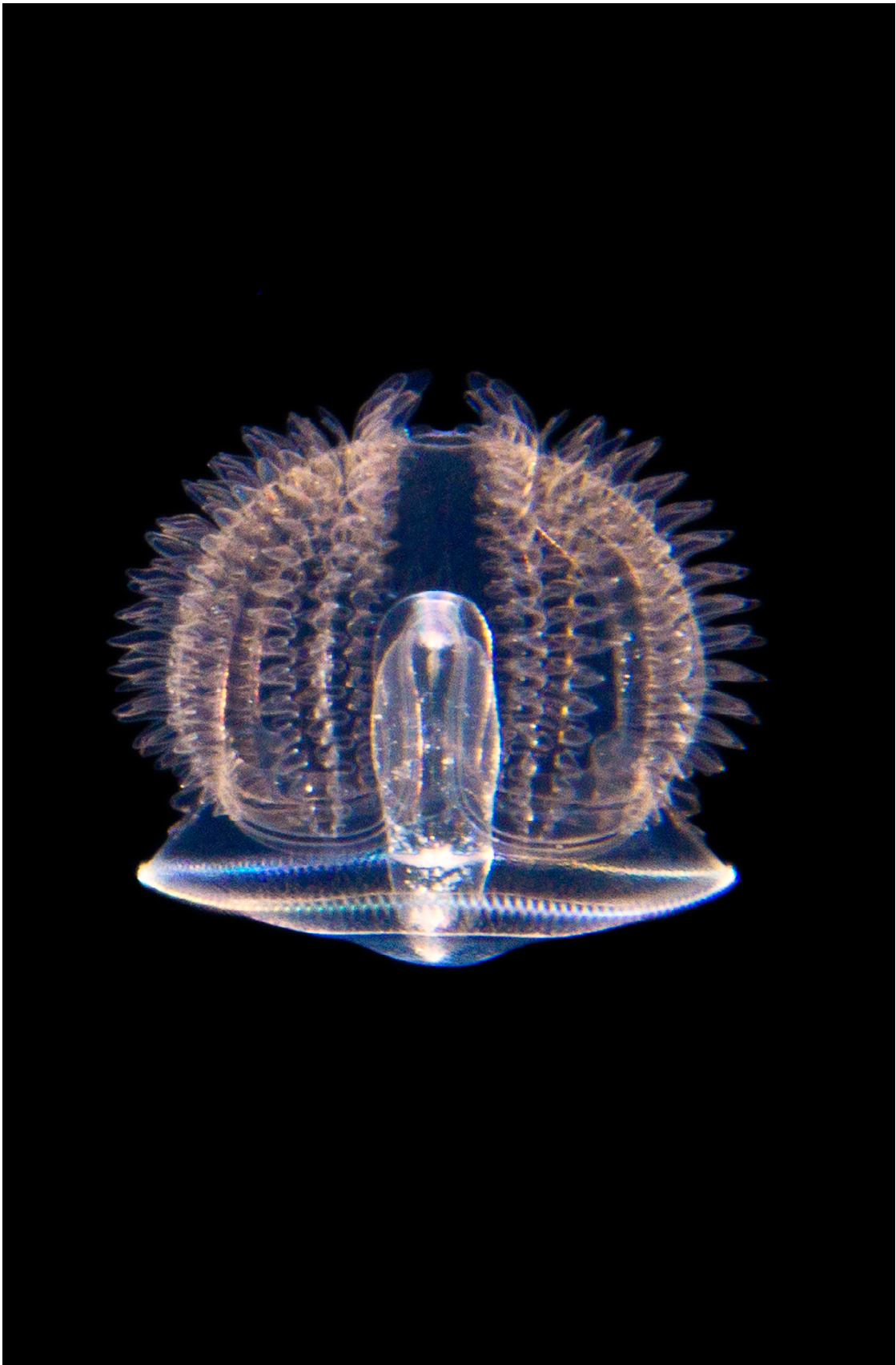
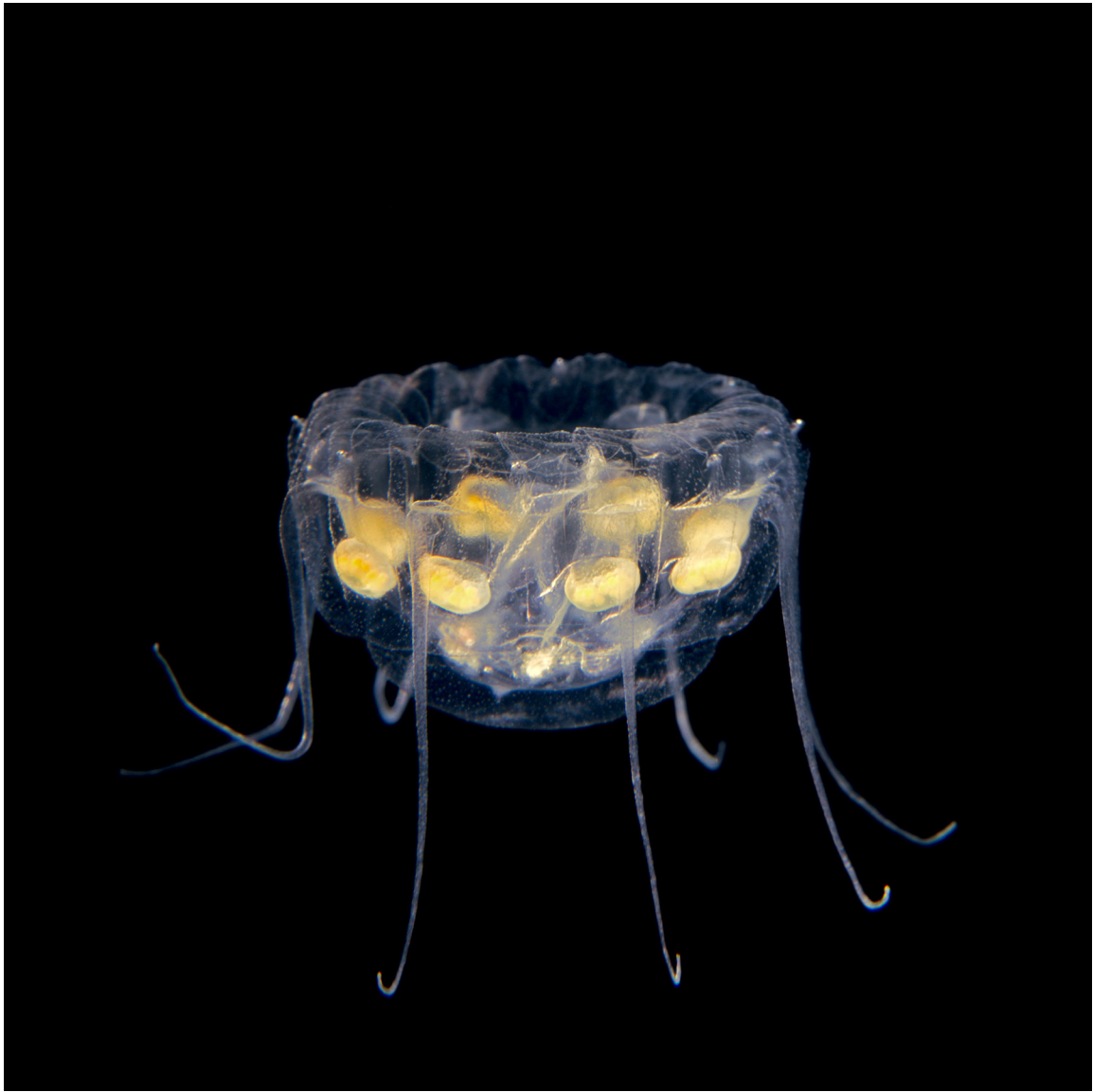
Oral view of a lobate comb jelly *Mnemiopsis* sp.

## The ocean by night

Author and Photographer **Vikas Nairi**



Crown Jellyfish (Family: Nausithoidae)



Tomaria larva of an Acorn worm (Phylum: Hemichordata)





Larva of Tonguefish (Family: Cynoglossidae)

I hover in the water column of the ocean. No reef below. At first glance, it seems just sheer blue water all around. But then you look closer and closer till you strain your eyes to focus. And that's when you see this world teeming with life. Where a speck of sediment suddenly finds wings and flies away like an angel. A flash of the light can bring out unimaginable colours. A world where the farthest distance is reduced a centimetre, and speed is measured in millimetres per hour. Even a small movement of my camera can create a storm for the creatures who are hurled away.

Every day, billions of these tiny marine plankton migrate to the surface from the depths of the ocean as the sun sets, and retreat again to its depths as the sun rises. Its much easier to spot these creatures on a night dive as they are attracted to my torch light. Zooplankton comprise marine worms, jellyfish, crustaceans, larvae of marine animals, while phytoplankton are mostly algae. All of them are very small creatures less than a centimetre in size. Except for jellyfish which can grow much bigger. Unlike their adult stages, these larvae and other creatures mainly drift along with the ocean currents, taking them far and wide across ocean basins. They can move small distances mainly to prey or to escape being eaten using cilia (tiny hairs) and moving their body with snake like movements.

The ocean is our major carbon sink and produces two thirds of our oxygen. The current climate crisis is also affecting marine zooplankton. The increased CO2 is making the ocean acidic which causes the calcium carbonate shell of these tiny creatures to thin; thus, making them more vulnerable to predation. In addition, the increased microplastic in the oceans is an added cause for concern.



Straight-needle pteropod, *Creseis acicula* (Family: Creseidae)



*Proboscidaactyla* sp. (Family: Proboscidaactylidae)



Scale worm (Family: Polynoidae)



Late Actinotroch larva of horseshoe worm (Phylum: Phoronida)



**Vikas Nairi** has been a dive instructor since 2003, and has loved every moment of being in the water till date. Photography was only to make that last out of water too :)

# Why we need to rethink our seahorse conservation strategy

Author **Tanvi Vaidyanathan** Illustrator **Manini Bansal**

On a bright sunny afternoon, after all the boats have come in for the day, a group of women fishers in a fishing village in Tamil Nadu sit around a pile of ‘trash’ fish. This is the catch, comprising a large number of invertebrates and non-edible fish, that will be dried and sold as animal feed and for fertilizer, but these women make a last-ditch attempt to sort through this fish to salvage what little they can. One of the women, Amutha\* triumphantly holds up a couple of seahorses and says, “This will help me buy some tea and snacks for the day.”

For people like Amutha, finding stray seahorses means some extra income for the family, while for the men, it usually covers the day’s alcohol and beedis. A trader comes in every day to buy all the seahorses they have collected (along with conches and other protected species that have gotten caught in their nets). It is a quick exchange, where the trader calls the shots. The fisher has no say in the price he or she will get for the seahorses, and they typically do not know what it is used for, other than the fact that it goes “to foreign” for some medicine.

It is very difficult to imagine that the seahorse, which is so casually traded for a pittance, is afforded the same protection by Indian law as the tiger.

## What is the seahorse, and why should we care about them?

The seahorse is a strange looking fish. They have a head like a horse, tail like a monkey, a kangaroo-like pouch, and eyes that move independently like a chameleon. Seahorses belong to the genus Hippocampus (from the Greek words for horse (hippos) and sea monster (campus)) and to the same family (syngnathids) as the pipefish. Seahorses are probably best known for the fact that, unlike most animals, it is the male that gives birth.

Seahorses are marine species, found amongst seagrass beds, mangrove roots and coral reefs, although some species are suited to dealing with varying salinity and are able to survive in estuaries as well. Seahorses manage to survive in their environment thanks to ability not just to change colour, but also to grow skin filaments and blend in with their surroundings. They use their camouflage, and flexibility to evade predators, since they are not the fastest of swimmers. In fact, the dwarf seahorse is considered to be the slowest fish in the sea. While they are able to evade predators in the wild, seahorses face a major





threat from overfishing and habitat degradation. Most often, like in Amutha's village, seahorses are caught incidentally in fishing nets. This means that they are not the main intended species of the fishing expedition, but are caught as a result of indiscriminate fishing gear.

This has led to a worldwide decline in seahorse numbers. Globally, there are 44 identified species of seahorses, of which 14 have been listed as 'threatened', 2 as endangered, and 12 as 'vulnerable' by the IUCN's (World Union for Conservation of Nature) Red List of Threatened Species, which assesses the extinction risk of species. Furthermore there is not enough data to assess the status of about 17 of these species, while 11 are listed as 'not threatened'. However, a recent study seems to suggest that at least 9 of the 17 species for which there is not much data may also be threatened. In India, there are currently 7 known species of seahorses in India, of which 6 have been listed as 'vulnerable' and the seventh species has been assessed as 'data deficient'.

There are a number of reasons why it is important that we understand how to conserve seahorses, and how the understanding can help improve our policies for marine conservation in general.

The threats faced by seahorses are the same that most other marine species face, including the degradation of their habitat, over exploitation, and being caught as bycatch. This has made seahorses flagship species for researchers to explain the need for marine conservation. Not only do they look extremely cool, they are also important players in the maintenance of the marine ecosystem, since they feed on organisms that live on the sea floor. Understanding the rampant exploitation and international trade of seahorses, and the fate of other incidentally caught species, can help strengthen legislation, and could go a long way towards protecting our marine environment.

### ***The global catch and trade of seahorses***

Seahorses are mostly an incidentally caught fish. This means that fishers typically do not set out to catch seahorses. However they are often caught in the net of bottom trawlers, where a net is dragged along the seabed, impacting nearly everything in its path. This is the most destructive fishing method used globally. Thousands of non-target species are caught using this method, and large areas of marine habitats are destroyed. Typically, bycatch from these bottom trawls include seahorses, sea cucumbers, and a large number of other species. This indiscriminate fishing



is believed to contribute to the capture of at least 37 million seahorses each year, and it is believed that a large number of seahorses caught as bycatch enter into seahorse trade.

Traditional Chinese Medicine is one of the main drivers of the trade of seahorses, as, in the dried form, they are believed to cure conditions like baldness, asthma and arthritis and improve sexual performance. Live seahorses are also in fairly popular demand and are traded for use in aquariums. Often, seahorses are sold as curios as well.

Despite a declining population, the trade continues to be rampant. Millions of seahorses are traded every year, and it is estimated that between 20 and 25 million seahorses are traded around the world annually. The demand for seahorses and their declining populations led to seahorses being listed in Appendix II of the Convention on International Trade of Endangered Species of Flora and Fauna (CITES) in 2002. This was seen as a means to regulate exports and ensure their wild populations remain intact. CITES is a Multilateral Environmental Agreement (MEA) and is the biggest and oldest wildlife trade convention that aims to regulate international trade of animals and plants.

### ***Seahorse fisheries and trade in India, and the ban.***

Until 2001, India was among the top four exporters of seahorses. But what changed after? To combat its substantial and unregulated seahorse fisheries, in 2001 India included all seahorses (and pipefishes) under Schedule I of the Indian Wildlife Protection Act. This signifies a ban on the capture and trade of these species. However, being a small, bycaught marine species, they often come up accidentally in nets and then can easily fit into a pocket or the pallu of a sari, making the enforcement of the ban is much tougher.

In mainland India, till the ban, most of the seahorses in international trade were caught from the south-





eastern coast of the country, from the Gulf of Mannar, and the Palk Bay, located in Tamil Nadu. While some of the seahorses were from targeted diving, a large number were incidentally caught using non-selective fishing gear. In addition to the large number of trawls operating in this region, seahorses face additional pressure from traditional but non-selective fishing methods such as the “Thallu madi” or drag nets. These nets, prevalent in the Palk Bay region of Tamil Nadu, are dragged along bottom-habitats in shallow waters directly over seagrass beds and, though often wind operated, are responsible for the catch of millions of seahorses.

While plenty of fishers continue to catch seahorses, fishers complain about declining fish catches, and many traditional fishers been severely impacted. For example, the fishers who are not able to catch seahorses anymore are losing out to the labour on trawler boats, who acquire seahorses as bycatch thus causing further grievances.

Although it has been fifteen years since the ban on catch and trade, what is clear is that seahorses continue being caught and traded in large numbers illegally. The demand for seahorses remains steady and the prices received by traders for seahorses also continue to increase, which makes conserving the species even more challenging.

### ***Do we need a change of tactic?***

Project Seahorse has been working extensively to try and understand the impact of the ban on the catch and trade of seahorses. What we found is that India’s ban on catching and trading of seahorses has in no way ended their extraction, just as so many other wildlife trade bans (e.g. elephants) have had little impact for conservation. The ban is rendered more ineffective because of the rampant indiscriminate fishing in the country. Seahorses that are accidentally caught in the nets are often dead by the time fishers sort their catches or reach the shore.

In the words of one of the fishers, Vellaiappan, “We cannot regulate catch in the ocean, and cannot control how much we catch, and cannot release seahorses once we catch them.” Instead, he advocates for the removal of the ban so that the fisherman can fish without fear.



The ban on seahorses is further undermined because of the poor communication to the fishers about the ban. After nearly two decades of the ban, what we found was that most fishers and officials, outside the state of Tamil Nadu were unaware of this ban. Fishers in other states often would speak of other banned species, but not of seahorses. For example, in Gujarat, fishers would talk about the ban on whale sharks but did not seem aware of the seahorse ban. In Kerala, on the other hand, there is a widespread belief that the ban only applied to Tamil Nadu fishers, and not to them.

Education and awareness often prove to be ineffective, since the question of livelihood is at stake. As one fisher from the Gulf of Mannar region of Tamil Nadu puts it, "Once the seahorse comes up dead, what is the point of throwing it back into the ocean? We may as well make some money from it." For the fishers, the profits from selling seahorses are minimal, and they are often at the mercy of the trader who determines the prices.

In the years after India banned its' seahorse catch and trade, a number of countries, such as Thailand and Vietnam, because of their inability to manage seahorse trades at sustainable levels, have since banned the trade of seahorses.

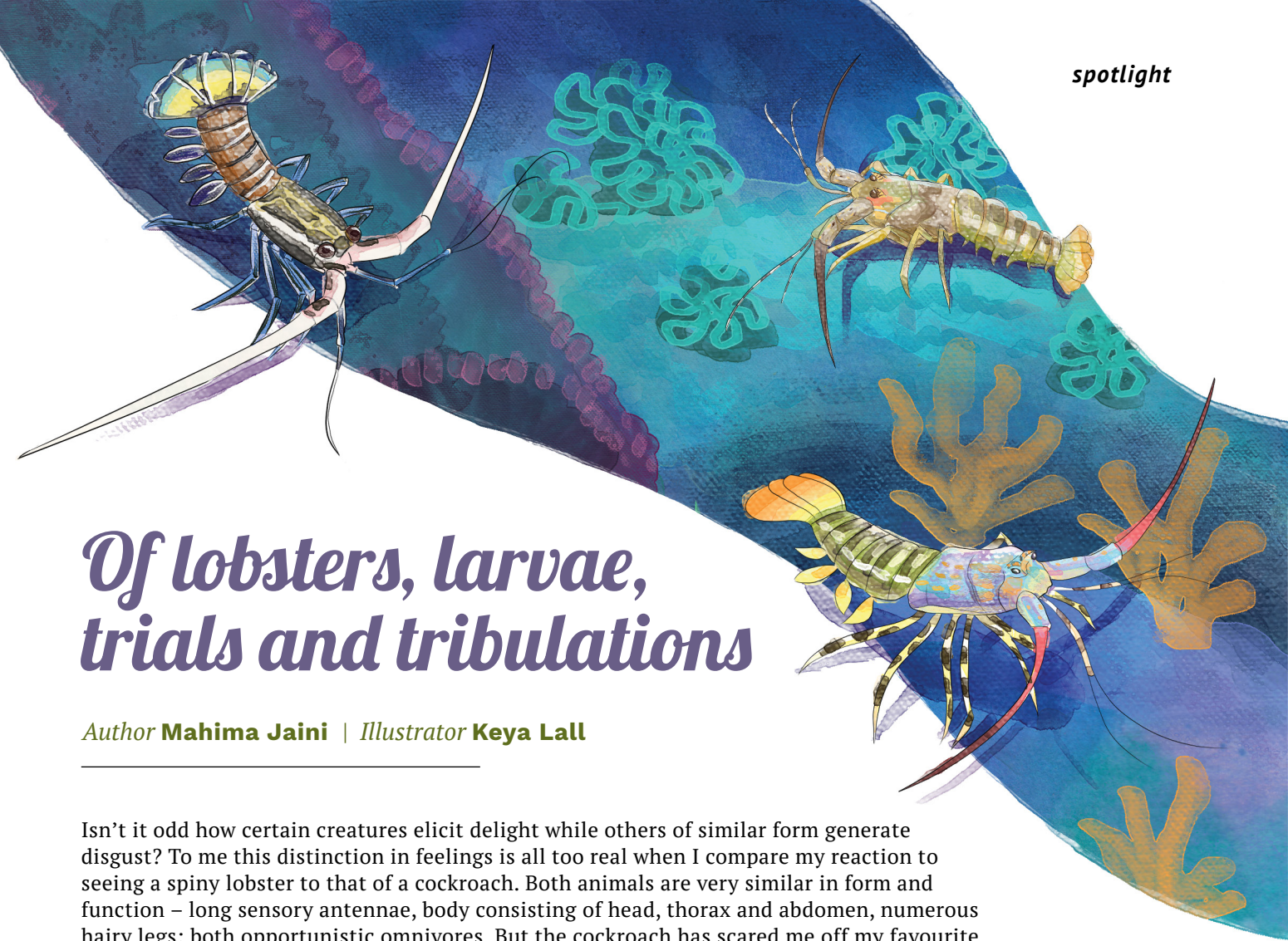
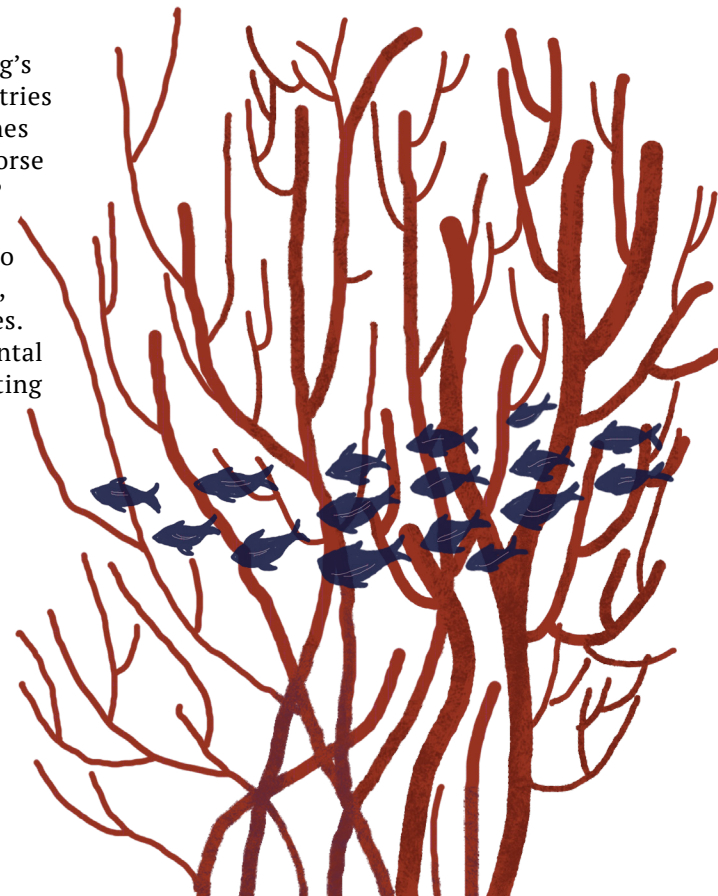
However, recent estimates suggest that around 95 per cent of the dried seahorses found in Hong Kong's large market are reported to have come from countries like Indonesia, India, Malaysia, Vietnam, Philippines and Thailand—all countries that have banned seahorse trade. This begs the question: is the ban effective? Many governments find that it is easier banning the trade of seahorses than developing measures to ensure the conservation of these species. Till date, the focus has always been on the trade of seahorses. However, given that seahorses are typically incidental catch, it may be more effective to focus on preventing the extraction of seahorses from the ocean.

Rather than focusing on the ban of extraction and trade of specific species, what needs to be done is to phase out destructive methods such as bottom trawling. Controlling the kinds of gear used or setting some restrictions on the time or place where fishing can happen, could help.

Until there is a concerted move to control the devastation caused by indiscriminate fishing, the trading of seahorses and other banned species will continue. The trader who regularly visits Amutha's village agrees. According to him, all the regulation must happen at sea. "As long as there are no regulations on seahorses being caught at sea, we will continue to have business in these villages."

**Tanvi Vaidyanathan** is a researcher based out of Canada, working in the marine conservation space. Specifically, she studies species that are incidentally caught in fishing gear, focusing on seahorses in the Indian subcontinent.

**Manini Bansal** is a visual communication designer whose work is mostly inspired by nature. She is trained to see through an analog lens which works its way into her illustrations.



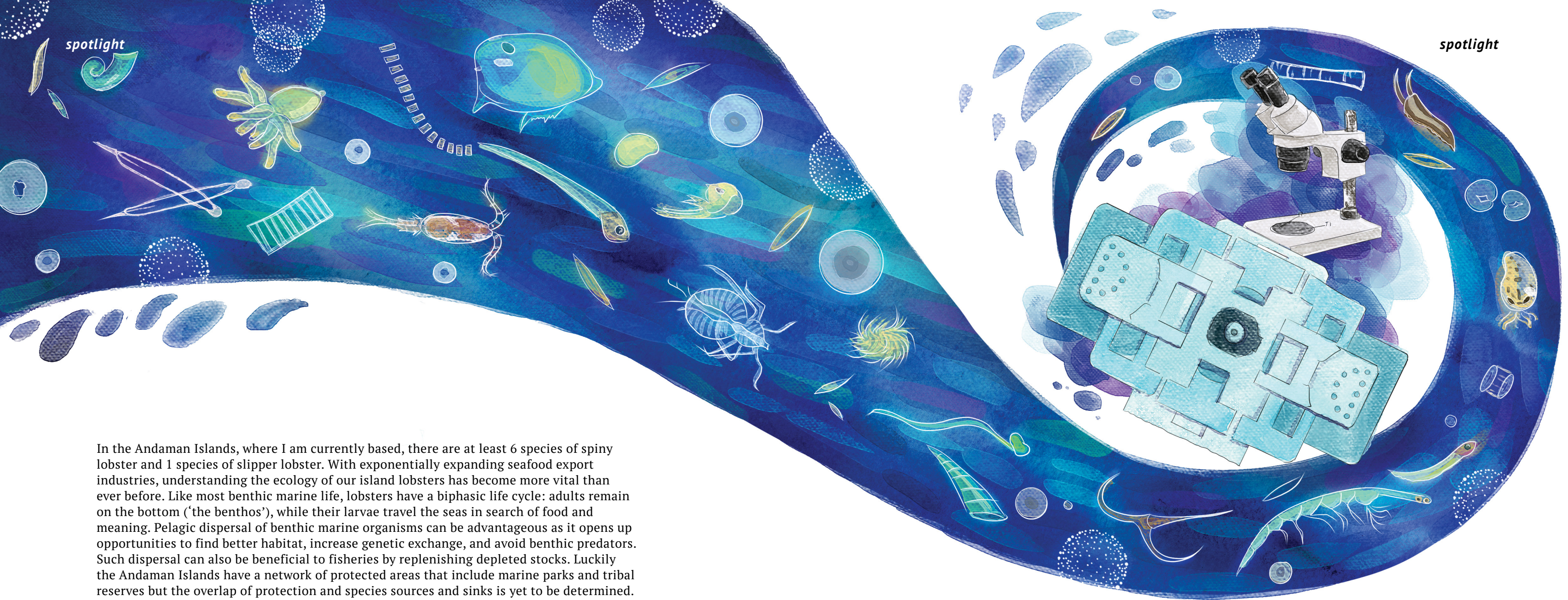
## Of lobsters, larvae, trials and tribulations

Author **Mahima Jaini** | Illustrator **Keya Lall**

Isn't it odd how certain creatures elicit delight while others of similar form generate disgust? To me this distinction in feelings is all too real when I compare my reaction to seeing a spiny lobster to that of a cockroach. Both animals are very similar in form and function – long sensory antennae, body consisting of head, thorax and abdomen, numerous hairy legs; both opportunistic omnivores. But the cockroach has scared me off my favourite oceanic islands and the most majestic tallships, while the lobster on the other hand prods my scientific curiosity. I studied the reproductive ecology of American lobsters for my master's at the University of Maine, USA, and my affinity for these crustaceans has followed me to the tropical islands of the Indian Ocean. Tropical spiny lobsters are bizarre but beautiful, with complex life histories and population dynamics that can take many human lifetimes to uncover.

The common names of spiny lobsters like the painted (*Panulirus versicolor*), ornate (*P. ornatus*) or scalloped (*P. homarus*) demonstrate their visual appeal. Tropical shallow-water spiny lobsters are intricately patterned and display a wider range of colours than an artist's palette. The carapace that protects the cephalothorax and the base of the antennae and feet are all covered in forward pointed spines, making it tricky to capture them unless you have evolved to prey on them or are a trained lobster biologist or fisher. Their exquisite colours are often lost when the lobster is cooked; the heat turns the exoskeleton into a bright red. Thus the beauty is best observed on dives or at fish landing sites and stores. Lobsters have evolved to be creatures of the night and only step out of their holes and crevices after dusk once their visual predators like triggerfish, have gone to bed. During the day, the gregarious adults hang in groups of 2 or more, often hiding in coral crevices and under ledges. The juveniles tend to be more solitary occupying small coral holes. But they all sit with their faces pointed outwards, their antennae gently swaying in the tropical waters that are full of smells, sounds, and vibrations. The sway of lobster antennae is very similar to the sway of cockroach antennae both of which I have gotten very good at detecting, albeit for different reasons and outcomes.





In the Andaman Islands, where I am currently based, there are at least 6 species of spiny lobster and 1 species of slipper lobster. With exponentially expanding seafood export industries, understanding the ecology of our island lobsters has become more vital than ever before. Like most benthic marine life, lobsters have a biphasic life cycle: adults remain on the bottom ('the benthos'), while their larvae travel the seas in search of food and meaning. Pelagic dispersal of benthic marine organisms can be advantageous as it opens up opportunities to find better habitat, increase genetic exchange, and avoid benthic predators. Such dispersal can also be beneficial to fisheries by replenishing depleted stocks. Luckily the Andaman Islands have a network of protected areas that include marine parks and tribal reserves but the overlap of protection and species sources and sinks is yet to be determined.

Spiny lobsters take 7-11 years to attain sexual maturity, fertilization is external and fertilized eggs are carried by females for 3-6 months. Hatched spiny lobster larvae undergo a series of moults, drifting in currents for 12 – 15 months, before finding suitable benthic habitats to settle onto. The larvae themselves are very bizarre looking. The early larvae metamorphose into an alien-like creature called the phyllosoma, which literally translates into 'leaf body'. The phyllosoma's cephalothorax is disc shaped and enlarged- kind of like the Millennium Falcon – gliding through the water column at the mercy of currents and consumers. Phyllosomas can be large - upto 4cm in length – and are often observed hitching rides on jellyfish. These space crafts moult into the final larval stage – the puerulus that starts resembling the adult. Once the puerulus reaches 'competency' i.e. the ability to detect the benthos and an affinity to occupy it, it will 'settle' to the bottom. These steps sound simple, biological, but are at the mercy of the wind, currents, pH, temperature, predators, and even plankton nets!

Currently, we are on month 8 of a yearlong study to profile the near shore plankton of the Andaman Islands. Our plankton net has mercilessly caught two lobster phyllosomas, both on new moon nights but months apart, and we are hoping more might be stored in our unanalysed weekly samples. This study aims to profile daily, lunar, and seasonal patterns in meroplankton diversity and abundance. Meroplankton are that part of the zooplankton community that only spend part of their life cycle in the plankton state, so these are usually larvae of benthic creatures. So far we have gotten a wide variety of fish, crab, cnidarian, shrimp, polychaete, and molluscan larvae and the list continues to grow. In addition to meroplankton, we are also studying changes in the dominant holoplankton community: the grazers (copepods), the filter feeders (appendicularians and planktonic

snails) and the ambush predators (the arrow worms). One arrow worm was also caught in the act of swallowing a fish larvae! While holoplankton can be processed efficiently with digital scanners and silhouette photo identification, the rarer meroplankton require visual searching by trained individuals. The sheer diversity of the tropics and severe knowledge gaps make our work difficult but not impossible. Funded by the Department of Biotechnology, this is part of a larger project at Dakshin Foundation that aims to develop inexpensive ways in which to profile nearshore planktonic communities. While zooplankton are too large, the project is demonstrating the value of inexpensive microscopes called foldscopes in studying phytoplankton communities – wherein techniques can be designed for long-term monitoring of coastal resources by citizen-scientists, local schools or colleges. Our work is opening up a Pandora's box worth of answerable questions related to the holy grail of marine sciences – supply-side ecology; some of which can be applied to study the fisheries ecology of Andaman's high value lobster and grouper seafood industries.

**Mahima Jaini** is the Marine Research Officer at the Andaman Nicobar Environment Team (ANET). ANET is a research and education center, located in India's Andaman Islands, co-managed by the Madras Crocodile Bank Trust (MCBT) and Dakshin Foundation.

**Keya Lall** studied design at the Srishti Institute of Art, Design and Technology, but her love for art and illustration has existed far longer. She finds a lot of inspiration from creatures both fantastical and real.



# Snapping, symbiosis, and sociality in the sea

Author Kristin Hultgren | Illustrator Akshaya Zachariah

One of the most ubiquitous sounds that snorkelers or scuba divers hear when visiting a coral reef is a subtle ambient soundtrack of snapping, crackling, and popping. Most visitors are surprised to learn that these sounds have a biological basis: they are made by thousands of snapping shrimps, living in the coral matrix. Snapping shrimp (*Alpheus* and *Synalpheus*) are one of the most abundant and diverse inhabitants of coral reef communities. Systematic surveys of coral reef diversity indicate that these shrimps constitute a significant proportion of what is known as the “cryptofauna”—small animals, both mobile and sessile, that live in the coral reef matrix or in symbiosis with other coral reef organisms. The din of snapping shrimps is so pervasive that one species was even named after the legendary band Pink Floyd (*Synalpheus pinkfloydi*).

The snap that gives these shrimp their name is produced by an asymmetrically enlarged claw, armed with a complex snapping mechanism. Although it was thought for years that the sound was produced by the two fingers of the claw striking together, studies utilizing high-speed video indicated that the snap comes milliseconds after the closing of the claw, and is produced by the violent implosion of a cavitation bubble. This implosion also causes a small flash of light and a powerful shock wave, giving these shrimps their other common name—pistol shrimp. These shrimps use their snapping claw for many functions, including communication, defense, and predation. Some species of *Alpheus* use specially modified hammer-like claws to drill elaborate galleries of tunnels into rock or dead coral. However, far from being a curiosity of natural history, the snap may have important consequences for coral reef communities. Recent studies have shown that the ambient noise of snapping shrimps can be an important indicator of reef health and may, in some cases, serve as an acoustic settlement cue for juvenile reef fishes.

The snap of these shrimps also plays an important role in communication and interactions with symbiotic partners of these shrimp. Although most snapping shrimps are free-living, many species form symbiotic relationships with other marine animals including sponges, corals, gobiid fishes, echiuran worms, crinoid echinoderms, and sea anemones. For example, many species of *Alpheus* snapping shrimps form partnerships with different species of goby fishes. These mutualisms have been some of the most well studied examples of cross-species communication in the sea. In this relationship, shrimp construct burrows in sand or rubble, which are colonized by gobies. In return, the goby acts as a lookout, warning the shrimp of approaching fish or other predators using a series of carefully timed tail flicks or other specialized behaviors. Shrimps maintain constant antennal contact with the goby while outside of the burrow, suggesting that this is necessary for accurate signal transmission.

Many species of *Synalpheus* snapping shrimps also dwell exclusively in the intricate canal systems of marine sponges. These sponges undoubtedly provide a critical predator-free habitat for these shrimp; fish typically immediately consume any shrimps removed from their sponge hosts underwater. However, experiments show that under some contexts, sponges can grow faster with shrimp living inside, and shrimp also defend their host sponge against predatory sea stars.

In some cases, these symbioses can have important effects on community functioning. For example, the shrimp *Alpheus lottini* typically lives symbiotically with branching pocilloporid corals. Although these corals are eaten by the crown-of-thorns sea star *Acanthaster planci*—a predator that can be several hundred times larger than the shrimp defender—*A. lottini* will vigorously defend its coral host by snapping and attacking the tube feet of the sea star using their snapping claw. Dense stands of this coral, protected by their crustacean symbionts, can actually provide refuge from *Acanthaster* predation to many other coral species, with important community consequences on coral reefs.

Snapping shrimp are also the only marine animals that show advanced social behavior, in the form of eusociality. Eusociality is most well-known in terrestrial insects such as ants and bees, and typically consists of colonies consisting of hundreds or thousands of workers that sacrifice their individual reproduction to support a single breeding queen and cooperatively care for the young of the colony. Several species of snapping shrimps in the genus *Synalpheus* are known to be eusocial. These shrimp dwell in dense colonies in marine sponges, consisting of typically a single reproducing queen shrimp and tens to hundreds of worker shrimp that jointly defend their host. They are capable of complex group and individual communication. For example, individual worker shrimp can discriminate between colony members vs. non-colony members, repelling the latter with fierce snaps. Some eusocial shrimp colonies engage in coordinated snapping, a collective group defense in which a sentinel shrimp recruits the rest of the colony to snap in concert, resulting in a loud crackling sound that repels invaders.

This suite of traits allows eusocial *Synalpheus* to be competitively dominant to pair-living species: two decades of research across the Caribbean indicate that eusocial species are typically far more abundant than pair-living species and use more host sponges. However, recent surveys indicate a drastic decline in the abundance of eusocial species in areas (e.g. Belize) where they have been numerically dominant for decades. These declines are thought to result from multiple factors, including population cycles of the shrimp and recent changes in sponge and coral community structure in Caribbean coral reefs.







Thus, snapping shrimps play important roles in coral reef communities—as defenders of corals and sponges, bioeroders, and creators of the ambient soundscape that signals a healthy coral reef. Although most conservation research has focused on charismatic reef fauna such as corals and fishes, the important ecological contributions of these cryptic shrimps demonstrate the importance of the hidden biodiversity of coral reefs.

### Further Reading

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**Kristin Hultgren** studies phylogenetics and evolution of crabs and shrimps. She is a faculty member at Seattle University.

**Akshaya Zachariah** is an illustrator by profession, who believes in making a difference with the little time she has on this planet. Learning about nature, right from a young age, has opened doors for her to utilise her knowledge and translate that into illustrations to educate everyone around, including herself.



# The healing hand of nature

Author **Caitlin Kight** | Illustrator **Kalyani Ganapathy**

Ever since I was young, feelings of melancholy or listlessness have inevitably given rise to a particular craving: to go outdoors. The urge has taken on different forms – sometimes I want to walk the clifftops by a tempestuous sea and have my face scoured by the salty wind; other times I want to lean back against the trunk of a venerable tree and look up at the golden sun shining down through its green leaves – but, no matter how it manifests, this desire has been a constant companion over the decades. Like a good friend who brings you soup when you have the flu, that companion has consistently helped me get through difficult times: when I return home after my dose of nature, I inevitably feel emotionally healthier and more balanced.

After years of thinking that my impulse to self-medicate with green spaces was a quirk of my own personality, I recently came to discover that it is actually a habit shared by many, and its value is documented by an increasing body of scientific evidence. Exposure to nature really is good for you, not just mentally but also physically. These benefits are observed across all demographics, habitats, activities, and lengths of immersion studied thus far.

If you're looking for testimonials on the value of a 'nature fix', as it is called by author Florence Williams in her book of the same name, you could read one of the many recent books on this topic including Joe Harkness's *Bird Therapy*, Sarah Ivens' *Forest Therapy*, Emma Mitchell's *The Wild Remedy*, and Wallace J. Nichols's *Blue Mind*. These and other similar volumes could be said to be descendants of *Biophilia*, a 1984 book in which biologist and conservationist Edward O. Wilson proposed that humans have an innate desire to 'affiliate with other forms of life', and suggested that we benefit from doing so.

Alternatively, if you would like more specifics about how to actually administer a green therapy, look no further; the following paragraphs detail the what, who, and why/how reported in the scientific literature to date.

### What are the health benefits of nature?

Humans have probably been deriving health benefits from the environments in which we live for as long as *Homo sapiens* has been a species. For example, some of our most commonly used pharmaceuticals come from nature: aspirin is derived from willow bark, and the antibiotic penicillin is derived from the penicillium mould.

However, biophilia is most frequently discussed in relation to mental wellbeing and one of the best-known early natural treatments is sea bathing. This was prescribed by doctors in the 18th and 19th centuries to combat 'melancholy' or 'spleen' (i.e., depression). These same physicians also saw the value of the fresh, clean air of mountaintops and deserts, where tuberculosis patients could retreat to sanatoria to recover their vigour and extend their lifespan. Sanatoria were no longer needed once anti-tuberculosis medication was discovered, but by then researchers had already confirmed that there were genuine benefits to spending time in these natural environments – for example, because sunlight can kill harmful bacteria and stimulate tissue generation. Recent studies have also shown that mortality rates, particularly those from cardiovascular problems, are lower in green environments than in those where nature is less prominent. This is likely related to the fact that both blood pressure and heart rate tend to be healthier in more natural spaces. It probably doesn't hurt that greener environments generally also protect against asthma and allergies.

Anyone who has gone on an extended camping trip will be familiar with the way that exposure to natural habitats alters sleeping patterns. Though those first couple days of waking at sunrise might come as a shock, the body seems to quickly adjust to the new rhythm, leaving you feeling more rested and energised. This has been formally documented, as has the fact that views of nature – even just glimpses through a window, scenes in a video, or artwork on walls – can



speed healing, boost your mood, and increase self-esteem. Interactions with nature also facilitate cognitive function, reduce feelings of stress, and enhance your sense of happiness and wellbeing.

Unsurprisingly, given this extensive suite of positive reactions and characteristics, nature is also known to boost creativity. Not just inspiring art, as in the case of writers and painters who become prolific during countryside retreats, but also facilitating the sort of 'eureka!' moments that lead to major innovative and philosophical breakthroughs (after all, Newton was supposedly sitting under a tree when he developed his Theory of Gravity). That said, nature is not just a mental stimulant. Proximity to nature also seems to inspire people to be more physical, prompting an increase in activities such as hiking, swimming, foraging, and, birding, all of which have been shown to have their own positive impacts on physical and mental health.

#### ***Who benefits from 'nature treatments'?***

This year, a UK-wide study on exposure to nature found that its benefits could be observed in all people examined – young or old, wealthy or poor, urban or rural, healthy or battling illness, male or female, disabled or not. Nature can help everyone.

One study on people who were moving house found that those who relocated to more natural environments experienced significant improvements in mental health relative to those who moved to new homes in less natural areas. Although the depressed mood did eventually improve in the latter group and return to baseline levels, the former group continued to experience the positive boost for an extended period of time. In a separate project conducted in the UK, scientists found that people

who live near the coast are healthier than those dwelling inland – a pattern that cannot merely be explained by increased levels of coast-related exercise (e.g., swimming or kayaking). Thus, it appears that individuals can benefit not only from living in natural areas, but also from living in particular types of habitat.

Attitudes towards and expectations of habitat can also play an important role in how people respond to it. Individuals with extensive experience in rugged, remote environments may find urban green spaces lacking; there are also some cultures in which negative associations with natural environments may prevent enjoyment of these spaces (though perhaps people may experience benefits of which they are unaware). City-dwellers with no exposure to the countryside may feel overwhelmed in the wild, and anyone who has had a traumatic experience in nature – being bitten by a snake, perhaps, or suffering a terrible allergic response to a plant – may find it difficult to relax in natural environments ever again. That said, it is possible that everyone may experience benefits from exposure to green spaces, even if they are unaware of these perks at the time.

People who are able to recognise biodiversity can get more enjoyment and benefit out of spending time in nature. This effect can be observed even if the biodiversity is perceived rather than actual and even if that diversity includes non-native species; this likely helps explain why some people get as much benefit from spending time in managed gardens as others derive from visiting a forest.

No matter where you go and what you encounter there, you may get more out of the experience if you are in greater need: Research has shown that more mentally

**People who are able to recognise biodiversity can get more enjoyment and benefit out of spending time in nature. This effect can be observed even if the biodiversity is perceived rather than actual, and even if that diversity includes non-native species; this likely helps explain why some people get as much benefit from spending time in managed gardens as others derive from visiting a forest.**







fatigued individuals anticipate more effective natural cures, leading to a sense of restoration. Indeed, a growing body of research has shown that green therapies are particularly helpful for those who are busiest, most stressed, and most unhappy – for example, children and young adults with ADHD. This also includes those who are otherwise neurotypical but are still worried about things such as school exams, adults with high-pressure jobs and packed schedules, and individuals who are feeling lonely. These are all aspects of the personal experiences documented in Emma Mitchell's *The Wild Remedy*, in which she describes the way in which nature acted as a lifeline when she needed it most.

### **Why/how does nature heal us?**

Generally speaking, time spent in nature is time spent away from stressful, sedentary, or otherwise harmful activities which goes a long way towards explaining many of the benefits of green therapies. However, nature is not helpful just because it is not something else; exposure to natural environments also impacts our health by altering physiological processes.

For example, plants act as natural filters, removing pollution from the air and leaving us with cleaner oxygen to inhale. Engaging in slower, deeper breathing tells the body that it can stand down the sympathetic nervous system – the one responsible for 'fight or flight' – and can instead allow the parasympathetic system to take over. The parasympathetic facilitates what has been known as the 'feed and breed' and 'rest and digest' groups of behaviours which are, on the whole, less stressful and more relaxed.

Deep breaths also result in increased oxygen intake, which helps balance out levels of serotonin – a neurotransmitter that impacts, among other things, mood, memory, and social behaviour. The air in natural spaces tends to have higher negative ion counts, which increases brain wave amplitude and facilitates alpha brain waves that give rise to a clear, calm feeling. Further, the natural landscape is filled with fractals, shapes in which the features of component parts match when scaled up to the features of the overall shape; these are also described as 'self-similar'. Looking at fractals can be very pleasing, which researchers now know is because these shapes interact with our visual processing system in a way as to activate the parahippocampus – an opioid-rich part of the brain that plays a role in regulating emotions.

Nature also engages our other main externally-focused senses, simultaneously delivering stimuli associated with visuals, scent/taste, sound, and touch. In the modern world it is increasingly rare for an experience to provide so many sensations all at once or for us to be in a

position in which we are actively concentrating on them all. Scientists have found that the types and amounts of stimuli in natural environments provide a Goldilocks-style experience: not so dull as to be boring, not so overwhelming as to be stressful, but perfect for keeping us engaged in a relaxing way. This balances out cognitive function and prevents any one part of the brain from being overwhelmed, which, in turn, allows our neurons to relax and recalibrate.

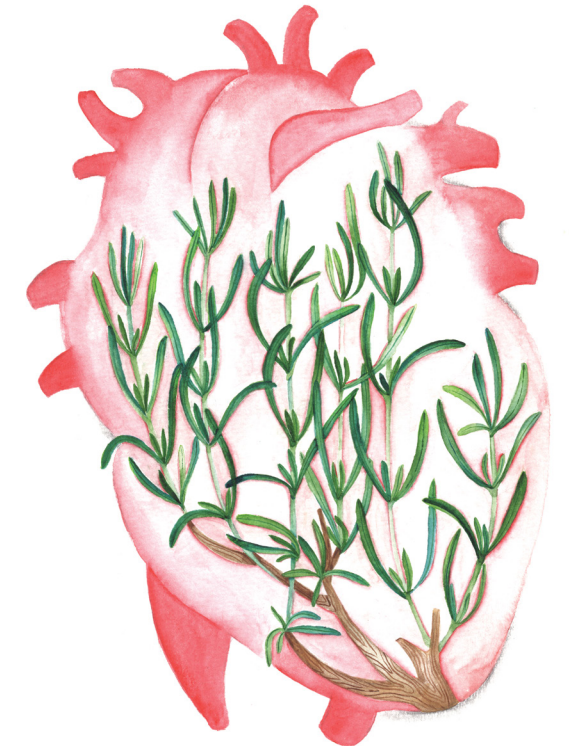
The rest of our bodies also benefit from this opportunity to unwind. Exposure to nature results in reductions in the hormone cortisol. Cortisol levels are also known to drop in response to pleasant-smelling plants like lavender and rosemary; these scents also increase blood velocity to the heart, thus improving circulation. Studies of another aromatic – extracts from the hinoki cypress tree – have revealed why exposure to green spaces can improve immune function: even just a few hours of breathing vaporized hinoki oil has been shown to increase the presence of natural killer cells, a white blood cell integral to our innate immune response.

The hinoki oil treatment described above has also been associated with better sleep and reductions in fatigue. In general, exposure to natural lighting scheme helps reset our circadian rhythms and improve our rest. Sunlight also stimulates the release of dopamine, a neurotransmitter that, among other things, acts in the retina to keep eyes healthy and prevent myopia. Depending on what you do when you venture out into nature, you may also be producing endorphins, chemicals that not only inhibit pain signals but also can produce feelings of euphoria – such as the 'runner's high'. You are particularly likely to experience if your green therapy involves activities such as rock climbing, kayaking, or trail running. Research has also found that spending time in nature can reduce blood flow to the subgenual region of the brain, which is related to feelings of self-wallowing; in other words, even if you don't achieve a 'high', you can perhaps combat a 'low' by heading outdoors.

One recent study found that it only takes two hours of green therapy a week to kickstart these processes and help you feel the benefits of what some researchers refer to as nature's 'biophysical ecosystem services'. You don't have to be active during that time and you don't even have to undertake all that exposure in a single go. Though the effects of the 'nature fix' can be felt almost immediately, it is not yet clear just how long these positive impacts can last; further research will be needed to determine how often you should administer a dose of nature if you want to maximize your health.

### **The future of nature treatments**

Researchers predict that, 30 years from now, some 70% of humans will live in urban spaces, where access to biodiversity and green spaces are often minimal. This is one of the main reasons that nature therapy has recently become such a hot topic; indeed, a majority of studies focus explicitly on urban habitats. Another key driver is





the global depression epidemic. Though increasing rates of diagnosis may simply reflect a better understanding of mental health and a greater disposition to discuss it, there is also some evidence that our increased isolation from nature and from each other, both of which have been linked to urbanization and to growing use of technology, are disrupting our brain chemistry and causing unhappiness.

Looking to make anthropogenic habitats more enjoyable, more aesthetically pleasing, and generally better for our wellbeing, everyone from doctors to social workers to city planners have already started implementing projects informed by the sort of research discussed above. Schools create gardens so that students can learn about plants through hands-on, whole-body experiences. Doctors and psychologists prescribe nature walks and community volunteering so that patients get fresh air in circumstances where they are also likely to make friends and grow support networks. Hospitals hang nature-themed art on the walls and provide patients with access to gardens. Prisons create green therapy spaces where the incarcerated can de-stress and regain their calm. Cities pass bills requiring the installation of green rooftops and green walls, and divert funds to the creation of, for example, water features specifically designed to mask the sounds of traffic noise.

These and many more measures have been very successful, though it is important to admit that nature cures aren't always perfect, or for everyone. For example, the introduction of water features might be aesthetically and aurally pleasing, but they could lead to stagnation and facilitate the growth of unwanted insect populations. In a bid to increase greenery, some landscapers might introduce plant species that cause allergic reactions in humans. Though many people love plants of all shapes and sizes, some can feel crowded and hemmed-in by certain types and amounts of vegetation, so it is important to consider not just location, but also structure and makeup of natural areas.

It has been documented that more and larger green spaces tend to be found in areas of higher socioeconomic status, suburbs and up-market parts of cities, whereas inner city communities often live in highly concretised

tenements. Future projects could very easily increase this divide between haves and have-nots. It is also somewhat ironic that many conservationists and environmentalists have pushed for an exclusionary approach, which seeks to move people out of natural areas where they have lived in the name of protecting species or habitats. This can only reduce the connections between people and nature, and remove the few benefits that they already receive.

Investigations of 'nature cures' are increasing alongside reports of 'ecoanxiety' – depression, post-traumatic stress, and anxiety related to climate change and environmental degradation; it is, in the word of one researcher, 'a chronic fear of environmental doom.' Many who experience ecoanxiety are nature-lovers who, like me, have spent their lives finding solace and healing in the outdoors and are now worried about the future of the planet.

But perhaps our growing awareness of how nature can positively benefit our own bodies might help spur more people into action; rather than trying to appreciate some distant and hard-to-see process such as nutrient cycling and buffering of floodwaters, people could appreciate the more visceral experience of lower blood pressure or lifted spirits. In other words, perhaps our greater investment in the creation and maintenance of green therapy opportunities for ourselves will facilitate conservation and restoration initiatives that will have positive side effects for wild ecosystems – a nature cure for nature itself.

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**Caitlin Kight** is an educator, communicator, and scientist. She is the author of the natural history book *Flamingo* and tweets as @specialagentCK.

**Kalyani Ganapathy** is a children's books illustrator. She lives in South India and enjoys observing nature. You can see more of her work at [www.kalyani-ganapathy.com](http://www.kalyani-ganapathy.com)

# current conservation

kids







# An unexpected catch

Words and Pictures **Matthew Creasey**



Sleepy early morning on the beach in Malvan, Maharashtra. Salty sea-dogs are combing the beach for scraps.

The rich pickings from the fisher's nets mean that the population is growing, but this causes conflict and many bear deep scars.

Along the beach, a shore-seine net is being pulled in.

Towing one end of the net, a boat has made a big arc out to sea. As the net is played out behind, it makes a semi-circle in which to trap the fish.

Once the boat has returned to shore, fishers pull in both ends of the net.

Pulling the left and right ends of the net, they make a semi-circle in the sea. Back-breaking work!

Finally, the net is close to shore and the catch can be landed...



But some sharp eyes have spotted something hidden in a corner of the net...

A green sea turtle, caught by mistake and hidden amongst the fish.







The surprised and excited fishers carefully release the turtle and it begins to haul its way back to the sea.

As the turtle slips back into the water, the fish is piled high.

**Matthew Creasey** is a biologist and science writer. He currently works for the wildlife conservation charity WildTeam.



## Scaly business

### — A day in the life of a sea snake ecologist

Words **Shawn Dsouza** and Pictures **Tara Sunil Thomas**

What do sea snakes eat? Do different types of sea snakes eat the same things? Do they live in the same places? Do these behaviours change throughout the year? For the past two years I've been working in Malvan, Maharashtra, trying to answer these questions. But first there was something I had to figure out: how does one study an animal that spends most of its time underwater? Three words – fishers, boats and nets.



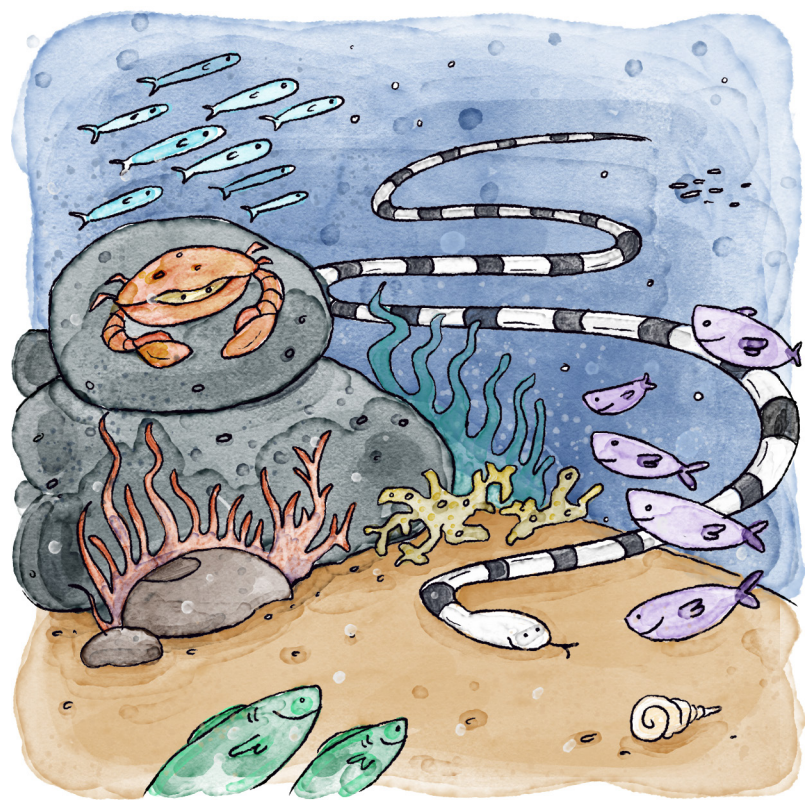
Perhaps before I go any further I should explain what a sea snake actually is. They are unique marine reptiles that evolved from land dwelling ancestors in the waters around Australia, 2 – 3 million years ago. Like all other reptiles they need to breathe air to survive, but can dive for up to 30 minutes at a time in search of food. Some sea snakes may come on to land to rest or to lay eggs - these are known as 'sea kraits'. True sea snakes on the other hand live their whole lives at sea. To do this, they have evolved to give birth to live young and may have around 20 babies at a time. Sea snakes can be found all the way from Australia in the east to the Eastern Coast of Africa. Throughout this range they frequently come into contact with people. In Malvan, we have found 5 species of true sea snakes, of which the Beaked sea snake and the Shaw's sea snake are the most common. These are the focus of my work.

Humans have been casting their nets into the oceans in search of food for thousands of years. As the number of people grew, more boats with better nets, lines, hooks and eventually engines began to operate in coastal waters. While we got better at catching large quantities of the tasty seafood we wanted, our nets would often also bring up other, inedible types of sea-life we hadn't meant to catch and had no use for. This is known as 'bycatch' and it affects scores of marine organisms in coastal areas and oceans around the world. Sea snakes are very often caught as bycatch in fishers' nets at Malvan, and we don't know very much about what effect this is having on these marine reptiles.

Every morning the fishers at Malvan set out, while it's still dark, around 2 am. They return to shore just after dawn, so my project assistant Yogesh and I try to wake up before the sun rises, as this the best time to meet them and see what they have caught. With our notepads and snake hooks (metal hooks with which we can gently pick up the snakes without being bitten) in hand, we walk along the beach. The fishers start with a bit of black tea then put on plastic overalls and start sorting their catch. Yogesh and I wave at our fisher friends and ask them what they caught that night. Every so often, a fisher will call us over. "Maruza!", he'll say, which means sea snake in the local Malvani. We then carefully collect the snake from the net and ask the fishermen for information about where they caught it, what depth the







net was at, and what the habitat is like on the sea floor in that area. This helps us understand more about where the sea snakes are spending their time. Sometimes, we may show up late for the catch and then get an earful from the fishers for sleeping in. On average, we get around 3 - 4 snakes each morning.

We then take these snakes back to our field base where we measure them and check their stomachs for food, or eggs if it's a female snake. We also take blood and scale samples which will tell us about what they've been eating and where they've been moving over the past few weeks or months. Once we have collected our data, we take the snakes back to the beach and release them into the water.

Through this work, with the help of our fisher friends, we hope to come a few steps closer to understanding how humans and sea snakes interact in their shared environment and how they can live together peacefully.

**Shawn Dsouza** is a researcher at Dakshin Foundation with interest ranging from marine ecology to marine resource management.

**Tara Sunil Thomas** is an illustrator/ animator from Kerala who was based in Brooklyn. She is known for her work in NGOs supporting causes like environmental conservation, animal conservation and education for children.

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