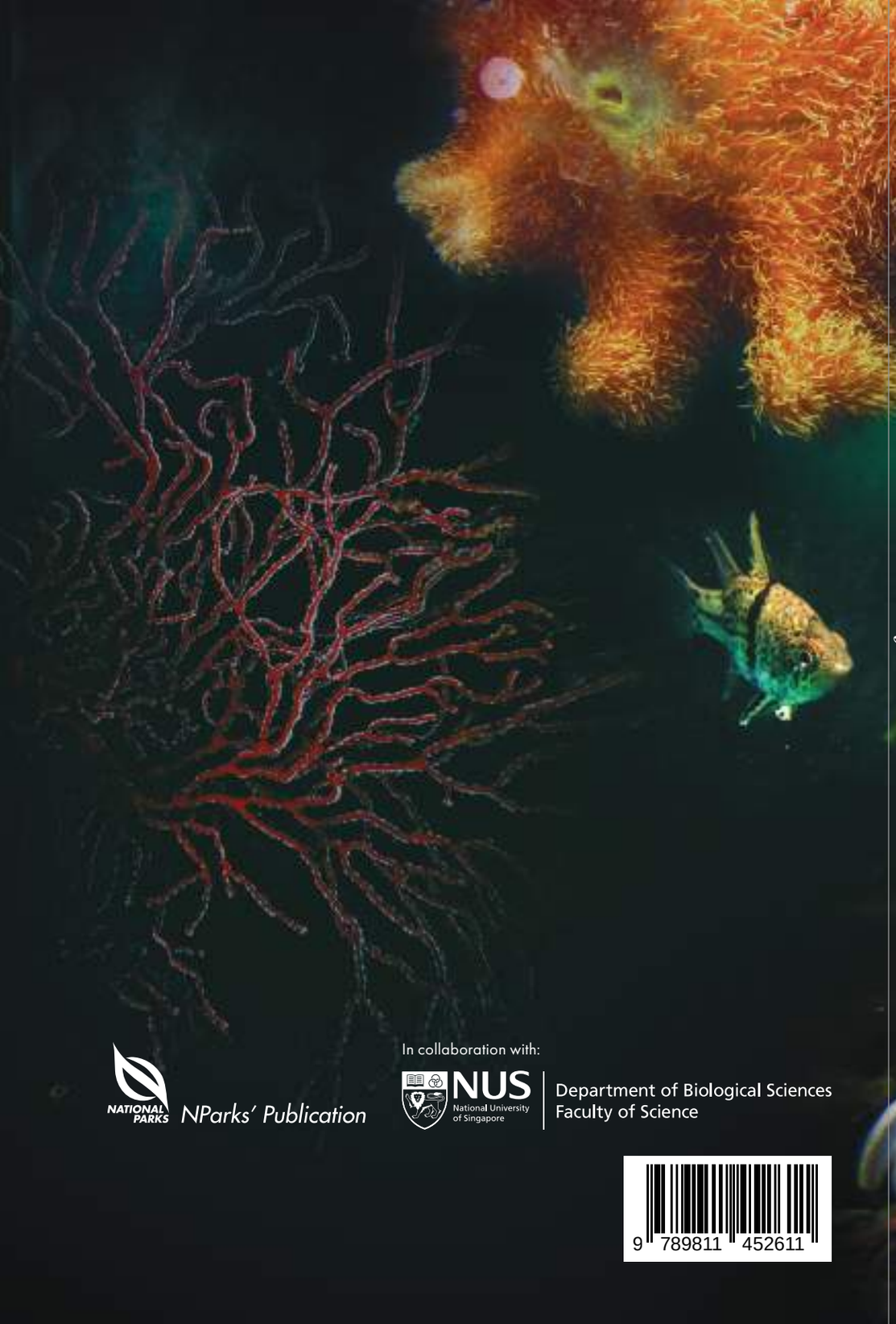


NATIONAL PARKS NParks' Publication

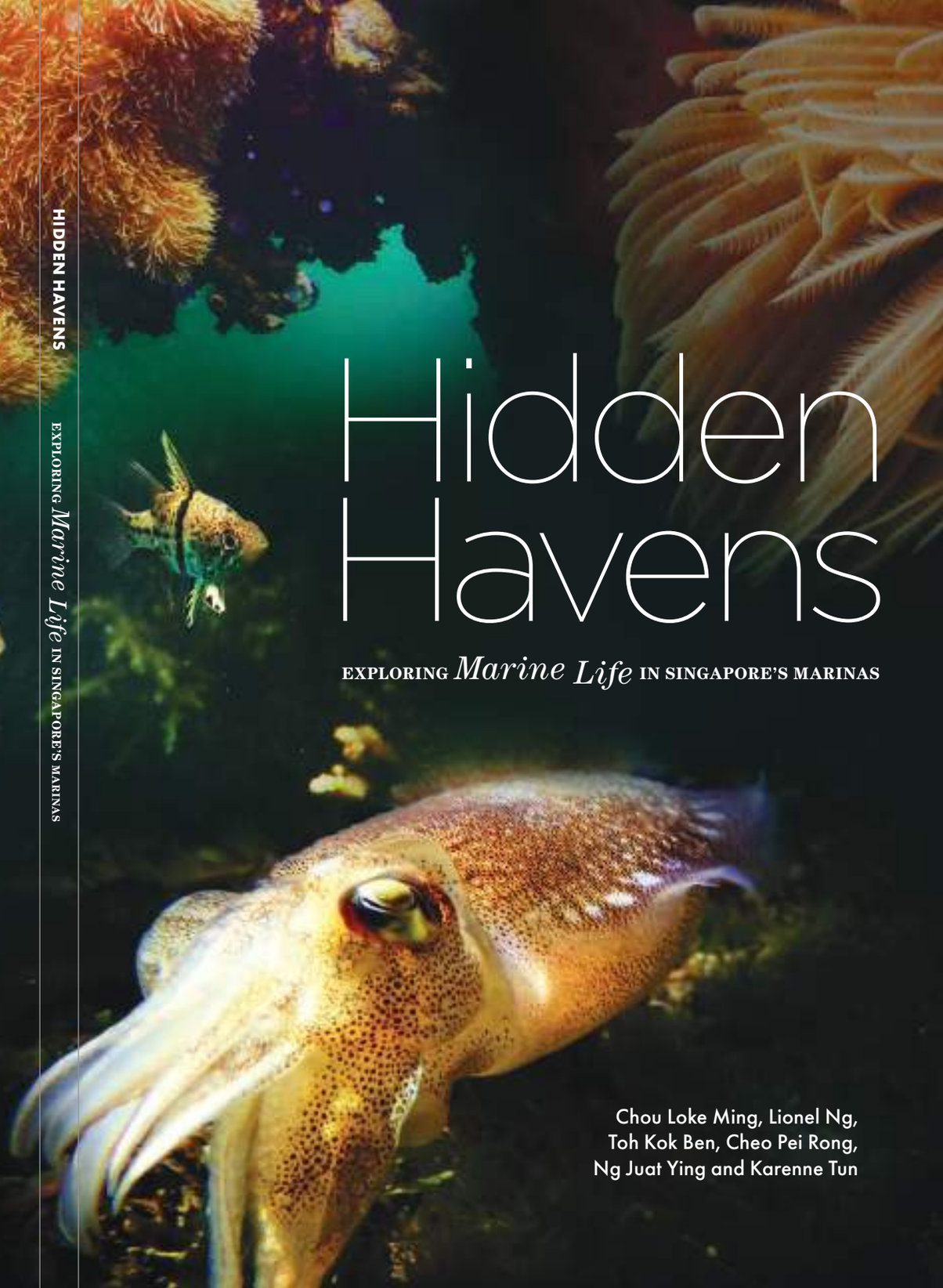
In collaboration with:

NUS National University of Singapore | Department of Biological Sciences Faculty of Science

9 789811 452611

HIDDEN HAVENS

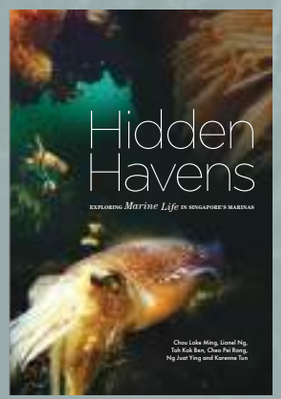
EXPLORING *Marine Life* IN SINGAPORE'S MARINAS



Hidden Havens

EXPLORING *Marine Life* IN SINGAPORE'S MARINAS

Chou Loke Ming, Lionel Ng,
Toh Kok Ben, Cheo Pei Rong,
Ng Juat Ying and Karenne Tun



Cuttlefishes, cardinalfishes, fan worms, seafans and sea anemones are just some of the fascinating sea creatures that you may find in Singapore's marinas. Beneath the surface of our urban waters, a myriad of forms and colours can be found in these hidden havens of biodiversity.

Hidden Havens

EXPLORING *Marine Life* IN SINGAPORE'S MARINAS

Chou Loke Ming, Lionel Ng,
Toh Kok Ben, Cheo Pei Rong,
Ng Juat Ying and Karenne Tun

NATIONAL PARKS
LET'S MAKE SINGAPORE OUR CITY IN NATURE

In collaboration with:

NUS National University of Singapore

Department of Biological Sciences
Faculty of Science

FOREWORD

At first glance, a casual observer may think that Singapore's marine environment is devoid of life, just because we are one of the world's busiest ports. Many people will therefore be surprised to learn that our coastal waters are home to a rich and diverse selection of marine life, even in highly-modified environments like the marinas.

Hidden Havens: Exploring Marine Life in Singapore's Marinas is an aptly named book that will hopefully bring readers on a journey of discovery as we explore the myriad of living things that thrive in our marinas. As we descend below the surface amidst the many pleasure crafts, past the dolphin piles and through the water column to the seafloor, we will encounter a variety of marine life in many colours, shapes and forms that will amuse, amaze and captivate.

I am heartened to see that flora and fauna which one would most commonly associate with coral reefs can not only live, but actually prosper in the busy waters of our marinas. This book reminds us of the resilience of nature and the ability of biodiversity to adapt and flourish even in highly modified habitats. Of course, these habitats would have to be conducive to supporting life, and I am glad to see that efforts have been made to provide optimum conditions for biodiversity to thrive. This book is not just a showcase of the beautiful marine biodiversity in Singapore's marinas. It serves a greater purpose – to remind us that nature is able to do well in urbanised environments, and of the need to conserve nature while our country continues to develop to meet the needs of Singaporeans. The concept of 'building with nature' is not new and Singapore is well-placed to transform into a City in Nature that is liveable and rich in biodiversity.

While we applaud the success of the conservation efforts that the National Parks Board and members of the nature community have achieved so far, the responsibility of nature conservation does not fall on them alone. Each and every one of us can also play a role in conserving nature, as described in the concluding chapter of the book.

I heartily congratulate the authors for revealing and sharing with everyone, the beauty and secrets of the hidden marine havens. I hope that more Singaporeans will be inspired to discover the wonders of our marine environment and join us on our nature conservation journey.

Professor Leo Tan

President and Fellow
SINGAPORE NATIONAL ACADEMY OF SCIENCE

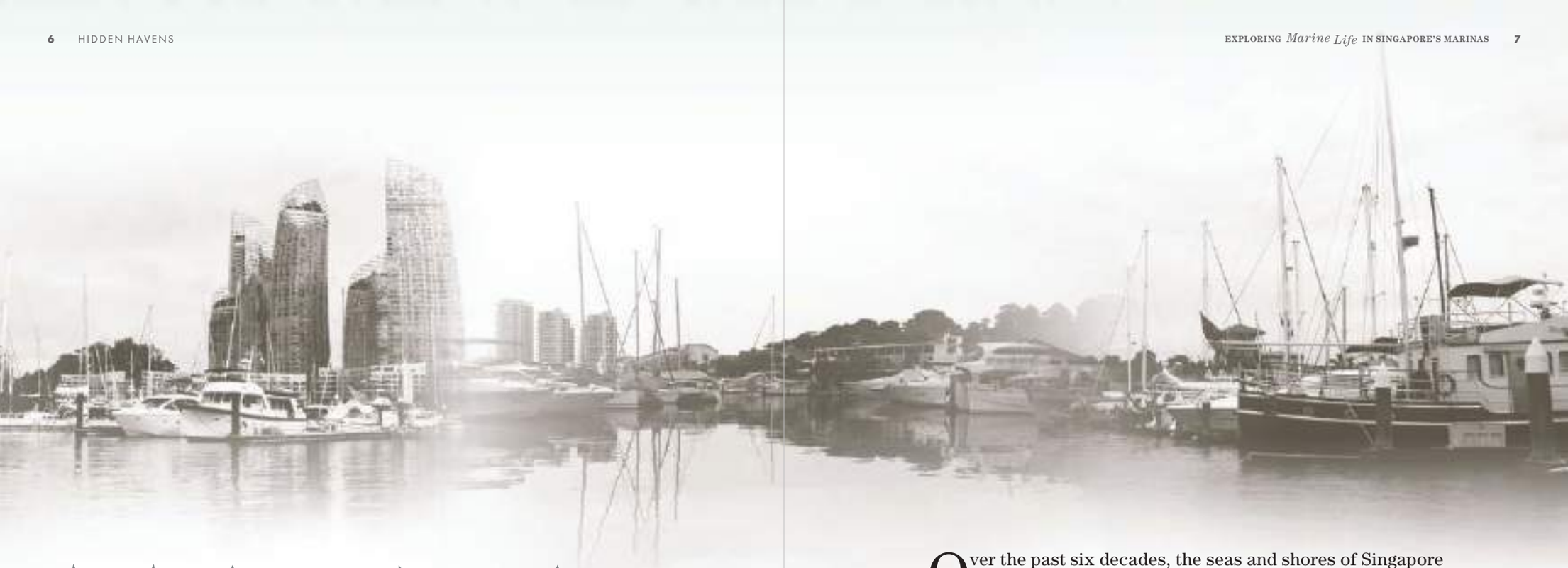
Chairman
GARDEN CITY FUND

INTRODUCTION

From the sea's surface to the sandy seabed, the waters of Singapore's marinas are hidden havens of biodiversity. This rich marine life can be explored through the pages of this book.

The first chapter introduces readers to the epibiotic organisms that not only grow on the submerged surfaces of floating pontoons, but also on seawalls deeper down. The second chapter presents the fishes and other pelagics that traverse the water column of the marinas, and the third chapter features the animals that inhabit the sandy-silty seafloor, collectively termed soft-bottom macrobenthos.

Through a collection of stunning underwater photographs, readers can get a glimpse of the amazing diversity of fauna and flora that have come to live and thrive in Singapore's marinas. As there is still much to learn about marine life, this book identifies each animal to its lowest known taxonomic level (in terms of scientific naming), and provides a common name for each, where applicable.



MARINAS & MARINE BIODIVERSITY

Over the past six decades, the seas and shores of Singapore have been altered by coastal development in several ways. Singapore's total land area has expanded by more than 20% since the 1960s due to land reclamation, and its territorial waters see intensive shipping and aquaculture use. Coves, jetties and marinas have also been constructed to meet the rising popularity of marine recreation and seafront living. These have resulted in changes to the marine environments in Singapore, affecting tidal flow and water quality.

Despite these impacts, research has shown that modified marine environments can function as new habitats that provide shelter and support for a diverse range of marine life. This is surprisingly true for Singapore's marinas, where casual visitors can easily see corals and sponges growing on the sides of berthing pontoons. A closer look into the water would reveal small fishes swimming just below the surface, and if people were able to peer deeper down, they would see a wonderful world of marine life.

GROWING ON

Surfaces

In spite of the limited area, the submerged sides of pontoons host a variety of sessile life forms, which in turn serve as habitats and food for mobile organisms.

Such habitats are unique because they are permanently submerged, but remain close to the water surface. The closest analogues in nature are floating pieces of debris. Space is a premium as fauna and flora jostle for the best spots where there is good water exchange and ample sunlight.

The seawalls in the marinas also provide great opportunities for the establishment of reef fauna. Granite rock seawalls, in particular, serve as stable platforms for immobile organisms (such as corals and sponges) to establish themselves. Despite being kilometres away from coral reefs, both the physical design of the marinas coupled with the dynamic nature of the marine environment have enabled larvae of reef-associated organisms to enter and colonise these substrates.

Serrated Green Seaweed
(*Caulerpa serrulata*)

Oval Sea Grapes Seaweed
(*Caulerpa racemosa*)

Coin Green Seaweed
(*Halimeda* sp.)

Halymenia sp.

SWAYING SEAWEED

Green seaweed can be found in a diverse array of forms, ranging from crisp calcium-incorporated types, to those with serrated edges, and even ones resembling grapes.

Species of red seaweed, like green ones, are also able to photosynthesise. They can be found in shallow, bright areas such as pontoons and the upper zone of seawalls capturing as much sunlight as possible.

Halymenia sp.

POMS-POMS OF THE SEA

Soft corals of the family Nephtheidae are common on various submerged surfaces in the marinas. The colonies, which come in bright colours such as cream, yellow, orange, brown and pink, can be seen hanging from the sides of many floating pontoons, swaying with the current.

Nephthea sp.

Stereonephthya sp.

This bushy looking soft coral (*Dendronephthya* sp.) with vivid pink hues is usually found in areas with fast currents. Small brittle stars or crustaceans can be seen seeking refuge among its branches.

Dendronephthya sp.

Lendenfeldia chondrodes

Neopetrosia sp.

Clathria sp.

Xestospongia sp.

COLOURFUL WATER FILTERS

An amazing variety of sponges can be found in the marinas, providing bright colours and interesting textures to the otherwise drab-looking pontoons and seawalls. They filter plankton from the surrounding environment and help to improve water clarity.

Gelliodes fibulata

Rhabdastrella globostellata

Cladocroce sp.

Xestospongia testudinaria

Montipora Coral
(*Montipora* sp.)

LIGHT HARVESTERS

Acropora corals flourish in clearer water conditions. They are more commonly found in the outer reaches of marinas where the currents flow faster and water is less turbid.

Corals of the genus *Montipora* have numerous growth forms. One of the commonest is that of a plate-like form, angled to optimise light capture for photosynthesis.

Table Acropora
(*Acropora* sp.)

Lobophyllia sp.

Lobophyllia sp.

REEF BOULDERS

With vivid colours and a fleshy, brain-like appearance, *Lobophyllia* corals stand out on reefs. When the coral is disturbed, its tissues retract into the skeleton, revealing sharp teeth-like structures.

Cauliflower Coral
(*Pocillopora acuta*)

CORAL CRADLES

Species of the family Pocilloporidae have historically been recorded from Singapore reefs since the 1830s. However, habitat loss and coastal urbanisation impacts have resulted in only one species, *Pocillopora acuta*, remaining. This species of coral performs important ecological roles by functioning as food and shelter for various species of shrimp, crab and fish. It also reproduces by brooding its young, releasing their developed larvae that are ready to settle on the reefs.

CLEAR-HEADED

In spite of the high sediment load, *Pectinia* corals are able to thrive in Singapore's waters. They actively produce mucus to remove sediment particles from the surfaces of the colony, while their fluted structure reduces sediment accumulation.

Pectinia sp.

Mushroom Coral (*Fungia* sp.)

BREAKING FREE

This juvenile Mushroom Coral (*Fungia* sp.) was photographed growing on the side of a berthing pontoon. Corals of the family Fungiidae begin their lives attached to a stalk. As they mature, they break off from the substrate and continue life as a free-living individual. Some mushroom corals have been observed using their central mouth to ingest large organisms such as salps or even nudibranchs.

Bubble Coral (*Plerogyra* sp.)

HARD BUBBLES

This species of *Plerogyra*, also a type of hard coral, possesses many grape-sized pouches and is highly popular with aquarists and SCUBA divers.

Goniopora sp.

UNDERWATER FLOWER POTS

Goniopora corals have long fleshy polyps that make them look much larger than they actually are. A slight physical disturbance causes the polyps to retreat into the coral skeleton, revealing their true shape and size.

Turbinaria peltata

Turbinaria peltata

TENACIOUS T-CUPS

Hard corals of the genus *Turbinaria* can take the shape of wide disc-like cups or more compact and convoluted forms. *Turbinaria peltata* is one of the most common species in the marinas and thrives well due to its ability to cope with high sedimentation and reduced light levels.

Plesiastrea versipora

LIGHTS IN THE DARK

With their bright orange colouration, colonies of *Tubastraea* easily light up the darkest parts of the marinas, such as the undersides of berthing pontoons. Unlike other hard corals, they do not harbour symbiotic zooxanthellae. Thus, they do not photosynthesise but instead obtain nutrition by actively consuming plankton.

Cave Corals (*Tubastraea* sp.)

Thumbs-up Sea Squirt
(*Polycarpa papillata*)

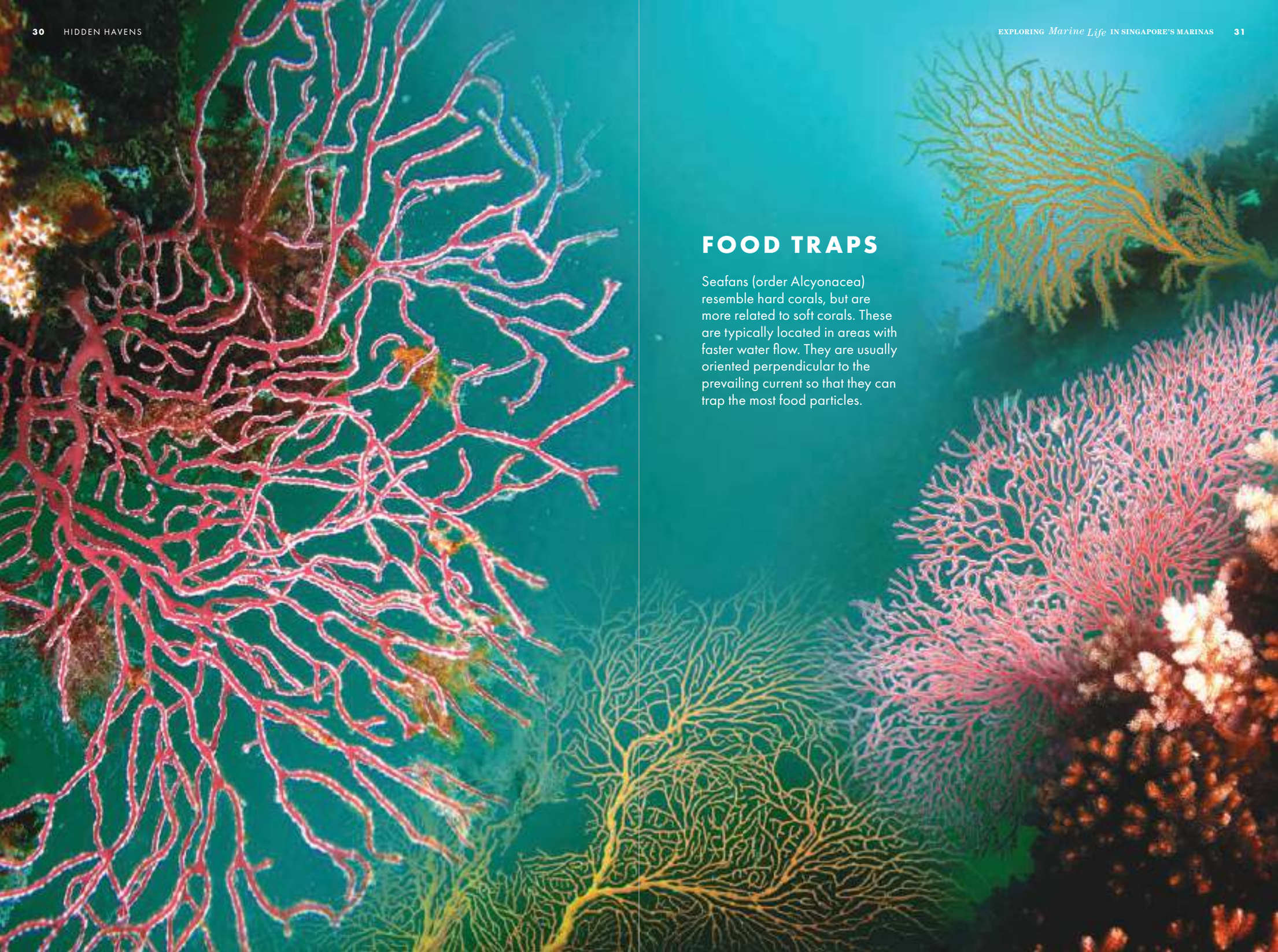
Phallusia philippinensis

Subfamily Botryllinae

WATER SQUIRTS

Also known as ascidians, sea squirts can be found growing on hard surfaces such as the pontoons or seawalls. The solitary ascidians resemble thumbs sticking out from the rest of the epibiotic growth, while the colonial ascidians form smooth mats comprising many small individuals. They appear to be simple animals, but are more closely related to humans than to other marine invertebrates. Their larvae possess a backbone-like structure which is lost upon adulthood. They feed by filtering plankton and bacteria from water taken in from one siphon, and then ejecting the water through another siphon.

Jelly Sea Squirt
(*Ascidia gemmata*)



FOOD TRAPS

Seafans (order Alcyonacea) resemble hard corals, but are more related to soft corals. These are typically located in areas with faster water flow. They are usually oriented perpendicular to the prevailing current so that they can trap the most food particles.

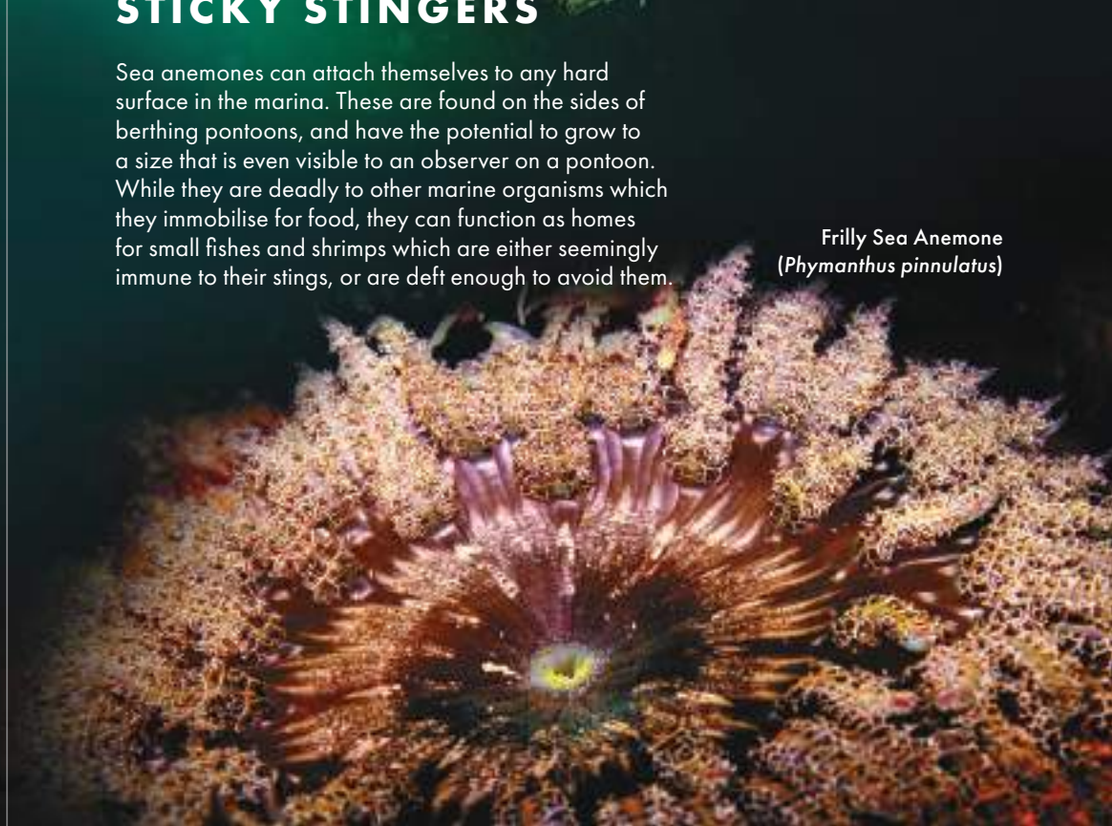
Bubble-tip Anemone
(*Entacmaea quadricolor*)

Mini Carpet Anemone
(*Sticodactyla tapetum*)

Giant Carpet Anemone
(*Stichodactyla gigantea*)

STICKY STINGERS

Sea anemones can attach themselves to any hard surface in the marina. These are found on the sides of berthing pontoons, and have the potential to grow to a size that is even visible to an observer on a pontoon. While they are deadly to other marine organisms which they immobilise for food, they can function as homes for small fishes and shrimps which are either seemingly immune to their stings, or are deft enough to avoid them.



Frilly Sea Anemone
(*Phymanthus pinnulatus*)

CORAL LOOKALIKES

Corallimorphs resemble hard corals but lack a skeleton. They are usually observed as large groups of individuals plastered on hard surfaces. The species shown here is popular in the aquarium trade, and can be distinguished by the 'star-shaped' tentacles on the oral disc that radiate outwards from the mouth.

Rhodactis inchoata

RINGED STINGERS

Zoanthids are relatives of hard corals and anemones, but have two rings of tentacles rather than one. Unlike the anemones which are solitary, most zoanthids exist as a colony.

Zoanthus spp.

HOMEWARD BOUND

Unlike their more mobile cousins, these vermetid snails only move around when they are young. Upon finding a suitable spot, they attach themselves to a hard surface and produce a coiled tube covering to form their permanent home. To feed, they cast out a net of mucus to trap food particles.

Vermetid Snails (*Vermetus* sp.)

Green Lipped Mussel
(*Perna viridis*)

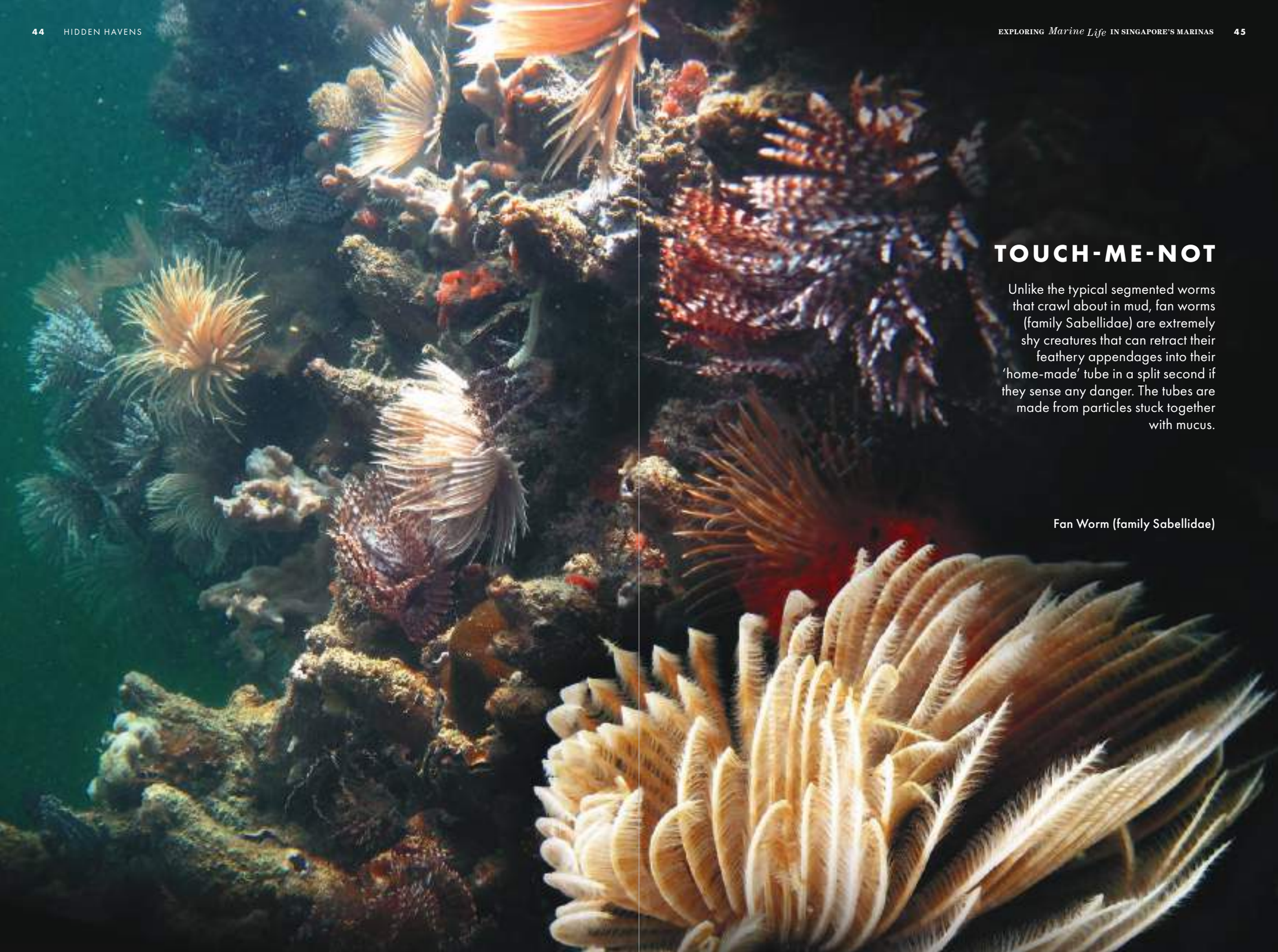
CAMOUFLAGED CUCUMBERS

Many sea cucumbers in the order Dendrochirotida can be found attached to the sides of pontoons with the help of their sticky tube feet. Typically well camouflaged among the surrounding epibiota, they are only noticed when they extend their feathery tentacles into the water column to trap plankton.

Thorny Sea Cucumber
(*Colochirus quadrangularis*)

MOVERS AND CLIMBERS

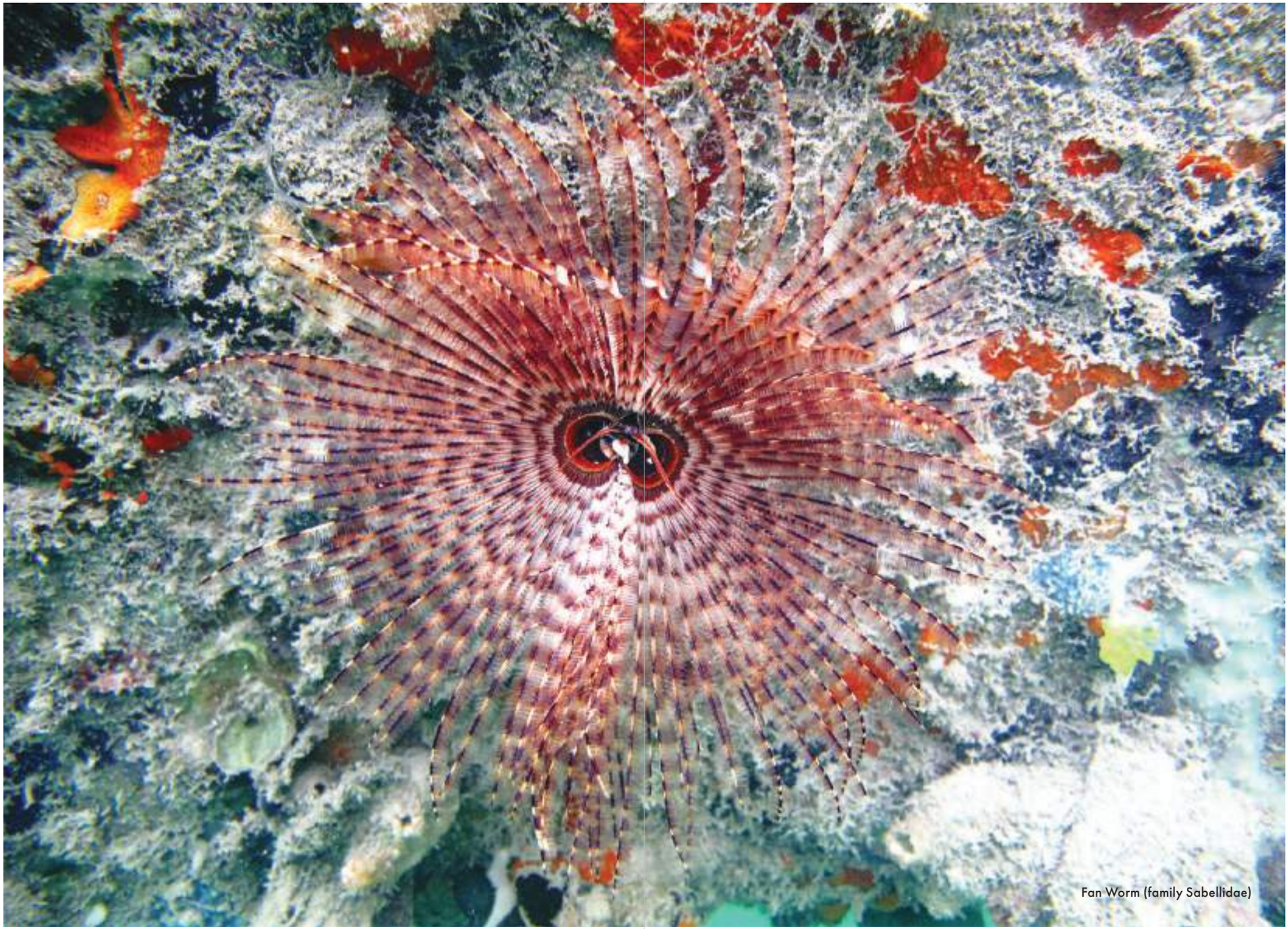
Synaptid sea cucumbers (order Apodida) are more worm-like than their cousins in other orders. Some of the species can grow to a few metres in length. They are often seen entwined among sponges, feeding off the organic material generated from their hosts. These animals get around by contracting and pulsating their body. Some possess little hooks on their skin which enable them to grasp onto vertical surfaces and climb around easily.



TOUCH-ME-NOT

Unlike the typical segmented worms that crawl about in mud, fan worms (family Sabellidae) are extremely shy creatures that can retract their feathery appendages into their 'home-made' tube in a split second if they sense any danger. The tubes are made from particles stuck together with mucus.

Fan Worm (family Sabellidae)



Fan Worm (family Sabellidae)

Black Sea Urchin
(*Temnopleurus toreumaticus*)

Long-spined Sea Urchin
(*Diadema* sp.)

SPINY GRAZERS

Short-spined sea urchins can usually be found grazing along the sides of berthing pontoons. They can adorn their body with pieces of debris as a form of protection. In contrast, their long-spined relatives look menacing without trying. The spines are sharp and brittle, and can easily pierce the skin of would-be predators.

These animals play an important role in the marine ecosystem by keeping algae in check, which could otherwise grow unrestrained and smother all other less mobile organisms.

FEATHERY ARMS

Although physically very dissimilar, feather stars (class Crinoidea) are relatives of sea cucumbers, sea urchins and sea stars. They can perch in areas with strong currents or swim by undulating their arms. Feather stars feed by extending their feathery appendages to trap food particles.

EAT-ME-NOT

As their breathing organs are exposed on their backs, these sea slugs are known as nudibranchs, meaning 'naked gills'. Nudibranchs (order Nudibranchia) are some of the most vividly coloured organisms in the marine environment. Without the protection of a shell, their flamboyance serves as a deterrence to predators. They obtain toxins or even stinging cells from the food they consume, which can include sponges, ascidians, or even other nudibranchs.

Elegant Phyllid Nudibranch (*Phyllida elegans*)

Lined Chromodoris Nudibranch (*Chromodoris lineolata*)

Blue Dragon Nudibranch (*Pteraeolidia semperi*)

Goniobranchus sinensis

Hypselodoris Nudibranch (*Hypselodoris* sp.)

Cheesecake Nudibranch (*Doriprismatica atromarginata*)

NEW LIFE

Nudibranchs have both male and female organs. After lining up alongside and impregnating each other, they separate and each lays its eggs in ribbon-like shapes onto a hard surface.

Lined Chromodoris Nudibranch (*Chromodoris lineolata*)

Nudibranch eggs

Blue-dot Margined Flatworm
(*Pseudoceros indicus*)

Pseudoceros sp.

Pseudobiceros sp.

DANCING RIBBONS

Marine flatworms (phylum Platyhelminthes) are so thinly flattened that oxygen can diffuse into them from the surrounding environment. Mating rituals in some species involve a bout of penis fencing where one flatworm stabs the other with its penis to transfer sperm.

SWIMMING
in the Sea

From the surface to the seabed, the water column supports an immense diversity of species. These organisms thrive due to the structural complexity and sheltered environment provided by the artificial structures found in marinas.

These species are often seen swimming near the surface or foraging among the epibiotic organisms on the pontoons. Zipping through the water column, they are constantly in search of their next meal or mate.

PECKISH PARROTS

This hard coral has white scar marks caused by parrotfishes using their strong beak-like jaws to chomp on clumps of algae and inadvertently, bits of coral. These form part of the natural bioerosion process in reef environments and result in the creation of sediment.

PREGNANT PAPAS

Seahorses (*Hippocampus* spp.) are shy fishes which prefer hiding amongst the epibiota growing on seawalls or the sides of berthing pontoons rather than swimming out in the open. Males carry the fertilised eggs in a pouch until they hatch, and resemble pregnant mothers. Indiscriminate harvesting to supply the traditional medicine industry has threatened wild populations of seahorses.

Pore Coral (*Porites* sp.)

Seahorse (*Hippocampus* sp.)

Blue-barred Parrotfish (*Scarus ghobban*)

SEA BUTTERFLIES

Like their namesake in the terrestrial world, brilliantly coloured butterflyfishes (family Chaetodontidae) gently flit around pillars and pontoons in the marinas, stopping every now and then to nibble on coral polyps or snap up small invertebrates. Their flat body enables them to easily seek refuge among corals, while the false eye spots near their tail help them to trick predators and enable a quick escape. The presence of butterflyfishes is often an indicator of a healthy reef.

Eightband Butterflyfish (*Chaetodon octofasciatus*)

Copperband Butterflyfish (*Chelmon rostratus*)

Ocellate Butterflyfish (*Parachaetodon ocellatus*)

NIGHT AND DAY

Young batfishes resemble dead leaves or debris floating just beneath the surface of the water. The juveniles are strikingly different from the adults which are silvery and disc-shaped.

Orbicular Batfish
(*Platax orbicularis*)

Bristle-tail Filefish
(*Acreichthys tomentosus*)

Fan-bellied Filefish
(*Monacanthus chinensis*)

Leafy Filefish
(*Chaetodermis penicilligerus*)

Strap-weed Filefish
(*Pseudomonacanthus macrurus*)

BLENDING IN

Leatherjackets or filefishes (family Monacanthidae) are among the most common fishes found in the sheltered waters of Singapore's marinas. They have some ability to change their pattern and colouration, and often resemble pieces of seaweed. They swim slowly and easily blend in with the turbid marine environment.

Cheilodipterus sp.

Orbiculate Cardinalfish
(*Sphaeramia orbicularis*)

DEVOTED DAD

The Orbiculate Cardinalfish (*Sphaeramia orbicularis*) is easily seen from pontoons as it hovers motionless near the water surface. The male is a doting father that incubates numerous eggs in its mouth for slightly more than a week.

Silver Moony
(*Monodactylus argenteus*)

TOUGH GUY

Well protected by the tough plates covering its box-like body, the Shortnose Boxfish (*Ostracion nasus*) can be seen pecking at invertebrates on pilings and seawalls. As a second layer of defence against predators, its skin can secrete a potent toxin capable of rupturing blood cells.

DARTING DIAMONDS

Silver Moonies (*Monodactylus argenteus*), also known as Diamondfish, school around and under the berthing pontoons, resembling flashing discs as they reflect the sun's rays.

Shortnose Boxfish (*Ostracion nasus*)

Pink-barred Shrimp-goby
(*Cryptocentrus melanopus*)

Saddled Shrimp-goby
(*Cryptocentrus maudae*)

Mud Reef-goby
(*Exyrias belissimus*)

SKITTISH SWIMMERS

Gobies (family Gobiidae) are extremely at home in Singapore's marinas, and can be found perched on the sandy-silty seabed and on seawalls. Some species live in burrows excavated by snapping shrimps, while others excavate their own burrows. Not all species burrow, as many smaller species hide in crevices, but all are skittish and immediately dash for cover at the slightest sign of danger.

SHINY SPOTS

The Green Chromide (*Etroplus suratensis*), also known as the Pearlspot Cichlid, feeds mainly on plants, algae and some animal matter. It reproduces rapidly, and its young can be found seeking shelter among the epibiotic growth on pontoons and pilings in the marina.

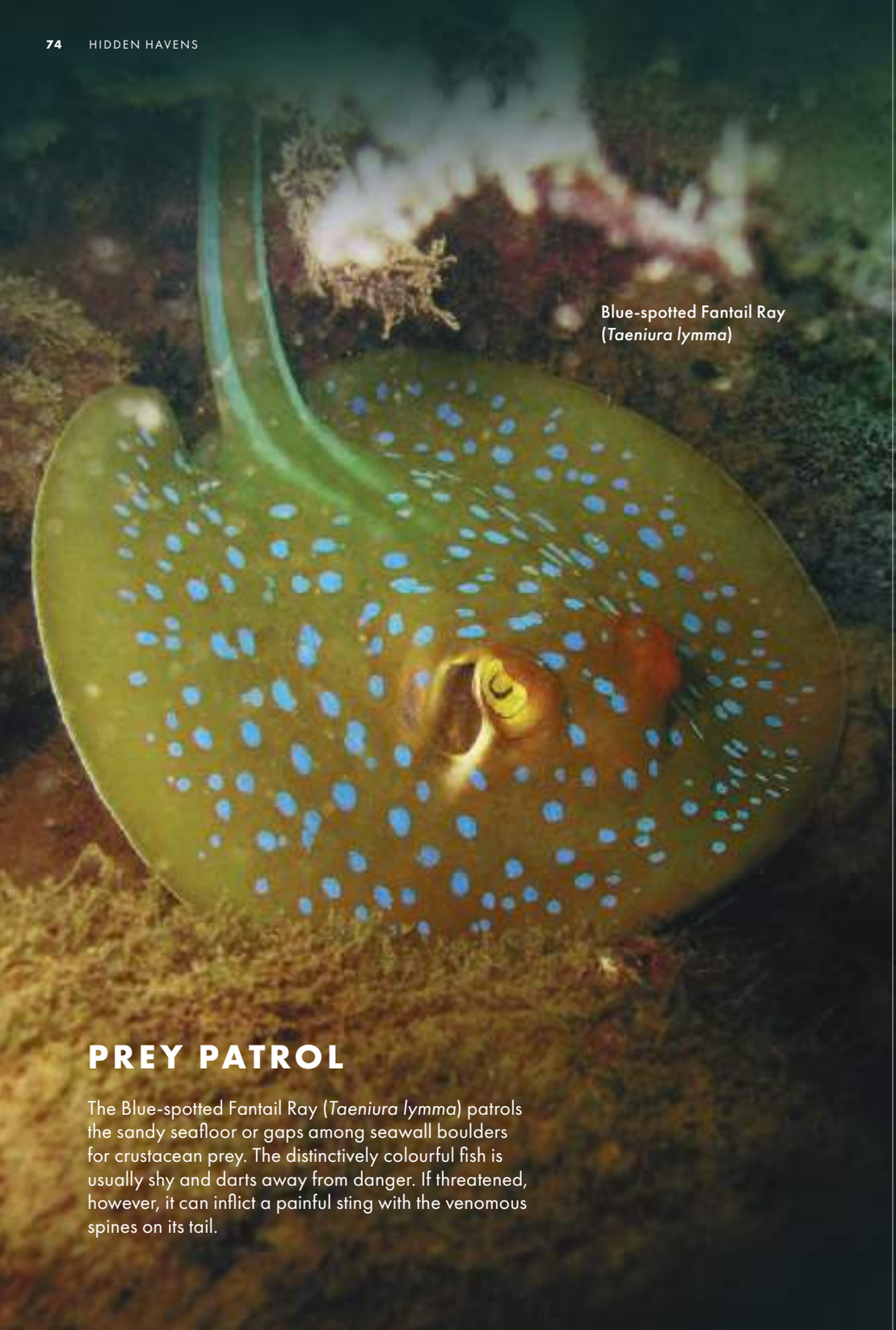
Green Chromide (*Etroplus suratensis*)

Three-spined Toadfish (*Batrachomoeus trispinosus*)

Three-spot Frogfish (*Lophiocharon trisignatus*)

AMBUSH MASTERS

Frogfishes (family Antennariidae) and toadfishes (family Batrachoididae) do not swim very much but excel at concealing themselves on the seabed, waiting for unsuspecting prey to come along. When that happens, all it takes is just a split second for these masters of camouflage to open their massive jaws and suck their prey into their belly.



Blue-spotted Fantail Ray
(*Taeniura lymma*)

PREY PATROL

The Blue-spotted Fantail Ray (*Taeniura lymma*) patrols the sandy seafloor or gaps among seawall boulders for crustacean prey. The distinctively colourful fish is usually shy and darts away from danger. If threatened, however, it can inflict a painful sting with the venomous spines on its tail.

Banded File Snake
(*Acrochordus granulatus*)

SWIFT HUNTER

The non-venomous Banded File Snake (*Acrochordus granulatus*) is occasionally seen in the marinas. This estuarine species adopts a laterally compressed shape as it moves though the water column to hunt small fishes. It grips and constricts its prey with the help of its rough scales. Female snakes, which are larger than the males, give birth to live young instead of laying eggs.

GRAZING RABBITS

Rabbitfishes (family Siganidae) often move in schools to forage among the stands of brown seaweed growing on the granite rock seawalls. They are named rabbitfishes for their rabbit-like mouth parts and preference for eating seaweed and seagrass. Some species are popularly eaten over the Lunar New Year period, as they are gravid and carry a lot of roe during the season.

Streaked Rabbitfish
(*Siganus javus*)

BOTTOM FEEDERS

Catfishes, which have bottom-feeding habits, are commonly found near the seabed of the marinas. Spines on their dorsal and pectoral fins serve as formidable defences against hungry predators. Juvenile striped eel-tail catfishes (family Plotosidae) are usually observed in the tens or hundreds as they congregate into large wriggly balls for protection. Unlike the eel-tails which lay their eggs in a nest on the seabed, male sea catfishes (family Ariidae) hold eggs in their mouths until the young are ready to hatch.

Sea Catfish
(family Ariidae)

Egg of an *Arius* sp.
(family Ariidae)
with yolk sac

Striped Eel-tail Catfish
(family Plotosidae)

GRACEFUL JELLIES

Various species of jellyfish visit the marinas, brought in and out by the changing tides. While they may seem like harmless blobs, the cells of their trailing tentacles produce stingers (known as 'nematocysts'), which can inflict pain when touched. These are extremely effective in catching planktonic prey. Small fish have been observed to hang around the bell of the jellyfish, presumably for protection against predators.

Spotted Jelly
(*Mastigias papua*)

WEAPONS OF MASS DISTRACTION

Cuttlefishes are extremely intelligent creatures. They distract with a myriad of colours and textures before snapping up their hapless prey with two lightning-fast tentacles. To confuse predators, cuttlefishes can discharge ink blobs shaped like themselves before jetting away to safety.

BIG FISH, SMALL FISH

Wrasses (family Labridae) are a diverse group of fishes spanning a range of shapes, sizes, feeding habits and ecological niches. The environment in marinas provides ample pickings for wrasses that prefer a diet of molluscs, crustaceans or echinoderms. Some species have been documented to make use of tools such as rocks to crack the shells of their prey.

Anchor Tuskfish
(*Choerodon anchorago*)

White-patch Tuskfish
(*Choerodon oligacanthus*)

Blackspot Tuskfish
(*Choerodon schoenleinii*)

CHOICE EATS

The marinas support a range of fish species that can be eaten by humans. As juveniles and subadult fishes are frequently found in the marinas, it is likely that marinas also play a special role in supporting the young of commercially important species.

FREQUENT VISITOR

The Hawksbill Turtle (*Eretmochelys imbricata*) is a species that has been found nesting on Singapore's sandy shores. It gets its name from its beak-like mouth, and has claws on its front flippers. Hawksbill Turtles feed mainly on crustaceans and sponges, and can sometimes be spotted swimming in the marinas.

Hawksbill Turtle
(*Eretmochelys imbricata*)

LIVING ON THE
Seabed

Usually comprising soft sediment and sand, the marina seabed remains hidden from view and may appear devoid of life.

The sandy-silty seabed of the marinas is filled with mostly tiny organisms comprising invertebrates such as worms, echinoderms, molluscs and crustaceans. These bottom-dwellers play vital roles in the marine ecosystem, including nutrient cycling. A marina's water quality can be gauged by observing the abundance of species that are sensitive or resistant to pollutants.

WORMS GALORE

Polychaetes are the dominant group of organisms inhabiting the seabed in Singapore's marinas. There exists an immense diversity of species, with many not larger than a few centimetres. Proper species identification can only be carried out in the laboratory with the help of microscopes.

Some worms use tentacles to gather organic particles in the sediment, while others use their strong jaws to chomp on smaller invertebrates. They are also a major food source for many marine organisms. As some species are sensitive to environmental changes, their presence or absence can provide scientists with useful information on the quality of the ecosystem.

Family Trichobranchidae

Family Sternaspidae

Family Capitellidae

Family Hesionidae

Family Oenonidae

Family Nereididae

Family Cirratulidae

Family Spionidae

Family Polynoidae

FIERY BEAUTY

The Golden Fireworm (*Chloeia flava*) is a beautiful large polychaete with mesmerising and elaborate patterns. As a defence mechanism against predators, this worm has fine bristles that break off easily upon contact and cause pain and itchiness.

Golden Fireworm (*Chloeia flava*)

Family Pharidae

Family Cardiidae

Family Tellinidae

Family Lucinidae

Family Veneridae

Family Mytilidae

BURROWING BIVALVES

A great number of bivalves, which include shelled animals such as clams, burrow into the soft sediment and are not easily noticeable. Despite some success at hiding in the seabed to avoid predators, they serve as important food sources for many animals.

Turritella cingulifera

Nassarius jacksonianus

Epitonium lineolatum

Eulima bifascialis

FUSS-FREE FEEDERS

These pretty snails are part of a large group of animals with wide dietary preferences ranging from mucus nets to cnidarians. Some species are scavengers, while others are parasites that target bivalves or echinoderms.

SEABED DIGGERS

Shaped like the elongated teeth of elephants, tusk shells or scaphopods are a type of mollusc. They inhabit the soft bottom sediment, burrowing in using a muscular foot that extends from the larger end of the 'tusk'. They feed on microscopic organisms and expel waste from the narrow end of their shell.

Episiphon virgula

NOT PEAS IN A POD

While they look similar, amphipods, isopods and copepods are quite different animals. These millimetre-long crustaceans form the basis of food webs for an immense variety of marine organisms.

Amphipods are flattened laterally (sideways) and feed on organic matter on the marina seafloor. Isopods are flattened dorsoventrally (top to bottom) and can be scavengers or blood-sucking parasites. Like a scene out of a science-fiction movie, one species even attaches itself onto the tongue of fishes and its own body eventually replaces the organ. Copepods are not obviously flattened. Some feed on detritus, some on algae, and others are parasitic.

MINI LAMPS

The tiny ostracod (class Ostracoda), usually smaller than 2 millimetres, looks like a clam but is actually a crustacean. Some ostracods emit bright blue flashes when physically agitated, such as by boat traffic or pounding waves. The luminescence is visible at night in dark areas, far away from the city lights.

THE MULTI-TASKERS

Sea cucumbers of the order Holothuriida are large animals that move about on the seabed, gathering sediment with their leaf-like feeding tentacles to extract the decaying organic material within. As such, they play an important role in the recycling of nutrients in marine ecosystems. Some also double up as homes for small fishes and shrimps. They can even eject sticky threads to distract predators. Some species are commercially valuable and are cultivated for food or traditional medicine.

Ocellated Sea Cucumber (*Stichopus ocellatus*)

Sandfish Sea Cucumber (*Holothuria scabra*)

CRUSHING CLAWS

One of Singapore's most common crabs, the Stone Crab (*Myomenippe hardwickii*), also known as the Thunder Crab, is a large brown species that can be found nestled among rocks or gaps in the seawalls of the marinas. Using a tooth-like structure at the top finger of each muscular pincer, it easily crushes the shells of molluscs that it snacks on.

Stone Crab (*Myomenippe hardwickii*)

Family Portunidae

SPEEDY SWIMMERS

Using their hindmost pair of legs which are shaped like paddles, swimming crabs (family Portunidae) can swim through the water with amazing speed and snap at prey and predators alike with their long sharp pincers. Members of this family include the Flower Crab (*Portunus* sp.), which is popular among seafood lovers.

SUPPORT OUR SEA LIFE

Even though Singapore's waters have been exposed to impacts due to urbanisation, marine biodiversity continues to thrive – even in highly modified environments such as marinas. While this shows the resilience of our natural heritage, it also highlights the need for marine conservation. There are many ways you can contribute to marine conservation efforts!

If you are involved in marina design, you can create favourable conditions in marinas for marine life, by considering these factors:

- the hydrodynamics and ecology of the surroundings before construction, as these factors are critical in the community of marine life that can inhabit the marina;
- sufficient water exchange to reduce the accumulation of pollutants;
- an external coating of concrete on pontoons to encourage the colonisation of sessile organisms that can attract other animals; and
- the provision of hard, stable substrates in the form of granite rock seawalls to promote the natural recruitment of hard corals and reef-associated animals.

As a marina owner, you can help reduce pollution by:

- discouraging the discharge of waste and pollutants within the marina;
- adopting 'green' practices to help improve water quality and overall biodiversity;
- having long-term biodiversity monitoring programmes, which can help to provide useful information in the event of an environmental impact; and
- working in collaboration with other stakeholders such as marina members, scientists, marine interest groups and government agencies to ensure that marinas can continue to serve as refugia for marine biodiversity.

As an individual, you can aid in marine conservation by:

- volunteering as a citizen scientist to survey marine biodiversity with programmes such as NParks' Intertidal Watch, NParks' Biodiversity Beach Patrol, Reef Friends and TeamSeaGrass;
- volunteering as a nature guide at the Sisters' Islands Marine Park, Sungei Buloh Wetland Reserve and Chek Jawa Wetlands;
- organising or participating in beach or dive cleanups to remove marine litter;
- observing good etiquette that helps protect the marine environment when enjoying recreational sea activities (such as diving, fishing, boating and kayaking);
- becoming an ambassador for nature and encouraging others to become better stewards of the environment; and
- contributing to the Garden City Fund, which helps to support projects that enable greater community education and outreach.

THE GARDEN CITY FUND is a registered charity and Institution of Public Character established by the National Parks Board in 2002. The Fund works with corporations, organisations and individuals to better engage members of the public through conservation efforts, research, outreach and education. In doing so, we hope to cultivate a sense of ownership and encourage the community to play its part in preserving Singapore's legacy as a lush and vibrant City in Nature.

If you would like to support marine conservation projects or contribute to conservation efforts for our City in Nature, please visit www.gardencityfund.org

NATIONAL PARKS
LET'S MAKE SINGAPORE OUR CITY IN NATURE

GARDEN CITY FUND

Share your love for nature and animals at
#NParksBuzz #AnimalBuzzSG
Subscribe to our Telegram channel: **t.me/NParksBuzz**

ACKNOWLEDGEMENTS

This book stemmed from a collaborative research project between the National Parks Board and the National University of Singapore, funded by the Technical Committee for the Coastal and Marine Environment.

The authors would like to thank the following individuals for assisting in the research and contributing beautiful images showcased in this book: Adelene Chia, Aizat Khalis, Christina Choy, Gavan Leong, Huang Danwei, Jani Tanzil, Low Inn Zheng, Quek Hansheng, Rene Ong, Rosa Poquita-Du, Samuel Chan, Samuel Loke, Stephen Beng, Toh Tai Chong, Wu Bokai and the crew of Galaxea (Ishak Bin Nis, Rahmat Bin Wahab and Wong Ann Kwang).

We would also like to thank Ada Davis and Victoria Cheong for reviewing the book.

We are also grateful to the following individuals for their kind help in identifying and verifying some of the species featured in this book: Cai Yixiong, Chim Chee Kong, Daisuke Taira, Huang Danwei, Iffah Iesa, Kelvin Lim, Law Ing Sind, Lee Yen-Ling, Lim Swee Cheng, Nicholas Yap, Oh Ren Min, Rene Ong, Rosa Poquita-Du, Serina Lee, Tan Koh Siang, Tan Siong Kiat, Toh Chay Hoon and Zeehan Jaafar.

Lastly, we thank the Maritime and Port Authority of Singapore, Marina at Keppel Bay, One Degree 15 Marina and Raffles Marina for their permission to conduct research and take photographs at the marinas.

Published by

NATIONAL PARKS BOARD
Singapore Botanic Gardens
1 Cluny Road
Singapore 259569

www.nparks.gov.sg
www.facebook.com/nparksbuzz
instagram.com/nparksbuzz
t.me/nparksbuzz

First published 2020

Hidden Havens:
Exploring Marine Life in Singapore's Marinas

ISBN 978-981-14-5258-1 (Print)
ISBN: 978-981-14-5261-1 (e-Book)

Design and production by Redbean De Pte Ltd

INDEX