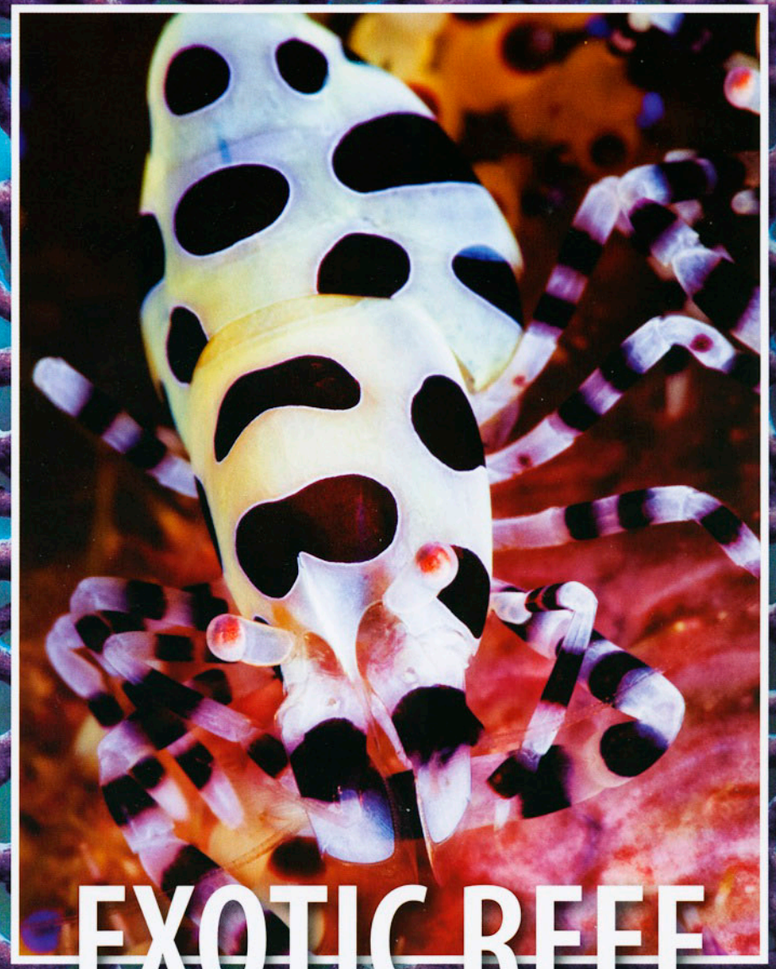
CORAL | THE REEF & MARINE AQUARIUM MAGAZINE

CORAL



EXOTIC REEF INVERTEBRATES

- Discovering *Pectinia*
- Blue-Water Mangroves
- Winning Detritus Wars

JULY/AUGUST 2019
$7.99 US/$9.99 CANADA

VOLUME 16 | NUMBER 4

EDITORIAL & BUSINESS OFFICES
Reef to Rainforest Media, LLC
140 Webster Road | PO Box 490
Shelburne, VT 05482
CUSTOMER SERVICE
customerservice@coralmagazineservice.com
844.204.5175 (toll free)
BUSINESS MANAGER |
Judy Billard | 802.734.6604
judy.billard@reef2rainforest.com
ADVERTISING SALES |
James M. Lawrence, Editor & Publisher
james.lawrence@reef2rainforest.com
802.343.0360
NEWSSTAND | Howard White & Associates
PRINTING | Dartmouth Printing | Hanover, NH
CORAL®, The Reef & Marine Aquarium Magazine, is published bimonthly in January, March, May, July, September, and November by Reef to Rainforest Media, LLC, 140 Webster Road, PO Box 490, Shelburne, VT 05482. Periodicals postage paid at Shelburne, VT, and at additional entry offices. Subscription rates: U.S., $37 for one year. Canada, $49 for one year. Outside U.S. and Canada, $57 for one year.
POSTMASTER: Send address changes to *CORAL*, PO Box 361, Williamsport, PA 17703-0361.
ISSN 1556-5769 (print)
CORAL® is a licensed edition of *KORALLE* Germany, Natur und Tier Verlag GmbH | Muenster, Germany

COVER CREDITS: Coleman's Urchin Shrimp, *Periclimenes colmani*, on fire urchin. John Muhilly/ Seapics.com. Background: Purple Sea Fan, *Gorgonia ventalina*, Beth Swanson/ Shutterstock.

ECF
ELEMENTAL CHLORINE FREE

6 **LETTER FROM EUROPE** *by Daniel Knop*
9 **EDITOR'S PAGE** *by James M. Lawrence*
10 **REEF NEWS** CORAL *staff reports*
22 **REEF VISIONS** *by Matt Pedersen*

FEATURE ARTICLES

32 **INVERTEBRATES RULE PART 1**
A CORAL *magazine series*
34 **CRUSTACEAN WORLDS**
Shrimps, crabs, lobsters, and their ilk
by Daniel Knop
46 **CORAL CRABS**
Cryptic symbiotic residents of branching stony coral colonies *by Scott W. Michael*
56 **UGLY DUCKLING CORALS**
After several years of domestication, the genus *Pectinia* starts to come of age *by Felicia McCaulley*
66 **RAJA AMPAT PART 3: INTO THE BLUE WATER MANGROVES**
Exploring the fringing near-reef habitats in the heart of the coral triangle *by Werner Fiedler*

AQUARIUM PORTRAIT

78 **ONE MAN'S REEF IN SPACE & TIME**
by Manfred Musil

DEPARTMENTS

87 **REEFKEEPING 101:**
Detritus Wars *by Daniel Knop*
Blackcap Gramma, *Gramma melacara by Scott W. Michael*
93 **SPECIES SPOTLIGHT:**
Bicolor Goatfish, *Parupeneus barberinoides*
by Daniel Knop
98 ***CORAL* SOURCES:** Outstanding aquarium shops
100 ***CORAL*EXICON:** Technical terms that appear in this issue
102 **REEF MARKETPLACE:** The marine products showcase
104 **ADVANCED AQUATICS:**
Breathe easy: Using respiration rates to determine relative stress levels in fish *by Jay Hemdal*
112 **ADVERTISER INDEX**
114 **REEF LIFE:** *by Denise Nielsen Tackett & Larry P. Tackett*

Raja Ampat:

INTO THE BLUEWATER MANGROVES

article & images by **Werner Fiedler**

Mangrove biome—shoals of young fishes among stilt roots.

Exploring the fringing near-reef habitats in the heart of the coral triangle

Mangrove zone with Banded Archerfishes (*Toxotes jaculatrix*) and halfbeaks (*Zenarchopterus* sp.).

We came for the coral reefs, but our curiosity drew us into the mangroves—the lush, pungent, sometimes intimidating shallows that line the shores of this sprawling archipelago of 1,500-some islands in the Coral Triangle. Life in these strange tidal thickets of stilt roots is more closely linked to the world-renowned neighboring ecosystems than might seem be the case at first glance.

Tropical marine fauna is probably nowhere else as diverse as among the Indonesian islands of Raja Ampat. Driven by unique ocean current patterns and its remoteness, the ecological characteristics that explain this phenomenon have been the central themes of the two previous parts of this report. They are supplemented by an additional important element: the mysterious forests of mangroves that characterize the tidal zone in many places are also part of a mosaic of closely interwoven habitats.

The warm, unusually nutrient-rich waters of the Raja Ampat archipelago, west of the giant island of New Guinea, are famous for their incredible wealth of marine creatures. Both species (including some endemic to the region) and individuals are present in large numbers. Beneath the surface you will encounter large fishes and impressive shoals of smaller ones, conspicuous and secretive inhabitants of the wonderfully intact coral reefs and the other, often closely interlocked habitats. These are predominantly areas of rubble and sandy

Top: Marbled-Mouth Frogfish (*Lophiocharon lithinostomus*) walking on its fins.

Bottom: Zebra Mantis Shrimp (*Lysiosquillina maculata*).

expanses, along with thriving seagrass meadows. There is also the mysterious fauna that leads a rather shady existence—in both senses of the term—beneath the canopy of the mangroves in the shallow coastal areas. Unlike the stereotypical muddy, murky mangrove swamps many of us may imagine, Raja Ampat is famous for its "bluewater" mangrove coasts, where sparkling conditions and amazing underwater life captivate the intrepid explorer.

RUGGED BELTS OF GREEN

Dense thickets of green are found thronging thousands of miles along these shallow, irregular tidal coasts. The mangrove biome is known as a mangal, and it can be composed of different species of salt-tolerant trees, mostly of the genus *Rhizopora*. Their exposed location lies between two worlds; it is flooded at high tide but can be exposed at low tide. The flora must come to terms with these extreme conditions, which are made more complicated because it is a saline amphibious zone (or at least brackish in river mouths).

The plants of the mangrove zones achieve the salt tolerance indispensable for colonizing intertidal areas primarily by having roots that are equipped to absorb only part of the salt ions contained in the water they take up. The water-soluble material that nevertheless enters the plant is usually stored in leaf cells and later exported when the leaves drop. Some species also have glands in their leaves that can excrete marine salt.

Another special characteristic of the habitat is that the vegetation along the waterfront must be able to withstand violent wave forces. Over eons, the plants of mangrove zones have evolved extremely stable root systems, which they use to anchor themselves solidly in the sandy or muddy bottom of the shallow coastline. The front row of the belt of woodland consists of bushy forms with remarkable stilt-like aerial roots that can claw deeply into the bottom, and in some places these species also occur singly or in groups in front of stands of larger trees. In Raja Ampat these green walls of vegetation are recruited mainly from the well-known Spotted Mangrove (*Rhizophora stylosa*) with its typical growth habit.

A real mangrove forest, truly deserving of the name, spreads out where there are areas of flat floodplain landward of the shore. The trees—mainly the Black Mangrove (*Bruguiera gymnorrhiza*)—attain a height of 33 feet (10 meters) or more. To ensure the stability of the slender trunks, each tree has a wide base of radially extending plank-like structures from which stout roots branch into the ground. Because the soil in such locations is waterlogged and depleted of oxygen, these plants possess special oddly-shaped roots used for breathing called pneumatophores. In the Stilted Mangrove, the exposed sections of root assume this function. So-called knee roots protrude from the ground where the Black Mangrove grows. Other species form closely-packed, upward-spreading stems variously called straw, snorkel, knee, or ribbon roots.

The plants of the mangrove zone have also adapted their reproduction to the extraordinary conditions of the habitat. This includes the family Rhizophoraceae, to which the two species mentioned above belong. These shrubs/trees are viviparous, continuously developing individual fruits that germinate while still on the tree. When the strikingly long seedlings, sharply pointed at the bottom, detach and fall, they can immediately drill a little way into the soft ground, giving them a considerable advantage at the start of their dynamic tidal existence. This way, if they are carried away by the current, they retain the ability to take root elsewhere.

NEIGHBORING HABITATS

Areas of mangrove forest that flood periodically are of little interest to the marine aquarist, which is why we will focus here on the zone where shallow water permanently washes around the stilt roots. It goes without saying that this coastal vegetation borders a variety of habitats, depending on the underwater landscape fronting it, such that the mangrove zone is a vital puzzle piece in the great mosaic of marine habitats.

On the side facing the sea, the mangrove belt is often hemmed in by slopes of light sand, in some cases interspersed with areas of rubble or even small corals, which provide more structural variety. In other places, an overgrown rocky bottom predominates. While the soft substrates harbor a community of fauna specially adapted to the shortage of cover, the spectrum of species is naturally wider and differently composed over the coarse substrates. This has been covered in detail in the previous parts of this article (*CORAL* March/April and May/June 2019), so only a few examples will be provided here to illustrate the crossover between habitats.

Sponge larvae drift everywhere in the shore zone and colonize stilt roots in the shadowy environment. Upside-Down Jellyfishes (*Cassiopea andromeda*) are characteristic inhabitants of brightly-lit stretches of water in the coastal jungle of shrubs and small trees. They usually rest on the bottom, canopy-down, so that the symbiotic algae in their appendages receive enough light to power photosynthesis. Because the medusae find equally ideal condi-

tions on the neighboring sandy bottom and among the seagrass, they are just as much at home there. Smaller specimens sometimes seem to suddenly develop legs and flit away. What has actually happened is that an Urchin Crab (*Dorippe frascone*) has seized a jellyfish and is carrying it around for camouflage.

Other invertebrates also alternate between the habitats, like certain spider crabs (*Achaeus* sp.), gastropods (e.g., the sea slug *Plakobranchus* sp.), and Berry's Bobtail Squid (*Euprymna berryi*), which can be found both inside and outside the mangrove zone. Cardinalfishes (Apogonidae) are likewise not bound to any particular territory and thoroughly enjoy the biocover on the stilt roots. Groupers (*Epinephelus* sp.) and Humpback Groupers (*Cromileptes altivelis*) hunt in both habitats. A solitary bright red juvenile Shaggy Frogfish (*Antennarius hispidus*) seems to have strayed onto the almost-white sand. The thicket of mangrove roots is an effective barrier to larger predators, and many reef fishes get a safe start in this protected environment, gradually venturing out as they gain size and survival proficiency.

Even mangroves and corals become neighbors where the profile of island shores runs flat for just a short distance and then drops off steeply. Because the tidal currents have a greater effect in such zones, hardly any organic deposits can settle, especially among the outer, still open, stilt-root areas. As the islands of Raja Ampat consist predominantly of fossil reefs, calcareous sand and rubble dominate the bottom, which is populated by attractive green algae (*Halimeda, Caulerpa*) that form bright green cushions and creeping shoots. The spreading trunks and branches of the mangroves sometimes extend over the fringing reef, whose roof—if you can call it that—remains very narrow.

Similar conditions are found in some sections of the magical Hidden Bay, a narrow, winding fjord popular with divers that extends into the island of Gam. Here, in the semi-shade of the canopy, in the play of light from broken sunbeams that dance steeply through the water, the reefs display an unusual charm. The spectrum of stony corals is visibly limited; *Acropora* and *Porites* stand out. Gorgonians such as sea fans, *Melithaea* sp., and others colonize everywhere, even the shallows. Colorful soft corals, particularly those of the genus *Dendronephthya*, can grow on mangrove roots. Delicate to sturdy, transparent to brightly colored sea squirts adorn every substrate; the impressive assemblages of magnificent Oxheart or Goldmouth Sea Squirts (*Polycarpa aurata*) are particularly memorable. Huge Magnificent Sea Anemones (*Heteractis magnifica*) extend their crowns of tentacles.

These examples show how much dissimilar habitats can be interconnected. Many typical reef-dwellers, especially fishes, regularly invade these mangrove zones. Shoals of glittering juveniles find a safe spot among the stilt roots.

MANGROVES BY NIGHT

In the vicinity of the Papua Explorer Resort on Gam Island lies a shallow, mangrove-lined bay. It can only be reached by boat, because a shallow extension of the shoreline creates a barrier that can only be passed at flood tide. We failed to plan our trip carefully and had to wait almost an hour to get there.

Visibility conditions were rather poor above the bottom of fine sand and mud, but the hidden refugium had a surprise in store: Psychedelic Mandarinfish (*Synchiropus picturatus*) living in a tangle of algae, seagrass, and sponges. These fish lead a secretive existence, and their splendid coloration was almost impossible to appreciate in the murky water. Photographing them was a real challenge, as they hardly ever left cover in daylight hours.

Shortly after making this unexpected discovery, we decided to undertake a night dive in the same area (in strict accordance with the tide tables). In the darkness, the tangle of stilt roots became even more of an eerie jungle. Our thoughts involuntarily wandered to Saltwater Crocodiles (*Crocodylus porosus*), which also live in coastal waters and are sometimes seen in Raja Ampat. We had asked our local guides in advance about these dangerous reptiles. Their answer was initially an ambiguous smile, but eventually they allayed all our concerns; they were sure that we wouldn't encounter any large reptiles.

I spotted several invertebrates here for the first time, including an inconspicuous Sheriff-Badge Starfish (*Asteropsis carinifera*) and an unfamiliar crab with powerful claws. We inadvertently woke a number of fishes, including the Red or Volitans Lionfish (*Pterois volitans*) with its long fin-rays, the Dash-and-dot Goatfish (*Parupeneus barberinus*) wearing its resting coloration, the Seram Blenny (*Salarias ceramensis*) with its tuft-like tentacles, the strikingly-patterned Papuan Toby (*Canthigaster papua*), and the bizarre Bristletail Filefish (*Acreichthys tomentosus*). The Horned Flathead (*Sunagocia carbunculus*), an unusual scorpionfish, wasn't disturbed at all by our visit. The highlight of the evening was the unexpected appearance of a rarely seen Marbled-Mouth Frogfish (*Lophiocharon lithinostomus*). This normally lethargic lurking hunter came galloping across the bottom and wouldn't even stop for a photo. What could have induced it to make this solo dash?

AT THE EDGE OF A LAGOON

Bays framed by stands of amphibious woodland are typical of the island of Pef, home to the Raja4Divers Resort, which also has access to a fabulous mangrove refugium. The higher water level during the flood tide makes it easier to explore the aquatic part of the mangrove zone, but you have to avoid the leafy branches that droop down and sometimes dip into the water. The further inland you go, the denser and more impenetrable the undergrowth becomes. This is where

Gold-Mouth Sea Squirt (*Polycarpa aurata*) and colonial sea squirt *Pycnoclavella* sp.

Fan coral (*Melithaea* sp.) beneath mangrove.

the zone of successive silting begins, as fallen leaves and sediments are retained by the tangle of roots and exploration becomes almost impossible. Mangrove swamps and forests are known to be tremendous carbon sinks, repositories that rival other types of tropical woodlands for their concentration of carboniferous biomass, living and dead.

The sunlight can only penetrate the jungle canopy to a limited extent, so the magical underwater landscape is sparingly illuminated. Because muddy-brown, organic deposits cover the bottom, the world around you looks pretty dark, and the stilt roots look like outsize, ghostly fingers. Snorkelling here forces you to pay attention to the beats of your fins so you don't spoil the already limited visibility. Trying to watch the mobile mangrove inhabitants stalking around isn't practical, and it is advisable to seek out a suitable spot and quietly remain there. The fishes will show themselves sooner or later, sometimes quite close to you.

It isn't easy to push aside the tough roots, their ends free in the water, when swimming along. This is a bad idea anyway, as accidental contact with them often has nasty consequences: unpleasant stings on bare skin. The culprits are inconspicuous but well-armed hydrozoans (Hydrozoa), most likely looking like delicate fluff when illuminated from behind.

It goes without saying that other representatives of an invertebrate fauna adapted to tidal conditions are among the characteristic colonists of the stilts. Besides the encrusting and clumpiform sponges already mentioned, you can also see a yellowish, finely-divided sponge with long ends extending to a point. Occasional sun corals (*Tubastraea* sp.) exploit the organic substrate. Here and there, tubeworms (*Sabellastarte* sp.) extend their pretty crowns of tentacles. Delicate sea squirts also live on the roots; we found the colonial tunicate species *Eudistoma laysani* only here.

The soft bottom also harbors secretive inhabitants. The bizarre-looking Zebra Mantis Shrimp (*Lysiosquillina maculata*) digs its burrow deep into the bottom and lies in wait at the entrance for any prey that approaches. Not far from one such shaft, we found a near-white brittle star of undetermined species in the mud.

As in other mangrove zones, fishes are inconspicuous but ubiquitous as they travel. There is no shortage of juvenile fishes and their pursuers, although the complex nature of the terrain makes hunting difficult for the latter. The predators include the slender halfbeaks (*Zenarchopterus* sp.) that swim immediately below the surface of the water and are difficult to spot because of their silvery appearance. Their arrow-fast strikes stun prey, whose most important life insurance policies are shoaling and hiding among the palisades of roots.

Shoals of the commonplace Orbiculate Cardinalfish (*Sphaeramia orbicularis*) and the rare Tearful Cardinalfish (*Zoramia flebila*) were floating through the thicket.

Berry's Bobtail or Hummingbird Squid (*Euprymna berryi*) is no larger than 2 inches (5 cm).

The inflated faces of some larger specimens indicated that they were carrying eggs in their mouths. The damselfishes found here include the Indo-Pacific Sergeant (*Abudefduf vaigiensis*), and we encountered *Halichoeres chloropterus* (Green Wrasse), one of many Labrids. In addition, there was a young Greenthroat or Singapore Parrotfish (*Scarus prasiognathus*) sporadically feeding on algae among the mangroves.

We encountered Mangrove Red Snappers (*Lutjanus argentimaculatus*), still a long way from full-grown but already outgrowing their banded juvenile dress. Half-grown Blackspot Snappers (*Lutjanus ehrenbergii*) and Three-Striped Whiptails (*Pentapodus trivittatus*) also value the relative safety of the mangrove zone and will roam around it.

The Banded Archerfish, *Toxotes jaculatrix*, is a permanent resident of the mangrove zone. It employs a unique, admirable hunting technique. Its upward-pointing mouth indicates that the fish takes its prey from the water's surface. However, the archerfish actively obtains prey by bringing down insects spotted on the branches above in a remarkable way, using a well-aimed and carefully calculated jet of water (hence the name archerfish). Their aim is said to be accurate within a range of 5 feet (150 cm), while larger specimens can hit targets 7–9 feet (2–3 meters) away.

Mangrove zones hold many surprises for those who dare to venture in. We can find areas that are alien to us and fascinating, but biologically linked to the more familiar adjacent reef and deep-water biotopes. While the rest of Indonesia has lost an estimated 40 percent of its mangroves in the past three decades, the green coastal belt is an important cog. Raja Ampat archipelago is largely intact and healthy, a key to sustaining the region's status of having earth's greatest assemblage of marine biodiversity.