

: ETHAN DANIELS © 2008

+ AN OFTEN OVERLOOKED PIECE OF PALAU'S BIODIVERSITY PUZZLE, NUDIBRANCHS COMPRISE AN INTRIGUING COMPONENT OF THE ARCHIPELAGO'S MARINE HABITATS.

PALAU'S PERFECT LITTLE PREDATORS

Looking like tiny creatures made up in the imagination of a creative child, nudibranchs vivid colors and flamboyant decorations make them one of the most fascinating animals groups commonly found in sea. The nudibranchs of Palau inhabit a mixture of marine ecosystems and come in every shape and tint conceivable. *Glossodoris rufomarginatus* is just one example of this diverse group.



Over the past two decades the Palauan archipelago has become one of the most celebrated diver destinations. Few areas can compare to the overall marine biodiversity found within Palau's lagoon and barrier reef. This maze of islands, uplifted during volcanic activity caused by tectonic plate shifts, are over 30 million years old and now support a collection of the world's most delicate and diverse marine life. Divers arrive here anticipating reliable and exhilarating shark encounters, massive fish schools, manta rays, and World War II wrecks. But few anticipate or appreciate the amount of invertebrate life proliferating throughout the islands' mangroves, seagrass beds, marine lakes, and coral reefs.

Most nudibranch-fanatics, also known as 'nudiphiles' or 'nudi-freaks', regularly travel to the Philippines, Malaysia, or Indonesia where thousands of species of nudibranchs, bubble-shells, sap-sucking slugs, and other opisthobranchs dwell. The encompassing geographic region, or 'Coral Triangle', seems to be the bio-

geographic centre for sea slug diversity, as well as most marine fauna. Located about 600 miles northeast of Papua and 600 miles east of the Philippines, Palau is on the edge of this triangle and has a myriad of nudibranchs though they're overshadowed by the plethora of charismatic megafauna. Despite often displaying varied colourful and psychedelic patterns, Palau's nudis tend to be overlooked by divers, expertly blending into their chaotic surroundings.

Nudibranchs are some of the most attractive and fascinating invertebrates due to their strange, vibrant colours and peculiar life histories. It's hard to believe, but most marine scientists, aided by images and observations by recreational divers worldwide, have just begun to comprehend the most basic foundations of nudibranch life histories. These tiny predatory jewels have an endless range of behaviours, morphologies, patterns, and colors. New species are found, photographed, and described from the world's oceans each year, especially within the Indo-Western Pacific where Palau lies.

Having evolved from slow, armoured gastropods, eons of natural selection have

reduced nudibranchs' protective calcium carbonate shells to naught, giving greater speed and mobility. Rare beneficial mutations acquired through millions of years of genetic mixing have allowed nudibranchs to invade and thrive in narrow niches to which their shelled

Below, left to right: One of the more distinguishable slugs found on shallow reefs and sheltered, sandy lagoon floors is *Chromodoris leopardus*. Fairly large, this species' mantle almost glows underwater, whites fading into rusty reds outlined by a dark violet margin.

When looking for particular species it pays to go to their hunting grounds. Probably due to where its food grows, *Glossodoris atromarginata* is often found on sunken ships within the protected lagoon.

Reticulidia fungia is one of the many members of the Phyllidiidae family, conspicuous due to their lack of a noticeable or "naked" gill. There are a variety of Phyllidia nudibranchs found in Palau and it's rare to go on a dive without finding at least one species within this family.

Interestingly, many nudibranch species are found in Palau but many of them are scarce. The beautiful *Hypselodoris obscura* is a rarity and was found only once by the author, crawling along the silty lagoon floor at 30 m.



“ OBSERVING THESE UNIQUE CREATURES IN THEIR NATURAL HABITATS GIVES DIVERS A GLIMPSE INTO THEIR FASCINATING LIFE HISTORIES AND EVOLUTION ”



ancestors were unsuited. These slugs have opted for other defensive weapons – potential predators face armaments including noxious chemicals, acids, or stinging cells. Nudibranchs advertise their defensive wares with an array of magnificent body colours and patterns. Some species without such obvious warning colourations may burrow into the soft bottom, emerging only at night to feed. Nearly all nudibranchs are specialized carnivores that have one or a small group of preferred prey species. They locate prey using their rhinophores, the antennae located on their head, which detect chemical compounds emitted by other organisms. They may also track down mates by ‘tasting’ and following mucus trails left behind by animals as they slime their way across the reef.

Locomotion is via transversal contraction waves traveling through the nudibranch’s muscular foot. These propel the slug slowly forward on a mucous film produced by a gland near the head. This would be like a mammal’s nose continuously dripping fluid so that the animal could slide around its environment. Some nudibranchs, like the massive Spanish dancer *Hexabranhus sanguineus* are powerful enough to swim away when disturbed. This species is relatively rare in Palau, but can be seen at night crawling along barrier reef dropoffs or in the numerous coral gardens.

Nudibranch reproduction is an entertaining aspect of their life histories. All sea slugs are either simultaneous or sequential hermaphrodites and reproduce throughout the year in the tropical waters of Palau. They copulate in pairs, arranging themselves right side to right side, each individual internally fertilizing the other’s eggs with sperm. Once fertilized, eggs are laid near a food source by each individual, usually in a tight ring expanding counter-clockwise. In many cases the eggs are brilliant red or yellow spiral ‘flowers’ and are

Left: The colouration of *Glossodoris cincta* is fascinating, camouflaged on top of the mantle with a frilled, iridescent blue fringe. These slugs don’t stand out on the reef and have to be searched for but they are worth the effort!

Uniquely arrayed, *Pteraeolidia ianthina*’s many cerata house zooxanthellae and are thought to provide plenty of surface area for the algae to collect light and use it for photosynthesis. These nudibranchs are frequently seen in channels, especially Lighthouse Channel where they aggregate on a current-swept wreck.

A geographically widespread nudibranch, *Hypselodoris bullocki* is a relatively rare find in Palau. This particular individual was photographed on one of the WWII wrecks that litter the lagoon floor and provide perfect substrate for artificial reefs.

spotted by divers due to their prominence on the reef. Other nudibranchs lay eggs in gelatinous masses, eg. the dragon nudibranch *Pteraeolidia ianthina*.

Eggs incubate for various time periods, and are dependent upon water temperature. Microscopic veliger larvae eventually emerge to drift in local currents and eventually settle on or near a food source like a sponge, coral, or hydroid colony. Larvae then quickly metamorphose into tiny replicas of adults. Unfortunately nudibranchs generally live fast and die young. The majority of species live for less than one year and many only survive a few months or weeks. Palau’s nudibranch populations vary in size throughout the year due to the natural life cycles of their prey.

There are two important suborders of nudibranchs found in Palau – Doridacea, the largest group, and Aeolidacea. The Dorids are the most recognizable and aesthetically pleasing nudibranchs found

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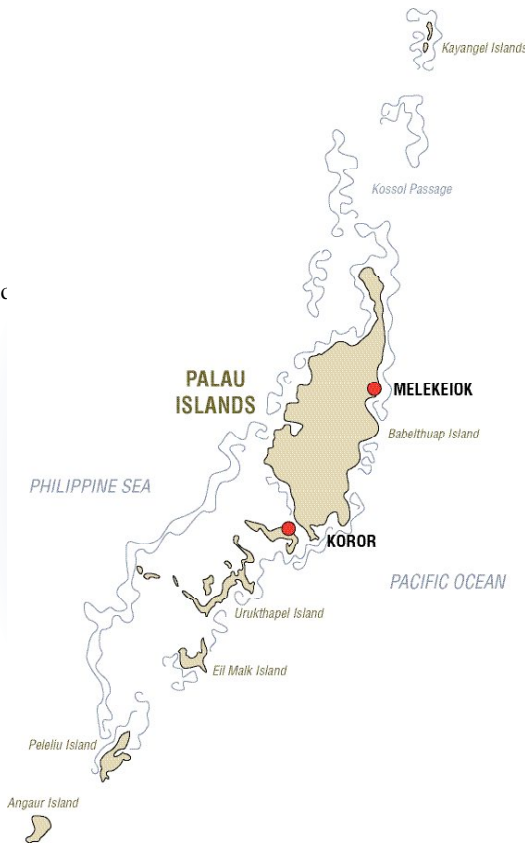
in Palau. Most have a pair of chemosensory rhinophores on their head and prominent gills on their back. This group contains the *Chromodoridae*, the largest and most recognized family of nudibranchs in the Indo-Pacific region. *Chromodoris* species feed on sponges and transfer toxic chemicals produced by their prey to glands along their dorsal side making them a rather noxious meal for predators. While in Palau, divers commonly find *Ardeadoris egretta*, *Risbecia tyroni*, *Glossodoris atromarginata*, *G. cincta*, *Hypselodoris bullocki*, *H. obscura*, *Chromodoris coi*, *C. kuniei*, *C. fidelis*, *C. verrieri*, *C. leopardus*, and *C. geometrica* and a few other species in all types of habitats, including walls, coral gardens, sand and rubble bottoms, and wrecks.

Palau’s most universal family of nudibranchs Phyllidiidae. There are a handful of species that can be seen on virtually every reef habitat. These sponge predators are easily identified as a group by the absence of gills on their backs. The mantle encloses the gills



The brilliant white and yellow colouration of *Ardeadoris egretta* makes it virtually impossible to miss on the reef. Its flowery gills wave back and forth with whatever current is flowing.

Colourful and fairly common, *Chromodoris coi* is quite distinctive, raising and lowering its mantle margin while crawling across the reef.



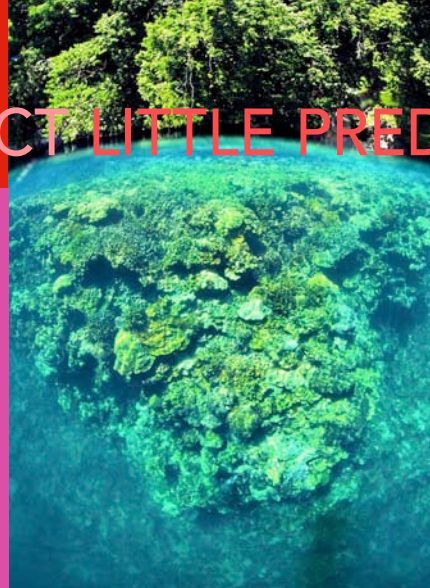
making them invisible to divers. This unique family of slugs have no teeth and must secrete digestive enzymes on to their prey before they consume them. Rarely are Phyllidia species pointed out to divers because they’re so frequently found. Due to their small size, several of the species are hard to tell apart and are quite similar in morphology. *Phyllidia varicose*, *P. elegans*, *P. tula*, *Phyllidiella pustulosa*, *Phyllidiopsis annae*, *P. fissuratus*, *P. kremfi*, *P. striata*, and *Reticulidia fungia* are all prevalent.

The third most widespread family found in Palau is Notodorididae. This group contains *Notodoris* species (*N. minor*, *N. gardineri*, and an undescribed species) that feed on sponges and somewhat resemble mutated sponges themselves. These species grow fairly large for nudibranchs, greater than 10 centimetres, and have three appendages protecting their fragile gills. Their bodies are clay-like and moderately colourful. The *Notodoris* found along the barrier reef dropoffs lay bright yellow egg masses easily seen from a distance and the nudibranchs that laid the eggs are often found nearby. *Notodoris* species have been found at all recreational dive depths where their preferred food source lives, from three to over 200 feet.

The suborder Aeolidacea comprises nudibranchs with narrow bodies and paired oral tentacles and chemosensory

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marine life°



rhinophores found on their heads. Identifying this group is relatively easy due to tube-like projections known as cerata along their backs. The cerata are digestive gland extensions with extremely thin walls but they also acts as gills, allowing gas exchange with the surrounding water. Aeolids feed on cnidarians: soft and hard corals, hydroids, and anemones.

Aeolids have an amazing self-defense technique. While feeding on cnidarians,

they'll digest the prey tissue that they consume except for the juvenile stinging cells or nematocysts, which all cnidarians possess. The nematocysts are moved through the digestive system to the cerata and arranged within the nudibranch's tissues to be used for their own defense. Two of the more common families are the Flabellinidae, containing the species *Flabellina exoptata*, and Facelinidae, containing the species *Pteraeolidia ianthina*. These nudibranchs can be found along most walls and dropoffs. *Flabellina exoptata*

Often confused with close relatives, *Nembrotha kubaryana* is an animal prevalent throughout the Western Pacific, found in channels, patch reefs, and along the dramatic vertical dropoffs of the barrier reef.

The wide variety of habitats available in Palau, along with the islands' geography, are what truly allow high nudibranch diversity. From mangroves and seagrass beds, to fringing reefs, patch reefs, wrecks, muck, and barrier reefs, Palau offers plenty of environments for nudis to spread out in.

is a tiny pink nudibranch about three centimetres long with yellow-tipped cerata that lives on walls and dropoffs.

Pteraeolidia ianthina looks like a small pipe-cleaner and is especially common in the channels close to the main inhabited islands of Palau.

Observing these unique creatures in their natural habitats gives divers a glimpse into their fascinating life histories and evolutionary history. Looking at any of Palau's sea slugs, it's easy to ponder the mutations and natural selection that's occurred over geologic time.

How and why did they evolve into the forms that exist today? What role do they play within their diverse marine communities? Why have they been so successful over time and where did they originate? While engrossed by the beauty of nudibranchs and pondering the mutations and natural selection that's shaped them over geologic time, it's easy to overlook the larger picture and the complex food webs in which they thrive.

We're living in an era of astounding biological diversity, yet for many species extinction looms. Changing climatic conditions, habitat destruction and loss, pollution, and chance play major roles in the future of Palau's reefs. Knowledge of species, from nudibranchs to fish populations, is the best weapon for properly managing Palau's still vibrant marine ecosystems. We, as divers and marine explorers, shouldn't only admire the larger more conspicuous creatures in the Earth's oceans, but should also treasure the smaller, less prominent, equally exquisite species like nudibranchs. They play small but vital roles in their ecological communities.

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