

Nudibranchs of Palau

by Ethan A. Daniels

Over the past decade the Palau archipelago has become one of the most famous destinations on the planet for serious divers. There are few locations on earth that can compare to the overall marine biodiversity found within such a confined area, all within a 45-55 minute boat ride from Koror, the nation's capital. This group of islands, uplifted during volcanic activity caused by tectonic plate shifts, is over 30 million years old. Subsequently, coral reefs have been growing ever since the uplift, creating a myriad of habitats for marine life.

Divers arrive in Palau looking forward to the reliable and exhilarating shark encounters, schooling fishes, manta rays, and World War II wrecks. Few people visit the islands anticipating the amount of invertebrate life that proliferates throughout the mangroves, seagrass beds, and coral reefs surrounding the islands. Whatever people's underwater interests may include, Palau accommodates them.

One of the most conspicuous groups of marine invertebrates are the nudibranchs, naked-gill sea slugs. Nudibranchs fall within the Phylum Mollusca, Class Gastropoda, subclass Opisthobranchia, order Nudibranchia. The majority of people who are attracted to these colorful sea slugs make their way to areas in the Philippines, Malaysia, or Indonesia where thousands of species of opisthobranchs are known to be found. This geographic region seems to be the bio-geographic



Glossodoris atromarginata is found frequently on wrecks within the inner lagoon.

center for sea slug diversity, as well as most marine fauna. Geographically, Palau is in an excellent spot to collect marine organisms from diverse areas, located about 600 miles northeast of Irian Jaya, and 600 miles east of the Philippines. The reefs and inner lagoon of Palau, better known for large fishes, are home to a wide variety of nudibranchs and other mollusks that can readily be found by visiting the right spots and having a keen eye.

Nudibranchs are considered by many knowledgeable divers to be the most attractive and fascinating of invertebrates due to their strange, vibrant colors and life histories. Scientists have just begun to comprehend the most basic pieces of nudibranch life histories. The wonderful aspect for divers who become interested in these tiny predatory jewels is that they have produced endless variations of behaviors, morphologies, and colors.

New species are found, photographed, and described from all over the world's oceans each year. New records of nudibranch species in Palau should be anticipated as more recreational divers



H. bullocki a species with variable colors, tends to be translucent white and is uncommon in Palau's waters.



Notodoris minor is one of the larger and unmistakable species of nudibranchs easily spotted on Palau's reefs.

and researchers seek them out

Through millions of years of natural selection, nudibranchs have reduced their protective calcium carbonate shells, allowing greater mobility. Over time, rare, beneficial mutations have allowed nudibranchs to invade and succeed in narrow niches



Ardeadoris egretta is another fairly common chromodorid whose geographical distribution ranges from the Arabian Sea to Palau.



Chromodoris coi can regularly be seen along the walls and current-swept channels of the outer reefs.



Miamira sp is one of the most seldomly encountered nudibranchs in the archipelago.

to which their ancestors, shelled gastropods, were unsuited. Instead of the protection provided by a hard shell these slugs have opted for other defensive weapons. Potential predators are faced with various armaments including noxious chemicals, acids, or stinging cells. Nudibranchs advertise their

defensive wares to possible predators with a wide array of magnificent colors and patterns arranged on their bodies. Some species without such obvious warning colorations 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 prey species. They locate prey using their rhinophores, antennae located on their head, which detect chemical compounds emitted by other organisms. They may also track down mates, or potential prey, by following the mucus trails left behind by the animals as they slime their way across the reef.

Locomotion is accomplished by transversal contraction waves traveling through the nudibranch's foot. These contraction waves propel the slug forward on a mucous film that is produced by a gland near the head. This would be like a mammal's nose continuously dripping fluid in order that the animal could move around its environment. Some nudibranchs, like the Spanish Dancer, *Hexabranchus sanguineus*, are powerful enough to

actually swim away when disturbed. This species is relatively rare in Palau, but can be found at night crawling on the drop-offs or coral gardens along the barrier reef.

Reproduction in nudibranchs is an entertaining aspect of their life histories that divers may have the opportunity to witness on any given day. All sea slugs are either simultaneous or sequential hermaphrodites and tend to reproduce all year round in the warm 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 by each individual, usually, in a tight ring expanding counter-clockwise. In many cases the eggs may look like brilliant red, or yellow flowers. These brightly colored spirals are easily spotted by divers due to their prominence on the reef. Certain species lay eggs in gelatinous masses, e.g. *Pteraeolidia ianthina*.

Eggs are usually found near the food source of the adult and incubate there for various time periods, depending upon the species of nudibranch and/or water temperature. The veliger larvae that hatch from the eggs drift and swim with ocean and local currents for some time, eventually settling on or near a food source, i.e. sponge or hydroid colony. Larvae then metamorphose into juvenile nudibranchs, looking much like the adults. Unfortunately for them, nudibranchs have somewhat short life spans on average. The majority of species live for less than one year and many only survive a few months or weeks. The populations of certain species may vary greatly due to the natural life cycles of their prey.

There are two important suborders of nudibranchs found in Palau, Doridacea, the largest



Nudibranch eggs on Polycarp sp ascidian

group, and Aeolidacea. Two other suborders are present but much less common. The Dorids are the most common and recognizable nudibranchs found in Palau. Most have a pair of chemosensory rhinophores on their head and gills on their back. This group contains the Chromodoridae, the largest family of nudibranchs in the Indo-Pacific region. Chromodoris species feed on sponges and transfer toxic chemicals produced by their prey to glands in their tegument (along the dorsal side) making them a rather noxious meal for predators. The chromodorids contend with a few other families for the brightest and most aesthetically pleasing to human eyes. While in Palau, divers most 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 and dropoffs, coral gardens, sand and rubble bottoms, and wrecks.

The most common family of nudibranchs found throughout Palau is Phyllidiidae. There are a



Hypselodoris obscura is another rarity, photographed at 35m on the silty bottom of the inner lagoon.

handful of species that can be seen on almost 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 making them invisible to divers. This unique family of slugs lack teeth and must secrete digestive enzymes onto their prey before they consume them. Rarely are Phyllidia species pointed out to divers because they are so frequently found. Several of the species are very similar morphologically and hard to tell apart. *Phyllidia varicose*, *P. elegans*, *P. tula*, *Phyllidiella pustulosa*, *Phyllidiopsis annae*, *P. fissuratus*, *P. kremfi*, *P. striata*, and *Reticulidia fungia* are all easily located. Few species grow larger than five or six centimeters.

The third most common family found in Palau is the 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 cm, and have three appendages



Phidiana indica can usually be found on wrecks or reefs within Palau's Rock Islands.

protecting their fragile gills. Their bodies are clay-like and moderately colorful. The Notodorids found along the drop-offs of the barrier reef lay bright yellow egg masses that can be seen from a long way off. 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 is made up of nudibranchs that have narrow bodies with pairs of oral tentacles and chemosensory rhinophores found on their heads. It is easy for divers to identify this group due to the cerata, tube-like projections along the nudibranchs backs. The cerata are digestive gland extensions with extremely thin walls to allow the exchange of gases with the surrounding waters. The cerata therefore act as the gills. The aeolids feed on cnidarians: soft and hard corals, hydroids, and anemones. Aeolids have an amazing way in which they defend themselves. While feeding on cnidarians, they will digest the prey tissue that they consume except for the juvenile stinging



Chromodoris kuniei is one of the most prolific chromodorids in the Western Pacific and makes an excellent photographic subject.

cells, called nematocysts, which all cnidarians possess. The nematocysts are moved through the digestive system to the cerata and arranged within the nudibranchs 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 drop-offs. *Flabellina exoptata* is a tiny pink nudibranch, about three cm 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.

Several of the families and many species found throughout Palau's limestone "Rock Islands" and inner lagoon, patch reefs and barrier reef have not been mentioned because they are not easily found. Divers who are interested in finding the less common species of nudibranchs must find



Chromodoris leopardus has exquisite coloration and is found infrequently among various Palauan dive sites.

their food source and then have patience and sharp eyes. Night diving is one way in which to increase chances of finding these animals. Many species are nocturnal predators.

Closely related species are extremely difficult to distinguish merely by looking at morphological, or physical features. Comparing their genetic structures (DNA sequences) is the best way nudibranchs can be divided or grouped together into families, genus, and species. The taxonomy of nudibranchs is in desperate need of revision. The future certainly holds more discoveries and surprises for scientists and laymen alike.

Not only should divers appreciate locating and observing these unique creatures in their natural habitats, but also their fascinating life histories and evolutionary history. Looking at nudibranch morphologies, it is easy to wonder about the mutations and natural selection that has taken place over millions of years. How and why did they evolve into the forms that divers observe



Flabellina exoptata a common aeolid throughout the Indo-Pacific, is unmistakable with its purple coloration and yellow-tipped cerata.

today? What role do they play within their small, but diverse marine communities, and how have they been so successful over time? Divers should also contemplate the larger picture, beyond the aesthetic beauty of nudibranchs, and think about the range

of environments in which they live and how to preserve them. Ecologists almost completely agree now that the best way in which to save a particular species is by preserving their habitat. Who knows what the effects of losing these incredible species would be as their habitats are degraded.

We are living in an era of astounding biological diversity, yet extinction is also a common event in this age. This may be due to the combination of several factors, such as changing climatic conditions, habitat diversity and destruction, pollution, and chance (to name just a few). We, as divers and explorers of the marine world, should not only admire and be in awe of the large conspicuous creatures that inhabit the Earth's oceans, but also the smaller, less prominent, but just as exquisite, species that play important roles within their ecological communities.

Shooting Nudis

Capturing an outstanding nudibranch image on film or flashcard is more difficult than it may seem. The trickiest part is actually finding them among all of the other bright and cryptic reef organisms. Though they may not move as fast as a shark or billfish, most nudibranchs are constantly on the prowl for food and keep chugging along in that pursuit. At least most of them have such vibrant coloration that it's hard to lose them while framing and focusing, unlike a pygmy seahorse. After setting up and shooting one shot, it's likely you'll have to adjust your position to get the right angle and background. Be patient and careful with your fins and body position, there's absolutely no need to



Reticulidia fungia, within the *Phyllidiidae* family, has a unique but variable pattern and is a rare find amongst the diverse reefs of Palau.

lie on the bottom to shoot any subject! Obviously, buoyancy control is key to becoming not only a proficient nudibranch shooter but an all round good diver as well.

Regarding equipment, you'll need a decent macro setup. There's little point in using a lens wider than a 60mm. I still use an old, beat-up Nikon N90 with a 105 mm lens, housed in an Aquatica 90 with two Sea & Sea sub-30 strobes on short TLC arms which are easy to move around on ball joints. I always use manual focus because the body of the nudibranch may be at an angle where it will be slightly out of focus. Be sure to focus on the nudibranch's rhinophores! Even though the pros use housed cameras I still see great shots coming from extension tubes and framers once in a blue moon. It just depends on if the photographer pays attention to the limitations of his or her setup.

The technical aspects of photographing opisthobranchs is fairly straight forward. Personally, I keep it simple, usually shooting on manual at



Nembrotha cristata has a black body and green gills and pustules. This species is often confused with its close relative, *N. kuaryana* which may have a bit of red around its margins.

1/60th at f/16, 22, or 32 depending how close I am to the subject and what film is in the camera. I'm still using Fuji Velvia 50 ASA while shooting underwater these days. I haven't broken down and picked up a housing for my Canon 10D quite yet. The strobes are kept about 2 feet from the subject and are moved around quite a bit depending on how I want to light the scene. As with all images, the background is extremely important. This is an aspect of photography I can't stress enough. Pay attention to what the organism is on and what's behind it! The background can make or break an image even if everything else is technically correct, in focus and well lit.

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