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X-Ray Mag

GLOBAL EDITION
May/June 2020
Number 98

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COVER PHOTO BY PETE MESLEY

DIRECTORY

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COVER PHOTO: *Cave diving explorer Maria Bollerup inspecting an exquisite outcrop in one of the many virgin cave systems in Southeast Sulawesi, Indonesia,* by Pete Mesley **(petemesley.com)**

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Fusiliers swimming over the reef, Samoa, Polynesia. Photo by Brandi Mueller.

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Meet Maslow

Are we having diving withdrawals yet? Some of us surely are.

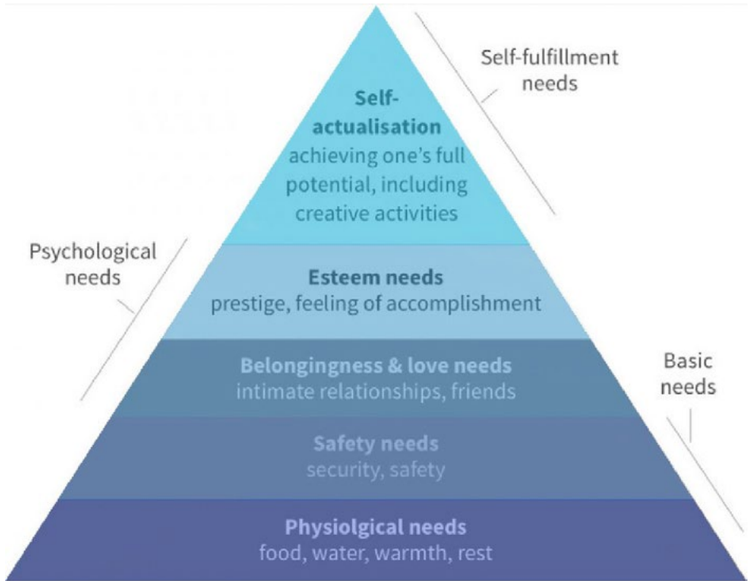
It has already been way too long since we got wet and who knows how much longer it will be before we can go diving again, other than alone at a local dive site that may be open, if we are lucky.

The coronavirus outbreak is an eyeopener in so many ways. It is giving us lessons on what is important. When the pandemic hit in earnest, many of us suddenly found ourselves focused on more basic needs than usual. If not food and shelter, then at the least, safety and health, and the wellbeing of our loved ones, some of whom we were not permitted to visit.

What role does diving play in our lives and in our wellbeing? How important is it really?

Enter Abraham Maslow, an American psychologist mainly known for creating *Maslow's hierarchy of needs*, which can be seen represented by the pyramid (below) in which the most basic needs are at the bottom and the need for self-actualization is at the top. The original hierarchy states that a lower level must be completely satisfied and fulfilled before moving onto a higher pursuit. This means that the lower levels may take precedence over the other levels at any point in time. Plenty more information about it can be found on the web.

The pandemic sent many of us tumbling down the rungs of that pyramid, at least temporarily. And hopefully, the experience—however unpleasant and disconcerting—has also served to provide us with some new insights, priorities and a different appreciation of the good things we have in life.



Maslow's hierarchy of needs

While diving is not a basic necessity but rather an activity at the top of the pyramid, being cut off has taught me a thing or two about how much I value the experiences diving provides me and the role it plays in feeling alive. As the old saying goes, you do not know how much something means until you lose it.

On a different note, this outbreak has also given us a better appreciation of and new perspective on protecting our natural environment. Pollution has gone down, air quality has improved, the skies are blue, without contrails, and during the travel restrictions, we may even have rekindled our relationship with local nature—some of which has flourished in the absence of human disturbance.

We have been shown, even if it is for just a brief moment and in glimpses, that if we give nature enough space and nurturing, it can rebound, and that humanity, if we adapt our technology and mitigate the damage and stresses we currently inflict, can coexist alongside healthy and diverse ecosystems.

We have been given a warning and a chance. We had better grab it.

— Peter Symes
Publisher & Editor-in-Chief

Edited by
Peter Symes

from the deep

NEWS

Our oceans could be restored in 30 years

Rebuilding marine life represents a doable challenge for humanity, an ethical obligation and a smart economic objective to achieve a sustainable future.

During the COVID-19 pandemic, nature has gotten a break in many places. Jellyfish swimming in the canals of Venice made the headlines, there are no contrails in the sky, and air pollution has plummeted over urban areas. As we reassess our priorities and begin to appreciate the value of what we are losing, it should make us wonder if there is a better way, post-COVID-19, to manage our natural resources—the oceans, in particular.

From pollution to restoration

On reflection, most of us have, at some point most likely looked at historical photos, say, from the 1960s or earlier, and noticed how dirty industry once was, with billowing smokestacks and untreated discharge choking waterways. Thankfully, such practices have since became outlawed through environmental protection laws in many regions, after which streams, rivers and lakes have been restored and once again become natural habitats full of life or even attractive recreational areas.

Restoring natural habitats may require a gargantuan and costly effort—for instance, where lakes have become heavily eutrophicated with their lakebeds covered in thick layers of stinky sediment. In some cases, it has been deemed necessary to empty the lake and have the sediment dug out with excavators. But often less is required, as life itself can be a major corrective force if provided with the right circumstances, nudged in the right direction and given time to heal. It is a process that, in most cases, takes many decades, but signs of improvement will often show much sooner.

PETER SYMES

Ocean health

Regarding the oceans, at least one-third of fish stocks are currently overfished; one-third to one-half of vulnerable marine habitats have been lost; a substantial fraction of the coastal ocean suffers from pollution, eutrophication, oxygen depletion and is stressed by ocean warming; and many marine species are threatened with extinction.

Nevertheless, as a major new scientific review published in the journal *Nature* points out, global fishing is slowly becoming more sustainable, and the destruction of habitats such as seagrass meadows and mangroves has almost come to a halt. In many locations, such habitats are actually being restored. Biodiversity losses in the ocean are less pronounced than on land, and many marine species are capable of recovery once pressures are reduced or removed.

Efforts to rebuild marine life cannot, however, aim to return the ocean to any particular past reference point. After all, the ocean has changed considerably and—in some cases—irreversibly, including the extinction of at least 20 marine species.

Focus of restoration

Instead, the focus should be on increasing the abundance of key habitats and keystone species, as well as restoring the three-dimensional complexity of benthic ecosystems. The yardstick of success should be the restoration of marine ecological structure, functions, resilience and ecosystem services, increasing the capacity of marine biota to supply the growing needs of an additional two to three billion people by 2050.

The time that is required to rebuild components of marine life depends on the extent of previous declines, which are often substantial. The reduction in species

news

Edited by
Peter Symes

QUANG NGUYEN / PIXABAY

abundance and biomass relative to pre-disturbance baselines averages about 44 and 56 percent, respectively, across affected marine ecosystems.

Moreover, although the maximum rates of recovery of marine populations typically range from two to ten percent per year, rates slow down as carrying capacity is approached. (The carrying capacity of an environment is the maximum population size of a biological species that can be sustained in that specific environment, given the food, habitat, water and other resources available.)

Substantial vs complete recovery

Thus, substantial (50–90%) rather than complete (>90%) recovery may be a more realistic target for rebuilding marine life in the short term. Based on the case studies examined, the authors propose three decades from today (2050) as a target timeline for substantial recovery of many components of marine life, recognizing that many slow-growing, severely depleted species and threatened habitats may take longer to recover, and that natural variability may delay recovery further.

Some of the interventions required to rebuild marine life have already been initiated, but decadal time lags suggest that the full benefits are yet to be realized. Before the outbreak, this magazine had already reported on many cases where Marine Protected Areas had been effective in restoring biodiversity and fish stocks by providing a refuge from fishing and other exploitation—provided they are well managed and policed. That said, as most current MPAs are less than ten years old, their full benefits, which increase with the age of the reserve, are yet to be realized

Recovery wedges

MPAs on their own will not be sufficient, as there is no single solution for achieving recovery of marine ecosystems. Rather, recovery requires the strategic stacking of a number of complementary actions, termed "recovery wedges," each of which will help to increase the recovery rate to reach or exceed the target of 2.4 percent increase per year across different ecosystem components. In that mix, MPAs represent a necessary and powerful recovery wedge across multiple components of the ocean ecosystem, spanning from coastal habitats to fish and megafauna populations. The current growth of MPAs is currently on track to meet ambitious targets: 10 percent of ocean area protected by 2020, 30 percent by 2037 and 50 percent by 2044.

The authors of the review conclude that recovery rates across studies suggest that substantial recovery of the abundance, structure and function of marine life could be achieved by 2050, in three decades provided major pressures—including climate change—are mitigated and the current surge in restoration efforts are sustained. This will require sustained perseverance and substantial commitment of financial resources, but the ecological, economic and social gains will be far-reaching. The measures needed—including protecting large swathes of ocean, sustainable fishing and pollution controls—would cost billions of dollars a year, the scientists say, but would bring benefits ten times as much.

"One of the overarching messages of the review is, if you stop killing sea life and protect it, then it does come back. We can turn the oceans around and we know it makes sense economically, for human wellbeing and, of course, for the environment," said Professor Callum Roberts of the University of York. ■

SOURCE: NATURE

NICOLE KLESY / PIXABAY

Edited by Peter Symes and Scott Bennett


ALBERT KOK

The staghorn coral (*Acropora cervicornis*) is a branching, stony coral with cylindrical branches ranging from a few centimetres to over two metres in length and height.

Coral restoration projects show promise in Florida Keys

Reef restoration projects in the Florida Keys National Marine Sanctuary could play a key role in helping staghorn coral recover.

Reef-building staghorn coral (*Acropora cervicornis*) was abundant and widespread throughout the Caribbean and Florida until the late 1970s. The fast-growing coral formed dense thickets in forereef, backreef and patch-reef environments to depths over 20m.

However, significant population declines in staghorn coral and elkhorn coral (*Acropora palmata*) began in the 1970s and now exceed over 90 percent around Florida. The losses were caused by a combination of coral disease and bleaching, with possible contributions from other stressors, including pollution and other disturbances that affect sites at regional and local scales.

Reproduction in the wild by fragment regeneration and sexual recruitment is inadequate to offset population declines. Recovery has not occurred in Florida because stressors persist.

Starting in 2007, the Coral Restoration Foundation evaluated the feasibility of outplanting nursery-raised colonies of staghorn coral to reefs in the Florida Keys to restore populations at sites where the species was previously abundant.

Outplanting viable

While coral outplanting is considered a viable strategy to help meet the restoration criteria outlined in the NOAA Recovery Plan (NRP), coral propagation and outplanting are still a relatively new idea. The approach was based, in part, on a long history of projects that reattached corals dislodged by storms or by ship groundings, as well as outplanting advancements adapted from terrestrial silviculture practices and the aquarium trade.

Survivorship was initially high but generally decreased after two years. After four years, approximately one-third of surviving colonies were over 50cm in maximum diameter. Furthermore, approximately 15 percent of outplanted colonies that survived four years attained greater than 100 cm maximum colony diameter, so at least a small proportion of outplanted colonies retain the capacity to grow as fast and large as the largest colonies in natural local populations.

Results support NRP conclusions that reducing stressors is required before significant population growth and recovery will occur. Until then, outplanting protects against local extinction and helps to maintain genetic diversity in the wild.

A significant challenge for restoration managers is how to address the inevitable population declines that are caused by multiple sources of mortality. One approach is based on the idea of assisted evolution, in which selective breeding of corals or other genetic enhancements are used to produce corals that can thrive against the increasing frequency and magnitude of stressors, especially those related to warming and bleaching. ■ SOURCE: PLOS ONE

Scientific breakthrough could save Florida's Reefs

Scientists in Florida have announced a breakthrough that will help save "America's Great Barrier Reef," the third largest coral reef in the world. For the first time, Tampa's Florida Aquarium has successfully reproduced ridged cactus coral in human care and have posted a video of the history-making discovery on Twitter.

The corals were rescued by the Florida Fish and Wildlife Conservation Commission and NOAA Fisheries after an outbreak of Stony Coral Tissue Loss disease commenced 2014. Previously, little was known about ridged cactus coral reproduction, as no photos, videos, or published studies were ever done on the species' reproductive biology.

Ridged cactus corals are brooding coral, as only their sperm, not the eggs, is released into the water. The eggs are then fertilized, and larvae development occurs within the parent coral. Upon being expelled, the baby coral swims until they find a place on the reef where they can anchor.

Breakthrough

Scientists are now caring for the rescued adult coral colonies to breed and reproduce in hope of restoring the reefs once the disease has passed. In the process, scientists are discovering basic information on their biology, such as when they have babies or what their larvae look like.

"We are losing coral species faster than we can learn about them," Keri O'Neil, senior coral scientist at the Florida Aquarium. "This breakthrough is just really exciting; we're still learning basic new things you'd think we've known for hundreds of years. It's just people never worked with this species before and now that we have the opportunity to work with these corals in the lab, we're going to find out so much more about them."

Reproduction process

After witnessing the corals "give birth" for the first time, scientists discovered the larvae of this species' to be the largest they have ever seen. Spawning commenced in early April, and to date, over 350 coral babies have been released. The next step is to discover how long the larvae swim before settling and becoming adult coral.

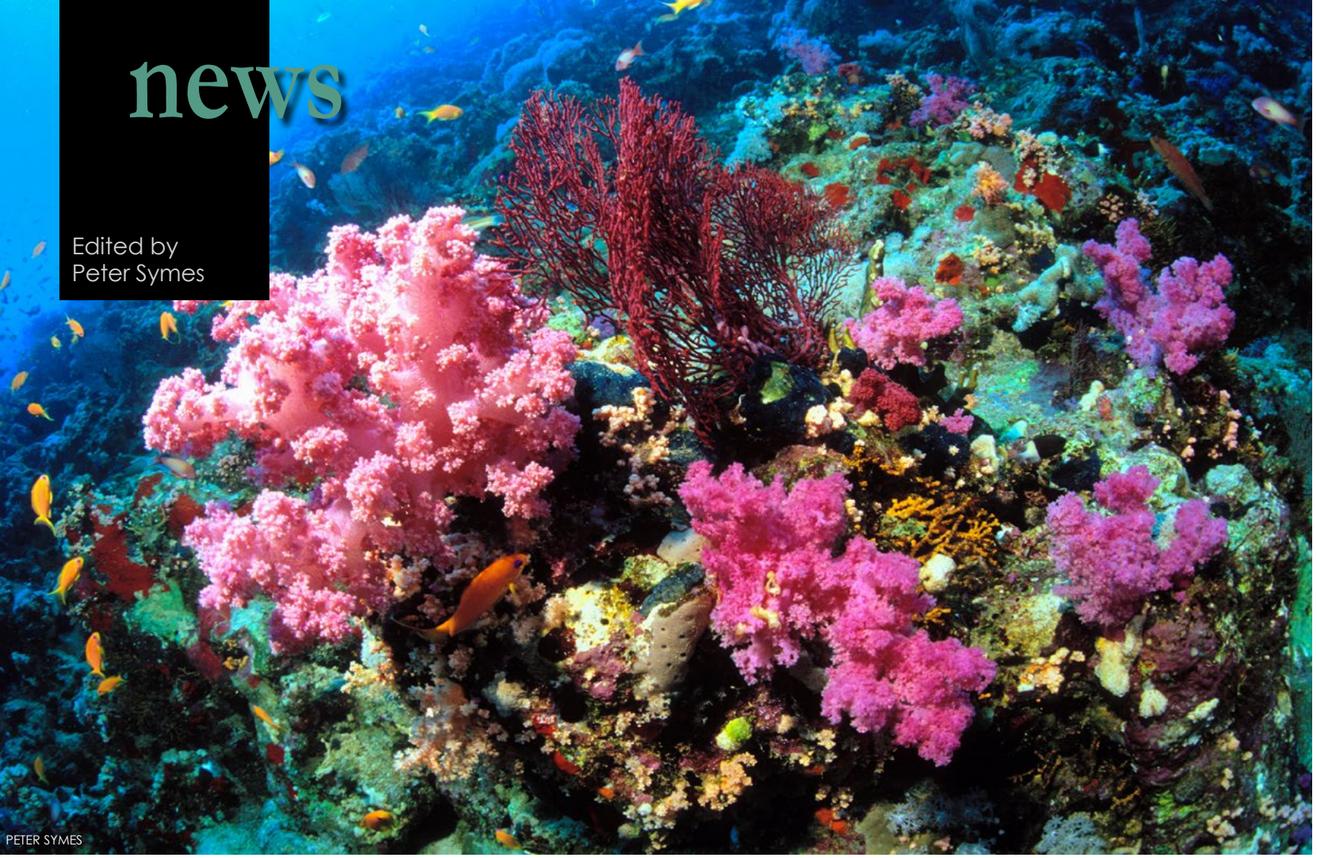
"Healthy coral reefs are vital to the survival and quality of life of humans and animals, especially here in Florida and throughout the Caribbean and Gulf of Mexico. We believe it's our responsibility to save the Florida Reef Tract from disappearing," said Roger Germann, president of The Florida Aquarium. ■ SOURCE: FLORIDA AQUARIUM, CNN


FLORIDA AQUARIUM

The ridged cactus coral, relatively uncommon but striking in its beauty, had reproduced in a lab for what the aquarium says is the first time.

news

Edited by
Peter Symes


PETER SYMES

Corals in the bay of Aqaba, Red Sea

Red Sea coral resilient to climate change

Despite sea temperatures rising faster than the global average rate, no mass bleaching events have occurred in the northern Red Sea.

In recent decades, many coral reefs around the world have been suffering tremendous damage as a result of global climate change. However, in the northern Red Sea, the situation seems to be somewhat different. Research has shown that the coral reefs in both the Gulf of Aqaba/Eilat and the Gulf of Suez are unusually resilient to climatic changes. Corals in the northern Red Sea regularly experience 4.0˚C - 6.5˚C daily changes in seawater temperature and seasonal variations that exceed 29˚C.

Recently, Israeli scientists found that the northern Red Sea corals are not only adaptable to changing environmental conditions but also continue to produce offspring at the same rate and quality, which could ensure reef survival for many years to come, provided we humans do not interfere.

How come?

The new study conducted by Professor Maoz Fine of the Faculty of Life Sciences at Bar-Ilan University, proposed that millennia of natural selection in the form of a thermal barrier at the southernmost end of the Red Sea have selected coral genotypes that are less susceptible to thermal stress in the northern Red Sea.

Further scrutiny of these species and the mechanisms by which they are able to thrive is ongoing, as they hold the potential to benefit other coral communities as a resilient transplant species and model for understanding coral survivability in extreme environmental conditions. ■

SOURCE: OPEN JOURNAL OF ECOLOGY

Edited by
G. Symes

PHOTO COURTESY OF MIDE

New dates set for Malaysia International Dive Expo

In light of the Covid-19 pandemic, the Malaysia International Dive Expo (MIDE) will now take place from 4 – 6 December 2020 at the World Trade Centre, Kuala Lumpur.

Exhibitors and partners can be assured that MIDE's organizers, AsiaEvents Exsic, have put into motion a solid plan to deliver the same targeted results that their mid-year event consistently provides.

This will be MIDE's 15th year, and it promises to run at full capacity in December, not only welcoming water enthusiasts, exhibitors, speakers and other participants, but also continuing to offer the best available platform for B2B networking.

MIDE draws at least 10,000 visitors every year, with over 160,000 visitors coming to the show between 2006 and 2019. While the majority of visitors to the expo are scuba divers, the inclusion of boating and recreational water-sports will be sure to attract even more water-loving enthusiasts.

B2B networking platform

A new and improved dynamic networking platform, with a preview function for browsing potential buyers and sellers, will help businesses and exhibitors schedule meetings in advance, making the most of their time at the three-day event.

Dive education

Visitors can look forward to a series of presentations focusing on topics in dive education and marine conservation, including the annual Ocean Rescue Forum with its 2020 theme of "Eco-Friendly Diving," as well as a new all-female line-up of speakers in the field of underwater photography.

MIDE's cave diving forum is a chance for technical divers to get up-to-date information and valuable tips on safety, equipment and destinations. In addition, there will be a forum for persons with disabilities in which panel members will share life-changing experiences with audiences, as they relay their stories in discovering diving for the disabled. DAN World is also returning to share more invaluable tips on dive safety.

Register today!

Go to "Entry to Expo" at:
mide.com.my/admission

For more information, please email: **info@mide.com.my** or visit: **mide.com.my** for details. Get the latest expo news and updates via MIDE's social media pages @Mideexpo. ■

Diving in

The Era of COVID-19

Text by Douglas Ebersole, MD

April 2020 — I come to you as a recreational and technical diving instructor, as a physician consultant for Divers Alert Network, and as a COVID-19 survivor. For me, it was just an occupational hazard. I tested positive for COVID-19 after seeing a patient in my cardiology clinic for an unrelated condition who seemed quite short of breath. He was admitted to the ICU and tested positive for COVID-19.

Thankfully, he did not require a ventilator and recovered after approximately two weeks in the hospital. I was notified of his positive test one week after my exposure. As I had been wearing my N95 mask when I saw him, I was advised to take my temperature daily and self-monitor for symptoms.

I did well for a few days and then began developing a cough and profound fatigue followed by fever. I ended up testing positive and spent the next couple of weeks quarantined at home. I have now recovered and will be going back to work this week and look forward to returning to diving. More on that later.

I am definitely one of the lucky ones. Thousands of others have been hospitalized, required ventilators, and have died. Our thoughts and prayers should go out to those patients and their families.

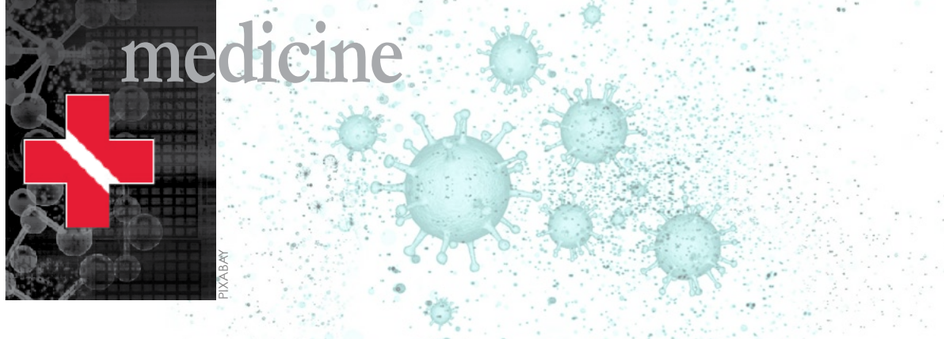
While this is a horrific global event, the diving industry will come out the other side. When we do, how do we safely get people diving? This is a multifactorial issue, involving dive shops, dive charters, instructors and the individual diver or dive student.

Background

The novel coronavirus, known as SARS-CoV-2, is the cause of the disease COVID-19, which has killed almost 200,000 people worldwide as of the date of this writing (25 April 2020). SARS-CoV-2 is part of the viral group known as "corona" (Latin for "crown" or "halo") because of the pattern of proteins that stud its surface. Coronaviruses are responsible for 15 to 30 percent of acute respiratory infections each year. Human-to-human spread of the virus is by way of large respiratory droplets (coughing, sneezing, speaking) and touching contaminated surfaces. The incubation period of the virus is two to 14 days, with a mean of 5.1 days.

Medical experts believe a vaccine for COVID-19 is still at least 18 months away. Until a vaccine is available or effective therapies are found, the disease will continue to spread. The impact of social distancing and "flattening the curve" has been helping keep people safe and helping to avoid overwhelming our medical resources, but it has also had a massive economic impact on society.

This impact has been felt especially severely in the diving industry as it is based on discretionary spending by consumers. Additionally, for many divers, their interest in diving is strongly linked to the ability to travel internationally. Until travel restrictions are lifted and consumers are confident in the ability of the airlines and



cruise industry to keep them safe, the dive industry will likely continue to suffer economically. But enough doom and gloom. What can we do as a community to help the dive industry?

Dive centers

The diver or dive student needs to feel safe before they will go into a store to purchase gear or training, to board a dive charter, or simply to go diving. For the foreseeable future, this is going to mean wearing masks in public, social distancing in dive shops, fewer passengers spread out on dive charters, an emphasis on online training where possible, and smaller class sizes—again to allow students to practice social distancing. Pay by phone or curbside tank drop off could also be effective interventions to reduce the chance of infection.

One positive aspect of this pandemic is it has forced dive shops and training agencies to move towards more online training. E-learning has been growing in popularity for some time and has been embraced by various training agencies and dive centers to greater and lesser degrees.

RAID now allows students access to all of their training materials, from open water diver through cave diving instructor, at no cost. Other training agencies have also moved towards offering certain courses at low or no cost to students in an attempt to keep money flowing into the dive centers during this very difficult time.

Webinars and Zoom conferences have become the new normal. There have been a number of outstanding live conferences put on by The Diver Medic, Dirty Dozen Expeditions, Dive Ninjas, Deeper Discussions and Shallow Thoughts, Divesoft Talk Live, and many others these past few weeks. I imagine dive centers will incorporate this mode of education into some aspects of their academic courses in the future.

Unfortunately, many dive centers will not be able to financially weather this storm, but as a community, we need to do everything we can to help support our local dive centers. Take this time out of the water to get your gear serviced.

For dive centers not located in diving hotspots like Florida or California, it is going to be really tough until travel restrictions are lifted and their customers feel comfortable getting on an airplane. If you have a trip that is in jeopardy, consider rescheduling rather than canceling and asking for a refund. Buy gear in preparation for upcoming dive trips in advance of the quarantines and shelter-in-place orders being lifted. Sign up for continuing education and do the academic portions online or via a conferencing app with your instructor. Every little bit helps. We are all in this together.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Gear cleaning

Rinsing off dive gear at the end of each pool session will no longer suffice. We need to truly disinfect any items that could be shared among divers, especially regulators and BCDs. Divers Alert Network (DAN) has recently published guidelines regarding disinfecting scuba gear. The link is here: **diversalertnetwork.org**

Coronaviruses belong to a group of enveloped viruses, which means the virion (the form that the virus takes while outside the host cell) is protected by an oily lipid layer. As with most enveloped viruses, damaging or destroying this lipid layer will inactivate the virus. Studies of other coronaviruses have shown their infectivity can be reduced by heat, UV light and alkaline or acidic conditions. Because of this, and the fact that enveloped viruses are generally easily inactivated, surfaces can be disinfected using household cleaning products.

Because research into SARS-CoV-2 is ongoing, there is debate about how long it can survive on surfaces. Recent studies have shown that it can survive up to three hours in an aerosol droplet (such as from a sneeze), four hours on copper, 24 hours on cardboard, and two to three days on plastic and stainless steel.

In water, however, it is unclear how long SARS-CoV-2 survives. Studies on the SARS virus, called SARS-CoV-1 and the cause of an epidemic in 2003, have shown that it remained infectious for long periods in surface water (lakes, rivers, wetlands, etc.) and previously pasteurized sewage at both low and ambient temperatures. In chlorinated or bromated pools and hot tubs, the CDC specifies that SARS-CoV-2 would be inactivated.

Heat

There is very little data on SARS-CoV-2, and much of it is preliminary. In times like these, scientists will look to related but slightly harder-to-kill viruses. In the case of the novel coronavirus, some data reports are based on the SARS-CoV-1 virus because it is more difficult to kill than the novel coronavirus. One study found that the SARS-CoV-1 virus loses infectivity after being heated to 133°F (56°C) for 15 minutes, and the WHO specifies this temperature and timing as well. Another study found that the SARS-CoV-1 virus remains stable between 40°F (4°C) and 98°F (37°C) and would lose infectivity after 30 minutes at 133°F (56°C).

DAN has received questions about the virus entering a scuba cylinder as a

result of contaminated air being drawn into the compressor. During the process of compressing air, using the ideal gas equation T2 = T1 x (P2/P1)(n-1)/n, we can calculate that a four-stage compressor with 1 ATA inlet pressure and an 80°F environment, pumping air up to 29 ATA or around 4000 psi, would have an interstage temperature inside the cylinder of 224°F. This calculation is very basic and does not account for anything outside of ideal conditions. However, it does indicate the instantaneous temperature at the moment of peak pressure.

In reality, the outlet valve temperature will likely be 170°F to 190°F, and the gas temperature around 150°F, occurring during each stage of the compressor (i.e. four cycles for a four-stage compressor assuming each stage's outlet temperature is the same). Because this is definitively hot enough to kill SARS-CoV-2, it is therefore unlikely that COVID-19 would survive this process should an infected individual cough into the compressor intake. It is important to note that infected droplets exhaled by a person can be as small as 0.5 micron; the filter systems alone would not remove these, but the virus should be dead at that stage.

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It should be noted, however, that if an individual carried the virus on their hands, either as a result of being infected or unknowingly touching an infected surface, and touches the cylinder valve or fill whip, the virus could potentially enter the cylinder through this route. It has been shown that some viruses are extremely pressure resistant—an order of magnitude above diving gas storage pressures.

These studies, however, were conducted on noroviruses, a non-enveloped group of viruses that are generally harder to kill than enveloped viruses. Other studies conducted on enveloped viruses such as the flu only explored the efficacy of high hydrostatic pressure at 289.6 MPa (42,003 PSI). It is therefore very important to practice hand washing and disinfection of high-touch areas including cylinders and fill stations, as it is likely that a virus could survive at diving gas storage pressures.

EPA guidelines

No matter the active ingredient or method of disinfecting scuba equipment, proven efficacy against the novel coronavirus is of utmost importance. The US Environmental Protection Agency's (EPA) "List N" (at: **epa.gov**) is a compilation of products that have proven efficacy against SARS-CoV-1 and will therefore also work to kill SARS-CoV-2. Outside of the United States, local governing bodies may also have registered disinfectants. Following the directions for use for each individual product will ensure its efficacy.

When product manufacturers register their products with the EPA, they must submit a list of uses for the product. It is uncommon for registered products on List N to contain "scuba"; more likely to be listed are respirators or materials that scuba equipment is made of. When choosing a disinfectant solution from List N, it is important to check that the product's EPA registration specifies its use for the materials in question. See: **epa.gov**

Some products commonly recommended by underwater breathing equipment manufacturers are classified as quaternary ammonium sanitizers registered with the EPA for use in food service only and are not currently on the EPA's List N. The EPA does not consider them to be effective against SARS-CoV-2 when applied on those materials and surfaces.

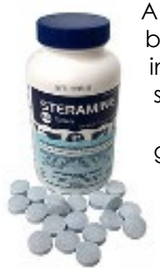
Quats

Quaternary ammonium compounds, or quats, are a group of chemicals that are exceedingly common as active ingredients in cleaning solutions. These agents are hydrophobic and as such are effective against enveloped viruses.

Quats are thought to react with the viral envelope and "disorganize" it, leading to the contents of the virus leaking out and degrading. In addition, little evidence exists to support viral resistance against these compounds. Studies have shown that quats are effective against SARS-CoV-1, and the World Health Organization recommends the use of cleaning products containing these compounds in their laboratory biosafety guidance related to coronavirus disease 2019.

Madacide. Madacide-1 (reg # 1839-83) is on the EPA's List N and has been shown to be effective against SARS-CoV-1 for hard non-porous surfaces. It is effective against the SARS-CoV-1 virus if used with a contact time of 10. Madacide FD (reg # 1130-15) requires a contact time of three minutes.

Simple Green. Simple Green D Pro 5 (reg # 6836-140) and the spray Simple Green Clean Finish (reg # 1839-220) have been shown to be effective against viruses similar to SARS-CoV-2 when used in accordance to its directions for use. According to the EPA website, Simple Green D Pro 5 requires 10 minutes of contact time and Simple Green Clean Finish requires five minutes of contact time. Both of these products are safe for use on face masks and respirators as well.



Steramine. While Steramine is an effective sanitizing product, and some manufacturers recommend it for use on dive gear, it does not appear on the EPA's "List N" and is thus not endorsed for removal of the new coronavirus.

Bleach

Bleach, or sodium hypochlorite, has been studied in many different concentrations, and its effectiveness against viruses has been proven. It is a strong oxidant that works by damaging the viral genome. According to the WHO, the recommended bleach solution for general disinfection is a 1:100 dilution of 5% sodium hypochlorite. (Note that some brands of bleach have different concentrations of the active ingredient, such as those that are thickened and marketed to reduce splashing). This dilution yields 0.05% or 500 ppm of the active ingredient and requires a soaking time of 30 minutes if objects are immersed in the solution or at least 10 minutes if sprayed onto a nonporous surface.

In a study that examined SARS-CoV-2 specifically, it was found that a bleach concentration of 0.1% or 1,000 ppm was needed to reduce infectivity when sprayed onto a hard-non-porous surface. A second study on the same virus found that 0.1% sodium hypochlorite would inactivate the virus within one minute. A study on SARS-CoV-1 found that both 1:50 (0.1%) and 1:100 (0.05%) inactivated the virus after an immersion of five minutes.

When using bleach, the use of gloves, a mask, and eye protection is encouraged. Mix the solutions in well-ventilated areas, and use cold water, as hot water will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decompose the active ingredient. It is important to never mix bleach with other chemicals and to remove all organic matter from items to be disinfected, as this too will inactivate the active ingredient.

Items disinfected with bleach must be thoroughly rinsed with fresh water and allowed to dry before use, as it is corrosive to stainless steel (in higher concentrations) and irritating to mucous membranes, skin and eyes. Highly concentrated bleach solutions have also been found to be harmful to life-support equipment, causing metal fatigue, and in some cases, hose failure during the Hart building anthrax attack. As such, these solutions are not used by EPA units for dive equipment when effective alternatives exist.

Soap and water

Washing hands and surfaces with soap and water is one of the most effective ways to protect against the virus. The type of soap used is not important. Washing with soap and water does not kill microorganisms but physically removes them from a surface. Running water by itself can be effective in removing some unwanted material from surfaces, however, soap will physically pull material from the skin and into the water.

DAN was asked why soap and water will not work for scuba equipment if it is recommended for hands. Soap and water, as stated above, must be combined with mechanical action to be completely effective. Soaking scuba equipment in soapy water alone is not an effective disinfection method. If soapy water was combined with mechanical action, it would theoretically prove to be more efficient. However, there are some parts of scuba equipment that are not easily reached without disassembly, such as the inside of a regulator. Since an exhaled breath will travel through the inside of a regulator and make contact with the diaphragm, lever arm, and other internal surfaces, soaking the regulator in a disinfectant solution may be a better option.

Best practices

When selecting a disinfectant, it is of utmost importance to use a product that has proven efficacy against either SARS-CoV-2 or the harder-to-kill SARS-CoV-1. Consult your local governing body's pesticide registration system for its list of registered disinfectants if the products specified in the EPA's List N are unavailable in your area. When using these products, be sure to follow the directions and use the specified personal protective equipment (such as gloves or eye protection) when disinfecting. If registered products cannot be found, be sure to use disinfection protocols outlined by the US Centers for Disease Control and Prevention (CDC) at: **cdc.gov**.

To disinfect equipment to kill the virus that causes COVID-19, a disinfectant on the EPA's List N should be used. Before using a product, check to see if it has been registered with the EPA for use on dive equipment, respirators or the materials these are made of. Alternatively, the CDC recommends a 4:100 bleach solution (1/3 cup of bleach in one gallon of water) with a contact time of one minute.

After disinfecting equipment, one must take care not to re-infect the equipment, such as by handling it when storing. Dive shop employees should take care to maintain good hygiene by washing hands frequently and regularly disinfecting high-touch areas, including fill stations (as outlined in the "Heat" section of this article).

When using any disinfectant, be sure to follow the manufacturer's instructions for use. Follow this with a thorough rinse in fresh water and allow the equipment to dry completely before use.

Finally, consider updating your existing emergency action plan to include a potential COVID-19 infection by staff or customers. Be sure to outline all disinfection protocols and ensure that they are being diligently followed by all staff. The most important consideration is the health and safety of your staff and customers.

DAN advice

DAN has also issued some advice regarding protecting divers when they travel—and especially with respect to renting gear. DAN states:

"Equipment can be effectively sanitized by submerging it in a 10% bleach solution or using a cleaning product such as Steramine tablets or any other quaternary ammonium compound. Be sure to use these products according to the manufacturer's directions and then rinse the gear with fresh water.

"Products that are commonly used to clean dive gear but are ineffective against coronavirus include antibacterial and chlorhexidine mouthwashes or sprays. Hot soapy water must be paired with mechanical action such as scrubbing with a soft toothbrush to be effective."

If you are traveling and using rental gear, DAN suggests using a "household disinfecting wipe" to clean your regulator mouthpiece, snorkel, BCD oral inflater and the inside of your mask, and then rinsing with fresh water before use. DAN advises you to ask your operator to sanitize the equipment you are renting—if you do not have access to wipes to do it yourself.

Dive training

The main issue with training divers is how do we effectively teach them the important skill of air-sharing without potentially putting their health at risk. Training agencies require students to demonstrate in-water "air-sharing" exercises to meet general standards published by the various diving standards organizations. Widespread concerns surrounding the novel coronavirus and COVID-19 infection have demanded we allow changes to the way this skill is demonstrated and practiced during both confined skills training and open water certification dives.

Since RAID has a mandatory S-Drill and


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is a "primary" gas-sharing agency, cross-contamination is impossible to reduce. Therefore, RAID has designed a new protocol that, with only a minor change, will still meet the requirements for certification. Other agencies are considering similar changes in their training standards.

In simplified terms, to demonstrate a classic air-sharing drill, one diver gives their buddy an out-of-air (OOA) signal, their buddy donates their primary regulator second stage, and the diver simulating OOA places it into their mouth and breathes from it. Under present circumstances, this method could present an opportunity for cross-infection, not just in chlorinated swimming pool water but also, certainly, in freshwater or the open ocean. In the interests of diver and instructor safety, and until further notice, RAID is asking its members to follow this revised protocol for S-Drills and in-place OOA simulations.

Drill begins:

1. Diver one, simulating OOA, signals their buddy, "Out of Air!"
2. Diver two presents a working second-stage regulator.
3. Diver one takes the offered regulator and switches from their primary regulator to their back-up second stage while gently purging the donated second stage to check that it is working.
4. All the steps from a normal air-sharing drill are practiced—only the switch to the buddy's regulator is simulated.
5. When the drill is completed (after horizontal swim, ascent, etc.), diver one returns the donated regulator to their buddy.

This method adequately demonstrates all of the component skills of an air-sharing drill, including having the OOA diver switch regulators without exposing either diver to an elevated risk of cross contamination.

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may be helpful in making recommendations for divers until we have better data on COVID-19.

A study of the pulmonary function and exercise capacity in survivors of severe acute respiratory syndrome (SARS) was reported in the European Respiratory Journal in 2004. They looked at 46 survivors of SARS three months after hospital discharge. (Eur Repsir J 2004:24:436-442). No abnormalities were detected in the pulmonary function tests in 23 (50%) of the patients. Abnormalities of forced vital capacity (FVC), forced expiratory volume in one second (FEV1), FEV1/FVC and TLCO were detected in seven (15%), 12 (25%), one, (2%), and 18 (39%) of patients, respectively.

Returning to diving after COVID-19

What about the diver, like myself, who has contracted COVID-19? When can they safely return to diving? Unfortunately, the answer to that question is not known at the present time, but is not likely to be a "one size fits all" answer.

Like with any illness, the diver will need to completely resolve their symptoms and have good exercise tolerance before even considering a return to diving. However, COVID-19 in some cases aggressively attacks the pulmonary and cardiovascular system, and the duration of these effects is unknown, but likely highly variable among individuals.

COVID-19 (SARS-CoV-2) is a coronavirus and is similar to, though not exactly like, the coronavirus (SARS-CoV-1) that caused SARS (severe acute respiratory syndrome). As we do not have a great deal of long-term data yet on COVID-19, looking at the longer-term effects from SARS-CoV-1 on Facebook. Dr Hartig is an avid diver and heads the emergency department in the hospital. He is responsible for coordinating the care of their COVID-19 patients.

He reports having treated dozens of COVID-19 patients in recent weeks, six of whom were divers. All six of these divers did not require hospitalization and felt as though they had recovered from their illness five to six weeks earlier. However, two of the patients showed hypoxemia under stress, two demonstrated reactive airway disease, and four showed "impressive" lung changes on CT scans. The English translation reported "the damage to the lungs is irreversible"' though the follow-up tests only occurred approximately six weeks after clinical resolution of symptoms.

All of these abnormalities were mild except in one case. Breathing reserve was low in four patients and significant oxygen desaturation was detected in another four patients. Comparison of the measured exercise capacity with resting pulmonary function tests showed many cases of discordance in impairment.

They concluded that pulmonary function defects were detected in half of the recovered severe acute respiratory syndrome patients three months after hospital discharge, but the impairment was mild in almost all cases. Many patients had reduced exercise capacity that could not be accounted for by the impairment in pulmonary function.

Studies

Recently, a preliminary report from Frank Hartig, a senior physician at the Innsbruck University Clinic in Austria, was published in the dive magazine *Wetnotes* and an English translation was posted

We must interpret this small case series with caution for now, while awaiting further data. It is definitely interesting, quite thought-provoking, and is hypothesis-generating for future research. However, it is only six divers and is very short follow-up. It is, however, a good reason to pause and consider how to decide when to return to diving after being infected with COVID-19. We just need to wait for larger, more controlled studies with longer follow-up before becoming overly concerned and making sweeping changes to evaluation of fitness-to-dive protocols around the world.

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Position papers

The Undersea and Hyperbaric Medical Society (UHMS) put out a position paper on their website (**uhms.org**) on 24 April 2020. They agree that at the present time, we simply do not have sufficient data to support or refute the proclamations made by the case series from Dr Hartig. They feel the list of potential variables related to how this disease manifests, its clinical course, and long-term prognosis is lengthy and may include factors such as underlying medical conditions, age, disease severity and secondary complications.

Case reports suffer from multiple design weaknesses to include a lack of controls and randomization, which makes any conclusions that we may want to generalize to a larger population suspect. While these findings are indeed disquieting, it will take time before the potential impact on individual health, and any lasting effects on lung or heart function, are captured in the peer-reviewed literature.

A position paper by the Belgian Society for Diving and Hyperbaric Medicine (SBMHS) was published on 12 April 2020 in an attempt to provide guidelines to physicians evaluating divers who have suffered COVID-19. Here are their recommendations (**sbmhs.be**):

Position of the Belgian Society for Diving and Hyperbaric Medicine (SBMHS-BVOOG) on Diving after COVID-19 pulmonary infection

April 12, 2020 – The COVID-19 pandemic has had a major impact on recreational and professional diving activities, with an almost complete cessation of this activity during many weeks/months. These measures were a logical consequence of Government and Public Health Care recommendations to limit unnecessary commuting but also because it is virtually impossible to observe the regulations of "social distancing" and avoiding the possible sharing of divers' breathing equipment. Lastly, there is a real possibility that emergency first aid teams may be overwhelmed by cases related to COVID-19 or the logistics involved (decontamination procedures), and not be able to respond in a timely and efficient manner.

When the precautionary measures to combat the pandemic will be relaxed, it is important to resume normal recreational and professional diving activities as soon as reasonably possible, both for the social, physical and mental welfare of the diving population. The question has been raised, whether having suffered and recovered from COVID-19 has any influence on the medical fitness to dive or the risk of diving accidents.

Novel Corona Virus (SARS-CoV-2) infection (COVID-19) can manifest itself with various clinical syndromes, ranging from no symptoms, over a flu-like syndrome, to severe pulmonary compromise (ARDS – Acute Respiratory Distress Syndrome) and cardiac symptoms (cardiomyopathy). Factors that determine the severity of COVID-19 symptoms are but incompletely known: older persons, suffering from other medical conditions, are an obvious group at risk; also, heavy smokers and obese persons seem to have more risk of complications; however, there are numerous cases reported of young, previously healthy persons in whom the disease has had a sudden and dramatic evolution. In general, if the symptoms were mild and improve within a week to complete resolution, the risk for permanent damage to heart or lungs is very low.

The Board of the SBMHS-BVOOG, after examining the relevant and available literature and discussion with several experts, recommends:

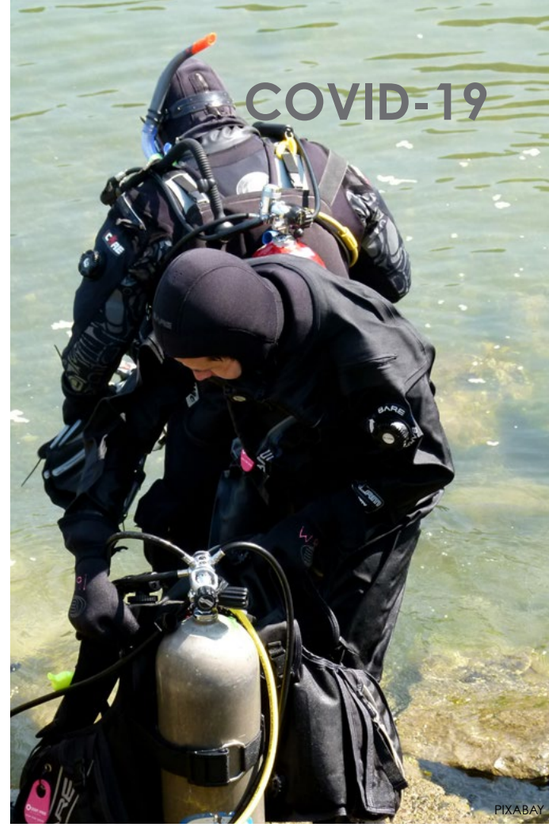
1. <u>Risk of spreading COVID-19</u>: A person who has had symptomatic COVID-19 can, just as someone who was infected but did not have symptoms, spread viral particles in nasal or oral secretions for a certain period after recovery, and thus, still be contagious to others. The exact period during which this is possible is not known and probably variable, but has been reported to be up to 37 days or longer. This is an important consideration for the possible sharing of breathing regulators (buddy-breathing) but also for rescue actions in case of a diving accident.

Therefore, it is recommended:

a. That divers, who have had symptomatic COVID-19, wait a minimum of TWO months, preferable three, before resuming their diving activity.
b. That divers who have tested positive for COVID-19 but have remained completely asymptomatic, wait ONE month before resuming diving.
c. Divers who have never had symptoms and have not been tested (who either have not been infected or have had the infection completely asymptomatic) may not have developed immunity against the disease (currently, serological tests are not widely available and do not confirm with 100% certainty a sufficient level of immunity). Therefore, they may still be infected by other divers and would need to observe a waiting period after the release of the confinement period. The duration of this waiting period may be variable depending on the local situation (type of diving, location and local organization).
d. Divers and dive centers should observe strictly the guidelines for disinfection of diving gear (as issued by the diving Federations and DAN Europe).

2. <u>Risk for pulmonary overpressure syndrome (lung barotrauma):</u> A person, who has had COVID-19 infection with severe pulmonary symptoms, may suffer from prolonged or even permanent pulmonary damage, even if the lung function seems to have returned to (near) normal. This damage may give a higher risk for lung barotrauma, even after dives without a rapid or uncontrolled ascent.

Therefore, it is recommended that a diver, who has been hospitalized with or because of pulmonary symptoms



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in relation to COVID-19, should, after the three-month waiting period (as indicated above), undergo complete pulmonary function testing as well as a high-resolution CT scanning of the lungs.

Pulmonary function testing should include FVC, FEV1, PEF25-50-75, RV and FEV1/FVC), and the CT scan should show a return to normal, before resuming diving. It is important that these tests should be interpreted and validated by a medical officer with specific knowledge of diving medicine.

If major pulmonary symptoms have been present, even if not requiring hospitalization, pulmonary damage may have occurred, and a pulmonary function testing and CT-scan are useful tests.

3. Risk for cardiac events: In the context of general illness and severe pulmonary infection, a COVID-19 cardiomyopathy may not be a prominent symptom and may even go unnoticed during the acute phase of the disease. This, however, may be the cause of heart muscle damage and subsequent scarring. Cardiomyopathy or cardiac scar tissue may be an important factor in the occurrence of sudden cardiac failure and sudden death during diving immersion.

Therefore, it is recommended that a diver who has been hospitalized with or because of cardiac or pulmonary symptoms in relation to COVID-19, should, after the three-month waiting period (as indicated above), undergo cardiac evaluation with echocardiography and exercise test (exercise electrocardiography) to ascertain normal cardiac function.

If major pulmonary symptoms or extreme fatigue/exhaustion have been present, even if not requiring hospitalization, this may indicate a possible cardiomyopathy and cardiac testing is useful.

4. Pulmonary oxygen toxicity: At this time, there is very little known as to a possible increased sensitivity of the pulmonary tissue to the toxic effects of oxygen; therefore, a prudent attitude would be that technical diving (with prolonged breathing of hyperoxic gas, with a pO2 of 1.3 ATA or higher) should be avoided. Simple "nitrox" diving (whereby a maximum pO2 of 1.4 ATA is only breathed for short periods, at the deepest part of the dive) should not present any problem.

5. Decompression sickness: Even less is known about the possible alteration of the "bubble filter" function of the lung after COVID-19 pulmonary infection. This may imply that the risk for decompression sickness could increase significantly. It has been shown that after deeper recreational dives (close to the No-Decompression-Limit – NDL – of the dive computer, or with mandatory decompression stops), in 70-90% of cases, inert gas bubbles can be detected. These bubbles circulate in the venous blood and are filtered out by the pulmonary capillary circulation, and thus, usually do not cause decompression sickness. If the lung "bubble filter" would become less efficient, these bubbles could pass into the arterial circulation ("arterialize"), comparably to divers with a Patent Foramen Ovale, and cause cerebral, vestibular or other types of decompression sickness.

Therefore, a prudent attitude would be that divers who have suffered from pulmonary symptoms of COVID-19, limit their dives temporarily (or definitively) to well within the NDL of their computer (so that at no moment during the dive, the computer indicates mandatory decompression stops).

These recommendations are very sensible and should help guide us while we await more data. If a diver suffered a mild case of COVID-19 and is now back to jogging five miles per day without issues, he or she can probably return to diving without restrictions or further testing. However, if a diver had a prolonged ICU stay from the infection, especially if they required intubation, maybe they should have follow-up CT scans, showing resolution of the changes, and maybe even pulmonary function testing and echocardiography prior to resuming diving. Only time—and, more importantly—DATA will tell.

What does this all mean?

We are in the midst of a generation-defining pandemic the world has not seen in 100 years. There is an appropriate amount of fear and uncertainty gripping the planet. Along with everyone else, we, in the diving industry, are concerned as to what the long-term effects of this pandemic will be on our livelihoods and the sport we all love.

First of all, we need to make sure our sport is safe for our students, our certified divers and for ourselves. This means changing disinfecting policies, changing some aspects of training, and allowing for social distancing in our dive centers, our dive charters, etc. The best advice at the moment is for any diver who has had a symptomatic case of COVID-19 to be examined by a physician with diving knowledge prior to resuming diving.

As for myself, I am one of the lucky ones. My symptoms of COVID-19 were no worse than a bad case of the flu. I had a normal chest x-ray, normal oxygen saturations, and never had symptoms of shortness of breath. After about two weeks, all of my symptoms resolved and my exercise tolerance on my home rowing machine was back to baseline. I am looking forward to slowly getting back to scuba diving sometime in the next few weeks.

Be safe, everyone. We will come out the other side of this—hopefully, as better people in better nations, and living in a better world. ■

The author thanks Divers Alert Network and the long list of diving educators, dive instructors, training agencies and equipment manufacturers whose edits and input helped him put this paper together.

Douglas Ebersole, MD, is an interventional cardiologist at the Watson Clinic LLP in Lakeland, Florida, USA, and is the Director of the Structural Heart Program at Lakeland Regional Health, an 850-bed tertiary referral hospital in Lakeland. He has been diving since 1974 and is an avid recreational diver, technical diver, rebreather diver and cave diver. He is also a recreational, technical and rebreather instructor for several training agencies, is a cardiology consultant to Divers Alert Network, and is the Florida Sales agent for KISS Rebreathers.

Edited by
Peter Symes

Light at the end of the tunnel?

The dive industry is intrinsically linked to the travel industry. Not only have many dive operators, resorts and liveaboards—whose clientele are inbound dive travellers—been forced to mothball their operations as borders remain shut and airlines have parked their fleets, but dive shops, which provide local dive communities with equipment and training, are also seeing a big dip in business, as there are no prospective holiday-makers shopping for equipment for upcoming dive trips.

Massive decline

The scale of the coronavirus pandemic's impact is outlined in a report by the World Tourism Organization (UNWTO), which predicts a decline in international travel of between 58% and 80% in 2020. The prediction of a 58% decline is based on the gradual reopening of international borders and easing of travel restrictions in early July; the 80% figure is based on early December. This year, global airline revenues are forecast to drop by more than half ($314bn) according to the latest estimates by the International Air Transport Association's (IATA). This is almost three times worse than its "worst-case scenario" from late March, with around 95% of international passenger traffic now lost due to travel restrictions.

Testing in airports?

Could testing prior to departure or before entry at the destination become a standard requirement? In Austria, in line with many other countries, arriving passengers have been required to present a health certificate showing a negative COVID-19 result, which is no older than four days, or go into quarantine for two weeks. To avoid having to be quarantined, Vienna Airport now offers passengers arriving without the required health certificate an onsite test at the airport, which will provide a result in two to three hours. The airport tests, which cost €190 (USD 205), can also be taken by passengers leaving Vienna to demonstrate their virus-free status at their destination.

Meanwhile Heathrow, Europe's biggest airport by passenger traffic, is trialling large-scale temperature checks, which are already being carried out at departure gates on people going to places where this is a requirement. John Holland-Kaye, CEO at Heathrow Airport, said the introduction of common standards would allow airlines to start flying again more frequently and urged the UK government to produce a plan on what standards airports should adopt. Temperature checks in airports were also applied when SARS broke out in the early 2000s, but as COVID-19 infections are often asymptomatic, it is not clear how this would be effective. The airport is also trialling ultraviolet lighting to sanitise security trays and contact-free security screening equipment to reduce person-to-person contact.

New airline practices

A number of airlines are rolling out new policies aimed at protecting passengers and crew from coronavirus transmission and increasing consumer confidence in air travel safety.

Some US carriers, among them Delta Air Lines and American Airlines, have announced that they were now requiring employees and passengers to wear face masks. According to a statement made by Delta Air Lines, "… face coverings will be required starting in the check-in lobby (…) boarding gate areas, jet bridges and on board the aircraft for the duration of the flight—except during meal service." Carriers have also modified in-flight service to minimize touchpoints and have moved primarily to pre-packaged foods and sealed beverages.

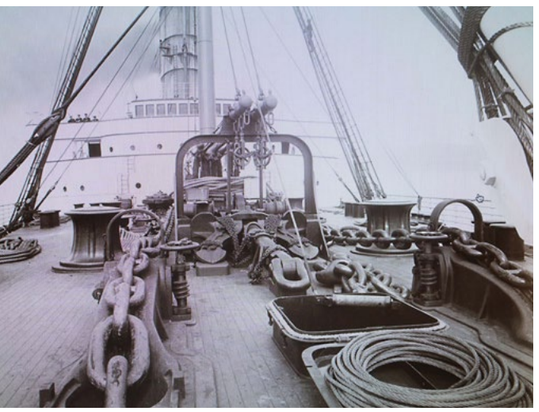
Travel bubbles?

New Zealand announced that it has stopped community transmission of COVID-19, effectively eliminating the virus. With the virus under apparent control, Australia and New Zealand are discussing forming a "travel bubble" that would allow people to resume international journeys across the Tasman Sea without quarantine restrictions. Both Australia and New Zealand are currently limiting international travel to only "critical" trips, such as those for essential, urgent, or medical reasons. The "bubble" idea would presumably be one of the first steps introduced once travel restrictions are eased and help revive businesses as the world readjusts to life with the coronavirus. Other nations, including some Baltic and Scandinavian countries, are currently also engaged in talks with their neighbours on how and when to open their shared borders. ■

Diver with the anchor chain and winch on the wreck of the *Lusitania*

Text and photos by Vic Verlinden

After the *Titanic*, the RMS *Lusitania* is probably one of the wrecks in the world which most captures the imagination. It was therefore a great and challenging endeavor for me to be able to see this wreck with my own eyes.



Historical photo showing the anchor chain and winch on the *Lusitania*

The WWI Disaster of

RMS Lusitania

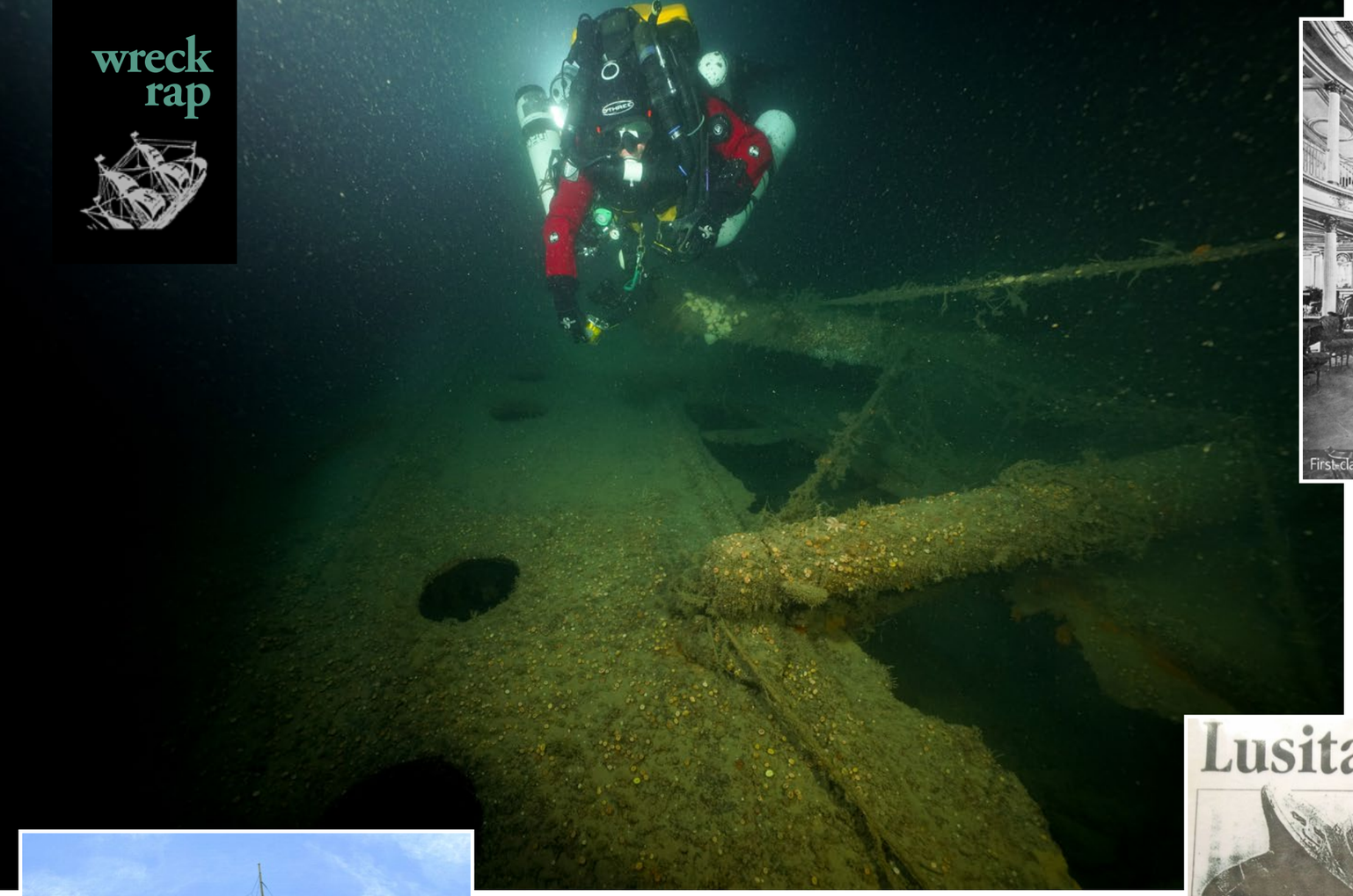
History

Despite warnings from the German embassy in the American press not to start the crossing with the *Lusitania*, the ship was brought under steam on 1 May 1915. On board were 1,257 passengers and 702 crew members. The command was in the hands of Captain William Thomas Turner. The passengers on the *Lusitania* did not worry too much because it was assumed that the Germans would not dare torpedo a ship with so many American civilians on board.

The first-class passengers thoroughly enjoyed the luxurious interior of this beautiful ship. One of those passengers was Sir Hugh Lane, the director of the National Gallery of Ireland, who reportedly had brought paintings on board worth US$60 million.[1] Among these alleged paintings were a Monet and a Rubens transported in lead tubes. When the ship approached the coast of Ireland after a trouble-free passage, it was reported that there was a German submarine nearby.

Immediately, Captain Turner had the lookout doubled. In the previous week,

1 LUSITANIA MUSEUM, KINSALE, IRELAND



Diver at the davit, or crane, on the wreck of the *Lusitania* (left); Historical photo showing the lavish luxury interior of the first-class salon on the *Lusitania* (above); Historical photo of a newspaper article about the Rubens art lost in the sinking of *Lusitania* (below)

Painting of *Lusitania* by Stuart Williamson

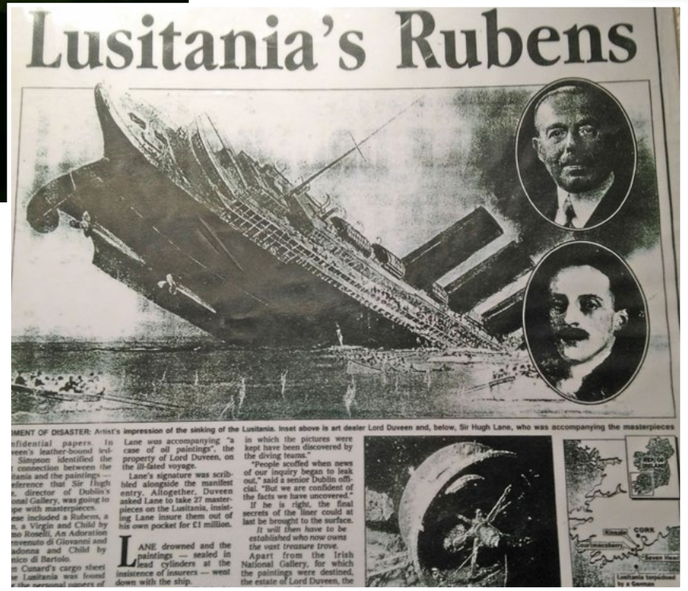
three ships had been torpedoed in this area, so the captain did not want to take any chances. The first warning about the presence of a U-boat came on 5 May, but there were also reports on 6 and 7 May.

At 2:15 p.m., the *Lusitania* was about 10 miles south of Old Head of Kinsale when the ship was hit by a torpedo between the first chimney and the bow. Immediately afterwards, a second powerful explosion occurred, which caused a lot of damage in the engine room. The ship was now keeling heavily, making it difficult to lower the lifeboats. At 2:26 p.m., after barely 15 minutes, the ship sank, and 761 people drowned, including 94 children. Of these victims, 124 were American. The American government was furious, but the Germans said that the ship had ammunition on board and therefore the torpedoing was legitimate.[2]

The torpedo was fired by U20, under the command of Captain Lieutenant Walther Schwieger. In his report, he mentioned one single torpedo. The torpedoing of the *Lusitania* did not do any good for the German cause and was certainly the spark that led the United States to enter the Great War to defeat the Germans.

Later, there were deep discussions in the press about the fact that there had been a second explosion. This was attributed by the Germans to the transport of a load of ammunition during the crossing of the *Lusitania*.

[2] HOCKING, C. (1994). DICTIONARY OF DISASTERS AT SEA DURING THE AGE OF STEAM. NAVAL & MILITARY PRESS LTD.


Lusitania's Rubens

MENT OF DISASTER: Artist's impression of the sinking of the Lusitania. Inset above is art dealer Lord Duveen and, below, Sir Hugh Lane, who was accompanying the masterpieces

First plans for an expedition

I had been looking for an opportunity to dive on the wreck of the *Lusitania* for a few years but could not find a team to go with me. However, in 2017, I saw a message about an expedition organised by Peter McCamley. He wanted to bring a team together to realise a project that would spread over several years. During the project, it was, among other things, the intention to shoot good 3D images of the wreck. After I sent an email to Peter, he agreed that I would come to Ireland to help on the boat.

Unfortunately, I would not be able to dive because I was not on the list of the permit applications. It is impossible to dive on the wreck without the approval of the Irish government and the American owner, Gregg Bemis. Even without diving, I definitely wanted to get involved in this special project, and at the end of July, I left in good spirits.

My plan was to take the ferry to Rosslare in Ireland in the French city of Cherbourg. It was about 650km to Cherbourg, and I still had 60km to go

wreck rap

RMS *Lusitania*

Owner: Cunard SS Co.

Builder: J Brown & Co, 1907

Weight: 30,396 tons

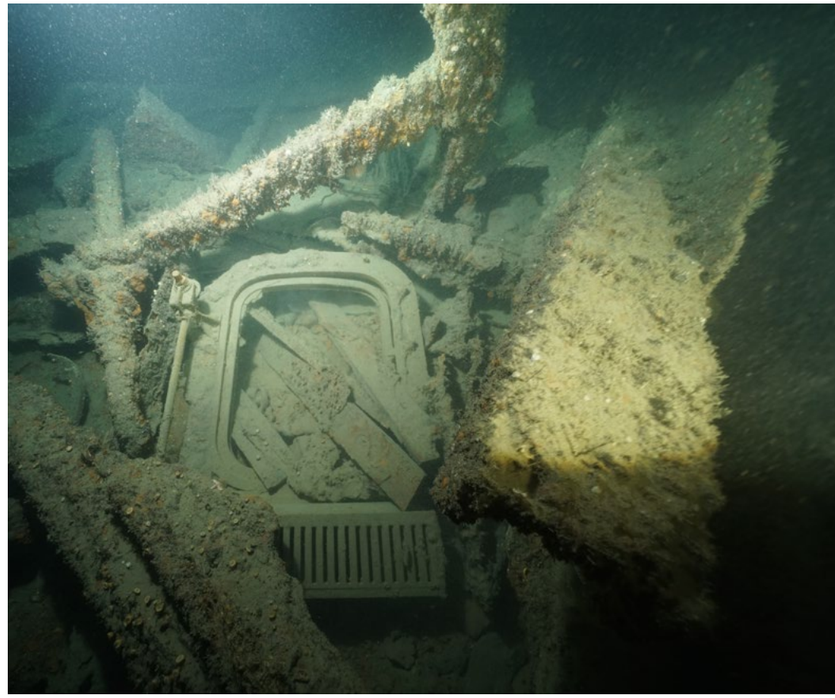
Engines: Turbine

Length: 240m

Width: 29m

Piece of mosaic floor from the bathroom on the wreck of RMS *Lusitania* (left); Anchor among the wreck debris (below); Detail of ornate porthole (lower left)

RMS Lusitania



when I decided to leave the highway to have a coffee. When I hit a narrow road, I suddenly felt a loud bang at the bottom of the car. I got out, and when I looked under the car, I saw the oil running out of my carburettor. I had hit an iron pole on a small central reservation and my car was now unusable. I did have insurance but would never get to the ferry on time. My planned trip for 2017 was over.

Second attempt in 2018

In the winter of 2017/2018, Peter put together a new team, and this time, I was on the list to dive. I prepared for my trip well—physically and mentally, and with all my dive equipment in top shape. This time, the crossing went without any problems, and I was able to bring my equipment aboard our expedition ship, which was equipped with an elevator to pick up the divers.

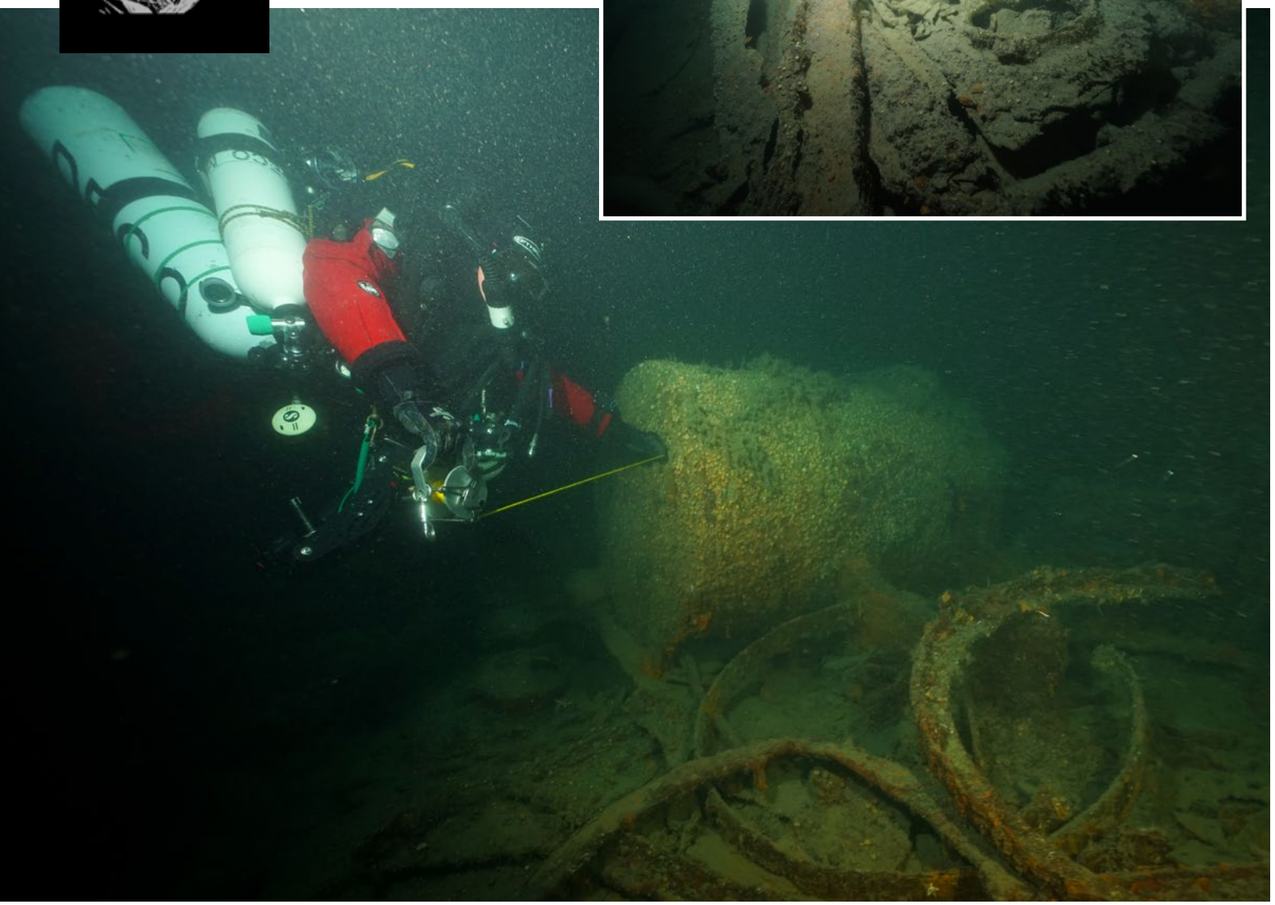
The weather was very good with a soft breeze and sunshine. It was 24 September 2018, and today, I would make my first dive on the *Lusitania*. The team that first went into the water included Dave Gration and Kari Hyttinen who wanted to shoot 3D film footage of the bow of the wreck as they did the year before.

I was in the second team together with Steve Saunders. However, while we were still descending, we ran into the first team of two who were already heading onward. They showed us that the downline was not anchored on the wreck and communicated to us that we had to return. At that moment, I was at a depth of 70m and returned to the surface. This was a severe setback, and for the next few days, there was no possibility of diving due to the bad weather.

After five days, the weather got better, and we could try again. The downline had shifted, and a short time later, I was descending to the wreck. I had been working for years to realise this

Diver with one of the davits on RMS *Lusitania*

Square porthole and wreck debris on the *Lusitania* (right); Diver with the only remaining watertank on *Lusitania* (bottom)



dream, and now I would finally see the wreck for myself. The visibility on the bottom was no more than 5m, and I immediately saw that there were a lot of fishing nets on the wreck.

I decided not to swim too far away from the ascent line. The downline's treble hook was not far from the bridge in front of the wreck. However, it was difficult to orient myself. I did see one of the iron curved levers for the lifeboats. This was at the edge of the wreck, and I also saw a row of round portholes. These were still in the hull of the wreck, and I decided to follow them because there were fewer nets there.

When I followed the side of the hull, I suddenly came to one of the large entrance doors, which served to welcome the passengers on board. Along the way, I also saw large round bronze windows. This was not surprising because a large passenger ship like the *Lusitania* had hundreds on board.

I decided to turn right and swim back in the direction of the ascent line's treble hook. On the way back, I saw that the wreck had suffered heavily from the currents and saltwater. However, it was high time to start my ascent. Twenty minutes of bottom time had passed quickly, and now a long decompression time awaited me. The next day, we dived again on the wreck, but time to explore the *Lusitania* was limited because I did not want to take any risks.

wreck rap

The Lusitania Memorial Garden in County Cork, Ireland

Ventilation shaft of the engine room on the wreck of *Lusitania* (right); Skylight and shower (left); Painting of the wreck of *Lusitania* by Stuart Williamson (lower right)

The long-awaited expedition in 2019

In the summer of 2019, I returned to Ireland to dive the wreck of the *Lusitania* again. I had prepared myself well, and Karl Van Der Auwera (my dive buddy of many years) had also come along for the expedition.

In the beginning of the trip, the weather was not good, and we could not dive. After five days, the weather got a bit better, and we decided to risk it. The downline's treble hook was at the bridge again, and when we came down, I saw that the visibility on the wreck was also much better than the year before.

Karl unrolled the reel, so we could easily find the ascent line again. We could now explore the wreck in peace. Just by the ascent line's treble hook, we found several rectangular bronze windows. These adorned the cabins of the first-class passengers. We also found one of the water reservoirs, which stood on the deck. Not far from there, we found two showers and a piece of mosaic floor from the bathrooms.

As we swam towards the bow, we found pieces of the wreckage littered with portholes of all shapes and sizes. On the bow itself, we recognised the ship's anchor chain and the winch that raised the anchors. We also found two bollards around which ropes were still twisted. Pieces of the wooden floor on the fore-deck were still intact.

Visibility at this location was at least 8m, which is exceptionally good on this wreck. Over the following days, we did more dives and thousands of pictures were taken by the different teams.

After four days of consecutive dives at a depth of 90m, I had had my fill of diving the wreck and needed to take a rest. However, it was a priceless experience to be able to participate in this wonderful adventure, and next year, we will definitely try to return to explore even more places on the wreck. It is also our intention to bring objects from the wreck to the surface in an archaeologically responsible way in the future. These will then be exhibited in a new museum to be built in Kinsale. ■

Having dived over 400 wrecks, Vic Verlinden is an avid, pioneering wreck diver, award-winning underwater photographer and dive guide from Belgium. His work has been published in dive magazines and technical diving publications in the United States, Russia, France, Germany, Belgium, United Kingdom and the Netherlands. He is the organiser of TekDive-Europe technical dive show. See: ***tekdive-europe.com****.*

Samoa

— *Polynesian Diving in Upolu*

Text and photos by
Brandi Mueller

Looking out from the shore past To-Sua Ocean Trench on Upolu Island in Samoa. PREVIOUS PAGE: Seafan and soft coral in Samoa

Located in the Polynesian region of the South Pacific Ocean, the idyllic paradise of Samoa, which comprises the two main islands of Savai'i and Upolu and several smaller islands, is part of the Commonwealth of Nations. Brandi Mueller managed to venture to Upolu Island before the coronavirus pandemic forced countries to close borders and stay-at-home orders came into effect. She shares her experience exploring the natural beauty to be found in the Samoan islands, above and below the waves.

The small, nine-passenger, turboprop airplane violently shook us up and down like an amusement park ride. Out of the windows, all I could see were the gray clouds of the seemingly endless succession of storms that had been ravaging the area.

Those of us in the back of the small plane could see into the cockpit and past the single pilot's vision and his view was just as impenetrable with thick, dark clouds as what we saw through our windows. I let out a slightly insensitive giggle on one stomach-dropping descent through the air (I have little fear of airplanes and enjoy a good roller coaster every now and then). But I glanced to my left at a man, white-knuckling his thighs with his eyes closed, and made sure to not make a sound for the rest of the 35-minute flight.

Apia

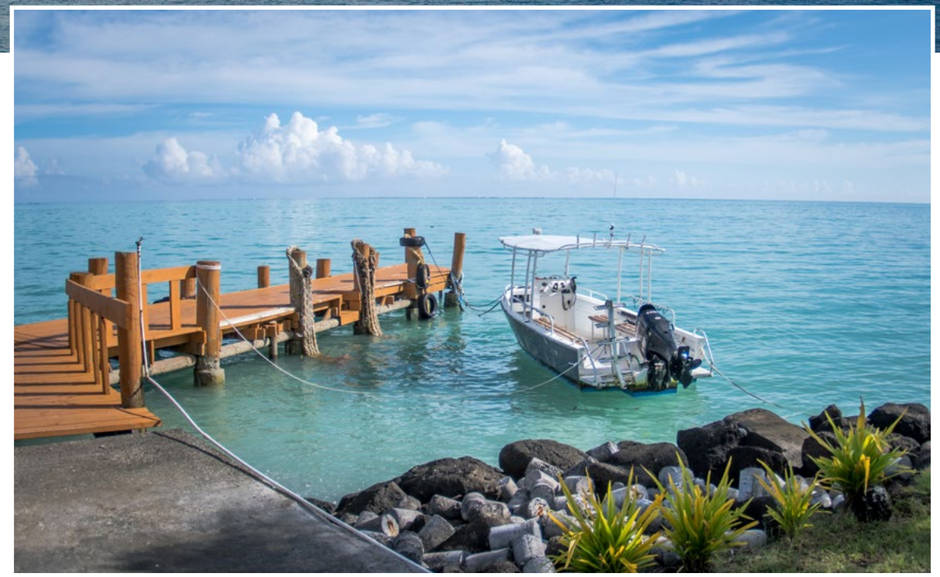
Our destination was Apia, Samoa, and I was three days late coming in from Pago Pago, American Samoa because the airport had been closed due to a line of tropical storms and cyclones that just did not seem to stop. Several days earlier, my original flight from Honolulu to Pago Pago had also been delayed for 24 hours due to unsafe weather conditions, and when it was time to make this short hop, the storms just kept coming. Once the airport was finally opened, I was on the first flight over, but the weather had not suddenly changed to blue skies and sunshine, and when we landed in Apia, the clouds poured down on us, soaking through layers in my suitcases.

I was feeling quite successful having finally arrived, even with the weather.

The beach view from the Sheraton Samoa Beach Resort (above); Sopoaga Waterfall (top right)

Samoa

The island of Apolima with Savai'i behind it (above); Pure Ocean dive boat at their dock (right)



After clearing immigrations and collecting my luggage, I headed out of the airport, contemplating to myself what a nice airport it was for such a small island, particularly because Talofa Airways (which I was on) lands at the domestic airport. Looking at the arrivals board, I noted a few flights from Australia and New Zealand and a bolt of panic rose up from my stomach. Oh no. We must have landed at the international airport, but I had told the manager at Pure Ocean Dive and Watersports to pick me up at the domestic airport.

Asking around, I discovered the domestic airport was still closed because of the weather, so the flight landed at the international terminal, which was a 45-minute drive from where I had asked to be picked up. A feeling of dread built up inside me that the kind person who volunteered to pick me up might be driving to the wrong place. Not to mention, I was already three days late and had been sending daily emails about cancelled flights and my undetermined arrival. I was feeling terrible for all the inconveniences I was causing.

As I fiddled with my phone, trying to get the international calling plan to work, Oli from Pure Ocean came walking up. He already knew the domestic terminal was closed and the specific terminal in which I would actually be arriving (it is amazing how first impressions and great customer service can calm the panic of a wayward traveler). He also seemed not at all concerned about my being three days late, as we loaded up my luggage and he drove me to the Sheraton Samoa Beach Resort where I would be staying and diving.

After checking into a beautiful ocean-view suite, I enjoyed a lovely outdoor dinner listening to the rain calmly falling and went to bed early. The plan was to dive in the morning, but the weather would dictate if that was going to happen.

Apolima

I opened my eyes to sunshine filling my room and it took me a second to process what the sun was after a week in the South Pacific of solid rain. Looking out the window, it did not even appear windy, so I put

View from the dive boat

Cliffs on Apolima Island (above); Looking out from the shore, past To-Sua Ocean Trench (left)

my camera together and piled up my dive gear before heading to breakfast.

The resort stretched out along a white sandy beach, with only the occasional palm tree breaking up the 180-degree brilliant blue ocean view and the largest island in Samoa, Savai'i, just a shadow in the background. The tables of the open-air breakfast buffet were arranged, looking out at the sea, and I could not help but marvel at the beautiful view. I wanted to slowly sip my coffee and take it all in, but with hopes the boat might go out, I quickly finished breakfast and headed to the dive shop.

It seemed that perhaps my weather-bad-luck was changing, and the dive crew was loading the boat as I arrived. Pretty soon, we were departing the island of Upolu, heading out to dive Apolima. This extinct volcanic crater is the smallest inhabited island in Samoa, both in size and population, and it is located in between Upolu and Savai'i. Accessible only by boat and only by invitation, you cannot just show up at Apolima.

As the boat made its way closer to the steep black volcanic rock cliffs of the island, I was wondering where the people lived. A small community of about 80 residents was known to live on the island, and as we started to make our way around the island, a small opening appeared. A very narrow, rocky inlet led to a flat interior section of the island with houses. A treacherous landing to say the least, the remnants of a small vessel that met its demise could be seen smashed on the rocks to one side.

Diving

Our destination was not the village though, but instead, dive sites around the island. The boat slowed and my dive guide jumped in to check the current. It was mild and I geared up, back-rolling off the side of the boat. After we met at the surface and descended, all I saw was blue. As I slowly followed the dive guide down, out of nowhere, a massive school of giant barracuda came right up to us. It was like they were waiting to say hello. After I snapped a few photos, they got bored and left, and I could see the seafloor emerging into view at around 30m (100ft).

As we headed to the reef, massive sea fans, which revealed a deep red hue when I shined lights on them, dotted an underwater land-

scape, swirling with fish. Large hard corals covered the bottom and another large school of a smaller barracuda species overtook us and continued past, out of view. In amongst the hard corals were dots of brightly colored soft corals—not the massive draping kind you see in other places, but numerous smaller patches, like puffballs brightening up the seascape.

While conditions were drastically better than I had expected, the effects of the storms remained in the form of swell. As we got shallower towards the end of the dive, we were tossed back and forth and up and down in the waves. The surf made for a beautiful panorama of white water washing up against the island from below, as we completed our safety stop and headed back to the surface.

The boat was waiting right above us and the captain helped us back onto the boat. Back on board, we continued to circle the island and found another spot to jump in after our surface interval. With another slight current, we drifted along at that perfect speed where you are not going too fast but also do not have to work too much to keep going. It was very relaxing, with lots of marine life to see.

I finished my first day of diving around Apolima, feeling that the diving was just really nice. The water was warm, so a rash guard would have been fine, although I was comfy in a 3mm wetsuit. There were not massive reef structures but endless hard coral plains covering the sea bottom, which supported a lot of fish. Schools of fusiliers passed by. As we came around a corner, the current shifted, but we

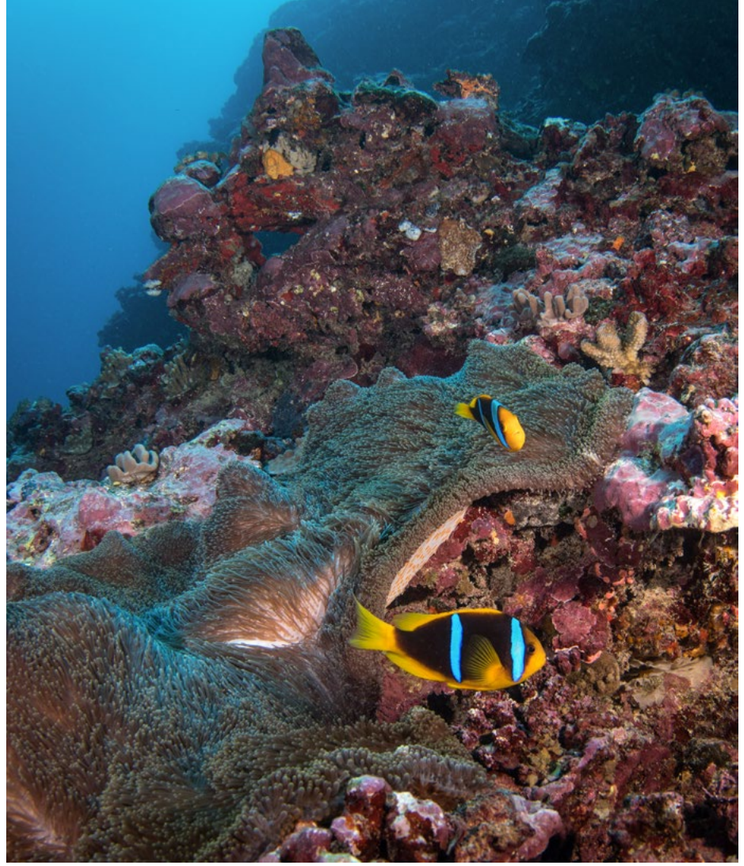
School of reticulated dascyllus hovering over hard corals (above); Diver with huge seafan on reef (top right), soft corals (top left) and school of great barracuda (left) at Apolima

kicked a bit into it until we got a bit farther and were mobbed by fish. White pyramid butterflyfish, with yellow edges, feasted on plankton in the water column, and a turtle swam by. There were also several anemones with anemonefish within.

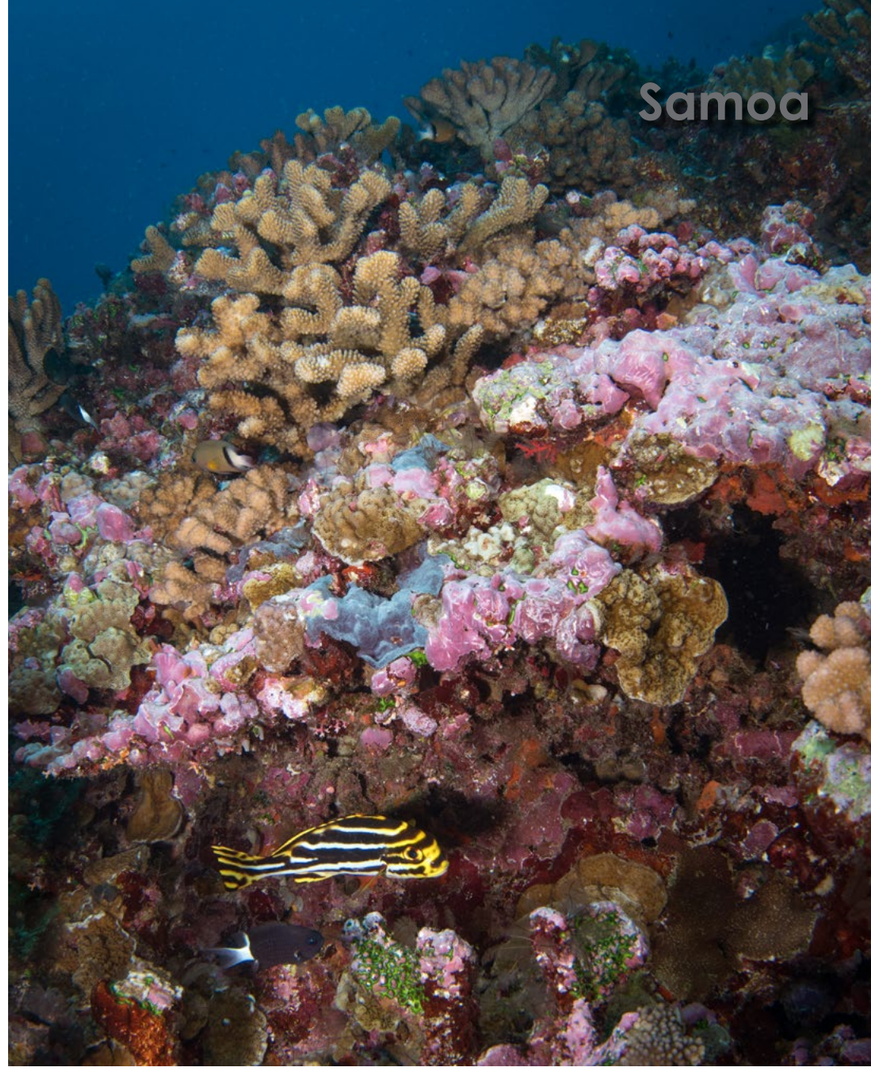
Exploring Upolu

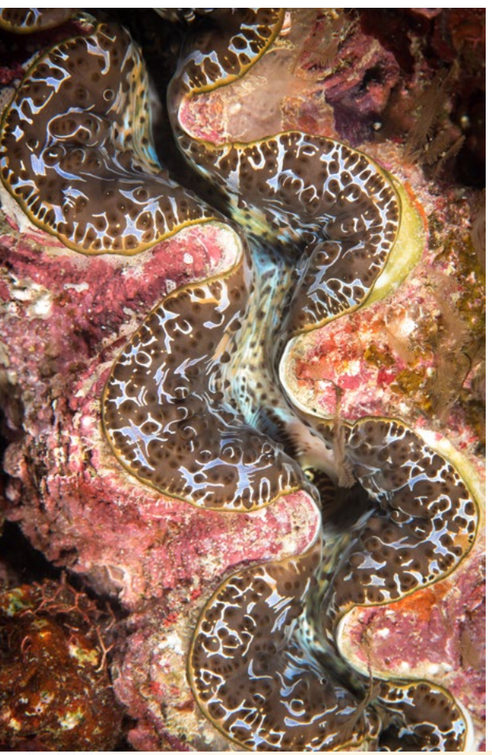
Wanting to explore the island, I rented a car and prepared myself to drive around the island. But before they would rent it to me, I had to get a Samoan driver's license. While it sounded intimidating, it turned out to consist only of filling out a form with the information from my American driver's license and paying a fee of around US$20, but I felt pride that I passed my Samoan driver's test.

With 210km (130mi) of beach and roads allowing one to circumnavigate almost the entire island, I set out… on the left side of the road. I found this slightly humorous, having just come from American Samoa where



Hawksbill sea turtle at Apolima (above); Clark's anemonefish on anemone (top right); School of pyramid butterflyfish (top left); Tomato anemonefish with baby (far left); Reticulated butterflyfish (center)





Giant clam (left); Diver on wall festooned with hard corals (above); Arc-eye hawkfish (top center); Porcelain crab (right); Sub-adult oriental sweetlips on reef (far right); Giant moray eel hiding in reef (bottom right)

people drove on the right side of the road, and pondered why islands linked so closely culturally (and closely in distance) are so different in practicalities. Doing some research, I found that because Samoa has closer ties with New Zealand and Australia (while American Samoa has closer ties with the United States), far more cars with left-side steering wheels were being imported at cheaper prices into the country. So, in 2009, they decided to just change which side of the road they would drive. On 7 September 2009, they officially changed the law to drive on the left and even made a two-day holiday on the 7th and 8th to help reduce traffic while people started to get used to it.

I admire this move and several others Samoa has done over the years to make the way the country operates make more sense. This includes when, in 2011, the country changed its date and gave up a day by moving itself west of the International Date Line. Previously, Samoa was in the same time zone as American Samoa, but, again, due the country's close working ties with New Zealand and Australia, they were essentially losing two workdays a week, because when it was Monday in Australia, it was still Sunday in Samoa —so, no one was working. And on Friday in Samoa, it was already Saturday in Australia (and no one was working there). From a business standpoint, it made more sense to change their time zone.

This makes it very interesting to fly from American Samoa to Samoa (which I did), as in a 35-minute flight (125km or 78miles), one goes through a 23-hour time change. Surprisingly, I felt no jet lag.

One last recent change occurred when Western Samoa decided to change its name to Samoa in 1997, dropping the "Western." This move upset the people of American Samoa as they said it "diminished its own identity." So, currently, the country is called the Independent State of Samoa, while American

Princess damselfish

Diver on reef with whip coral (above); The writer Robert Louis Stevenson's room in the Robert Louis Stevenson Museum (top right); The safe he brought to Samoa to store his writing and valuables (right); His wife, Fanny's, room (far right)

Samoa remains an unincorporated and unorganized territory of the United States.

Robert Louis Stevenson Museum

Robert Louis Stevenson (RLS), the Scottish author of the classic books *Treasure Island, The Strange Case of Dr Jekyll and Mr Hyde* and many other great works, spent the end of his life in Samoa until 1894, when he passed away at age 44. Suffering from illness (possibly tuberculosis) since he was a child, RLS led a life of adventures and travel, and he made his way to the Pacific in 1888, settling in Samoa with his wife, Fanny Van de Grift Osbourne, and her daughter, son and mother in 1890. While in Samoa, they had a mansion built called Vila Vailima, which still stands today and currently serves as a museum, commemorating how he and his family may have lived in Samoa, with original and replica antiques as well as a few first edition books.

Driving just out of Apia and up into the higher elevations of the center of the island, one can see that Vailima was built on a hill, with a beautiful ocean view and in the perfect spot to get trade winds to keep the home cool in the sweltering tropical heat. After removing my shoes (as the Samoans do), a museum guide took me through each room of the house and showed me the kitchen built behind the house (to prevent fires).

The walls were covered in photographs, taken from the 1880s to the 1890s, of the family and staff and of RLS with Samoan villagers. He had close ties with the Samoans, and they called him "Tusitala," which means "writer of tales." In RLS's bedroom and writing room, there were bookshelves full of his books, including translated copies in every language, including Samoan. Several first editions were on display.

My favorite room was Fanny's, the only room never painted, as she had redwood logs shipped to Samoa for her room, so that she could be surrounded by the trees of her native California. Downstairs in the dining room, there was a massive safe—said to have been carried up the hill on the backs of many Samoans—in which RLS kept his manuscripts locked up, as well as other valuables.

Museum of Samoa

Also in Apia is the Museum of Samoa where I spent some time learning about the culture and history of the islands. On display were pottery and stone artifacts thought to be 3,000 years old, originating from the time when the Samoans first arrived on the islands. Tapa cloths, which are traditional barkcloth made from the paper mulberry tree and painted with intricate designs, were hanging on the walls along with information on Samoa throughout history. As one moved from room to room, the displays chronologically moved through time on the Islands.

The giant swimming hole, To-Sua Ocean Trench, is accessed via ladder (above); "Fale," or "house," at Pure Ocean (top right); Sopoaga Falls (right)

Similarities and differences

Prior to arriving in Samoa, I had spent a few days in American Samoa, but unfortunately, I was unable to get into the water due to bad weather and was mostly confined to my Airbnb during Tropical Storm Wasi. But I was fascinated about the similarities and differences between these two very distinct countries, which are so closely tied culturally and physically. The museum shed some light on these differences, yet, the term *Talofa* (or *Hello* in English) was still heard on both islands, both cling to the traditions of the Samoan culture, and both live life *Fa'a Samoa* or "the Samoan Way."

While driving around Tutulia (American Samoa) and Upulo (Samoa), I observed that every village had at least one (but usually many) *fale. Fale* means "house" but refers to an oval-shaped building with no walls, just pillars holding it up, and a thatched roof, lashed and tied together with plant fiber rope, usually made from dried coconut fiber. Originally constructed with no metal, now some also use modern construction equipment. They are still used today for meetings and gatherings, and I often saw people just hanging out in them, as I drove through the villages.

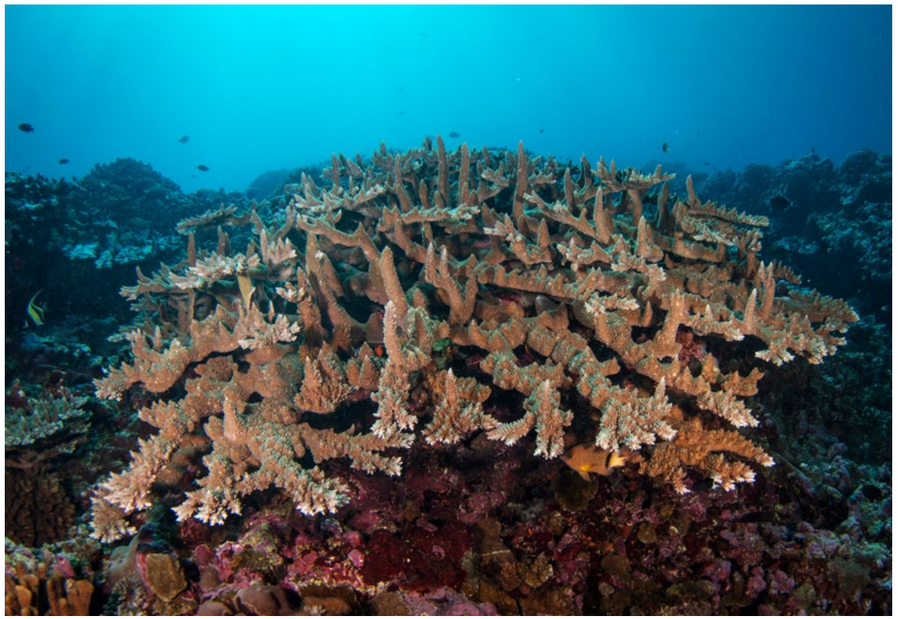
On the side of the road, I also often saw large metal tanks (similar to the large cylinders one might use to fill a lot of scuba tanks), hanging with their bottoms cut off, like a bell. I later learned that these were used to alert the village of something important. They also would be sounded to alert people of "Sa" (meaning "sacred"), which is a religious evening prayer curfew, usually around 5:00 to 6:00 p.m. each night. During this time, no one is allowed to walk around the village, from the time the bell was sounded until the bell (or sometimes it was the blowing of a conch shell) was later sounded three times.

Samoans are deeply religious, and Sundays are a day of worship. Almost everything is closed for the day, although hotels and some tourist restaurants stay open. I even saw signs posted at beaches, forbidding swimming on Sundays.

To-Sua Ocean Trench

Continuing my drive around the island, I reached To-Sua Ocean Trench on the southern coast. Meaning "giant swimming hole" in English, To-Sua is a cave, connecting to the open ocean, that can be reached via a descending staircase and ladder. From above, it looks like a giant hole in the ground, which it sort of is, but with plenty of beauty surrounding it. The entrance is located within a native garden, and if you can pull yourself away from the giant swimming hole, you will find that the garden abruptly ends at a cliff with a spectacular view of the Pacific Ocean.

Resuming my driving tour of the island, I stopped at a few waterfalls (there are plenty), and I soon became very familiar with "custom fees," which are customary fees visitors pay to access sights on private land, such as To-Sua, the waterfalls, and even several beaches. Each time I pulled off the highway towards a "waterfall" sign, I would be met in the parking lot and asked for 10 or 20 tala (about



Manono Island (above); Pufferfish (top center); Lobster (right); Hard corals on Apolima's reef (left)

US$7-12). I was glad I brought some cash and small bills with me.

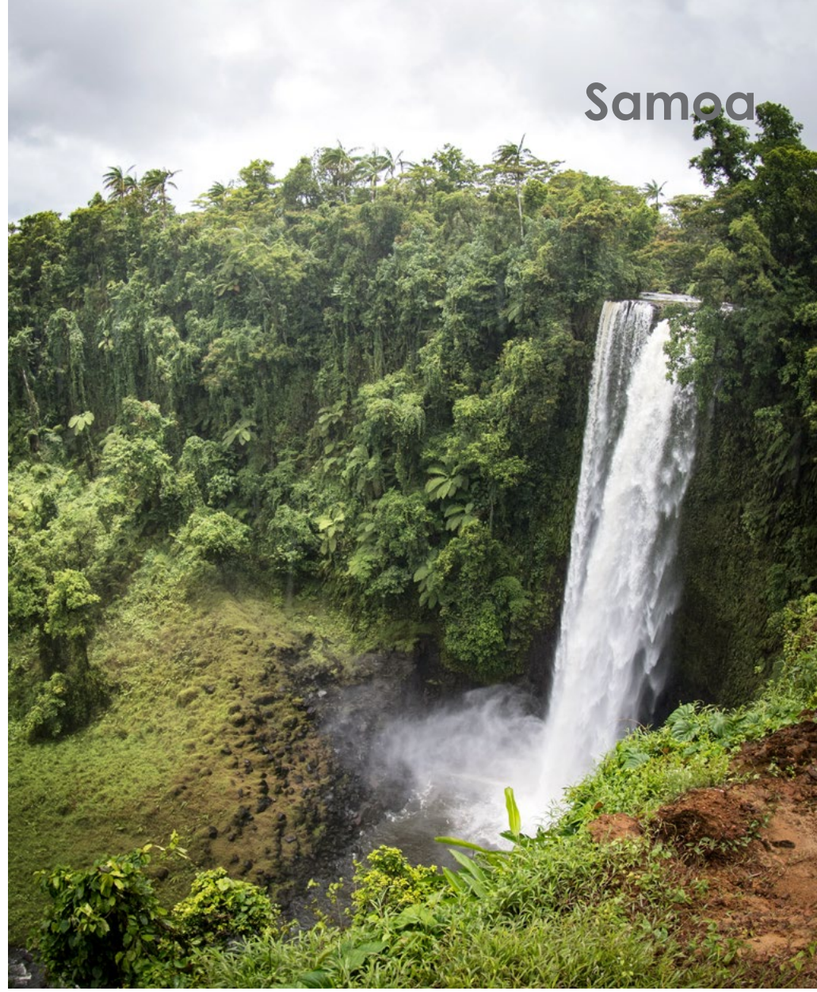
Sopoaga Waterfall was beautiful, and only a few feet from the parking lot. I also stopped at Fuipisia Falls, which required a bit more work to reach. After parking my car and paying the fee, I was sent off along a grassy path, which crossed a small babbling brook and then turned into a very deep and slippery muddy path. I lost my sandals to the thick mud several times before giving up and walking barefoot until I reached the falls when a soft rain started falling, making the mud even worse. The waterfall was gorgeous, though, and green forest surrounded the area.

Traveling during COVID-19

As my trip in Samoa began in mid-February 2020, the island nation was already ramping up its protective measures against COVID-19. The country still has not forgotten the 1919 Spanish Flu outbreak during which it suffered more than any other Pacific Island Nation, as 90 percent of the population got infected and over one-fifth of the population died. In nearby American Samoa, Spanish Flu was prevented entirely due to the governor quarantining the territory and not allowing any ships in. Samoa had no cases until the arrival of the SS *Talune* from New Zealand, and seven days later, the epidemic was uncontrollable.

While I was reading about this event in the Museum of Samoa, I was also getting updates of COVID-19 cases occurring around the world. On arrival to Samoa, I was temperature-checked and passengers who had been to China, Italy, Iran, or coming from California in the United States were not allowed to enter. I had not left the Pacific in over two months and had not been in or traveled through any countries that had confirmed cases prior to my arrival in Samoa. But stricter measures were being taken every day, including halting cruise ships from docking.

The day I left Samoa, the Samoan govern-



Pure Ocean's dive boat at Nu'ulopa, also known as Bat Island due to the flying foxes that live there (above); Fuipisia Falls (top right)

Springer's blenny (above); A tiny blenny peeks out from the coral reef (left); Reticulated dascyllus (right)

Dot and dash butterflyfish on reef

ment cut flights in half and increased the number of countries not allowed entry to try and stop Samoa from becoming infected with the virus. Although I am sure this did harm to tourism, in a country with a vulnerable population and a healthcare system that most likely could not support a pandemic, these were likely very good (and very quick) responses to protect Samoans from the virus.

Macro critters

On my last morning of diving in Samoa, I made the tough decision to put on my macro lens and capture some of the lovely reef fish I had been seeing on every dive. Samoa was a hard place to choose to shoot macro because every dive had the possibility of seeing larger animals like turtles, reef and nurse sharks, as well as endless fields of coral. But during my dives, I was glad I did, as I chased around butterflyfish and tried to capture the many black and white dascyllus, which would hover above the hard coral only to dart back into the branches and hide whenever I was about to snap a photo.

Throughout my dives in Samoa, I had occasionally seen a large blenny, with bright reddish orange spots, sitting on rocks or on coral. I made it my goal to get a photo of this one and probably bored my dive guide to tears as I stayed in one section trying to follow the skittish blenny. I did snap an image of one that sat still long enough. There were also numerous different-colored giant clams all over the reef, ranging from purple to orange to deep blue.

With my nose in the coral, my dive guide called me over and showed me the tiniest blenny, smaller than a pencil eraser hiding in a small hole showing only his head. I am still not certain what species it was, but it sure was cute!

Snorkeling

Back on the boat, I was content with my macro morning and was debating in my head if I should spend the afternoon

THIS PAGE: Resort guests were treated to a traditional "Fia Fia," a dinner show with Samoan stories, music, song and fire dancing.

relaxing at the pool or the beach when Oli called from the office. He asked if I wanted to join a snorkeling trip going out in the afternoon, which would visit Nu'ulopa Island (also known as Bat Island, home to a conservation area for flying foxes). That seemed like the perfect place to fly my drone, so I quickly abandoned my visions of napping in a beach chair.

With plenty of shallow reef teeming with fish, Samoa has some great snorkeling. But I was excited for the snorkeling surface interval on the small island known for its bat population (Fun fact: Bats do not like drones). The small island was covered in palms and other trees, and I learned it was sometimes used as a cemetery for high chiefs.

Samoan music and dance

After the island visit and more snorkeling, I got back to my room to change quickly and make my way to the "Fia Fia." Roughly translating to "celebration" or "happy," the Sheraton Samoa Beach Resort does a weekly traditional dinner show with Samoan dancing and music.

While we guests sipped cocktails and enjoyed traditional Samoan cuisine, several stories of Samoa were relayed to us via music and dance. The highlight of the evening was the fire dancers at the end of the show.

Since I was flying out the next day, when the forecast also called for rain, this seemed like a perfect way to end my trip to Samoa. The sun was setting over the tranquil blue ocean, and I was already making a mental list of things to come back to do and see: Do more hiking, visit Savai'i, and, of course, do more diving. ■

Special thanks go to Pure Ocean Dive and Watersports and the Sheraton Samoa Beach Resort.

American underwater photographer, dive writer and regular contributor Brandi Mueller is a PADI IDC Staff Instructor and boat captain living in Micronesia. When she is not teaching scuba or driving boats, she is most happy traveling and being underwater with a camera. Mueller's book, Airplane Graveyard, featuring her underwater photos of forgotten American WWII airplanes at the bottom of the Kwajalein Atoll lagoon, is available at: ***Amazon.com****. For more information, please visit:* ***Brandiunderwater.com****.*

fact file

Samoa

History Research suggests Samoa has been inhabited for over 3000 years and the islanders most likely followed the Polynesian migration throughout the Pacific. Genetic and cultural studies show strong ties between Samoans, Fijian and Tongans. First contact with Europeans was in the 18th century. In the 1800s, whaling vessels frequented the islands and missionaries started arriving in 1830. The Germans, British and Americans all had vested interests in Samoa in the late 1800s and it was thought war would break out until a storm in 1889 destroyed the warships, ending the conflict. In 1898, fighting broke out again and was resolved at the end of 1899, with the United States taking control of the eastern islands (now American Samoa) and the Germans taking control of the western islands. The British gave up claims in exchange for Tonga, the Solomon Islands south of Bougainville and some parts of West Africa. When WWI broke out, the British convinced New Zealand forces to seize control of German Samoa, and New Zealand ruled from 1914-1962. In 1962, Samoa was granted independence, signing a friendship treaty with New Zealand. It was the first small island country in the Pacific to become independent. In 1997, the government changed the country's name from Western Samoa to Samoa. Government: parliamentary republic. Capital: Apia.

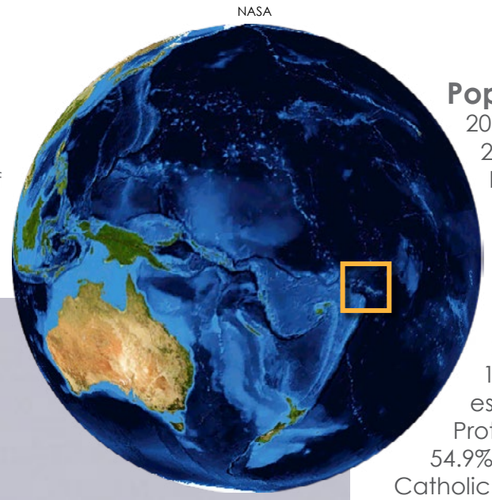
Culture Samoans take their culture, protocol and custom seriously and religion is woven in tightly. Sunday's are reserved for worship and almost everything closes. Hotels and some tourist restaurants stay open, but even most attractions (including some beaches) are closed. Many villages have a "sa" or curfew each day around 6pm where all activity must stop and you cannot walk around the village. If visiting villages, women should cover shoulders and knees. Traditional lava lavas (large pieces of colorful cloth wrapped around the waist and covering past the knees) are popular for both men and women. Bikinis and even swimsuits are not recommended at public beaches and if worn in the water covering with a lava lava or sarong right before entry and after exiting the water is expected (they are fine at hotels and resorts). Shoes are removed before entering fales or homes. If visiting villages, it is wise to ask hosts about protocols.

Geography Samoa lies south of the Equator and comprises two large islands and three islets in the Polynesia region of the Pacific Ocean. Although the islands were created from volcanic activity, only the island of Savai'I is still active with the last eruption occurring in 1911. Upolu and Savai'I make up 99% of the land area and Apolima, Manono and Nu'ulopa are three islets in the Apolima Strait. Coastline: 403km. Lowest point: Pacific Ocean 0m. Highest point: Mount Silisili 1,857m. Natural hazards: occasional cyclones and active volcanism.

Environmental issues Like so many island nations, Samoa faces many environmental threats. Overfishing from commercial trawlers has depleted the fish stock and locally destructive dynamite fishing still occurs. Deforestation for agriculture and homes is occurring and because most of the population's infrastructure is low-lying coastal areas, sea-level rise is likely to be a problem. Increase in number and severity of cyclones has been an issue. Coral reefs are also at risk and previous cyclones have destroyed large areas of coral. Increased water temperatures have led to coral bleaching episodes. Invasive species are a problem including the giant African snail which destroys vegetable roots and other agriculture. Taro leaf blight, an infectious plant disease, decimated the island food staple and overseas export with taro production decreasing over 95%. Merremia vine and Mikania micrantha are aggressive weeds that out compete native plants and inhibit crop growth. Samoa is susceptible to other invasive animals, plants, and diseases that have caused problems on other Pacific Islands.

RIGHT: Location of Samoa on global map
BELOW: Location of Apia on map of Samoa

NASA



US CIA WORLD FACTBOOK / PUBLIC DOMAIN

Economy Agriculture is Samoa's main export and includes coconut products, cocoa, bananas and noni. Tourism makes up about 25% of the GDP and has been increasing since the mid-1990s. Samoa relies heavily on development aid and remittance sent from relatives living in other countries. As of 2018, the nominal GDP was $881 million and $4,420 per capita.

Climate Samoa has an equatorial climate that is generally hot and humid year-round with an average air temperature of 24-30°C (85-86°F). The rainy or monsoon season is November to April which is also when cyclones are more likely to develop. Water temperatures average between 27-29°C (80-84°F).

Population 203,774 (July 2020 est). Ethnic groups: Samoan 96%, Samoan/New Zealander 2%, other 1.9% (2011 est). Religions: Protestant 54.9%, Roman Catholic 18.8%, Mormon 16.9%, Worship Centre 2.8%, other Christian 3.6%, other religions including Baha'i and Muslim 2.9% (2016 est). Internet users: 58,508 or 29.4% (July 2016 est)

Currency Tala (SAT) Exchange rates: 1USD=2.77SAT, 1EUR=2.99SAT, 1GBP=3.42SAT, 1AUD=1.77SAT, 1SGD=1.94SAT
Currency can be exchanged at the airport, banks and some hotels and ATMs are available at these points, but prone to running out of bills. Credit cards are accepted with fees by major hotels and restaurants, but cash only at smaller establishments and entrance to beaches and waterfalls.

Language Samoan (Polynesian) and English.

Phone/Internet Cell phone and data coverage is quite good with 4G around Upolu and Savai'i. SIM cards are available on arrival at the airport for two telecommunications providers, Bluesky and Digicel, and plans are generally inexpensive. Hotels and some restaurants provide wifi for free or at a cost.

Travel/Visa No visa is required for most travelers for 60 or 90 days, depending on nationality. Travelers must have a passport valid for six months after departure date and an onward ticket. Currently, proof of measles vaccination is required.

Getting there Samoa receives international flights from Honolulu, New Zealand, Australia, Fiji and American Samoa, and ferry service from American Samoa.

Health & Safety Check with your state department for travel advisories before your trip. Tap water is not safe to drink but bottled water is easily obtained. Be cautious when partaking in community kava ceremonies in case unsafe water is used. Samoa has had its fair share of mosquito-borne disease outbreaks including Chikungunya in 2015 and has the mosquito species that spreads Dengue and Zika (both of which have occurred), so avoid being bitten by mosquitoes. There is no malaria. Routine vaccines are suggested and due to a recent and devastating outbreak of measles on Samoa, documentation of having received the vaccine is required upon entry into the country. Crime rates are low, but petty theft may occur. Lock cars and do not leave valuables in view or unattended at beaches. Watch out for and avoid aggressive stray dogs.

Decompression Chambers
AMERICAN SAMOA (nearest):
Lyndon B. Johnson Tropical Medical Center at LBJ Hospital
Fagaalu, Tutuila Island
Phone: (684) 633-1222

Web sites
Samoa Tourism **samoa.travel** ■

SOURCES: *LONELY PLANET: RAROTONGA, SAMOA & TONGA* (2016), PURE-OCEAN.COM, SAMOA.TRAVEL, SHERATONSAMOARESORT.COM, US CDC, US CIA WORLD FACTBOOK, US DEPT OF STATE, WIKIPEDIA.ORG, XE.COM

My Favorite Macro Dive

— Contributors' Picks from Around the World

Text and photos by Scott Bennett, Larry Cohen, Brent Durand, Jennifer Idol, Kate Jonker, Matthew Meier, Brandi Mueller, Don Silcock, Peter Symes & Olga Torrey

We asked our contributors what their favorite macro dive was and they answered with stories and images from some of the most beautiful and unique dive sites on the planet. From the depths of Lake Baikal in Siberia to a shore dive off Florida to the tropical paradise of Indonesia, Papua New Guinea and the Philippines to the temperate waters of British Columbia and South Africa, *X-Ray Mag* contributors share their favorite shots and experiences.

PETER SYMES

Mimic octopus (left), with an exposure of ISO125, f/16, 1/60s, and pair of emperor shrimp on sea cucumber (above), with an exposure of ISO160, f/25, 1/80s, were photographed using a Nikon D200 camera with a Nikon 105mm macro lens, Hugyfot housing and two Ikelite D125 strobes.

PREVIOUS PAGE: Pair of gammarids, Lake Baikal, Siberia, Russia. Photo by Peter Symes.

Robust ghost pipefish pair (above). Exposure: ISO125, f/29, 1/60s. Gear: Nikon D200 camera, Nikon 60mm macro lens, Hugyfot housing, two Ikelite D125 strobes.

Puri Jati, Bali, Indonesia

Text and photos by Scott Bennett

Situated on Bali's northern coast, Puri Jati features a slope of volcanic sand easily accessible from shore. Although desolate in appearance, looks are deceiving. This is critter heaven, home to a bewildering array of the weird and wonderful creatures. I spent three memorable days here, with each dive revealing photo subjects galore. Lone anemones hosted blacksaddle anemonefish, porcelain crabs and commensal shrimps, while a sea cucumber carried two colourful hitchhikers: a pair of imperial partner shrimp.

Octopus species abound, and I giddily checked two off my bucket list on one dive: the wonderpus and mimic octopus. Be aware of your surroundings, as the substrate is alive with Ambon scorpionfish, devil scorpionfish dwarf scorpionfish, cockatoo waspfish and dwarf lionfish. Need more? Throw in nudibranchs, painted frogfish, finger dragonets, ornate and robust ghost pipefish, seahorses and cuttlefish and your shutter will blast into overdrive.

With depths generally less than ten metres, dive times can easily exceed an hour. As a photographer, your battery power will run out long before your air! Visit: **xray-mag.com/contributors/ScottBennett**

Pair of ghost pipefish (left); Squat shrimp (above); Mantis shrimp (right). Camera gear: Olympus OM-D E-M1 camera, Olympus M.Zuiko 60mm f/2.8 macro lens, Aquatica AE-M1 housing with flat port, Sea&Sea YS-D1 strobes.

Technical tips for shooting macro

Text by Larry Cohen

One of our responsibilities as photographers is to pick the correct ISO, aperture and shutter speed for the images we are creating. There are many factors to consider. First and foremost is the amount and quality of the light. When shooting in relatively shallow water on a bright day: The lower the ISO, the less digital noise we have in our images. In dim light, you have to use a higher ISO.

When shooting macro images, we have shallow depth of field. If we want the whole subject sharp, we need to use a smaller aperture opening (larger f/stop number). Some images may look better by using a larger aperture opening (smaller f/stop number) to have the background and/or part of the subject out of focus. Having part of the subject out of focus can be effective as long as the eyes are sharp.

Camera shake that causes blurred images is magnified when shooting macro. For this reason, it is best to use a fast shutter speed. When shooting most macro photos, the background is close to the subject, so your strobes will light both the subject and background. In this case, controlling the ambient light with the shutter speed is not important. ■

Tufi Resort's dock, Oro Province, Papua New Guinea

Text and photos by Larry Cohen

Just a 15-minute boat ride from Tufi Resort's dock in Papua New Guinea are some of the most stunning reefs in the world, but one of the best sites is the dock. This wharf area was a PT boat base during WWII and offers world-class muck diving. It is littered with machinery and bottles that shelter marine life. There are plenty of creatures to observe in less than 10m (33ft) of water. Diving double tanks, my dive partner, Olga Torrey, and I did multiple three-hour dives here and were never bored. Three of my favorite subjects include a squat shrimp, a pair of ghost pipefish and a mantis shrimp. To capture these images, I used the Olympus M.Zuiko 60mm f/2.8 macro lens on the Olympus OM-D E-M1 camera. The camera was in the Aquatica AE-M1 housing with the flat port. For lighting, I used Sea&Sea YS-D1 strobes. Please visit: **liquidimagesuw.com**

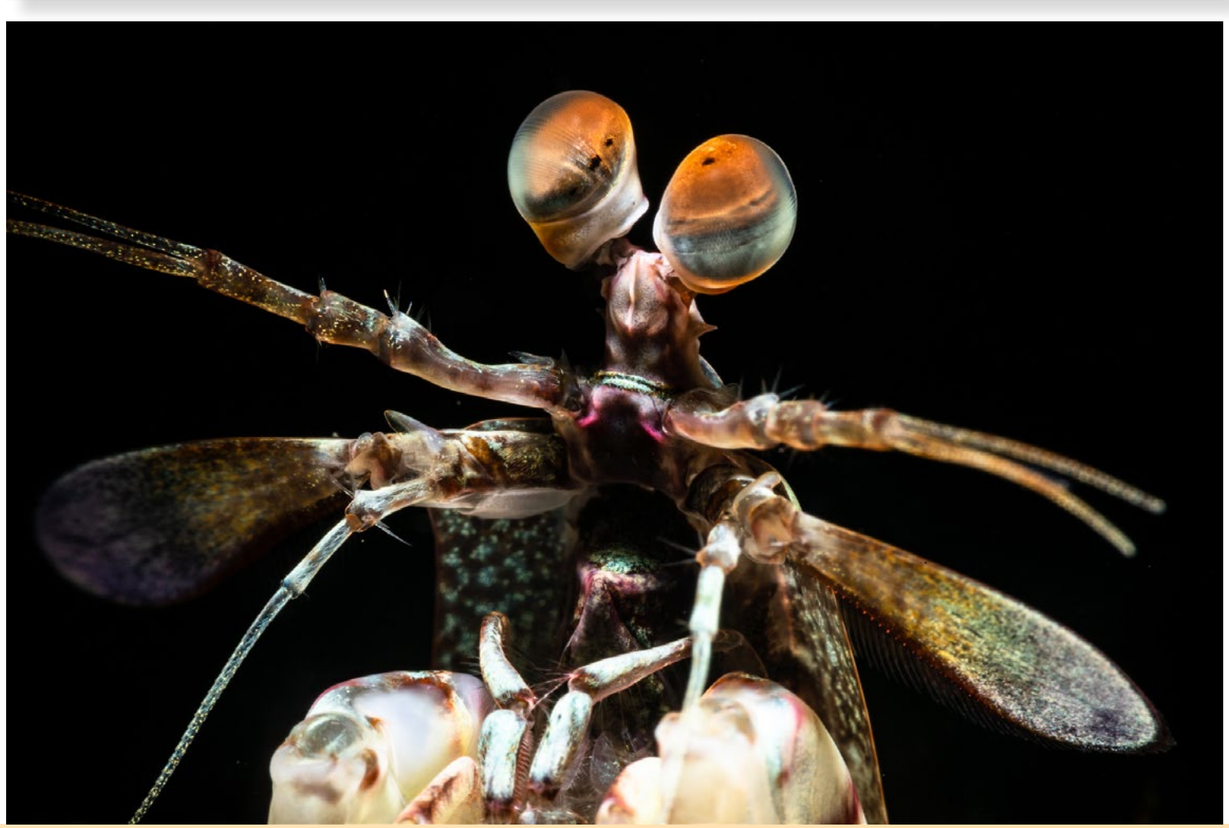
Punta, Dumaguete, Philippines

Text and photos by Brent Durand

I have had a number of favorite macro dives but would have to say that one particular dive in the Philippines last year stands out. I was visiting Atlantis Resort Dumaguete for work, getting familiar with the resort and diving as part of my new job. I had heard about Dumaguete for years and really wanted to (personally) see if the critter abundance and biodiversity was indeed on par with other famed macro hotspots. On this particular dive at Punta, we moved from great subject to great subject… and I was dialed in, getting the shots. Photographers, you know how that feels. I surfaced with a huge smile, confirming in my own head what so many divers already knew—that Atlantis truly deserves such a stellar reputation and that the macro diving in Dumaguete is off-the-charts excellent!
Visit: **tutorials.brentdurand.com**

Golden gobies (*Lubricogobius ornatus*). Exposure: ISO 200, f/29, 1/200s. Camera gear: Canon 5D Mk IV camera, Canon 100mm f/2.8L macro lens, Sea&Sea MDX-5DMKIV housing, one Sea&Sea YS-D1 strobe and DIY snoot (above)

Pink-eared mantis shrimp (*Odontodactylus latirostris*). Exposure: ISO 200, f/25, 1/200s. Camera gear: Canon 5D Mk IV camera, Canon 100mm f/2.8L macro lens, Sea&Sea MDX-5DMKIV housing, one Sea&Sea YS-D1 strobe and DIY snoot (right)



Blue Heron Bridge, Florida, United States

Text and photos by Jennifer Idol

Blue Heron Bridge in Florida is known for its world-class macro dives. I have been there a few times but I will always remember diving there with fellow photographer Suzan Meldonian as she shared her treasure. Tides limit dive times, but we were able to dive early mornings this past winter. We worked to find a seahorse, and fortunately found one in the first half of the dive. This was the first seahorse I saw at the bridge, which is now protected from specimen collectors. So as not to stress our feeding seahorse, we spent the rest of the dive finding other worthy subjects such as frogfish and eventually even a mantis shrimp. I was shocked to see the mantis shrimp as I did not realize they lived in Florida waters. These images were taken with a Nikon D5 camera with a 105mm lens in a Nauticam housing with Inon strobes. Please visit: **theunderwaterdesigner.com**

Lined seahorse or *Hippocampus erectus* (above). Exposure: ISO 250, f/14, 1/250s. Camera gear: Nikon D5 camera, 105mm lens, Nauticam housing, Inon strobes.

Scaly-tailed mantis shrimp or *Lysiosquilla scabricauda* (right). Exposure: ISO 400, f/18, 1/250s. Camera gear: Nikon D5 camera, 105mm lens, Nauticam housing, Inon strobes.

Striated frogfish or *Antennarius striatus* (right). Exposure: ISO400, f/13, 1/250s. Camera gear: Nikon D5 camera, 105mm lens, Nauticam housing, Inon strobes.

Orange gasflame nudibranch—a huge nudibranch measuring about 10cm in length, photographed using a snooted strobe to light just the nudibranch and to separate it from the vibrant reef upon which it can be found. Exposure: ISO 200, f/18, 1/250s. Camera gear: Sony A6400 camera, Sony 90mm macro lens, Fantasea FA6400 housing and Inon Z240 strobe with Iardino's snoot.

Purple lady nudibranch (below)—a seldom-seen nudibranch photographed using a snoot torch to light just the nudibranch, highlighting its beautiful colours against a black background. Exposure: ISO 160, f/8.0, 1/200s. Camera gear: Sony A6400, Zeiss Touit 50mm macro lens, Fantasea FA6400 housing and MiniGear MS03 snoot torch.

Basket star on sinuous sea fan (bottom). This is one of the delicate baby basket stars for which this reef is named. Exposure: ISO 100, f/5.6, 1/250s. Camera gear: Sony A6400 camera, Zeiss Touit 50mm macro lens, Fantasea FA6400 housing, and two Sea&Sea YS-D1 strobes.

Sterretjies Reef, Gordon's Bay, Cape Town, South Africa

Text and photos by Kate Jonker

A new reef. Never before seen by human eyes! As we descended, a magnificent reef rose to greet us, revealing spectacular rugged ridges and gently sloping valleys. The ridges were adorned with vibrant pink and yellow soft corals. Rare nudibranchs and tiny blennies peered out from the dense marine life. The sloping valleys were home to forests of huge orange sea fans and the seafloor was softly carpeted with yellow sponges. Tiny baby basket stars clung to the sea fans and lazy puffadder shysharks snoozed on their yellow sponges. I spent an exciting 50 minutes exploring this uncharted reef and photographing marine life I had not seen for years. We named the reef "Sterretjies," which is Afrikaans for "Small Stars," for the many tiny basket stars that had made this reef their home. Besides the emotional attachment of discovery, Sterretjies has remained my favourite macro dive site due to its incredible diversity of marine life. Please visit: **katejonker.com**

Red paddle-flap scorpionfish (*Rhinopias eschmeyeri*) with an exposure of ISO 200, f/22, 1/125s (above), and with an exposure of ISO 200, f/20, 1/250s (top right). A mating pair of the small but venomous blue-ringed octopus species, photographed with an exposure of ISO 200, f/16, 1/125s (right). Camera gear: Nikon D810 camera, Nikon 105mm lens, Subal housing, two Sea&Sea YS-250 strobes and DIY snoots.

Goby Station, Lembeh Strait, Indonesia

Text and photos by Matthew Meier

One of my favorite macro dives occurred last fall while diving with Solitude Lembeh Resort at a dive site called Goby Station, in Lembeh Strait, Indonesia. On this one dive, I was able to photograph two species on my bucket list of rare creatures. We set out in search of red, yellow and purple Rhinopias, or paddle-flap scorpionfish, that had been seen at this site and instead, the first critter my dive guide Purry located, was a mating pair of blue-ringed octopuses! My mind was blown 10 minutes into the dive and it only got better as we subsequently located three Rhinopias, all of the red variety. The photos were shot with a Nikon D810 camera and a Nikon 105mm lens in a Subal housing, with two Sea&Sea YS-250 strobes and snoots fashioned from the "underwater department" at Home Depot.

The snoots are just lightweight plastic reduction tubing that I found in the plumbing or gardening aisle, and which happened to fit snugly over the end of my strobes. I had the strobe with me in the store to test the fit. I also added a tether so I can remove them for a shot and they will stay attached to the strobe and not float away. The opening at the end is about two inches, down from the original strobe width of over 3.5 inches. Visit: **MatthewMeierPhoto.com**

DIY snoot with tether on strobe

Banded jawfish (*Opistognathus macrognathus*) with brood of eggs in its mouth. Exposure: ISO 400, f/13, 1/200s. Camera gear: Nikon D7100 camera, 105mm lens, Ikelite housing and dual strobes.

Chromodoris nudibranch, *Chromodoris kuniei,* (top center). This beautiful nudibranch is always a treat to photograph, and after I snapped a few photos, I noticed it was laying eggs! I tried to get some of the vivid orange eggs it was laying in the shot. Exposure: ISO 200, f/22, 1/200. Camera gear: Nikon D850 camera, 105mm lens, Ikelite housing, dual strobes.

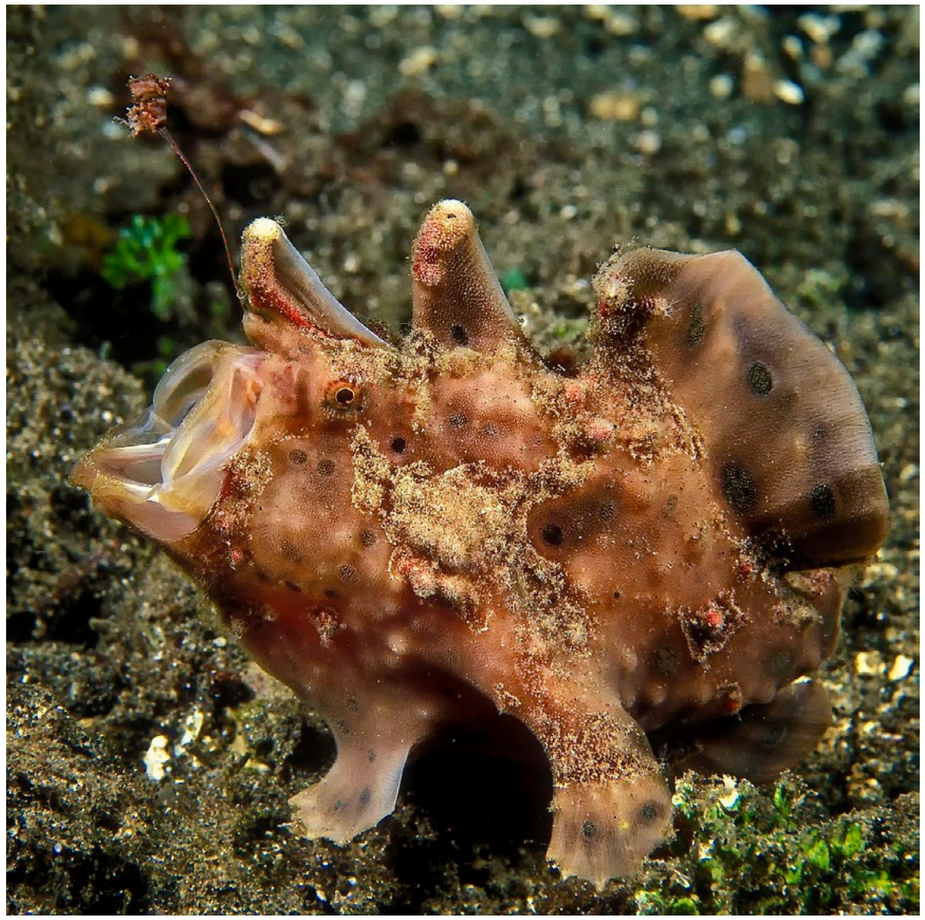
Thorny seahorse, *Hippocampus hystrix* (left). With its tail wrapped around some greenery, this seahorse was very camouflaged. Getting very low, I tried to be on the same plane as the seahorse to get a straight shot of it. Exposure: ISO 200, f/22, 1/200s. Camera gear: Nikon D850, 105mm lens, Ikelite housing, dual strobes.

Bianca, Lembeh Strait, Indonesia, and Blue Heron Bridge, Florida, United States

Text and photos by Brandi Mueller

Lembeh Strait in Indonesia is a famous destination for macro photography with so many of my favorite critter-hunting dive sites. One that never disappoints is Bianca. For someone who has not been there before, when the dive boat arrives, pulling up near derelict-looking boats, it is easy to question why anyone would dive here. Even when you first jump in and see mucky black sand below, and usually more garbage than any diver wants to see on any dive, the site seems questionable. But once you get closer to the sand (and have the help of an excellent dive guide), you will find endless macro opportunities—different colored seahorses, frogfish, tons of anemonefish, and on my last dive there, even a nudibranch laying eggs.

In contrast, shooting macro photography under the Blue Heron Bridge in Florida is one of my favorite spots because it is so unexpected. One would never guess in depths as shallow as two to three meters, there are octopus, seahorses, jawfish, nudibranchs, flying gurnards, juvenile fish of so many species and more. It is an easy-to-access shore dive (although you have to time your dive by the tides), and you can spend up to two hours shooting macro to your heart's content. Please visit: **brandiunderwater.com**



Harlequin shrimp or *Hymenocera picta* (top left). Exposure: ISO 200, f/20, 1/250s. Camera gear: Nikon D300 camera, Nikon 70-180 macro zoom lens, Subal housing and Sea&Sea YS90 strobes.

Ocellated frogfish or *Antennarius ocellatus* (left). Camera gear: Nikon F100 film camera, Nikon 70-180 macro zoom lens, Subal housing and Sea&Sea YS90 strobes.

Dinah's Beach, Milne Bay, Papua New Guinea

Text and photos by Don Silcock

My favorite macro site is Dinah's Beach on the northern coast of Milne Bay in Papua New Guinea, which besides being a great critter dive, is also the home of muck diving. "Dinah" refers to Dinah Halstead, the first wife of the late Bob Halstead, the pioneer of liveaboard diving in Papua New Guinea. The beach is right in front of Dinah's home village of Lauadi, and it was here that Bob first persuaded a group of well-heeled American divers to try what he christened as "muck diving." Defined as diving where there is no pretty scenery, the Americans were not easily convinced, and suspected Bob was simply trying to save on fuel. But they changed their minds once they saw the array of critters waiting for them! Like all good critter sites, what you will see varies with the time of the year and the water temperature. But there is always plenty to see and I have never had a bad dive there. You can read more about Dinah's Beach at: **indopacificimages.com**

Alabaster or white-lined dirona nudibranch (above); Pair of opalescent or flame-tipped nudibranchs (left); Juvenile wolf eel (right). Camera gear: Olympus OM-D E-M5 camera, Olympus M.Zuiko 12-50mm f/3.5-6.3 EZ Micro lens, Nauticam NA-EM5 housing, Sea&Sea YS-D1 strobes.

Browning Pass Wall, Port Hardy, British Columbia, Canada

Text and photos by Olga Torrey

Since I come from the Ural Mountains in Siberia, Russia, one of my favorite dive locations is the cold waters of Port Hardy in British Columbia, Canada. Browning Pass Wall is one of the best sites for both macro and wide-angle photography. Every inch of this wall is covered with life. Diving sidemount, the captain of the *Nautilus Swell* commented that my dive partner, Larry Cohen, and I did the longest dives and stayed within a 3m (10ft) area. The problem was what lens to bring? I enjoy using the discontinued Olympus M.Zuiko 12-50mm f/3.5-6.3 EZ Micro lens on my Olympus OM-D E-M5 camera. This unique lens has a button that puts it into macro mode. The lens does not produce a true 1:1 macro image but does provide a 1:2 half-life-size image. This is perfect for many of the small creatures on this site. Nauticam has a flat port and special ring, so one can access this button during the dive. This way, I could capture close-up and medium-wide images with my Nauticam NA-EM5 housing. I really enjoyed photographing this Alabaster Dirona, opalescent nudibranch and juvenile wolf eel. For lighting, I used Sea&Sea YS-D1 strobes. Please visit: **fitimage.nyc**

Northern California

— *A Dive off the American Wild West Coast*

Text and photos by Brent Durand

An ochre sea star (*Pisaster ochraceus*) clings to the rock reef.

A wave surges past a wash rock in Northern California (above); Large fish-eating anemone, or *Urticina piscivora* (top right and previous page)

Warm rinse water sloshed in the jug as my car hugged a sharp turn on California's Pacific Coast Highway. I looked left at the mighty Pacific Ocean, the cliffs tumbling to the sea dotted by rugged pinnacles, stretching farther up the coast than the jam band solo currently playing out of the car speakers. Deep blue, favorable conditions all week, minimal swell, no-wind forecast—only unpredictable visibility could affect the diving today.

The parking lot was empty as we unloaded and set up our gear on a downed redwood tree trunk. Today would be a wetsuit dive, since my dive buddy and I would be doing a lot of swimming. The cool steel 117 (15L) tanks were filled to the max. *Ziiiiiip.*

Snap. Clip. Clip. Zzzzzzzz. Hoooofff. "OK. Let's do it."

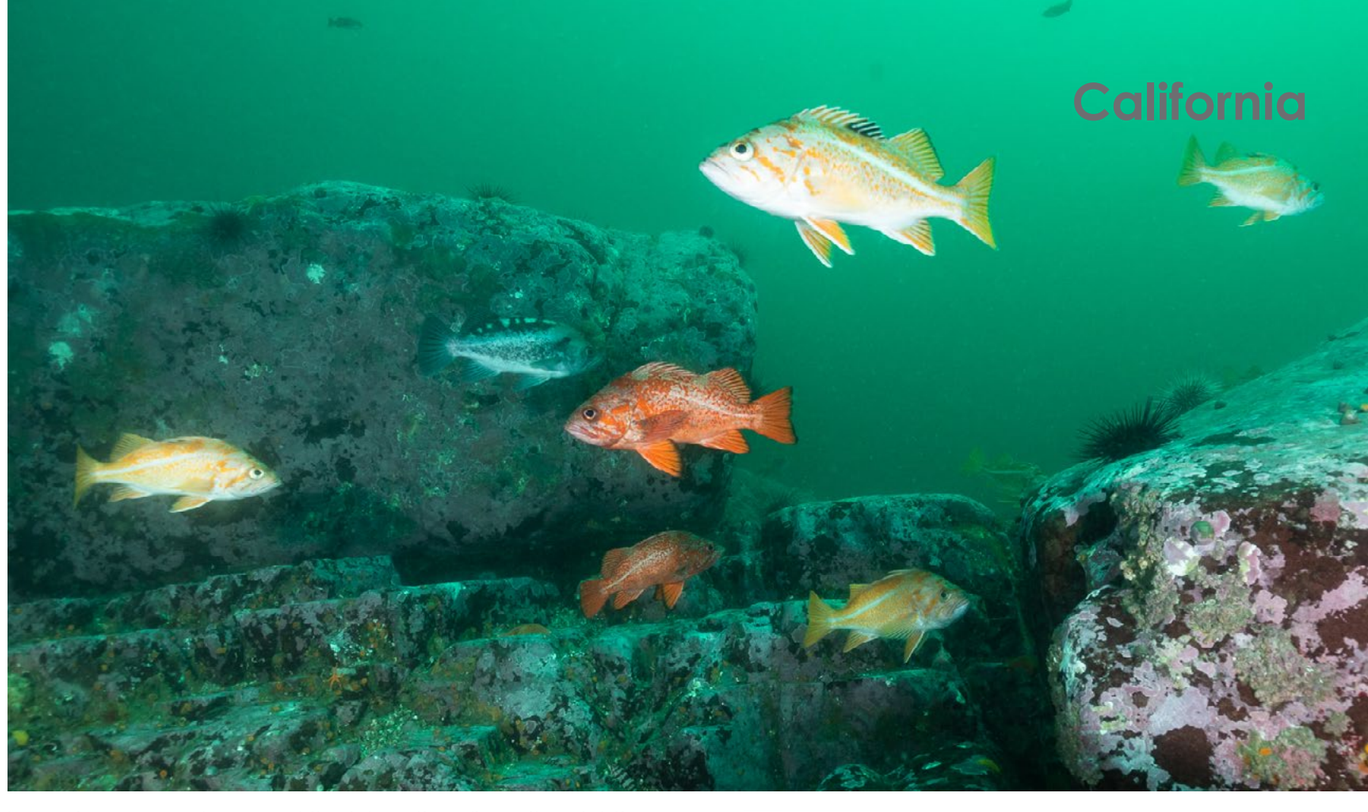
Soon, the soothing clasp of the sea compressed my legs as we walked over slippery rocks and rainbow leaf red seaweed (*Mazzaella splendens*) in the shallows. We kicked out towards a rock pinnacle in the center of the cove, our starting point for navigation, noting how we could see the bottom in 20ft (6m) of water. *This would be epic!*

We descended into a playground of rocks and boulders, mirroring the wild coastline above. The eerie lack of kelp strangely felt normal—sad, indeed, but reflective of the human condition. I unclipped my camera and carefully unfolded the strobe arms, listening to the capacitors charge up as I turned each knob.

A shadow blinked through the sunlight. Is today the day I see "the Landlord"? I glanced up. Nope, no great white shark, just a jellyfish—of the Pacific sea nettle variety (*Chrysaora fuscescens*).

Marine life

We started swimming west-southwest. Around here, some folks still believe one should never share exact coordinates—so take that for what it's worth. Most of the boulders were dotted with purple sea urchins. Rockfish stared blankly from crevices. Chitons and topsnails were everywhere. Crabs scurried about. A kelp greenling swam by at a distance, curious but shy. Scallops peered out from under rough ledges. Each abalone made me



Several curious fish species aggregate around the interesting divers (top right).

A classic Northern California shallow reef scene with sea urchins, starfish and kelp (above); Ambient light illuminates an area with a series of large rock slabs (top left).

smile. We kept swimming.

Gradually, we swam deeper. The shallow period surge left as the landscape dramatically changed, evidence I could only imagine of violent tectonic plate shifts. Massive rocks the size of houses tilted out of the earth as diagonal slabs, creating deep cracks, swim-throughs and mini-caves before dropping into 25ft (7.6m) walls, only to repeat and repeat as we navigated this rock city.

Rugged underwater landscape

The inside of each crack and the outside of each wall was covered in cup corals and strawberry anemones. At these depths, I could only imagine the force of winter swell funneling thick nutrient-rich water through these channels like a washing machine.

We kept swimming. The ambient light was much darker now. I noticed a metridium anemone (also known as plumose). A heavyweight green-mottled cabezon perched on a ledge, and I paused to slowly approach. It darted off just as I put my finger on the shutter, all fins extended. I could not imagine a more realistic dinosaur.

Swimming again. A group of three metridium grew on a corner of a slab wall. We were getting closer. My light tracked over vibrant orange and red corynactis (strawberry or jewel anemone), then past another group of four metridium anemones. We swam over the edge of the slab and the sight before me made me giggle through the regulator.

Precipice

The rock dropped off dramatically into dark blue-green blurriness, which was breathtaking—but it glowed too. It glowed bright white. But wait, the white was many whites. It was hundreds of metridium anemones blanketing the upper half of the wall, extending well beyond visibility!

I snapped a few photographs, enthralled with the combination of

Metridium anemone and corynactis grow on a rock while blue rockfish swim overhead (above); The impressive wall densely colonized by metridium or plumose anemone, cup coral and corynactis or strawberry anemone (left and below)

such rough landscape and delicate beauty. We had found it. That old diver with the piercing eyes had been right. He had given us the wrong directions, but we kept spending dive days searching and finally kicked into this incredible place with the method he had inspired—true exploration.

We were "all good vibes" on the surface swim back into the cove. A red-tailed hawk danced in an updraft off the cliff—perhaps a tip of the hat from Mother Nature? Soon enough, we were back in the parking lot, and I was pouring the jug of warm water over my head, already thinking about planning next week's dive. ■

An avid diver for over 20 years, Durand is a widely published underwater photographer and dive writer who has served as editor-in-chief of the Underwater Photography Guide and imaging expert at Scuba Diving Magazine and Sport Diver. With a reputation for insightful-yet-simple reviews and tutorial articles, he has written for most of the top dive publications. Helping hundreds of divers "take their photography to the next level," Durand has led underwater photography workshops in California, the Bahamas, Indonesia, Mexico, the Philippines and Sri Lanka. For more information, visit: ***tutorials.brentdurand.com****.*

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To book your virtual lesson, please visit: **tutorials.brentdurand.com/virtual-photo-lessons** ■

Mystified by

Salmon Sharks

in Alaska

Text and photos by Jennifer Idol

Glaciers pour into Prince William Sound just south of Valdez, including this retreating glacier in Shoup Bay.

Sharks elicit strong emotions, be it the thrill of a planned encounter underwater or fear propelled by social media and lack of information. Of the more than 400 species of sharks, it is the small family of mackerel sharks that is most iconic. These sharks prompted me to share why one of them, the salmon shark, is an especially remarkable species.

Why sharks?

Seeking encounters with sharks has become a mild obsession of mine, and sharing their story is deeply personal. My interest in sharks was spurred by years of diving and not seeing sharks on those dives. The few sharks I did see were mostly nurse sharks, which did not conjure the same kind of excitement as sharks typically depicted in movies and media. It was the brief glimpse of a bull shark in the Florida Keys that grabbed my imagination.

I also became curious about the motivations behind people's thirst for the thrill of seeing sharks and for fearing them. During the journey I took diving all 50 states of the United States, I continued to encounter few sharks. I saw a number of rays, part of the subclass that comprises sharks (*Elasmobranchii*), and adorable horn sharks, but only heard tales of encounters from other divers about other species. Their stories put purposeful encounters with sharks at the top of my bucket list.

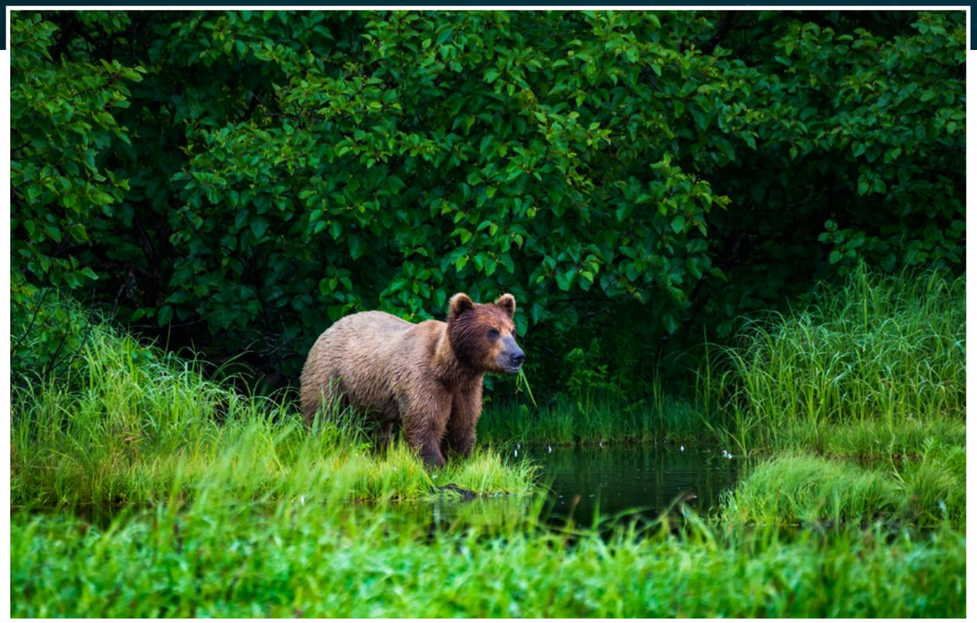
Some of my fascination with sharks can be attributed to my grandparents, who prohibited me from seeing the movie *Jaws*, the single most recognized media icon for promoting widespread fear of sharks. I still have not seen it. More recently, the Discovery Channel's *Shark Week* seems to feed on fascination driven by fear. Though educational and inspirational intent is at the heart of most programming, it is my impression that the viewers' main takeaway from watching these programs is the thrill of watching frightening shark behavior rather than gaining respect for a prehistoric wonder. How do we educate and illuminate audiences about a species that we love for its evolutionary feats and its recognizable teeth?

Answering these questions and

Visitors can hike Matanuska Glacier on the way to Valdez (above). Salmon sharks reach up to 3.6 m (12 ft) in length (top right). PREVIOUS PAGE: Salmon sharks lack a nictitating membrane, so their eyes can be seen following a subject.

Salmon Sharks

Fewer than 4,000 people inhabit Valdez, seen in its entirety from above (above). Ravencroft Lodge is the center for observing salmon sharks (right)



Grizzly bears inhabit the area around Valdez and can be seen even within the town (above); Salmon sharks are recognized by their giant eyes, white spotted belly, dark grey coloring, and torpedo-like shape (top left).

fulfilling my dreams to encounter sharks began in Alaska, at the end of my 50-state journey, where I learned about the fabled salmon shark (*Lamna ditropis*). I learned there was an operator in Prince William Sound, which offered trips to swim with them, and so I made plans that directed the next five years of my diving career.

Finding the town of Valdez

I signed up for my first trip with Ravencroft Lodge through shark expert Andy Murch of Big Fish Expeditions. Boone Hodgin now runs North 60 Adventures from his remote lodge to take a limited number of guests to encounter sharks each summer. He meets guests in Valdez and makes the crossing from Prince William Sound to Port Fidalgo. To get to the small fishing town of Valdez, I prefer to fly into Anchorage and then make the five-hour drive.

Alaska is one of America's last great wildernesses and home to grizzly bears, melting glaciers, salmon and bald eagles. Summers are a flurry of life, rushing to reproduce and eat while food is plentiful. Making the crossing to Valdez afforded me the opportunity to see sites such as Matanuska Glacier and Horsetail Falls.

Valdez is a tiny town whose name is recognizable from the Exxon Valdez oil spill in 1989, which originated from these waters. An earthquake in 1964 caused a tsunami that nearly wiped out the town and resulted in the construction of the modern marina, from which we depart today. Glaciers surround the town and are the source of the murky teal glacial waters seen near shore.

Salmon sharks and their relatives

Before any expedition, I research as much as possible about my subject to ensure the best encounters. Little is known about salmon sharks, but what I found correlated with what is known about all sharks. They are poorly protected, comprising part of an

This male shark shows fresh boat propeller scarring and has a number of copepods attached to his dorsal fin.

Feeding behavior is the only time salmon sharks display an open mouth.

Calm water is best for observing salmon sharks swimming through Port Fidalgo.

average 100 million sharks killed each year.

The salmon shark population was estimated at two million individuals in 1989 with poorly documented catches, showing that during some years, nearly 200,000 individuals were caught within a four-month window. Though they are listed as of "least concern" with the IUCN Red List, it is noted that this assessment is based on a lack of evidence regarding current populations and on reduced numbers of catches. Sport fishing for salmon sharks is prevalent in Alaska, with reports of a single competition killing 10,000 salmon sharks in Valdez around the year 2000.

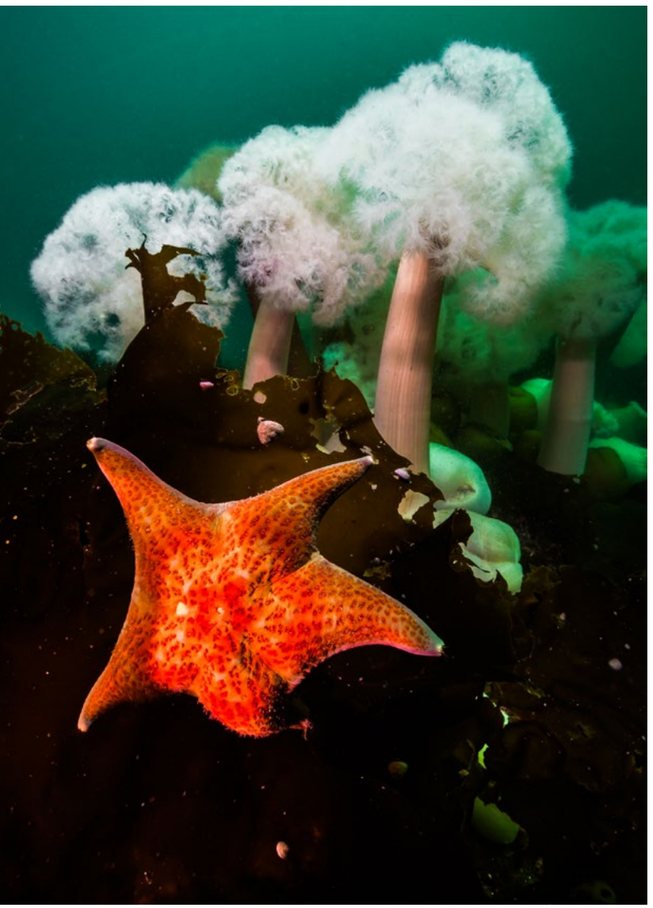
Salmon sharks are distinct, and at the same time, part of the most recognizable shark family. They belong to the family of mackerel sharks (*Lamnidae*), which also include great white sharks, shortfin and longfin mako sharks, and porbeagle sharks. They are remarkably adapted to their cold-water habitat and also share the uncommon characteristic of being endothermic, meaning they can keep their body temperature above the water temperature. This is especially helpful for when they mate in the Arctic.

Observing salmon sharks

Our group of divers waited patiently to observe sharks in the morning from Ravencroft Lodge. The sharks are frightened by movement in the water, so we entered the water as quietly as possible and hid beneath small boats to reduce our footprint. While we observed them swimming leisurely, it was important to keep in mind that these were the fastest sharks in the world, as determined by recent observations by the US Navy, recording salmon sharks swimming more

Salmon Sharks

Port Fidalgo is a calm and protected waterway during the summer (above); A variety of wildlife swim across Port Fidalgo, including this mule deer that was spotted swimming the three mile distance to avoid a grizzly bear (right).



Plumose anemones, starfish and kelp form the habitat in Port Fidalgo (above); Hooded nudibranch grow to large sizes in Port Fidalgo (right).

than 80km/h (50mph). Streamlined bodies propel them through the water with astonishing efficiency, which means they can swiftly vanish from encounters.

It was my first glimpse of a salmon shark reaching for bait that hooked my love for them. The full-throated view only appears when the shark is feeding. It is a desirable behavior for photography, and because these are deep-feeding sharks, up to 600m (1,969ft), we cannot observe their natural feeding behavior.

To find a salmon shark with which we could enter the water, we looked for the dorsal fin at the surface and watched the shark's movements. A leisurely shark swimming in circles is a good sign that the shark might not disappear before we can observe it in the water. A single herring was used to keep the shark interested in staying long enough for a group to observe it. Salmon sharks in Alaska feed on herring, one of the fish populations disrupted by the Exxon Valdez oil spill.

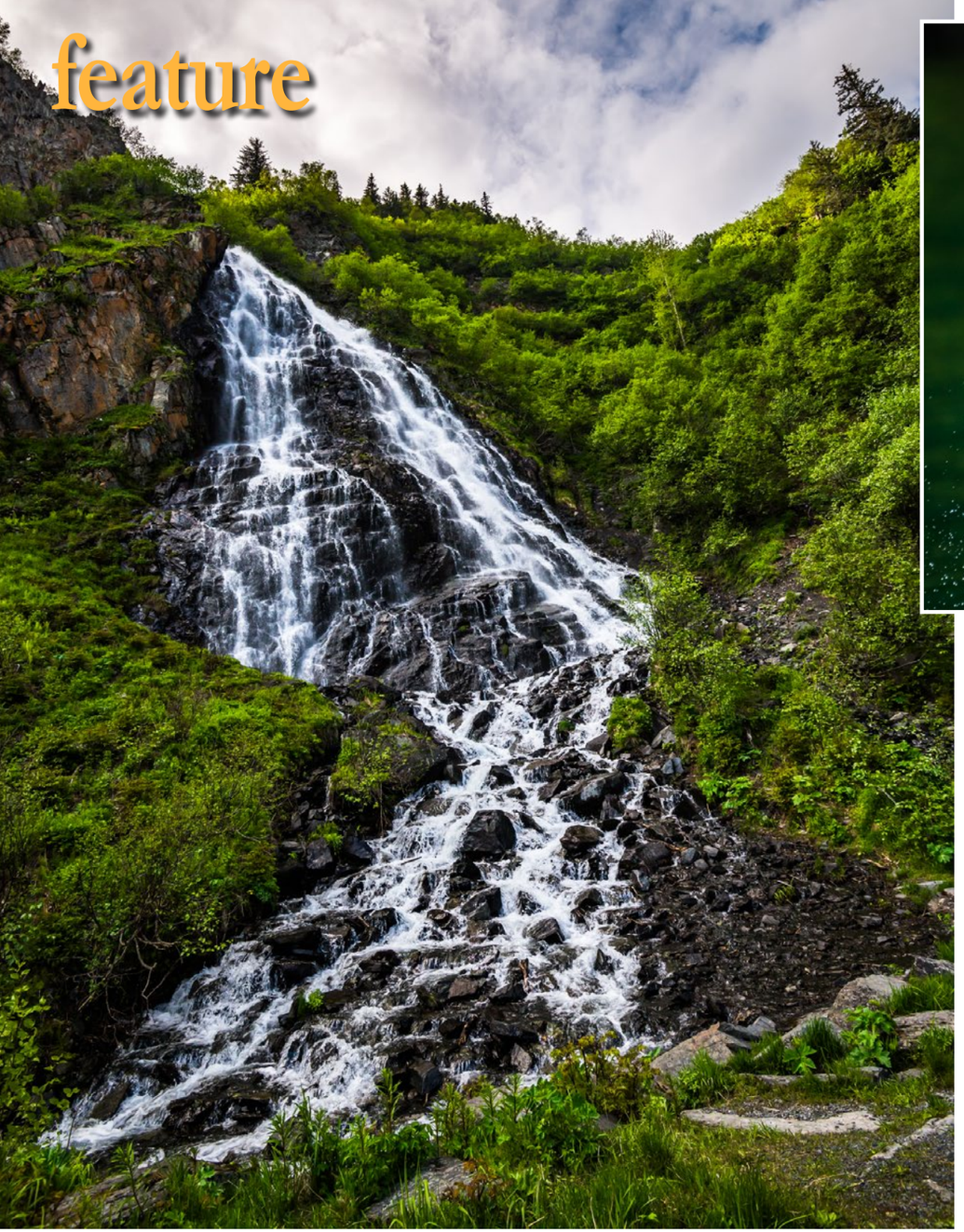
In every year I have returned to observe salmon sharks, I have seen new behaviors, such as watching them rub against floating logs and even seeing two unexpectedly leap out of the water. Mackerel sharks are famous for their breaching behavior, but seeing this in salmon sharks has been less commonly observed.

Salmon shark fins appear like tiny dots at the surface and require long telephoto lenses to see in detail.

They are beautiful sharks whose main predators are humans and some orcas. Unlike ground sharks such as tiger sharks, mackerel sharks such as the salmon shark do not have a nictitating membrane—a type of retractable eyelid. I find salmon sharks adorable with their wide, round faces and overly large eyes, useful for navigating deep water. They are a species of shark worth the investment in a trip to encounter them in their natural habitat.

Regional habitat

Salmon sharks are part of a rich ecosystem throughout Alaska and the North Pacific. While we observed them in Port Fidalgo, they have been known



Bald eagles watch from atop trees surrounding Port Fidalgo for the opportunity to catch fish (above); Sea otters can be found with their families in the inlets surrounding Port Fidalgo and throughout Alaskan waters (top right); Harbor seals congregate on icebergs left from glacial melt ((right); Hiking trails outside Valdez follow the spruce forest and lead to views of waterfalls such as Horsetail Falls (left).

to travel as far south as Northern California and as far west as Russia and Japan. Their feedstock is more varied than their common name suggests and includes herring, squid and salmon, among the dozens of fish they feed upon.

They leave Port Fidalgo before salmon spawning reaches peak season. The port itself is protected by mountainous landscape akin to the fjords of Norway and Iceland. It is a deep body of water in which I have seen orcas, Dall's porpoises, sea otters and even a mule deer swimming through.

Since salmon sharks are only observable in the morning, afternoons on salmon shark trips are spent photographing bald eagles diving for herring, or getting in the water with other wildlife. The Pacific Northwest is rich with life above and below water and includes large invertebrates such as hooded nudibranchs bigger than your hand. In late summer, moon jellies bloom for their reproductive cycle. Their mass gatherings can reach below recreational diving depths and spread across wide bodies of water.

The future of salmon sharks

Opportunities to encounter salmon sharks are rare and only commercially offered through Ravencroft Lodge with North 60 Adventures. They are a subject I will never tire of seeing, and I will continue working to educate people about how these special, endothermic sharks are an important part of our ecosystem.

We know little about the full extent of their behavior and can make observational inferences, but an important attribute of these and all sharks is that they help maintain ocean health by removing weak and sick animals.

I want to be able to dive with and document our sharks for a lifetime and

not just document their history. Improved understanding of sharks, bans on shark-finning and fishing, and limits to wasteful fishing practices with bycatch, are all steps to maintaining healthy biodiversity. ■

A widely published dive writer and underwater photographer, Jennifer Idol is the first woman to dive all 50 US states, which is chronicled in her book, An American Immersion. She has been an avid diver for 25 years, earning more than 29 certifications. A native Texan, she creates design and photography for her company, The Underwater Designer. To see more of her work, visit: ***uwDesigner.com****.*

In addition to hooded nudibranch, opalescent nudibranchs inhabit Port Fidalgo (above); Moon jelly aggregations can be so dense that their biomass makes the water appear as dark as night (left).

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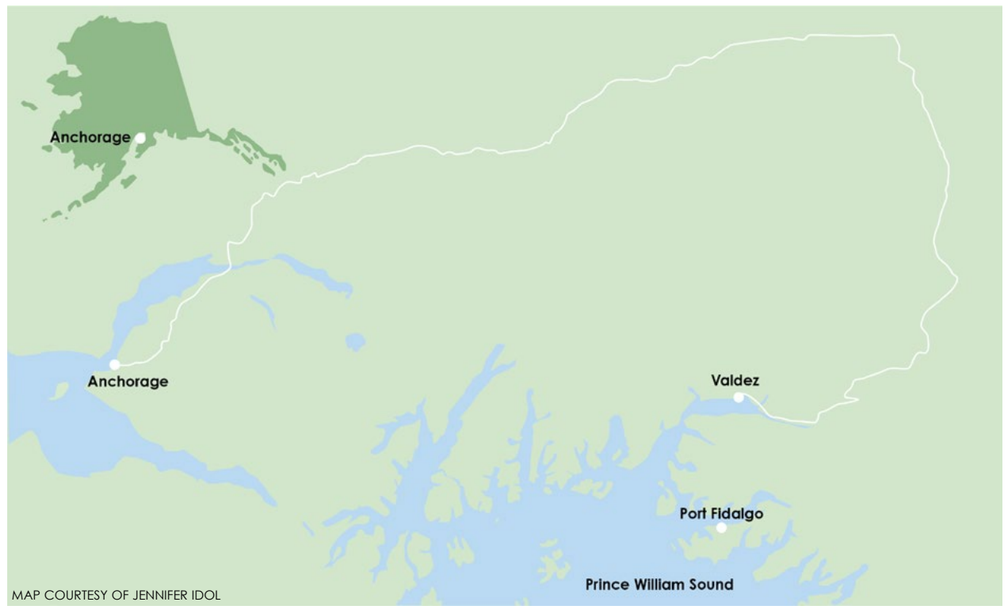

MAP COURTESY OF JENNIFER IDOL

Anchorage to Valdez route in Alaska (above); Location of Alaska on map of North America (left)

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Whale sharks live an incredibly long time

Thanks to atomic testing during the Cold War, scientists have discovered a way to find out the age of whale sharks.

Many divers dream of the day they find themselves swimming beside a whale shark. Its gentle demeanour and huge size presents a unique and humbling experience that is second to none. Yet, there is much we still do not know about the whale shark. Today, one of its hidden mysteries has been unlocked—its age.

Until recently, it was hard to fix a number to the whale shark's age, as it does not have bony structures (otoliths), which are traditionally used to calculate the age of fish.

Another method—counting the distinct bands in its vertebrae, akin to counting rings in tree trunks—was not conclusive, as scientists do not know with certainty how frequently new bands developed and for what reason.

Carbon-14

A by-product of the atomic testing that took place in the 1950s and 1960s was the radioactive element carbon-14. The tests caused the levels of the carbon-14 isotope in the atmosphere to increase—first in the atmosphere, then subsequently, in the oceans. Eventually, it penetrated food webs and found its way into every living thing on the planet.

"So any animal that was alive then incorporated that spike in carbon-14 into their hard parts," said Mark Meekan, from the Australian Institute of Marine Science in Perth, in a BBC news article. He is one of the authors in a study that was published in the *Frontiers in Marine Science* journal.

The key to using the carbon-14 as a dating device is due to the fact that we know the rate it decays. So, the older the shark, the less carbon-14 they would have in their body.

"That means we've got a time marker within the vertebrae that means we can work out the periodicity at which those isotopes decay," Meekan added.

The findings of the study revealed that whale sharks do indeed live a very long life, leading Meekan to conclude that "the absolute longevity of these animals could be very, very old, possibly as much as 100-150 years old."

This implies that the species is very vulnerable to being overharvested. With this discovery, scientists can now provide better guidance on how well a population is doing and whether any fishing can be allowed in a particular area. ■

SOURCES: FRONTIERS IN MARINE SCIENCE, BBC, EUREKALERT

A smooth stingray glides over the kelp at the Poor Knights Islands, New Zealand.

Sorting Out the Stingrays

Text by Nigel Marsh
Photos by Nigel Marsh and Andy Murch

Gliding slowly over the rocky reef, I was mesmerised, watching all the colourful reef fishes going about their daily activities. I was so entranced that I was startled to look up and find I was on a collision course with a massive stingray. This was the first stingray I had ever seen, and the giant creature terrified me. In the second it took my panicking brain to work out what to do, the stingray suddenly saw me and also got a shock. A mad splash of fins saw us both turn tail and flee in opposite directions!

I can still clearly remember that first stingray encounter, even though I was only nine years old, snorkelling in a bay north of Sydney, Australia. Once my courage returned, I jumped back into the water, and this time, got a closer look at this magnificent animal—a smooth stingray, the largest stingray species in the world. This graceful ray was almost 2m wide and did not seem to be too bothered by an annoying little kid swimming alongside. However, I was still very wary, staying well away from the tail, where I could see a large and lethal spine.

I think my love of stingrays started that day, and almost 50 years later, I still get a thrill whenever I encounter a member of this diverse and interesting group of animals—not because they are potentially dangerous with their dagger-like tail spines, but because they are fascinating to watch as they go about their daily lives; be it digging in the sand for food, gliding gracefully around the reef or simply lazing on the bottom.

Habitat

Stingrays are mainly found in tropical and subtropical waters, but a few venture into temperate zones. And as most stingrays inhabit shallow water, they can be found at many

Stingrays

Blotched fantail rays are often seen cruising or hovering in midwater when a current is running (left). This one was photographed off Tweed Heads, Australia; The bluespotted ribbontail ray is easy to distinguish from other small rays with blue spots by its oval shape (below). This one was found sheltering under a wreck in the Red Sea.

A view of the underside of a smooth stingray shows off its mouth and gills (left).

popular dive sites around the planet. At some dive sites, the stingrays are the main attraction. Accustomed to divers, they are easy to approach, study and photograph. There are also a number of popular stingray feeds, like the famous Stingray City in the Cayman Islands, where divers can literally get mugged by dozens of hungry rays.

Family shakeup

While many stingrays look the same, there are actually close to one hundred species that vary greatly in size, shape, colouration and tail length. In recent years, the stingray family has had a major shake-up, with many new species described and many species rearranged within the family, which can make sorting out the stingrays very tricky.

Stingrays are a member of the large and diverse ray family, *Batoidea*, which contains over 600 species in 26 family groups. Stingrays (the family is also known as whiptail stingrays) are placed in the order *Myliobatiformes*, along with the devil rays, eagle rays, stingarees and several lesser known family groups. Stingrays are further placed in the super family *Dasyatidae* which contains four sub-families: *Dasyatinae, Hypolophinae, Neotrygoninae* and *Urogymninae*.

Until recently, there was thought to be around 60 stingray species contained within five genera groups. However, a major review of the family in 2016 by researchers Peter Last, Gavin Naylor and Mabel Manjaji-Matsumoto, looking at morphological and molecular differences, has drastically changed the family, with 95 species now recognised within 19 genera. This is such a drastic change that most guidebooks and websites used to identify stingrays are completely out of date.

To help divers sort through the changes within the stingray family, this article will look at many common stingrays found around the world and where they fit within the stingray family tree. I will look at these stingrays, genus-by-genus, as each genus contains stingrays with similar features.

The genus names are quite complex, like *Bathytoshia*, so I have included a common group name for each genus. Some of these are in general usage, but I have also had to create a few names based on a common feature.

Bathytoshia – Roughtail Rays

This genus of stingrays contains three species that all have a rough tail, covered in dermal denticles.

Smooth stingray. The best known member of this family is the one I first met as a child, the largest stingray in the world, the smooth stingray (*Bathytoshia brevicaudata*). This species, like most stingrays, was once placed in the large *Dasyatis* genus, but the revisions have seen this genus reduced to just five species.

The smooth stingray is found only in the Southern Hemisphere, inhabiting the temperate waters of southern Australia, New Zealand and South Africa. Well known to divers in cooler waters, the smooth stingray reaches a width of 2.1m, and has a short tail and often a white-spotted V-shaped pattern around the head. In Australia, this species is very common around jetties and boat ramps—spots where fishers clean their catch and throw scraps to the resident rays. The rays are almost local celebrities, well known to everyone in the local community. Unfortunately, this does not stop some fishers from killing them or chopping off their tails if they are accidently hooked.

Stingrays

The broad stingray is found around the world in temperate and subtropical zones and has many common names (above); One of the strangest stingray aggregations occurs off Byron Bay, Australia, each summer when thousands of Coral Sea maskrays gather in the gutters at Julian Rocks (left); The Tortonese's stingray is often mistaken for the common stingray, which is not common at all, but has a larger spiracle (bottom left). This one was photographed at the Canary Islands.

One of the best places to see this species is the Poor Knights Islands in New Zealand, where it is called the short-tailed stingray. Seen on almost every dive at this wonderful dive destination, these rays are known to occasionally gather en masse over the summer months, cruising in midwater in caves and arches.

Broad stingray. The other common member of this genus has caused quite a bit of confusion since the recent review. The broad stingray (*Bathytoshia lata*) looks very similar to the smooth stingray but has a long tail and a row of thorns along its back. This species varies in colour from black to brown and grows to 1.8m wide.

Once thought to occur only around the Hawaiian Islands, the review found that several other stingray species from around the world were actually this species. However, since the Hawaiian one was the first to be described, the other scientific names have become obsolete.

For this reason, this species has many common names around the world, including the longtail stingray, black stingray, brown stingray and thorntail stingray. The broad stingray is found in both temperate and subtropical waters, with two of the best places to see them being the Canary Islands and Poor Knights Islands in New Zealand.

Dasyatis – Rough Rays

This poor genus took a beating in the recent review, losing almost all its members apart from five species that are limited to the Atlantic Ocean. The rough rays get their name from the Greek term *dasyatis*—with *dasys* meaning *rough*. But only some older rays in this genus have rough skin and a row of thorns along the back, but they all have the classic diamond shape and a medium-length tail with upper and lower skin folds.

Common stingray. Well known to the ancient Greeks and Romans, the common stingray (*Dasyatis pastinaca*) is the archetypal member of this genus. One of the first rays described by science, the common stingray is found in the Eastern Atlantic, including the Mediterranean and Black Sea. Typically grey to golden-brown in colour, there is a bit of a dispute as to how big this species grows, with some sources saying 60cm wide, and others 1.4m wide. The common stingray is not as common as it once was, due to fishing pressures, and is now listed as "near threatened." This species is mostly seen by divers in the Mediterranean and Canary Islands but is not really common anywhere anymore.

Tortonese's stingray. A more common member of this genus is the closely related Tortonese's stingray (*Dasyatis tortonesei*). This species is found over much the same area as the common stingray, and looks very similar, so telling them apart can be tricky, with the Tortonese's stingray having a larger spiracle. The Canary Islands appears to be the best destination to see this ray, especially at Los Gigantes on Tenerife. At this site, a ray feed is conducted, attracting up to six species of rays, with the Tortonese's stingrays being the most common and numerous of attendees.

A southern stingray digs in the sand, looking for food off Grand Bahama (left); A red stingray at the famous Shark Scrabble, off Tateyama, Chiba, Japan (below)

Southern stingray. While a few of these stingrays are seen by divers, the most famous member of this clan is the southern stingray (*Hypanus americanus*). Found from the southern United States to Brazil, this species is best seen in the Caribbean. The southern stingray varies in colour from grey to brown, with the females growing to 1.5m in width, while the poor males only reach 67cm wide. The best place to see dozens of these rays is Stingray City in the Cayman Islands.

Hemitrygon – Small Whiprays

These small to medium-size stingrays have the classic diamond shape, a medium-length whip-like tail and some have dermal denticles on the body and tail, while others do not. There are ten members of this genus that are found in the central Indo-Pacific and northwest Pacific in tropical to temperate waters.

Red stingray. The red stingray (*Hemitrygon akajei*) is probably the easiest member of this group for divers to see. Found off Japan, Korea and China, the red stingray does have a reddish-brown colour that can continue onto the ventral surface. Growing to a width of 66cm, this species is captured for food so is listed as "near threatened." Occasionally seen by divers in Japan, large numbers of these usually shy stingrays gather at a shark feed called the Shark Scramble, off Tateyama, Chiba.

Hypanus – Thorny Back Rays

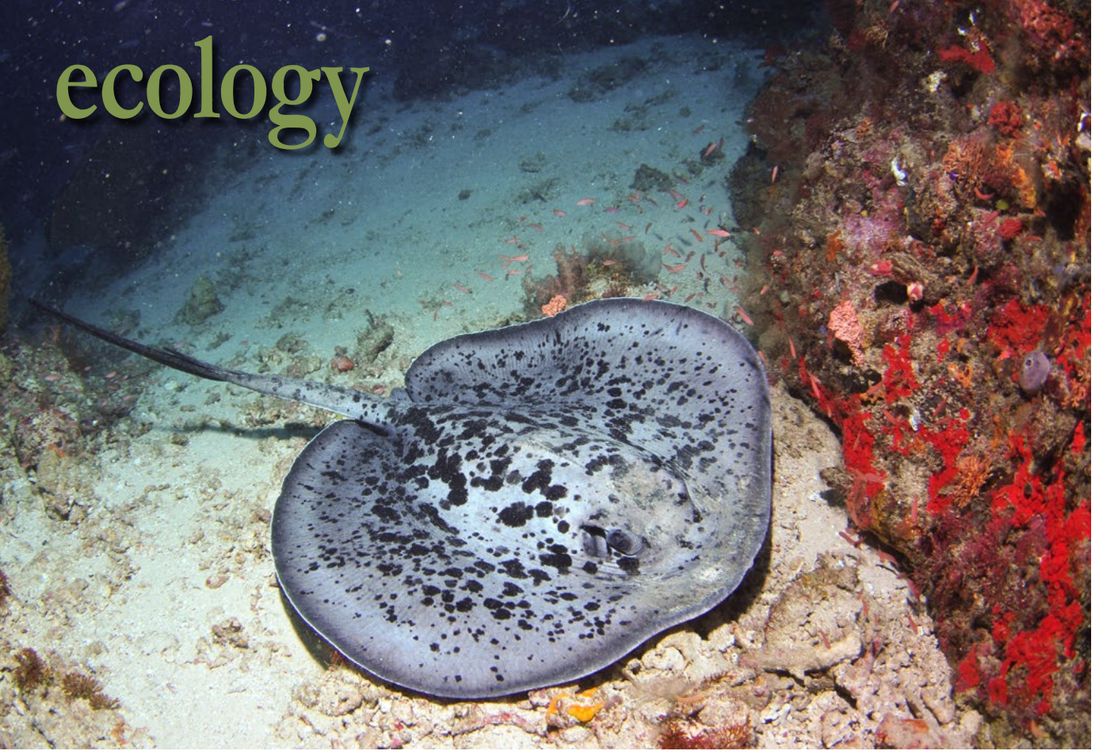
The stingrays in this family all have a row of thorny dermal denticles along their back, and a medium-size whip-like tail. The genus contains eight members that are only found in the warmer waters of the eastern Pacific and western Atlantic.

Taeniurops – Fantail Rays

The fantail rays typically have a round disc and a short tail with a long skin fold.

Blotched fantail ray. The most common member of this genus, which only contains two species, is the blotched fantail ray (*Taeniura meyeni*). This wide-ranging tropical and subtropical species is found throughout the Indo-Pacific region. This species has many common names, such as the marble stingray, black-blotched ray and black-spotted stingray.

ANDY MURCH



Stingrays

A juvenile bluespotted ribbontail ray found on a night dive off Uepi in the Solomon Islands (left). Baby and juvenile stingrays are rarely seen, as they hide from predators; Blotched fantail rays vary in colour from black to grey with blotches (far left); This round fantail ray shows off a typical feature of this genus, a round disc (center). This one was photographed in the Canary Islands.

The blotched fantail ray varies greatly in colour from black, to black with white or grey blotches and even grey with black blotches. This species grows to 1.8m in width and while it spends most of its time on the bottom, they also like to hover in midwater when a current is running. Blotched fantail rays can be seen almost everywhere, but they are particularly common in Australia. While you will run into the occasional one on the Great Barrier Reef or Ningaloo Reef, they are most abundant in subtropical waters, with large numbers seen off southern Queensland and northern New South Wales.

Round fantail ray. The only other member in this genus is the round fantail ray (*Taeniura grabata*). Found in the warmer waters of the eastern Atlantic, this species grows to 1m in width and is typically a brownish colour with darker spots and blotches. The round fantail ray is most commonly seen by divers around the Canary Islands. These two stingrays were some of the few that did not get a name change in the recent review, but two

members of this genus were removed to form the next genus, *Taeniura*.

Taeniura – Ribbontail Rays

The two members of this genus were removed from *Taeniurops* as phylogenetic research showed they were not related, even though they have a similar fan-like tail, but an oval-shaped disc.

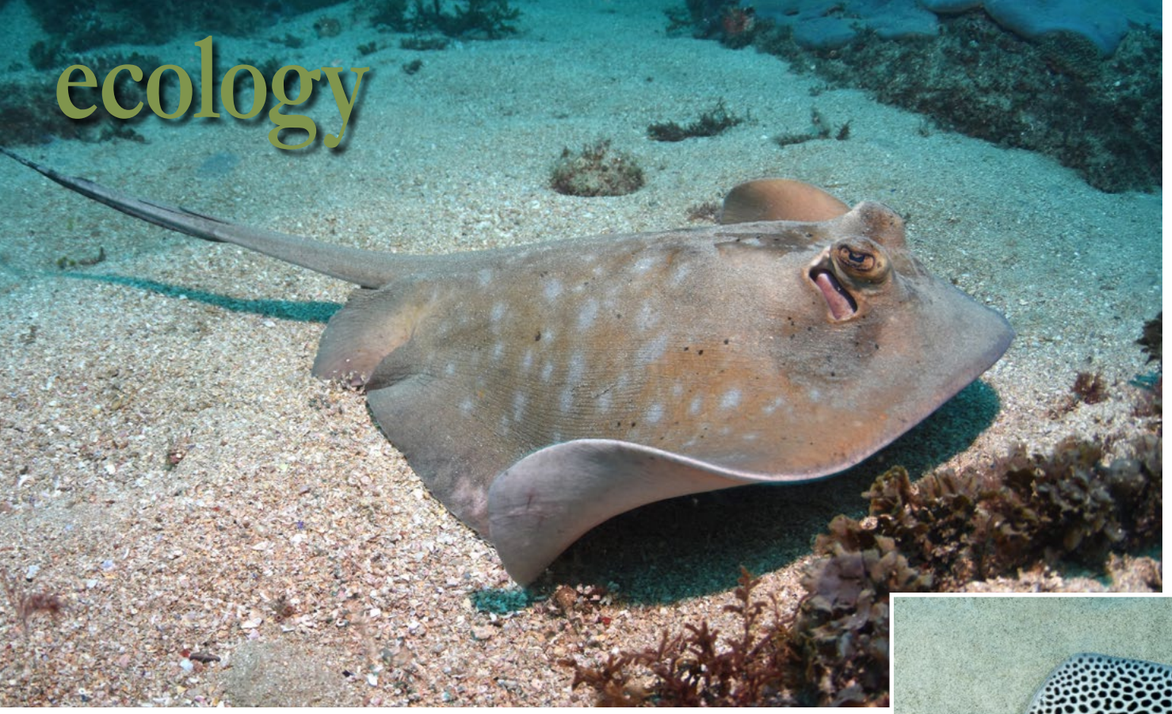
Bluespotted ribbontail ray. The most common member of this family seen by divers is the bluespotted ribbontail ray (*Taeniura lymma*). Found in tropical waters throughout the Indo-West Pacific, this species is one of the easiest to identify when exploring coral reefs, due to its oval shape and bright blue spots. This small stingray only reaches a width of 30cm, and they tend to hide under plate corals and holes in the reef more often than bury in the sand. Divers can see this species anywhere across its range, from the Red Sea to the Solomon Islands. There are several other small bluespotted stingray species, but it is easy to identify which is which as these other stingrays have a kite shape, less vivid spots and a dark mask across the eyes, which has led to them being called maskrays.

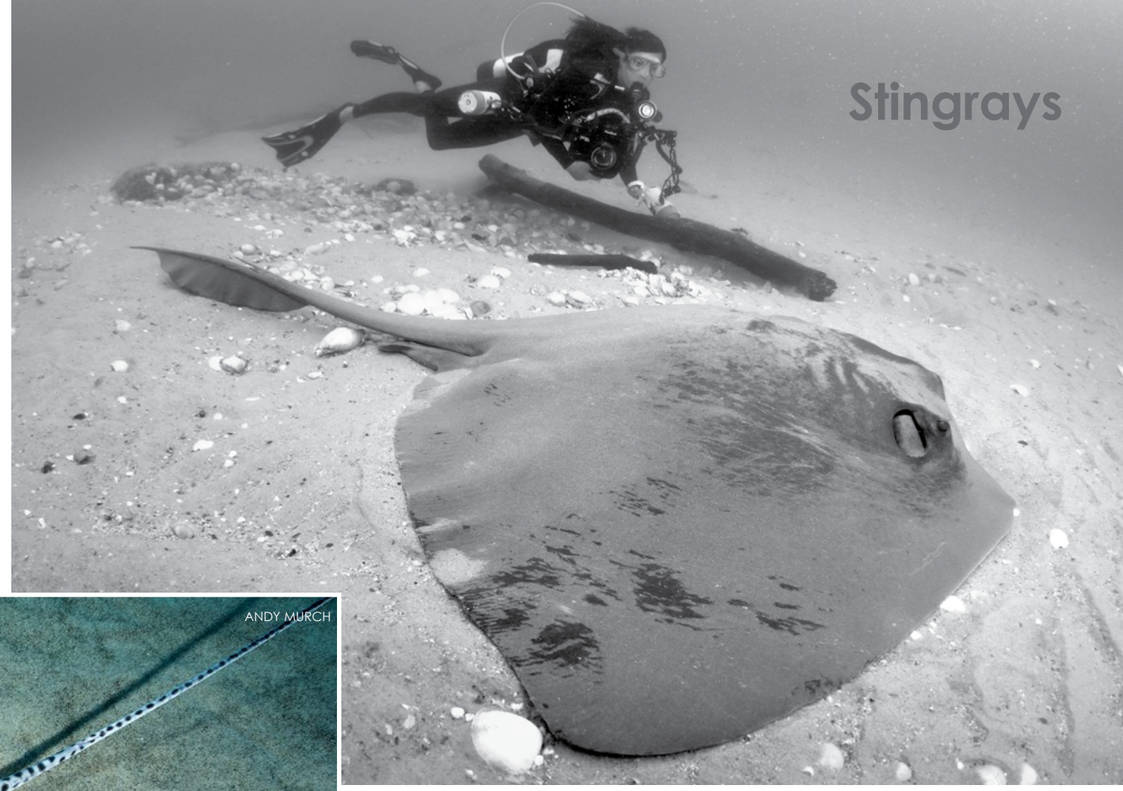
Neotrygon – Maskrays

One of the biggest shake-ups in the stingray family happened to the maskrays. These small stingrays got their own genus and what was once thought to be one wide-ranging bluespotted maskray, is now known to be eight different regional species. The maskray genus now contains 16 species that are found throughout the Indo-Pacific region. These stingrays are small, with a short tail and a distinctive dark mask colouration across the eyes. While species with blue spots are the best-known members of this family, others have black spots and some rarer ones have pretty mosaic patterns.

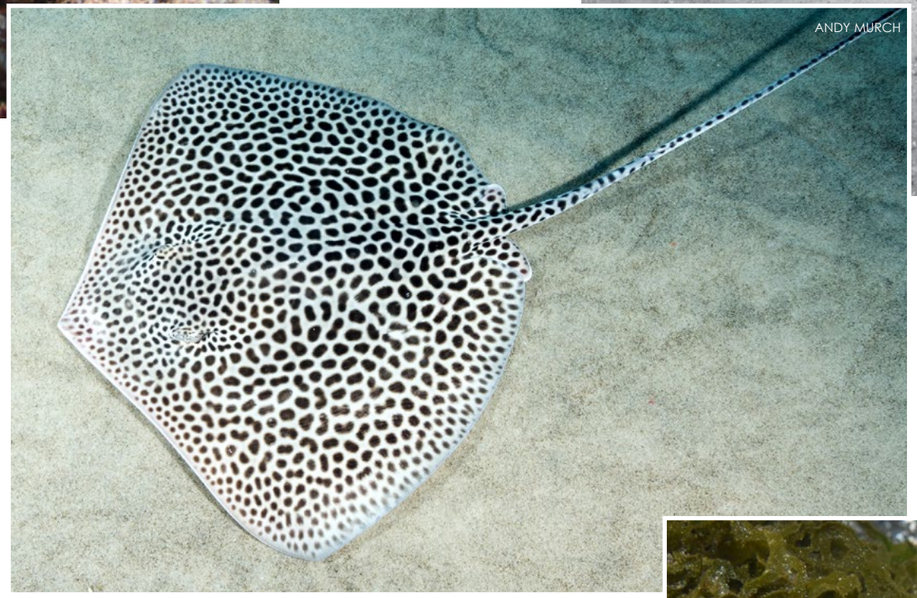
Oriental bluespotted maskray. Divers exploring the reefs and muck sites of Southeast Asia often come across the oriental bluespotted maskray (*Neotrygon orientale*). This small ray naturally has blue spots and was one of the rays commonly called the bluespotted maskray.

Coral Sea maskray. A far more common member of this genus that also has blue spots is found off the eastern coast of Australia and is now called the Coral Sea maskray (*Neotrygon trigonoides*). This is one of three maskrays with blue spots found in Australian waters, but this is the most abundant species, especially off southern Queensland and northern New South Wales. One of the best places to see this species is Julian Rocks off Byron Bay, and while several are always seen on a dive, sometimes over the summer months, thousands gather





The Coral Sea maskray is a common species off eastern Australia, with this one photographed at the Gold Coast (left); A diver gets close to a broad cowtail stingray off Brisbane, Australia (right); The beautifully patterned reticulated whipray is found throughout the Indo-West Pacific, with this one photographed off the Arabian Peninsula (below); The oriental bluespotted maskray is often seen at muck sites in Southeast Asia, with this one photographed off Lembeh, Indonesia (bottom right).



ANDY MURCH

in the sandy gutters at this site for some unknown reason.

Patinachus – Cowtail Rays

Until recently, there was only thought to be one wide-ranging cowtail stingray species found across the Indo-Pacific region, but the research found there are five regional species with the distinctive long skin fold at the end of the tail.

Cowtail stingray. The original cowtail stingray (*Pastinachus sephen*) is not as wide-ranging as originally thought and is only found in the northwestern Indian Ocean area.

Broad cowtail stingray. The most abundant and widespread member of this genus is the broad cowtail stingray (*Pastinachus ater*). One of the newly described species, this large ray grows to 1.8m wide and is found in tropical and subtropical waters throughout the Indo-West Pacific. Targeted by fishers for its flesh and skin, this species is listed as "near threatened," so is not as common as it once was. The only area that I have found this species to be common is off southern Queensland, Australia.

Himantura – Patterned Whiprays

Many more stingray species were once found in this genus, but the shake-up created six additional genera from the members of this group, leaving only four species in *Himantura*. The patterned whiprays have a very long whip-like tail and are the prettiest of all the stingrays, with their beautifully patterned skin. These rays are only found in the tropical and subtropical waters of the Indo-West Pacific.

Reticulated whipray. The reticulated whipray (*Himantura uarnak*) is the most wide-ranging member of this genus, found throughout the Indo-West Pacific, but not in Australia. These pretty rays can grow to 2m in width and have a spectacular skin pattern of reticulations and sometimes leopard-like spots. Encounters with this ray are rare.

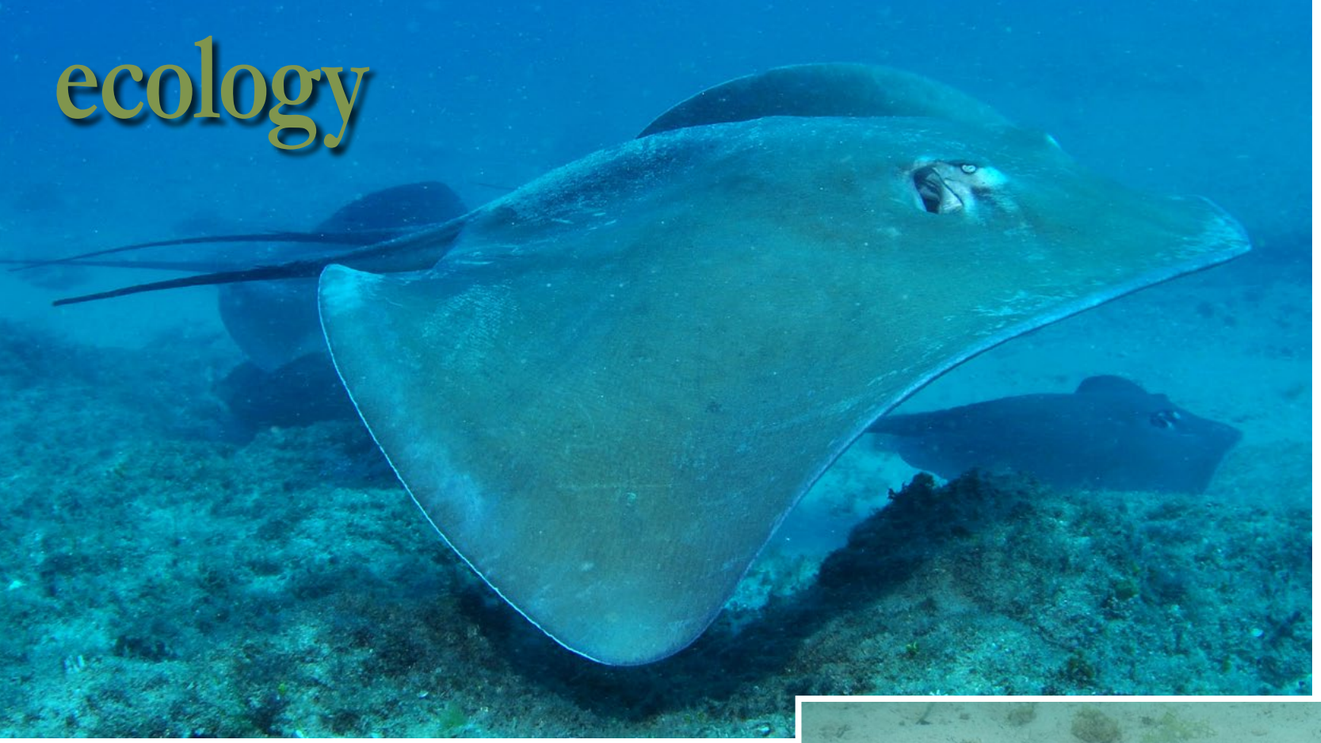
Australian whipray. The reticulated whipray was also thought to be found in Australia until the recent review, when it was discovered that the Australian whipray (*Himantura australis*) is a separate species. These two stingrays look almost identical, so locality is the best way to tell them apart. Divers have a better chance of seeing this pretty ray, especially off southern Queensland. Groups of Australian whipray are sometimes found at dive sites off Rainbow Beach, Brisbane and the Gold Coast.

Leopard whipray & honeycomb whipray. The confusing thing about this genus is that the reticulated and Australian whiprays can have leopard-like skin patterns, and the two other members of the group, the leopard whipray (*Himantura leoparda*) and the honeycomb whipray (*Himantura undulata*) also have a leopard-like skin patterns but are less commonly seen by divers.

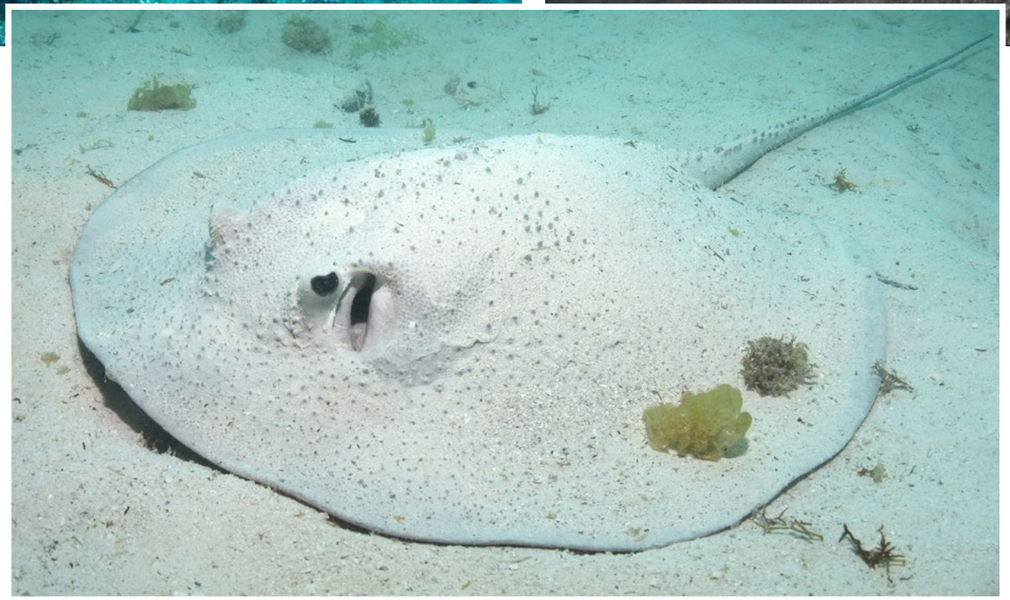
Pateobatis – Plain Whiprays

This is one of the groups that split from *Himantura*, they also have long whip-like tails, but have very plain colouration.

Pink whipray. This genus contains five species found in the Indo-Pacific region, with the most widespread and abundant species being the pink whipray (*Pateobatis fai*). Although called the pink whipray, this species



A fever of pink whiprays at Manta Bommie off Brisbane, Australia (above); The strangest member of the stingray family is the spine-less porcupine stingray (right). These rare rays are best seen in Australia, with this one found at Heron Island on the Great Barrier Reef.



The Jenkins whipray is best identified by the row of spines along its back (above). This one was found sheltering under a shipwreck off the Perhentian Islands, Malaysia.

is generally a brownish-grey colour and can reach a width of 1.8m. A very social stingray, pink stingrays are often seen in a fever (a group of rays) that can number from five to fifty. These rays also like to hang around other larger stingrays, and have been seen riding the backs of blotched fantail rays. The Maldives is a good place to see pink whiprays, and they are seen in large numbers at a shark/ray feed at Alimatha Faru. They are also common off southern Queensland, Australia, with large groups of them seen at Manta Bommie off Brisbane.

Jenkins whipray. The very similar looking Jenkins whipray (*Pateobatis jenkinsii*) is found over an almost similar range to the pink whipray, but is less commonly seen by divers. It may look similar, but the easiest way to tell them apart is by the row of short spines along the back of the Jenkins whipray. One of the best places to see this stingray is the Perhentian Islands off Malaysia.

Urogymnus – Prickly Whiprays

This genus was thought to contain only one species, the very strange porcupine stingray, but the recent review has found that several more species, once placed in *Himantura*, belong in this group. The genus now contains six species, all have a round disk, a long whip-like tail and dermal denticles on their backs and tail.

Giant freshwater whipray. A few of the prickly whiprays live in mangroves and rivers, including the famous giant freshwater whipray (*Urogymnus polylepis*) of Southeast Asia.

Porcupine stingray. The best-known member of this genus is the porcupine stingray (*Urogymnus asperrimus*), which is quite rare, but occasionally seen by divers in the tropical waters of the Indo-West Pacific. This strange ray is covered in short spines, hence the name, and is the only member of the stingray family to lack a tail spine. The porcupine stingray can reach a width of 1.2m and is listed as "vulnerable." Australia is one of the best places to see this weird ray, with occasional sightings on the Great Barrier Reef and Ningaloo Reef.

Mangrove whipray. The only other member of this genus seen by divers is the mangrove whipray (*Urogymnus granulatus*). Found on reefs and in mangroves, this ray is easily identified by its long white-coloured tail. Found throughout the tropical Indo-West Pacific, the mangrove whipray reaches a width of 1.4m. This is another ray that is best seen in Australia, on the inner islands and reefs of the Great Barrier Reef.

Other species

There are many other genera in the stingray family that I have not included in this article, as they are rarely seen by divers, either living in rivers and mangroves or having a pelagic lifestyle.

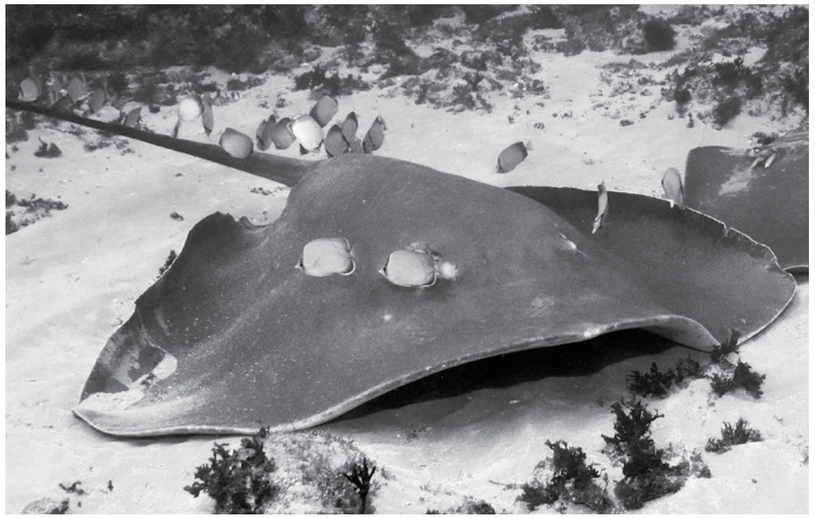
Sorting out the stingrays must have been a mammoth task for the scientists who did the research work, and there is sure to be more changes in the future in this complex and diverse family of rays.

If you would like to know more about stingrays and other rays, I have started a Facebook group called the Ray Photography Group, so people can share photos, videos and their knowledge of this very interesting group of marine creatures.

Biology and behaviour

Stingrays, like all the rays, are very closely related to their cousins, the sharks, and share many similar body features. The main difference between the two is that rays have their pectoral fins fused with their head and also have their gills

Like many stingray species, round fantail rays like to rest in caves (right); A rarely seen sight, a pink whipray being cleaned by a group of butterflyfish (below); When heavily pregnant blotched fantail rays get large bulges on their backs (center); The mangrove whipray is rarely seen by divers (bottom left). This one has lost its distinctive white whiptail and was photographed off the United Arab Emirates.



on their ventral surface (the underside of the body). Stingrays differ from other closely related members of the ray family by their longer tails, which lack dorsal, anal and caudal fins, but can have skin folds. Most stingrays are quite large, over one metre in width, but their disc can vary greatly in shape—from round to diamond-like to even oval. They also have small pelvic fins, and many have rough spines, dermal denticles or tubercles, on their tail or back. All stingrays have a tail spine (except for the porcupine stingray) for defence, which regrows when lost.

As most stingrays like to hide under a layer of sand, they have modified their breathing to suit this behaviour. While they can breathe in through their mouth and out through their gills to extract oxygen, they have developed large respiratory openings behind the eyes called spiracles to intake water. These spiracles allow them to breathe normally for extended periods when buried in the sand, without ingesting sand. Sharks also have spiracles, but they are very small in most species, apart from a few bottom-dwelling sharks.

Like sharks, stingrays have an acute array of sensors that help them detect prey. As most of their prey lies buried in the sand, where they cannot be seen by rays, they rely on other sensors to locate prey. To find buried prey, stingrays use a combination of smell and special electrical sensors on their snouts called the ampullae of Lorenzini, which detect weak electrical signals given off by animals. The rays then use their mouths to dig into the sand to grab their food, which can be fish, worms, crustaceans or molluscs. Many stingrays feed by day, others only

feed at night, but some feed at any time, driven more by the tides, especially if they feed on mudflats.

Mating and reproduction

Stingrays are typically solitary animals, only coming together to mate, or when feeding. But a few species are quite social, forming small groups, called a fever. Little is known about the dynamics of these groups; are they together for company, for ease of finding a mate, for defence in numbers or simply because there is abundant food in the area? Some gather into large aggregations when breeding, others get together for no apparent reason at all.

Romance and mating between stingrays is rarely witnessed. Premating rituals are poorly understood, but generally entail the male, or several males, following a female to see if she is in season, and then biting and shoving the female (if she is smaller, but in many cases, the female is larger than the males). When mating, the male typically bites the female on the edge of her disc, then either twists around her, or lies belly-to-belly to insert one of his two claspers into her cloaca. The claspers are penis-like organs, formed from modified pelvic fins, that deliver sperm into the female. Pregnant females are often seen with large swellings in their back.

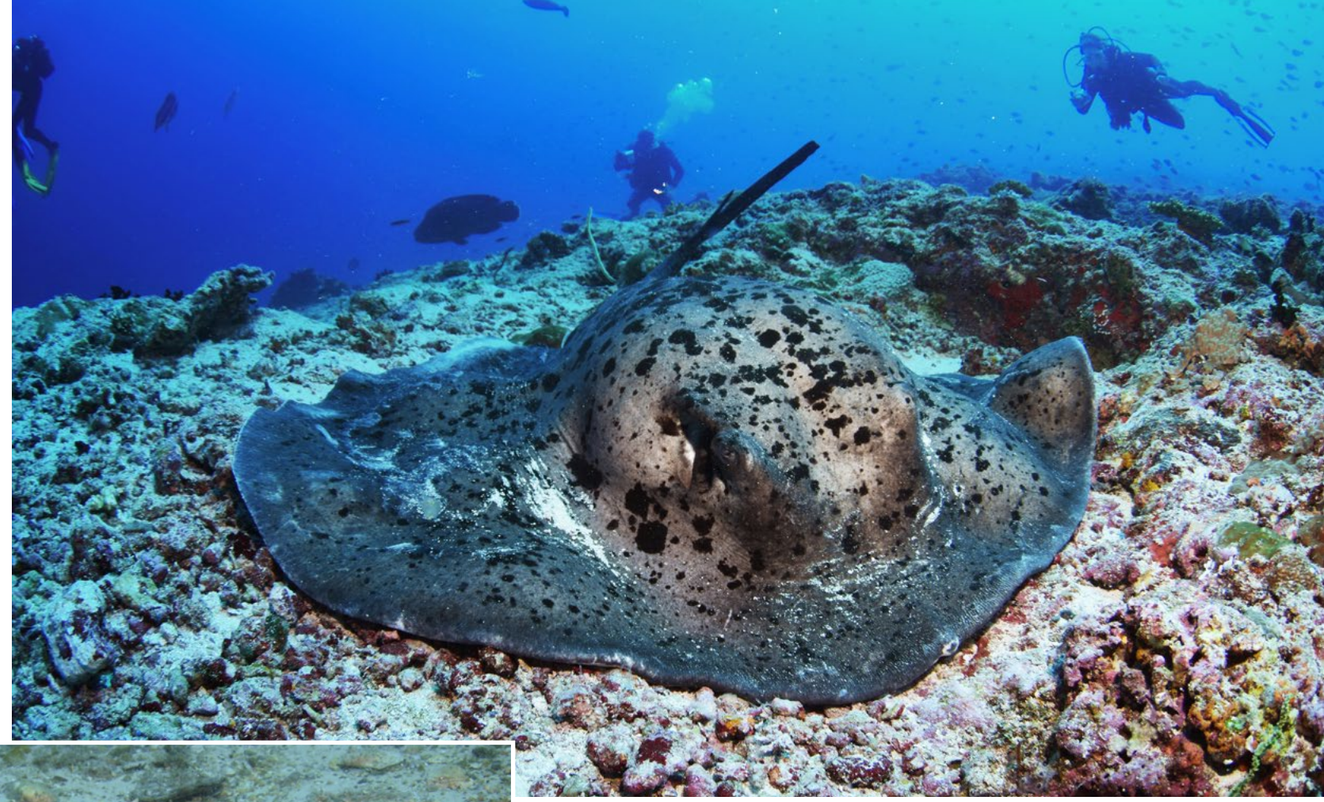
Stingrays give birth to live young, with litters varying in number from two to six after a gestation period of up to 12 months. Young rays are rarely seen, because they either hide in deep water, mangroves, estuaries or rivers. The only juvenile stingrays I have seen are bluespotted ribbontail rays at night on a reef at Uepi in the Solomon Islands, with the small rays emerging from hiding spots amongst the coral.

Cleaning stations

Stingrays spend much of their time either resting or feeding, but many regularly visit cleaning stations to get rid of parasites, old skin and other blemishes. Over 50 species of fish are known to provide cleaning services, but most stingrays utilise the services of the widespread common cleaner wrasse (*Labroides dimidiatus*). These tiny wrasse pick over the skin of the stingray, and even enter the mouth and gills. But I have also witnessed a group of Guenther's butterflyfish (*Chaetodon guentheri*) picking over the skin of a pink whipray off Brisbane, Australia.

Defense against predators

The main predators of stingrays, apart from humans, are sharks and orca. To avoid being eaten, stingrays hide under a layer of sand or rest in caves, shipwrecks or under ledges. But when these evasive measures fail, stingrays use their tail spines for defence. They use the spine like a dagger, bringing the tail over their head



Pink whiprays at a shark/ray feed at Alimatha Faru in the Maldives (above); The business end of a blotched fantail ray, its lethal tail spine (right)

To get close to stingrays, like this blotched fantail ray in the Maldives, it is best to approach the ray from the side (above).

to either stab or slash at the attacker. The spine is serrated, covered in venom-secreting tissue and has two longitudinal grooves, which enclose venom-secreting cells. The spine is designed to break off in the attacker and cause infections.

Large stingrays have spines up to 20cm long, but even this does not deter some attackers, with some great hammerheads (*Sphyrna mokarran*) found with dozens of stingray spines stuck in their heads. Stingrays pose little threat to divers and snorkellers, with fishers and people wading in shallow water being the most likely ones to get jabbed. If ever jabbed by stingray, even if it is minor, seek immediate medical attention to get the wound properly cleaned to avoid infection.

Diving with stingrays

While the general public have the perception that stingrays are dangerous, especially after the death of Australian zookeeper and wildlife expert Steve Irwin, stingrays are in fact docile animals that have a tail spine for defence only. Very few divers or snorkellers have been stabbed by stingrays, as they would rather flee than fight; but if cornered or grabbed, they will lash out.

Over the years, I have encountered thousands of stingrays, and I have only ever had two raise their tail at me in a threat display. Both were smooth stingrays, and both encounters are worth looking at.

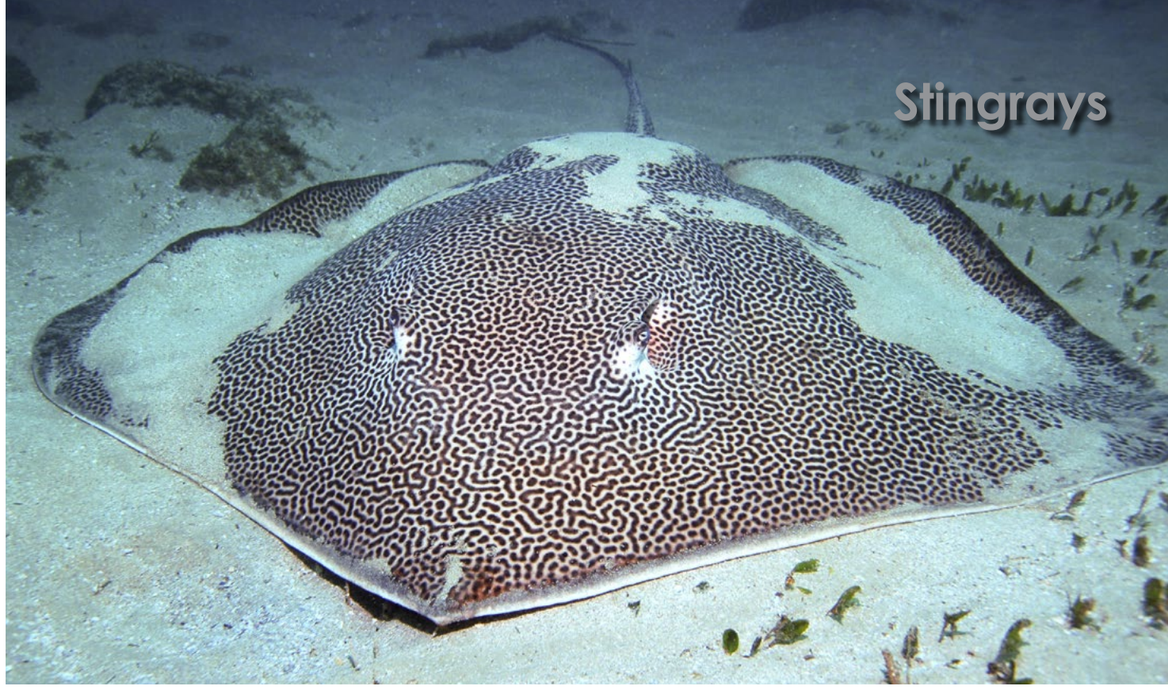
In the first case, my buddy and I were diving off Jervis Bay, south of Sydney, through a series of interconnected caves off Point Perpendicular. In one of the caves, we found a large smooth stingray resting on the bottom. Having encountered dozens of these large rays before, I thought it would not be an issue swimming over the ray to exit the cave. The ray was okay at first, but as I got closer to the exit, the ray felt trapped and raised its tail at me, warning me to back off. I quickly did, and my buddy and I decided to find another exit from the cave. Lesson learnt—do not corner a stingray or block its exit.

Snorkelling off Sydney, I encountered a pair of smooth stingrays in a rocky gutter at Little Bay. One of the rays was huge, 2m across, but the other one was only half this size. I watched them from the surface as the small ray swam around the large resting stingray.

After observing them for several minutes, I realised that the large one was a female and the smaller one an amorous male. I then dived down to get some photos, thinking I might witness the rays mating. But as I swam towards the female, she suddenly lifted her tail over her head and pointed her spine at me, warning me to stay away. I took note and headed back to the surface, but only minutes later saw her also do the same thing to the small male, telling him to back off. This was very interesting behaviour to see her warning both me and the horny male. I am still not sure if she thought I was another male stingray, or if she was just sick of being harassed. Another lesson learnt—do not intrude on stingray romance.

At stingray feeds, the tail spine is not an issue, as the rays do not feel threatened; it is the mouth you have to worry about. Stingrays have small plate-like teeth that are designed to assist them grub in the sand for a variety of prey. However, as they need to crush the shells of some prey, their jaws are quite powerful. I have never been bitten at a stingray feed in the wild but I have been bitten in an aquarium when photographing feeding time.

The head diver warned me that the sharks and fish were not an issue, but to watch out for the stingrays, and to keep my hands well away from their mouth. This ended up being easier said than done as the stingrays, a gang of blotched fantail rays, were all over us. This made it very hard to get photos, as I had to constantly push and bump the stingrays away to avoid being knocked over. The rays were constantly searching



The Australian whipray is a recently described species that is only found in Australia (above). This one was photographed at Cook Island, Tweed Heads; Broad cowtail stingrays like to hide under a layer of sand, but are always ready to explode off the bottom when a diver gets too close (left).

for our hands, knowing that this was the source of food, and eventually one latched onto my hand and BAM! It felt like my fingers had been hit by a hammer! Another lesson learnt—keep fingers away from a stingray's mouth.

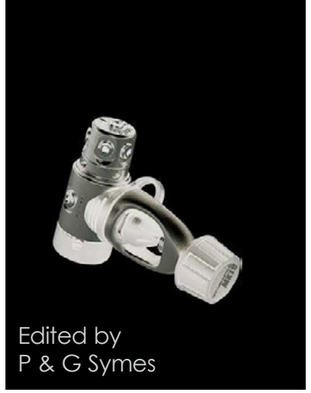
Underwater photography tips

Getting close to stingrays underwater can be tricky, as most species are preyed upon by sharks, so are wary of large creatures heading towards them. Stingrays that regularly encounter divers at popular dive sites are often easy to get close to, as they are unperturbed by the close presence of a diver. However, most stingrays are shy, and take flight when a diver approaches.

To get close to a stingray, the best approach is to come in slowly from the side, and not charge in head first with a camera raised like a weapon. A trick I often use is to angle my body like I am swimming away from the ray, but then shuffle sideways towards the animal, which is not an easy manoeuvre, especially into a current. It is also good to slow your breathing, and not look directly at the ray, instead face away and look at it from the corner of your eye.

Some stingrays will allow you to get right up beside them, while others will take off the second they see you. The less threatening you appear, the better the encounter, and generally the fewer divers, the better. Stingray encounters are the highlight of many diving adventures. ■

Nigel Marsh is an Australian underwater photographer and photojournalist whose work has been published in numerous magazines, newspapers and books, both in Australia and overseas. Over the last 37 years, he has dived extensively around Australia and also throughout Asia, Pacific Ocean, Indian Ocean and Caribbean. He has also produced a number of diving-related books, including two dive guidebooks with Neville Coleman: Dive Sites of the Great Barrier Reef and the Coral Sea *(New Holland, 1996) and* Diving Australia *(Periplus Editions, 1997). His self-published book,* HMAS Brisbane Queensland Coral Warship *(Nigel Marsh Photography, 2011), is a photographic exploration of one of Australia's most popular dive sites. Recently, he has produced a series of children's books on marine-related subjects* (A to Z of Sharks & Rays, Exploring Shipwrecks, Crabs & Crustaceans, Weird & Wacky Fish) *and a series of dive guides* (Underwater Australia, Muck Diving, Coral Wonderland, Diving with Sharks) *for New Holland Publishers. Please visit:* ***nigelmarshphotography.com***.



Edited by
P & G Symes

POINT & CLICK ON BOLD LINKS

Equipment

Shearwater warranty extended

To support the dive community during these difficult times, Shearwater Research has extended its product warranty to 1 January 2023 for any new Teric, Perdix, Perdix AI, Petrel 2 or Nerd 2 bought in 2020. No need to register, just keep your receipt. **Shearwater.com**

Waterproof BODY X and 2X

Inspired by polar bear fur, these undergarments are made of a newly developed, highly functional, moisture wicking, pill-resistant brushed fleece material—a hollow fiber polyester, whose insulating, hollow structure is filled with air, keeping you warm and dry, without increasing weight. Modular in design, the two-piece, pee-hose prepared fleece underwear with flatlock seams, extended tail, thumb loops, foot straps and power stretch for freedom of movement, can be mixed and matched, so you can combine the tops and bottoms for the best fit. Available in men's and women's sizes from 3XS to 3XL. Comes in plastic-free packaging. **Waterproof.eu**

Dive Rite's 901 Series drysuit

With a core of 100% butyl rubber set between two polyester layers, the suit's Parmasoft Active trilaminate is about 30% lighter but still tests strong against CE standards. The suit's hidden seams, which are strengthened with seal tape for both waterproofness and wear, use an innovative glue-and-stitch process so there are no visible stitches. The high quality YKK Aquaseal front entry zipper has a protective outer sheath with zipper. A telescoping torso, with integrated crotch strap, makes it easy to don. Choose either latex seals or the Si Tech ring system, with user-replaceable silicone seals. Other features include a SiTech swivel inlet valve and adjustable, automatic exhaust valve, for fine-tuning suit volume (31-inch low-pressure inflator hose included); large storage pockets on both thighs, with inside webbing loop for cord attachment, an internal sleeve for wet notes and a closure flap with a small zipper compartment; and durable, low-profile, attached neoprene boots with rubber sole and coated toe, which fit most fins. Deluxe 5mm hood and 35L Ortlieb dry bag included. Available in XS to XXL sizes, each with short and tall versions. Custom sizes can be ordered. **DiveRite.com**

Dive manufacturers step up

As COVID-19 sweeps the globe, dive equipment and drysuit manufacturers are stepping up to help produce protective gear and medical ventilators for hospitals.

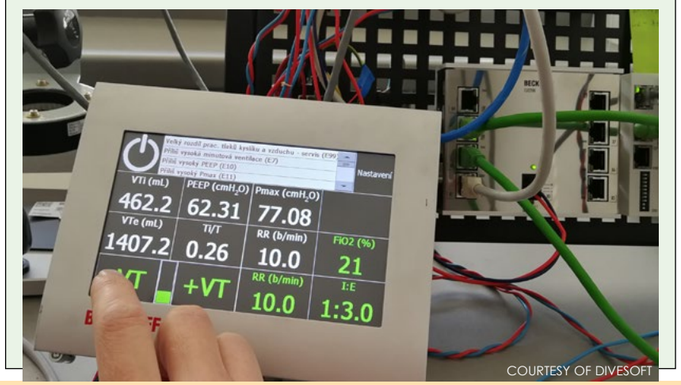
COURTESY OF SANTI DIVING

Santi & Seacraft

Drysuit manufacturer Santi has designed, produced and donated hazmat suits for testing in local hospitals in Poland, and has teamed up with underwater scooter manufacturer Seacraft to design, produce and donate protective visors for healthcare professionals. They estimate a weekly production run of 40 to 50 pieces. In addition, Santi has dedicated part of its production capacity to sew two types of protective masks. So far, nearly 4,000 masks have been produced and donated to regional hospitals.

Divesoft

Rebreather manufacturer Divesoft has donated time and expertise in the development of medical ventilators for treating patients with COVID-19, as part of a team of programmers, scientists and technicians in the Czech Republic, aiming to deliver 500 ventilators by April, at a fraction of the cost of a typical ventilator. Learning from issues raised in Italy and China, the design features easy-to-manufacture and generally available parts, a user-friendly interface (minimizing training time), simple assembly, the ability to run on oxygen tanks and compressed air, and compatibility with existing hospital systems. Once the design passes testing, it will be made available worldwide to aid others in need. ■



COURTESY OF DIVESOFT

Going Pro

Part I: To Divemaster & Beyond

Text by Simon Pridmore
Photos by Brandi Mueller

— The Scuba Confidential column in this issue is adapted from a chapter in Simon Pridmore's book Scuba Professional: Insights into Sport Diver Training & Operations.

A thought that crosses the mind of many divers at some point in their diving lives is: "Do I have what it takes to be a full-time dive professional—or even just start a scuba side hustle?" The enticing concept that if you are a keen diver, you can turn your hobby into a career is one that commercial training agencies promote heavily because they make good money from instructor courses.

If you walk into a dive centre with more than a few dives under your belt and say you are thinking of "going pro," nobody will turn you away. There is no assessment process, no enrolment interview, no talent spotting. The fact that you are accepted as a candidate for a dive instructor course does not mean that someone has seen that you have the right attitude, aptitude and personality. You have to decide this yourself and that is why I thought an article on the topic would be useful.

You are not submitting a job application when you say you want to become a dive instructor—you are buying a product. And the agencies are very good at delivering this product. Very few people fail an instructor course. But not many people subsequently succeed in forging a long-term career in scuba diving. Most folk quickly decide that the life of a scuba professional is not for them after all.

So, what are the requirements? What talents and qualities do you need to have a good shot at a full-time or part-time career in diving?

Here is a short summary of what I see as the key factors:

Dive technique
Your personal diving skills need to be excellent and instinctive, so that you can devote 100 percent of your attention to the divers in your charge. But good technique alone does not make you a good dive instructor.

Knowledge
Your diving knowledge should be well beyond the level you are teaching. Simply reading the material the night before the class is not enough. Scuba diving students are not passive drones. Many will be smarter than you and will have informed questions. It is very helpful to have some wider knowledge in related fields also, subjects such as marine biology, human physiology or gas physics.

Experience
You should have experience of a variety of types of diving and diving environments. Your breadth of experience will be more valuable than the number of dives you have done. You will find yourself drawing on this when you need to find a context to illustrate a teaching point.

Vocation
You need to have a teaching vocation. If you have done teacher training, are already a teacher or trainer in another walk of life and like what you are doing, so much the better. As a dive instructor, you will spend most of the time teaching. If you do not get excited at the prospect of passing on the joy of the sport and seeing a diver's eyes light up when they conquer their fears and "get it," then you will not remain a dive instructor for long.

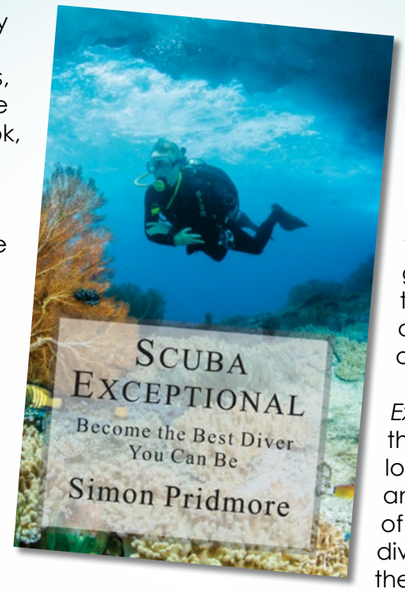
The other reason I place vocation so high on this list is that jobs in scuba diving are not well paid, so you will need to have the same sort of dedication that other professionals like nurses or schoolteachers have, in order to endure long, difficult working hours for little financial reward.

People skills
Dive professionals have to be people persons, as their whole day is spent interacting with people. Many scuba instructors in the early days were not so much people who liked people; they were people who liked ordering other people around. Today, the world of scuba diving is very different. Sympathy and empathy are the key words; if you can develop bonds easily and have the capacity to understand what someone is experiencing from within their frame of reference, you will make a good dive instructor.

An inner calm
Groups of divers are composed of free-thinking, unpredictable, excitable individuals who can disrupt your carefully laid plans in an instant. The limits of a dive instructor's ability to remain calm are tested every day.

Time management skills
It is crucial for a dive instructor to know how to manage time. Whether you are teaching a course or leading a group of divers, you are always limited by time.

A New Book for Scuba Divers!



Scuba Exceptional may be the fifth in Simon Pridmore's *Scuba* series, but it is actually the true follow-up to his first book, the best-selling *Scuba Confidential*.

The philosophy of safer diving through the acquisition of knowledge and skills is the same, although this time the themes are different. As before, Pridmore provides us with a whole host of extremely useful advice and techniques, illustrated by real-life experiences and cautionary tales. The focus this time, though, is more on issues that experienced divers face. There is more technical diving content, and Pridmore covers some relatively complex issues in his usual clear and easy-to-read style. In many cases, the issues that concern technical divers reflect those that affect scuba divers at every level. After all, as Pridmore writes, technical diving is on the same spectrum as conventional sport diving: It is just a different frequency.

Scuba Exceptional also deals in more detail with the psychological approach to scuba diving, broaching familiar topics from new angles and borrowing techniques and procedures from other areas of human activity.

While most of *Scuba Exceptional* focuses on the diver, it also takes a look at the wider picture and highlights a number of areas where scuba diving professionals and the "industry" as a whole are letting divers down. As always, Pridmore is realistic in his assessments. He may shine a little light on the dark side of the scuba diving world, but he does this in order to illuminate bad practices and encourage change, while offering solutions.

Scuba Exceptional: Become the Best Diver You Can Be by Simon Pridmore is available on: **Amazon.com**.

You have to exercise time discipline yourself and ensure that your students and customers do likewise, all without spoiling the fun. It is a tough balance to achieve.

Employability

If you see becoming a dive instructor as an opportunity to leave home and head for an exotic tropical destination, you will find plenty of job vacancies. Dive instructors often burn out or move on. Recognise, however, that you will be competing in an international job market where everyone has your diving qualifications and more. So, you must have other strings to your bow too, in order to find work. The ability to speak a number of languages is very useful, as is a work background as a mechanic or in the hospitality, service or travel industries.

If you plan to stay at home and teach diving part-time as a side hustle, then your success will depend on finding a local dive centre through which to teach and coming up with a hitherto-untapped source of potential scuba diving students, beyond your family and friends. Have a viable business plan before embarking on your instructor course.

Fitness

You need to be physically and mentally fit. Full-time scuba instructors dive between 15 and 30 times a week and work long hours. A lot of that time involves hauling gear and loading and unloading trucks and boats. They are also "on stage" for much of the time, keeping the customers happy and entertained. There is not much downtime and, in high season, very little time off.

The divemaster myth

You will have noticed that, despite having referred to the role of divemaster in the title of this piece, I have mostly discussed becoming a dive instructor. It may be that you want to guide divers, rather than teach them. Unfortunately, although the training agencies refer to divemaster as a professional qualification, in practice, if you hail from a country that likes to think of itself as "first world," it is almost impossible to find a paid job in scuba diving if you are not at least an instructor.

Generally speaking, the only people without instructor qualifications who can find paid work as guides or divemasters are people from countries where economic levels are much lower than in the West. These folk earn extremely low salaries and the main reason they are not instructors is that they cannot afford the course fees, which, everywhere in the world, are set at first-world levels (a shameful aspect of the sport diving industry that will no doubt be the focus of a future article in this series). ■

Simon Pridmore is the author of the international bestsellers Scuba Confidential: An Insider's Guide to Becoming a Better Diver, Scuba Professional: Insights into Sport Diver Training & Operations and Scuba Fundamental: Start Diving the Right Way. He is also the co-author of the Diving & Snorkeling Guide to Bali *and the* Diving & Snorkeling Guide to Raja Ampat & Northeast Indonesia. *His recently published books include* Scuba Exceptional: Become the Best Diver You Can Be, Scuba Physiological: Think You Know All About Scuba Medicine? Think Again! *and the* Dining with Divers *series of cookbooks. For more information, see his website at:* ***SimonPridmore.com***.

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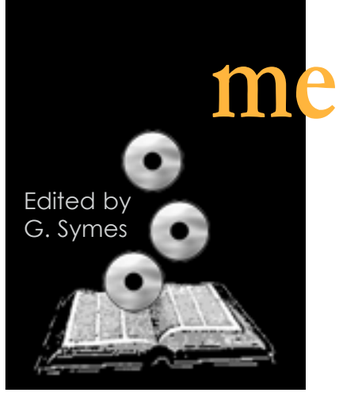

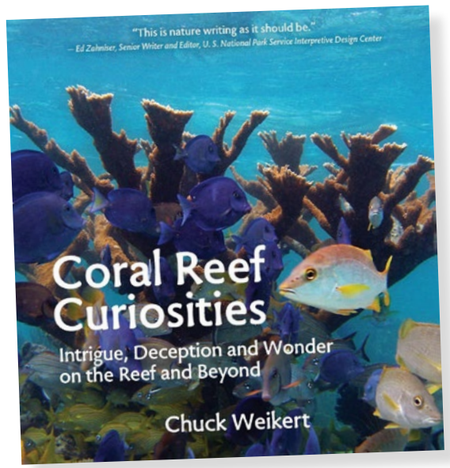

Reef Life

Coral Reef Curiosities: Intrigue, Deception and Wonder on the Reef and Beyond, by Chuck Weikert

In this book, author Chuck Weikert dives into the secret lives of fascinating coral reef creatures such as sharks, sea turtles, octopuses, bumphead parrotfish, barracuda, stingrays, sponges, squids, Spanish dancers and solar-powered sea slugs. In a bid to raise awareness and protection of these beloved critters, this richly illustrated book reveals the diverse ecosystems in which they live as well as their connections to humans, highlighted in art, literature and science. Through 25 chapters, each uncovering the natural and cultural history of a unique creature, readers will learn about scientists and sailors, artists and poets, as well as writers such as Herman Melville and Jack London, who contributed to our knowledge of coral reef biodiversity.

Hardcover: 140 pages
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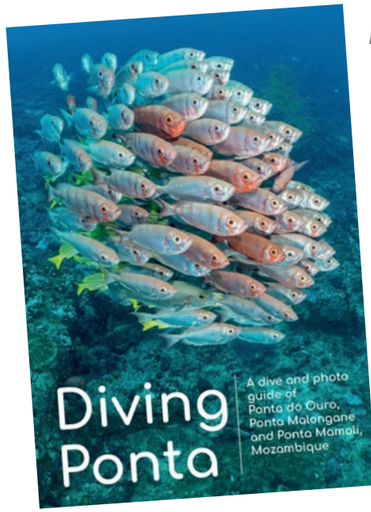

Mozambique

Diving Ponta: A dive and photo guide of Ponta do Ouro, Ponta Malongane and Ponta Mamoli, Mozambique, by Luca Crudeli

This dive guide highlights the rich diversity of marine life found in the waters of Ponta do Ouro in Mozambique, a country which hosts a coral density second only to the Coral Triangle in Southeast Asia. The book includes a detailed overview of the reefs and marine life in Southern Mozambique, how to set up one's camera to photograph the incredible marine biodiversity found in this area as well as information about Ponta dive operators. There is something for every diver, of any skill level, from beginning recreational to advanced technical, at Ponta do Ouro, which translated, means the "Point of Gold." Underwater photographers will find an impressive range of marine species to capture in macro and wide-angle photography at the numerous dives sites in the Partial Marine Reserve coverd by this guide, which stretch from Ponta do Ouro, Ponta Malongane, Ponta Mamoli and beyond.

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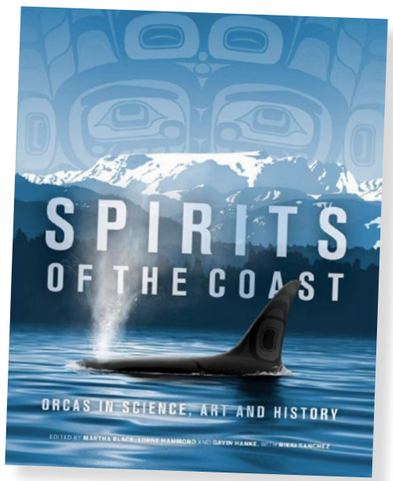

Orcas

Spirits of the Coast: Orcas in science, art and history, by Martha Black, Lorne Hammond, Gavin Hanke and Jack Lohman

An apex predator of the oceans, the orca is a powerful symbol of British Columbia's wild Canadian coast. This book explores the orca's plight, history and potential, offering a literary and visual insight into the magic, myths and ecology of the species from marine biologists, Indigenous peoples, artists, poets and storytellers. As social beings, orcas have a culture and language of their own and are honored and respected by Indigenous cultures, who see orcas as friends, family or benefactors, in contrast to Western cultures, which have long feared the orcas as "killer whales." With diverse perspectives from contributors such as Briony Penn, David Suzuki, Gary Geddes and Michael Nicoll Yahgulanaas, learn how these enigmatic creatures have influenced humans and how humanity's actions have impacted them.

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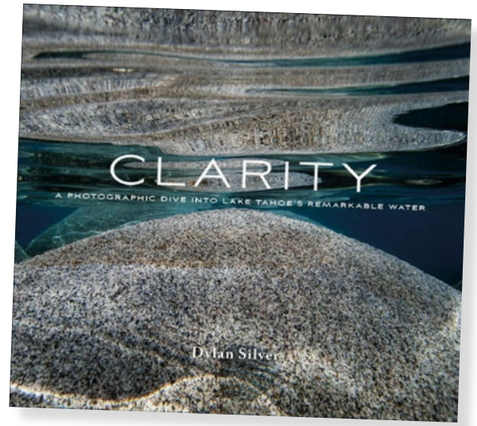

Underwater Photography

Clarity: A Photographic Dive into Lake Tahoe's Remarkable Water, by Dylan Silver

This book, the first to feature underwater photography of America's most famous lake, captures the bizarre and fluid forms of Lake Tahoe's crystal-clear waters. In a call to help preserve this cherished body of water, over 180 images celebrate the breath-taking submarine scenery of this 191 squ mi lake located on the California-Nevada state line. Like a splash into liquid glass, Dylan Silver's images reveal the lake's brilliant colors, teal shadows, rounded boulders and quiet depths in surreal still-lifes and swirling compositions.

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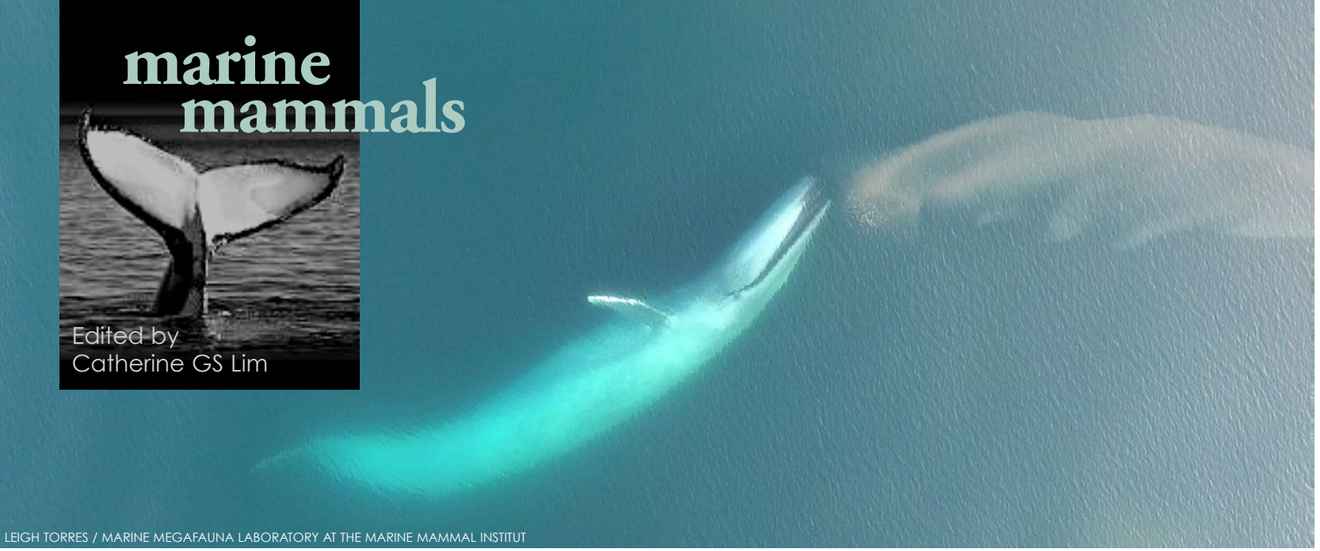


LEIGH TORRES / MARINE MEGAFAUNA LABORATORY AT THE MARINE MAMMAL INSTITUT

A blue whale begins eating a large krill patch. The krill nearest the whale's mouth are beginning to jump as they recognize the predator approaching.

Surface feeding important for blue whales

The blue whales in New Zealand waters have been feeding at the ocean surface as a way to optimise their energy use.

When blue whales feed on krill, a lot of energy gets used up in the process of diving, holding their breath and opening their mouth as they plunge into the swarm of krill. And, considering how the massive size of these whales compares to that of krill, these large whales definitely need to consume a lot of krill.

"People think about whales having to dive deep to get to the densest prey patches, but if they can find their prey in shallow waters, it's actually more energetically profitable to feed near the surface," said Leigh Torres, an assistant professor and director of the Geospatial Ecology of Marine Megafauna Laboratory at Oregon State University's Marine Mammal Institute.

And that is precisely what the blue whales in New Zealand waters have been doing.

These blue whales were found to forage more in areas where krill was dense and shallow. Torres elaborated, "Their dives were relatively short, and they were feeding more at the surface, which requires less energy."

Torres is one of the authors of a paper published in the journal *PeerJ*, which described the surface feeding behaviour of blue whales in New Zealand.

Observation by drone

Although tags attached to whales can give a glimpse into whale behaviour and diving patterns, surface feeding has not been well understood. This is partly because it is difficult to analyse tag data and quantify the size of the prey patches at the ocean surface.

In February 2017, Torres and her team observed blue whales off the coast of New Zealand, and used a drone to film surface feeding on the krill patches.

They noticed that the density of krill patches was greater near the ocean surface. In addition, the overall dive times of the whales were shorter than that of other blue whale populations (like that off the Californian coast).

On average, the New Zealand population clocked about 2.5 minutes, while other populations clocked about 10 minutes. In fact, when the New Zealand whales foraged, their time dropped to 1.75 minutes.

The drone footage captured four encounters between a blue whale and surface prey patches, providing an insight into the decision-making processes of the whale in response to the size and orientation of the prey patches. For instance, it showed how the whale used its right eye to target the prey and showed the whale's decision to rotate from one side to the other to better capture its prey.

According to Torres, the drone footage was invaluable in revealing "a lot of really cool kinematics and body movement coordination by the whale that we haven't been able to see before." ■

SOURCE: PEERJ – LIFE AND ENVIRONMENT

DAN Safety

Debunking DCS

Myths & Misconceptions

Sponsored content by DAN

Decompression sickness (DCS) is a complicated phenomenon, even for the doctors and scientists who dedicate their lives to studying it. Every certified diver has learned about DCS, but once training ends, memories fade and questions come to mind. Because DCS is not the most straightforward diving injury, myths and misconceptions about it tend to arise. DAN is committed to continually educating divers about it, and we have decided to clarify a few of the most common misconceptions about it to ensure that all divers are better able to recognize DCS, respond to it and get the treatment they need in time.

DCS occurs when bubbles of inert gas (usually nitrogen in recreational diving) manifest in the body in blood and/or other tissue. These bubbles can cause dizziness, fatigue, numbness, tingling, joint pain, shortness of breath, paralysis, muscle weakness, a rash, difficulty urinating, confusion and even loss of consciousness. If you suspect you or your buddy has DCS after a dive, summon emergency medical services, administer first aid and emergency oxygen, then call the DAN Emergency Hotline at +1 (919) 684-9111. Even if you are not a DAN member, DAN medics will provide guidance and help you get the care you need. Following a DAN medic's guidance will also help keep you from being led astray by the myths surrounding DCS and its treatment.

In most cases, DCS symptoms arise within a few hours of diving, but contributing factors such as altitude exposure while flying (or even driving at high altitude) can cause symptoms to arise as many as 12 to 24 hours later (or even longer). Typically, the more time it takes for symptoms to appear, the more benign the DCS. From time to time, DAN medics receive calls from divers who are worried they are experiencing DCS weeks or even months after their last dive. If you experience new symptoms of what you believe to be DCS any longer than a couple of days after a dive, you can feel confident the underlying condition is not DCS. Still, consult a physician.

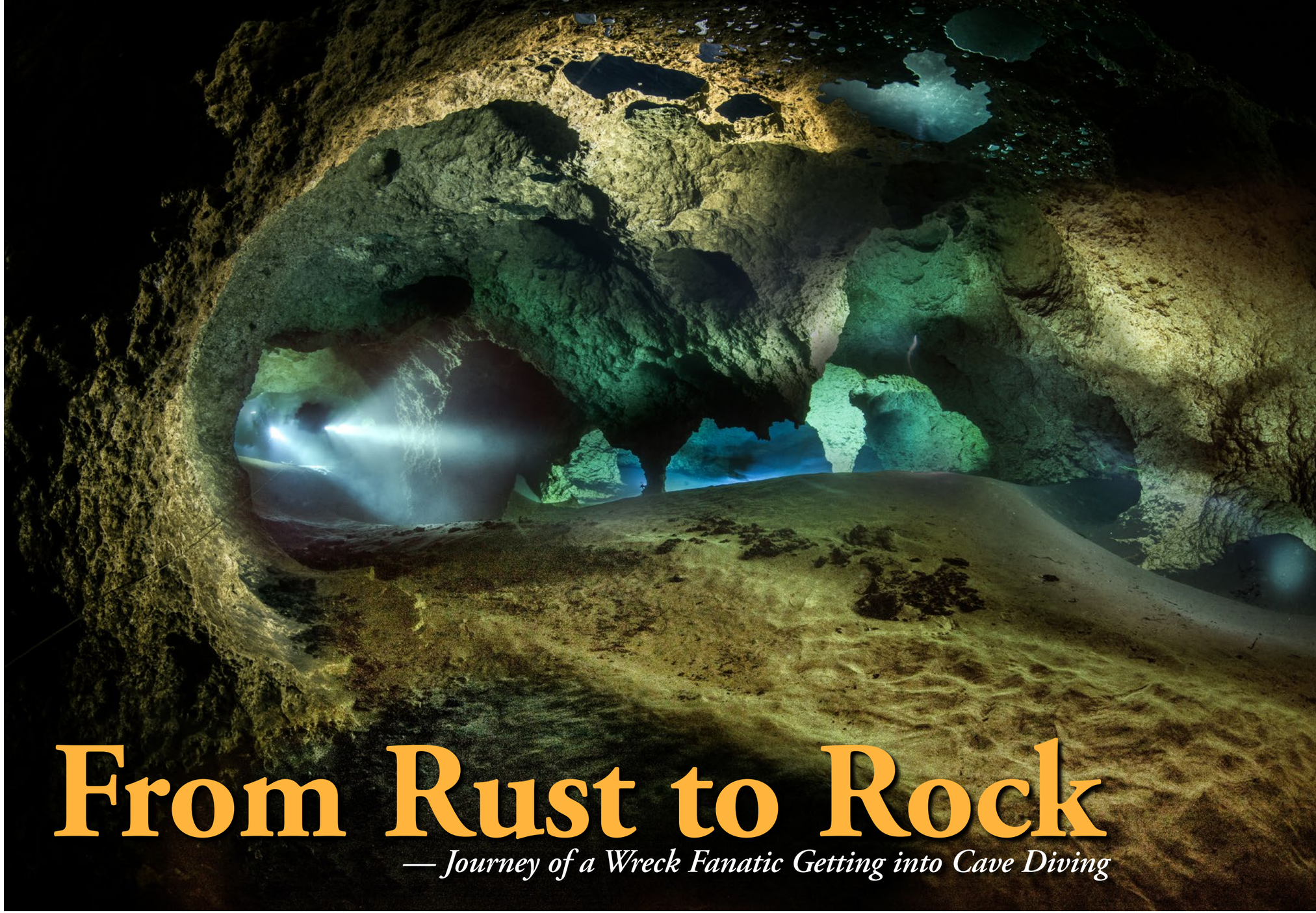
Another misconception that can prove detrimental is that divers involved in an accident should be taken straight to a hyperbaric chamber for treatment. This is incorrect and could even be dangerous. Any person with suspected DCS should be taken straight to a hospital, clinic or other emergency medical facility for immediate evaluation. That way the injured diver can be stabilized, any life-threatening injuries can be treated, and a physician can refer them to a hyperbaric treatment facility that is available to treat divers. While some hyperbaric chamber facilities treat divers, many do not, and those that do may not have a physician on staff to evaluate an injured diver or will require referral by an emergency physician before administering treatment. To avoid any delay in treatment after a diving accident, call EMS first, then call DAN and let the experts point you in the right direction.

In addition to misconceptions about seeking treatment for DCS, there are also myths out there about its recurrence. One question that DAN medical staff are asked frequently is, "I've had the bends before; does that make me more susceptible to getting them again?" The short answer to this question is, "not necessarily." Assuming complete resolution of previous DCS and no preexisting anatomical or physiological susceptibility, there is no hard evidence that suggests you will be more susceptible to DCS in the future. Factors such as having a PFO or diving aggressively do need careful consideration. Making conservative changes to the way you dive may reduce the risk of getting into trouble again.

Listen to your body: If you do not feel well, do not dive. There is no shame in calling off a dive, and deciding to sit one out might just save your life. If you feel ready to dive, make sure you dive a conservative profile, stay within your limits, do not overexert yourself, make a safety stop and ascend slowly. Unfortunately, most cases of DCS occur well within recreational limits, and even though almost all divers take steps to prevent it, some still get it.

To minimize the likelihood that you or a buddy suffers DCS, take measures to actively avoid it every time you dive, and make sure you remember how to recognize it, respond to it and seek proper treatment if it occurs. And remember, DAN is there for all divers—call us if you need us.

For more information, visit: ***DAN.org.***



From Rust to Rock

— Journey of a Wreck Fanatic Getting into Cave Diving

Cave divers in the underwater cave system of Peacock Springs, located in Florida, USA, where I did my cave training

Text and photos by Pete Mesley

For years and years, people have often asked me, "Hey, why aren't you a cave diver?" And I would respond simply, "When I have dived all the wrecks of the world (twice), I will then think about diving Wet Rocks!"

I learnt to dive in 1989, doing my initial training dives in the quarry at Stony Cove in England, a popular inland dive location about 125 miles north of London. I remember, to this day, doing my first training dives. It was January, in mid-winter. The water temperature was 4°C (that's the recommended temperature for drinking Heineken) and I was in a wetsuit!

When we finally got off the deck and had a swim around, we were guided around some structures, which were sunk in the lake for us to look at. A plane fuselage, bus, VW combi-van and a small boat were conveniently placed around for us to stumble over in the dark abyss. I remember swimming into the fuselage of the plane and becoming instantly hooked. From that second onwards, every waking hour of the day, I was thinking about wrecks, researching and diving them. This was when my "Lust4Rust" was born.

Wreck diving passion

We formed a small group of mad keen diving fanatics, and we would meet every Thursday evening at the local pub in London without fail. Here, we would plot and scheme what wrecks we would be diving on the weekend.

I loved every second of it: getting up at 4:00 a.m. in the morning to drive down to the coast; eating "bacon butties" before we got onto the dive boat; shortly thereafter, losing all stomach contents to the ocean as soon as we left the harbour; battling through questionable seas, shotting the wreck; getting geared up; jumping in; doing a 30-minute bottom time; doing safety/deco stops, holding onto the shot line in the current like a granny in a gale force wind; getting picked up by the boat (which stank of diesel and dead fish—more stomach contents lost!) and navigating the fishbone ladder in a 3m swell. To the untrained ear, this does not sound inviting at all, but we all loved

Deep in the engine room of Heian Maru, Truk Lagoon, Micronesia (left); The author with mentor and friend, Jill Heinerth, who took him through his paces in cave country (below)

Rust to Rock

it and lived for it. This was the beginning of what would be 29 years of wreck exploration (and counting).

Looking at it now, if I did my open water course in Florida and all my mates were mad keen, passionate cave divers, and all the talk I heard was about caves, would I still be mad keen into wrecks? Or would I acquire an equal passion for cave diving?

First steps into cave diving

For decades, the thought of cave diving never entered my mind. I had no interest in it what-so-ever. It was not until about five years ago, when I was looking at images of the flooded mines off Bell Island, Newfoundland, that I really wanted to get into those mines myself and take some pictures of my own. It was this that really prompted me to take the steps to get full cave training, as this was a prerequisite for the trip. So, begrudgingly, I set out to do my course.

So, who would I get to do my course? Who better than world-renowned explorer, diving pioneer and good mate—Jill Heinerth? I contacted Jill, and we were on!

Some months later, I found myself in Florida. Wanting to fully immerse myself, I rented out an RV in the middle of cave country, bought a banjo, sat on a wooden rocking chair and attempted to play that song from Deliverance. Just kidding! (About the last two bits.)

We started our training at Ginnie Springs, and one of the first things Jill said to me was, "How far do you want to go in your training?" And (stupidly) I replied, "Just push me as far as possible until I let out a whimper," or "as far as you think I am capable of."

Well, that was some of the best training I have received in the last 10 years collectively! It was great. Lost-line drills, no-mask and loss-of-light drills. Swimming blind for hundreds and hundreds of metres, deep inside the cave. Learning the art of touch communication, entanglement protocol, line work and extensive dive planning were just some of the skills that were honed on the course. I also learnt (the hard way) what "Ginnie Fingers" meant and also learnt to swim against very powerful water flows, figuring out how to read the flow by observing rock outcrops.

Not only was I pushed to the limit, but I also learnt the spiritual side of cave diving too. Jill's insight into how the caves were formed, water flow and all the hidden aspects of respecting the environment really opened my eyes to a whole new world. Was I warming to the fact that cave diving was not as bad as initially thought?

I even resurrected my blue helmet (which I thought was pretty cool 16 years ago while open ocean diving). Since then, it has been on the shelf… until now! It has saved my head on more than a few occasions, squeezing into tight areas.

Do wreck divers think the same as cave divers?

There are many similarities that wreck divers share with cave divers. The sense of exploration, working as a team and precise planning are a few of these shared traits. It was also interesting to learn all about the cave, how it was formed, outcrops, how mud on the bottom had not been disturbed for thousands upon thousands of years.

I also learnt a strong sense of pride, ownership and preservation from Jill about every cave we dived. These views are shared with fellow wreck divers, who yearn for knowledge about the history of a wreck, how it was sunk, what its cargo was, etc. Over the years, I have also learnt about preservation of our precious resources. It was not always that way.

When I cut my teeth on wreck diving back in 1989 in the United Kingdom, it was all about "spidge" (artefact recovery) and BRASS! That was the predominant pastime—getting as much brass as you could. Something I have learnt over the years is that 99 percent of all the brass recovered off wrecks, portholes, binnacles, etc—ends up rotting away in someone's garage or lying in the long grass in-between the garage and the boundary fence!

Of course, I do not partake in that anymore. In fact, that is how I got into photography, because I was absolutely rubbish at collecting artefacts and could not see the point. I just focused on taking pictures from then onwards.

Cave photography

It was really interesting for me to dive with some cave divers while I was in Florida after my course. The first thing I wanted to do was get back to Peacock Springs and take some pictures of some of the fantastic rooms I visited. I was lucky enough to dive with a local prominent GUE cave instructor. I warned her that I probably would not go that far and would spend quite a while in one place.

Sure enough, we got about 200m into the cave. I saw the frame I wanted and proceeded to carefully place lights. After about 90 minutes of set up, long expo-

COURTESY OF PETE MESLEY

Rust to Rock

Exquisite formations found in the cave system on Muna Island in Southeast Sulawesi, Indonesia, during the cave exploration expedition

sures and light painting, we ended the dive. I apologised about taking so long and thanked my buddy for her patience. One of the things she said to me was really interesting. She said that she had been through there hundreds of times but never "saw" the cave in that light before.

This was also an observation I made while diving with a group of cave divers in that same timeframe. For the first dive, we planned to go to a place called the "Dome Room." We planned it, discussed procedures, how many jumps we would do, etc. All good. Off we went.

As we were heading to our objective, swimming against the flow, we came into many spectacular rooms. I had two large (15K) floodlights and lit up these large areas. We did not stop to enjoy these amazing views. Instead, we pushed on. I guessed we would have time on the way back to appreciate these outcrops and topography.

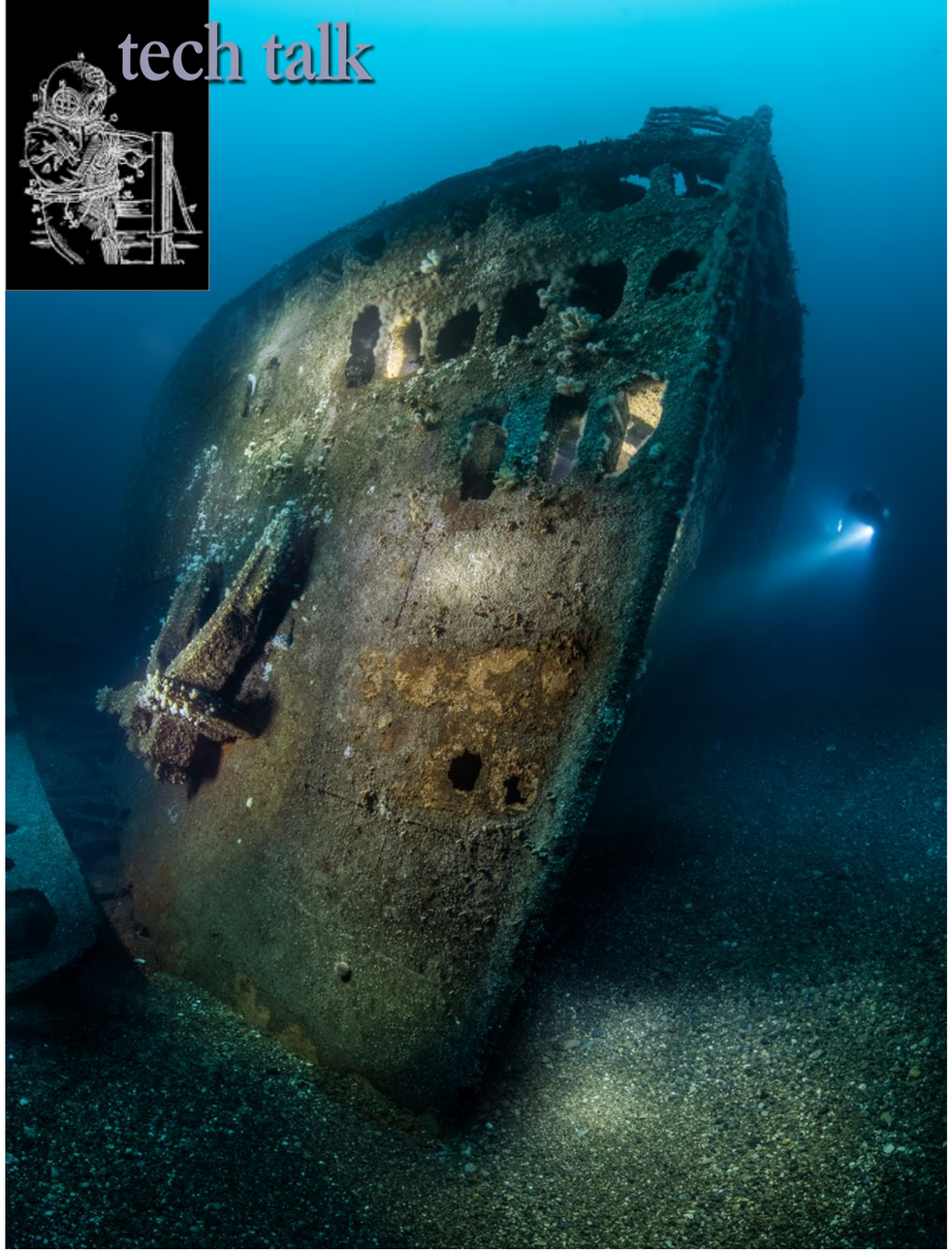
As we got to the Dome Room, we kind of "touched the back wall," and then the sign was given to head back. OK, maybe we would stop on the way back to check out these rooms. Nope! On completion of the dive, the guys said how amazing the dive was. I made a comment, asking how come we did not stop in these rooms to enjoy them. "We were heading for the Dome Room," was the answer. What about the bits in-between?

On the next dive, the guys wanted to go farther into the cave, with more complex jumps. I declined. It seemed to me that the main objective (of this group) was just in the planning of the dive and how well the jumps were executed. The visual features of the cave were not really discussed at all. This was really odd for me. But, on reflection, thinking more about it, the same could be said about wreck divers solely focused on artefact recovery—or photography, for that matter.

Single-minded

I went to Malin Head, County Donegal, Ireland in 2017. I was diving with a mate of mine, Barry McGill, who was extremely knowledgeable on the area and had been running trips there for years. I had been wanting to dive these wrecks for decades. When I finally got to go, I had one picture in mind for each wreck. With this in mind, I spent an entire dive getting that "one money shot."

Now, logic would dictate that one should have a good look round the wreck and get a good idea of the ship first. But what I ended up doing was focusing on one area. On reflection as to why I chose to do that, it was simple. For me, my personal objectives and outcomes for that trip were straightforward. I really just wanted to get a few images, which depicted the essence of the wreck. In my experience, this takes time,



Diver at bow of SS *Justicia,* located off Malin Head in Donegal, Ireland, shot from the front (left) and from the port side (above)

effort and focus.

One particular dive was on the SS *Justicia*—a 32,000-ton, 237m-long ocean liner converted to a troop carrier in the First World War, which was sunk after being hit no less than six times by torpedoes. She now sits in 68m of water. I focused on the bow section, spending the whole 40 minutes on the bottom to get two shots! But for me, personally, this was totally worth the dive. So, are we wreck divers really that different from cave divers?

Could the tides be changing?

Recently this year, in February, I was very fortunate to be part of a small team of cave explorers. We went to the Southeast Sulawesi province in Indonesia. The objectives of the expedition were to seek out new virgin caves, explore them, and map, document and photograph them. I had never been a part of this kind of cave exploration before, and I was excited about the concept. I did not take my camera on these initial dives. Instead, I mounted a small point-and-shoot camera on my helmet (which ended up being a dumb idea on open circuit).

I have to admit, when I got my head around the fact that we were exploring, I became a ferret, poking into holes, looking for any passageways. Although I was still scoping out possible future picture opportunities, my mindset was completely different than when I had a camera in my hand.

It was fun—lots of fun. We came up with a lot of dead ends, got stuck quite a few times and laid a lot of line. Great times. But taking images of these places brought the biggest joy to me. I "get it" now, about caves.

Some lasting thoughts

I think our interests are widely influenced by our geographical surroundings and the people around us. One thing is for sure, it does not really matter much what you pursue. If you surround yourself with like-minded people and positive role models, you can feed your passion—whatever it is, wherever it is. Be open to trying new things. You might surprise yourself… I did!

So, seeing both ends of the spectrum, I am really privileged to have the opportunity to experience different worlds, and also to have positive role models in my life. Everyone has their own objectives in their activities. The key is to match these objectives with the people with whom you dive.

I have been actively exploring shipwrecks for the last three decades, and it is a very addictive thing. Having that urge to learn new things too, is equally addictive. I am still a "Rust Guy" through-and-through, but I am looking forward to planning new cave adventures and spending time with friends; to finally get to Newfoundland and dive those flooded mines, which started me on this mad journey; to learn new things. I can't wait.

We might all be suffering from current global adversities, BUT the future is looking very exciting. ■

Based in New Zealand, Pete Mesley, owner and sole operator of Lust4Rust Diving Excursions, runs specialised trips to some of the world's best wreck diving destinations. He runs a tight ship and is totally dedicated to safety by bringing an experienced hyperbaric physician with an emergency medical kit on all his trips. For more information on Lust4Rust Diving Excursions trip schedules, please visit: ***lust4rust.co****.*

Fellow students ion GUE's CCR 1 course engage in multiple practice dives each day day to practice new skills (right); The author's rebreather rig (below)

Going Through the Paces of

GUE's CCR1 Course

Text and photos by Adam Hanlon

I completed a Module 1 course on the Inspiration Classic back in the late '90s but found that my limited ability meant that maintaining situational awareness while also having to continually monitor handsets was very difficult. In the early 2000s, I also did a series of technical diving courses with Global Underwater Explorers (GUE), and I still rate these lessons as the most significant dive training that I have ever undertaken.

The arrival of heads-up displays (HUDs) and wrist-mounted pO_2 monitoring has meant that maintaining situational awareness has become a great deal easier. In early 2019, GUE launched a revised series of courses, training individuals to use closed circuit rebreathers (CCR), or more specifically, the JJ CCR rebreather in a GUE modified configuration. Given my positive experience of previous GUE training, it made sense to me to sign up for the CCR1 course with GUE instructor Richard Walker.

Theory and preparation

Day one of the course saw my fellow students, Richard Savenije and Will Zhou, and I being introduced to the general theory about rebreathers by Richard and then building up and preparing the units under his watchful eye. The GUE version of the JJ CCR has several notable features. First among these is the addition of a pair of (typically) 7-litre cylinders manifolded via a flexible isolation manifold. These provide diluent (via the right-hand

Diver deploys a delayed surface marker buoy druing a drill (left); Pre-dive checklists were completed and placed on gear to show it was "ready to go." (right and below)

post regulator and the JJ's ADV) and bailout (via either OC necklace regulator or BOV). The configuration retains GUE's signature OC long hose, feeding off the left post and stowed in a "Hogarthian" loop under the rebreather's loop.

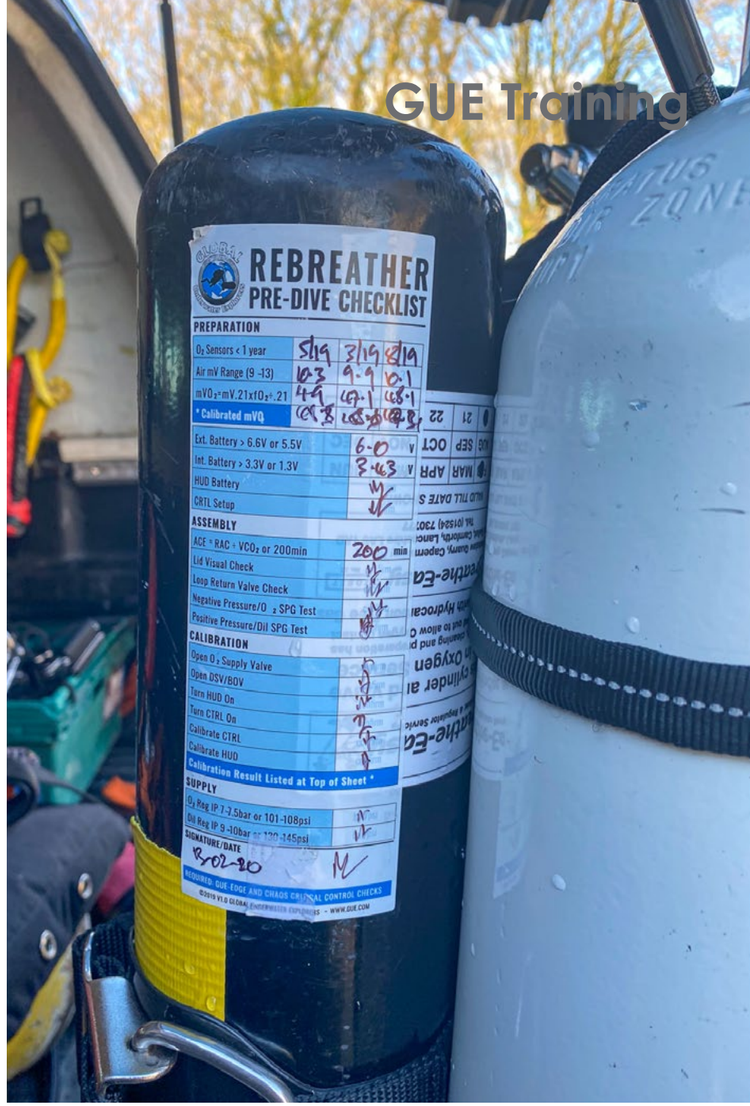
Oxygen is supplied via a rear-mounted cylinder, which feeds the unit's solenoid and MAV. Both diluent and O_2 gauges are routed to the left-hand side and clipped off onto a hip D-ring. As the bailout/diluent cylinders will typically be using helium-based breathing mixtures, drysuit inflation is done via a small cylinder mounted on the backplate, or a larger cylinder mounted on the rear of the unit, if required.

Checklists

GUE's approach to rebreather safety has, as one of its cornerstones, rigid adherence to a series of checklists. This includes a pre-dive checklist that ensures that the unit is assembled and working correctly. This should be completed each time the unit is assembled, with additional checks before each day and each dive. The pre-dive checklist is completed and then attached to the unit to ensure that in an environment that has multiple similar units, it is immediately apparent which units are "ready to go."

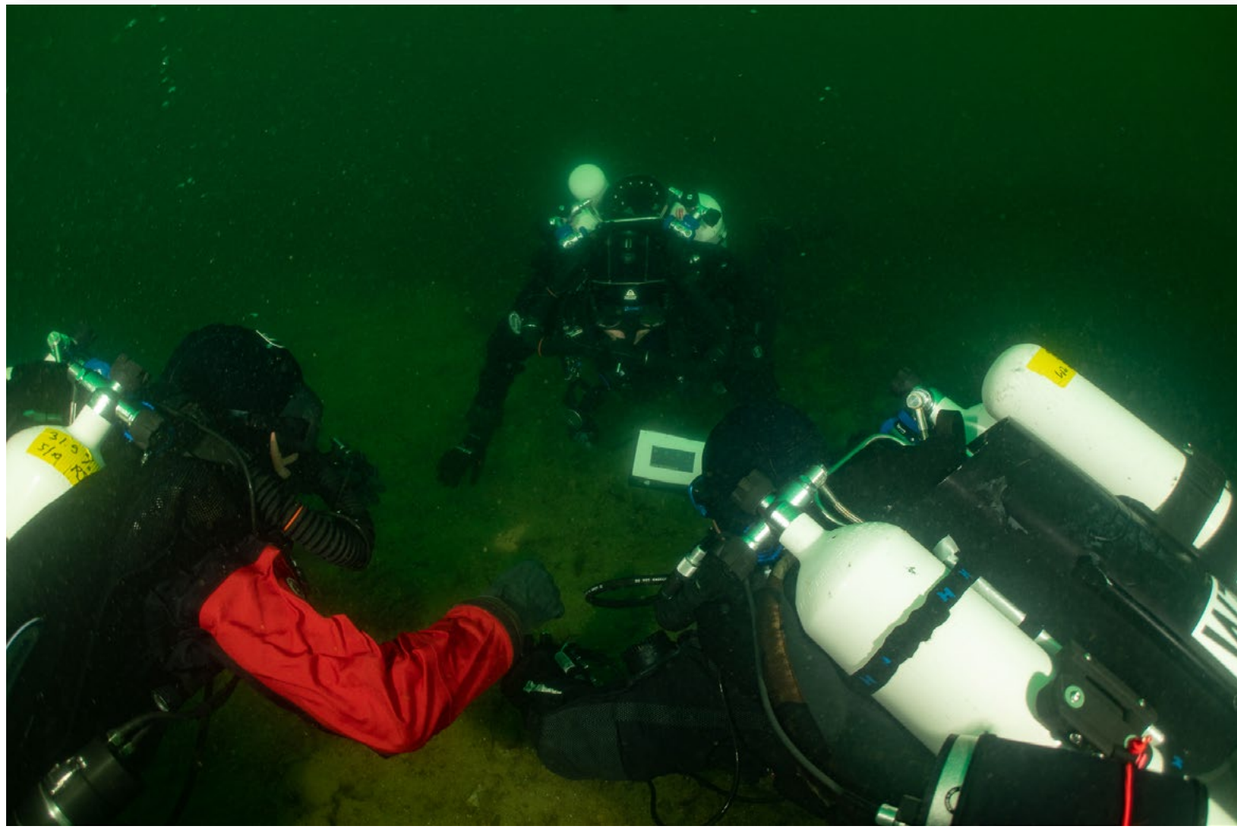
Once the units were ready, Richard took us through a "dry dive," discussing how to come on and off the loop, mouthpiece seals, achieving optimal loop volume, pO_2 awareness, and communications.

Before each dive, GUE mandates a five-minute pre-breathe, during which the user carries out a series of function tests, known as a CHAOS drill. So, after completing this, we planned a dive using the standard GUE EDGE dive planning tool and went diving!



Checklist for GUE CHAOS five-minute pre-breathe protocol

The fourth course day focused on "failure cards," to which the team had to respond for various failure scenarios shown.



Diving

On the first day, we did four dives, each one introducing new skills on the unit. These included bailouts, gas sharing, flying the unit manually, dewatering, flood recovery and diluent flushes. Also, we completed some of GUE's standard skills, including delayed surface marker buoy (DSMB) deployments and ascents, situational awareness, team drills, and all the usual buoyancy, trim and propulsion skills.

We split the units down and returned to the classroom for a debrief and discussion, before Richard introduced some of the features of GUE's gas choices and how they integrate into CCR use, monitoring pO_2 and the issues around failing to do so. Finally, we rebuilt the rebreathers and carried out the pre-dive checklist, ready for the next day.

Bailout

Day three commenced with a CHAOS drill and GUE EDGE planning session before completing two longer dives. During these dives, we further practised the skills that had been introduced the previous day.

The GUE JJ CCR setup provides a swift and efficient bailout option. If equipped with a BOV, a twist gives access to 14 litres of back gas. This provides plenty of time to make crucial decisions and to figure out what to do next!

If it is decided that a full bailout is required, the protocol is to deploy the long hose, run it over the rebreather's loop, and to breathe from it, removing any issues with the work of breathing. If not equipped with a BOV, the user would switch to the necklaced second stage to achieve the same effect.

Day three involved practising ascents after bailing out, including gas sharing with another diver during an ascent. After the dives, we again stripped, reassembled and checked the units, and returned to the classroom where Richard covered gas management and dive planning, along with decompression strategies. GUE's stance on dive computer use is that they are one of several tools that can be used, and while their input can be valuable, understanding decompression and utilising a variety of planning tools is more important than relying on any single device.

Failure cards

Richard introduced "failure cards" on day four. These showed a picture of the screen of the Shearwater dive computer, displaying specific failure modes. We then reacted as a team to these and took (what we thought were) appropriate actions.

Pretty rapidly, the scenarios became pretty complicated and required both troubleshooting and decision making, along with team input and communication. As always, it was required that this all took place with good buoyancy control, situational awareness and propulsion techniques. Richard's topic for the theory was an introduction to human factors in rebreather diving safety and how to quantify, and hence, reduce risks.

The last course day focused on in-water rescue techniques, ending with a final exam, swim tests and a "fun" dive.

Rescue techniques and final exams

Our final "school day" introduced us to in-water rescue techniques both on the surface and underwater. We completed one more training dive, in which the cards made an appearance again, forcing us to refine our responses and troubleshooting skills. We then did a couple of experience dives, before finishing up with a session in the workshop, looking at servicing and repairing the unit. Along the way, we completed the CCR1 exam, and Richard reviewed our answers with us as well as the mandatory GUE swim test (500yds/450m in less than 14 minutes and 60ft/18m on a breath-hold).

Our final dive together was a "fun" 84-minute dive. GUE, rightly, does not allow photo shoots to take place during training dives, so we use this post-course dive to get some pictures and to enjoy using our new-found skills to explore the dive site.

Afterthoughts

GUE's CCR1 course is thorough and demanding, and provides a very solid grounding in using the JJ CCR as configured by GUE. Given that it currently has a prerequisite of GUE Tech 1 to attend, it builds on the skills emphasised in this course and applies them to using the rebreather.

It was interesting that the three of us on the course had never dived together yet were able to operate as an effective dive team from the very first dive. Dive conditions during the course were a little challenging, and this presented no problems at all in terms of situational awareness and team cohesion, primarily due to our prerequisite training.

I began this report by mentioning that my experience with GUE training still rates as the best diver training experience I have had. I am delighted to report that CCR1 upholds this standard, and the training I received will continue to be something that will be a part of every dive I carry out. ■

The author offers his humble thanks to his team members Richard Savenije and Will Zhou and special thanks to his excellent instructor, Richard Walker.

*Underwater photographer Adam Hanlon is the publisher and owner of Wetpixel (**wetpixel.com**), the premiere online resource for underwater image-makers. He holds qualifications from PADI, IANTD, TDI, CMAS, NAUI and GUE and owns a dive school based at Capernwray Diving Center near Lancaster, United Kingdom. To see more of his images, please visit: **hanlon-photography.com**.*

photo & video

If you cannot go out, shoot studio portraits at home, like this one of Olga Torrey, using seamless background paper and radio flash triggers to fire speed lights off camera in a soft box. If you do go out, be safe (right); Times Square, New York City—using water as a reflection and design element (far right)

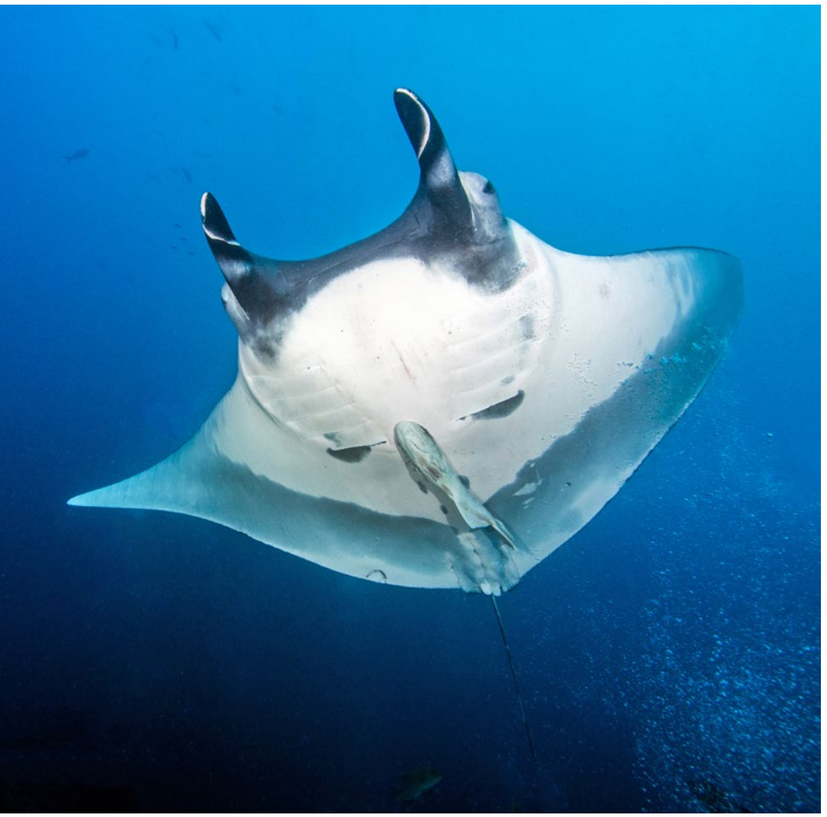
Text and photos by
Larry Cohen and Olga Torrey

As countries around the world have placed populations in quarantine with stay-at-home orders in an effort to stop the spread of the COVID-19 pandemic, many underwater photographers have found themselves stuck inside with no option to travel or go diving. Two of *X-Ray Mag's* regular contributors are based in New York City, a current epicenter of the pandemic. They share their images of the transformed "Big Apple," normally bustling with people and traffic, in intriguing side-by-side comparisons with underwater images from their archives, and offer some ideas and tips on how underwater photographers can keep their skills sharp and minds active and creative during their time at home.

What Underwater Photographers Do When

Put in Dry Dock

Comparison and contrast of shape and color: Giant manta ray in the waters off San Benedicto, Mexico (below), and a monarch butterfly collecting pollen in a New York City park before migrating south (right) Getting low and shooting up is a good perspective when creating images on land or underwater. Photos by Olga Torrey



Dry Dock

Most underwater image-makers start out as surface photographers. Once they get their scuba certification, it is a natural progression to begin capturing images underwater. However, while on dive trips, most underwater shooters will also take shots above the waterline. So, what happens when we underwater photographers are not permitted to dive and cannot travel?

During the worldwide coronavirus pandemic, many of us cannot even leave our homes but still want to be creative. Here are some ideas:

- While being grounded, we can still capture still-life images and portraits at home.

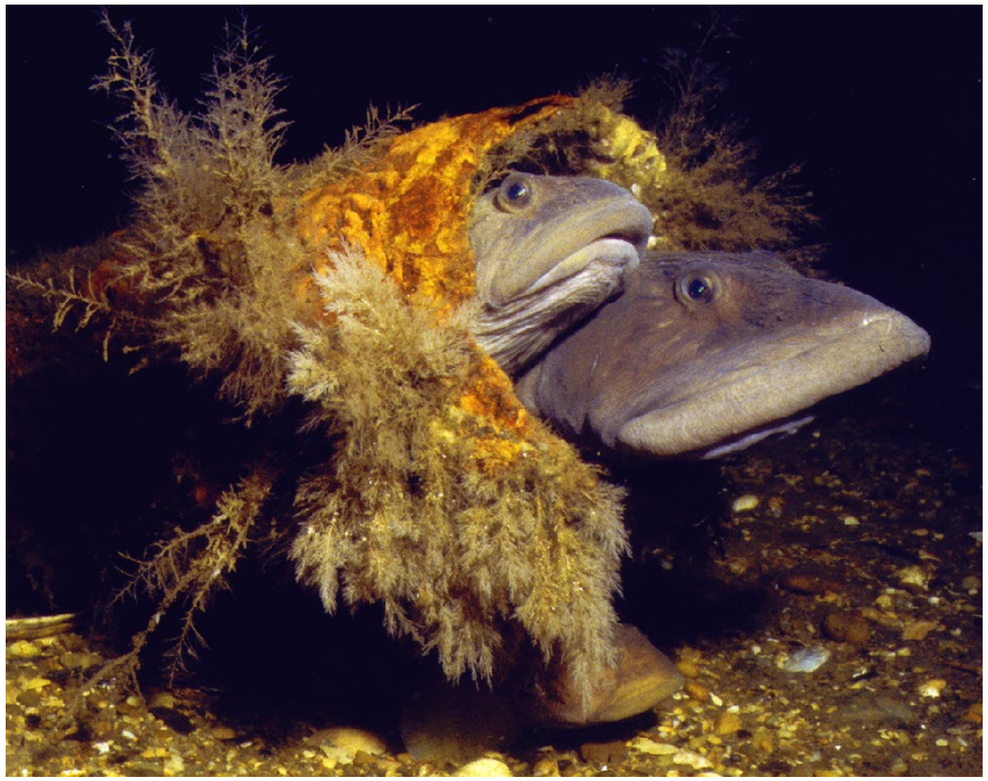
- There is also the Getty Museum Challenge This is a fun project that involves picking a work of art and recreating it, using what you have in the house. All of these at-home projects will improve your studio-lighting skills, which will improve your understanding of light, and thus improve your underwater imaging. (Learn more at: **blogs.getty.edu**.)

- Taking an online editing software class is also a good use of time. There are also many tutorials on the Internet that will improve your postproduction skills.

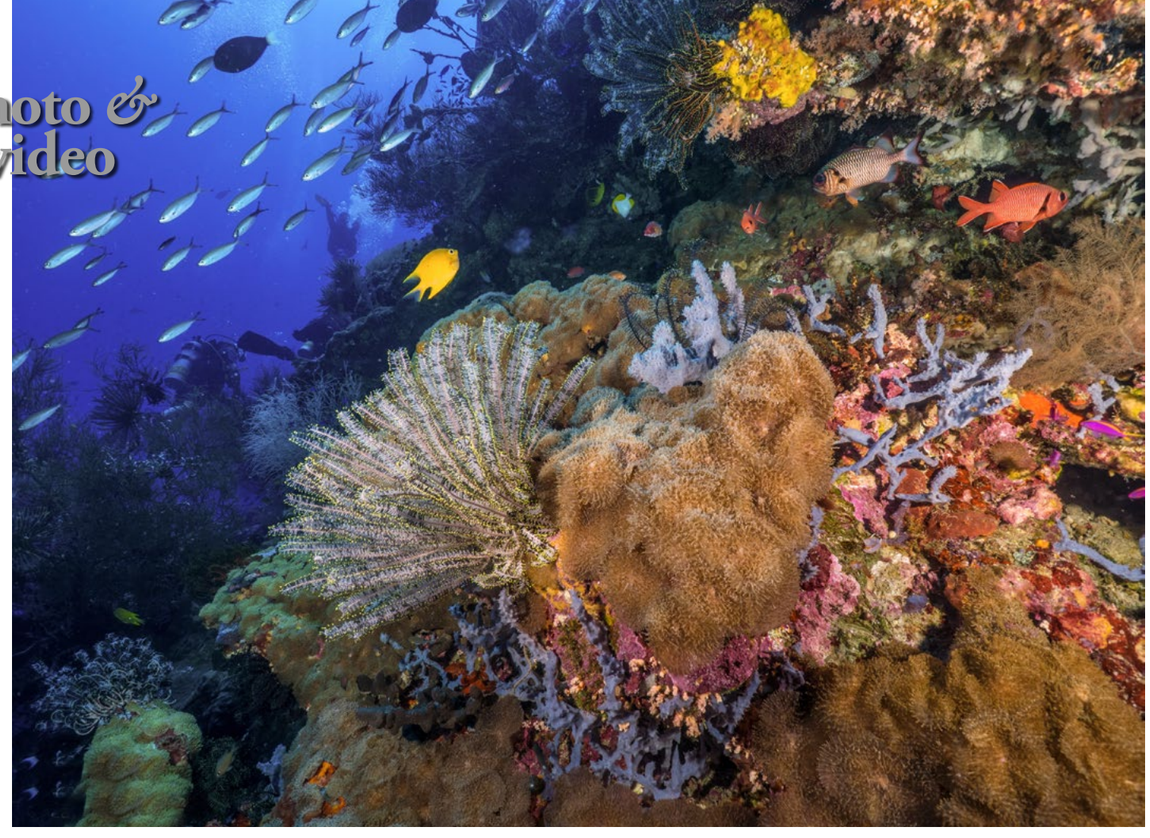
- The time stuck at home can also be used to organize your digital files and update your website.

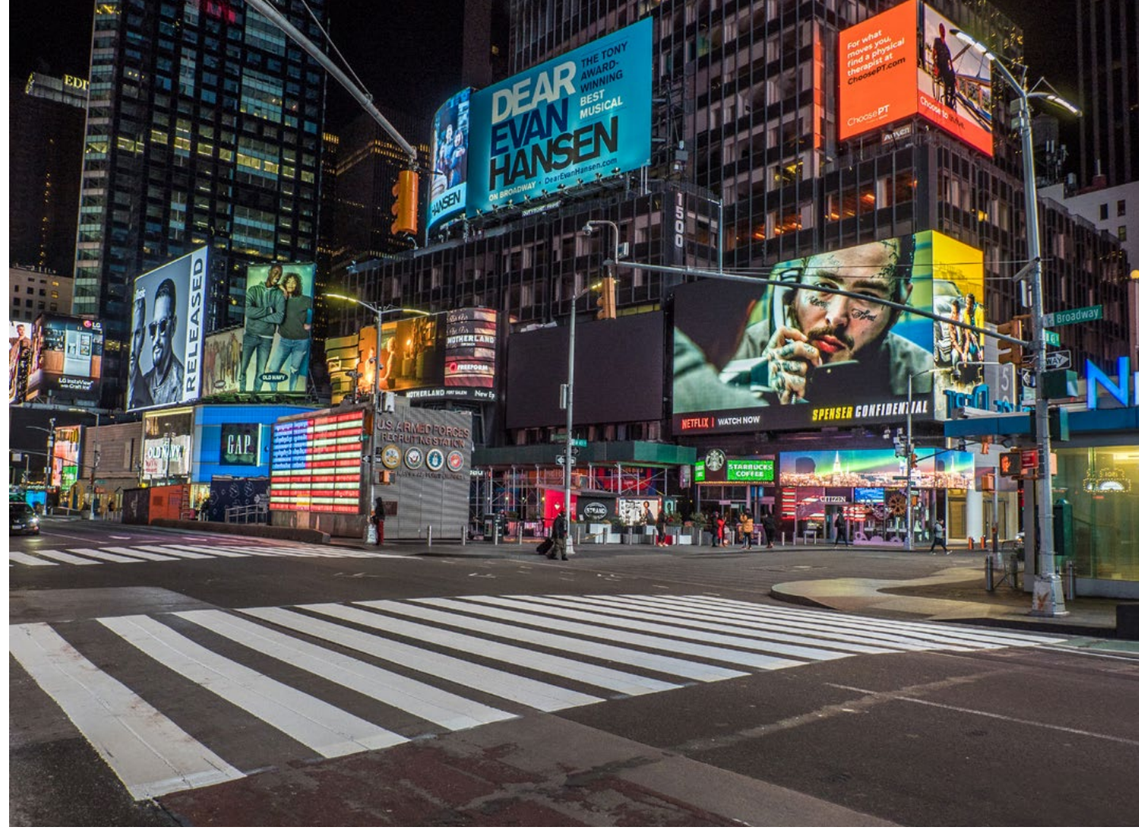
- Some photographers, who are lucky enough to have a great view out their window, can create images with a telephoto lens.

In the United States, we are encouraged to stay home unless we have to go out for essential errands or to get to work, but our movements are not restricted at the time of this writing. We thought this was a good time to treat our hometown as a travel location. Major cities, including New York City, now have empty streets. So, on our limited outings, we took our cameras with us to photograph sites that are normally very crowded. It is impor-



Comparison: Pair of ocean pouts on *Resor* wreck in New Jersey (above), and pair of juvenile great horn owls in Ephrata, Pennsylvania (above). Photos by Larry Cohen.





Comparison and contrast of color and composition: Papua New Guinea reef, teeming with life (right) and an empty Time Square, the night New York went on pause in response to the coronavirus pandemic (far right). Above water and underwater wide-angle lenses are useful for seascapes, landscapes and city-scapes. Photos by Larry Cohen.

Comparison: A*Chromodoris annae* nudibranch, reaching for Christmas tree worms (above left), and a ladybug, sheltering from the sun in a New York City park. Photos by Olga Torrey.

tant to document this surreal time in history and show the new normal.

Of course, we need to wear a mask, gloves and stay far away from any other people that might be on the street. In New York, state and city parks are still open. Besides getting fresh air and exercise during the pandemic, the parks are a good location for landscape and wildlife images, especially birds.

As image-producers, we need to use this time to stay active and creative. This is a time for learning new skills and looking at life from a different point of view. Working on improving our above-water photo skills will improve our underwater imaging techniques and help us create unique images above and below the waves. ■

Larry Cohen and Olga Torrey are well-traveled and published underwater photographers based in New York City, USA. They offer underwater photography courses and presentations to dive shops, clubs and events. For more information, please visit: ***liquidimagesuw.com*** *and* ***fitimage.nyc****.*

Comparison of lines and shapes: Challenger 600 jet submerged in Dutch Springs, Pensylvania. When the water is cold, visibility is usually better since there are no algae blooms. This is a good opportunity to photograph large structures with ambient light. (right), and a Harrier jump jet monument in Havelock, North Carolina. Using a wide-angle lens and shooting at a low angle can make a small puddle look like a large lake. (far right). Photos by Olga Torrey

Comparison of lines and shapes: Japanese Zero plane parts in the Fujikawa Maru wreck, Chuuk Lagoon, Micronesia (far left). Shooting inside the wreck's cargo hold, strobes were the only lights that illuminated the plane parts. US jet on display at the Intrepid Sea, Air & Space Museum in New York City (left). When taking photos above water, just like in open water, your flash can be used to illuminate the subject. Use your shutter speed to change the exposure of the background. Photos by Larry Cohen.

photo & video

Comparison of shapes and angles: Divers on the wreck of the German submarine U-*352* North Carolina (right) and the USS *Growler*, which is the only US guided-missile submarine the public can visit, located at the Intrepid Sea, Air & Space Museum in New York City (far right). A submarine conning tower is an interesting subject above and below the water because of its shape. When photographing shipwrecks, using divers adds a human element. Using different lenses will create a different look. A fisheye lens was used for the *Growler* photo. Photographing the submarine at sunset, speed lights were used to fill in the shadows. The lens was set to a small aperture to control the flair when shooting directly into the sun. Photos by Larry Cohen.

Comparison of light and shape: Gray reef sharks, swimming under a circle of sunlight in the Gardens of the Queen marine park of Cuba (far left) and the circle of a full moon, rising up behind a pine tree in a New York City park (left). When shooting underwater sunball photos, place the subject in the frame so that it covers the bright center of the sun. Use a small aperture so the circular edge of the sun is not too bright. The subject will be in the shadow, so use your strobes to get detail in the subject. When shooting a moonball photo, set your camera to expose for the bright moon. Leaving the subject in the shadow as a silhouette can be effective. Photos by Olga Torrey.

Critter comparison: Sea lions playing in the waters of Isla Espíritu Santo, Mexico (right), and a harbor seal relaxing during low tide in Sandy Hook, New Jersey (far right). Similar subjects may require different lenses on land. Photographing harbor seals resting on rocks during low tide required a telephoto lens. I experimented with gear, using a manual focus Novoflex 600mm rifle lens from the 1960s. Photos by Larry Cohen.

Take the *X-Ray Mag* Photo Challenge

Stuck inside? Using found objects at home, or what you can photograph looking outside your window, why not try recreating one of your own underwater photos from your image archives? The five best shots will be shared on our website. Here are some tips:

Match the colors. Find objects at home that have similar colors as your underwater image and arrange them in a similar way as they are composed in your underwater image.

Match the shapes and lines. Arrange objects from home to mimic the lines and shapes found in your underwater image.

Think outside the box. Try an abstract approach rather than a literal representation. Go macro and get close in on a subject. Try using unusual elements. There may be dry goods in your pantry or things in the fridge that may come in handy. Who knows? Your composition might be edible after the photo shoot.

Take a look at the lighting. Use creative lighting techniques, homemade snoots, and other lighting fixtures and filters found in your home to recreate the lighting found in your underwater image.

Make use of reflections. Mirrors, glass, liquids, water... experiment with reflective surfaces and shooting angles through them.

Mix it up. Do several and pick the best one. The more attempts, the better chance for a great image.

Photography tips. Use your camera, smartphone, tablet or computer camera to capture the image. If you do not have a tripod, steady your shot with a homemade tripod made out of objects found in your home. If you are in the shot, you can use a remote shutter release device, the timer on your camera or have someone at home take the shot. Try taking different exposures and angles of the same composition.

Share your images. You can post your images on Twitter or Instagram at: **#xraymagphotochallenge**. Or send them through our Facebook page: **@XRayMagazine**.

Please remember to post both your original underwater shot and your new homemade shot, so viewers can see them together and compare.

Captions. Tell us briefly the story behind your images, where they were shot and what objects you used in your homemade image.

Please keep your images family-friendly and mind the social media's policies for posting. Most of all, have fun! ■

Color and shape comparison: Dorid nudibranch, *Goniobranchus leopardus*, on soft coral in Papua New Guinea (above) and crocus plant blooming early in spring in New York City (right). Above or below the waterline, there are many small subjects for which to use your macro lens. Photos by Olga Torrey.

photo & video

Edited by
Rico Besserdich

ALL PHOTOS COURTESY
OF THE MANUFACTURERS

Inon UWL-95 Wide-Angle Wet Lens

The UWL-95 is a wide-angle wet lens specifically designed for compact cameras with 24mm lenses. It is available with M52 or M67 threads and offers a 95∞ field of view underwater. By attaching an optional dome-lens unit, the field of view (underwater) can be increased up to 141∞. Using the UWL-95 reduces the minimum focusing distance of the camera lens, according to the manufacturer. Its weight is 605g topside, 396g underwater. The UWL-95 is depth-rated to 60m (200ft). As of April 2020, the wide-angle lens is compatible with the Olympus TG 3, 4, 5 and 6 series and with Sony RX100 M3, 4 and 5. **inon.jp**

Gates GT14 Underwater Imaging Light

The Gates GT14 Underwater Imaging Light unites various practical features for the underwater videographer into a compact, travel-friendly package. It provides up to 14,000 lumens of light, with a 90-degree beam angle. A big, glove-sized power ring switch rotates through seven different light power outputs, including a very low power mode for night diving. Fuel gage and light level indicators are mirrored to provide easy reading from either side. A water-cooling contact behind the LED enables higher efficiencies for high light power outputs and longer burn times without overheating the LED. On full power, the light works for 30 minutes; on half-power, 75 minutes; and on low power, 10 hours. The battery pack can be charged in three hours. The GT14 provides 5000K colour temperature, is depth-rated to 137m (450ft), a has a dry weight of 1.4kg topside, and a negative weight of 538g underwater. **gateshousings.com**

Anglerfish 4K Underwater HDMI Field Monitor

The AFCL-HD57 by Canadian manufacturer Anglerfish is a 4K resolution 5.7-inch field monitor designed specifically with underwater videographers and photographers in mind. It features a 5.7in IPS Screen, full 4K resolution, a brightness of 550cd/m≤, 1400:1 contrast, support of 1920x1080 (HD) and 4K input, and customizable menu colours. Each model gets colour-calibrated before shipping. The monitor is powered by a Sony NP-F750 (4-cell, 7.2V rechargeable) lithium-ion battery pack, which allows a run-time of approximately four hours. By using a special 50Wh battery pack, the run-time can be extended up to 6.25 hours. Additional features include brightness histogram, peak focus assist (three colours options), zebra exposure (1-100IRE adjustable), Scan Mode (Under Scan, Over Scan), Check Field (Red, Green, Blue, Mono), Anamorphic Mode (1.3x, 2.0x, 2.0x magnification), Ratio marker (4:3, 13:9, 14:9, 15:9, 16:9, 1.85:1 and 2.35:1), colour temperature adjustment, and various output formats from 480i up to 4K UHD. The monitor's body is made of aluminium, comes with standard ball-mounts and can be operated from -3° to +50°C (27° to 122°F). **anglerfishlighting.ca**

Lomography Analogue Aqua Camera

Lomography's new Analogue Aqua is a simple-to-use, reloadable camera, which comes in an underwater case, depth-rated to 10m. The camera is available in two versions, pre-loaded with one of two Lomography films: Colour Negative 400 for classic analogue character or LomoChrome Purple for violet tones. Once the 27-exposure, pre-loaded film is full, it can be replaced with another roll. The Analogue Aqua operates on a single AA battery, features a basic fixed-focus, 31mm F9 lens, with allows one to focus on anything from 1m (3ft) to infinity. The camera has a permanent, fixed shutter speed of 1/120s. In addition, it features a built-in flash (with a recycle time of 15 seconds). **lomography.com**

SeaLife Micro 3.0

Sealife's newest flagship of permanently sealed underwater cameras comes with a Sony 16MP 1-inch sensor, RAW-shooting option, an improved 2.4-inch LCD display and 4K video capabilities. The built-in 19mm equivalent f/2.8 lens has a field of view of 100∞. The camera features an on-board 64 GB storage. Its battery provides enough energy for three hours of continuous use, according to the manufacturer. Compared to its predecessor, the Micro 3.0 offers faster burst shooting (10fps vs 5fps) and reduced shutter lag (0.1s vs 0.5s). Other new functions are WiFi capability, time-lapse and burst shooting up to 10 fps. Furthermore, the Micro 3.0 now supports manual white balance. The camera is depth-rated to 60m (200ft). **sealife-cameras.com**

"Back to the surface," by Delbos Yannick of France, winner of the Porfolio Category, Lens Beyond Ocean Photo Compeition 2019. A mother humpback whale guides her calf at Saint Paul off Reunion Island in the Indian Ocean.

Lens Beyond Ocean submission deadline extended

In light of the COVID-19 pandemic, the dates of the Malaysia International Dive Expo (MIDE) have been changed to 4 – 6 December 2020. As a result, the final submission date for the Lens Beyond Ocean (LBO) international photo competition, which is hosted by MIDE, has been extended to 1 November 2020.

The LBO international photo competition, now in its tenth year, keeps on getting bigger and bigger, having drawn entries from over 850 underwater photographers around the globe as well as sponsors providing US$25,000 in high-quality prizes. These include dive travel packages to some of the top dive destinations in Asia to top-end dive gear and camera equipment, which participants can look forward to competing for in the contest.

Judges

This year's judges include renowned underwater photographers Tobias Friedrich of Germany, Jason Isley of the United Kingdom/Sabah and Nurul Yazid of Malaysia.

Be a winner

If you are a diver, passionate about sharing your underwater images and experiences, LBO offers a great chance for you to show off your talent. First and second place winners will be selected in each of seven categories, including: Macro, Wide-Angle, Portfolio, Compact Camera, Creative, Freediving, and 3-Minute Video. Judges will also select images for honorable mention as "Memorable Pictures."

Showcase of winning entries

Winners will be announced on Friday, 27 November 2020, and awarded prizes on MIDE's main stage on Saturday at 11:00 a.m. In addition, all winning images will be on display in the foyer, and winning videos showcased on the main stage's big screen, during MIDE from 4 – 6 December 2020 at the World Trade Centre, Kuala Lumpur.

Submission deadline

The final date is 1 November 2020.

Call for sponsors

The benefits to your business or organization in sponsoring the event or donating prizes is expansive international exposure, as your logo will be included on all print and online promotions and collateral. Your company or group will also be listed as a sponsor on the Lens Beyond Ocean website, with a link to your organization's website. In addition, your logo and brand will be present and promoted on social media, the Lens Beyond Ocean gallery banner and the venue banner on display during MIDE 2020. ■

For more information, please visit: ***lensbeyondocean.com****.*

Jenny Berry

P O R T F O L I O

portfolio

Mangroves: Between Land and Sea, by Jenny Berry. Acrylic on canvas, 61cm x 122cm

PREVIOUS PAGE: *Nautilus Rising*, by Jenny Berry. Acrylic on canvas, 90cm x 90cm

Edited by G. Symes. All artwork by and photos courtesy of Jenny Berry

South Australian artist Jenny Berry creates marine life paintings and murals that portray the serene beauty and unique species found in underwater Australia. Her artworks feature underwater critters such as the giant cuttlefish, which has an annual mass breeding aggregation in South Australian waters that not many locals know about, raising awareness of special local denizens and the fragile ecosystems in which they live. *X-Ray Mag* interviewed the artist to learn more about her creative process and perspectives on the role of art in conservation.

Seadragon Porthole, by Jenny Berry
Acrylic on linen, 75cm x 75cm

X-RAY MAG: Tell us about yourself, your background and how you became an artist.

JB: Like most artists, I have always been a creative person. As a child, I often drew and loved my coloured pencils. As I got older and turned my focus to starting a career, being an artist was not an option that was ever entertained. Like so many people, growing up in the '80s meant getting a "real job." For me, becoming an artist has been like walking down a long road that has many bends and forks where you must decide which path to take.

After high school, I studied graphic design as I thought that was a career option that enabled me to use my creative urges and have a steady income at the same time. My heart was not in it and I spent many years in other professions until I finally came back to where I was meant to be! It did teach me a lot about colour theory and compositional balance though, so eventually it was useful.

I continued to paint as a hobby in my spare time. I enjoyed the process and sold my work through local art shows. I started to also sell a bit through word of mouth without really trying to.

Taking a pause from an administrative career to have children later in life enabled me to think outside of the restraints I felt life had given me. I realised that what I had been doing as a hobby for years could actually be my career. I plunged myself wholeheartedly into not just creating art but having the courage to promote it and share it with the world.

X-RAY MAG: Why marine life and underwater themes? How did you come to these themes and how did you develop your style of painting?

"Macky" Spanish Mackerel, by Jenny Berry
Acrylic on illustration board, 25cm x 70cm

JB: In 2001, my husband and I quit our jobs and travelled around the stunning coastline of Australia for six months. I was lucky to spend almost every day surrounded by the beauty of the ocean. This time in my life changed everything for me. Two life-changing things happened for me during this trip.

Firstly, I learnt to snorkel. I cannot explain how profound this was for me. I had never really been underwater like that and I absolutely loved it. I felt completely immersed in a whole different world. A world with no man-made sounds, with my senses heightened in a completely new way. I learnt to control my breathing and be more present in the moment. It blew my mind and I began to discover

Rhythmic Reef, by Jenny Berry. Acrylic on canvas, 40cm x 101cm

these creatures that I knew very little about that were totally fascinating. I snorkelled the Great Barrier Reef and saw the shapes and colours of corals that I didn't even know existed. From that time on, I never wanted to paint anything else. Even in my quiet moments of self-doubt, I cannot ever see myself painting any other subject matter.

The second life-changing thing that occurred at the same time was that I picked up acrylic paints for the first time. My first-ever painting was of a coral trout. I fell in love with the vibrance of the colours, the texture and the patterning. I still have that painting on my studio wall today! I had the freedom to create what I wanted without fear of judgement, and I found my true passion.

Acrylic paints felt completely right for me. Their fast-drying and water-based nature made them easy to travel with. I practised with this medium for hours upon hours. I completely taught myself how to use them through trial and error. In my early years of painting, I did not understand that I could touch up a small area at a time. If I had made an error in colour, I thought I had to repaint the whole fish. My early paintings must have had so many layers to them!

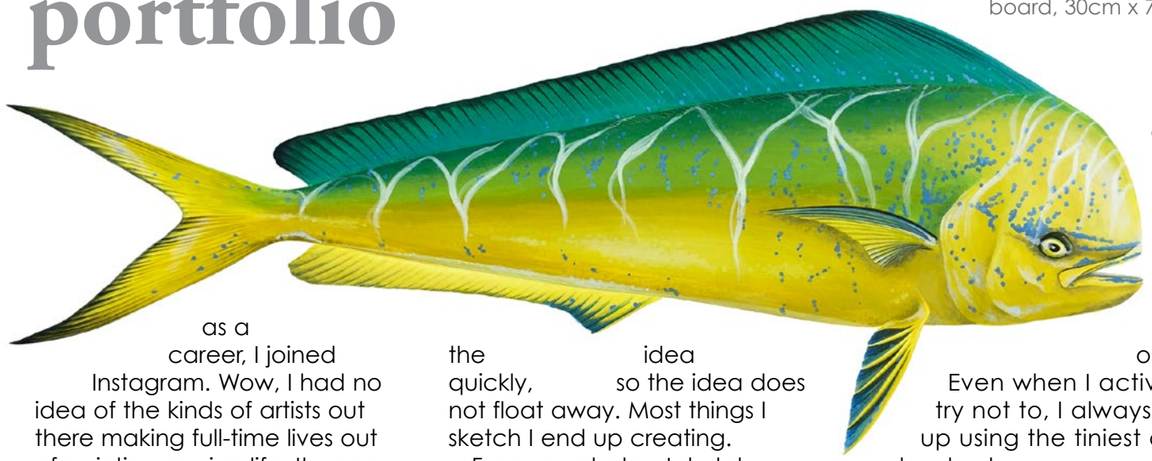
Gradually, a painting that would take me literally hundreds of hours became easier and easier. I learnt techniques that made my painting easier and better too. I am still learning techniques today that are improving my artworks, and I love that I am still learning every day. I largely learn through trial and error. It feels like such a privilege to have a career in which I can still learn and grow on the job.

X-RAY MAG: Who or what has inspired your artwork and why?

JB: In my early years of painting, I did not really have any inspiration from outside. I felt completely compelled to learn in my own way and was quite happy creating in a bit of a bubble. In my early years of painting, the Internet also was not what it is today. The accessibility to see what other artists were doing was not really there.

I took a local art class in which I could get some mentoring whilst still painting what I wanted. This was perfect for me as I steadfastly wanted to paint marine life. I had no desire to paint anything else. It did not interest me at all. Whilst on some level I knew that must be self-limiting, I had this burning thought in my soul that it was not the right way for me. I gained some technical skills here; however, mostly, I confirmed to myself that I was on the right path. Practice and passion have always been my guides.

In Australia, it seems there are not too many artists who completely devote themselves to painting marine life. Once I made the decision to pursue painting



"Mahi Mahi" Dolphin Fish, by Jenny Berry. Acrylic on illustration board, 30cm x 70cm

as a career, I joined Instagram. Wow, I had no idea of the kinds of artists out there making full-time lives out of painting marine life. It was so cool to see what other people were producing. I found Roger Swainston, who is totally the most inspiring artist I have come across. He has done a documentary for ABC Television in Australia, and I highly recommend you look him up. Absolutely fascinating.

X-RAY MAG: What is your artistic method or creative process?

JB: My creative process has definitely evolved to where it is today. I feel my best pieces come from some sort of first-hand experience with the ocean. My initial idea is generally from something I have experienced myself. I have a GoPro camera, which I try to take with me every time I am underwater. I use burst mode to take photos as this enables me to quickly capture what I am looking at, whilst also capturing some movement.

Most paintings come directly from an underwater experience I have had. I will see something happening in front of me and know that I will create a piece based on it one day. Some I am compelled to create straightaway, and others have to wait. Maybe I have a commission or an exhibition I am committed to complete first. I will often sketch the idea quickly, so the idea does not float away. Most things I sketch I end up creating.

From my photos, I sketch an initial idea. I then do some online research. I will look for photos that others have taken and find out species names and affiliated habitat. I am very particular about replicating the ecology accurately. It is important to me to have the facts and basics correct. I will even research aquatic plant life to ensure the marine life I am featuring is surrounded by the correct environment. I have studied coral species for my paintings and learnt so much about symbiosis.

Once I have all the elements, I sketch them up into a design. Here, I play around with the elements to come up with a pleasing aesthetic. With the design in place, I do some colour studies. I like to use cohesion of colour in my pieces and the underlying hue will often be used across all colours. For example, I might choose a brown colour that I then mix in with every colour in the painting. For me, this provides colour unity and makes everything work together. I am very methodical, and cohesion is very important to me.

After my design and colours are laid down, I start applying paint to the chosen surface. I work on canvas mainly but also enjoy using reclaimed timber as a substrate. From here, it is layers and layers of paint. Even when I actively try not to, I always end up using the tiniest of tiny brushes!

X-RAY MAG: How have your experiences underwater influenced your art? In your relationship with reefs and the sea, where have you had your favourite experiences?

JB: My experiences in the water influence pretty much every painting I create. Every artwork is based on a feeling I have felt in the ocean. It might be the colour of the water on a particular day or it could be the way a fish's fins play in the sway of the ocean, the clarity of visibility, the cloudiness of the sea, the excitement upon seeing a particular species or even the light reflecting up off the ocean floor.

I have been lucky to have been in some terrific waters and had some awesome experiences. Ningaloo Reef (off the Western Australian coast) is astounding and the colour of the water is just superb. I travelled there in 2017 to swim with whale sharks and it was an unforgettable experience. The gentle nature of these huge creatures is totally humbling. Sometimes in life, I am filled with the swell of gratitude and this was one of those times. To spend a week snorkelling the amazing reef there and have it culminate in going into deep water and swimming alongside a whale shark is incredible. The deep cobalt blue of the water is stuck forever in my

Oceans Blush I and *Oceans Blush II*, by Jenny Berry. Acrylic on canvas, 61cm x 76cm each panel

When Angels Dance, by Jenny Berry. Acrylic on board, 1m x 1m (right)

Ocean Between Our Love, by Jenny Berry. Acrylic on reclaimed timber, 20cm x 25cm

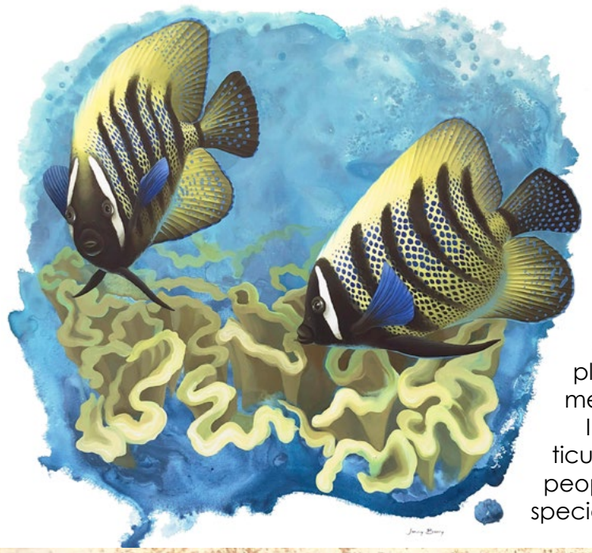
mind. I have tried to replicate that blue in a couple of paintings you see here.

Last year, I stayed on Fitzroy Island in the Great Barrier Reef. It was totally remarkable because you can walk to the beach in front of the resort, put your mask and fins on, and within five minutes, you are swimming with hawksbill sea turtles in their own habitat! I stayed, watching them hack away at coral with their beaks, and just felt astounded at their grace of movement. I was also struck by their ability to camouflage. I find it hard to explain the feeling of euphoria when you are peacefully swimming along, inspecting coral and fish flitting past, when you realise you are a metre from a wild turtle!

It is fair to say every experience I have underwater is being filtered in my mind as a potential artwork. Everything is being filed away as reference for future pieces!

X-RAY MAG: What are your thoughts on ocean conservation and coral reef management and how does your artwork relate to these issues?

JB: Wow, both ocean conservation and coral reef



Jenny Berry

management are so important to me. I have such a profound and deep love of this environment that I want to share with every painting.

As lovers of the ocean, we understand the role it plays in keeping our planet healthy. We understand the life the ocean supports and why it is so vitally important to conserve it. If my paintings encourage viewers to think about this part of our planet and help them love it too, then that makes me really happy.

I like to use my art to educate people about particular species that they may not be aware of. A lot of people are completely unaware of the unique marine species they have on their own doorsteps. For me per-

Ocean Soul, by Jenny Berry. Acrylic on reclaimed timber, 20cm x 25cm

Symbiotic Relationship, by Jenny Berry. Acrylic on canvas, 76cm x 122cm

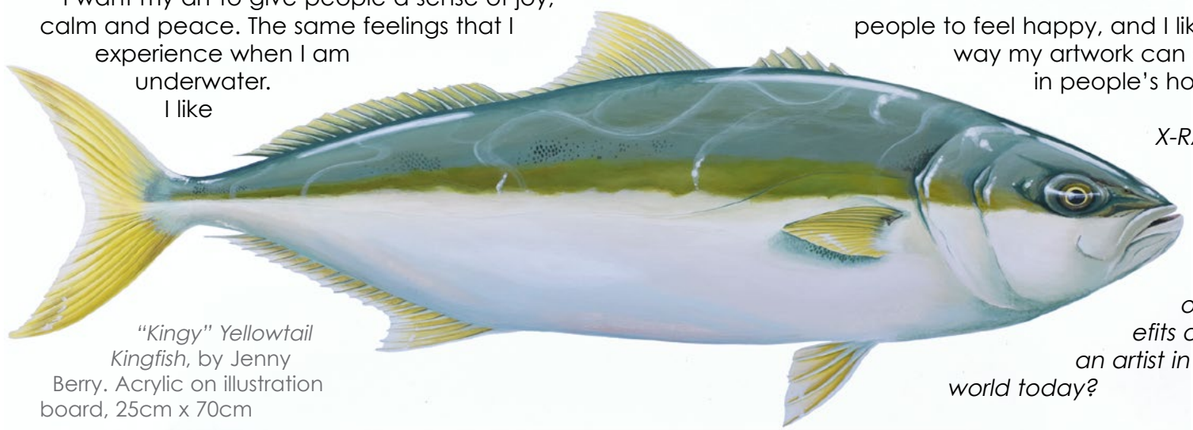
sonally, I live in South Australia where the giant cuttlefish have one of the world's only known annual breeding aggregations. It amazes me that this fact is largely unknown in my local community. I believe that by painting this amazing species, we start a conversation about it. I was very pleased to see David Attenborough include this species in the *Blue Planet II* series. We cannot and will not be motivated to save ocean life if we do not know what is there. The first step in conversation is education. I hope my work helps people become aware of and educated about marine life.

I do like to use reclaimed timber to paint on. I have sourced old bits of timber from my husband's workshop and sanded them up and repurposed them. I like that this helps make my work more sustainable, but I also like the organic feel it contributes to the artwork.

X-RAY MAG: What is the message or experience you want viewers of your artwork to get?

JB: I really want to keep our oceans and its precious marine life top of mind for everybody. I do not mind that some viewers of my art might think it is just a pretty picture. What matters to me is that everyone that sees my art now has an affinity and appreciation for the life held in our oceans. You will not protect what you cannot see and do not understand. If you do not snorkel or scuba, you cannot have that deep appreciation for what is under there. I really believe that by giving people a glimpse into how gorgeous, unique and special our marine life is, they will in turn be compelled to want to save it.

I want my art to give people a sense of joy, calm and peace. The same feelings that I experience when I am underwater. I like people to feel happy, and I like the way my artwork can do that in people's homes.



"Kingy" Yellowtail Kingfish, by Jenny Berry. Acrylic on illustration board, 25cm x 70cm

X-RAY MAG: What are the challenges or benefits of being an artist in the world today?

JB: I feel especially lucky to be an artist in today's world. The connections that we have access to through social media and the Internet are absolutely incredible. I can sell art directly from my studio to anyone, anywhere in the world. In the past, to get your art out to the world, you needed to be represented by a gallery. Giving away a large percentage of your sales in commission was an integral part of being a working artist. Today, this is no longer always the case. I have so much control over how I sell my art.

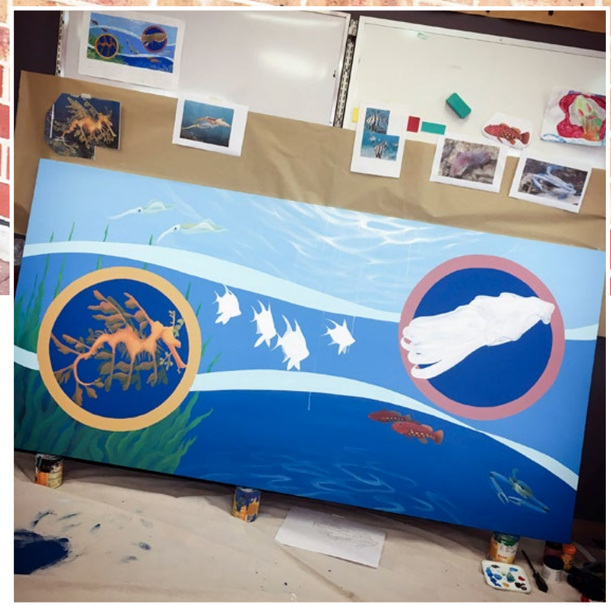
Being so connected enables people, who are passionate about the marine world, to find my artwork. Finding people that share your interests has never been easier. I try to connect with dive groups and clubs on Facebook, so I can share my art with like-minded people.

X-RAY MAG: How do people—adults and children—respond to your works?

JB: Both adults and children find delight in my artwork. Usually, they will connect with it through the subject matter. Every diver, snorkeller, boatie, sailor, fisherman and ocean lover has a story to tell and reminisce about—a time that my artwork will remind them of.

Recently, I have created a marine life mural at

The artist with the mural she created for a local primary school in South Australia (right); School children and their teacher, who were able to see the development of the mural at different stages (lower right) enjoy seeing the finished artwork (below)



a local primary school. The kids here were completely enamoured with the whole process. I was told by a student, "You are my hero." Wow, it doesn't get any better than that, does it? I love creating art, and until that moment, did not realise I was inspiring other people to believe that they too can make a living from following one's passions.

I have painted a commission piece for a gentleman living in Paris, focusing on giant clams. He snorkelled Ningaloo Reef and sent me a wonderful note explaining that he and his wife get to be reminded of that wonderful time every day even though they live in one of the world's largest cities. That is the connection to like-minded people I was referring to in my last answer.

X-RAY MAG: What are your upcoming projects and events?

JB: This year, with the Covid-19 crisis unfolding, my forward planning has changed a little. An exhibition I have scheduled for August will now be online. Like everything, this has its own setbacks and opportunities. I am currently planning what this event will now look like. At this stage, it will be an online exhibition with a virtual tour and possibly a live Facebook chat about the work and my process. Check my Facebook page for more info!

I have also applied for a grant with our local government to create a mural about our local Port Jackson sharks. Like the giant cuttlefish, they too have a mass breeding aggregation annually that not many locals know about. I would love to give them a voice and help our community understand how lucky we are to have them in our local waters. Fingers crossed!

Over the last 18 months, I have been creating a series of murals for a local primary school, and it has been an absolute pleasure and privilege to be doing this.

The murals are designed to focus on endemic species and inform the students about what is unique and special about their local environments. The first one is my passion area of marine life. I am amazed at how little our children know about their local waters. Painting the murals has given me a unique insight into how children think about their world. Their eagerness to learn and their innate curiosity is wonderful. Much like a lot of today's children do not understand how vegetables grow, they also do not really understand that the fish or squid they eat are living creatures that survive in our oceans. It has been wonderful to talk to them about that and help them see that these marine creatures have lives and habits and are important to our whole world.

Although large in size, the murals have been created on large marine plywood boards, which has enabled me to paint in a spare classroom. I have opened the room up to the students during their breaks to see the artwork being created. They have loved being part of the creation of these artworks. They have watched them go from a blank piece of timber to an artwork that houses a whole different ecology to the one they live in every day. For them, they benefit from the knowledge they are gaining about the subject matter, but they also see that careers can take many different shapes.

For me, personally, I get to be surrounded by passionate little people whose eyes light up with joy every break when they come in to check on the progress—an audience that gives me quite unbiased and honest feedback every day and who love having me there. It's terrific! ■

For more information or to order original artwork, commissions and prints, visit the artist's website at: ***jennyberryartist.com***.