ALERT DIVER

THE MAGAZINE OF DIVERS ALERT NETWORK

FALL 2015

Blue Water RED SEA

TASMANIA: FOR SOMETHING COMPLETELY DIFFERENT / DCS UNCERTAINTY / ARCTIC ADVENTURE

LAURENT BALLESTA: BLENDING SCIENCE AND ART / CHILDREN AND DIVING

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ALERT DIVER

THE MAGAZINE OF DIVERS ALERT NETWORK FALL 2015

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Striving to make every dive accident- and injury-free. DAN's vision is to be the most recognized and trusted organization worldwide in the fields of diver safety and emergency services, health, research and education by its members, instructors, supporters and the recreational diving community at large.

DAN
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MISSION

DAN helps divers in need of medical emergency assistance and promotes dive safety through research, education, products and services.

Divers Alert Network® (DAN®), a nonprofit organization, exists to provide expert medical information for the benefit of the diving public.

DAN's historical and primary function is to provide timely information and assistance for underwater diving injuries, to work to prevent injuries and to promote dive safety.

Second, DAN promotes and supports underwater dive research and education, particularly as it relates to the improvement of dive safety, medical treatment and first aid.

Third, DAN strives to provide the most accurate, up-to-date and unbiased information on issues of common concern to the diving public, primarily — but not exclusively — for dive safety.

ALERT DIVER'S PHILOSOPHY

Alert Diver® is a forum for ideas and information relative to dive safety, education and practice. Any material relating to dive safety or dive medicine is considered for publication. Ideas, comments and support are encouraged and appreciated.

The views expressed by contributors are not necessarily those advocated by Divers Alert Network. DAN is a neutral public service organization that attempts to interact with all diving-related organizations or persons with equal deference.

Alert Diver is published for the use of the diving public, and it is not a medical journal. The use and dosage of any medication by a diver should be under the supervision of his or her physician.

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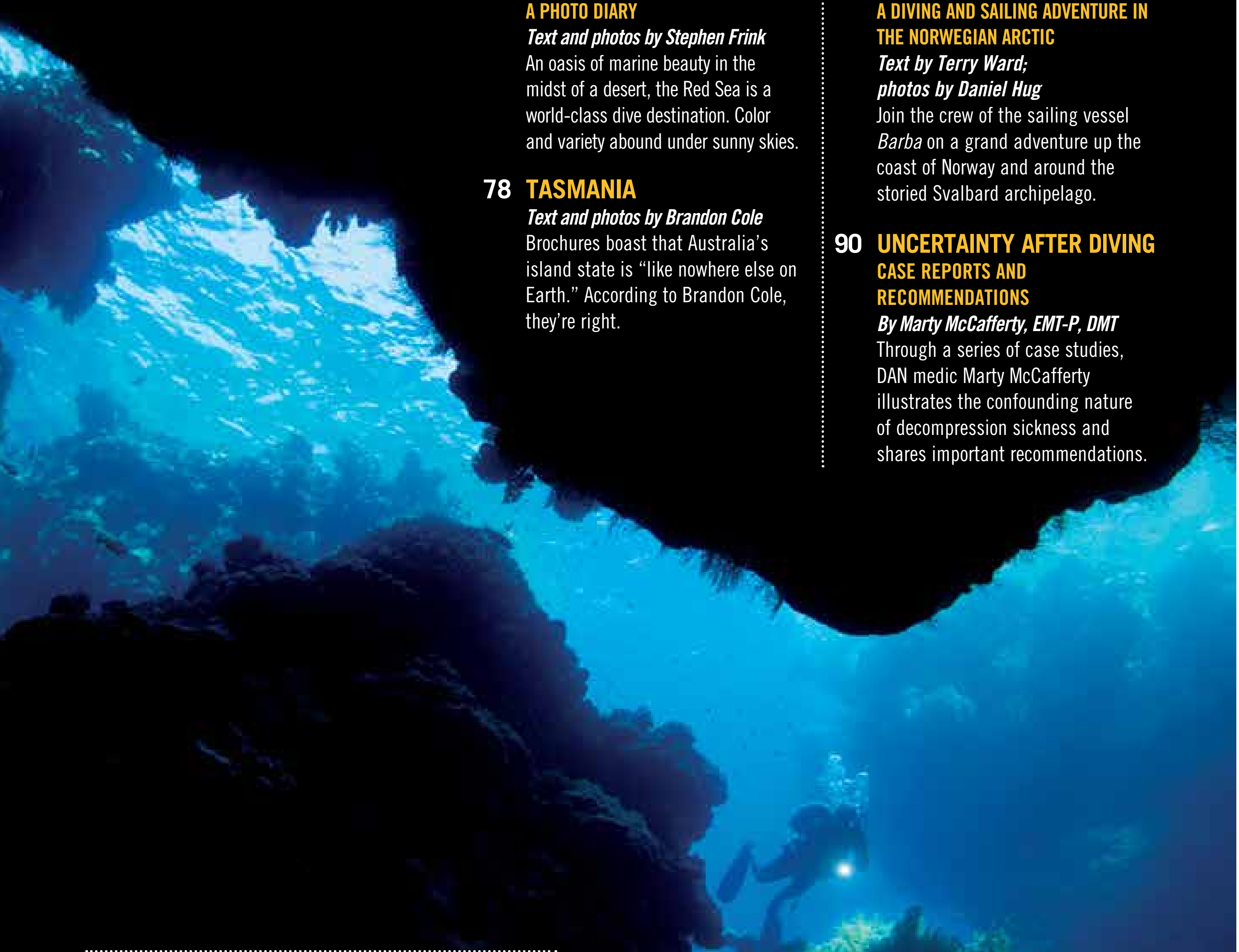

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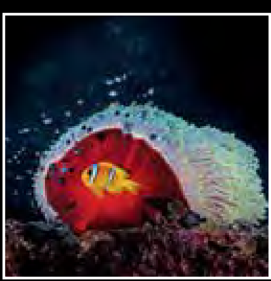
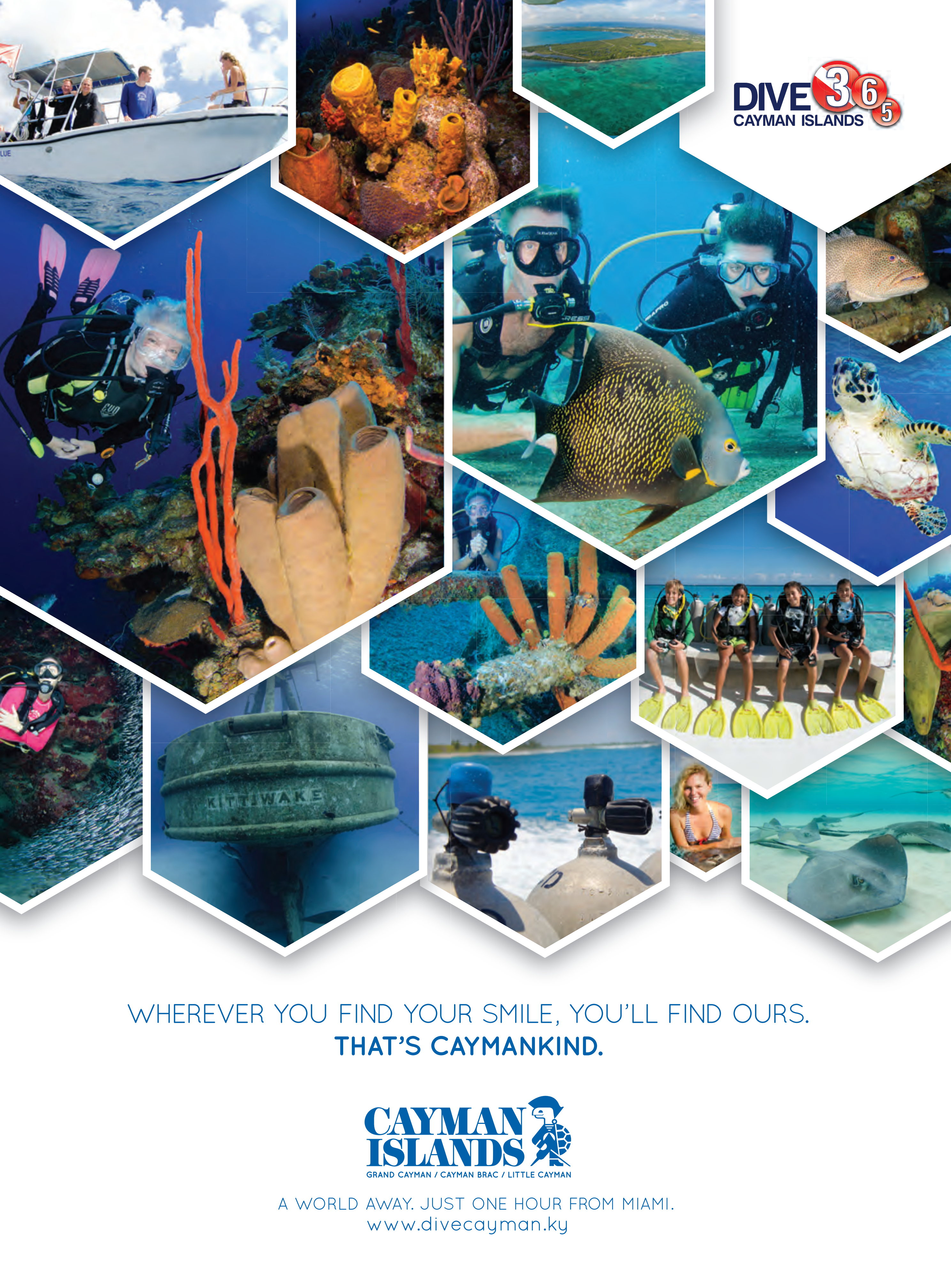


ON THE COVER: A twoband anemonefish presents a striking contrast with an anemone's crimson mantle at Fury Shoal in the Red Sea. Joe Poe took the photo using a Canon EOS 5D Mark III with a Canon 16-35mm 2.8 II at 30mm, Inon Z-240 Strobes (2) and Nauticam housing, 1/180 sec @ f/13, ISO 320.

THIS PAGE: St. John's Caves, Southern Red Sea. Photo by Stephen Frink



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Bluecheek butterflyfish,
a Red Sea endemic.
Photo by Stephen Frink

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Oxygen First Aid Preparedness

By Bill Ziefle

Dive accidents can happen anywhere, any time and to anyone. As divers, we know that oxygen is widely accepted as the standard first aid for symptoms after diving. Oxygen is so vitally important that it should be readily available wherever people are diving.

Oxygen provides many benefits, including mitigating respiratory distress, reducing swelling and increasing oxygenation of the body's tissues, which promotes healing. In cases of suspected decompression illness, oxygen helps minimize further tissue injury, enhances elimination of inert gas (e.g., nitrogen) and contributes to good outcomes. It can even save lives.

It is important that you take responsibility for your safety. Ask your dive operator about the availability of oxygen. It is absolutely reasonable to ask to see the oxygen unit before the boat leaves the dock; this ensures you know where it is and that it's in good condition. Note that some dive professionals present the oxygen unit as part of their dive briefing. Depending on the location of the dive site, ask if there is enough oxygen to get at least one injured diver back to the dock or to the closest medical facility. Finally, identify which of the dive staff are trained in oxygen first aid.

Simply having oxygen it is not enough. Safely and correctly administering oxygen first aid requires proper training. Fortunately, DAN has you covered. The DAN Emergency Oxygen for Scuba Diving Injuries course was developed by medical experts and designed to provide divers (and nondivers) with the skills to respond to emergencies with confidence. For more than 20 years this course has taught divers how to administer oxygen in the event of diving injuries and other aquatic emergencies.

DAN is here to field calls about oxygen administration, transportation to medical facilities, follow-up care and other dive accident concerns. We encourage divers and others responding to emergencies to call the DAN Emergency Hotline (+1-919-684-9111). We even provide medical consultation to emergency departments, hyperbaric facilities and other medical professionals to assist with treatment.

Obtaining medical-grade oxygen can be a challenge in many places because of the need for a prescription or limited access to a facility that supplies oxygen. If you have trouble filling your oxygen unit, contact DAN at +1-919-684-2948.

> "Oxygen is so vitally important that it should be readily available wherever people are diving."

DAN developed the Oxygen Grant Program to both enhance diver safety and support dive professionals. The program improves access to this potentially life-saving treatment by providing oxygen units to dive operations and organizations that demonstrate a genuine need. Improving access to oxygen is particularly important in remote locations, where getting proper medical care may be not be straightforward.

When dive injuries occur, being able to recognize the problem and respond with the appropriate care can speed recovery and minimize lasting effects. DAN feels so strongly about the need for access to oxygen first aid and the benefits it provides that we are dedicating all the proceeds from our end-of-year fundraiser to expanding our Oxygen Grant Program worldwide.

DAN would not be what it is today without the support of divers and the dive professionals who work to keep divers safe. Spread the word: If you know an organization that has a genuine need for oxygen in the pursuit of their interaction with the dive or aquatics communities, tell them about the DAN Oxygen Grant Program. Most importantly, make sure your emergency action plan includes access to first-aid oxygen. AD

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KIM ELDRIDGE

Stephen Frink photographs spinner dolphins in the Southern Red Sea.

Geopolitics and Dive Travel

By Stephen Frink

This issue's cover story is about a dive safari I did in July to the Southern Red Sea (see Page 70). No other dive destination is quite like the Red Sea in terms of water clarity, abundance of soft corals and endemic species. I've chartered liveaboards there nine times — more than any other exotic destination — and I find it one of the most photographically productive.

Europeans go there far more often than North Americans do. British underwater photographer Alex Mustard said, "I have been there more than 30 times. From a European perspective, it is great value for money. Flights are direct from across Europe, just two to five hours and only one or two time zones away. It is definitely our nearest warm water." That's probably about as often as I've been to the Bahamas. Clearly, proximity is relevant.

The Red Sea is where I booked my very first liveaboard in 1982. The boat I chartered, the *Sun Boat*, has now been scuttled and is a tech dive site off Eilat, Israel. This is only one of many changes to tourism in the Sinai Peninsula over the past few decades. In 1982 the last Israeli troops were leaving the region, a result of the peace treaty between Egypt and Israel in 1979, after reaching agreement during the Camp David Accords in 1978. Many booms and busts in tourism have occurred there over the years, with most related to the politics of the Middle East.

When planning my trip to the Red Sea earlier this year I'd mention it to friends, and surprisingly often I'd get a sage nod and a comment such as, "I'd like to go there when things calm down." The news media makes it hard not to be at least a little concerned about instability in that part of the world. While the perception may have induced some anxiety, the reality I experienced was pleasant and mild.

The Hurghada airport was brand new and efficient, and the immigration procedures were simple. We spent the night in a modern Marriott and then drove three hours on a well-maintained highway to Port Ghalib the next day. We also could have flown into Marsa Alam and been just minutes away from Port Ghalib. Access was simple.

Port Ghalib encompasses a marina with scores of dive liveaboards and an upscale development of hotels, restaurants and condos around the waterfront. The Egyptians were warm and welcoming. Being a North American in the Red Sea wasn't exactly a novelty, but I had the impression that fewer of us are going there since the Egyptian Revolution of 2011. Not so with visitors from the rest of the world: *Travel and Tour World* reports, "With large numbers of tourists returning to Egypt, the sector is once again witnessing new investments and stimuli as visitors from new markets visit the country. Multibillion-dollar investments in new development projects and hotels and increasing numbers of tourists from developing markets such as Russia and China are driving the industry to new heights." Despite the quality of the diving, the relative strength of the economy and the significant dive infrastructure, geopolitical concerns keep some divers from considering the Red Sea. But not me; I'm eager to book my 10th liveaboard trip there.

Coups and political unrest have occurred over the years in places you would normally assume were calm and bucolic, such as Fiji or the Solomon Islands. Generally these are transient local issues. Many of these island nations depend on tourism, so interruptions of the status quo can create temporary chaos if people feel uncomfortable traveling there. If there is somewhere you might like to go in the diving world but feel some apprehension, what can you do?

The first and most obvious thing is to check with the U.S. State Department for travel advisories (*state.gov/travel*). The website offers resources to help with lost or stolen passports, traveler's health inquiries, injury or death abroad, visa assistance, Trusted Traveler programs and current travel warnings. I noted no travel advisories for Egypt, but perusing the website I did discover the Smart Traveler Enrollment Program (STEP), which seemed like a prudent free benefit for American travelers (*https://step.state.gov/step*).

After filing your planned itinerary with STEP you gain the benefit of timely, relevant information sent to you via email, and it also helps the State Department know which citizens are in a particular country at any given time. If there is an emergency, political unrest or a natural disaster, you will be made aware. I enrolled in STEP before the Red Sea trip, and I never heard anything from it, which I took to be a good thing.

Many of the places we travel to as divers have great economic disparity, and we can do a lot to prevent bad events simply by using good judgment. Don't travel with flashy jewelry, and don't allow yourself to be compromised (drunk or otherwise impaired) in public places where you might be a target. I take comfort in carrying DAN's Annual Travel Insurance everywhere I go (*DAN.org/travel*). It helps with compensation for emergency assistance and transportation as well as trip cancellation and interruption. DAN's Elite per-trip travel insurance plan allows cancellation for any reason, including geopolitical situations or coups.

Probably the best protection you can have is situational awareness and vigilance on the road. AD

WHAT'S NEW ON ALERTDIVER.COM


ETHAN DANIELS

CAPE COD CHARISMA

Explore Cape Cod on Page 36, and then see more of the area's special charm in Ethan Daniels' bonus photo gallery.

REVELING IN THE RED SEA

After diving into Stephen Frink's photo diary about the Southern Red Sea on Page 70, jump online to see more of this oasis of marine beauty.


STEPHEN FRINK


BRANDON COLE

TOURING TASMANIA

Begin your Tasmanian voyage with Brandon Cole on Page 78, and then discover more of what makes the island unique in the online bonus photo gallery.

TREATING INJURED DIVERS

A new online column highlights medical facilities from DAN's global network that provide optimal care for injured divers. The featured facilities are available 24/7, are equipped and willing to treat divers and are invested in providing a high standard of care.


STEPHEN FRINK

ALL THIS AND MUCH MORE AWAIT AT ALERTDIVER.COM

STEPHEN FRINK

IF YOU SEE SOMETHING, SAY SOMETHING

Your article "When Bad Things Happen to Good Divers" (Publisher's Note) and the letter from Shane Gross (Letters) in the Summer 2015 issue really got my attention. I often get looks when I comment on things I see that are unsafe. I feel all divers — not just working pros — have a duty to help educate those who are less experienced and to help prevent accidents.

Diving is a recreational sport, but we put our lives on the line every time we dive. I have seen divers bully their buddies into making dives they clearly weren't comfortable with. I have seen divers who are more concerned about being first in the water than about safety. I have spoken up during such events because the crew apparently did not want to offend the guests. If more divers become focused on safety, speak up and help educate, we all benefit.

— Kelly M. Lee, via email

SHARED RESPONSIBILITY

I missed the article "Don't Blame the Dive Operator" (Dive Safety Culture, Spring 2015) that Shane Gross mentions in his letter in the Summer 2015 issue, but I would like to comment. I am a 78-year-old guy who took up diving late in life. Though I have attained the Master Diver certification I still prefer to stay close to the divemaster (DM). My navigation skills are still not as good as I would like them to be, especially in blue water, and I'm more comfortable knowing I'm not going to lose the boat. I agree it is divers' responsibility to keep tabs on their own air, depth, weather and everything else that might affect the dive.

However, I believe it is still the DM's responsibility to check on the divers often to be sure nobody is trying to get his or her attention. I have dived with many DMs who never check to see if they might be needed. Although they all say to let them know when we are at 1,500 psi and then 700 psi, many never look back to check.

I know I need to improve my blue-water navigation skills and need to always know where I am in relation to the boat, but I also feel it is the DM's responsibility to make sure I am not lost, especially if I said I would be diving close by and explained why. Is this wrong? Am I expecting too much?

— Gary McCoy, Carrollton, Texas

HEAVY GEAR

I have a minor correction to the article "Year of the Military Diver" (Dive Slate, Summer 2015). The Mark V (like other models of "heavy gear") does not have a neck seal. The suit bolts to the breastplate with an integral rubber gasket, and the hat connects to the breastplate with an interrupted bayonet thread and leather gasket. Air flows freely between the hat and suit.

— Chris DeLucchi, via email

A MAN OF HONOR

In "Year of the Military Diver," I am disappointed that *Alert Diver* omitted the 45th anniversary of Carl Brashear's achievement of Master Diver, the highest designation a U.S. Navy diver can achieve. Brashear was the first African-American diver in the U.S. Navy. His advancement to Master Diver came four years after he located a hydrogen bomb from a downed B-52 bomber in 2,850 feet of water off Palomares, Spain, which led to its recovery. He lost his leg in an accident during the recovery of the bomb. Brashear was born to a poor rural sharecropping family in Kentucky in 1931. His is a remarkable story of the triumph of the human spirit.

— Gary Lehman, via email

SMALL CHOICES

After I finished reading your cover story, "Racing Extinction" (Dive Slate, Summer 2015), I considered how I might become an "indomitable spirit" and make "small choices" that "lead to the kind of world we all want for the future," and I came to a decision. Since I don't eat shark fins or manta ray gill rakers, at the very least I will no longer contribute to the acidification of the ocean by flying on large carbon-burning aircraft to those exotic dive destinations advertised in your magazine. And no longer will I use carbon-burning

dive boats to transport me to dive sites or use air compressors that use electricity created by burning carbon fuel or, for that matter, will I purchase any dive product (such as those advertised in your magazine) that uses fossil energy to produce it. Also, in further effort to minimize my carbon footprint, I'll never again patronize a dive resort that serves beef since cow flatulence is even more harmful to the sea than all those other activities combined! Yes, it's going to be difficult bicycling and sailing to dive destinations, getting by on sprouts and beans for breakfast and diving without gear. But if I love the ocean (and I do), what other choice do I have? Rank hypocrisy? AD

— Steve Borgess, Wachapreague, Va.

WRITE US

Tell us what's on your mind by writing us at:

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ONLINE
Send email to:
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All letters included in this column are subject to editing for length and content.

CORRECTION

The black-and-white photo of Chuck Nicklin on Page 28 of the Summer 2015 issue was not credited to Lee Peterson as it should have been. We apologize for the omission.


LEE PETERSON

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EVAN KOVACS


MICHAEL BARNETTE


MICHAEL BARNETTE

Back to *Britannic*

By Michael C. Barnette

For experienced technical divers, the *Britannic* is the quintessential wreck dive. This *Olympic* class ocean liner is the sister ship of perhaps the most famous vessel in history: RMS *Titanic*. Unlike the *Titanic*, *Britannic* never carried passengers on the transatlantic route. Instead, the British government employed it as a hospital ship with the outbreak of World War I. In the course of that service, it struck a mine deployed by the German submarine *U-73* in the Aegean Sea on Nov. 21, 1916. HMHS *Britannic* now rests on its port side in approximately 400 feet of water, less than 3 nautical miles off the Greek island of Kea.

Simply put, the *Britannic* wreck is spectacular. Given its pedigree and the fact it rests tantalizingly close to shore, one might think technical divers visit the site regularly. But there are even greater hurdles to exploring the wreck than its depth. One must first acquire permission from the British owner of the wreck site as well as permits from the Greek government before even considering the sourcing of tanks, breathing gas and additional gear needed for diving operations. Planning usually takes several months or even a year. And all this is easier said than done. Having participated in a previous expedition to *Britannic* in 2006, I was well aware of all the bureaucratic and logistical issues that generally wreak havoc on planned diving objectives. It is for this reason I was a little taken aback when I received an invitation to dive this epic ocean liner from noted wreck diver Richie Kohler with advance notice of only one month.

Unbeknownst to me, underwater imaging expert Evan Kovacs had hounded the Malta-based, Russian-staffed exploration and filming company U-Group for more than a year in hopes of joining them in Greece. Affiliated with the Russian Geographical Society, U-Group had been exploring and filming *Britannic* using a three-man submersible and remotely operated vehicle (ROV) from their research vessel *U-Boat Navigator* for the past two years. Kovacs hoped to piggyback on their permit to conduct reconnaissance in advance of a much larger future expedition to Greece.

With the apparent support of U-Group and excitement about again visiting the wreck of *Britannic*, we found ourselves headed back to Kea in late June 2015. Accomplished Italian diver Edoardo Pavia — driving a van full of tanks, breathing gas, rebreather consumables and other necessary gear across Greece — rounded out our small team. But because of a general lack of interaction and communication between Western divers and our Russian counterparts, we were not exactly sure what to expect upon our arrival.

Fortunately, our initial meeting aboard *U-Boat Navigator* allayed any uncertainty we may have had about

MICHAEL BARNETTE

Diver Edoardo Pavia illuminates the bridge of *Britannic*.

Opposite, from left: U-Boat Navigator **in Kea, Greece; *U-Boat Navigator*'s three-man submersible explores the wreck of *Burdigala*; the well-appointed clinic aboard *U-Boat Navigator***

the crew or their capabilities. We were pleasantly stunned by all the tools on board the research vessel. Aside from the aforementioned submersible and ROV, they had a large chase boat, a multibeam and side-scan sonar, a massive fill station, an elevated dive platform, an amazing clinic with a multiplace hyperbaric chamber, a fully equipped video production station and a diving bell complete with communications, video, hot water and abundant supplies of emergency breathing gas. The diving bell would allow up to two divers at a time to stand up in an air-filled chamber, remove their gear and have a chat or get a drink of water, all while being monitored by a hyperbaric physician topside. With planned dive times approaching six hours, the diving bell radically increased safety compared with conventional open-water decompression while also offering a great diversion from the monotony of decompression stops.

The enhanced safety provided by the in-water monitoring and the diving bell had special significance in light of Carl Spencer's fatal dive on May 24, 2009, while leading a National Geographic expedition to *Britannic*. Spencer was an extremely competent technical diver and was very familiar with *Britannic*; the 2009 project was his third expedition to Kea. He had also led or participated in numerous other technical diving expeditions, including a 2007 venture to the liner *Carpathia*, rescue ship to *Titanic*, which rests at approximately 500 feet about 200 nautical miles off the coast of Ireland. Yet he passed away on a dive that, at face value, should have been routine for someone with his experience. Unfortunately, he made a series of mistakes that culminated in him breathing from an improperly labeled cylinder, resulting in an in-water seizure from oxygen toxicity at approximately 120 feet. With no good options, support divers rushed Spencer to the surface in hopes of treating him in the expedition vessel's hyperbaric chamber. Tragically, all efforts to save him were unsuccessful. During our initial inspection of *U-Boat Navigator,* we realized with heavy hearts that had Spencer been diving with the tools we now had at our disposal, his death perhaps could have been prevented.

About 24 hours after I landed in Greece I was suited up and ready to splash on the wreck of the French liner *Burdigala* to conduct a checkout of my gear. Meanwhile, our entire team was evaluating the operations of the *U-Boat Navigator,* while I suspect the Russian crew was ensuring we weren't a bunch of crazy Americans (and one Italian) intent on killing ourselves. We successfully completed a shakedown dive on *Burdigala,* which rests at a little more than half the depth of *Britannic*, and interacted with the submersible and ROV at depth. On a second dive to the wreck, we included the diving bell in operations to test and familiarize ourselves with it prior to employing it on a much longer, deeper dive. Having established an efficient communication protocol with the topside crew and worked through potential scenarios for future dives, we were ready for *Britannic.*

Britannic, however, was not ready for us. Over the next several days we encountered very strong currents that prevented diving. On the first day, the ROV and submersible confirmed a three-knot current all the way to the wreck. Current is not usually a deterrent for live-boat operations, which utilize drifting decompression, but the Greek permit mandated a moored diving platform. We lost two more days to strong winds that made the sea conditions inhospitable, to say the least. Because of the short timeframe for this small-scale reconnaissance trip, we were now down to a single day to dive the massive liner.

Fortunately, the stars aligned and the Aegean presented us with spectacular conditions on the last day. Leveraging considerable skill and experience, and aided by multibeam sonar and navigational software, the *U-Boat Navigator* crew secured a three-point mooring directly over *Britannic's* bridge, exactly where we wanted to be. We knew where we were on the 880-foot-long wreck even before we entered the water. Our position was confirmed with the deployment of the submersible, ROV and diving bell, all of which fed live video to the dive vessel's control room. There was nothing left to do but suit up and dive in.

Splashing into the cool Aegean waters, we initially used the ROV's downline to descend out of the surface current before transferring over to the diving bell's umbilical line. On the bottom, Pavia and I were tasked with running a line from the diving bell out to our area of operations on *Britannic* to expedite Kovacs' and Kohler's assigned project. Our task completed, we proceeded to inspect the bridge area of the magnificent wreck and confirm the presence of several key artifacts and features for future work. Being focused on the various tasks at hand and consumed with capturing the wreck in both still images and video, I occasionally had to force myself to stop, put down the camera and just take in the magical scene laid out before me. In the muted but clear blue water was a massive structure with almost 100 feet of relief, portions illuminated by the piercing lights of the submersible and ROV. It almost seemed as if the surreal scene was an elaborately fabricated Hollywood production. All too rapidly, 40 minutes ticked by, and we began making our way toward the diving bell. En route, we all took one last minute to say goodbye to both *Britannic* and our friend Carl Spencer.

Ecstatic from our successful and productive dive, we slowly crept toward a surface that was 280 feet and almost five hours away. For me the time passed quickly as I replayed the dive in my head and reflected on the entire remarkable experience. After completing our lengthy decompression obligation, we surfaced tired, yet thrilled, having completed all our goals and objectives. In doing so, we furthered Spencer's vision for exploration of this iconic shipwreck and finally answered a question that has baffled historians for 99 years: Why did *Britannic* sink twice as fast as its more famous sister ship? We were also content in knowing that we had conducted one of the safest and best-supported technical dives on *Britannic* to date. Having forged a strong friendship with the crew of *U-Boat Navigator*, it's safe to say we are all giddy in anticipation of future work on *Britannic*.

LEARN MORE
Explore the history of diving expeditions to HMHS *Britannic* and learn some of the wreck's secrets in *Mystery of the Last Olympian* by Richie Kohler and Charlie Hudson, available in January from Best Publishing. For more information, visit *MysteryoftheLastOlympian.com*.

JOE PAWLIK

Overfishing Aids Sponges, Hurts Corals on Caribbean Reefs

By Joseph R. Pawlik, Ph.D.

With brightly colored branches, tubes, mounds, fans and barrels, sponges are dominant animals on most reefs. Despite their quiet stillness, they are involved in an ancient and ongoing struggle with their predators and competitors — and on modern-day Caribbean reefs, sponges appear to be winning.

Sponges feed by consuming tiny particles and dissolved compounds in the seawater they pump through their bodies. Millions of flagellated cells inside sponges power this pumping, generating an outward flow from the sponges' larger openings. A population of Caribbean giant barrel sponges can process the entire volume of seawater above a reef in as few as three to 18 days, depending on sponge abundance and depth. This unusual feeding strategy sets sponges apart from the other two primary reef occupiers, corals and seaweeds, which rely primarily or exclusively on sunlight and photosynthesis for their nutrition. Using this difference to their advantage in the struggle for available space, sponges can grow to shade and smother corals and seaweed and then steal the real estate.

When my research group from the University of North Carolina Wilmington began working on sponges more than 25 years ago, the conventional wisdom was that sponges on Caribbean reefs were largely unaffected by predation. Angelfishes and hawksbill turtles had been identified as sponge predators, but it was thought that their feeding activity was evenly spread out among sponges, not causing particular harm to any one species. We discovered that several species of parrotfishes are sponge predators. Furthermore, we determined that predators avoid some sponge species because of distasteful chemical compounds in the sponges' tissues. Over the years we have worked with organic chemists to isolate and identify the chemical compounds that serve as defenses for many sponge species. Some of these compounds show interesting properties that may be useful in the development of new drugs to treat human diseases.

Our research found that not all sponge species on Caribbean reefs have chemical defenses. Sponge predators targeted some very common species, such as gray tube and green branching sponges, in a series of experiments we conducted on reefs in the Florida Keys. We observed that these undefended sponges grow faster than chemically defended sponge species. This was important evidence for what ecologists call a resource trade-off: Sponge species invest their energy in either making chemical defenses or growing faster, but they can't do both.

Based on that observation, we predicted that undefended yet faster-growing sponge species would populate new reef habitats more rapidly than defended species. We were able to test this hypothesis with the sinking of the USS *Spiegel Grove* as an artificial reef off the coast of Key Largo, Fla., in 2002. After only four years the wreck was covered with undefended sponge species, and very few chemically defended species were present. Since then the wreck has attracted the angelfishes that eat these sponges, and on subsequent visits we have seen the relative proportion of undefended sponges decrease as the predators graze them and the chemically defended species steadily recruit and grow on the wreck.

To test our developing model of sponge ecology, a team of five of us conducted dive surveys of 69 reefs in 12 Caribbean countries over three years. We chose locations such as Jamaica and Martinique that have been overfished using fish trapping and netting as well as locations such as the Cayman Islands, Bonaire and the southeastern Bahamas with less-fished reefs that

When sponge-eating fish are overharvested, sponges can quickly overgrow and kill reef-building corals.

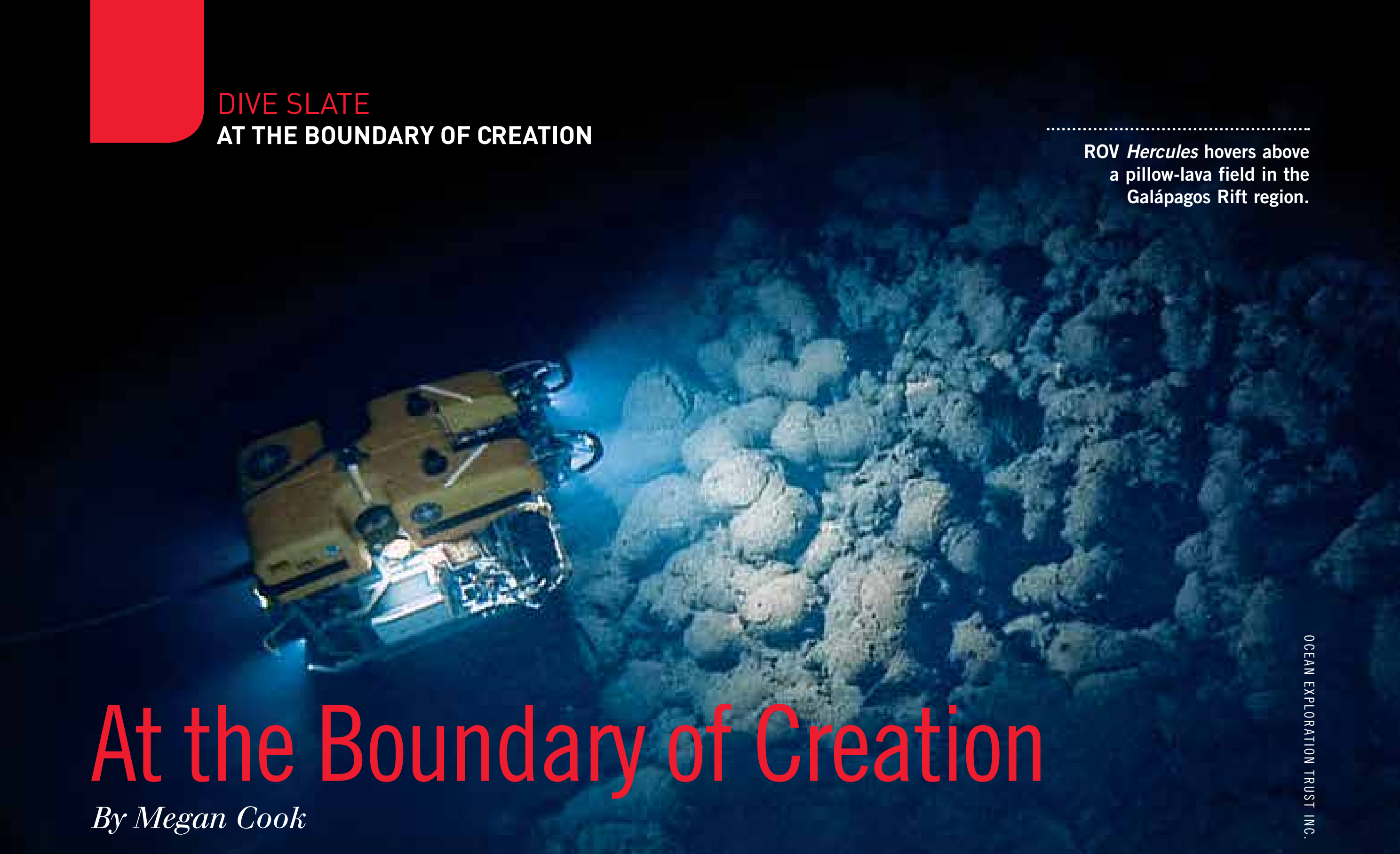
JOE PAWLIK

have been mostly protected from fishing. We predicted that the removal of sponge predators on overfished reefs would allow the undefended sponge species to flourish, while these species would be held in check by sponge predators on less-fished reefs — and that's exactly what we found. In particular, angelfishes had a dramatic effect on the sponge species they like to eat. Our results showed that overfishing of sponge predators altered the community of sponges in favor of faster-growing, undefended sponge species.

Overfishing of Caribbean reefs changed more than just the sponge community. Our Caribbean-wide study documented three times more sponge overgrowth of reef-building corals on overfished reefs, a direct consequence of undefended sponges growing unchecked by sponge predators. With the fast-growing sponges free from predation on overfished reefs, they were able to smother adjacent reef-building corals.

Divers know that corals, not sponges, build the reefs we cherish. Caribbean coral reefs provide shoreline protection for reef-adjacent countries as well as millions of dollars in annual tourist revenue. For the conservation of coral, the results of our research justify the protection of sponge predators on Caribbean reefs. The first course of action should be to ban fish-trapping and netting practices that indiscriminately remove fishes of all species. Sponge predators, particularly angelfishes, warrant special protection, especially from spearfishing.

Divers can help by encouraging Caribbean governments to enact protective legislation and to fund management programs and by supporting marine parks and protected areas that enforce fishing restrictions. These actions can help restore reef ecosystems that are severely out of balance.



ROV *Hercules* hovers above a pillow-lava field in the Galápagos Rift region.

OCEAN EXPLORATION TRUST INC.

At the Boundary of Creation

By Megan Cook

In 1977 a team of geologists from Woods Hole Oceanographic Institution (WHOI) took the manned submersible *Alvin* to the Galápagos Rift region off the coast of Ecuador. There lies a divergent boundary where the Nazca and Cocos plates separate at the speed fingernails grow, about two inches per year. Studies of the region indicated that heat was cycling along this east-west rift, but the seafloor process remained undescribed. The 1977 expedition, led by Robert Ballard, Ph.D., made an important discovery that would transform our understanding of how life functions on Earth.

Ballard and his team discovered an underwater Yellowstone — a highly geologically active area of lava flows, fissures, vents and chimneys. Towering hydrothermal vents stood as the backdrop for a realm of life no one had ever encountered: towering tube worms, massive clams, bearded mussels and ghostly white crabs. Peering out of *Alvin*'s tiny portholes, the three-man team sat awestruck by the oasis of life they found flourishing — entirely without connection to the sun's energy.

The tall chimneys grew, spewing vent fluids as hot as 650°F into the frigid surrounding seawater and depositing layer upon layer of dissolved zinc, copper, lead and iron. Billowing from these chimneys like factory exhaust, black vent fluids fed the community of creatures that clamored for Goldilocks real estate — near enough to feed from the flow but not so close as to be scalded.

Until 1977, all food chains and all life were thought to rely on solar energy and photosynthesis. The deep ocean was assumed to be a wasteland where sparse populations of deep-sea creatures looked upward for a meal of meager particles that rained down from the sunny shallows. But deep in the dark ocean, Ballard and his team had discovered organisms that sustained themselves completely with chemicals from within the Earth's crust. The fact that organisms could harness the energy of chemical bonds, a process called chemosynthesis, dramatically increased the number of habitats capable of carrying life — on Earth and beyond.

Fast forward nearly four decades to 2015. Although technology has made the seemingly impossible accessible and even commonplace, bewilderingly, 90 percent of the world's oceans remain unexplored. Floating on the open sea two miles above the Galápagos Rift is the 211-foot exploration vessel (E/V) *Nautilus*. In a darkened control room on its highest deck, a team of engineers, scientists, educators, technologists and students stare captivated into the glow of wall-to-wall video monitors. Each screen is a window onto the crushing and coal-black world being explored by *Hercules* and *Argus*, the team's remotely operated vehicles (ROVs). Linked to the ship by fiber-optic cables and linked to the entire world via live satellite broadcast, these robots are humanity's eyes on never-before-seen places.

Weighing more than 6,000 pounds and roughly the size of a car, *Hercules* is loaded with sensors and sampling tools, dexterous manipulator arms and cameras aimed in eight directions. In a decade of exploration, *Hercules* and *Argus* have sampled and surveyed deep-sea corals, ancient shipwrecks, underwater volcanoes, seafloor trenches and war history in the Mediterranean, Black and Aegean seas, the Gulf of Mexico and throughout the Caribbean. The goal of the 2015 expedition to the Galápagos Rift is to better understand how hydrothermal vent systems age and change. The voyage also represents a special homecoming. As Ballard directed the team from the *Nautilus* control center, he laid his eyes on the site of his most important discovery for the first time in nearly four decades.

When WHOI scientists visited the rift region in 2002, the original 1977 vent discovery site was nowhere to be found. Thick lava flows of glassy black blanketed the seafloor in all directions. All evidence of the towering tubeworm communities had been wiped clean, paved over by geological forces. During that expedition, the WHOI group carefully mapped and marked a new venting site named Rosebud. Researchers placed site markers and sampled a rich chemosynthetic community, advancing deep-sea science. When *Hercules* shone its lights on Rosebud a decade later, only collapsing lava domes, shattered columns and pillowed rock flows could be seen. The shiny basalt glistening in *Argus'* lights and the occasional dead clam told the story of a violent geologic upheaval that had wiped out the ecosystem.

In 2011 the *Okeanos Explorer,* a collaborating ship from the National Oceanic and Atmospheric Administration (NOAA), found a low-temperature diffuse vent field with nascent life present along the rift. NOAA named the site Tempus Fugit. In this year's mission, eager to determine how Tempus Fugit had matured in four years, *Nautilus* deployed its robots. Teams in the control center, collaborating scientists onshore, future explorers in classrooms and public audiences in museums nationwide sat glued to their screens as *Hercules* inched eastward along the Galápagos Rift.

As the ROV neared the seafloor and a faint white glow appeared at the perimeter of the camera's view, Ballard's voice called out from the control center, "We've got 'em!" The whole team leaned closer to their screens. From the darkness emerged the white stalks of the iconic tubeworms, *Riftia* sp., jumbled in stacks like a crumbling pipe organ. Three-foot worms concealed in 10-foot tubes stretched their feathery crimson plumes into the vent flow. The tubes rose like cathedrals all around venting flows. Football-sized clams and mussels spilled out of lava cracks and fissures. Hot water shimmered across the seafloor, blurring the camera's views of creatures basking in a nutrient soup rising from deep within the Earth. Less than five years had elapsed since ROVs recorded a nearly barren seafloor at this precise location. Data loggers in the control center captured images furiously as surveys identified a community of crabs, octopods, sea cucumbers and vent fish.

The moment of discovery on *Nautilus* was electric, giddy and ephemeral, and that same thrill was shared with armchair explorers gazing on through smartphones and laptops around the world.

Scientists now support the hypothesis that Galápagos vent communities are overturned on decadal timescales rather than at the millennial pace of many geologic processes. Studying creatures that thrive in this alien world reveals special adaptations for the boom-and-bust unpredictability of living off vent fluids. *Riftia* worms have no digestive tract; that organ system atrophies after juveniles settle near a vent site to allow more body space for internal chemosynthetic bacteria

PHOTOS THIS PAGE: OCEAN EXPLORATION TRUST INC.

Clockwise from top left: **The darkened control room of E/V *Nautilus*; the deep-sea octopus *Graneledone boreopacifica* spends its life in total darkness; Bob Ballard works with expedition leader Allison Fundis during a mission; *Riftia* tubeworms of the Tempus Fugit vent gain their energy from chemosynthesis; ROV *Hercules* can dive deeper than 13,000 feet to collect samples and stream HD video back to E/V *Nautilus*; E/V *Nautilus***

that harness the hydrothermal buffet flowing past. Almost all organisms in this environment broadcast spawn their larvae into ocean currents, hedging their evolutionary bets that offspring will land near another flow if the parents' vent fizzles out.

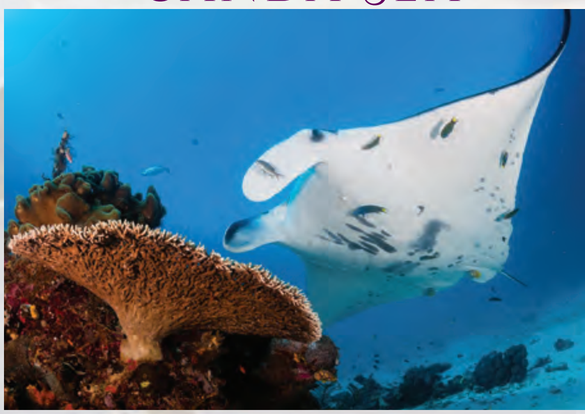
Future exploration of the seafloor will continue to unveil new answers and new questions about the flexibility of this environment and life itself. As pilots guided the robots (and a rapt global audience) through the deep-sea ecosystem, Ballard cheered for the beautiful communities and remarked, "They won't be here for long. All the wonderful vent sites we discovered in '77, '79 and 2001 have been completely destroyed by fresh lava. You're living on borrowed time when you're living at the boundary of creation."

JOIN THE *NAUTILUS*

The expedition to the Galápagos Rift was one of 12 exploratory missions conducted by E/V *Nautilus* in 2015. Opportunities to sail aboard *Nautilus* are available for high school students, undergraduate and graduate interns, formal and informal educators and collaborating scientists. Learn more at *oceanexplorationtrust.org.*

Anyone can join E/V *Nautilus* during missions via *NautilusLive.org,* 24 hours a day, 7 days a week.


New Horizons in Eastern Indonesia!
Raja Ampat




Raja Ampat Aggressor

MICHELE HALL

Text by Hillary Viders, Ph.D.; photos by Howard Hall

Hometown: Born in Binghamton, N.Y.; have lived in San Diego since 1973
Years Diving: 40+
Favorite Dive Destination: California — on a good day!
Why I'm a DAN Member: I value and support what DAN has provided to the diving community for decades. Knowing DAN will be there in the event of a medical emergency during my travels around the world brings me tremendous peace of mind.

From left: Michele Hall photographing a tiger shark at Tiger Beach, Bahamas; freediving with spinner dolphins in Kona, Hawaii; operating an IMAX 2D camera system and on comm during the making of ***Deep Sea 3D*** in California

Underwater filmmaker Michele Hall has produced 16 documentaries and won numerous awards, including the Antibes Film Festival Grand Prize, a Golden Reel award, an IMAX Hall of Fame award and an Emmy. In addition to her many accolades, she is a member of the Women Divers Hall of Fame, the Coral Reef Alliance, Ships to Reefs International, BlueVoice.org and Shark Savers, and she serves on the board of directors for the Academy of Underwater Arts and Sciences. In 2011 she and her husband were inducted into the International Scuba Diving Hall of Fame.

Although Hall's work has been firmly rooted in diving for almost four decades, her first career was in pediatric nursing. Everything changed in 1975 when she signed up for a scuba course at Chuck Nicklin's Diving Locker in San Diego, Calif., where she met the man she would eventually marry — her diving instructor, Howard.

While Hall has her own work responsibilities, she and her husband share several mutual business ventures, including a stock-footage library that licenses their productions for television, theater and exhibition. They recently began making films in nontraditional formats — three- to five-minute shorts and hourlong art videos — and are licensing these to entities such as Sony Entertainment and Netflix.

Whereas many people find it difficult to work with their spouse, for Hall it is just the opposite: "It was difficult when Howard and I were *not* working together, and he was away on filming assignments, sometimes for four or more weeks at a time," she explained. "Now we work at home together and travel together for dive, road, camping and filming trips."

Their upcoming adventures include filming thresher sharks in Malapascua, Philippines, along with a few nondiving trips on the horizon. The duo also enjoys capturing aerial footage from their experimental aircraft known as an ultralight trike, which they keep at an airport a few hours from their home in Del Mar, Calif. From the trike, they film breathtaking scenes of the desert and the surrounding areas. "We love filming and have incorporated it into all aspects of our lives and travels," Hall explained. "We love taking road trips, hiking and camping in our van. As the opportunities arise, we capture time-lapse sequences of sunrises, sunsets, clouds, the night sky and even the Milky Way."

When asked to name her favorite among her film productions, Hall found it difficult to decide. She mentioned the 1997 PBS release of a television

series called *Secrets of the Ocean Realm*. "I love that the series was composed of 10 half hours of programming, allowing us to explore a number of locations and a large variety of animal behavior," she said. "It was a fulfilling challenge to produce this lengthy series, which continues to be well received."

She also enjoys producing IMAX films, such as *Deep Sea 3D* and *Under the Sea 3D,* which were filmed in the South Pacific. Hall says that IMAX films present unique challenges: The production package weighs 8,000 pounds, it requires a field production team of 12 people, and it involves lengthy postproduction. The camera system weighs 250 pounds for standard 2D IMAX and 1,300 pounds for 3D IMAX.

Hall fondly recalls her first IMAX film, *Island of the Sharks*, which required a five-month-long filming expedition to Cocos Island. It was in 1998 during an intense El Niño event, and the water warmed to such an extent that the hammerheads disappeared from the island's diveable depths. "We dived 66 days over eight months before we saw even one hammerhead," she said. "What's more, the IMAX camera roared like a lawnmower with a bad ball bearing. It took five seconds to ramp up to speed, and by that time the school has scattered! During that time we considered aborting — or at least postponing — production. When we realized that we could make an even stronger film by incorporating the meteorological event into the story, we surged forward. The result is a film that I'm very proud of."

Reminiscent of her work in pediatrics, Hall has also produced films and books for children, including *Secrets of the Ocean Realm, The Shark Project Book* and *The Shark Sticker Book*. "I love that my films and writings might have a positive impact on younger generations," she said. "Exposure to the wonder of the natural world increases awareness and hopefully increases appreciation for the marine environment as well as conservation efforts."

Often asked to name her scariest dive experience, Hall says that her recent shark diving has been pretty daring: "From diving with oceanic whitetips and tiger sharks in the Bahamas to bull sharks in Fiji, my heart rate has increased a few times."

As far as scary filming situations, she cites the trimix technical dives Howard and other members of their team did for Greg MacGillivray's *Coral Reef Adventure*. During production, they made 21 dives below 350 feet. Richard Pyle, who trained the divers and was a member of their "deep team," said that there was a 30 percent chance that someone would get decompression sickness (DCS) on any given dive below 350 feet.

As it turned out, Howard got DCS during a 372-foot dive. A 3.5-hour in-water recompression session followed by a series of chamber treatments left him with virtually no residual effects.

Hall recalls how DAN played an important role in this ordeal. She called DAN at night from the dive boat, and the DAN staff stayed in phone contact with her throughout the next six days while Howard underwent the recommended chamber treatments. "DAN's reassurance and referrals were really helpful," she said. "They made themselves available to us even in the remote offshore waters of Fiji."

At present, Hall's exciting career is in full gear, and she has no desire to slow down: "I plan to continue diving, hiking, traveling and having as much fun as I can every day."

DAN

TRAVEL SMARTER

GEAR MAINTENANCE

As we settle into the colder months in the Northern Hemisphere, some divers choose to put away their gear for a while. Whether you continue diving year-round or take a seasonal break from the sport, here are a few helpful tips for maintaining and storing your gear.

STEPHEN FRINK

Item(s)	Before You Dive	After You Dive	Storage	Professional Servicing
Mask, fins, snorkel	Keep them well organized to minimize risk of being kicked or stepped on.	Rinse and dry.	Pack and store carefully to avoid having these items crushed by heavier gear.	n/a
BCD	Check valves, inflator buttons and pressure maintenance.	Rinse the outside, and flush the bladder with fresh water. Hang to dry.	After drying, partially inflate jacket for storage. Remove weights from pockets.	Test at least once every year.
Regulator	Inspect hoses, filters, connections, pressure, breathability and watertightness.	Soak and clean in fresh water while still connected to scuba cylinder and pressurized. Leave out to dry.	Keep dust cap in place, and store in a regulator bag.	Service at least once a year.
Wetsuit,boots, gloves, hood	Lubricate zippers if necessary.	Rinse, turn inside out, and hang to dry. If wetsuit has an unpleasant odor, use wetsuit shampoo in the postdive rinse tub.	Keep out of direct sunlight; neoprene, like most dive gear, is susceptible to UV damage.	n/a
Computer	Check battery life and gas settings.	Rinse and dry.	Store in a dry, cool, ventilated area.	Service every one or two years per the manufacturer's recommendation.
Cylinder	Handle with care; pressurized cylinders contain a lot of potential energy. Secure tightly for transportation.	Rinse thoroughly and let dry. Regularly remove tank boot to prevent buildup of salt and debris.	Never empty of gas completely. Reduce pressure to the lowest you can read on the pressure gauge. Keep a clean, dry dust cap on the valve.	Cylinders need a visual inspection once per year and a hydrostatic test every five years.

DAN EDUCATION SPOTLIGHT

THE DAN RESEARCH INTERNSHIP PROGRAM

Each year DAN's research department hosts interns to be mentored by the organization's experts in dive medicine and research. During the internship participants identify their particular scientific interests, gain research experience and build professional skills for career advancement. The program provides interns with the opportunity to gather and analyze data, learn about research ethics, practice scientific writing, present research findings, go on dive-research field trips and participate in a NASA-led hyperbaric experiment. At the end of the program, interns leave with a better idea of what they enjoy most about science — whether they want to work with people, data, statistics or even on a liveaboard.

The specific work interns do while at DAN varies according to their interests and skills. This flexibility allows them to bring their enthusiasm and hard work to the dive community as they enrich DAN's dive research and injury-prevention efforts.

"This program continues to be a wonderful addition to the organization," DAN President and CEO Bill Ziefle said. "Not only do we get the benefit of working with some of the brightest minds in the industry, but we also get the satisfaction of helping them along their way."

Since the DAN Research Internship Program began in 1999, several dozen interns have left DAN — trained in the full suite of DAN courses and with new knowledge about dive medicine and science — to return to

DIVE SHOWS AND EVENTS

Outdoor Adventure Show
Feb. 19-21: Toronto, Ontario
Many divers enjoy exploring the great outdoors by hiking, biking, climbing or paddling. Dive into all of your hobbies at once at Toronto's annual adventure showcase, and discover new destinations and the gear you need to get you there.

Our World-Underwater
Feb. 26-28: Rosemont, Ill.
Join DAN for a day of seminars, safety discussions and workshops at the Midwest's largest dive expo. Participate in the CPR challenge, and explore the latest in dive safety gear. Ask about our travel insurance, which is ideal for any dive trip. Bring your DAN membership card and photo ID to receive $5 off admission.

Boston Sea Rovers
March 5-6: Boston, Mass.
This weekend clinic features more than 40 seminars, advanced training, a film festival and workshops with industry experts. DAN will showcase its new dive-accident coverage, travel insurance programs and Health and Diving resources.

RESEARCH AND MEDICAL EVENTS

Dive Safety Seminar: "Field Investigation of Diver Deaths"
Dec. 2: Durham, N.C.
Diving conditions, human error, health problems and equipment all can play a role in diver deaths, making field investigation and equipment preservation critical. This presentation will cover field investigation techniques including evidence preservation and documentation, which can make the difference in understanding a diver fatality.

Dive Safety Seminar: "Advancement and Challenges in Rebreather Diving"
Feb. 3: Durham, N.C.
Rebreathing systems have a long history of use in diving, but development efforts in the past 20 years have been critical for advancing the technology sufficiently for it to become a mainstream tool. This presentation will describe how and where rebreather technology is being used, discuss limitations and accident data, and consider future directions.

communities across virtually every state in the country. These former interns act as ambassadors for DAN's mission of dive safety.

"For the interns, the most exciting part often is getting to work with highly recognized dive scientists," said Peter Buzzacott, DAN's director of Injury Monitoring and Prevention. "For us, the most exciting part is working with enthusiastic divers beginning their careers in dive science." Buzzacott, a former DAN intern, appreciates the experience from both angles. "Now that I'm in this chair, eight years later," he said, "the best thing for me is when an intern comes into my office, asks if I've got a minute, and says, 'I've got this idea ….'"

For more information or to apply, visit *DAN.org/Research/Intern*. The next application deadline is Jan. 15, 2016.

Below: A shorthead fangblenny, *Petroscirtes breviceps*, guards his nest of eggs.

Opposite, clockwise from top left: Fiji fangblenny, *Plagiotremus flavus*; a venomous striped fangblenny, *Meiacanthus grammistes*, being mimicked by a juvenile bridled monocle bream, *Scolopsis bilineatus*; venomous canary fangblenny, *Meiacanthus oualanensis*; a juvenile Fijian variation of a bridled monocle bream

Fangs

Text and photos by Ned and Anna DeLoach

I never gave much thought to fangblennies until one bared its fangs at my finger, which I'd placed imprudently close to a male guarding its nest. My hand snapped back as if I'd seen a snake. From a more respectful distance I watch the father-to-be glare at me from the open end of a tin can glistening with eggs. With a quick glance around it becomes clear that I am not the only one who has had a run-in with the formidable fangs: Not one of the numerous, forever-hungry wrasses buzzing about the bottom goes anywhere near the blenny's tempting cache of fat-filled eggs.

The adaptation of fangs has been a game changer for 55 blenny species in six genera in the Indo-Pacific. Unlike their endlessly cute, unarmed cousins that must spend their lives close to hiding holes, sabertooth blennies (or fangblennies as they have come to be known) evolved into streamlined open-water swimmers able to keep predators at bay with the threat of weaponry. As if fangs didn't provide protection enough, species in genus *Meiacanthus* won a second evolutionary jackpot: the ability to inject venom through a groove in their curved canines. This potent combination of adaptations provides such an advantage that over time a smattering of similar-sized reef fishes evolved to mimic several species of *Meiacanthus*. This charade, an example of Batesian mimicry, allows the impostor a bit more freedom from predation when feeding in the open.

Shortly after my fang encounter, Anna spots a juvenile bridled monocle bream hanging around a venomous fangblenny. The resemblance is uncanny. The mimic's size, black stripes and yellow upper body match up well with the model. The little bream has even taken on the blenny's herky-jerky swimming style.

After arriving home we contact longtime friend Bill Smith-Vaniz, an authority on the taxonomy and mimicry of fangblennies. His interest goes back to 1969 when as a graduate student he and his mentor, Victor Springer, Ph.D., a blenny man from the Smithsonian, traveled to the Gulf of Aqaba on a collecting trip. During the trip the pair decided to put three similar-looking blennies through a thorough test for mimicry. Their group of blue

and yellow fishes consisted of a venomous *Meiacanthus*, the model; a nonvenomous fangblenny of genus *Plagiotremus*, which makes its living snipping scales off unsuspecting fishes; and a fangless bottom-dwelling *Ecsenius*.

The scientists first had to find out for certain if their model was actually toxic. Springer — well established, married and the father of two — deferred to Smith-Vaniz, who in the best tradition of young graduate students allowed a maddened *Meiacanthus*, fresh from the lab tank, to bite him on his bare midriff.

"Stung like a bee, I wouldn't want to do it again," he chuckles over the phone from his home in Gainesville, Fla. "The wound turned red and formed a welt that lasted most of the day. But it was worth it. There was no doubt our model was venomous. Tell you what, I'll send you a set of my mimicry papers."

Days later a bulging envelope arrives. Out spills several hours of serious reading. From the beginning it becomes clear that mimicry by natural selection is difficult to prove, requiring a lot more evidence than species simply looking alike. For starters, true mimics should regularly associate with their models, models are expected to be more abundant, and deception and benefit must be proven. Then there is something called *geographic variation in appearance*, which states that if there is a strong regional variation in the model's appearance, this will be mirrored by the mimic.

On follow-up trips to the Gulf of Aqaba, Smith-Vaniz and Springer spent hours making observations underwater and hovering around aquariums with clipboards in hand. According to their co-authored paper, on their home turf the three blennies performed well, staying together 60 percent of the time in some combination or another. When offered up as food to a lionfish, a stonefish and a grouper in lab tanks, all the predators immediately spit out the venomous *Meiacanthus*, and from then on had little or nothing to do with blue and yellow fishes in general — the charade appears to be a win-win-win. By mimicking both the *Meiacanthus* and a defenseless algae-eating blenny, the scale-nipping *Plagiotremus* can more easily sneak up on prey. And the defenseless bottom-grazing *Ecsenius* can extend its feeding range by palling around with its model. At the same time the *Meiacanthus*' warning colors get advertised broadly.

While diving in Fiji, thousands of miles from the Philippines, we find our juvenile monocle bream once again, but this time it's completely yellow. It doesn't take much scouting around to discover the reason — the local fanged *Meiacanthus* and *Plagiotremus* are also yellow, a strong case for mimicry if there ever was one. AD

BOSU Training

BOTH SIDES UTILIZED

Text by Jessica B. Adams, Ph.D., and Jaime B. Adams
Photos by Stephen Frink

A Bosu® Balance Trainer (or Bosu ball) is an effective tool for adding balance and stability training to your workouts. Balance is important for managing dive gear on a rocking boat, and stability is key for maneuvering underwater where your muscles must pull on your core to propel you. A Bosu ball consists of a flat plane on one side and an inflated vinyl hemisphere on the other; the name "Bosu" comes from "both sides utilized."

In addition to the exercises provided in this article, you can do many of the exercises described in previous issues of *Alert Diver* on a Bosu ball. Bosu training can help you diversify your exercise routine, push through fitness plateaus, improve stability and balance, and keep your routine interesting.

The greatest benefits of exercise are seen when comparing people who do moderate exercise to people who do not exercise, which shows that any amount of exercise is better than none at all. If you can intersperse these exercises throughout your day, you will reap the greatest benefits.

Proper form always takes precedent over speed and number of rounds and/or repetitions. It is essential to train your nervous system to recruit the right muscle fibers for each movement. Improving muscle memory will ultimately allow you to reach a higher level of performance.

Try to do three rounds of the following exercise sequence. It's fine if you have the time or stamina for only a single round. You will be able to do more in less time as your fitness improves.

SIDE LUNGES (10 per side)

1. Begin standing on the Bosu ball, round side up, with your feet together.
2. Step to the side and squat down, pushing your butt back, keeping your eyes slightly up and forcing your weight through your heels.
3. Push off to return to standing with your feet together on the ball.
4. Repeat on the opposite side.

Tip: *Keep a slight bend in your knees when standing on the ball to assist with balance.*
Challenge: Between lunges, hop from one side to the other rather than returning to standing.

FRONT LUNGES (10 per side)

1. Begin standing with the Bosu ball about 2 feet in front of you (depending on your height), round side up.
2. Lunge toward the ball, placing one foot on top of it.
3. Drop your back knee close to, but not touching, the ground.
4. Push off to return to a standing position.
5. Repeat on the opposite side.

Tip: *Keep your torso upright while keeping your front heel on the ball. Momentum may lead your trunk forward, but maintain control, keeping your eyes and chest slightly upward.*
Challenge: Try adding dumbbells. First just hold the weights, then progress to adding a bicep curl or curl to shoulder press.

SIDE-PLANK DROPS (10 per side)

1. Begin lying on your side with your forearm on the top of the Bosu ball.
2. Your feet should be spread apart, top foot forward.
3. Elevate your hip to achieve a side-plank position.
4. Drop your hip to touch the floor.
5. Return to side-plank position.

***Tip:** If this is uncomfortable, you can start supported by your knees rather than your feet. Keep your forearm directly beneath your shoulder.*

Challenge: Stack your feet rather than separating them. If that's still easy, try lifting your top leg as you lift your hip off the ground.

BURPEE PUSH-UPS

(Start with three, and work up to 15.)

1. Begin standing with your feet shoulder-width apart and holding the Bosu ball at chest height, flat side toward you, with your arms bent.
2. Squat down, and hinge at your hips to place the curved side of the ball onto the ground.
3. Step or jump back into plank position.
4. Do a push-up, or stay in plank position for a 20 count, if possible.
5. Step or jump your feet forward toward the ball.
6. Hinge at your hips, and stand back up.
7. Extend both arms upward, pressing the ball toward the sky.

***Tip:** Keep your chest up, making sure your back does not round during the movement. Maintain a tight core — don't allow your abs to sag in the plank and/or push-up portion of the movement.*

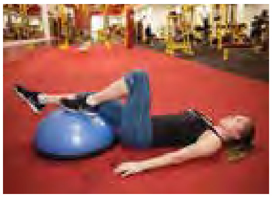
Challenge: Add a jump after the shoulder-press portion of the movement.

ONE-LEGGED BRIDGES (10 per side)

1. Start lying supine (on your back) with the round part of the Bosu ball right under your knees.
2. Place the sole of one foot near the top of the ball.
3. Elevate your hips by pressing into the sole of your foot, and keep the other leg straight.
4. Squeeze your glutes, and hold for two breaths at the top of the movement.
5. Relax and repeat.

***Tip:** Try to keep your knees together.*

Challenge: Try to push your hips higher, and hold for five breaths. AD



LOCATION COURTESY RETRO FITNESS, DURHAM, NC

NOTE: To avoid an increased risk of decompression sickness, DAN® recommends that divers avoid strenuous exercise for 24 hours after making a dive. During your annual physical exam or following any changes in your health status, consult your physician to ensure you have medical clearance to dive.

Between the Depths and the Shallows

EXPLORING CAPE COD'S WET HABITATS

Text and photos by Ethan Daniels

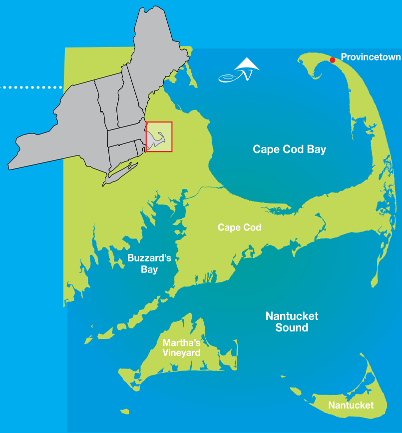
Lily pads, backlit by afternoon sunlight, grow along the shallow edge of a freshwater Cape Cod pond.

***Opposite, from left:* A starfish rests in a seagrass meadow. Cape Cod is extremely popular with boaters, but fewer people explore its underwater wonders.**

The Atlantic's nutrient-rich seas run through the veins of America's formative history and are still a cornerstone of New England culture. At the region's marine heart is an iconic peninsula, Cape Cod, described by Henry David Thoreau as "the bared and bended arm of Massachusetts," where lies "… nothing but that savage ocean between us and Europe."

Geologically fairly simple, the cape is a long, bent spit of sand left behind by retreating glaciers at the end of the Pleistocene epoch (the Great Ice Age, which ended about 11,700 years ago). The peninsula juts 65 miles from the mainland into the North Atlantic. Influenced by the fertile waters of the Labrador Current from the north and the warmer Gulf Stream from the south, the cape plays a vital role in the migration routes of many birds, marine mammals, fish and marine invertebrates. Just a couple of hours

HOW TO DIVE IT



Getting There

Regular dive charters are not often advertised, so it works best to contact one of the cape's dive shops ahead of time. Charters typically take place during weekends and depart from various harbors depending on weather and the shipwreck the captain has in mind.

Conditions

Water temperatures in Vineyard Sound, south of the cape, can be warm during summer months, reaching the high 60s (°F) or even low 70s (°F). Ocean temperatures off the outer cape are much cooler on average, only reaching the mid-50s (°F) during summer months. Most local divers use drysuits, though a full 7mm wetsuit with a hood and gloves could suffice if you're only diving for a day or two. The region is not known for clear water, and visibility varies from about 5 feet to 45 feet. Strong currents are found just about everywhere around the cape, and dives are usually planned for slack tides. Most offshore wrecks are considered intermediate or advanced dives due to the potential for currents and rapidly changing conditions.

Topside Adventure

When not underwater, hike the gorgeous trails around Cape Cod National Seashore, where, as Thoreau put it, "a man may stand there and put all America behind him." During summer months catch a Cape Cod Baseball League game; the league features some of the best collegiate baseball players in the country. Rent a kayak, and explore the many bays and coves that make up the peninsula's seashore.

from Boston, this stretched arm of sandy soil shelters the essence of New England, incorporating the classic imagery of vast tracts of beach and salt marsh, crusty fishermen and summer vacation homes. It also offers a range of remarkable diving opportunities.

The peninsula's many peaceful bays — littered with saltwater ponds, narrow creeks, marshes and inlets — serve as nurseries and fertile feeding grounds for all sorts of marine fauna. The ever-flowing waters in these calm habitats are rarely deeper than 20 feet and are home to teeming ecosystems. Incoming and outgoing tides play an influential role in the bays' ecological webs, where menageries of flora and fauna thrive below the low-tide line.

CRITTERS

Timid hermit crabs and well-camouflaged decorator crabs can barely be discerned from the surrounding seafloor due to the prolific sponge and algal growth hooked onto their articulated limbs. Scampering across the bottom, stirring up a cloud of sand in its wake, a large male blue crab disappears into a forest of seaweed. Submerged glacial rocks are carpeted with filter-feeding barnacles and bright orange and yellow sponges. Sprouting from the sand nearby, delicate branched arms of a sea cucumber patiently collect passing zooplankton, continuously stuffing the minute creatures into the animal's stationary gullet. A pair of russet-colored horseshoe crabs bulldoze through the scene, the smaller male clasping the massive female from behind. These distant relatives of scorpions evolved 450 million years ago; they are quintessential Cape Cod inhabitants and one of the peninsula's keystone species.

Above the kaleidoscope of bottom-dwelling creatures live dozens of species of vertebrates. A giant northern pipefish, a slender relative of the seahorse, appears out of the seaweed mélange, blending into the habitat with subtle color patterns. The strange, flattened profile of a

Clockwise from top left: A common snapping turtle, an apex predator in ponds and lakes; Cape Cod's reefs are home to myriad small fish such as this sea robin; more than 3,000 shipwrecks are found around the cape; a graceful blue shark, one of the fastest sharks in the sea

young summer flounder glides across the sand searching for small fish or crustaceans on which to feed. Schools of small mummichog and translucent silversides dart through a jungle of grass blades, avoiding deeper waters where predatory bluefish and striped bass patrol.

Not far from the protected bays, the open ocean is alive with movement. It swells and subsides, endlessly rolling and rocking according to earthly, solar and lunar rhythms. Microscopic, one-celled diatoms and other phytoplankton invisible to the naked eye make these pelagic waters so fertile. The shallow photic zone of the North Atlantic is like a colossal farm, producing immeasurable quantities of phytoplankton. Stellwagen Bank and Georges Bank, where nutrient-rich waters blend with sunlight, are especially productive due to deepwater upwelling. The abundant plankton feeds larval crustaceans, mollusks and fish such as sand lances, which in turn attract larger predators.

MAMMALS

Some of the most extraordinary and rare mammals on Earth feed and raise young here. Humpback, fin, minke and North Atlantic right whales may travel thousands of miles to be off the cape during the spring and summer. Once there, they strain enormous quantities of plankton through their baleen, fattening themselves for their long migrations to distant breeding grounds where they spend the winter. In near-shore ocean waters, thousands of harbor and gray seals prosper. Their breeding colonies have grown rapidly in the past 43 years because of the Marine Mammal Protection Act of 1972, which made it illegal to hunt, kill, capture or harass any marine mammal in U.S. waters (with limited exceptions).

SHARKS

The return of seal populations has signaled another stirring comeback: that of the great white shark, one of the food web's supreme carnivores. The stuff of legends and nightmares, white sharks appear during summer months to feed on the fat-rich meat of the abundant pinnipeds. Researchers have satellite-tagged more than 50 white sharks off the cape in the past few years to learn where they were coming from and where they went in the fall. It appears that the majority of these sharks migrate along the East Coast, following the continental shelf from Cape Cod in the summer and fall to an area between South Carolina and Florida for winter and spring. It is thought that larger, more mature white sharks probably exhibit different migratory behaviors and head for far-off breeding grounds.

A variety of other elasmobranchs — including skates, torpedo rays, pesky dogfish, gigantic basking sharks, speedy makos, toothy sand tigers and others — inhabit Cape Cod's cold waters. But arguably the most aesthetic species found offshore is the blue shark. These sleek and charismatic oceanic marauders prefer the edge of the Gulf Stream, where the water is significantly warmer and clearer than where the white sharks hunt. The majority of oceanic sharks are curious and continuously on the lookout for food, so being up close and personal with them for the first time can be nerve-racking. Fortuitously, blues are as benign as oceanic predators come, and within minutes their iridescent colors and agile movements become captivating.

STEEL

Despite this diversity of marine fauna, the aim of most divers on Cape Cod is to explore some of the more than 3,000 shipwrecks that lie scattered around the peninsula. Many of these sit in less than 100 feet of water and are fairly accessible by boat. The wrecks are oases on a submerged desert of sand, their enduring structures encrusted with multihued organisms. They provide niches for an array of fish, sponges, cnidarians, mollusks, worms, crabs, lobsters and echinoderms. Akin to blossoming flowers, lurid anemones brighten the dark scenery when seen with the aid of artificial light. Bottom-dwelling sea ravens blend into the bones of the wrecks, while schools of mottled tautog and Atlantic cod swim overhead. Large summer flounder skitter across the seafloor. Part of the mystery of the cape's abundant wrecks is that one never knows what exactly will be found on them.

FRESH WATER

Diving Cape Cod's greenish Atlantic waters can be challenging, but copious freshwater ponds and lakes dot the peninsula's landscape only a few miles inland. These charming aquatic habitats are often thought of only as respites from saltwater diving or humid summer days, but delving beneath the placid surface of ponds reveals delicate aquatic splendor. Each pond is a gem of natural history replete with remarkable amphibious and aquatic wildlife. Although not quite as majestic or dramatic as the nearby sea, the cape's soft light hitting a glassy pond early or late in the day can be overwhelmingly peaceful.

Thoreau saw lakes and ponds as "Earth's eye[s]; looking into which the beholder measures the depth of his own nature. The fluviatile trees next the shore are the slender eyelashes which fringe it, and the wooded hills … are its overhanging brows." Diving or snorkeling a Cape Cod lake is entering another time, another space, where a great discord of color is evident. Vibrant greens clash with sultry red lilies in unruly compositions. Sunlight passes through a canopy of lily pads to cast yellow beams through a miniature underwater jungle and illuminate silvery fish below.

Past the lilies grows a virtually impenetrable forest of multihued reeds, where sparkling schools of glossy minnows pulse through twisting lily pad stems. Obscure movements in the dimness outside the reeds signal the passage of a sizeable fish, making the small ones disappear. A largemouth bass, king of its aquatic domain, stares into the murky darkness of the reeds, willing the small fish to re-emerge. Along with primeval-looking snapping turtles, which can be enormous and are often found in the gloomy depths, bass are the foremost predators of the freshwater food web. A few perch come into view, and bluegills and sunfish swim by, while juvenile pickerel warily peek up from the depths.

It takes a hearty soul to experience firsthand wonders of the temperate seascape. Subtle beauty is the essence of Cape Cod's underwater habitats, and as local divers know, it takes time and sensitivity to appreciate these seductive environments. But in the end the beaches, the bays and the ocean's treasures beckon visitors to come back again and again. AD

Galapagos

STRANGE NEIGHBORS

A marine iguana soaks up the sun to get warm after a dive to feed on algae.

STEPHEN FRINK

By Ellen Prager, Ph.D.

Underwater in the Galapagos Islands the sights are magnificent. King angelfish hover over large green sea turtles; algae on the turtles' shells attract the fish like bees to honey. Large colorful parrotfish graze amid roaming schools of surgeonfish. Spotted eagle rays swim gracefully beside walls of coral and volcanic rock, while whitetip sharks lazily cruise by. In an archipelago that straddles the equator, these species are not unexpected. But then something strange occurs: A small black and white missile rockets past, leaving only bubbles in its wake. A penguin? Penguins living side-by-side with tropical fish and coral?

The Galapagos Islands host one of the strangest collections of animals in the world. Here marine organisms that we normally think of as warm-water species coexist with colder-water inhabitants. The confluence of ocean currents, the remote nature of the islands and adaptations over time have given rise to an abundance of species that are found nowhere else.

Known as "the enchanted islands," the Galapagos are located some 600 miles west of Ecuador. The equatorial latitudes provide conditions suitable for tropical fauna such as coral, colorful fish, sea turtles, eagle rays and warm-water sharks. But the islands' waters also host colder-water species such as sea lions and penguins. The only penguin found north of the equator, Galapagos penguins are relatively small, averaging about 19 inches in height. They are extremely cute and exceptionally fast underwater (and sneaky when you are trying to photograph them). Among the ocean currents that influence the islands' ecology are the Humboldt (or Peru) Current, the Panama Current, the North Equatorial Current, the South Equatorial Current and the Cromwell Current (or Pacific Equatorial Undercurrent).

These ocean currents along with the prevailing winds provide arrival routes for flora and fauna; they are also responsible for the archipelago's seasons. From about June to November, the southeast trade winds prevail, and the Humboldt Current, originating in the south from Antarctica and Chile, brings cool air and cold, nutrient-rich water to the Galapagos. This is the dry or *garúa* (Spanish for "mist") season. The cool air creates an inversion layer, and only the higher elevations receive significant rain, though a mist or fine drizzle often occurs in the lowlands and over the sea. The water is noticeably colder, the winds are stronger, and productivity increases throughout the islands. Whales such as humpbacks, Bryde's, minkes and even enormous blues may be present this time of the year.

From about December to May, the southeast trade winds abate, allowing the northeast trade winds and the warm, southward-flowing Panama Current to predominate. This is the hot, wet season in the Galapagos. Rain is more common, the winds diminish, and when clouds are absent or few, the sun's rays are intense. Surface waters are warm, but a sharp thermocline typically remains, and at depth the water quickly brings on a chill. This is especially true in the western islands, Isabela and Fernandina, where the eastward-flowing Cromwell Current strikes the islands at depth and upwells, bringing cold, nutrient-rich waters to the surface year-round. This is why marine life is especially abundant and often larger in the western part of the Galapagos. The rich oceanic food web in the region supports the largest marine iguanas in the Galapagos (they can be more than 4 feet long), and plentiful seabirds such as flightless cormorants, penguins and blue-footed boobies. Manta rays and whales, including a resident pod of orcas, are also more likely to be found in the western Galapagos.

The ocean currents also help explain the origins of many Galapagos species. Animals that floated in on currents, perhaps aboard rafts of vegetation, may have initially found little competition and abundant food. With the arrival of additional individuals, species then reproduced and became established. Over time and in isolation, these animals adapted to conditions in the Galapagos and evolved.

Two examples provide perhaps the most obvious and dramatic illustrations of this adaptation and evolution. Elsewhere in the world, cormorants are flying birds that dive for food and nest in trees. In the Galapagos, cormorants have only small vestiges of their original wings left. Known as flightless cormorants, these birds have lost the ability to fly; they build their nests on the rocky shore very close to the sea. Their legs are thicker and stronger than those of other cormorants — perfect for swimming and hopping around on land. Flightless cormorants' small scraggly wings seem to be used mainly for balance as they move about the rocky coastline. After their arrival and establishment, with little competition, few predators and plentiful food, there was no need for cormorants to travel between feeding and nesting sites, so over time the birds simply lost the ability to fly.

Marine iguanas are possibly the most bizarre and fascinating endemic species in the Galapagos. Primitive and darkly fierce-looking, they resemble something out of *Jurassic World*. But marine iguanas are docile ectothermic creatures that spend much of their time lying on the rocky shore to get warm. They do this to increase their body temperature after dives into the cold ocean to feed on algae. Marine iguanas reportedly can stay underwater for up to 45 minutes. There are few things stranger than seeing a marine iguana sitting on the seafloor munching

Clockwise from upper left: **green sea turtle; spotted eagle ray; schooling salemas; flightless cormorant**


MARVI CORDOVA


STEPHEN FRINK


MANUEL ALMACHI


STEPHEN FRINK

away. To rid their bodies of excess salt consumed while eating algae, marine iguanas frequently sneeze it out their nose. Land iguanas are abundant on some of the islands in the Galapagos. Presumably, competition for food and/or territory is what first drove land iguanas to the sea for food and led to the evolution of a new marine species.

Other endemic marine species include the Galapagos penguin, Galapagos shark, Galapagos sea lion, Galapagos fur seal and the salema, which is a small striped fish often found here in dense schools.

The islands' ecosystem is strongly governed by resource availability. When productivity in the ocean is high, life flourishes on land and in the sea. When resources become scarce, populations plummet. During strong El Niños, warm water typically flows eastward along the equator. The islands of the Galapagos are bathed in unusually warm water, and upwelling is shut down by strong stratification. Marine biologist Peter Glynn and his colleagues found that because corals are acclimated to relatively colder water temperatures in the Galapagos, up to 95 percent have perished in previous strong El Niños. Populations of penguins, marine iguanas, sea lions and seabirds also suffer significant mortalities when productivity diminishes. Some experts are predicting a strong El Niño for the second half of 2015, so researchers are closely monitoring water temperature and populations.

Diving or snorkeling in the Galapagos is a rare treat. After years of protected status, many of the islands' creatures have acclimated to human presence. Rolling with playful sea lion pups or being surrounded by unperturbed sea turtles is simply magical. Rays and fish swim close by, and schools of hammerheads often encircle divers for curious perusal. And when a penguin rockets by or feeds in a nearby baitball, it is nothing short of astonishing.

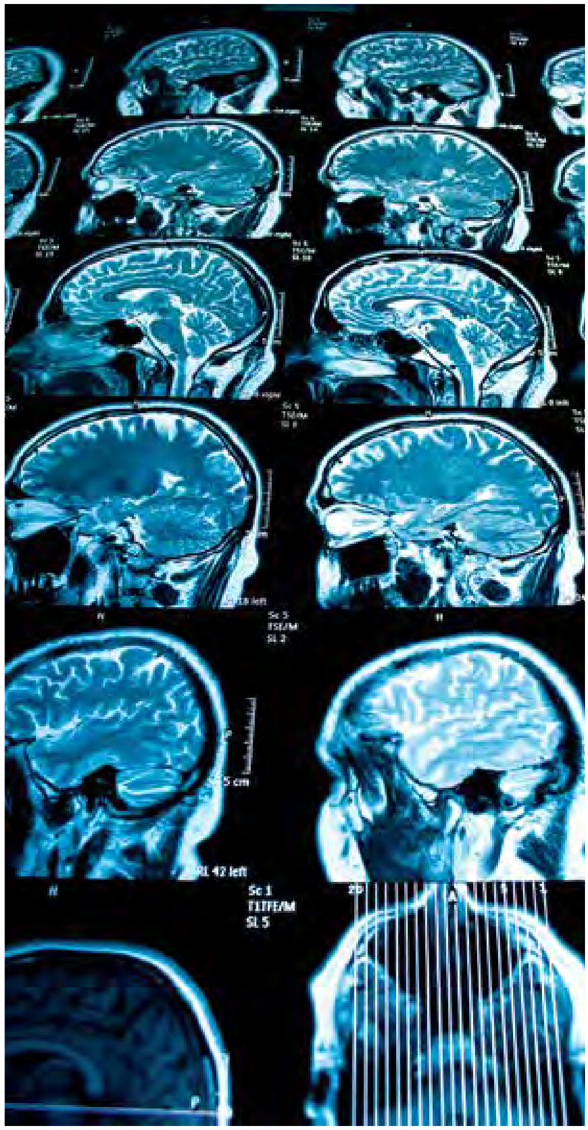
Although animals are protected on land and in the sea, illegal fishing and poaching is a serious issue. The Galapagos National Park directorate strictly regulates tourism in the archipelago, and a licensed Galapagos National Park naturalist guide must accompany all visitors. The system appears to be working, and for now the islands remain a wondrous adventure for nature lovers. I treasure every opportunity to experience the Galapagos and recommend it as a diving, snorkeling and hiking adventure for all. AD

A sea cucumber (*Bohadschia* sp.) releases eggs near Koh Tao, Thailand. Sperm released by male sea cucumbers will fertilize the eggs in the water column.

ALEX TYRRELL

When Scott Gleeson began experiencing headaches after diving, an MRI revealed a brain tumor attached to his pituitary gland and optic nerves.

STEPHEN FRINK



DOMINE/ISTOCKPHOTO.COM

Travel Plans Interrupted

By Robert Gleeson

My son, Scott, grew up in a diving family and around dive shops. He has been diving off and on for more than 35 years. A few years ago he began to experience headaches after dives. The headaches became increasingly common, but there were never any other symptoms or problems at the end of dives.

We typically did 65- to 75-minute multilevel dives. Thinking that his headaches might have something to with nitrogen exposure, Scott began diving with nitrox, which seemed to help alleviate them. For a while we thought the switch to nitrox had fixed the problem, but unfortunately the headaches came back. Scott enjoyed diving enough to put up with the discomfort he was experiencing, and we continued to go on weeklong diving trips together for several years after the headaches began to occur.

Late last year we planned our first liveaboard trip together to the Caymans. When booking the trip we purchased nonrefundable airfare, and we noted that the liveaboard trip was nonrefundable if we canceled within 90 days of departure. The dive operator suggested that we buy trip insurance, which seemed like a good idea to us since this was an all-inclusive, prepaid trip. We purchased DAN Trip Insurance to cover the cost of the nonrefundable round-trip airfare to Grand Cayman along with the cost of the liveaboard trip.

In late January, Scott began to experience more frequent headaches, which began to occur when he was exposed to bright light. His doctor referred him to a neurosurgeon, Holger Skerhut, M.D. An MRI revealed a brain tumor attached to his pituitary gland and optic nerves. Dr. Skerhut initiated treatment to reduce the size of the tumor and scheduled Scott for surgery.

The diagnosis of the brain tumor occurred three weeks before our scheduled dive trip. We discussed the trip with the doctor, who recommended against diving. Dr. Skerhut was a diver himself, and his son was a dive instructor, so he fully understood Scott's concerns not only about the impending surgery but also about his ability to return to diving. He was very confident about a good surgical outcome and reassured us that Scott should be able to return to diving after a successful procedure and recovery. He predicted that Scott would be able to resume diving a few months after the surgery.

Scott recovered from the surgery just fine. The doctor released him to return to diving, and we had a great trip to Cozumel this summer. Scott experienced no headaches or other problems in six days of diving.

When we became aware that the brain tumor and surgery were going to interrupt our Cayman trip, we notified the airline, the dive operator and DAN. Even though our tickets were nonrefundable, the airline agreed to refund our airfare in light of the circumstances.

Filing a claim with DAN was quite simple; we just needed documentation from the doctor and copies of our payment confirmations from the liveaboard operator. Once we filed this paperwork, the insurance claim was settled, and we received compensation in full for the missed trip.

The DAN representative and the claims agent were very helpful and patient, assisting us every step along the way. Our main concern was getting Scott through the surgery, so it was a great relief that the insurance claims process went so smoothly.

I can truthfully say that DAN Trip Insurance is now an essential part of all of our future dive travel plans. AD

Gradient factors are a way to enhance conservatism during dives. Dive computers that incorporate gradient factors typically provide either a limited number of choices or allow fully user-adjustable ranges.

STEPHEN FRINK

Gradient Factors

A PATHWAY FOR CONTROLLING DECOMPRESSION RISK

By Neal W. Pollock, Ph.D.

Decompression procedures used to be much easier to discuss. Not that long ago divers around the world generally trusted a small number of dive tables to protect them. Conservatism was added by either staying away from the limits or computing limits using greater-than-actual depths and/or bottom times to create a cushion. Simple.

We now have dive computers running an array of base algorithms. More challenging, many designers and/or manufacturers have modified the base algorithms, frequently providing no details about the modifications. Still, we often choose to trust the box and its creators, sometimes with a near-religious fervor if the Internet hype is sufficiently compelling. Also simple.

The problem with simple solutions is that they often come with critical limitations. We must remember that decompression algorithms are mathematical models intended to predict the outcome of complex physiological processes. They almost certainly do not capture "truth," but they do not actually need to. All they need to do is produce a satisfactory outcome frequently enough to be accepted. The problem comes when we believe these algorithms are smarter than they really are.

Decompression stress is determined by inert gas uptake and elimination. The dive profile is clearly the chief driver of this, but other factors, primarily thermal status and exercise, can play an important role in altering the rates. Dive computers are great at tracking dive profiles, but current devices do not integrate the impact of thermal or exercise factors in a meaningful way. And, yes, this is true even for the computers that measure water temperature and/or heart rate. It will also continue to be true for the forthcoming computers that measure heart rate, respiratory values and/or one- or two-site skin temperatures. The addition of these components is critical in learning how to build future-generation computers, but a tremendous amount of physiological data has to be collected and analyzed before we begin to understand how to meaningfully integrate such measures into decompression risk models.

What we do know now is that decompression algorithms this side of the Star Trek universe do not guarantee decompression safety. They can work well for some divers and some exposures, but the fact remains that decompression sickness (DCS) can develop in people who dive within the limits of decompression models. The actual risk results from a staggeringly complex interplay of the dive profile, the timing and intensity of thermal and exercise states and a host of individual factors. For some, the hopefully modest level of risk associated with current

decompression algorithms is acceptable. Others may need additional buffers, either to address differences in susceptibility or simply for peace of mind. This brings us to conservative settings.

Many dive computers offer some degree of user-selectable conservatism, which is important since what appears on a computer screen is often accepted as an article of faith. It can be easier to follow the computer display showing a more conservative profile than to remember to stay away from the limits shown with more liberal settings. The biggest challenge in any case is remembering that just because the computer says a profile is safe does not necessarily mean it is.

Manufacturers have implemented a variety of conservatism protocols in dive computers. Some are less logical than others, but again "truth" is less important than a good outcome. The difficulty comes in assessing the impact of the array of settings, particularly if they are incompletely or poorly described by manufacturers or marketers. Fortunately, in our imperfect world there is one computational method of conservativism that I find intuitively easy to both quantify and understand: gradient factors.

Developed by Erik Baker, gradient factors allow divers to adjust exposure limits to become fractions of another limit. Gradient factors are commonly used with the Bühlmann algorithm, a well-researched set of decompression procedures for which the underlying source code was openly released to the community. The open release allowed a lot of bright and inquisitive eyes to fully evaluate the algorithm and contribute corrections that were incorporated into subsequently revised versions.

We need a little more background to proceed. Gas uptake and elimination can be predicted using exponential half-times. To illustrate: A diver descends to a fixed depth and stays there. One half-time in this situation is the time it takes for a tissue to take up inert gas equaling half the difference between the inert gas content found at equilibrium with the surface pressure and the gas content the tissue would have if saturated at the pressure of the current depth. The next half-time eliminates half of the remaining difference, and so on. Complete equilibration is achieved in about six half-times. The complication is that body tissues take up and eliminate inert gases at differing rates. The fastest tissues are the lungs, which achieve equilibrium almost instantly. Blood is another extremely fast tissue, followed by the brain. The slowest tissues are those that are relatively poorly perfused, such as ligaments and cartilage, or those that are relatively poorly perfused and have a high capacity for inert gas uptake, such as some fat tissues.

Each half-time used in an algorithm is referred to as a "compartment." A given compartment does not have to equate to an actual tissue; rather, the intention is to use a collection of different half-time computations to estimate what happens throughout the body.

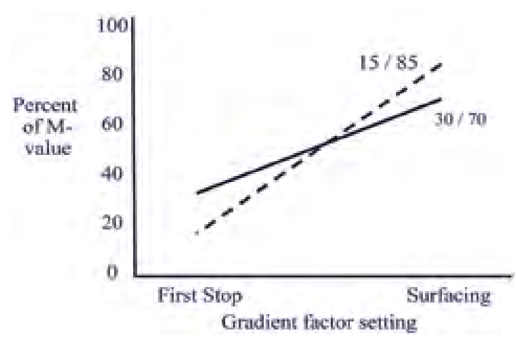
Robert Workman coined the term "maximum value," shortened to "M-value," in the mid-1960s when he was conducting decompression research with the U.S. Navy.[1] Albert Bühlmann and other modelers also used the term. The M-value describes the magnitude of supersaturation (gas pressure greater than the ambient pressure) that a given tissue can theoretically tolerate during ascent before an orderly elimination of inert gas is replaced with a negative outcome. M-values can be predicted for any tissue compartment construct. Faster tissues have higher M-values based on the expectation that they can tolerate higher degrees of supersaturation than slower tissues, in part because their fast clearance rate means that high levels will not exist for long.

The computational power of dive computers is essential for estimating the status of multiple compartments in real time, adjusting the exposure limits based on whatever compartment is deemed most critical at any point in the process — the controlling compartment. This is important since modern divers rarely follow uncomplicated square profiles. Instead, they frequently follow complex descent-ascent profiles, relying on the dive computer to keep track of their decompression status.

While the M-value is a useful concept, we know that bubbles can form and DCS can develop even in exposures within the M-value limits. This is where conservatism factors become important. Knowing that the theoretical limit may not be safe and additional conservatism is desired, the allowable limits during decompression (ascent) can be adjusted, with the computer displaying the revised guidance. This adjustment can be made with strategies that "fool" the computer. For example, the amount of inert gas in the breathing supply could be set higher than it really is (if user-adjustable capabilities allow), or nitrox could be breathed while using a computer set to air. Alternatively, the surface pressure could be set lower than the actual pressure to prompt more conservative computations. The problem with the fooling approach is that undesirable side effects can result. For example, if a diver is breathing more oxygen than the computer expects, it will not provide the warnings about excessive oxygen exposure that it would if the correct oxygen levels were registered.

A better alternative to fooling the decompression algorithm is to limit the severity of the exposure while fully informing the model. This brings us back to gradient factors, which are defined by two values: The first number of the pair ("GF low") represents the percentage of the M-value that establishes the first stop during ascent; the second number ("GF high") is the percentage of the M-value that should not be exceeded at any point during surfacing. The dive computer effectively draws a straight line between the two, creating the ascent slope.

Dive computers that incorporate gradient factors typically provide either a limited number of choices or allow fully user-adjustable ranges. The figure below shows two example settings. The 0 percent line on the percent of M-value scale (Y-axis) is the point of no supersaturation; this can be thought of as the bottom depth from which a diver will depart to surface. The 100-percent line corresponds to the M-value limit, one that we know is not universally safe to approach. The 15/85 setting (dashed line) might be selected by someone who believes in deep stops and has substantial confidence in being bends-resistant. The first stop at only 15 percent of the M-value in a typical bounce dive (one in which most tissues do not reach saturation) pretty much ensures that inert gas uptake will continue during the stop in the intermediate and slow tissues since they are almost certainly below saturation at the stop depth. Allowing the supersaturation to reach 85 percent of the M-value during surfacing provides a modest buffer from a theoretical limit. It may be sufficient in some cases, but it might not be enough for susceptible individuals or if factors not measured by the dive computer act to increase the risk. Finally, the fairly steep nature of the curve means that there is a high rate of relative pressure change near the surface, where current knowledge indicates that a slow rate of ascent is safer.



In comparison, the 30/70 setting (solid line) brings the diver farther off the bottom for the first stop, which reduces continued ongassing during the ascent. Reaching only 70 percent of the M-value during ascent provides a greater buffer for decompression safety, and the shallower slope indicates a reduced rate of pressure change in the critical near-surface zone.

Gradient factors were primarily developed for technical diving, but the concept translates directly to recreational diving, particularly use of the GF-high value. The typically slow ascent rates common in modern diving mean that GF low is often not reached unless a low value favoring deep stops (perhaps less than 20) is selected. GF high typically determines the greatest magnitude of decompression stress reached during the dive. Gradient factors are relevant to multilevel as well as square-profile diving.

Some divers will not appreciate the need to incorporate additional conservatism, particularly if they have not experienced decompression problems in the past. It is important to remember, though, that subclinical insults (undetected DCS) could pose some risk over time, that aging makes us all less bulletproof than we once were and that the real risk changes with the specifics of every individual and for every dive. Extra conservatism can be reassuring, and for many divers spending extra time in the water is a pleasure and not a penalty. Alternatively, most people will probably agree that DCS is a penalty.

Guaranteeing a safe outcome for all divers would almost certainly require an unacceptable degree of conservatism, but tools such as gradient factors can provide a middle ground. Divers who want to adjust their exposures for conservatism beyond base levels can do so easily. Computers that allow setting changes during a dive provide even more flexibility. Issues that may warrant adjustment include expending greater physical effort than expected at the bottom and a partial loss of gas supply. In the first example, the diver could reduce GF high to add more buffer or, in the second example, could increase it to prioritize surfacing speed over decompression conservatism. Those who rely on dive computers that lack the flexibility described here must remember to build in and follow their own buffers, regardless of what the box displays.

Learning about the available options is an important strategy in managing risk. The thoughtful and well-informed diver knows far more about conditions that may affect real-time risk during a dive than our current dive computers do — and probably far more than dive computers will for many years to come. It is important to use the available tools effectively for both planning and implementation on every dive. This will help ensure the good outcomes that every diver expects. AD

CHOOSING A DIVE COMPUTER

Mandatory features

- A thoughtfully selected decompression algorithm
- Sufficient computing power to run the complete algorithm
- Clearly explained and intuitively valid user-adjustable conservatism settings
- Ease of operation that does not require a user manual to implement even after a period of non-use
- A display that is easy to read and interpret
- Long battery life with clear power-level indicators and/or easily replaced batteries

Optional but helpful features

- Conservatism factors that can be adjusted during the dive to accommodate changing risks and priorities
- Downloading capability so dives and settings can be easily reviewed and compared

Dive computers' computational power is essential for estimating the status of multiple tissue compartments in real time.

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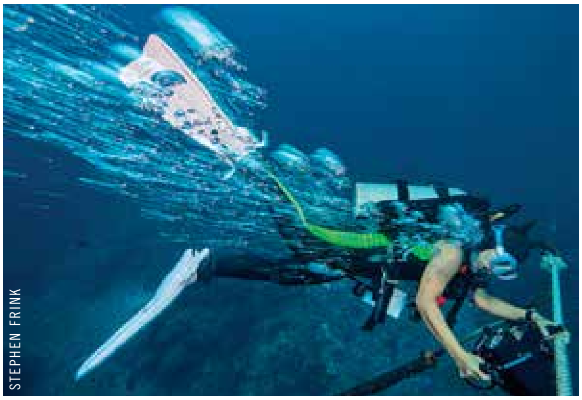
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Existing dive computers do not integrate the impact of thermal or exercise factors on decompression stress in a meaningful way.

REFERENCE

1. Baker EC. Understanding M-values. Available at: *www.ddplan.com/reference/mvalues.pdf*

WAYNE HASSON

Children and Diving

WHAT ARE THE REAL CONCERNS?

By Matías Nochetto, M.D.

When recreational diving equipment became commercially available in the 1950s, scuba was established as an exciting activity for courageous adepts all over the world. As equipment and confidence in technique evolved, diving became available to more people, including children.

Children and diving, however, is not without controversy. Concerns range from kids not having sufficient body size and strength to aid a fellow diver to the risk of inhibited bone growth and other medical concerns.

Children are not small adults. They are still growing, with different organs and systems developing at various speeds. They are maturing and evolving both physically and psychologically. Children are predisposed to ear infections as a consequence of their Eustachian tubes' immature form and function, which may also increase their risk of middle-ear barotrauma.

Children burn lots of calories, and the resulting heat provides them with good tolerance to cold. Once the expendable calories are exhausted, however, without adequate thermal insulation children may be more prone to hypothermia, and their relatively high body-mass-to-surface-area ratio leads to accelerated heat loss.

Childhood asthma underscores how pulmonary function is still evolving in young people, and any risk of air trapping is a serious concern when breathing compressed gas.

Perhaps the most significant concern about children and diving involves psychology and cognitive ability. Children often lack the mental maturity to understand and manage invisible risks, and they can behave unpredictably in stressful circumstances. Adherence to plans can be a problem for those who are easily distracted.

Diving and dive training practices currently address the physical, physiological and psychological challenges inherent to children by adapting equipment, modifying techniques, limiting exposure and mandating strict supervision.

Data about diving injuries among children are very scarce. Limited statistics available through some training agencies do not provide any cause for alarm, and injuries reported through the DAN Emergency Hotline rarely involve children. Some dive instructors praise youngsters' surprisingly good water skills; others argue that a single dive-related fatality in a child would be too many.

We ask the experts.

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What risks concern you most when it comes to young divers?

Simon Mitchell: I am generally relaxed about diving by children provided there is strict adherence to the recommendations around training, supervision and scope of diving promulgated by the major training organizations. I think the biggest potential problems relate to emotional and behavioral immaturity in children that may lead them to make poor decisions or be inattentive to plans. This concern can be mitigated by appropriate supervision.

David Charash: In general the risks of diving include barotrauma, decompression sickness, arterial gas embolism, panic, drowning and traumatic events. The risks of diving don't discriminate based on age or experience. So the real questions are:

- How well can an individual diver handle a given problem?
- Can the diver understand the level of risk present and decide on the degree of risk he or she is willing to accept?
- Can a child mitigate the risk by adjusting his or her dive profile?

Thomas March: By and large the pediatric population is quite healthy. We worry much more about mental errors that are unforgiving in scuba. The frontal lobe, which is associated with judgment, is generally not fully developed until the mid-20s. Panic, overconfidence and anxiety are serious concerns in the pediatric population. I also worry that many pediatric-age divers do not have the physical strength and/or skills to be a dive buddy responsible for the life of another diver.

David Wakely: Inexperienced adult divers are the greatest risk to children who dive. A child diver has a very different mindset from that of an experienced adult. Adults who think the child they are diving with is capable of all conditions and scenarios, who jump in the water beside the child but do not really watch them closely, are dangerous buddies for a child to have.

A child should always be paired with an adult who has the experience to deal with the child's short attention span and tendency to be distracted by shiny objects. The adult should constantly monitor the child's air and depth, swimming position and rate of ascent or descent.

Do you think that limiting the exposure makes diving safer for children?

Mitchell: Limiting depth/time exposures makes diving safer for adults and children. It is one of a number of pragmatic ways of mitigating the possibility that children may be more prone to events such as running out of air and rapid ascent. It clearly does not affect the risk of some diving problems such as barotraumas.

Charash: Intuitively, placing a clear and defined limit on depth and time of exposure is likely to add an additional layer of safety in children, but we must not forget that there is risk at any depth and dive time.

March: Turning loose young divers with compressed air even in shallow depths may be a big mistake. In my opinion it's more important that the instructor has the skills to assess a young diver's ability to be mentored. Stratification based on skills and experience — as seen in martial arts training, for example — could be useful. Many young divers are eventually able to appreciate the risks, but readiness can vary dramatically and depends much less on age than maturity. I think efforts to credential specialized instructors might be worthwhile.

Wakely: A graduated response to learning and freedom to dive is essential for child safety. I like to use the analogy of skiing — it's a potentially dangerous sport, but there are few adults who argue that children shouldn't be skiing. It's widely accepted that children should start on gentle slopes, wear a helmet and gradually move up to more advanced terrain according to their abilities.

Is decompression stress a concern with regard to long bone development in children?

Mitchell: There is no evidence for it. The epiphyseal plates of the long bones do not close until late adolescence, and there has been extensive diving by teenagers for decades. Despite this, I am unaware of a single case of apparent growth inhibition in a limb as a result of decompression sickness in a teenager.

Charash: There are no studies that show clear evidence that diving (decompression stress) can affect long bone development in young divers. What is not so clear is the effect of microbubbles that may enter the circulation and possibly affect the blood vessels in the growth plates (epiphyseal plates). I suggest limiting children's exposure to nitrogen by restricting depth and dive time and increasing surface interval time.

March: We know that tissue perfusion in the growth plates is significantly different from that in most other body compartments. This is clear because we find pediatric patients much more susceptible to bloodstream infections in these areas. The standard gas-compartment models are likely inadequate as routine dive tables, and experimental confirmation is neither ethical nor practical. The general consensus of a margin of safety seems prudent.

Wakely: There is no evidence that the hyperbaric environment has any ill effect on growing bones. The Undersea and Hyperbaric Medical Society (UHMS) lists 14 medical conditions that are known to benefit from

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hyperbaric oxygen therapy (HBOT). For two of these conditions, osteomyelitis (long-term bone infection) and osteoradionecrosis (bone damaged by radiation therapy), the HBOT addresses the underlying problem (infection and dead bone), encourages new blood vessels to form in the bone and allows the bone to heal itself. HBOT has no known negative effect on healthy bone of any age.

Do you think 10-year-olds have the mental maturity to understand and manage the invisible risks involved in scuba diving?

Mitchell: The question requires context. Within the framework of a dive training program and guidelines of practice designed specifically for this age group, my answer would be "yes, in most cases." Put another way, if the supervision and depth/time recommendations for diving are adhered to, then most properly motivated 10-year-olds should be fine. But if the question is whether a 10-year-old should be considered an independent open-water diver (as we understand that concept in adults), then my answer would be no.

Charash: To answer this question it is important to understand normal childhood growth and development. As there is significant variation in maturity and development, it is not possible to predict who will have the capacity to understand and also manage risk. Specific to the question, it would be a challenge to expect a 10-year-old to understand "invisible risk."

March: Many 10-year-olds may be capable, but many more may not be. Unfortunately there are often incentives for instructors, parents and even dive operations to train unready students. Adults who have the skills to assess the readiness of pediatric-age divers can facilitate positive and acceptably safe in-water experiences for kids of any skill level.

Prioritizing positive experiences for pediatric-age students allows for better advancement of all skill levels and avoids the all-or-none dichotomy of certification-focused programs. This also prevents a sense of failure for students unable to complete certification and may relieve some of the pressure parents place on instructors to certify students.

Wakely: Every child differs, but between the ages of 7 and 11 children's cognitive abilities change in two ways. First, concrete thinking occurs. This is the ability to solve logical problems that apply to actual objects or events. Second, children become less egocentric and develop the ability to view things from others' perspectives. So the average 10-year-old should have the mental maturity to understand the concept of risk and be able to solve concrete gear-related problems. However, the formal operational stage of thinking — using abstract thought and applying it to problems that have not even occurred yet — does not manifest in most children until ages 11 to 15. The major dive training agencies' programs for young divers do a good job of reflecting these stages of cognitive development.


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What characteristics do you consider necessary for a child to be a good candidate for scuba diving?

Mitchell: The most important thing is that the child wants to dive. It is also vitally important that the parents are supportive and wholly involved in the decision to allow diving, acting as informed risk-acceptors on the child's behalf. The child should exhibit a level of emotional, intellectual and physical maturity compatible with the scope of diving prescribed for his age group. Note that these characteristics cannot be adequately assessed in an office-based consultation. Thus, the evaluation of a child's suitability for diving is substantially the responsibility of the diving instructor who sees the child perform in the water, rather than the doctor.

Charash: There are five components that suggest that a given child is a good candidate for scuba: medical fitness (absence of any medical condition that could affect safety), psychological fitness (appropriate motivation for diving and achievement of relevant developmental milestones), physical fitness (capability to manage equipment and swim against a current), knowledge (knowing how to respond to situations appropriately) and skills (ability to clear a mask, buddy breathe, etc.).

March: Demonstrated surface skills such as breathing through a snorkel without anxiety are minimal requirements for undertaking instruction. Poor attention span, overconfidence and anxiety would seem to be exclusionary criteria. Pediatric patients do well with incrementally increasing responsibility. Unfortunately age alone is not a good indicator of developmental capabilities, and tailoring advancement based on the individual's readiness requires skills on the part of the instructor and mentors. As we consider the potential risks and harm that can be done, we must also balance this with the opportunities for enriching the appreciation of the underwater world and developing confidence and skills in our future generations of divers

Wakely: Several factors should be considered when assessing a child scuba student.


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Psychological maturity: Candidates should be calm and rational, not prone to extreme emotional outbursts and not prone to anxiety in unfamiliar situations. They need to understand risk and risk avoidance.

Educational maturity: The child should be able to learn independently. Learning scuba theory is a big undertaking, and the students must be able to concentrate on the material and know when to ask questions. They should be able to understand what they are reading enough to apply the principles described to situations they see around them in daily life.

Physical maturity: The child should be able to swim and should be very comfortable in and around water. Currently dive equipment for very small children is hard to find, so the child should be physically large enough to wear the available gear correctly and safely.

Desire to dive: The desire to dive must come from the child, not the parent. A dad asking an instructor to teach his son is very different from a child who wants to learn to dive like his dad.

Medically fit: Asthma, ADHD and morbid obesity are prevalent today, and these three conditions commonly disqualify children from diving. If you are considering arranging for your child to learn to dive, discuss your plans with a doctor familiar with dive medicine.

What has been your biggest challenge in training young divers?

Margo Peyton: My biggest job is educating parents. Parents frequently fail to disclose important information on medical forms because they worry their child will be prevented from diving. Full disclosure of all medical conditions is crucial — not only to maximize the child's safety but also so the dive operator can accommodate any special needs the child may have.

For example, we once had a child with autism in our program and were unaware of his condition until he panicked during his first open-water dive. He became very agitated and aggressive. Thankfully no one was hurt, but the child had to be removed from the program, which was humiliating for him. Had we known about his autism we would have provided him with his own private instructor who had experience teaching children with autism.

Parents should be aware, however, that not all dive operators have experience working with children. Adequate oversight should not be taken for granted. I recommend that parents ask dive operators the following questions before their children go diving:

- Is a first aid kit and oxygen unit on board or nearby?
- Is a radio or cell phone available?
- Are all staff divers current and active divemasters or instructors? (Don't hesitate to ask to see their C-cards.)
- What are the depths and conditions of the dives? (Make sure the child won't be diving deeper than what is recommended for his or her age.)
- Do any of the instructors have training or experience working with kids?
- Does the boat have a safety tank, dropline and dive flag on board?

Parents should request a refresher course for children who have not been diving in 12 months, and they should not hesitate to ask that a divemaster accompany them if they aren't comfortable diving alone with their child. AD

MEET THE EXPERTS

David Charash, D.O., CWS, FACEP, UHM, is medical director of wound care and hyperbaric medicine at Danbury Hospital in Connecticut. He is a certified diving medical examiner as well as a DAN Referral Physician and DAN Instructor. Dr. Charash lectures locally and nationally on dive safety and dive medicine.

Thomas March, M.D., a practicing pediatrician for 30 years, has a special interest in developmentally and behaviorally challenged pediatric patients. A diver for more than 35 years, he has special training and interest in administrative medicine and fitness-to-dive evaluations.

Simon Mitchell, MB, ChB, Ph.D., FUHM, FANZCA, is a physician who is widely published in his specialist fields of anesthesiology and dive medicine. Head of the department of anesthesiology at the University of Auckland, he is an avid technical diver, a Fellow of the Explorers Club and the 2015 DAN/Rolex Diver of the Year.

Margo Peyton, MSDT, is a scuba educator, member of the Women Divers Hall of Fame and the founder and director of Kids Sea Camp, through which more than 5,900 young people have learned to dive. Each year roughly 1,200-1,600 students dive with Kids Sea Camp, which has a perfect safety record.

David Wakely, FRCEM, FRCS, MBBS, BSc, Dip IMC, EDTC-II, is a consultant in emergency medicine as well as wound care and hyperbaric medicine at the King Edward VII Memorial Hospital in Bermuda. He also is a dive medicine consultant for the Bermuda police and government and a dive instructor who works extensively with children.


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The Social Psychology of Safe Diving

By Jason Martens, Ph.D.

As certified divers, we should already have a pretty good understanding of how to dive safely. But many of us have found ourselves in unsafe diving situations such as diving beyond our training or diving despite apprehension or discomfort. Many of these dangerous situations result from poor decisions made before a dive, but why do divers make bad decisions when we know better?

I have found myself in several unsafe situations in diving. Once a dive operator encouraged me to go on a dive that was deeper than I was trained to go. Another time one put together my equipment for me, and when I went to double check it he told me not to bother, saying they had "been doing this for years." Many divers give in to this sort of pressure, but why does this happen despite all the training we've undergone?

We could say these dive operators have an unsafe dive culture, but I think we must examine how such cultures arise. Many factors contribute to unsafe diving. One is pluralistic ignorance, which is when people act as if nothing is wrong because nobody else is acting like anything is wrong. In diving, this can occur when someone suggests something unsafe and nobody speaks out against it. When this happens we tend to look around, notice that nobody else seems to be concerned, and think something like "Well, nobody seems concerned, so maybe I'm paranoid; it must be OK." We must not take the inaction of others to mean that everything is as it should be.

Another factor is known as diffusion of responsibility. This occurs when a person's sense of responsibility diminishes in the presence of other people. In diving, we might see something that is inappropriate but say nothing because we assume it is someone else's responsibility to say something. It is particularly easy for novice divers to fall into this trap since they tend to assume that everyone else is better suited than they are to take responsibility for the dive. Remember, you are the best advocate for your own safety.

Deindividuation is another factor that can lead to unsafe diving. This phenomenon is often called "being lost in the crowd," but it doesn't necessarily require a large group. We feel fewer constraints on our actions when many people are around us, as might be the case on a full dive boat. When we are lost in the crowd, we tend to act more impulsively and may thus be more prone to making errors.

Close-knit groups of friends can be particularly prone to groupthink, which is when everyone in a group agrees with each other without thinking things through. Someone might suggest an unsafe dive, and everyone gives their assent without much thought.

On the other hand, diving with people you don't know can also be problematic. We tend to want to be liked by others, so we sometimes do things we normally wouldn't to get along or for others to like us. Often called normative social influence, it can encourage us to make an unsafe dive in an attempt to be liked by others. If someone suggests diving deeper than you are trained to, you might feel pressure to say yes if you want to be liked by that person. Although putting your life in danger just to be liked might seem strange, normative social influence is powerful and should be taken seriously.

Informative social influence is a bit different. This is when we do as others do because we think they know what is best. We learn from them and follow their lead. This is a good thing as long as the person we are learning from is doing things properly. Unfortunately, novices often look toward anyone with more experience, but not every diver is a worthy role model.

The good news is that we can counter these unwanted influences in many ways, including reading articles like this one. The simple act of learning about these influences can be enough to weaken them. We can also do the following:

- ***Take control.*** Don't assume somebody else will say something is amiss. Review your training, and stick to it. If someone suggests doing something outside of your training, say you aren't comfortable doing it. Chances are that someone else in the group is similarly concerned but is too shy or uncomfortable to say so.
- ***Slow down.*** We tend to act impulsively around other people, so slow down and think. Rarely do we have to make split-second decisions before we dive. Taking a minute or even just a few seconds to think things through can effectively counter errors due to impulsiveness.
- ***Play devil's advocate.*** It's natural to blindly go along with the crowd at times. To counter this, think about what might go wrong. We won't always identify plausible concerns when we play devil's advocate, but sometimes we may notice potential problems.
- ***Rely on your training.*** Part of safe diving is recognizing unsafe diving. If you are unsure, consult your manual or ask a diver with knowledge, experience and a commitment to safe diving. You can often tell who these people are: They tend to talk about safety, have advanced training and help novices before dives.
- ***Model good behavior.*** If you are an experienced diver, lead by example. Don't be afraid to go out of your way to make it clear you are a safe diver. For example, you might invite novices to plan their dives with you. This helps create a climate that benefits everyone.
- ***Role-play.*** Practice with a friend what you would do if someone pressured you to make an unsafe dive. We often make poor decisions because we are put on the spot and don't have time to think things through properly. Practicing what you would say and who you would say it to can make it considerably easier to make the safe decision. Prior to doing something exciting like diving, we tend to respond with our dominant response, but a beginner's dominant response is not always the correct one. Through role-playing and practice you can make your dominant response one that supports safety.

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Divers should be aware of the various ways social pressure can influence their behavior. When in doubt, rely on your training and never forget you are the best advocate for your own safety.

Most of us understand, intellectually at least, the risks associated with cutting corners, rushing dives and not being fully prepared. By learning to recognize factors that lead to unsafe decisions, we can help keep ourselves out of dangerous situations. AD

Timing Exercise and Diving

DAN MEDICS AND RESEARCHERS ANSWER YOUR QUESTIONS ABOUT DIVE MEDICINE.

Q: How is a dive professional supposed to stay in shape when we're advised to avoid vigorous exercise within 24 hours of diving? What kind of exercise is recommended for a divemaster or instructor who dives daily?


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A: The problem you describe is, unfortunately, something of an intractable one. There is no easy solution. A compromise is almost always required. The simplest rule is that the highest-intensity exercise should be separated from diving, particularly from more extreme dives.

Some runners run every day regardless of other activities. The first recommendation for such people is that they dive very conservatively. This advice is by itself a problem since it is difficult to quantify "conservative," and the spirit of the recommendation is not generally understood in the diving community. Diving within the limits of a dive computer or table does not necessarily constitute conservatism. There are a variety of different limits, and many divers have developed symptoms while adhering to them. Computers or tables provide estimates for a variety of people and exposures based on limited input.

A major challenge in appreciating the risk of decompression sickness (DCS) is its probabilistic nature. The fact that a diver might tolerate a given exposure once, twice or 10 times without incident doesn't mean the exposure is safe. If DCS results from the 100th exposure, this is not an undeserved hit — the diver simply ended up on the wrong side of the probability line that day.

Humans have a tendency to let good habits erode when nothing bad happens. We tend to increase our driving speed and push depth and/or time limits on dives. Furthermore, we often fail to appreciate that we are not being as conservative as we once were. This can lead to surprise when things go bad.

This surprise can create a tendency to look for some factor to blame. With DCS, dehydration is often the scapegoat. The reality in most cases is that a similar state of hydration probably existed on many other dives. The real problem with this tendency is that it may encourage the diver to ignore the depth-time profile, which is by far the most important factor. While it can be comforting to identify a simple cause, it is a disservice to safety. The risk of DCS is affected by a large number of factors acting in complicated concert. True conservatism is required to increase the likelihood of consistently safe outcomes.

The daily runner will have a sense of the normal pains and discomfort associated with his or her exercise. Atypical pain or discomfort in a diver will raise suspicion of a decompression injury. Again, the ideal choice for this person would be to limit diving to conservative exposures. The next best choice would be to fit in the intense physical activity as far from diving as possible. It is safest to limit physical activity to that with very low joint forces — the closer to diving, the lower the forces. Modest swimming, for example, involves much lower joint forces than running. Cycling can also involve lower joint forces than running. These are not absolutes, though. It is not enough to choose an activity that might have low joint forces; it is necessary to practice it in a way that ensures low joint forces.

The practical approach is to separate physical activity from diving, with the lowest-intensity exercise closest to the diving. Swimming and walking typically produce less strain than intense cycling or running. High and repetitive joint forces should be minimized. The diver should be mindful of the activity level and honestly appraise the risk. By making small decisions that consistently favor the slightly safer option over the slightly more aggressive, an adequate safety buffer can be created.

This is not a simple answer, but reality is messy. Exercise, especially intense exercise, can increase the effective decompression stress. If it is not avoided, an honest appraisal of conditions and actions is important to control the risk. If a problem does develop, it is best to skip the denial and blame phases. DCS can and does happen, often following dives that were assumed to be safe.

Ultimately, each diver should appreciate the risks, work to control them and accept that diving involves complicated hazards. Getting bent should not be considered a personal failing. Being open to the possibility of DCS can start a diver down a very positive road of preparedness and action to reduce risk at every opportunity. Employ physical activity thoughtfully; ultimately the self-aware and self-critical (honest) diver will likely end up being the safest one.

— Neal W. Pollock, Ph.D.

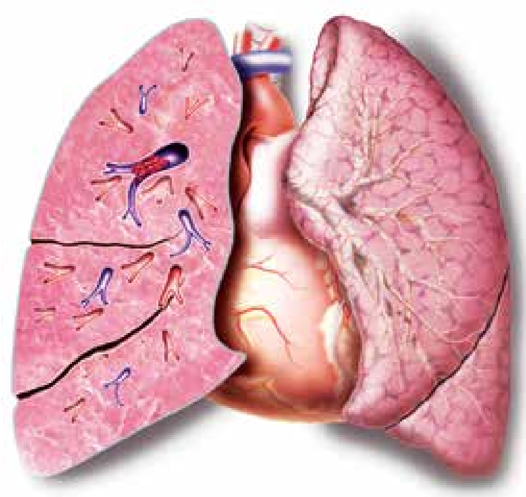
Q: I'm 56 and in good health. Three years ago I had an idiopathic pulmonary embolism. I am no longer taking anticoagulant medication, and I remain very active. Can I dive?

A: Several things need to be considered when evaluating fitness for diving after a pulmonary embolism. First is the cause, because it is important to determine the risk of recurrence. Determining this risk may be difficult in your case because your embolism was idiopathic (of unknown origin). Next the damage to the lung must be assessed. Scarring and/or adhesions may prevent proper gas exchange, making diving unsafe.

DAN is not in a position to determine an individual's fitness for diving; a physician must make that decision. The best way to begin the process of assessing your fitness to dive is to get a high-resolution spiral CT scan to determine if there is damage to the lung tissue. If there isn't, and exercise tolerance is normal, diving can be considered.

Pulmonary hypertension and other associated medical conditions may restrict your exercise tolerance. Certain medications can have side effects that might limit your ability to dive safely, so you should discuss all medications you take and your complete medical history with your doctor.

A pulmonary embolism is a blockage of one of the arteries that carries blood to the lungs, usually caused by blood clots.



JFALCETT/ISTOCKPHOTO.COM

If your doctor approves your return to diving, request this approval in writing so you can provide documentation to dive operators, who will likely require a written statement before allowing you to dive.

— ***Lana Sorrell, EMT, DMT***

Q. On a recent dive a buddy rolled backward into the water, and his tank valve hit me on the head. I saw a flash and was disoriented for a few seconds. I've been lightheaded and have felt a little out of it for the past few days. I'm guessing I should avoid diving for the time being; when will it be safe for me to get back in the water?

A. You are absolutely right to avoid diving for now. The primary concerns following a head injury are lapses in consciousness and the risk of seizures. Even a brief loss of focus can lead to a loss of buoyancy control and a rapid ascent with potentially dire consequences such as pulmonary barotrauma or arterial gas embolism. Seizures underwater can cause loss of the regulator, loss of airway control and, ultimately, drowning. Seizures that occur out of the water are typically transient and manageable events; seizures that occur underwater are typically fatal.

The Brain Injury Association of America classifies concussion (brain injury) as follows:

Grade 1 Concussion (mild)

- Person is confused but remains conscious.
- Signs: Temporary confusion, inability to think clearly, difficulty following directions
- Time: Symptoms clear within 15 minutes.

Grade 2 Concussion (moderate)

- Person remains conscious, but develops amnesia.
- Signs: Similar to Grade 1
- Time: Symptoms last more than 15 minutes.

Grade 3 Concussion (severe)

- Person loses consciousness.
- Signs: Noticeable disruption of brain function exhibited in physical, cognitive and behavioral ways
- Time: Unconsciousness lasts for seconds or minutes.

The potential for returning to diving varies based on the severity of the injury. Doctors trained in dive medicine generally recommend the following periods for returning to diving after recovery from a head injury:

- **Mild**: 30 days out of the water
- **Moderate**: 1 year out of the water
- **Severe**: 3 years out of the water

Please note that the clock starts not with the initial injury, but at the time you become symptom-free. If you are still experiencing symptoms of a head injury such as headaches, seizures, periods of amnesia or any other symptoms, the waiting period has not yet begun.

These recommendations are all general guidelines; you should be evaluated by a physician trained in dive medicine before considering a return to scuba diving — for your own safety as well as others'. Remember, diving is a buddy sport, and any event that occurs underwater also affects your buddy, other members of the dive group and potential rescuers.

JOE POE

Please feel free to contact us at +1-919-684-2948 for further questions, and encourage your doctor or neurologist to do so as well. AD

— Frances Smith, EMT-P, DMT

End-of-Life Care

By Richard Fortin

Most of us take first aid training to have the knowledge and skills needed in the event we have an opportunity to help someone. I have taken first aid courses and refreshers and participated in first aid competitions for as long as I can remember, but I never expected that all my training was preparing me for something life had in store for me.

First aid courses teach us to prioritize our own safety when approaching an emergency situation so that we may effectively help others. But what happens when the situation is not an emergency? What happens when a loved one who has decided to no longer accept cancer treatments asks you to be her primary caregiver so she can die at home?

My late wife, Laurel, had a long road to travel and lived with cancer for many years. She underwent successful treatment to remove cancer from her brain four times. With the fifth recurrence, she chose to stop the treatments she had endured for 19 years. Over the years my role as a caregiver evolved, and with the help of an extraordinary team of nurses and doctors I was able to provide some medical care to Laurel. The first aid training I had acquired helped prepare me to confidently supplement her care and, ultimately, enable her to die at home.

When the conversation about a home death arose, the first question I had to answer was "Can I handle it? Do I have the skills to keep her and my kids safe?" My answer, because of my training and the medical team's confidence in my abilities, was yes.

DAN's Basic Life Support and First Aid (BLSFA) course teaches us how to react and keep people alive in emergencies. What may not be apparent is that the skills learned from this training can help you provide care in other scenarios. Here is how my DAN training helped me provide palliative care:

BLSFA

- **Scene safety:** I often needed to assess Laurel's room for hazards (e.g., Did she fall out of bed? Possibly break a mirror?) Before I helped her I would don my gloves to protect her weakened immune system as well as to protect myself.

JM GUYON/ISTOCKPHOTO.COM

- **Initial assessment:** Laurel had weakness on the right side of her body from her many brain surgeries, causing her to tumble several times. After a fall I would perform a quick head-to-toe exam to check for any injuries.
- **Bandaging and wound management:** There were many opportunities to practice these skills following Laurel's four craniotomies. I changed dressings to keep the incisions clean, applied new dressing to protect her from bed sores and kept injection ports clean and sterile.

- **Medical emergencies — seizures:** With Laurel's type of cancer, seizures were frequent. Knowing how to respond to the initial seizure helped keep everyone calm. My skills also helped with her recovery following major seizures; sometimes it would take several days for muscle and verbal ability to return.
- **Temperature-related injuries:** Near the end of her life, Laurel's autonomic nervous system failed, which affected her ability to regulate her body temperature. Being able to recognize and properly treat heat- and cold-related problems proved to be very helpful and prevented worsening of her condition.
- **Home emergency plan:** When we decided that Laurel would die at home, we formulated Plans A through Z using the emergency planning skills I'd picked up in my training. This helped everyone know what to do in the event of various situations as they arose.
- **Lifting and moving:** This was a skill I used daily when getting Laurel into and out of a chair or bed, rolling her for cleaning, changing dressings and for comfort. Knowing how to do this without injuring her or myself was very important.

NEUROLOGICAL ASSESSMENT

- **Conducting a neurological assessment:** At each checkup, the doctor performed the same tests on Laurel that DAN's Neurological Assessment course teaches. I used these skills to determine whether her condition was improving or declining. Conducted weekly, these tests measured neurological function and over the months established a baseline for comparison, especially following events such as a seizure or brain surgery.

EMERGENCY OXYGEN

- **Oxygen administration:** As divers we all know the benefits of oxygen. The doctor recommended that Laurel breathe pure oxygen for 30 minutes each day, if possible. I used my DAN oxygen unit for these treatments, which I believe helped speed her recovery following surgeries and seizures.

This is a short list, but it illustrates that while first aid training is typically undertaken to prepare us to react in emergencies, life can challenge us in ways we never imagined. The life-saving skills taught in these courses can easily be adapted and applied to other challenging situations your loved ones or other people in your life may face. AD

Good Fortune After Bad

By James M. Chimiak, M.D.


STEPHEN FRINK


STEPHEN FRINK

THE DIVER

A 40-year-old male did four rebreather dives one day from a liveaboard near Socorro Island. Maximum depths of the dives ranged from 115 to 128 feet of seawater; dive times were from 62 to 76 minutes. This was the third day of his dive series, which totaled 10 dives. All dives were uneventful, and he was out of the water at 6 p.m.

THE INCIDENT

Approximately 3.5 hours after his last dive, the diver experienced nausea, vomiting and difficulty breathing during dinner. His fellow divers reported that he was unable to recognize them and could not recall his home address or date of birth. Fortunately, two physicians were among the passengers, and they examined the diver. The exam revealed dilated pupils, slurred speech, motor weakness and involuntary muscle contractions.

The crew activated the vessel's emergency action plan. They placed the diver on oxygen at approximately 10 p.m. and contacted DAN® for medical advice and to initiate an evacuation to a suitable medical facility.

THE COMPLICATIONS

Located in the eastern Pacific south of the Baja peninsula, Socorro Island is approximately 240 nautical miles from Cabo San Lucas. It is one of four volcanic islands that make up the Revillagigedos Islands (the other three are San Benedicto, Roca Partida and Clarion). The boat ride to Cabo San Lucas takes about 24 hours.

A Mexican military airstrip is on Socorro, but the runway is unable to accommodate larger aircraft, including those that can maintain sea-level pressure during flight. Inbound flights require permission from the military and must clear customs and immigration on the mainland before departing. The airstrip is insufficiently lit to allow takeoff or landing at night.

As evacuation plans were being made, the diver's symptoms began to resolve as he breathed supplemental oxygen. DAN established direct contact with the small military facility on Socorro, which has a functional hyperbaric chamber and professional staff. They quickly recognized the severity of the diver's condition and that a favorable window of opportunity existed to recompress him, so they agreed to receive the patient. Though there was no physician at the chamber, the diver's improving condition made treatment at the local facility a good option.

The diver arrived at the military facility within four hours of his notable decline. He was able to walk into the chamber, and the chamber operators administered a U.S. Navy Treatment Table 6 with guidance from DAN's physicians. The treatment led to complete resolution of symptoms, and the diver was released to the boat for monitoring and frequent detailed neurological evaluations by the physicians on board the vessel. A well-known dive medicine physician happened to be aboard another dive boat in the area, and freely rendered his assistance. After a detailed evaluation, he confirmed full resolution of the patient's symptoms. The diver made an uneventful return home and did not experience any return of symptoms aside from some mild, intermittent general soreness.

DISCUSSION

Evacuation of this diver presented many challenges to the medical personnel involved in his care, and there are excellent lessons to be learned at each phase of treatment.

First, quick recognition of serious dive-related problems is important. In many cases, denial can lead to a refusal to accept that something is wrong and needs attention. Divers may employ hopeful rationalizations to discount early symptoms, because a declared emergency has the potential to end further diving — for both the injured diver and others. Even when an injury is finally recognized, a desire exists for things to spontaneously improve without the need to notify the divemaster. In this case an astute dive team recognized abnormal symptoms and behaviors that led to a diagnosis of cerebral decompression sickness (DCS).

Next, caregivers should administer first aid promptly and conduct further investigation. This dive team quickly provided oxygen, which resulted in dramatic improvement in the diver's condition, and then identified medical professionals in the group and engaged them in his care. They contacted DAN for help with both treatment suggestions and evacuation options. In remote locations, it is important to be familiar with local medical capabilities and evacuation options before emergencies happen.

In this case a two-leg flight would have been necessary to get the diver to a fully capable hyperbaric facility (at the University of California, San Diego). There are hyperbaric facilities in Cabo San Lucas, but getting there would still require air evacuation or a long boat ride. Because of the limited capabilities of the island's airstrip, an unpressurized aircraft would have to take the patient to the mainland, where a second flight would deliver him to San Diego for definitive recompression therapy. Symptoms developed in the evening, so due to darkness any flight to the island would have to be delayed until morning, introducing further delay.

DAN notified the Mexican navy of the diver's serious condition, and they understood that a delay in treatment could lead to a poor outcome. Despite the busy tempo of the remote diving unit, the commanding officer opened his recompression chamber to the civilian diver. The chamber crew were true professionals who quickly administered the necessary hyperbaric treatment that resulted in complete resolution of all the diver's symptoms. Doctors on the dive boat reevaluated him and decided he could remain aboard and transit back to the mainland according to the ship's original itinerary. Three days after his treatment he made an uneventful flight back home.

Four fortunate events positively affected this diver's episode of serious cerebral DCS. First, his well-trained fellow passengers and the crew quickly recognized the problem and monitored his health until he reached the medical facility. Second, they administered oxygen quickly, which resulted in considerable improvement. Third, an expert in diving medicine was diving in the vicinity and rendered assistance. And fourth, the highly professional Mexican navy opened a restricted facility, which enabled definitive treatment and prevented potentially permanent neurologic injury to the diver. He was indeed lucky, but he also was a beneficiary of divers' willingness to help other divers. Such willingness can overcome significant obstacles, even international borders, as seen in this case.

Please take time to thank the professionals who are committed to helping injured divers. In particular, thank those who keep hyperbaric facilities open for diving emergencies 24 hours per day, seven days a week; they are diving's unsung heroes. AD

DAN
YOUR DIVE SAFETY ASSOCIATION

Be Ready To **Respond**

Every day, divers and emergency response personnel around the world trust DAN's oxygen units and first aid kits to perform in an emergency. That's because DAN's products have been developed, tested and refined with input from leading doctors and researchers to meet the discriminating requirements of the diving community. So be ready to respond. Explore **DAN.org/STORE** and make sure you are prepared to effectively handle an emergency situation with the latest safety equipment.

SOFT-SIDED EXTENDED CARE BACKPACK

DAN's lightweight, soft-sided, easy-to-transport oxygen unit holds one Jumbo D cylinder that delivers approximately 45-60* minutes of oxygen. Its large mesh pockets, deep stuff-pocket, and dual external zipper pockets offer ample storage for a range of accessories. This bag is equipped with an adjustable backpack harness system that distributes weights for added comfort over long distances. Includes a brass multifunction regulator, demand valve with hose, non-rebreather mask, oronasal resuscitation mask, and Tru-Fit mask.

601-1080	Soft-Sided Extended Care Backpack	**$660.00**
601-1090	Soft-Sided Extended Care Backpack w/MTV-100	**$810.00**
611-1010	Jumbo D Cylinder (optional)	**$100.00**

International White Cylinder Paks

601-1083	Soft-Sided Extended Care Backpack	**$660.00**
601-1093	Soft-Sided Extended Care Backpack w/MTV-100	**$810.00**
611-1013	Jumbo D Cylinder (optional)	**$100.00**

601-1080

Optional second cylinder shown.

RESCUE PAK

601-4000

DAN's Rescue Pak is a compact oxygen unit featuring a smaller M9 cylinder that delivers approximately 14-20* minutes of oxygen. This unit also comes complete with a brass multifunction regulator, demand valve with hose, non-rebreather mask, oronasal resuscitation mask, Tru-Fit mask, and a waterproof Pelican 1450 case. Ideal for wet environments and locations closer to emergency assistance.

601-4000	Rescue Pak	**$475.00**
601-4100	Rescue Pak w/MTV-100	**$625.00**

International White Cylinder Paks

601-4003	Rescue Pak	**$475.00**
601-4103	Rescue Pak w/MTV-100	**$625.00**

1. Note: Oxygen units may require prescriptions and/or training in administration of oxygen before they can be filled.
2. Note: All cylinders are shipped empty.

* O_2 delivery times listed are approximate and will vary based upon rate of flow and other factors.

The Leader In Dive Safety For 35 Years

COAST GUARD COMPLETE KIT

DAN's Coast Guard Complete Kit has the first-aid supplies needed to meet the U.S. Coast Guard's requirements for small passenger vessels. Ideal for up to 8 persons, this kit includes ammonia inhalants, an oronasal resuscitation mask, trauma pads, and more.

631-3200	Coast Guard Complete Kit	**$120.00**
631-3300	Coast Guard Complete w/Pelican® 1300 Hard Case	**$150.00**

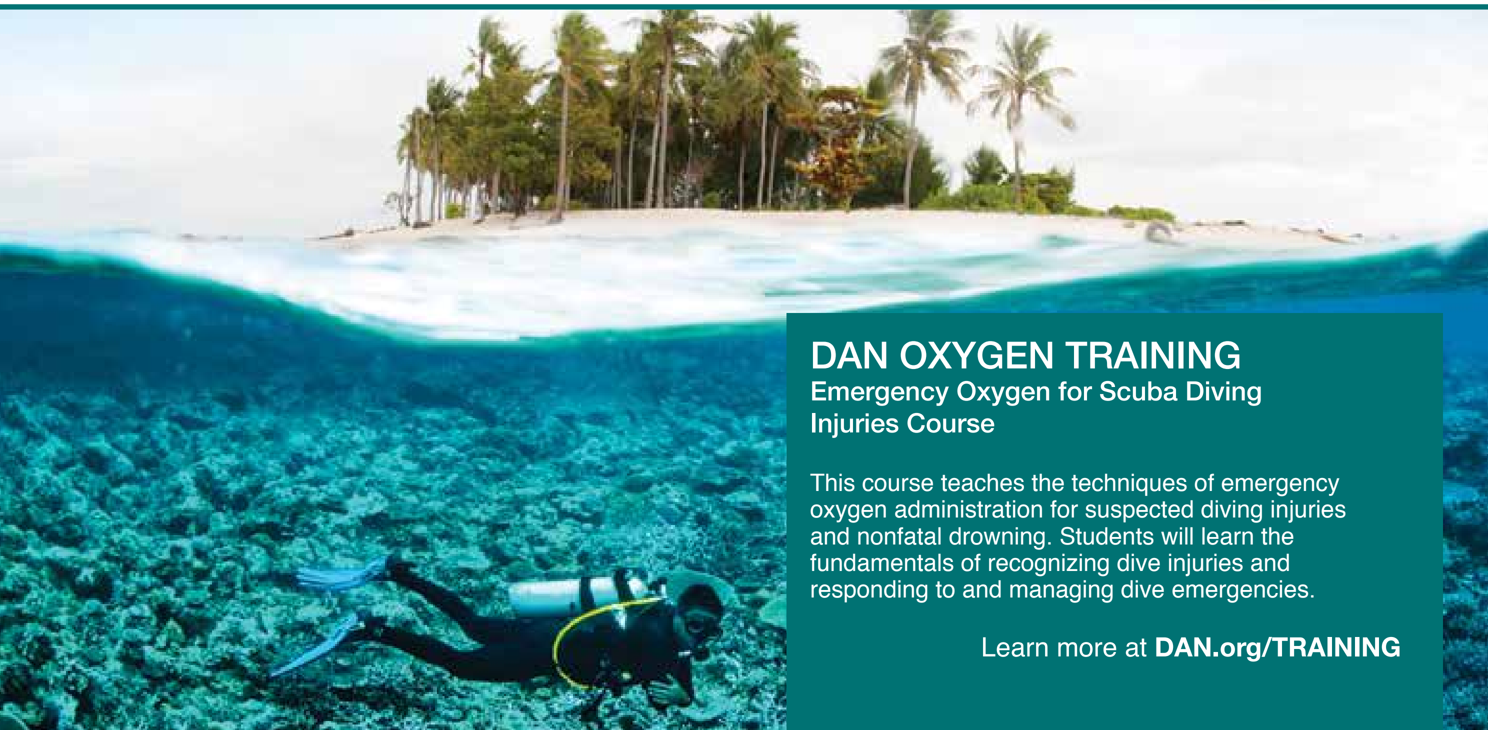
FIRST-AID BACKPACK

The First-Aid Backpack is fully stocked with an assortment of first-aid essentials to handle a range of emergencies. Common medications, stop-bleeding wraps, wound-care bandages, fracture/sprain splints, and burn care supplies are included. Features ample storage compartments for all first-aid components as well as an open storage area for additional supplies. This durable First-Aid Backpack is designed for dive operators and other active individuals.

631-3000	First-Aid Backpack - Complete with Supplies	**$145.00**
501-6300	First-Aid Backpack Only	**$80.00**
631-2000	First-Aid Refill Pack Only	**$38.00**

631-3000

Includes a waterproof cover stored in bottom compartment of pack



DAN OXYGEN TRAINING

Emergency Oxygen for Scuba Diving Injuries Course

This course teaches the techniques of emergency oxygen administration for suspected diving injuries and nonfatal drowning. Students will learn the fundamentals of recognizing dive injuries and responding to and managing dive emergencies.

Learn more at **DAN.org/TRAINING**

DAN.org/STORE

THE SOUTHERN RED SEA

A Photo Diary

Left: The late afternoon light percolates through the reef complex at St. John's Caves, while a vibrant soft coral decorates the foreground.

Right: This digital composite illustrates iconic elements of the Red Sea reef: a coral grouper, anthias and soft corals in the foreground along with endemic bluecheek butterflyfish, all photographed at Farsha at Wadi Gemal.

TEXT AND PHOTOS BY STEPHEN FRINK

The Red Sea is a vast body of water that flows into the Indian Ocean. It's rimmed by the arid lands of Egypt and the Sudan to the west and Saudi Arabia to the east. Most Red Sea dive tourism is to the Egyptian Red Sea, traditionally via Sharm el Sheikh and Hurghada. In the past decade a new portal to the Southern Red Sea has evolved at Marsa Alam. Via direct flight to nearby Marsa Alam or three-hour bus ride from the Hurghada airport, the marina at Port Ghalib has become a convenient gateway to the extraordinary dive options of the Southern Red Sea. The images in this photo diary are all from a 10-day liveaboard safari in July 2015.

Because the Red Sea is essentially an oasis of marine beauty in the midst of a desert, there is very little fresh water to degrade visibility. The stark contrast between the azure depths, punctuated with soft corals of every imaginable pastel hue, and the tan sand and hills above are one of the wonders of the world of diving. With 1,200 species of fish, 10 percent of which are endemic to the region, the Red Sea is remarkably fertile for underwater photography. While macro subjects abound, I have always found it difficult to take my eye away from the fish portraits and wide-angle vistas the Red Sea presents.


Big Brother Island


Daedalus Reef


Zabarghad Reef


Port Ghalib Marina

Spinner dolphins, Satayh, Fury Shoal

Hawksbill turtle, Daedalus Reef

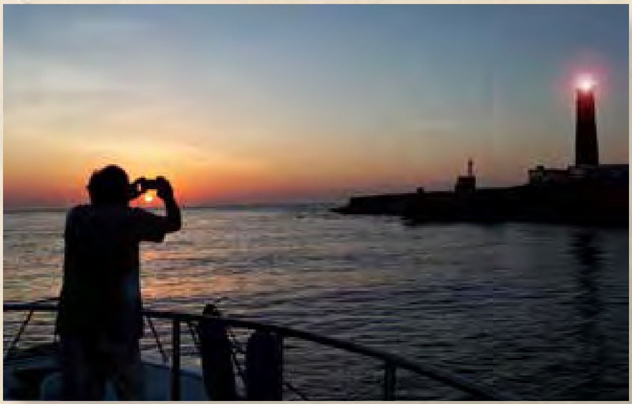
Bluecheek butterflyfish, Habili Jaafar pinnacle

Soft coral and anthias, Farsha at Wadi Gemal

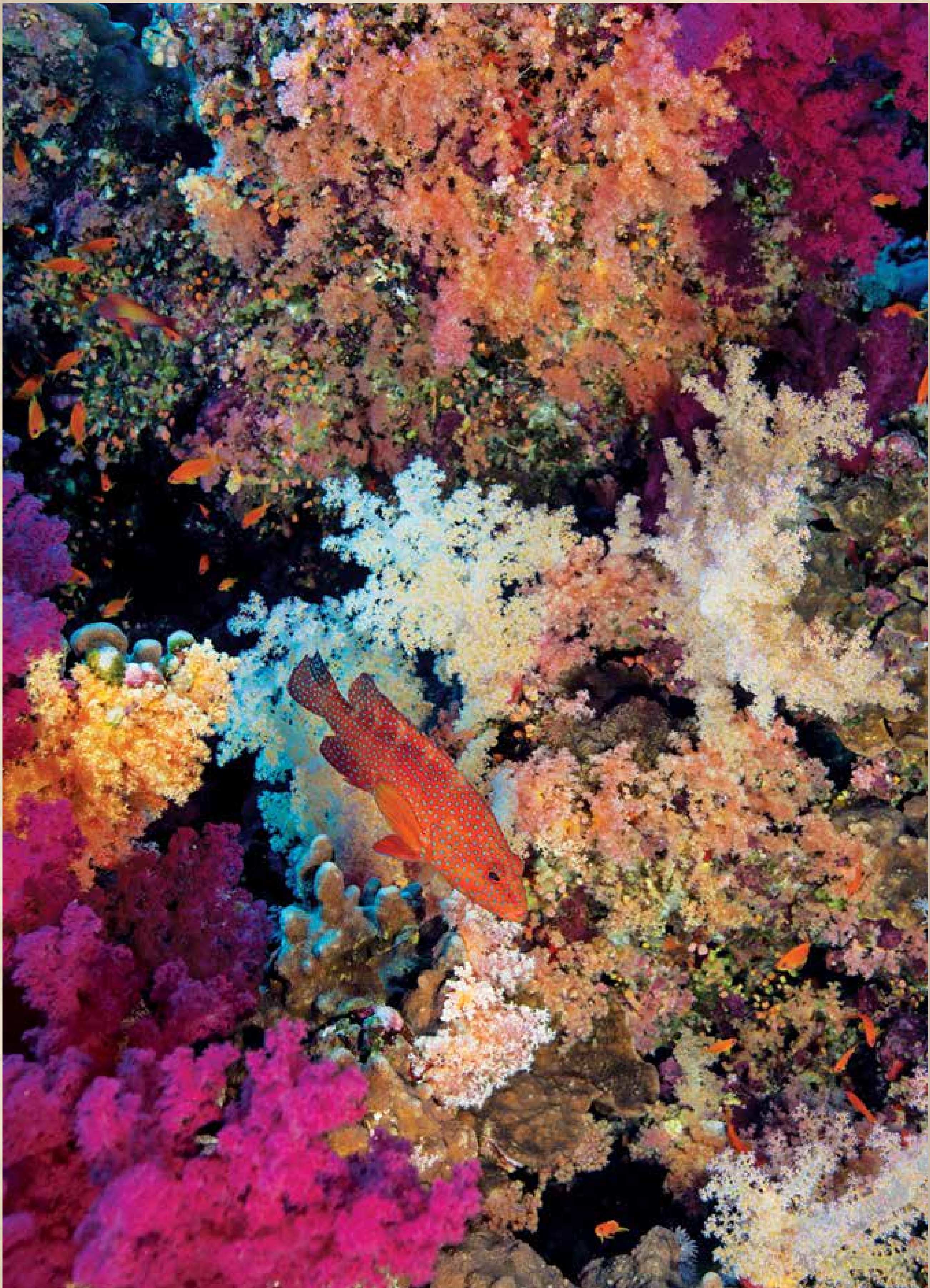
Lionfish, Zabarghad Reef

Titan triggerfish, Shaab Sharm at Wadi Gemal

Giant moray, Little Brother Island



Sunset and lighthouse, Big Brother Island



Coral grouper and soft corals, Little Brother Island

No one seems to know for sure how the Red Sea got its name. Had the ancient Egyptians who first explored the area in 2500 B.C. donned scuba gear and peered beneath the surface, the appellation could have been for the brilliant soft corals, the large schools of bigeye along the walls at Little Brother Island or the mantles of the anemones decorating the shallows at Daedalus Reef. AD

HOW TO DIVE IT

GETTING THERE

Both Hurghada and Sharm el Sheikh are popular fun-in-the-sun vacation destinations for Europeans, and there are modern international airports at both cities. It is easy to connect via Cairo or major European gateways. There are also direct commercial and charter flights to Marsa Alam from Cairo and Europe, but flights are less frequent than those to Hurghada. It is a three-hour bus ride from Hurghada to Port Ghalib. Be sure to arrive on time for your liveaboard departure because security regulations prohibit boats from returning to port to pick up tardy passengers or delayed baggage.

CONDITIONS

The difference between winter and summer conditions is dramatic. In the winter the water may cool down to 72°F while it may be as warm as 84°F in the summer. Winter winds typically pick up as well, making some of the crossings to the offshore islands more difficult. Some sites are easy dives, while the effects of currents can complicate others. Most dives are multilevel, offering the possibility to work up a wall or a pinnacle to offgass. Dive operators in the Red Sea tend to enforce the buddy system, and divers should be adept at deploying a surface marker buoy. There are modern hyperbaric chamber facilities in Hurghada, Sharm el-Sheikh and elsewhere in Egypt, as well as in Israel, Jordan and Saudi Arabia.

Common seadragons (also known as weedy seadragons) are some of the most bizarre, fantastical creatures in the sea.

Opposite: The red handfish is a critically endangered anglerfish found only in Tasmania. It walks along the bottom on its modified handlike pectoral and pelvic fins.

T A S M

TEXT AND PHOTOS BY BRANDON COLE

We might as well be on Mars for all the good my marine biology training is doing me right now. What's that spiky fish in the convict suit? With severe angles, knifelike fins and a protruding Pinocchio nose, it resembles a cross between an alien fighting machine and a cartoon character. Genus and species of the cloud of pink fish? No clue. Pouring down from above in the hundreds, they must be the rain that nourishes this thriving garden of sponges in Crayola-bright colors. And what's the blue-chinned, thick-lipped piscine oddity that slips furtively among 3-foot-high, peach-hued candy-cane-shaped things? It's a scene straight out of a Dr. Seuss story. I don't recognize any of the players on the stage, and my ignorance is bliss. Who wants to travel 9,000 miles to see the same old things?





Tasmania is a place "like nowhere else on Earth," the brochures claim. It's a lofty boast, but from where I swim, awash in the weird and wonderful 125 feet below the surface of the Tasman Sea, I must agree.



Clockwise from top left: **The seacliffs of Waterfall Bay; southern rock lobsters; shore diving at Waubs Bay; an invertebrate-encrusted deep reef; a bigbelly seahorse; an Australian swellshark; the propeller of the SS *Nord*; a smooth stingray, the largest stingray in the world**

OFF THE RADAR

The goal was to broaden our dive horizons by jumping off the beaten path. In Tasmania we were destined to succeed big time. Tucked beneath the bulk of mainland Australia, this island serves up some of the world's best temperate-water diving.

The seed of inspiration for a trek to Tassie was planted 20 years ago by photos I saw in *National Geographic* — pictures of strange creatures, shadowy kelp forests and invertebrate-plastered rocky reefs under a heaving ocean and towering sea cliffs. It took a while to reach these distant shores, but we're finally here, down under the land down under. Irrefutable proof of our location are the road signs we passed on yesterday's drive from Hobart, the capital, to Eaglehawk Neck, warning of crossing Tasmanian devils. Further corroboration is the tiny red handfish now posing in front of my camera. It's one of the world's rarest fish; the Australian Department of the Environment estimates that fewer than 1,000 exist in the wild, and they're all in Tasmania. It's a real beauty, even if it appears to have a bad case of measles. But it seems happy enough as it walks stiffly along the bottom on scarlet-fingered fins.

It took Mick Baron's eagle eyes to find the cryptic beast hiding among a surge-tossed tangle of algae 15 feet deep in **Frederick Henry Bay**. Baron gives me a good-natured ribbing while we're celebrating after the dive. "Sneaky little buggers," he said. "Reckon you'd have found it on your own?"

"Not in a hundred years," I answer unequivocally.

"That's about average," Baron continues. "Takes a while to figure them out. You're off to a good start having seen a handfish already." With a combined 75 years of diving between them, Baron and his business partner, Karen Gowlett-Holmes, know a thing or two about this unique corner of the underwater world.

TOURING THE TASMAN PENINSULA

From our base in Pirates Bay we head south along a remarkably rugged coastline into Munro Bight to dive the wreck of the **SS *Nord***. One of Tassie's signature dives, this 290-foot cargo steamship sank in 1915 during a brutal storm. We're smack dab in the middle of the "roaring forties," where gale-force westerly winds and punishing waves have a long history of wreaking havoc on vessels plying these extreme southern latitudes. But today's June weather is lovely — 60°F under the bluest of skies with just a gentle breeze — and my wife, Melissa, and I thoroughly enjoy surveying this sleeping giant from a past age. It rests upright on a sandy bottom at 130 feet. Our 28 percent nitrox is put to good use, extending our bottom time at the stern. The *Nord*'s enormous rudder and propeller are the prime photo attractions, glowing a soft yellowy orange in the blue-green gloom thanks to a patina of encrusting zoanthid anemones and sponges.

We descend on the resplendent **Deep Glen Bay North Wall**, a colorful tapestry of fish and invertebrate life. Drawing on Gowlett-Holmes' encyclopedic knowledge I'm able to put names to the faces of Shaw's cowfish, banded morwongs and gorgeous "crays" (rock lobsters), which I find crammed into a crevice. She saves the day when I return from a shallow dive on kelp-wreathed **Fok Rock** with photos of more mystery critters that she quickly identifies as ocellate sea stars, a Maori octopus, and *Pseudopallene ambigua* — canary-yellow creepy-crawlies also known as a pycnogonid sea spiders. In picturesque Waterfall Bay we explore **Cathedral Cave**, swimming in through the "eyes" of the skull cave portion of this extensive sea cave system, the largest in Australia. While Melissa and I traverse interconnected tunnels and chambers at around 50 feet, we hear powerful *wuuummphing* sounds around us every 15 seconds; it's the waves smashing into the cliff walls outside. It sounds like a giant heartbeat, rhythmic, incessant and more than a little bit eerie.

With a weather forecast calling for another nice day before winds and swell begin to build, we plan visits to two of the more exposed sites. Because of the depth as well as surge and strong currents that Baron says are impossible to predict, **Sisters** and **Thumbs** are both advanced dives. Here we plummet through darkness to stunning sponge gardens that bloom brightly at around 130 feet. We come back up with eyes wide in wonder — and a new list of species we've never seen before.

TWILIGHT OF THE KELP KINGDOM

As we drop anchor near a floating mat of golden kelp fronds in **Fortescue Bay**, I proudly exclaim to all, "Giant kelp, *Macrocystis pyrifera*!" I am redeemed, finally having recognized something in Tasmania's marine ecosystem.

Minutes later I'm swaying in the surge 40 feet beneath the canopy, gazing up at the magnificent algae I know so well. I'm smiling but confused. What's that fish over there? And that sponge to my left? Though the neighborhood's architecture is familiar (this is indeed the very same kelp species that flourishes on the other side of the Pacific in my old stomping grounds, California), its residents are unknown to me. Luckily, Baron anticipated this and jumped in with us this time. He whips out a slate and starts my education, first pointing at something and then writing down its name as we tootle about the forest: Johnston's weedfish, banded stingaree, a cute little Australian swellshark, a ginormous 5-foot-wide ray, a short-tail stingray, and my convict-striped bizarro — the longsnout boarfish. My head threatens to explode from this influx of arcane fish lore. After 50 minutes we've covered both sides of the slate. During our safety stop he directs my attention to a school of bronzy fish swimming

underneath us. He squeezes in one more name and hands me the slate: bastard trumpeter. I burst out laughing.

Back on board, I seek confirmation on the last sighting. Baron affirms, "Sure enough, bastard trumpeters. We also have real bastard trumpeters. Different species." I start laughing all over again. Australians have a way with the English language, and their panache is quite charming. But my good humor ebbs when I learn about Tasmania's disappearing kelp forests.

Giant kelp used to thrive all along Tassie's east coast. Scientists say that 90-95 percent of the forests are now gone, the amazing algae a victim of warming oceans. Wintertime temperatures used to average 50°F; today we measured 57°F. The southward-flowing tropical East Australian Current (the underwater highway Nemo rode to Hollywood fame), which historically veered east when it passed Sydney, is now pushing farther south, warming Tasmanian waters. This spike in temperature has caused sea urchin populations to boom, and they're feeding on kelp nonstop, year-round. The forests are being clear-cut. The last holdfasts for *Macrocystis pyrifera* along the Tasman Peninsula are in Fortescue Bay and Munro Bight. With no guarantee they will still be here in 10 or 20 years, the time for kelp fans to dive Eaglehawk Neck is now.

It's nearly time for phase two of our expedition, but before we depart the peninsula for the northern reefs of Bicheno we dedicate a day to enjoying topside scenery. We begin with a prebreakfast clifftop hike around Waterfall Bay for a spectacular bird's-eye view of some of our dive sites. Farther south, Cape Hauy's iconic sea-stack rock formations — the Candlestick, Totem Pole and the Lanterns — beckon alluringly in the mauve-tinged dawn. We answer their call, taking a high-speed Zodiac cruise. Highlights include bow-riding dolphins, sightings of seals and albatrosses and staring up slack-jawed at imposing Cape Pillar. This impossibly sheer precipice of columnar dolerite rises 1,000 feet straight up from the churning sea.

"SPECCY" DIVES IN BICHENO

A three-hour drive north takes us to Bicheno, a cool seaside town cradled in an idyllic bay. The soaring sea cliffs and craggy forested slopes of the south have been replaced by gently rolling hills and a beach of red lichen-covered rock slabs sliding into the sea. This is Tasmania's other famed scuba hub. Just a stone's throw offshore, Governor Island Marine Reserve contains most of the area's top spots, which include deep pinnacles ("bommies" in Aussie-speak), luxuriant sponge gardens and interesting reefs formed by building-sized granite boulders.

Two old wife fish (*Enoplosus armatus*) under a colorful ledge

Top: **A diver in a kelp forest on the Tasman Peninsula**

Without delay we head for the water, climbing onto *Iruka*, a sturdy, custom-built Devil Cat boat with a splendid Shaw's cowfish painted on its hull. (I learned something in my Tassie marine biology 101 course at Eaglehawk.) Bruce Priestley greets us warmly. He's a giant of a man, reminiscent of Cape Pillar, and he crushes my hand with a smile. "Welcome. Ready to go? We'll be at **Toblerone** shortly."

Fast forward five minutes and we're dropping through the blue, 120 feet straight down. Outcroppings shaped like pyramids rise from a flat sandy plain. Each is an oasis of life, a riot of garishly colored invertebrates over which a variety of fish swarm — wrasses, filefish and

even a family of boarfish awkwardly parade back and forth under a bristling hedge of brilliant finger sponges.

The Canyon has great "bottomography" — a mix of miniwalls, rock piles, alleyways and underhangs with no substrate left uncolonized. Life is stacked upon life. On **Trap Reef** we are mobbed by a dense school of pink butterfly perch. A pile of monolithic boulders at **Bird Rock** creates swim-throughs with walls carpeted in countless jeweled anemones. A cavelike chamber called the Ballroom has a ceiling plastered with them, too. Bullseye sweeper fish lurk in the shadows above plate-sized abalone. A massive cray creeps from a crevice, antennae twitching in irritation at our intrusion.

I put in a special request for **Golden Bommies**, a must-do according to a local photographer. Sucking 29 percent nitrox for what Priestley hinted was another squarish, deepish profile, we freefall through open water to 90 feet when, sure enough, two golden bommies heave into view. Their domes are smothered in yellow zoanthid anemones and are positively hairy with sea whips. A vision of harvest-ready wheat kissed by warm sunlight comes to mind. Entranced, we sink deeper along a wall decorated with fiery finger sponges. To my nitrogen-loaded brain they appear as bloody, grasping hands, or perhaps they are the writhing fingers of orange-red flames hungrily licking upward from the reef. My capacity for imagination certainly seems to grow with depth. We touch down at 125 feet and pause to take it all in. Such a pity we can't do our deco down here.

HOW TO DIVE IT

CONDITIONS

Depths range from 10 to 140 feet, and currents range from mild to wild depending on the site and Poseidon's whim, so pay attention to briefings, and dive within your limits. Required skill level is intermediate to advanced. Water temperatures average 55°F to 65°F year-round, so a drysuit or full 7 mm wetsuit is recommended. Visibility ranges from 30 feet to more than 100 feet, with the best clarity in winter (June through September). There is a hyperbaric chamber at the Royal Hobart Hospital.

GETTING THERE

Fly into Hobart (HBA), rent a car, and drive to Eaglehawk (approximately one hour) or Bicheno (approximately three hours).

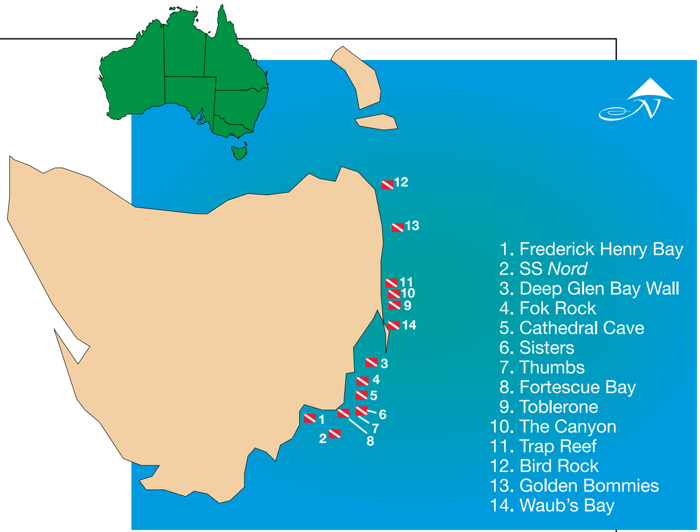
TOPSIDE ACTIVITIES

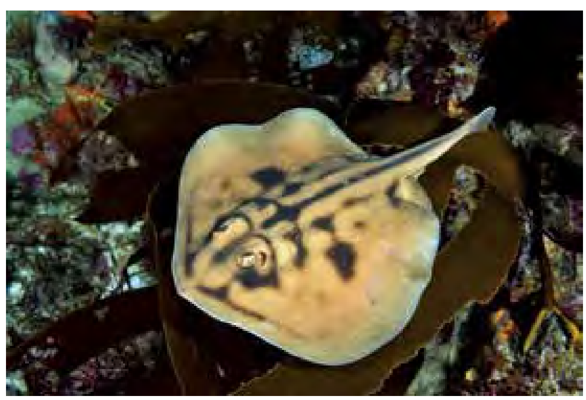
On the Tasman Peninsula:

- Hike the Cape Hauy track for breathtaking views of the Candlestick and Totem Pole sea stacks.
- Take an ecocruise between Eaglehawk Neck and Port Arthur to see majestic sea cliffs and abundant wildlife such as albatrosses, seals and dolphins.
- Stroll back through time at the Port Arthur historic site, a former timber station and penal colony.
- Come face to face with everyone's favorite carnivorous marsupial at the Tasmanian Devil Conservation Park, and see other native wildlife including quolls, wombats, pademelons and more.

In the Bicheno area:

- Take a nighttime tour to see wild blue fairy penguins.
- Feast on killer, creative pizzas and local, organic fare at Pasini's Café.
- Paddle a sea kayak for a day (or longer) in the Bay of Fires Conservation Area.
- Explore picturesque Freycinet National Park, where you can picnic on a perfect beach in Wineglass Bay, photograph the pink granite peaks of the Hazards Range and trek for days.





Clockwise from top left: **Blue-throated wrasse; the stern of the SS *Nord*; banded stingaree; Maori octopus**

Opposite: **Waterfall Bay on the Tasman Peninsula is home to some of the best temperate-water diving on the planet.**

Upon reluctant return to the surface world, Priestley grins at us and asks drily, "Worth the effort?"

"Absolutely. Absolutely amazing," Melissa answers.

Casually, our captain agrees, "It's a really speccy dive." Though the colloquial tongue is sometimes a bit hard to follow, this time we need no translation: It was really spectacular indeed.

HERE BE PENGUINS (AND DRAGONS)

The blue fairy penguins waddling across the road are yet another reminder we're not in Kansas anymore. We stop the car and hang out of the window, managing a quick photo before they scramble into the underbrush. Just another night on the town in Bicheno. The little guys have just returned from dinner at sea, where we happen to be headed for a night dive.

Everyone knows about the Tasmanian devil, this island's signature marsupial that resembles a vicious hyena-rat hybrid. But less well known are the island's penguins — and dragons. No joke, dragons fly through the Tasman Sea. We've already done three superb, shallow shore dives in **Waub's Bay** this week for seadragons while offgassing between deeper dives. And we've signed up for one more, this time by moonlight.

We start in just 10 feet and swim steadily deeper, navigating easily by keeping the algae-festooned rocks to our right and the sand to our left. Banded stingarees, those dime-a-dozen photogenic stingrays, flutter through our light beams. There are nudibranchs and crabs, scorpionfish and cuttlefish. We've really found our groove by the time we hit 30 feet, spying critters one after another. I point out a swellshark resting on its kelp blanket and then a big-belly seahorse hanging upside down. I capture a nice portrait of a sleepy Shaw's cowfish. Males are striking photo subjects with their Maori tattoo-inspired neon patterns.

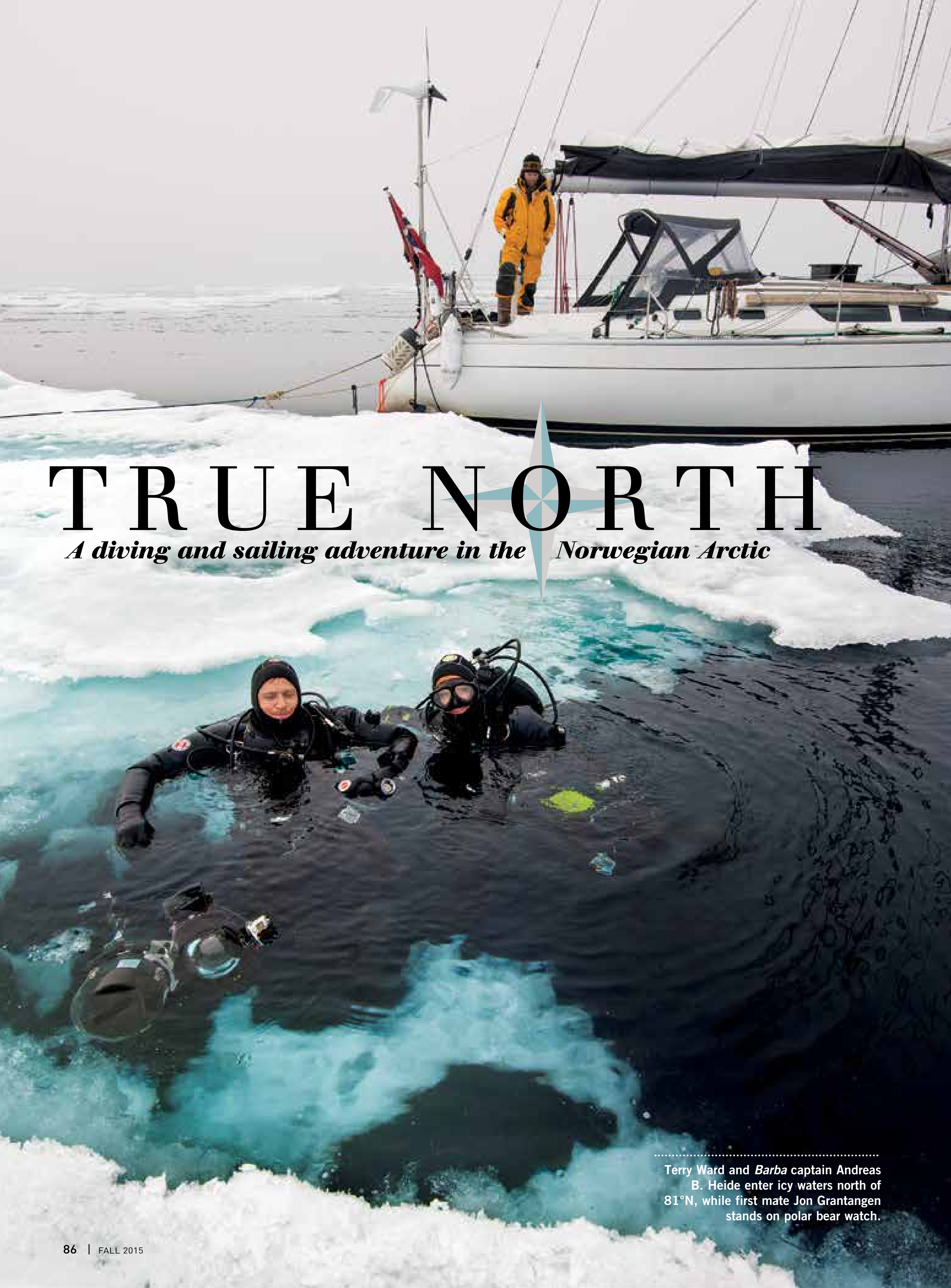
My wife outdoes me handily when she parts a curtain of kelp fronds to reveal a weedy seadragon. So improbable in appearance it must be magical, this creature is an Australian aboriginal painting of some fantastical beast come to life. Its psychedelic coloration is indescribable. Its body shape defies logic. It is so exceedingly strange it can't possibly exist. We find three more by the time we emerge exhausted but victorious 80 minutes later. Melissa sums things up eloquently: "I'd travel all the way to Tasmania just for the dragons. They really are the weirdest things I've ever seen."

As our plane hurtles into the sky to take us up and far away, I can't help but press my face to the window. I gaze longingly down at this most singular island. I squeeze my eyes shut, willing myself to sear every detail of this extraordinary experience into indelible memory.

Some say that from the air, Tassie resembles the footprint of a beast or a shark's tooth. Maybe. But I know with certainty that from below, beneath the waves, it looks like nowhere else on Earth. AD

TRUE NORTH

A diving and sailing adventure in the Norwegian Arctic



Terry Ward and *Barba* captain Andreas B. Heide enter icy waters north of 81°N, while first mate Jon Grantangen stands on polar bear watch.

TEXT BY TERRY WARD; PHOTOS BY DANIEL HUG

Exactly what I did not want to happen has happened. I'm dangling upside down in murky marina water in Stavanger in southern Norway. The neoprene boots of my drysuit have ballooned with air, and the soles of my feet inside them are pointing skyward. It's a classic conundrum for rookie drysuit divers.

Drysuit training is part of the preparations for an epic expedition we've planned to the Norwegian Arctic aboard *Barba*, a 37-foot sailboat. Our goal is to sail *Barba* all the way up Norway's coast and then northward across the Norwegian Sea to Svalbard, an Arctic wilderness the size of West Virginia. Covered in glaciers, Svalbard is home to the densest population of polar bears on the planet.

After a few unsuccessful attempts to right myself, I give up and wait for my buddy. In a moment Andreas Heide, *Barba*'s captain, fins up from below, grabs my harness and turns me upright.

Heide is no amateur. He started freediving at age 7 in the southern fjords of Norway. After getting his open-water certification at 17, he joined the Norwegian navy to become a combat diver. This is a guy who has bailed out of a submarine's torpedo hold. But training me, a Florida-based dive writer accustomed to tropical waters and luxury liveaboards, is a whole new challenge.

After a few more practice sessions in the harbor and some tough love from Heide, I finally start to master my buoyancy. Then on the longest day of the year, the summer solstice, we set sail from Stavanger under a sun that barely dips below the horizon, with four months and 3,400 nautical miles of adventure ahead of us.

THE CREW

Our five-person crew is a multinational, thrill-seeking bunch. First mate Jon Grantangen, a calm and cool Norwegian who has walked the entire length of Norway, has accompanied Heide on previous sailing expeditions to the Faroe Islands and the remote Arctic island of Jan Mayen. Daniel Hug, our German photographer, works as a geographer and avalanche observer in the Austrian Alps. He has brought along a paraglider, which he dreams of flying over polar bears once we get to Svalbard. Moscow-born Ivan Kutasov spent months sailing aboard a plywood boat to Novaya Zemlya in the Russian Arctic, where he once shimmied up a roof to escape a charging polar bear.

We're sharing a small space, every inch of which is loaded with adventure gear — climbing harnesses, ice axes, paragliding equipment and, of course, dive gear.

NORTHWARD ALONG NORWAY

Our route will take us along the Norwegian mainland as far north as Tromsø, and from there we'll make the roughly four-day crossing (about 600 nautical miles) to Svalbard. Once there, we hope the summer ice conditions will allow us to circumnavigate the archipelago, one of the Arctic's wildest places. But first we have 900 nautical miles to travel along what has been called the most beautiful coastline in the world.

North of Bergen we stop at Store Batalden, a peak that rises 1,600 feet above an archipelago swirling with currents that promise abundant marine life. The calm harbor is a good place to practice diving from our small sailboat platform. We need to perfect our diving procedures for the remote regions of Svalbard, so we'll squeeze in some training every chance we have along the Norwegian coast.

"The key words for the diving we're doing are *safety* and *simplicity*," Heide tells me as we gear up on the boat's small deck, "Everything has to be optimized for ease of access since we're bound to be in choppy seas." We store our dive gear in two top-opening holds in *Barba*'s cockpit. Our compressor is a gasoline-powered, German-made Bauer that can fill one of our 15-liter steel cylinders in about 30 minutes.

In addition to our drysuits (which would double as our survival suits in a worst-case scenario), we wear heavy neoprene boots and gloves and carry surface marker buoys as well as a McMurdo marine tracker that we can trigger if we lose sight of *Barba*. It sends a beacon with our location to the boat's chart plotter so the crew will know where to find us.

We dive well within recreational limits and no more than twice a day, avoiding decompression obligations and always doing safety stops. When conditions warrant, we dive with a watertight drum, which is packed with flares and a hand-held VHF radio, trailing us on the surface. I ensured my DAN dive accident and travel insurance were current before I left Florida.

Getting separated from the boat is our biggest concern. "Even with a drysuit you have limited life expectancy in water this cold," Heide reminds me. Along the coast of mainland Norway the water has yet to dip below 39°F, but it'll get colder as we push north. And in Svalbard, even if we managed to swim to shore after a hypothetical separation from the boat, polar bears patrol the coast.

Norway's landscapes constantly one-up each other as you travel north. Among the most memorable is the fairy-tale setting of Træna, a striking archipelago of more than 1,000 islands and islets on the Arctic Circle.

Three weeks after leaving Stavanger we arrive in Tromsø. There's much work to be done to ready the boat for the four-day crossing to the southern tip of Svalbard, including provisioning for a 45-day stretch with minimal support, filling containers with extra diesel and raiding construction-site dumpsters for ice-pushing poles.

ARRIVAL IN SVALBARD

Our crossing goes as smoothly as we could hope, and we spot our first iceberg — the size of a car — about 12 hours before we make landfall on Svalbard's southern tip. The reality of where we are sinks in. Even a small bergy bit has the power to sink *Barba* if we hit it at cruising speed. Being on watch now requires constantly scanning the water for ice. By the time we enter Hornsund, Svalbard's southernmost fjord, we are in the thick of it. The fjord is lined with glaciers, and their moans and groans fill the air as icebergs calve into the sea. We anchor and take a dinghy ashore, and there on the black-sand beach where we first set foot on land are fresh polar bear tracks.

All visitors to Svalbard who leave the town limits of Longyearbyen — Svalbard's municipal capital, with a population of roughly 2,000 people and an airport — are required to carry a high-powered rifle and to know how to use it. The archipelago and the pack ice to the north are home to about 3,000 polar bears. Any time we venture ashore in Svalbard it's with either Heide or Grantangen, our ex-military marksmen who carry rifles as well as flare guns for keeping curious bears at bay.

We spend a few days enjoying the creature comforts in Longyearbyen — bars, restaurants, shore power and fresh water in a terrific marina — before setting out on the toughest part of our expedition: circumnavigating Svalbard.

FINDING TRUE NORTH

In addition to reindeer, polar bears, Arctic foxes and a host of seals, Svalbard has a population of about 2,000 walruses, which were hunted for nearly 350 years, almost to the point of extinction. We pass several sandy-beach walrus haulouts on our way north but decide to stick to observing the animals topside rather than risk tangling with them underwater, following the advice of a local wildlife filmmaker.

Walruses live primarily on shellfish, for which they forage on the seabed using their sensitive whiskers. They suck the meat straight from the shell and can eat thousands of clams during a single feeding session. The odd lone male has also been known to hunt seals, I learn. "They basically squeeze them to death and suck up their flesh," the filmmaker in Longyearbyen told me. This is as good a reason as any to skip diving here and instead entertain ourselves with hiking, paragliding and enjoying beach campfires fueled by logs that floated to treeless Svalbard from Siberia.

One afternoon in Woodfjord, on the north side of Svalbard's main island of Spitsbergen, we spot the telltale signs of exhaling cetaceans. We slip into our drysuits and attempt to snorkel with a pod of belugas swimming along the shore, but the animals are too quick for us. Their loud vocalizations (like bees buzzing combined with a finger circling the rim of a glass, as I've heard it described) fill the air topside and echo in our ears underwater.

We get in our first scuba dive at Depotodden on the island of Nordaustlandet on the west side of the archipelago, where we've anchored in front of a sheer mountainside the color of charcoal and streaked with snowy patches. Where there's too much glacial runoff (about 60 percent of Svalbard is covered by glaciers), the water is too murky for diving to be worthwhile. But the beach at Depotodden is glacier-free, and the water under the boat looks clear and promising.

The stark scenery topside left us unprepared for the explosion of color that greets us beneath the surface. We don't spot a single fish, but we scooter past bommie after bommie covered with orange and yellow anemones and crawling with crabs and sea slugs. When we surface, a walrus is swimming in the distance.

The next morning we get a wakeup call to remember. While struggling to raise a kelp-laden anchor, Heide spots a polar bear swimming straight for *Barba* and hustles below deck to grab his rifle and wake up the crew. Luckily our ice-pushing sticks are enough to keep the determined visitor from clambering into our dinghy. The look on the bear's face is pure offense that we wouldn't want him onboard as he tries again and again.

The 20 minutes we spend in such close proximity to the young male will surely go down as one of my life's most memorable moments. The fact that we were diving in this water only hours earlier is not lost on us.

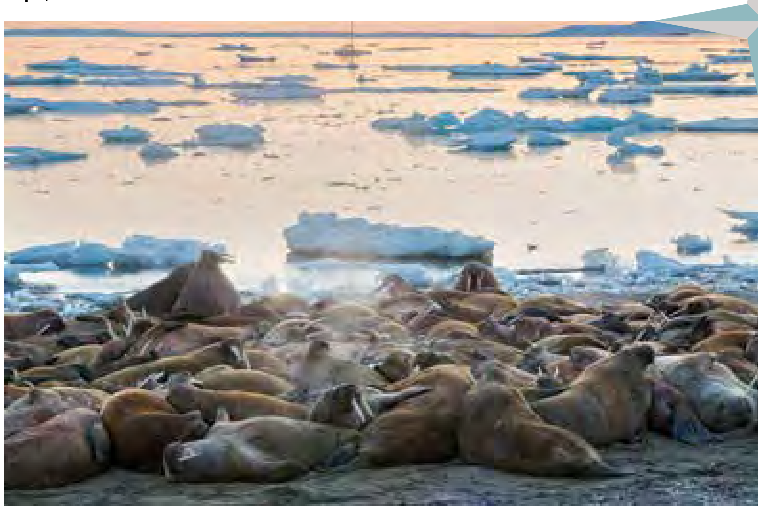
INTO THE POLAR ICE PACK

We detour from our circumnavigation one day to sail northward to the polar ice. For many hours the sea is strangely ice free. And then suddenly floes begin to materialize around us. Small pieces give way to flat expanses the size of basketball courts and larger. Northern fulmars, the fighter jets of birds, carve turns above us, while ice floes bob slowly up and down on the glassy sea. Grantangen saw a polar bear on a distant ice floe, but we've lost sight of it now. We spot a seal asleep in the water nearby.

I look at Heide with a knowing glance. "Ready to dive?" I ask. If I've trained for anything, it's the chance to see the underside of an ice floe where polar bears hunt. Grantangen stands watch on the stern, and we review our standard Svalbard diving procedure. He'll toss a flare off the bow if he spots a bear and then will make sure it keeps its distance so we can surface safely.

PAUL NICKLEN

Clockwise from below: **A walrus haulout on the island of Edgeøya makes for a scenic, icy anchorage; *Barba*'s multinational crew near the Arctic Circle, from left: Daniel Hug (Germany), Terry Ward (USA), Ivan Kutasov (Russia), Andreas B. Heide (Norway) and Jon Grantangen (Norway); a curious and persistent polar bear made repeat approaches toward the sailboat when *Barba* was anchored on the north side of Svalbard; *Barba* dwarfed by the Austfonna glacier, one of the world's largest ice caps; Svalbard beneath the waves. See more at *Barba.no*.**



My adrenaline is through the roof as we suit up on the ice and make a giant stride into the water. Clouds of tiny krill fill the 30°F crystal-clear water. There are no fish, just the odd tiny jellyfish with ruby-red tentacles. For 30 magical minutes as we make our way under and around the ice floe, our roof is an upside-down mountain range tinged glacier blue. We surface not to a bear but to our floating home, which has brought us all the way north to the polar pack ice — to the very edge of the world.

A few days later we sail south through the icy Hinlopen Strait. Along the Austfonna glacier, one of the largest ice caps in the world, we see more belugas beneath the waterfalls that gush over its edge. One day Heide and Hug soar with their paragliders over a cliff, where they are elated to spot a polar bear hunting below them.

In the end we manage to circumnavigate Svalbard. When we arrive back on the Norwegian mainland after a rough crossing, triumph trumps exhaustion.

All those frustrating upside-down moments training in Stavanger have been replaced with upside-down views of Arctic ice in one of the world's last true wildernesses. Getting there was not easy, but the best things in life rarely are. AD

STEPHEN FRINK

Climbing a ladder while wearing heavy gear, for example, can cause pain, soreness and even numbness or tingling that might be confused for DCS. However, symptoms after a dive warrant prompt administration of oxygen and evaluation by a medical professional.

UNCERTAINTY AFTER DIVING

Case reports and recommendations

BY MARTY MCCAFFERTY, EMT-P, DMT

A 53-year-old man was diving at a resort in the South Pacific. He was doing approximately four dives per day; all his dives were on air, and all were within his computer's no-decompression limits. In the evening on the third day, approximately three hours after his last dive and a half hour after dinner, he began to experience severe abdominal pain. The pain radiated to his back, just below his right shoulder blade. He vomited several times, felt weak and needed help walking. Concerned about the possibility of severe decompression sickness (DCS), his friends called a taxi and rode with him to the local hospital.

Some things about this diver's symptoms and recent history suggest DCS, and most doctors would include it on their list of differential diagnoses. The evaluating physician in this case considered it, but he knew that other potential causes had to be eliminated first. After a cardiovascular emergency was ruled out, blood tests and ultrasound imaging of the diver's abdomen revealed stones in the gallbladder that were causing acute inflammation. The diver underwent laparoscopic surgery and made a successful recovery.

SYMPTOMS OF DCS

Books and articles about DCS usually include an extensive list of signs and symptoms. It is important to remember that none of the signs and symptoms in any such list is exclusive to DCS. Here are examples of some of the most common symptoms of DCS:

- ***Headache***
- ***Lightheadedness and/or dizziness***
- ***Nausea***
- ***Joint and/or muscle aches***
- ***Fatigue, lethargy and/or generalized weakness***

As you can see, these symptoms can apply to a wide range of medical conditions, not just DCS. This can make diagnosing DCS a challenge.

MEDICATIONS

A 48-year-old woman completed a dive to 95 feet for 25 minutes on 32 percent nitrox. Approximately 10 hours after surfacing she began to experience widespread but intense muscle pain. She could not find a comfortable position, and nothing seemed to offer relief. She called emergency medical services (EMS), which transported her to the local hospital. When discussing her medical history, the doctor found out that the woman had begun taking a statin medication to lower her cholesterol three weeks earlier. Muscle pain is a rare side effect of statins, and blood test results suggested that her pain was most likely due to the medication. However, the hyperbaric physician who was consulted did not want to dismiss the possibility of DCS and treated the diver in the chamber with a U.S. Navy Treatment Table 6 (TT6). The hyperbaric treatment had no effect on her symptoms, which confirmed that the muscle pain was probably due to the medication.

Whenever you begin taking a medication, whether prescription or over-the-counter, make sure you familiarize yourself with the potential side effects. As this case illustrated, the side effects of some medications can mimic DCS. Medications can also affect your ability to function normally, regardless of whether you're on land or underwater. Common seasickness medications, for example, come with advisories stating that they may cause drowsiness. Physicians trained in dive medicine typically recommend waiting at least 30 days after starting a new prescription medication before diving. Similarly, divers should always try nonprescription medications well in advance of diving so they will know how the drugs affect them. In addition to limiting the risk of disorienting or otherwise hazardous side effects at

STEPHEN FRINK


STEPHEN FRINK

Fatigue after diving is not uncommon, but significant fatigue may be a sign of DCS.

depth, this recommendation also helps reduce the risk of confusing the medication's side effects with DCS.

MUSCULOSKELETAL SYMPTOMS

Diagnosing DCS can be challenging: It is a relatively rare condition, there are no lab tests to confirm it or rule it out, and it shares signs and symptoms with many other illnesses and injuries. Divers who have pre-existing musculoskeletal issues such as spinal problems, arthritis or residual effects from previous trauma can be particularly susceptible to diagnostic uncertainty. The physical stresses and activities associated with diving and travel (e.g., carrying heavy equipment, enduring uncomfortable sleeping or travel accommodations, swimming against currents or experiencing boat rides in rough seas) can aggravate existing conditions. Strains, sprains and overuse injuries that occur in the absence of diving are relatively easy to diagnose. But when diving is involved, a doctor might reasonably decide to conduct a costly and time-consuming hyperbaric chamber treatment to be on the safe side.

Musculoskeletal problems, whether pre-existing or not, can manifest as pain, numbness, loss of strength and/or reduction of mobility, all of which are also possible symptoms of DCS. The key to learning the true cause of such symptoms is a thorough review of the diver's medical history and the circumstances surrounding the complaints.

DAN Medical Services often receives calls from divers who have traveled to tropical or subtropical destinations and are experiencing a severe headache, multiple joint or muscle aches, abdominal pain, nausea and general malaise, often after a few days of diving. With no additional information it would be easy to conclude that these symptoms were the result of DCS. However, further inquiry often reveals a fever and diarrhea. This suggests a tropical disease rather than DCS. When such reports include a fever but not vomiting or diarrhea, this suggests dengue or another tropical virus. People with these symptoms may require prompt medical attention but not evacuation to a recompression facility.

DIAGNOSIS BY EXCLUSION

Diagnosing DCS is generally a process of ruling out other causes. It is imperative that we not discount the possibility of nondiving-related injuries or illnesses just because someone was diving. However, this is not to suggest we should discount the risk of DCS: When a person has been diving, DCS absolutely needs to be considered in the physician's differential diagnosis.

A 46-year-old male diver on a weeklong dive trip on a liveaboard vessel was doing four or five dives per day. All dives were within recommended recreational no-decompression limits. His deepest dive was to 115 feet, which was his first dive on the third day. The next morning he complained of right shoulder discomfort. Five years earlier he had surgery on that shoulder to repair a torn rotator cuff. Since the surgery five years prior he had done more than 80 dives with no problems, but it was not uncommon for him to experience discomfort in that shoulder with exertion or certain activities. Usually he could find a position of comfort, apply ice and take ibuprofen to relieve the discomfort, but this time the symptoms were somewhat different and not as easily relieved.

The diver's companions believed that his symptoms were due to his previous medical history because they had all dived the same profile without any problems. When the diver finally reported his symptoms to the boat crew, they provided him with high-flow oxygen. Based on the fact that the symptoms were different from those the man typically experienced, the captain diverted the ship toward an island with a dive clinic.

After breathing oxygen for approximately 30 minutes, the diver reported some improvement but not much. The ship arrived at the island 30 minutes later, and the diver was taken to the clinic. The physician on duty evaluated him and discovered that his right arm (his dominant arm) was significantly weaker than his left. He diagnosed DCS and treated the diver with a U.S. Navy TT6, which provided measurable improvement. Because the symptoms did not completely resolve, the doctor treated him again the next day with the shorter U.S. Navy TT5, which brought complete resolution of the symptoms.

There is controversy regarding the potential for increased risk of DCS at the site of a previous injury. Little scientific data addressing that issue is available. But controversy notwithstanding, we know that when people with pre-existing musculoskeletal problems choose to dive, diagnostic confusion can result. If you or your dive buddy has such issues, it is imperative for both of you to know what the other person's usual state looks like. Before diving, discuss any existing pain, movement restrictions, weakness or other information that establishes a clear baseline. Communicating information about a diver's normal state can be of great value. Any variation of symptoms from previous experience demands assessment but does not by itself constitute a definitive diagnosis. Divers with these sorts of problems should regularly get a detailed neuromuscular exam by a doctor. After a dive is no time to discover a deficit that may or may not have been there before.

STEPHEN FRINK

Drink responsibly; hangovers can cause you to miss dives and may involve symptoms that mimic — or mask — symptoms of DCS.

THE MORNING AFTER

A group of friends in their early 30s was on a dive vacation on a Caribbean island. They did four dives on their first day; their first dive was to 85 feet, and the next three were to 60 feet or shallower. They waited at least an hour between each dive, breathed air and had bottom times that were all within their dive computers' no-decompression limits. All dives were uneventful.

The group went out for dinner and drinks that evening. The next morning they met for breakfast prior to boarding the dive boat. A 33-year-old male member of the group was absent. His roommate reported that when he left, the friend was in the bathroom and was expected to join the group later. After eating, the roommate and two others went to check on their friend. He was in bed and appeared pale. He complained of a severe headache, nausea, weakness and feeling "totally out of it." The headache was severe enough that he was sensitive to light. He also reported vomiting "once or twice." The group decided to take him to be evaluated at the local clinic; because they had been diving they were concerned about DCS. The diver had a slight stagger when walking but required no assistance.

The clinic was a five-minute cab ride away from the resort. The physician on duty and her assistant obtained the diver's vital signs and conducted a neurological examination. The physician also obtained a history of events. The diver denied any symptoms prior to going out for the evening. He also admitted that the events following dinner were not clear to him because he had consumed "a lot" of alcohol, which his friends confirmed. The physician ordered the administration of IV fluids, acetaminophen and meclizine (antinausea medication). The doctor also instructed the man to avoid diving for the next 24 hours and to return to the clinic if he didn't feel better that day. The diver rested and was able to eat and drink (nonalcoholic beverages) over the course of the day, and he felt much better by that evening. The next morning he was feeling 100 percent better and resumed diving with no further issues.

Having a good time on vacation is part of the experience, but overindulging in alcohol during a dive vacation is not prudent. There is suspicion that alcohol consumption before or after diving could contribute to DCS, but more importantly, the aftereffects can easily be confused with DCS. Many divers in similar situations have needlessly undergone hyperbaric treatments.

CONCLUSION

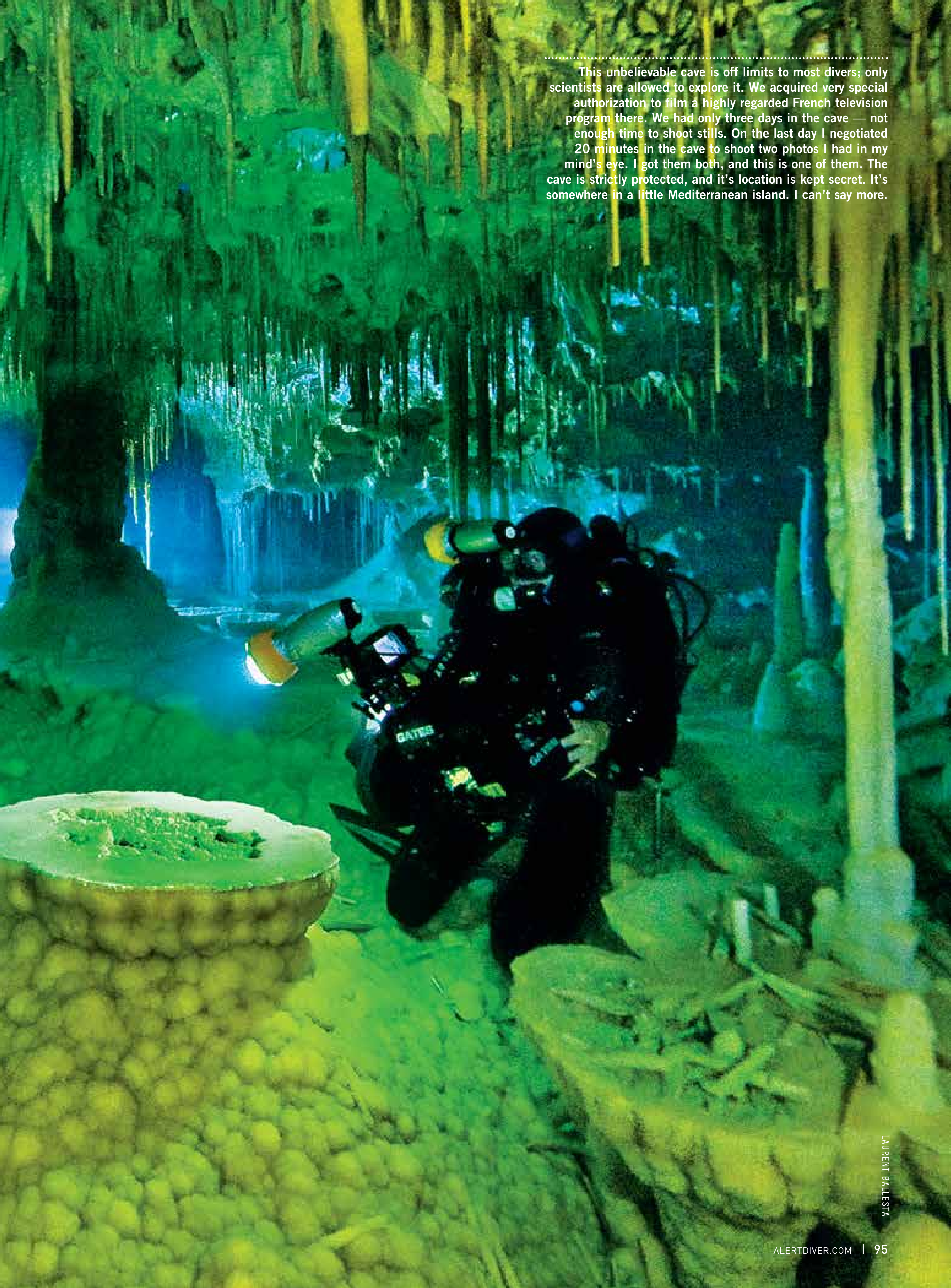
The signs and symptoms of DCS are not exclusive to that condition. However, when a person experiences signs or symptoms after diving, DCS is very often presumed to be the diagnosis. This is not all bad, because it encourages divers and dive staff to administer oxygen and ensure the injured diver gets prompt medical care. But it becomes a problem when divers refuse to accept alternative explanations and become fixated on the need for chamber therapy at the expense of other diagnostics and/or treatments that may be delayed. In addition, the diversion of a nondiving-related emergency from appropriate medical treatment for an unnecessary recompression treatment, especially by air late at night, can introduce additional risks to the patient as well as the aircrew. There are many medical conditions much more serious than DCS for which timely treatment is critical.

In the event of symptoms after diving, provide oxygen and get the injured diver to the closest medical facility. Don't hesitate to call EMS if the situation is serious, and feel free to call the DAN® Emergency Hotline (+1-919-684-9111) at any time. Tell the doctor that the person was diving, and encourage him or her to contact DAN for consultation. But keep in mind that there are more dangerous ailments than DCS, some of which must be considered first. AD

LEARN MORE

For more information about the causes, mechanisms, manifestations, management and prevention of DCS, consult DAN's Health and Diving Reference Series, available in print or online at *DAN.org/health.*

IMAGING



This unbelievable cave is off limits to most divers; only scientists are allowed to explore it. We acquired very special authorization to film a highly regarded French television program there. We had only three days in the cave — not enough time to shoot stills. On the last day I negotiated 20 minutes in the cave to shoot two photos I had in my mind's eye. I got them both, and this is one of them. The cave is strictly protected, and it's location is kept secret. It's somewhere in a little Mediterranean island. I can't say more.

LAURENT BALLESTA

SHOOTER: LAURENT BALLESTA

Photos by Laurent Ballesta; text by Stephen Frink

Sometimes a photograph reveals things about the photographer. That is certainly true of this image of a coelacanth in its natural habitat, taken by French scientist and marine photographer Laurent Ballesta. To me the photo reveals previsualization, extraordinary dedication and careful execution. I knew it could not have happened by accident. Ballesta confirms and explains:

"I had in my mind's eye a photograph of a coelacanth, not a fish-identification portrait (although I intended to shoot that as well) but a cover photo for my book, and I wanted to show it where it lived — in its own ecosystem. This happened to be off the coast of South Africa at 400 feet."

"The idea was to shoot from a distance while a diver inside the cave with a strong dive light illuminated the cave to silhouette the coelacanth's unique profile. The problem was that there were eight such caves in the area, and each time we went to the bottom we had to figure out which one might hold a fish. Coelacanths are not particularly shy, but they aren't inquisitive either. We couldn't expect the fish to come to us, so we had to find where one might be, and that took precious minutes away from each dive. We dived using rebreathers, and each dive afforded us only 35 minutes on the bottom while requiring five hours of decompression. With three or four divers searching the bottom for the first 12 minutes of every dive, we would find the fish maybe 30 percent of the time."

"In the end it took 15 days of trying to get this shot. I don't know whether to say I captured the image in 1/15 of a second or 120 hours, which is about how much time I spent traveling to the site, diving and maintaining my camera and rebreather during those weeks. If you consider I had the image in my mind when I was a graduate student reading about the coelacanth for the first time and dreaming of photographing one in the wild, this was the culmination of a 20-year quest, distilled down to that single press of my shutter."

Four hundred feet deep in Jesser Canyon off Sodwana, South Africa, Tybo was supposed to go inside the cave to light the background behind the coelacanth, while Yanick and Florian were supposed to stay above the cave with their impressive scientific equipment and video cameras. After 15 days and 11 dives, I got the photo. The hardest part was convincing my team to waste the first five minutes of each 30-minute dive to try for this photo.

The Mediterranean Sea is known for its spectacularly clear water, particularly in the south of France. But this clarity is not found off Montpellier, where Ballesta grew up. A far cry from the French Riviera, Montpellier's coastline is characterized by muddy green water, rough seas and poor visibility. The snorkeling and diving are arduous, and the environment does not readily reveal charismatic sea creatures. In fact, the visibility is often so poor you can see your watch or dive computer and little more. But such an environment will teach someone who cares to look for marine life how to detect it. Studying this almost imperceptible marine life was Ballesta's childhood passion and likely the first steps along his path of an illustrious career as a marine scientist and an underwater photographer of the highest caliber.

Like many underwater photographers, Ballesta was first inspired by the exploits of Capt. Jacques Cousteau. But as a child watching the documentaries on French television, he didn't want to be a filmmaker like Cousteau or the skipper of the *Calypso*. In his fantasies he was the marine biologist on board — the man who would find the rare and unusual creatures and point them out to Cousteau. Cousteau died when Ballesta was a teenager, which was a great disappointment to the young man. He would have to find another path that related to the sea.

His first passion for the ocean world was to observe it; his second was talking about what he saw. He would bore friends and family with constant stories about the weird and wonderful creatures he discovered in Montpellier's turbid waters. Eventually one of these offshore encounters drove him to try underwater photography.

While looking for a deep wreck to dive, Ballesta and his buddy saw the giant dorsal fins of a school of basking sharks swimming nearby. The water was cold, dark and dirty, but he swam with the baskers. He didn't have words in his vocabulary to describe what he had seen when he went home to his parents, and in their eyes he could see skepticism. Right then he knew he needed an underwater camera, and his dad agreed to buy him a Formaplex Aquamatic. The camera used 126 film (28 mm square), and flashbulbs provided the only artificial light. But as crude as the system was, he could take pictures underwater.

A few years later he convinced his dad to buy him his first modern camera, a Nikonos V with an SB-105 flash. Once Ballesta finished his education and had an assignment for a science expedition in French Polynesia, he went to the bank to get a loan for a Nikonos RS. Finding the versatility of a housed single-lens reflex (SLR) camera better suited to his needs, he bought a Nikon F100 and a Seacam underwater housing, and he has stayed with those two brands ever since. Today his favorite camera is a Nikon D4S because of its ISO sensitivity and ability to perform well in low-light situations (he sometimes uses ISO settings as high as 30,000 for low ambient light). He uses a housing with a special deepwater dome port to withstand the crushing pressures of the deep depths to which he dives.

After earning his master's degree in marine ecology at the University of Montpellier, Ballesta and three partners founded Andromede Oceanologie, a firm specializing in underwater mapping of the seafloor, studies of pollution and surveys of harbors and other coastal areas. Andromede Oceanologie also conducts pure research, particularly in deep Mediterranean ecosystems. To this end Ballesta and his partner, Pierre Decamp, have developed competency for rebreather diving in depths to 600 feet. But this is not deep diving for its own sake; it's expedition diving for the purpose of solving scientific mysteries, producing media content such as photo galleries or books, and enhancing human knowledge about dive technology and physiology.

STEPHEN FRINK// I think I first became aware of your work through a very unusual series of images of a mantis shrimp catching a fish (see photos on Page 99). This was in 1999, so it almost had to have been made with film. I thought these photos were cutting edge at the time, and they're still quite innovative. How did you get the shots?

LAURENT BALLESTA// As a marine biologist I knew that the mantis shrimp has a punch of amazing speed — some say like the speed of a bullet. I understood that to capture that speed would be quite a challenge. I was at Loloata Resort near Port Moresby, Papua New Guinea, and the guides there knew of a large and relatively accessible mantis shrimp at a nearby reef. So the elements were right to try for the shot, but I still needed it to catch a fish and then capture that on film.

I spent two days hoping to get the shot by luck — well, maybe a little more than luck for I confess I tried to coax a few fish into striking range of the mantis shrimp. But I think the reef fish knew very well where this mantis shrimp lived and wouldn't go near its tunnel on the seafloor. Finally I set up my housed Nikon F100 on a tripod with a cable release and aimed the strobes toward where the shrimp would exit its hole. I set the motor drive to the highest speed and the strobes to the lowest power so they could recycle almost immediately for a burst of 10 or 12 frames. I did a test to find the right aperture, again for the distance at which the mantis shrimp would be when attacking prey in ambush. Then I swam away and left it all in place overnight. This led the fish to accept the new object in their habitat. I also think it might have disrupted their normal patterns, because when I went down to the reef on the third day a small sharpnose puffer swam too near the mantis shrimp. When it got close I pressed the cable release in anticipation of possible predation, and I captured a burst of shots, though I didn't see anything. I noticed the fish was gone, but neither my dive buddy nor I knew what happened to it. It wasn't until I had the film processed that I realized I had gotten the shot.

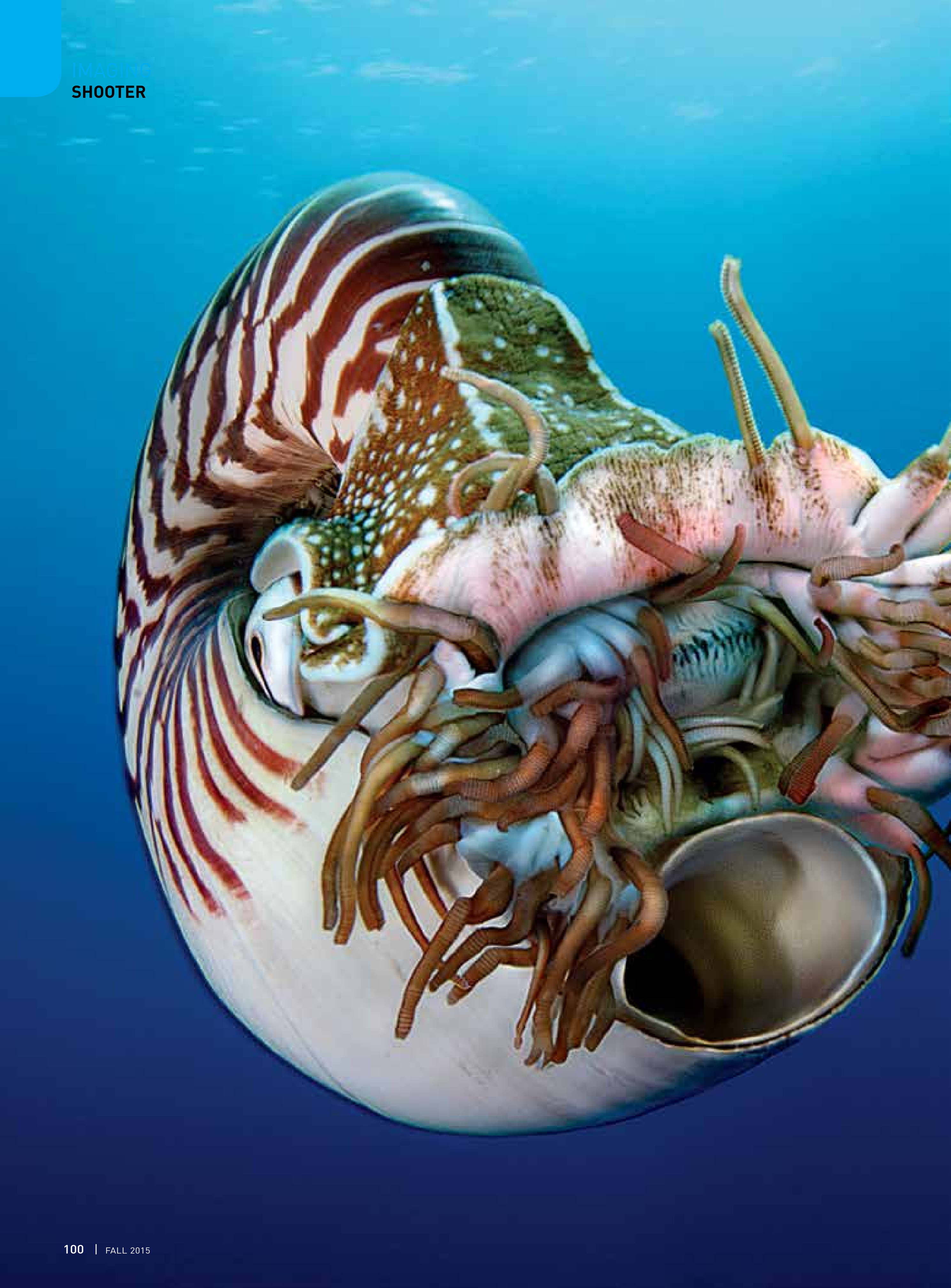
That has been my approach to underwater photography from the very beginning. I try to imagine an impossible photo and find a way to capture it. Mostly it doesn't work, but sometimes it does, and I will have a photo, recorded in what I hope is an artistic way, that science hasn't seen before.

SF// Tell me more about your work with coelacanth. If the mantis was your most unusual image early on, your expedition to photograph these living fossils has excited a lot of contemporary interest in your work.

LB// As a student of marine biology it was impossible to not have heard about the coelacanth. They were known from fossil records but thought to have gone extinct 65 million years ago in the great extinction event that killed off the dinosaurs. A museum curator aboard a South African fishing trawler discovered the first living coelacanth in 1938. They are large fish, up to 6.5 feet long, and very distinctive looking with a pair of lobed fins that extend from the body. They live very deep, some as deep as 2,300 feet below the surface. By the time I was studying them in school there were specimens of them in museums, and fishermen sometimes caught them. They had been seen via remotely operated vehicles (ROVs) and submarines, but no one had ever photographed one in the wild.

In 2000 I heard that a diver named Peter Timm had actually seen a coelacanth in South Africa off Sodwana Bay on a deep dive to 400 feet. After he told what he had seen, two other divers tried the same dive with cameras, and they both died. In my experience there is a huge difference between a touch-and-go dive and a working dive at these kinds of depths. Anyone can take a mixed-gas course and learn how to reach a target depth and safely return to the surface. It is a different matter to do so in a 13-foot swell and a 2-knot current and then perform a task when you get to the bottom. This is dangerous for anyone without the necessary skills, and when I first heard there was a place where people knew there was a coelacanth, I did not have the skills to get the shot.

"I NOTICED THE FISH WAS GONE, BUT NEITHER MY DIVE BUDDY NOR I KNEW WHAT HAPPENED TO IT. IT WASN'T UNTIL I HAD THE FILM PROCESSED THAT I REALIZED I HAD GOTTEN THE SHOT."



At Lifou Island in New Caledonia, nautiluses can be found in shallow water at night, but we wanted to find them in the depths during the day. We put some bait at 550 feet and found a nautilus there the next day. His reflection in my camera's dome might have appeared to him to be a sexual partner, and to my surprise he eagerly posed for photos for more than an hour.

Right, second from top: I photographed this giant Pacific octopus during a trip to God's Pocket Resort in British Columbia. I like to think of this photo as a tribute to Jules Verne.

Right, bottom two: For four weeks, camouflaged groupers aggregate to fight each other all day and try to escape from sharks at night while they await the full moon. Don't misunderstand: These fish are not kissing each other. They are fighting for territory or a mate.

By 2008 I had been diving to 660 feet regularly. These were eight- or nine-hour dives, often in rough water. At that point I was working with a great team of divers; we knew each other's abilities and trusted each other. We went to dive with Timm, and after about two weeks he gained enough confidence in us that he agreed to take us to the site. This was an exploratory expedition, but it was very successful. *National Geographic* ran some of those first images, and there was a lot of excitement about the fact that we had gone so deep and gotten the shots. Yet there was much more to do to really record not only the fish but also the ecosystem. We knew we could get the images of the coelacanth I had in my mind's eye, so we got the necessary permits.

But such an expedition is expensive. We had a budget in mind of 1 million euros, and we needed a sponsor. For two years I went to meetings with corporate sponsors, armed with the photos I'd already taken and my dreams about how to do an expedition bigger and better, but I received only rejection and humiliation. Then I had an appointment with luxury watch manufacturer Blancpain. To my great delight, the president and CEO of Blancpain, Marc Hayek, joined the meeting. He is a diver and underwater photographer and immediately understood what I was trying to accomplish. Within five minutes I knew we would move forward. The Gombessa Project (*gombessa* is the South African name for the coelacanth) successfully documented the fish and habitat, and then we moved forward with Gombessa II.

SF// I do know a little about Gombessa II, in which you and your team in 2014 went to the south pass of Fakarava atoll in French Polynesia to document the mating aggregation of the marbled or camouflage grouper, *Epinephelus polyphekadion*. Thousands of fish congregate during the full moon in June, and I know you were there to get stills and video of that phenomenon. But you also spent 24 hours continuously underwater on that expedition — tell me about that.

LB// I had known about the aggregation since 2000, but when we went we wanted to be able to advance the science. We wanted to count the grouper, count the sharks that come in for the spawn and record the mating of the grouper. As for the 24 hours underwater, I didn't want to do that as a stunt. There are behaviors that happen all day and all night, so it was a valid approach for that reason, but we also wanted to do 24 hours at 66 feet or deeper to meet the associated technological and physiological challenges and thus improving our knowledge and operational capabilities.

My friend and diving supervisor, Jean-Marc Belin, and I spoke to commercial diving specialists at Comex about how to do such a dive, and they told us what we already knew: To dive to 66 feet for 24 hours would require decompressing for another 20 hours. That's not at all what I had in mind, so I went to see other experts, this time the people responsible for the Chunnel, the tunnel beneath the English Channel that connects France and the U.K. This project had to contend with workers at depth, just as the construction of the Eads and Brooklyn bridges in the United States did in the late 1800s. As most scuba divers know, that's when "caisson disease" (decompression sickness) was discovered, and I hoped the knowledge had advanced since then.

In consultation with this team of scientists we came up with a dive protocol that used 10 percent oxygen heliox as our basic mix for the first 18 hours and almost pure nitrogen with a small amount of oxygen after that. This allowed me to ascend in only two hours and 20 minutes. I felt remarkably fresh and happy afterward, aside from my teeth being sore from holding a mouthpiece in place for 24 hours. I know this oversimplifies what was a fairly complex and daunting element of our expedition.

SF// I know you said you use a special dome for working so deep. Are there other special preparations you have had to make for your camera housing to work at such depths? It seems the springs for the buttons and shutter release would need to be modified as well.

LB// I would say that the critical points for dives deeper than 330 feet are the dome and, even more challenging, the flat port for the macro lens. Harald Hordosch of Seacam built and tested special ports for me that are thicker and more resistant to pressure. The other difficult aspect was the buttons. Deeper than 300 feet, normal springs won't return to their initial position after you press them. Hordosch replaced all the springs with ones that have higher tensile strength. It hurts my finger to press the buttons, but they work. As for the housing itself, it is much more pressure resistant. It can go to at least 660 feet — I know because I've taken it there.

SF// What's next for you?

LB// Stay tuned for our Antarctica Expedition. With the ongoing support of Blancpain we will collaborate with Luc Jacquet, the creative genius behind *March of the Penguins*, for unprecedented deep dives under the ice. Deep, dark and cold — it will certainly be a challenge for our team, and we hope to further science as a result. AD

Face-to-face with a living legend, the coelacanth, at 400 feet. Neither shy nor curious, the fish doesn't care. It's as if he's still somewhere 65 million years ago.

We spent three weeks in a freshwater lake in Switzerland. Grass or ringed snakes swam all around us; suddenly we found one with a frog stuck in his mouth. He never swallowed it, he just spit it out and left.

Collaborating with a Dive Guide

Text and photos by Mike Bartick

My first dive trip to Lembeh Strait was an eye-opening experience that forever changed my approach to diving and shooting underwater. I had always considered myself to have a good eye for finding unusual subjects and even took a bit of pride in my ability. But when I was introduced to my first real dive photo guides, I realized just how little I really knew.

As I prepared for my first dive my guide gave a short but detailed briefing. Actually it was more of a strategy session, covering specifics such as the hand signals he used and how we would work together to photograph our target subject. This was a step above any dive briefing I'd been given in the past, and by sticking to the plan we successfully photographed my first pygmy seahorse on that initial dive.

The differences between a dive photo guide, or spotter, and a typical divemaster can be summed up easily: A dive photo guide's primary role underwater is to keep an eye open for critters and to assist the diver in finding and photographing subjects. A divemaster is mainly concerned with the safety of the group (although he or she may point out a few things along the way).

GENESIS OF THE DIVE PHOTO GUIDE

In the late 1980s Larry Smith took the helm of a then no-name resort in an obscure corner of North Sulawesi, Indonesia, now known as Lembeh Strait. Smith's passion for diving and obsession with exotic

Clockwise from far left: A lemon goby in an empty bivalve shell; a flamboyant cuttlefish embryo; a blue-ringed octopus in hunting pose; a black hairy frogfish (*A. striatus*) fishing for a meal

animals were already legendary when he began to train his local divemasters in the fine art of the critter hunt. He and his staff began to explore the area for new dive sites, and he soon realized the new dive staff had a natural talent for finding the critters. The news soon spread, and Smith's efforts began to be noticed throughout the dive community, particularly among underwater photographers. Soon the resort was buzzing with photographers, all clamoring to get images of these seemingly new and rare critters of the strait. With hard work and dedication he and his crew carved out an entirely new niche in the dive industry now known as "muck diving" and established the role of the dive photo guide.

Today, finding the right guide has become an important consideration for underwater photographers. It's been said, "It's not the dive site, it's the dive guide on the site" that makes a dive come to life, and that has definitely been my experience.

GETTING THE MOST FROM YOUR COLLABORATION

Preparation is key to getting the most from your guided experience. Knowing the possible subjects and creating a list before your trip of what you would like to see or photograph is a great way to start. There is a Holy Grail of exotic macro life specific to any destination, and the guide will already know what the marquee subjects are.

One thing your guide won't know is what your portfolio already has in abundance. So if longnose hawkfish are redundant to you, let your guide know. Or if you truly covet a photo of a blue-ringed octopus, likewise tell your

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guide. If you sense that your guide is excited about something or there is a subject he or she really wants to show you, then it's certainly worth investigating. Many times that familiar tug on my fin afforded me an opportunity to see something completely off the charts. An opportunity to photograph something unusual can even arise through observing your guide's body language underwater, so pay attention.

THE TORCH, STAGING AND THE STICK

One of a guide's most valuable tools is his torch, which is used regularly to find subjects of all shapes and sizes during the day and at night. A strong light with a tight beam can scan algae, peek under coral heads, peer into crevices and scan the sandy bottom, perhaps prompting movement in an otherwise stoic or cryptic subject. This slight movement is often all that's needed for a guide's eyes to discover a subject. Lie-in-wait predators such as frogfish and lacy scorpionfish survive by remaining motionless and relying upon their camouflage to hide and hunt. To the untrained eye even these somewhat gaudy subjects can blend in perfectly with their habitat.

Staging is a practice in which a guide assists a photographer in composing an image by encouraging the subject to move into a more photogenic position. Some resorts and photographers are ethically opposed to staged photos — for good reason — but it is naïve to assume staging doesn't happen. It may be as benign as enticing an octopus to engage its curious nature or using a blade of seagrass to gently brush the subject, but it also might be egregious — puffing pufferfish or holding turtles underwater,

Communicating with your guide can lead to some extraordinary finds and special photo ops such as (*from top*) magnificent shrimp gobies, a pink-eared sea mantis with white eggs, and Holy Grail subject *Rhinopias.*

***Opposite:* Hairy shrimp are one of the most sought super-macro subjects in the Indo-Pacific.**

HOW TO SAY THANKS

- Give a cash tip in the local currency. (Follow resort protocol in terms of when and how to give a gratuity.)
- Share proceeds or a contest prize.
- Tell the resort management how much you appreciated your guide.

for example. Most guides will know such behavior is wrong and won't be tolerated by their clients, but a fine line separates engagement and harassment. Each guide will have his or her own standards regarding this practice; a simple tap on the hand or a grunt will alert the guide that enough is enough and it's time to move on. Praising your guide topside for being gentle is a good practice for promoting a more eco-friendly approach to the hunt. A compliment is much more powerful than a complaint; remember you're a team and need to work together — mutual respect can go a long way.

Nearly all dive photo guides now carry a "muck stick" to use in a variety of ways in the pursuit of different subjects. Pushing aside algae or tickling the foot of a crinoid with his stick, a guide can move quickly around a dive site, probing and searching. To some divers this activity might seem a bit heavy-handed or intrusive, but in the right hands a muck stick can be just the opposite. Some guides will carry several differently sized sticks, zip ties, a small piece of monofilament line or, my favorite, a chopstick. All of these can be used to tickle a subject, encourage movement or stabilize a diver without destroying habitat or unduly disturbing a subject.

COMMUNICATION ABOVE AND BELOW

Communicating effectively above the waterline will increase efficiency below, where time is limited, thus improving your ability to collaborate with your guide and subjects. Occasionally your bottom time will be consumed searching for a specific subject, so when it's finally located it's important to be ready — relax and concentrate on working the subject with your guide.

Some of the most productive dive sites tend to be the busiest, so it's also important to learn how to communicate with your guide underwater. Some guides use a honker, shaker or tank banger to signal their guests. Unfortunately these approaches also signal everyone else on the dive site, and a photo melee may ensue. A quieter method will allow guide and diver to move around a site and attract very little attention, even among a crowd, while still communicating with each other. A low-pitched grunt and a few hand signals can say it all. To further maximize your bottom time, try to arrange for a low guest-to-guide ratio or, better yet, private one-on-one excursions. Many resorts will offer such services at a premium, and the results generated may be well worth the added cost.

MIKE BARTICK/SALTWATERPHOTO.COM

CRUSTACEANS AND NUDIBRANCHS

Ornate colors and interesting body structures are just a few of the reasons why crustaceans and nudibranchs are desirable photo subjects. But finding them isn't as easy as you might think. Tiger shrimp, harlequin shrimp, hairy shrimp, bumblebee shrimp, boxer crabs and many of the light-sensitive nudibranchs don't just sit on top of the reef. Finding these subjects may require searching through rubble and dead coral, for example. A guide who knows where to look and how to photograph these animals can be much less intrusive than a diver who digs into fragile habitat without knowledge of the area.

Using your field ID book as a wish list, poll your resort's guides: Ask what they are good at finding or what is seasonal, and let them know if there is a particular subject that you would like to see. Chances are good that something special might come to mind, which always adds excitement to a dive.

Many guides who live in remote regions of the world have dedicated themselves to diving, sometimes despite local pressures to fish or collect. Their knowledge of the local marine life can be extraordinary, and their insights about behaviors can be remarkable even in the absence of formal education. Many guides have been responsible for discovering new marine animals.

The close working relationships of divers and photo guides can forge lifelong friendships and create incredibly rewarding and enjoyable life experiences. It is hard to match the pure elation of finding a wish-list subject, discovering something new together or showing a diver a subject he has traveled thousands of miles to see. AD

The Status of a Symbol

FLORIDA'S MANATEES

A manatee hovers peacefully at the Crystal River National Wildlife Refuge.

NOTE: Just before this magazine was printed, the U.S. Fish and Wildlife Service announced that the existing regulations for viewing manatees at Three Sisters Springs will remain in place for the 2015-16 season. Substantial public response to the draft environmental assessment prevented the adoption of the stricter regulations prior to the beginning of this season.

STEPHEN FRINK

By Allison Vitsky Sallmon, DVM

Like many kids who grew up in Florida decades ago, my earliest interactions with manatees just … happened, and they did so quietly with a minimum of fuss. The first "sea cow" I encountered simply snuffled toward me in the St. John's River while I swam near my parents' dock. And the last time I traveled to Crystal River (this is where I date myself), it was a serene destination with a tiny dive operation or two, a couple of local hotels and a few snorkelers floating blessedly far apart from one another. Manatees had plenty of room to approach humans — or not — as they foraged in peace. It's hard to believe that this area and this creature are now the focus of contention.

But things change, even in Crystal River. Between 2000 and 2010, Citrus County (which encompasses Crystal River) saw a population increase of more than 19 percent, which undoubtedly included many new residents dreaming of tranquil days on or near the water. Local ecotourism has grown even more. Florida's manatees gather every winter near freshwater springs and power-plant outflows where the water is warm (a constant 72°F) compared with ocean and air temperatures. Crystal River's Three Sisters Springs has the greatest freshwater outflow in the area and a correspondingly large wintertime manatee population. Visitors swarm the area to visit the gentle, goofy-looking marine mammals that are a symbol of Florida's wildlife conservation efforts. Three Sisters drew more than eight times as many visitors in 2013 as in 2006. The U.S. Fish and Wildlife Service (FWS) reports that on the busiest days the springs can get more than 100 visitors per hour, and a brief Internet search reveals pages of manatee-related activities for sightseers. Snorkeling? Paddleboarding? Kayaking? If it has to do with viewing manatees, people will line up to do it.

Manatee protection efforts have been adjusted and expanded over the past several decades to keep up with the influx of humans. Created in 1983 to protect Florida's endangered West Indian manatees, the Crystal River National Wildlife Refuge (NWR) limits in-water activities at the headwaters of Crystal River. Several winter sanctuaries that ban all human-manatee interaction also have been established. To prevent boat strikes, authorities have lowered speed limits and limited watersports zones. Although "swim-with" manatee permits have been granted to some tour operators, more anti-disturbance rules have been put into place over the years (prohibited activities include pinching and standing on manatees, suggesting that egregious conduct does take place on occasion). Last year Three Sisters Springs implemented additional precautionary measures, including decreased paddlecraft access and the option to close the area to the public during extreme cold fronts. But some recent reports suggest that current guidelines may still fall short.

The Florida Fish and Wildlife Conservation Commission (FWC) conducts statewide aerial surveys to track manatee populations one to three times each year. While the surveys aren't perfect census tools, they indicate that manatee numbers are on the upswing — from around 1,200 animals counted in 1991 to more than 6,000 in 2015. But in Crystal River the increase in manatee numbers is confined to small areas that are increasingly overrun with people. Well-meaning as most of us may be, realities remain: Local boaters want waterway access, local tour operators want to please tourists, and visitors want to go home having interacted with a manatee.

As for what the manatees want, we can assume their primary goals are to eat and survive. Perhaps biology determines the rest. We should consider a key feature of manatees' sensory systems. Their bodies are covered with vibrissae (tactile hairs), which provide the animals abundant information about their environment from the pressure and movement of water.

"Simply put, touch is their 'super-sense,'" explains Iske Larkin, Ph.D., lecturer at the University of Florida's Aquatic Animal Health program. Martine de Wit, DVM, of the FWC, concurs, stating, "These are very tactile animals, and the proximity of lots of people may affect them more than we can imagine."

For the manatees, escaping the crowds means moving to colder water. From a nutritional standpoint, manatees exposed to water temperatures below 68°F have much greater caloric needs — up to 50 percent more according to one researcher — than manatees in warmer habitats. Below a certain water temperature, juvenile manatees simply cannot eat enough to survive. Cold stress is particularly hard on young animals.

"These animals need to eat almost constantly to maintain their internal temperature, as they cannot hold heat as effectively as adults," explains Mike Walsh, DVM, co-director of the University of Florida's Aquatic Animal Health program. "When the springs get crowded, many manatees will just leave. However, young manatees can make bad decisions about when — or whether — to return to warm water."

When water temperatures drop into the 50s (°F), the situation becomes more acutely dangerous. "At this point, manatees get skin lesions that resemble frostbite in humans," explains Ray Ball, DVM, medical sciences director at Tampa's Lowry Park Zoo. "Manatee blood vessels are structured in a unique and unforgiving way to begin with, and their blood is very prone to coagulation at cold temperatures."

From left: **During winter months, Three Sisters Springs is a warm-water haven for large numbers of manatees. Paddlecraft and swimmers may inadvertently disturb manatees to the point that the animals leave the warm springs, which places them at risk for cold stress. A young manatee with cold stress-related lesions is cared for at Tampa's Lowry Park Zoo.**

Undoubtedly, staying warm is a matter of life and death for manatees, even if doing so means dodging boat traffic (something they do poorly) and tolerating pursuit by throngs of humans. The situation is exacerbated by a declining freshwater aquifer that allows intrusion of salt water, which is quite cold during the winter months, further heightening the manatees' biological need to gather near the warmer spring outflows.

Despite unprecedented mortality events due to cold and toxic algal blooms in recent years, manatee numbers are increasing, leading some people to believe manatees should no longer be listed as endangered. A group of area residents and homebuilders, along with a conservative public law firm, sued the FWS in 2012 to downgrade the manatees' status to "threatened." A decision is anticipated this December.

While downlisting their status would indicate a solid recovery of these animals, Patrick Rose, executive director of the Save the Manatee Club, cautions that changing the manatees' status isn't just a numbers game. "According to the Endangered Species Act, downlisting an animals' status requires that their habitat is secure for the foreseeable future," Rose said. "Loss of the manatees' warm-water habitat is a huge limiting factor. The power plants are reaching the end of their lifespan, and Florida's aquifer is under such incredible consumptive pressure that spring output is diminishing. A mortality event similar to those we've seen in recent years could result in catastrophic animal loss with little recovery potential."

Complicating matters, the FWS is also under pressure to increase manatee protection. Earlier this year a nonprofit environmental group along with local naturalists threatened to sue the agency for violations of the Endangered Species Act and demanded an end to "swim-with" manatee programs.

Crystal River NWR manager Andrew Gude said this threat had no impact on the draft environmental assessment (EA) the FWS released in August 2015 for Three Sisters Springs. The EA, which had been in the works for more than a year, outlines options to further increase manatee protection during the upcoming winter season and details a preferred strategy that would reduce the number of in-water tour operator special-use permits from 44 to five and strictly limit the number of swimmers in the water at a time to a maximum of 29 (20 visitors, two photographers and seven guides).

"This is a huge step we're trying to take," Gude said. "Although the visitors who intentionally harass these animals are a very small minority, we need to prevent even the unintended effects we have on manatee behavior. We must initiate a social change, staying focused on manatee protection while at the same time facilitating responsible wildlife viewing from both land and water."

The proposed plan takes a bold, decisive step to protect manatees, but it has been met with mixed and sometimes angry responses, including concern about the negative impact on local businesses, assertions that the many are being punished for the actions of the few, and questions about whether people will care as deeply about Florida's manatees if they can no longer interact with them in their natural environment.

After spending hours talking to scientists and studying the history of this complex battle, I am as perplexed as ever. How can this situation be resolved? We must protect manatees, but can regulations, as some have suggested, go too far? Or should we be guided by the concern that if we do not sufficiently protect manatees now, someday there might be none left to protect at all? Is it even possible for such conflicting positions to find agreement?

Adrián Cerezo, Ph.D., director of Conservation Education Research at the Saint Louis Zoo and an expert in complex environmental scenarios, assures me that it is: "Avoidance of extinction is a weak platform on which to build conservation policies. We need to cast a wider net to build effective, long-term solutions, and that wider net is sustainable development. If we contribute our passion, knowledge and actions to this larger goal, we not only improve the long-term outlook for manatees, we build a world fit for humans, manatees and all other species."

For the sake of Crystal River and its manatees, I hope he is right. AD

MEMBER TO MEMBER

Attracting College Students to Diving

By Reilly Fogarty

STEPHEN FRINK

At a recent Beneath the Sea dive expo, I had the experience of being — as far as I could tell — the youngest active diver in attendance.

The people I dive with, my dive-industry colleagues and the diving role models I aspire to follow are all a generation or two older than me. Diving's attractions haven't changed much since those divers discovered the activity, and the costs haven't become more prohibitive, but it is difficult to find evidence of a new generation of divers embracing the sport.

By finding ways to appeal to groups of college-age people, rather than just individuals, and intentionally reaching out to a younger demographic, the dive industry can attract not only more divers, but the divers who will make up the next generation of our sport.

My own introduction to diving set the hook firmly. Among the reasons it succeeded are that it involved a group of like-minded divers my own age, it provided college credit, and it offset some of the costs. These factors led me and many of my fellow students to take ownership of both the learning process and the sport.

The most effective means of imparting this ownership, from my perspective as both a young diver and a member of the industry, is the integrated college program. These programs offer classes with a single up-front cost and convenient access to gear, instructors and facilities. Students can go through the course with a group of friends, which removes the social hurdle of entering a sport dominated by a generally older and wealthier demographic.

I was trained through Project DEEP, a nonprofit based in Gloucester, Mass., that targets college students and requires an investment of time and money that I believe is within reach of most interested and motivated students. I was initially drawn to the program at my college by the single all-inclusive cost. The fact that my friends and I could take the course together and for college credit sealed the deal. Getting certified along with classmates led to a tightly connected diving community that has endured years after graduation.

I won't say that college-aged divers are the be-all and end-all of the next generation of diving. Many families get involved and grow our community with their spouses, mothers, fathers, sons and daughters. And, of course, many divers pick up the sport later in life. But my experience learning from someone close to my age along with a group of students like me demonstrated the value and effectiveness of the integrated college program. And I believe a young adult who dives of his or her own volition is likely to join a club, bring friends to diving and dive often.

In support of attracting new divers, I volunteer for Project DEEP and groups like it, and I believe I offer welcome encouragement to the new students. You too can volunteer with college groups, dive clubs and industry outreach programs, and you may find, like I did, that these programs do good things for not only the students and the dive community but for you as well. AD

SHARE YOUR STORY

Do you have tips, advice, travel strategies, dive techniques, lessons learned or other words of wisdom to share with your fellow divers? *Alert Diver* wants your story! Email it to M2M@dan.org, or mail it to "Member To Member," c/o *Alert Diver*, 6 W. Colony Place, Durham, NC 27705.

Establishing a Baseline

HOW DIVE COMPUTERS DETERMINE SURFACE PRESSURE

By Tyler Coen

As altitude increases, atmospheric air pressure decreases. This simple fact has important implications for both our bodies and the operation of depth gauges.

Rather than measuring depth directly, digital depth gauges measure absolute pressure, which includes both the water pressure and the atmospheric air pressure above the water (hereafter referred to as surface pressure). A computer cannot measure the surface pressure during a dive, so this information is determined and saved before the dive. The computer calculates depth by subtracting the saved surface pressure from the measured absolute pressure.

Errors in determining surface pressure may result from the unit being slightly submerged at the time of sampling or from defaulting to a standard value equivalent to sea-level pressure when the diver is actually at altitude. Using a surface pressure that is higher than reality is bad in two ways. First, too much pressure will be subtracted from the absolute reading, resulting in a depth estimate that is too shallow, possibly causing you to exceed your planned depth. Second, an erroneously high surface pressure estimate means the decompression calculations will underestimate the magnitude of the decompression stress, effectively increasing the risk of decompression sickness (DCS).

Weather can cause the surface pressure to vary, but only by amounts that are relatively insignificant for diving purposes (typically no more than 6 inches of water depth). Altitude, conversely, has a much larger impact. For example, diving in Lake Tahoe (elevation 6,225 feet) involves a reduction in surface pressure equivalent to about 6.5 feet of water depth compared with sea level.

When a diver surfaces at high altitude, the surface pressure is less than that of sea level. This means the diver's tissues have a relatively higher level of supersaturation, which promotes greater bubble growth, thus increasing the risk of DCS. Decompression models used by dive computers must know either the altitude or the surface pressure so they can establish appropriate no-decompression limits. Some models do this automatically, while others require manual user input.

In a review of dive computers currently on the market, all were found to feature automatic compensation of depth readings for altitude. This is good, as it saves the user from needing to manually perform an adjustment. However, the method used to determine surface pressure varies among manufacturers, and some methods may be more accurate than others.

The ideal method for determining surface pressure would be reliable and accurate, require no intervention from the user and never be fooled by events that cause pressure changes (such as air travel or brief submergence before a dive). This can be difficult to achieve in real life, as designers must balance competing variables such as unexpected user behavior, hardware limitations and the need for low power consumption.

The computer often uses the moment of activation to sample the surface pressure. This works well when the user turns on the computer at the surface immediately before a dive. Since this step can be forgotten, however, most computers are designed with automatic activation backup. If activated while submerged, the much higher density of water compared with air can result in significant error in the surface pressure estimate for even minor depths of submergence. Auto-activation techniques must take steps to protect against such errors. Some models have wet contacts to detect the presence of water for auto-activation. Once the unit senses water, it will turn on if needed and then sample the ambient pressure. This can provide a good estimate of surface pressure, provided that the sampling is frequent and minimal descent has occurred. Wet contacts are typically sampled every 1 to 5 seconds. Problematically, significant error could result if a diver initiated an immediate descent upon entering the water.

Models without wet contacts will auto-activate when an increase in pressure is detected (i.e., a descent begins). Because these models are already underwater when activation occurs, they must keep a history of pressure samples while in standby mode and then apply an algorithm to determine the surface pressure. These methods may be complex and are not typically released in detail. Some computers detect a relative increase in pressure for auto-activation. The advantage of using a relative pressure increase is the activation depth can be

STEPHEN FRINK

STEPHEN FRINK

Dive computers use various methods to determine surface pressure, and some are more accurate than others. To help ensure your computer measures the correct surface pressure, turn it on before you enter the water. This also allows you to confirm function and battery life.

STEPHEN FRINK

STEPHEN FRINK

the same when diving at high altitude as when at sea level. However, it is possible for sudden pressure changes to trick the computer into falsely initiating a dive.

Some computers do not auto-activate until an absolute pressure threshold is reached. While this method prevents erroneous activation, the disadvantage is that if the depth for auto-activation is 3.3 feet at sea level, it would increase to about 10 feet at an altitude of 6,500 feet. For example, some computers keep a 10-minute history of pressures and upon activation choose the lowest pressure as the surface pressure. However, a dive could conceivably begin with a long swim shallower than 10 feet, which could result in an incorrect surface pressure determination.

The simple solution to all of these problems is to manually turn on the dive computer while on the surface before the dive.

Many decompression models adjust for altitude, which makes proper surface pressure determination critical. Other computers require manual adjustments for diving safely at altitude. Divers should refer to their dive computer's operating instructions to see if automatic altitude adjustments for depth measurements are performed and if any limitations are listed. Note that some models, especially older ones, may not provide any compensation for altitude and/or may not have an auto-activation feature.

RECOMMENDATIONS

As a rule, turn on your dive computer manually at the surface immediately before each dive. This will allow you to confirm normal function and adequate battery life and allow the computer to sample the true surface pressure. When at altitude, some computers will display a mountain icon or other indication that the computer has adjusted for the reduced surface pressure.

Read your computer's operating instructions to learn its functions and limitations, and consider diving with multiple instruments — at least with a backup depth gauge. A second depth reading provides a reference to help spot errors. Ideally, the two instruments would be made by different manufacturers to avoid common failures in design or usage. Since an error in surface pressure measurement will appear as a constant offset in the depth reading throughout the dive, it can be spotted early, while the diver is still shallow.

Diving at altitude is more complex than diving at sea level, and extra steps may be required. Don't hesitate to ask questions of your dive computer's manufacturer if you cannot find all the information you need. AD


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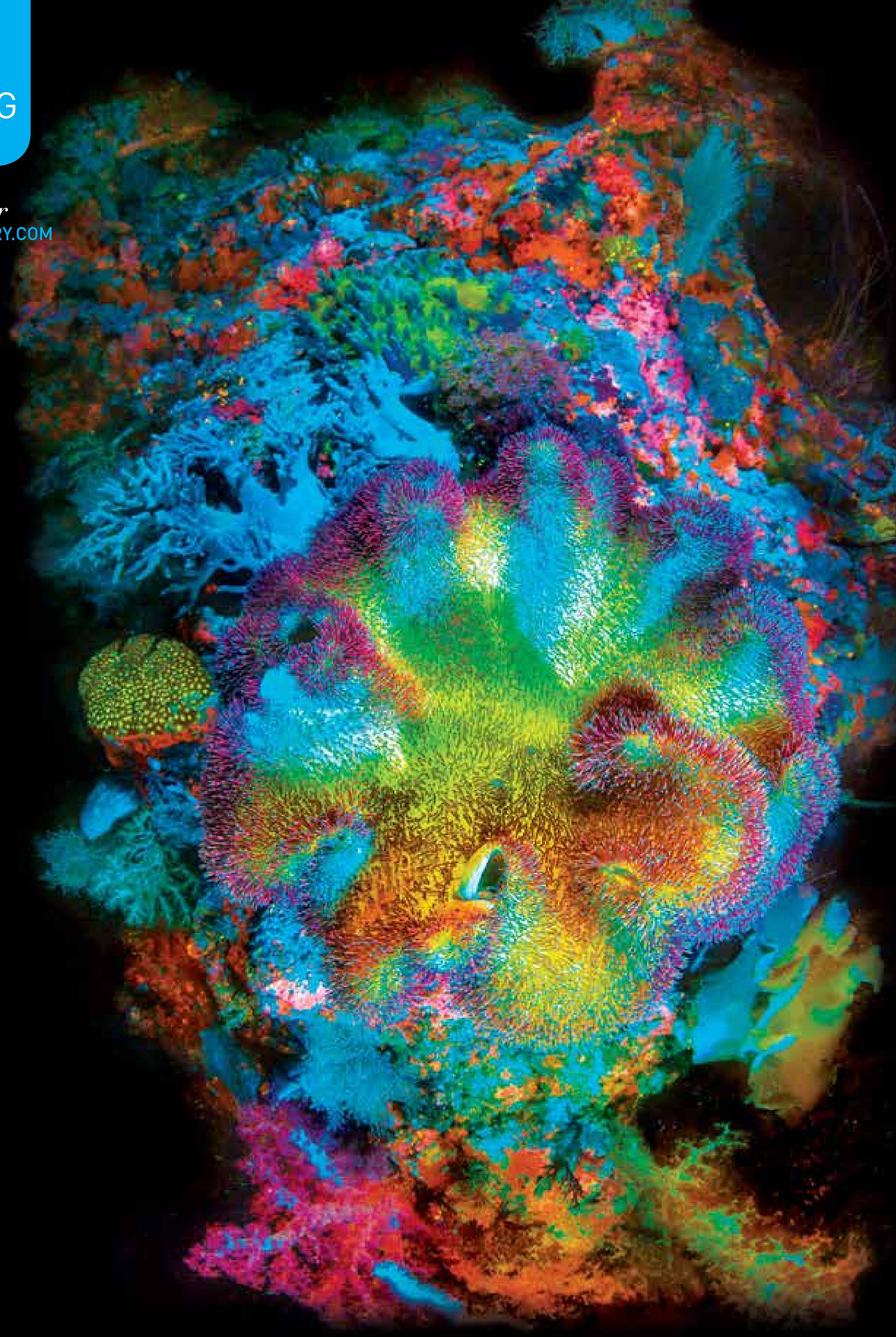
PARTING SHOT

By Clark Miller
AQUATERRAIMAGERY.COM

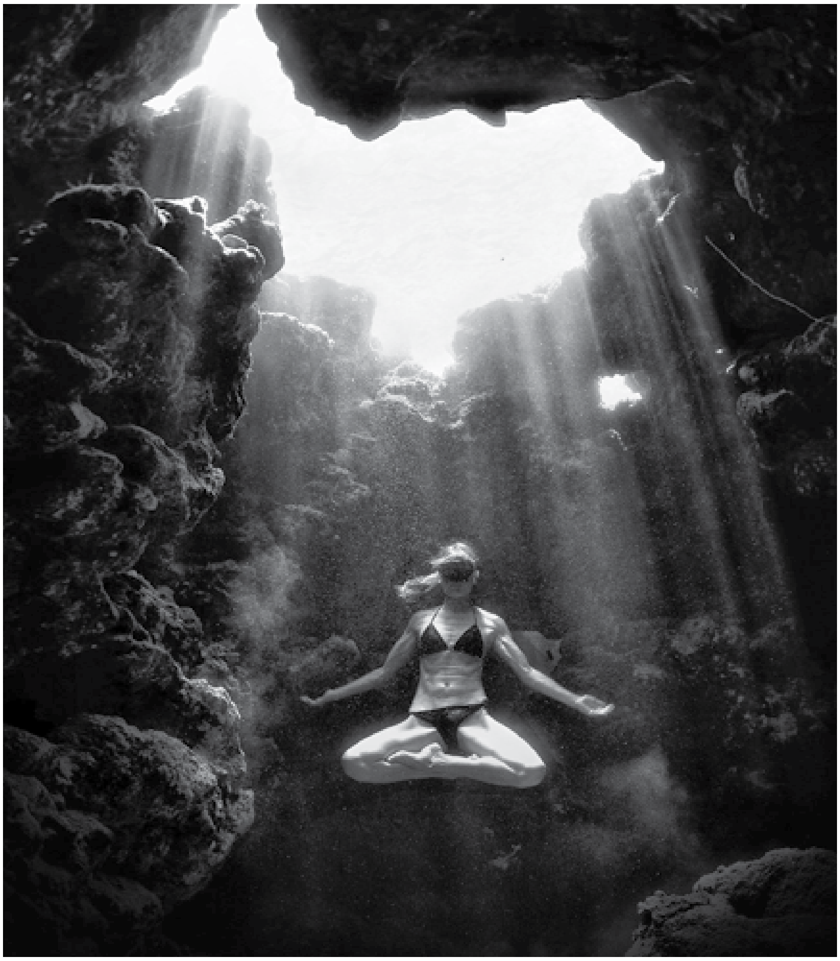


Adriana Basques and I have been working on a photographic technique we call wide-angle mixed fluorescent photography.

Wide-angle fluorescent photography requires a lot of light, typically four or more light sources. One method of shooting fluorescence is to use high-powered LED video lights with filters, but most video lights (except for very powerful and expensive LED lights) have insufficient power to bring out fluorescence because of the filters used. This leads to turning up the ISO to a point that introduces too much noise. However, strobes with properly fitted diffusers can do the same thing but with significantly more instant light. The ISO can remain much lower, and noise can be kept to a level that can be addressed in postprocessing.

We use a variety of colored lens filters and strobe light diffusers to shut out specific wavelengths of light and capture the florescence. With the right amount of light and careful postprocessing of the RAW image, it is possible generate significant fluorescence and reveal a variety of colors. There is no one way to accomplish this, and the process continues to be a fascinating experiment. AD

EQUIPMENT: Canon EOS 5D Mark III, 8-15mm fisheye lens at 15mm; amber filter; Sea and Sea YS-120 strobes (2) and YS-D1 strobes (2) with specially fabricated prototype blue CM dome diffusers; Aquatica housing with 9-inch glass megadome
SETTINGS: 1/60 sec. @ f/5, ISO 640
LOCATION: *Liberty* wreck, Tulamben, Bali



Jacques de Vos South Africa

At the end of 2007 while enjoying 'days off' from his position as an engineer in the oilfield services, Jacques de Vos was inspired by his scuba instructor (also a talented underwater photographer) to purchase his first underwater compact camera and Ikelite housing. Since then he has qualified as a SCUBA instructor and Commercial Diver, and upgraded through numerous camera systems. He now shoots both stills and video and has developed the skill set to do all of this while freediving.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