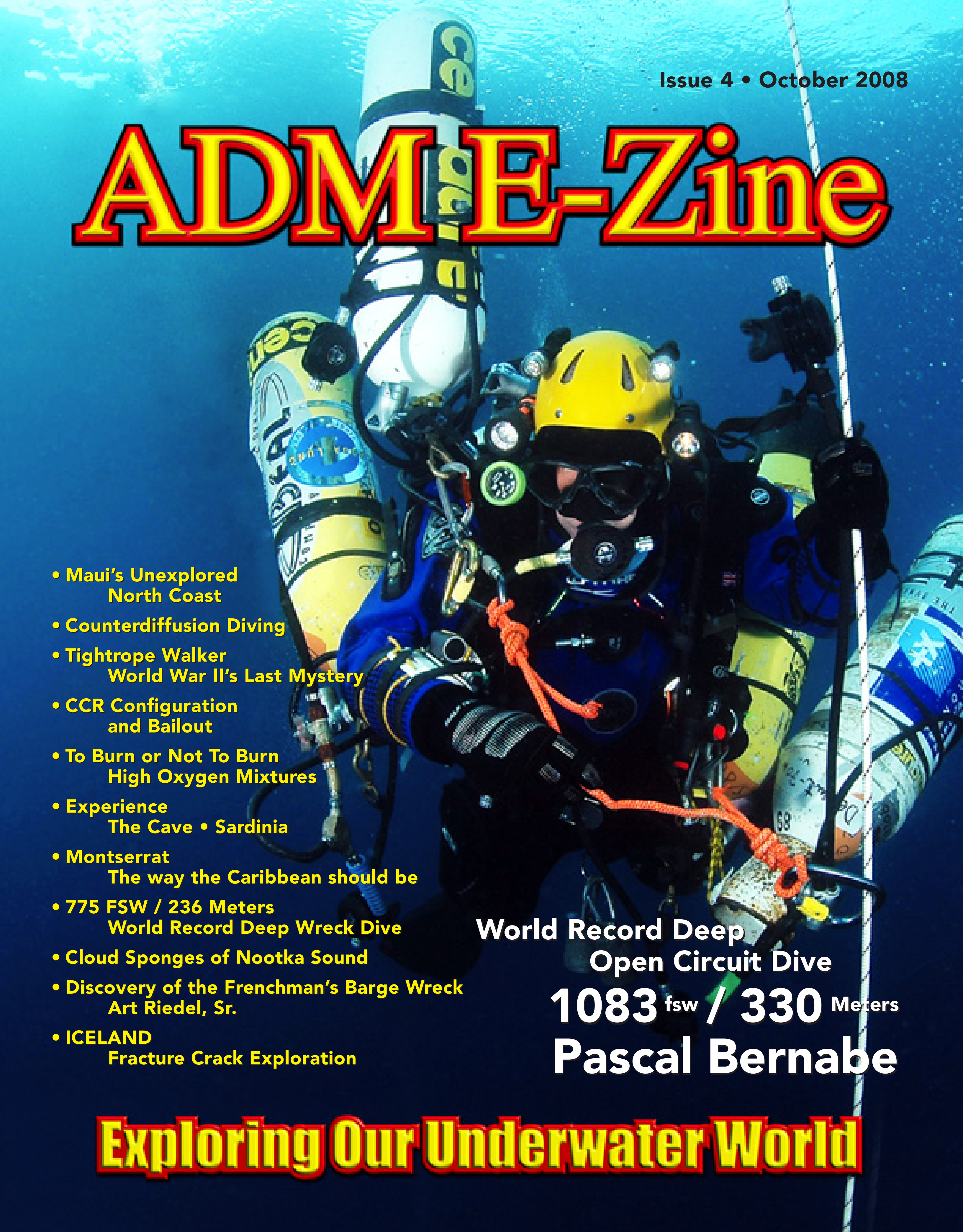

Issue 4 • October 2008

ADM E-Zine

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- Counterdiffusion Diving
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World Record Deep Open Circuit Dive

1083 fsw / 330 Meters

Pascal Bernabe

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Publisher's Notes

I am excited and proud to announce the merger of Advanced Diver Magazine and Rebreather World. Together, ADM and RBW will be able to expand their ability to bring news and the most up-to-date technical information to the entire world of divers.

The initial transformation will remain subtle until all web files and databases have been moved to ADM's host site in the USA. After the dust has cleared, I envision many changes and additions to both Rebreather World and Advanced Diver Magazine. The result will be all for the better, allowing us to bring our ADM readers and RBW members the latest in rebreather technology information, CCR travel-friendly facilities, and updates on the latest CCR exploration projects.

ADM E-Zine Issue 4 comes with a whopping 140 pages of informative editorials and outstanding photography — free for the world to download and enjoy. Advanced Diver Magazine Issue 30 (hard copy) is on schedule for printing and mailing to subscribers in December.

And stay tuned! Plans are in the works for several 2009 dive expeditions, ADM live-aboard dive charters, and even a CCR / OC Grand Cayman photo shoot-out competition.

As you can see, the partnering of Advanced Diver Magazine and Rebreather World has set high goals for 2009, and we are hard at work to meet or even exceed your expectations.

Curt Bowen
Publisher & CEO
Advanced Diver Magazine & RebreatherWorld.com

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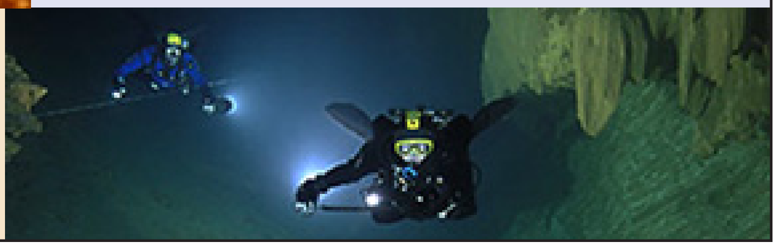

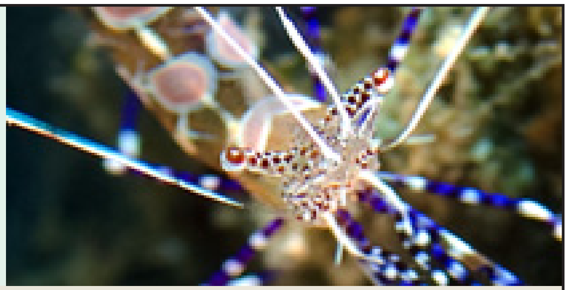

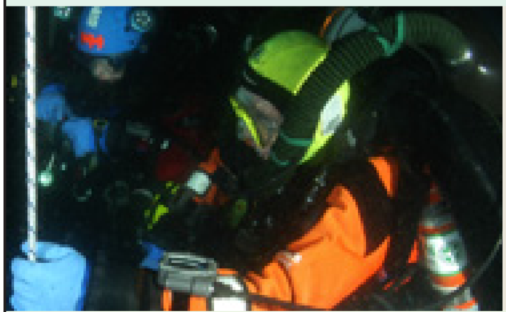

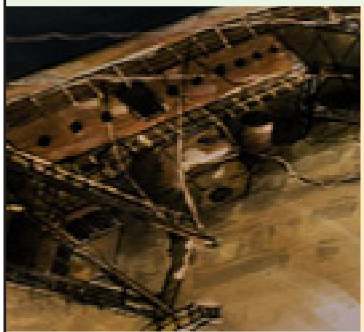

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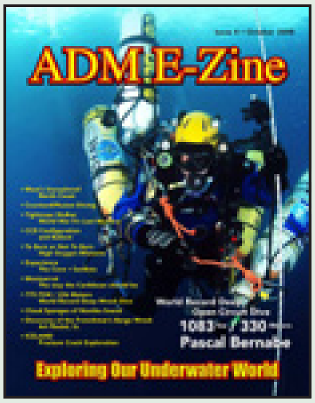
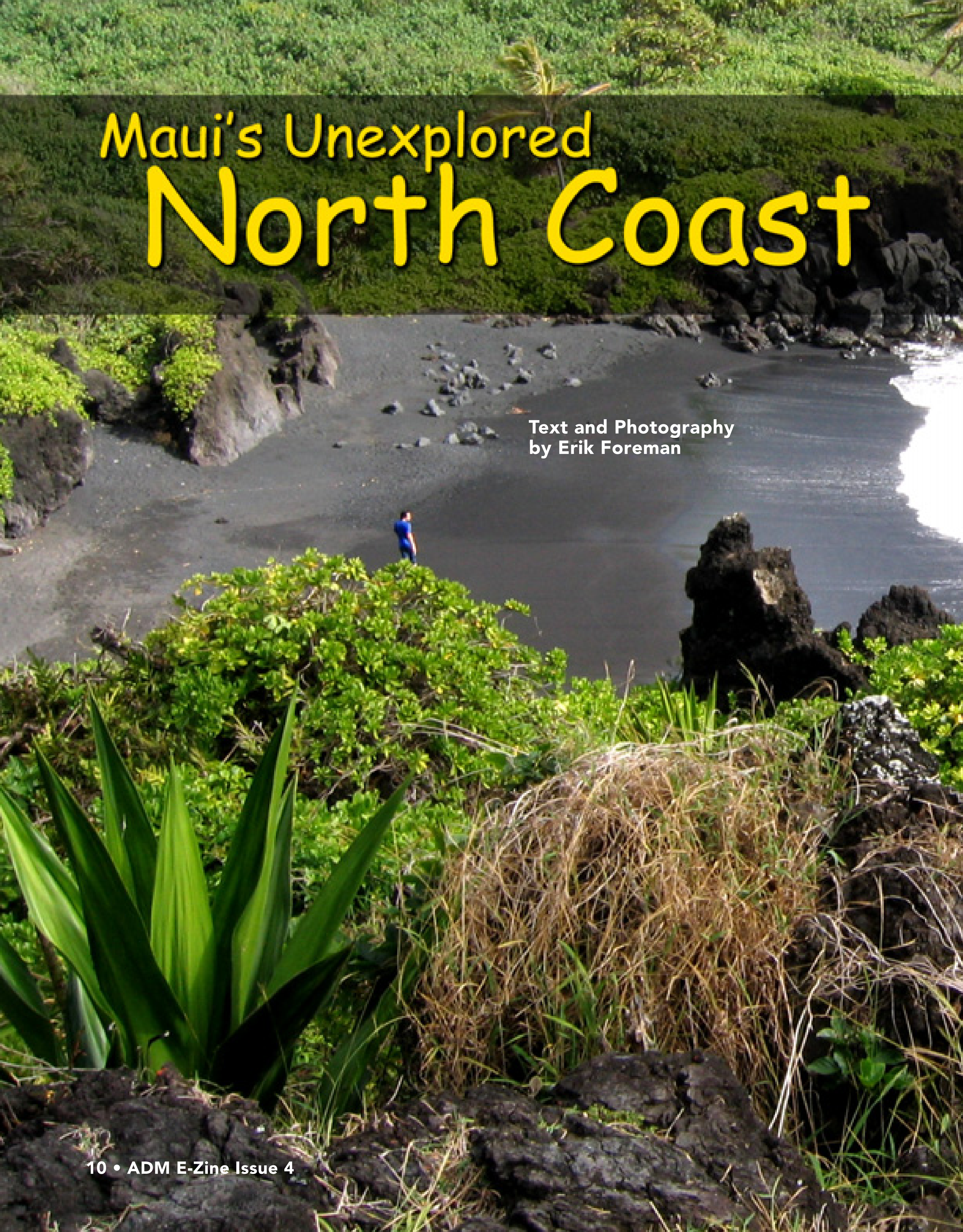


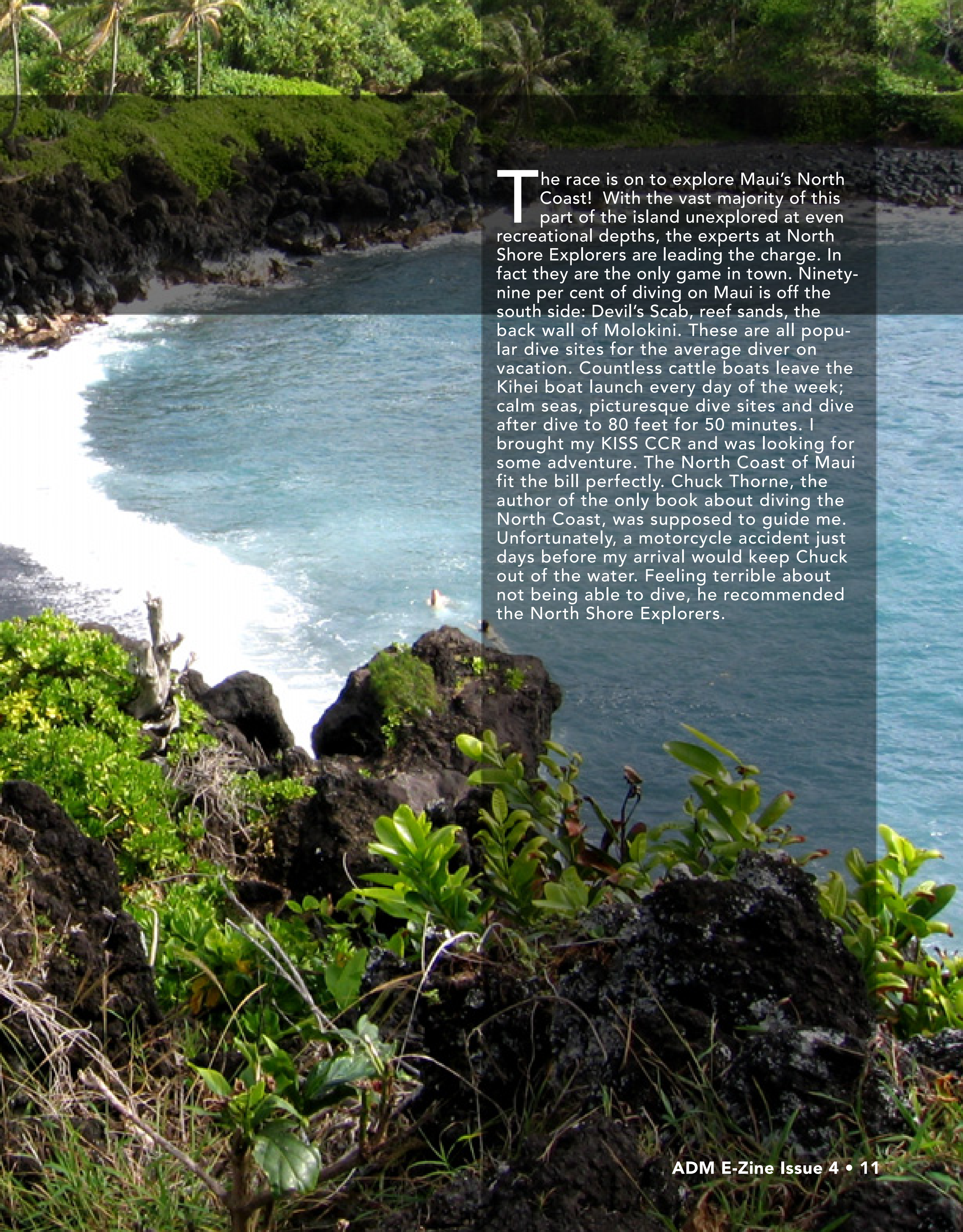
World record deep open circuit diver, Pascal Bernabé hangs on the decompression line after his dive to 1083 feet / 33 meters

Photography by Francois Brun

Maui's Unexplored North Coast



Text and Photography by Erik Foreman



The race is on to explore Maui's North Coast! With the vast majority of this part of the island unexplored at even recreational depths, the experts at North Shore Explorers are leading the charge. In fact they are the only game in town. Ninety-nine per cent of diving on Maui is off the south side: Devil's Scab, reef sands, the back wall of Molokini. These are all popular dive sites for the average diver on vacation. Countless cattle boats leave the Kihei boat launch every day of the week; calm seas, picturesque dive sites and dive after dive to 80 feet for 50 minutes. I brought my KISS CCR and was looking for some adventure. The North Coast of Maui fit the bill perfectly. Chuck Thorne, the author of the only book about diving the North Coast, was supposed to guide me. Unfortunately, a motorcycle accident just days before my arrival would keep Chuck out of the water. Feeling terrible about not being able to dive, he recommended the North Shore Explorers.

Todd Winn and Chris Quarre started North Shore Explorers (NSE) with a dream to show those select divers, both open and closed circuit, the primeval underwater wonders of the United States' last tropical paradises. They knew a critical part of that dream was having the right equipment. NSE was born out of a desire by its owners to do something different within the Maui dive industry. The end result has been to create a Maui dive charter that does just about everything differently.

Starting from scratch, they found a boat that could do the job. However, their first business purchase was a former military Deuce and a half, a 2 ton truck capable of towing ten thousand pounds. The only problem was the Deuce was in New Hampshire and the boat was in Iowa. In August 2006 they flew to New Hampshire, and in September drove it to Iowa to pick up the boat. Finally, on Thanksgiving Day they began the trek of towing the boat from Iowa to San Diego for shipping to Maui. Their 3500 mile journey was documented with daily logs, pictures and some video on the NSE website.

A former 30 foot Navy Seal RIB (rigid hull inflatable Zodiac style boat) with twin 300 HP turbo diesel jet engines, this boat was built to be dropped out of a plane at 1800 feet. The Pailolo, or crazy seas as it's known in Hawaiian, has been completely overhauled and modernized with the latest electronic and safety equipment. Safety is always the number one priority, and each diver is issued a reel, a surface marker and a Sea Shepard locator beacon - the only charter on the island to use these.

I arrived at the NSE training facility and could tell right away from the army truck parked in the driveway that I was going to fit right in. The large door rolled open, and I got my first look at the thirty-foot Pailolo. NSE is the only truly rebreather-friendly operation on the island. Both owners, as well as the Dive Master, Ryan Kenney, are closed-circuit certified. Other charters will let you dive closed-circuit, but they treat you as a curiosity.

We were led upstairs into a comfortable briefing room with a large map of the United States prominently displayed. This map was punctuated with stick pins marking NSE's route from New Hampshire to San Diego and then to Maui. After a thorough explanation of the safety equipment and a quick overview of what we might encounter, the diving conditions, schedule of events and a list of recent aquatic sightings including turtles, black coral, various species of sharks, many species of tropical reef fish, scorpion fish and possibly the seldom seen bearded borefish.

With the gear already loaded, we made our way a short distance to the boat launch. Within minutes we were underway. The Pailolo has several comfortable seats with many handholds which everyone is encouraged to use. This boat is fast, steady and powerful. With seas running at 7-10 feet, we passed through several rain squalls followed by magnificent rainbows, arriving at the dive site about forty-five minutes later. With so much of the North Coast completely unexplored, Todd and Chris can pick somewhere new almost every time. The area they had chosen, Ryan called Po'i (poh'ee, means crest of a breaking wave in Hawaiian).

After gearing up we entered the water among large swells, crashing waves, and swirling surf. Descending quickly, a completely vertical wall covered with sea life came into view. Dropping down into the 90-100 foot range, numerous tropical fish and large heads of black coral clinging to the wall could be observed in rapid succession. With visibility nearly 100 feet, schools of barracuda circled above. The first dive ended with a slow free-water ascent, making it easier for the boat to retrieve us.

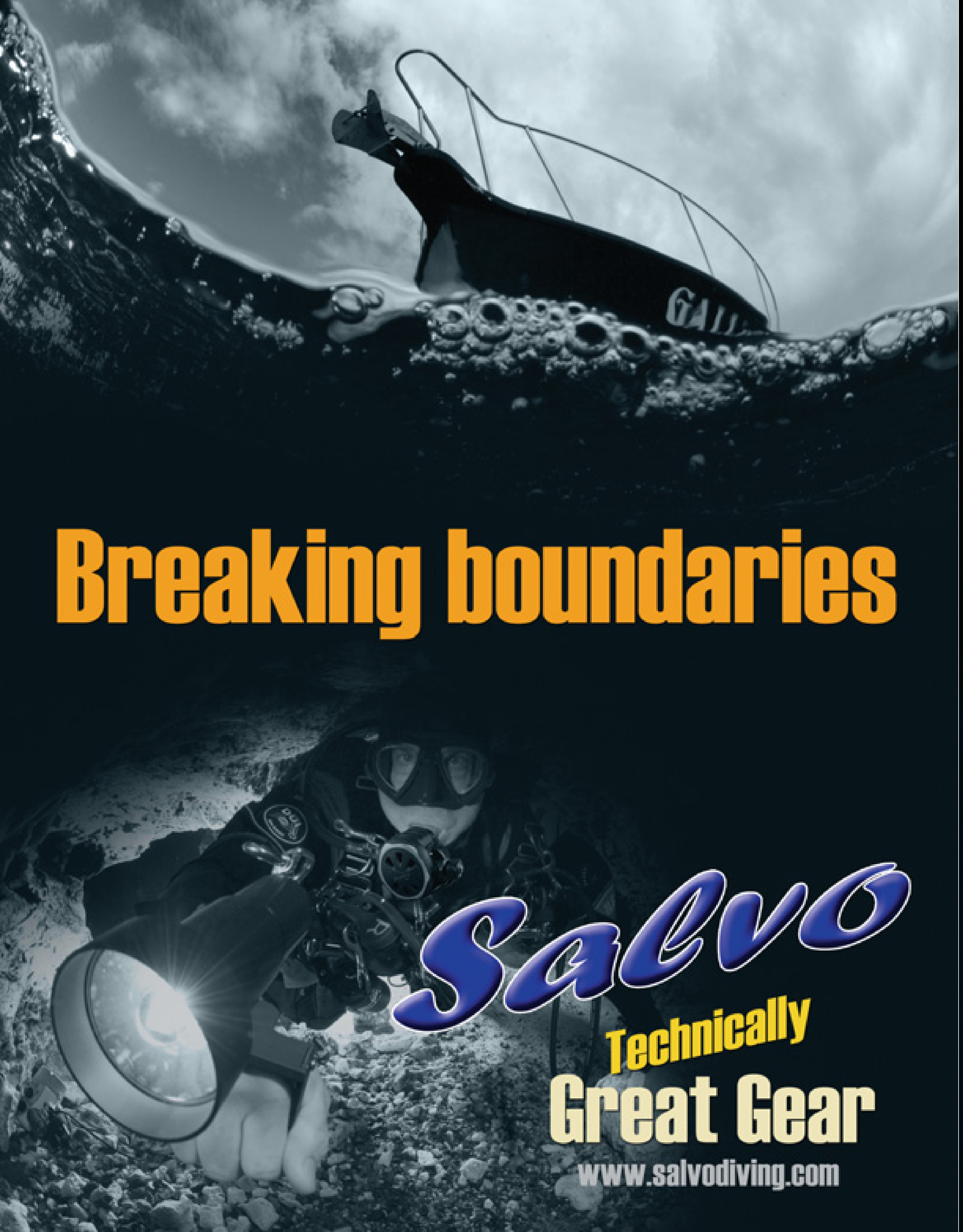
Spending the surface interval motoring to the next dive site, we were offered sandwiches, fresh fruit and drinks. I had no idea where we were headed. We arrived before long at the next dive site; it looked somehow familiar. Chris announced “Here we are – Jurassic Rock,” the site of the opening scene of Jurassic Park, the movie. And we were going to dive it! Our plan was to get dropped on one side and have the boat pick us up on the other side. We wanted to look for a possible swim-through on the backside of this large pinnacle of rock. The entry was a bit easier this time because it was somewhat sheltered.

The slope was strewn with giant volcanic boulders covered in corals and abundant sea-life. We were about 30 minutes into the dive when Ryan began signaling me frantically with his light. Swimming over quickly, there it was – the elusive whiskered borefish. I was told that most people who dive Maui their entire lives never see one. As it hovered very still and seemed not frightened, I captured several photos. Almost immediately one of the other divers spotted a pair of Scorpion fish. Searching for more than twenty minutes unsuccessfully for a passage all the way around, we swam free and ascended to the surface where the boat was waiting.

The ride back was one of the wildest I've ever had on water. With humpback whales breeching all around, giant swells and Todd at the controls, we gave wave-jumping a whole new name. The Pailolo seems to be capable of almost anything; including delivering us safe and sound back at the dock.

If you're going to Maui and want some grand adventure, you've got to look these guys up.

www.NorthShoreExplorers.com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Counterdiffusion Diving

Using Benthic Mix Switching to Reduce Decompression Time

BMX -- More Bottom Time – Less Deco!

By: Glenn H. Taylor
NOAA Undersea Research Center
University of North Carolina Wilmington

A recent article in Advanced Diver Magazine (Wienke and O'Leary, 2007) laid out the dangers and benefits of isobaric counterdiffusion to the technical diver. This article will introduce you to "Benthic Mix Switching," switching mixes on the bottom, a technique that takes advantage of the "good" isobaric counterdiffusion. Read on to enter the weird world of *Counterdiffusion Diving*, where you can off-gas without decompressing, enjoy a nice legal buzz, and cut your total stop time by 40%.

Try this at home.

Fire up your favorite mixed-gas decompression program and give me your best shot for a 130' dive for 90 minutes. Most likely you'll want to use nitrox with oxygen deco, but you'll have to dial back on the O2 in the nitrox mix to stay within exposure limits.

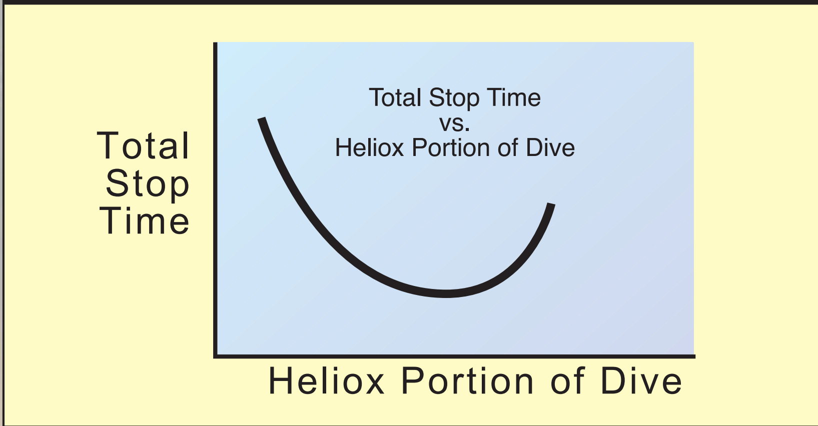
So what did you come up with for total stop time? ProPlanner, with 28% nitrox and deco on the bottom mix and oxygen, gave a total stop time of 85 minutes. But using an interesting new technique called Benthic Mix Switching, or BMX, you can cut that by 40% to about 50 minutes! For longer dives, you can save even more time.

Here's how.

Plug in the same dive, 130' for 90 minutes, only this time start the dive with 5 minutes of heliox. Use the same percent O2 as the nitrox and do the rest of the bottom time, 85 minutes, on the nitrox and finish up with oxygen decompression. What happens to the total stop time? It drops a little. Try it again with 10 minutes of heliox and 80 minutes of nitrox. Total stop time drops again. Do more trials adding five minutes of heliox while reducing the nitrox portion by five minutes to maintain a bottom time of 90 minutes.

What you'll find, as shown in Figure 1, is that as the heliox time at the beginning of the dive increases, the total stop time decreases, reaching some minimum value before it increases again. That minimum value marks the optimum time for the switch from heliox to nitrox during the bottom portion of the dive. That is Benthic Mix Switching.

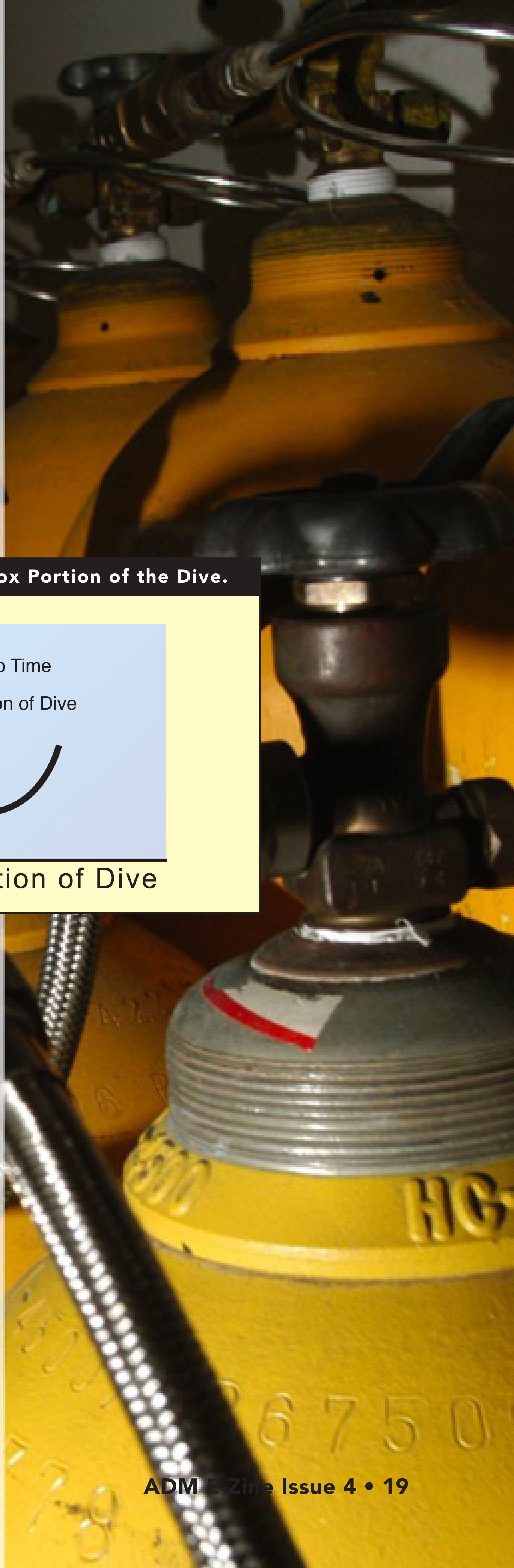
Figure 1. Total Stop Time vs. Heliox Portion of the Dive.



Why does that happen?

The answer lies in the physical differences between helium and nitrogen. Graham's Law states that the rate at which a gas will diffuse into or out of a liquid is inversely proportional to the square root of its molecular weight. Using Graham's Law, we find that helium will diffuse into and out of a liquid about 2.6 times faster than nitrogen.

This means that if a diver breathing heliox switches to nitrox on the bottom, without changing depths (a benthic or isobaric mix switch), the helium will begin diffusing out of his or her tissues faster than the nitrogen will be diffusing in The situation where gasses are moving in opposite directions is called "counterdiffusion," and for the diver it can be good or bad. When a diver has more than one inert gas onboard, the decompression obligation depends on the sum of the inert gas tissue tensions. Following a benthic or isobaric mix switch from heliox to nitrox there is a decrease in the total inert gas tissue tension, and this causes a reduction in total stop time.

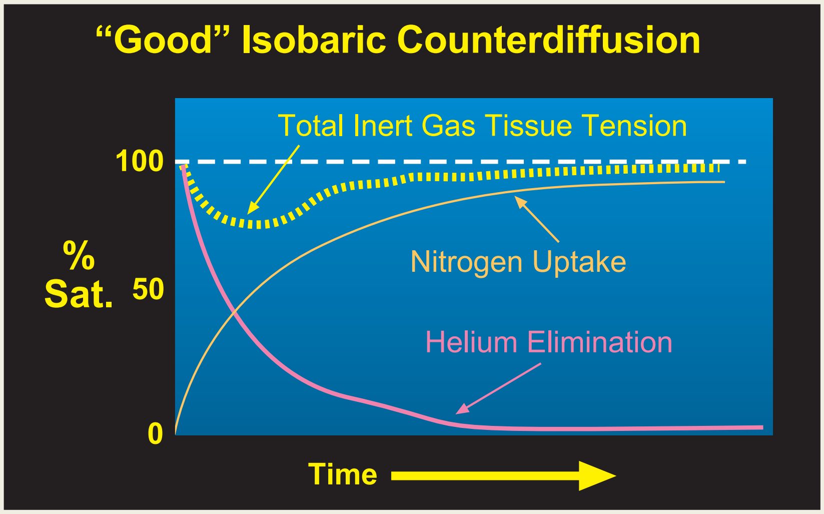


"Good" Isobaric Counterdiffusion

Researchers studying isobaric counterdiffusion used the terms "subsaturation" (Lambertsen, 1978), "desaturation" (Lambertsen and Idicula, 1975; Wienke, 2001), and "undersaturation" (D'Aoust, 1983) to describe the theoretical decrease in total inert gas tissue tensions following an isobaric mix switch from heliox to nitrox. Yount (1982) used hypothetical tissue halftimes to illustrate that mix switching could reduce decompression below that of either mix used alone. Animal experiments (D'Aoust, 1983) supported the theory that advantageous mix switches, such as helium-to-nitrogen, could produce a decompression advantage.

Figure 2 illustrates the case where tissues are at or near saturation with helium, and the diver's breathing mix is switched to a nitrogen mix. The total inert gas tissue tension will temporarily drop (Keller and Bühlmann, 1965; Lambertsen and Idicula, 1975; Lambertsen, 1978; D'Aoust, 1983; Wienke, 2001) because the helium is diffusing out faster than the nitrogen is diffusing in. This creates a decompression advantage that may be optimized by carefully timing the mix switch (Keller, 1967). Using the trial-and-error method above, you were able to easily determine the optimal time for that switch. Open water demonstration dives in December 2003 (Taylor, 2005), showed that the theory worked in practice.

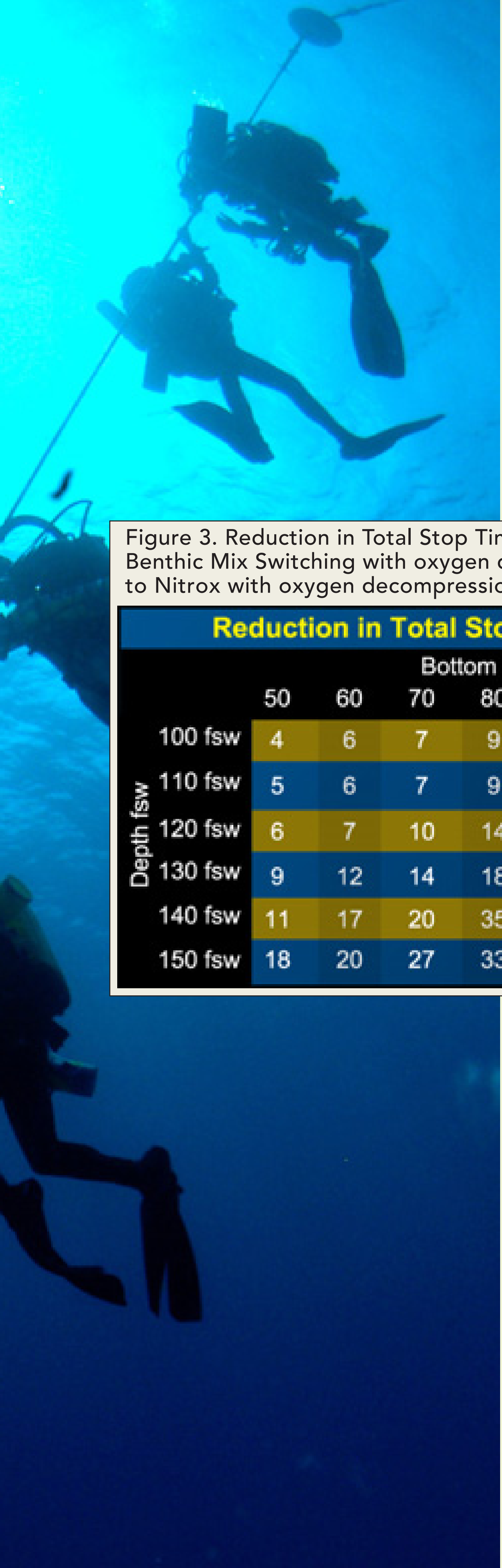
Figure 2. Showing the reduction of total inert gas tissue tension following a Benthic or Isobaric Mix Switch from heliox to nitrox.



Early pioneers

Experiments begun in 1959 by Hans Keller and Albert Bühlmann (Keller and Bühlmann, 1965; Keller, 1967 & 1968) first made use of the idea that different inert gases have different saturation speeds and that by switching mixes containing these inert gases, based on the rate at which these gases are taken up and eliminated by the body, a decompression advantage would result.

Beginning in 1962, chamber experiments sponsored by the U.S. Navy used multiple inert gases to optimize decompression from deep dives ranging from 130 fsw to 1,000 fsw. Of the many experimental dives in this series, one used an isobaric mix switch. That dive was performed in a chamber to a depth of 130 fsw for 120 minutes, used seven human subjects, switched from oxygen /helium (40/60) to oxygen / argon (40/60) after seventy minutes, and used oxygen for the final portion of the decompression.



In 1975, Bühlmann described the theoretical benefits of Isobaric Mix Switching in an identical dive profile that substituted nitrogen for argon in the second mix. These experimental and theoretical dive profiles demonstrated a major decompression advantage over conventional methods, but are impractical for open-water diving because they far exceed tech diving oxygen exposure limits.

Try this at sea.

Divers from the NOAA Undersea Research Center performed four 60-minute test dives using Benthic Mix Switching at the Speigel Grove off Key Largo in 130 fsw in December of 2003. They used side-mounted heliox (27/73) cylinders as they would a travel tank breathing it from the surface to the bottom until they reached the optimum switch time, in this case about twenty minutes. Three of the four divers experienced a rather pleasant, transient, enhanced narcotic effect — a nice legal buzz. The divers then swam along the bottom entirely around the wreck, collecting enough equipment to start a small dive shop, and ended the dive at one hour. Decompression was done using VR3s and matched the theoretical reduction in total stop times expected. Since that time, divers from NURC/UNCW have used the technique for servicing instrumented trawl-proof cages and moorings in 130 – 140 fsw off North Carolina with significant reductions in decompression time for square dives, and huge reductions on multilevel dives.

Figure 3. Reduction in Total Stop Time in Minutes Using Benthic Mix Switching with oxygen decompression compared to Nitrox with oxygen decompression.

Reduction in Total Stop Time Using BMX

Depth fsw	Bottom Time (minutes)							
	50	60	70	80	90	100	110	120
100 fsw	4	6	7	9	9	11	15	25
110 fsw	5	6	7	9	12	19	33	37
120 fsw	6	7	10	14	22	31	32	44
130 fsw	9	12	14	18	34	33	68	66
140 fsw	11	17	20	35	34	53	65	-
150 fsw	18	20	27	33	60	54	-	-

How much stop time does it save?

Benthic Mix Switching typically reduces total decompression time by 30%-40%. As Figure 3 shows, the greater the exposure, the greater the savings in time. Figure 4 compares the total stop times for 130 fsw dives for various bottom times using nitrox with oxygen decompression and Benthic Mix Switching using oxygen decompression.

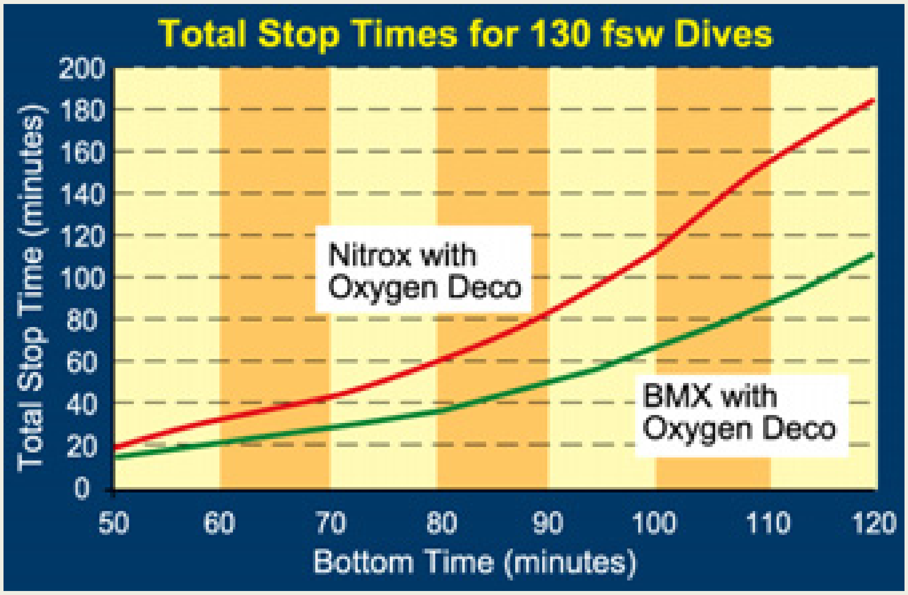
.

Any downside?

Benthic Mix Switching is only useful for long dives in the deep nitrox range. BMX requires technical diving equipment and techniques, rebreathers, or surface-supplied gear. The diver must be qualified on the mix and the equipment used. Helium is expensive, but then so are all the steps that bring one to this type of diving.

Some researchers suggest that divers may be susceptible to inner ear decompression sickness due to counterdiffusion when using switches from helium to nitrogen-rich mixes even without decompression (Doolette and Mitchell, 2003).

Figure 4. Comparison of Total Stop Times for a 130 fsw dive for various bottom times using Nitrox with oxygen deco and BMX with oxygen decompression.



On the plus side...

Benthic Mix Switching uses standard technical diving equipment and techniques. BMX calculations can be done using any mixed gas decompression program, and the dive can be controlled with any programmable mixed gas diving computer. The diver need not use the rule of thirds with the heliox since switching back to this mix would be a bad idea. We sent our spend heliox cylinders to the surface.

Benthic Mix Switching optimizes the bottom time/decompression time equation. You may use BMX to increase bottom time for a given total decompression time or reduce decompression for a given bottom time. BMX improves dive efficiency in two ways: first it reduces decompression time, and second, because deco time is shorter, it allows higher partial pressures of oxygen in the bottom mix.

Practical Matters

Oxygen toxicity is the biggest single factor in planning this type of dive. Some dives were only possible with this technique, because it reduced decompression enough to allow the dive to be within O2 limits. We used a 27/73 mix for our dives to simplify things. We ordered the heliox in K bottles from a commercial vendor and mixed the nitrox to match it. This mix, while not the optimal mix for all dives, was good over a range of depths and provided a safety margin with regard to oxygen toxicity during working dives.

Benthic Mix Switching is not a panacea. It is simply another tool in our bag of tricks that enables us to reduce decompression for long dives in the deep nitrox range. It worked well for servicing moorings where we knew the depth and needed more time. It should be really useful for divers using rebreathers and surface supplied gear where extended dives with open circuit gear are impractical.

In addition to the momentary buzz from the switch, it's a novel experience to see the total "Time-To-Surface" on my VR3 dive computer go <u>down</u> as I continue my dive, showing that I am off-gassing without decompressing!

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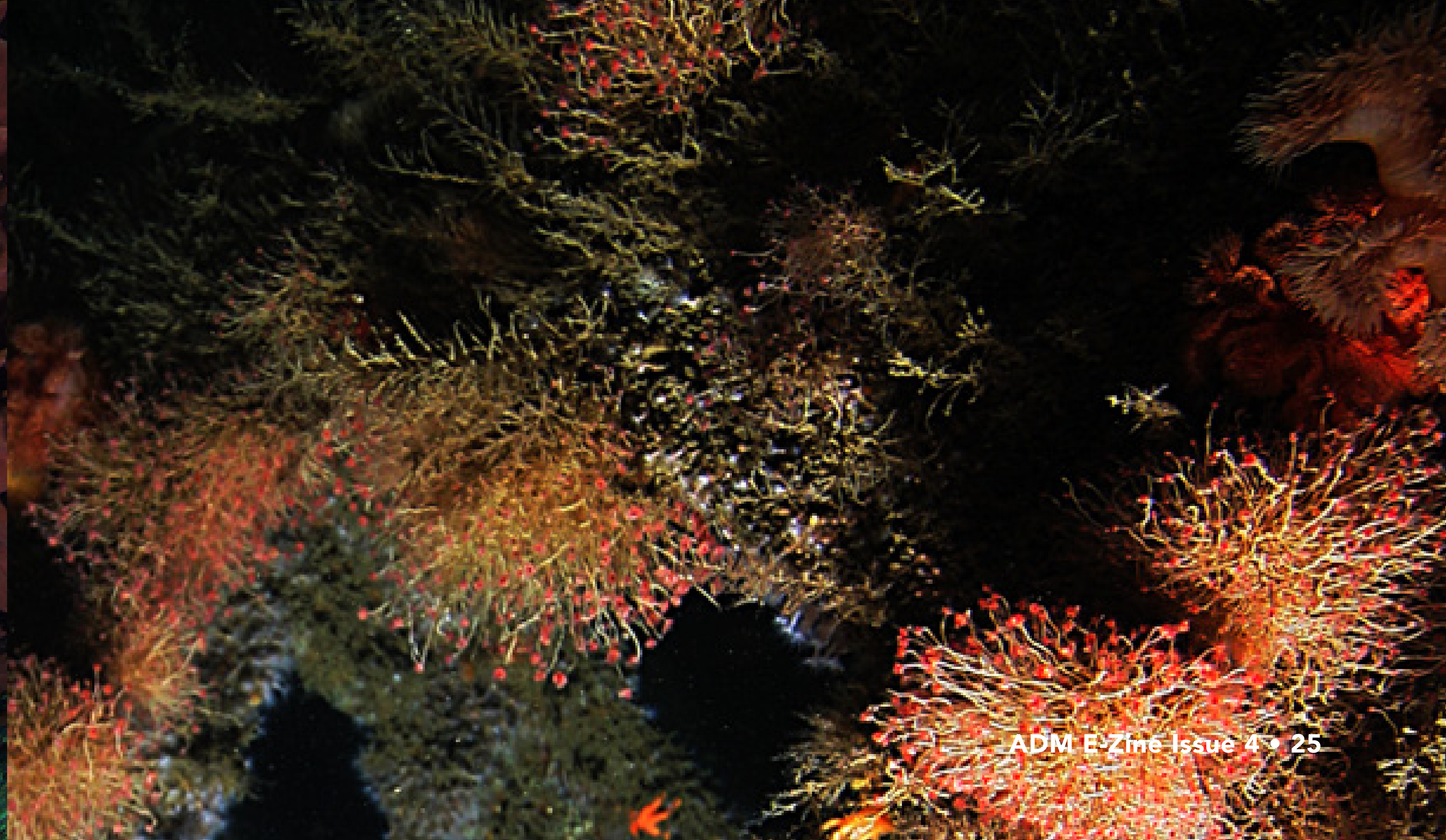
Tightrope Walker
World War II's Last Mystery

By Jeff Toorish
Photos by Jeff Toorish and Rick Marshall

> **"I must confess that my imagination refuses to see any sort of submarine doing anything but suffocating its crew and floundering at sea."**
>
> **– H.G. Wells**

Submarines are, by their very nature and purpose, mysterious. Their mission is to quickly and silently glide to their target, unleash their devastating weapons, and then simply disappear. But the mysteries of U-853 are deeper, deeper even than the 130 feet of cold, dark water that forms her military graveyard off Block Island, Rhode Island.

What we do know is that *Unterseeboot* 853 is the last German U-boat sunk in a naval battle off the coast of the US.



War Almost Over

At around 5:00 PM on May 5, 1945, the U-853 sealed her own fate when her young commanding officer, *Kapitanleutnant* Helmut Fromsdorf, ordered her crew to torpedo the S.S. *Black Point*, a freighter heading to Boston with a load of coal. Fromsdorf was known as a supremely confident commanding officer. He had brazenly operated his boat undetected off the northeastern coast of the United States since February of that year. A day before U-853's attack on the *Black Point*, the German High Command issued a cease hostilities order to all U-boat commanders. Admiral Karl Doenitz of the German navy had replaced Adolf Hitler as acting Fuhrer after Hitler committed suicide. Adm. Doenitz is quoted as telling Nazi forces, "The struggle against the Western Powers has become senseless." A deep part of the U-853 mystery is whether *Kapitanleutnant* Fromsdorf received the order and ignored it, or simply never received it.

Fromsdorf carefully sights his target through a periscope. With deadly accuracy, the torpedo from U-853 rocketed through the cold Atlantic water and struck the *Black Point* in the stern section. A 40-foot piece of the *Black Point*'s stern was blown into the sea. No one on the *Black Point* saw the torpedo coming; no precautions were taken. The commanding officer of the freighter, Charles Prior, had cancelled lookout watches in the tragic belief that hostilities had ended, and his ship was in protected waters.

Twelve of the 46 crewmembers aboard the *Black Point* died in the attack. The ship sank in minutes to a depth of 95 feet; however, the victory would prove hollow for Fromsdorf and his crew. A shallow water attack is extremely risky for a submarine. The U-853 essentially had no place to run after sinking the *Black Point*. Standard tactics call for the sub to unleash torpedoes, verify the kill, and then "go deep" to avoid detection. That option was fatefully not open to U-853.

The *Kaman*, a nearby freighter, registered under the flag of Yugoslavia, radioed the U.S. Coast Guard about the attack. Coast Guard and Navy warships quickly assembled and started hunting the submarine visually and with sonar. Eventually, two blimps offering air support would join them.

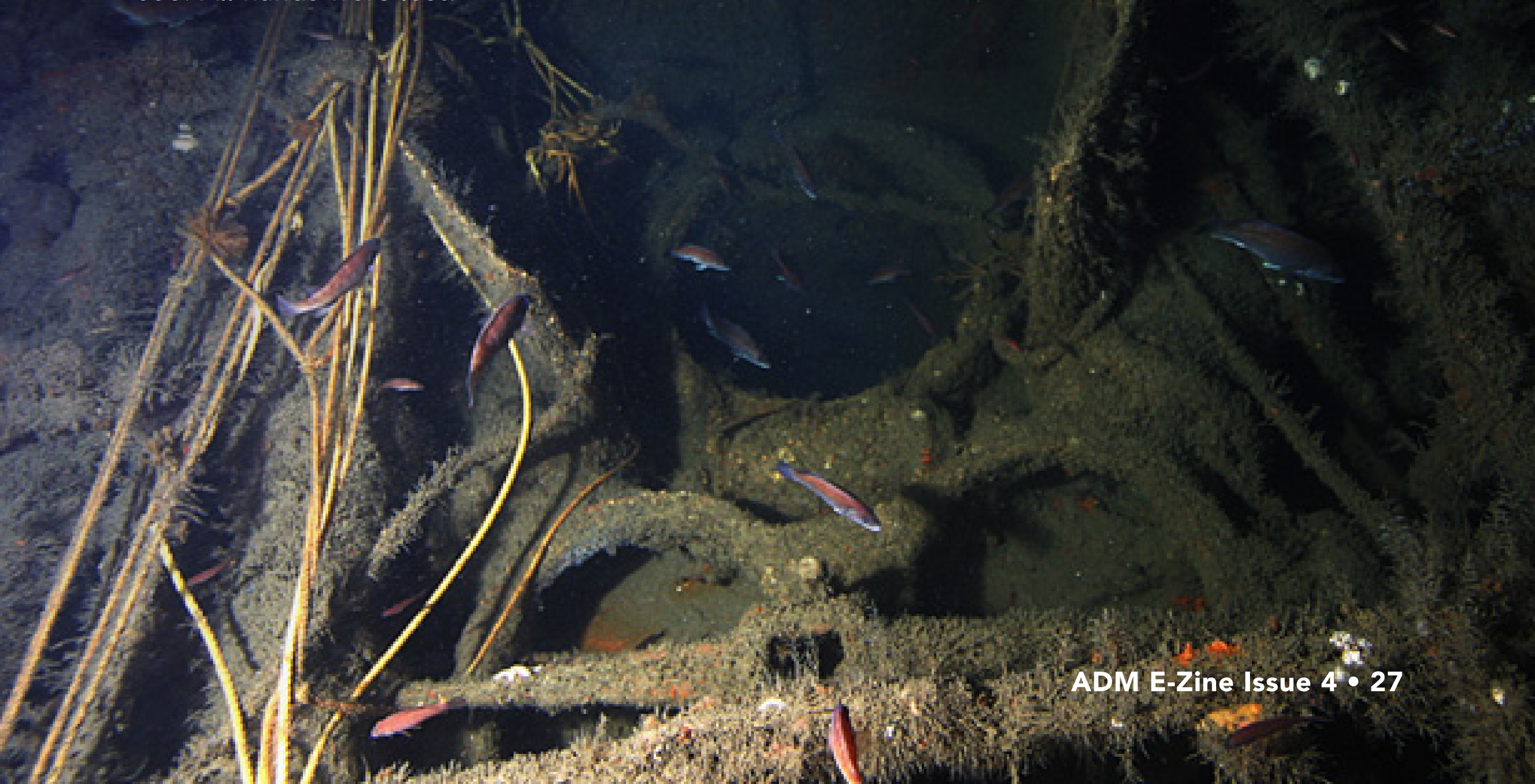
The submarine was in shallow water and had nowhere to go. Fromsdorf tried to hide in nearby shallows, but when the USS *Moberly* and USS *Atherton* arrived with their complements of depth charges, a horrific night battle ensued. The warships relentlessly pounded the submarine. By morning, mortally wounded, the U-853 sank about six miles off the coast of Block Island. Reports at the time cited sailors seeing the white hat of the captain floating on the surface near a large oil slick, the hallmark of a sunken submarine. The next day a Navy hard-hat diver descended into the murky waters and confirmed the destruction of U-853. All hands were lost.

The *Unterseeboot* 853's prospects had been different just a couple of weeks earlier when her crew had defended itself against three attacking aircraft, damaging one so badly it was jettisoned after returning to its ship. This is a remarkable feat for a submarine that is the natural prey of aircraft. *Kapitanleutnant* Fromsdorf had earned the respect of his crew who had nicknamed U-853 *der Seiltänzer* ("the Tightrope Walker").

Rumors Abound

Tightrope Walker has been rumored to have been Hitler's private escape submarine as well as reputed to have carried an immense treasure of silver and gold. The submarine itself was designed to run mostly on the surface. She had significant limitations while submerged.

U-853 employed a *schnorkel* layout, type IXC, which gives the boat its design. The *schnorkel* was invented by the Dutch. The German navy co-opted the design after invading Netherlands in May of 1940. Earlier submarines had to run on batteries while submerged, their diesel engines turned off. The older subs spent much of their time on the surface, running their engine to recharge batteries. This created a significant vulnerability.

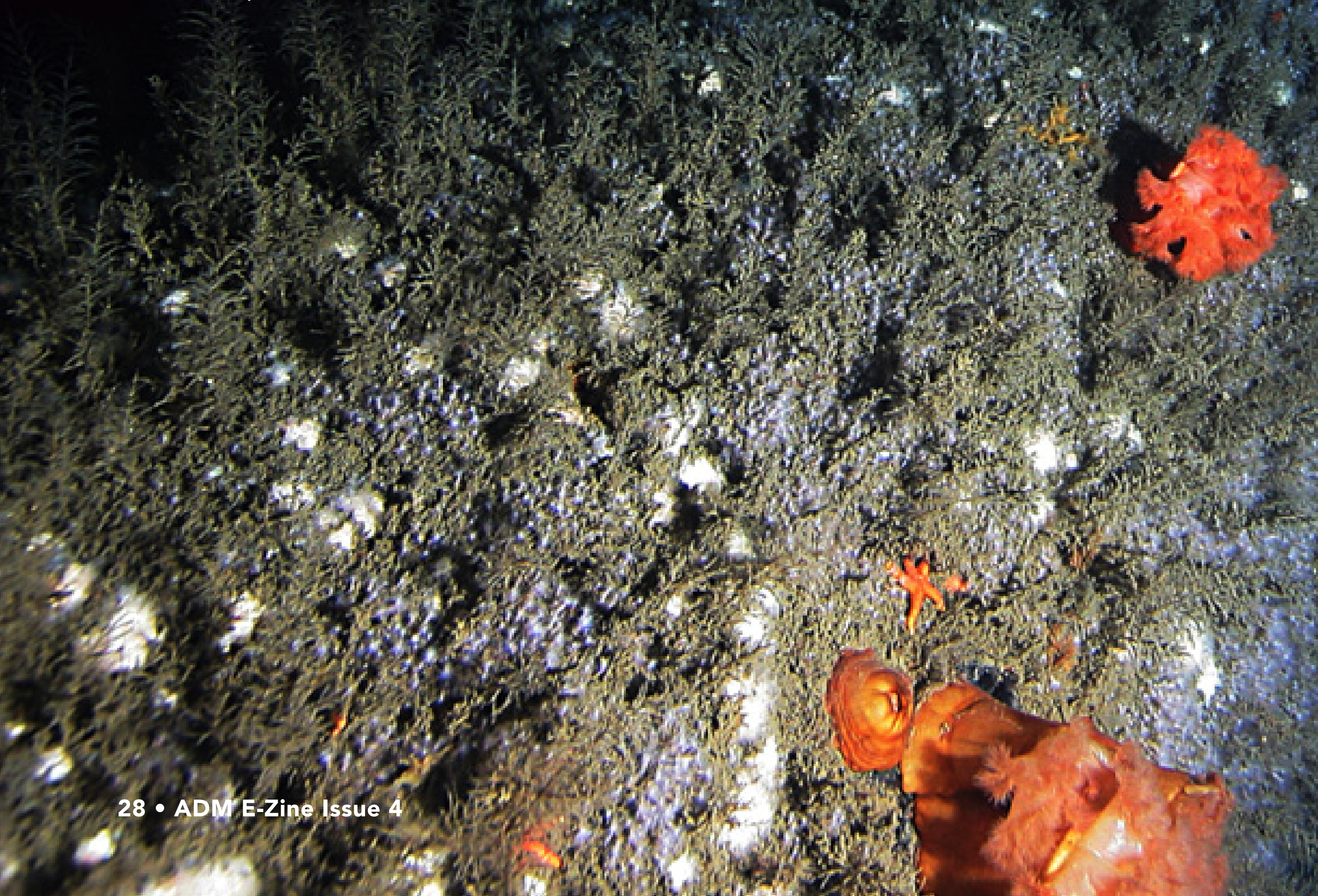


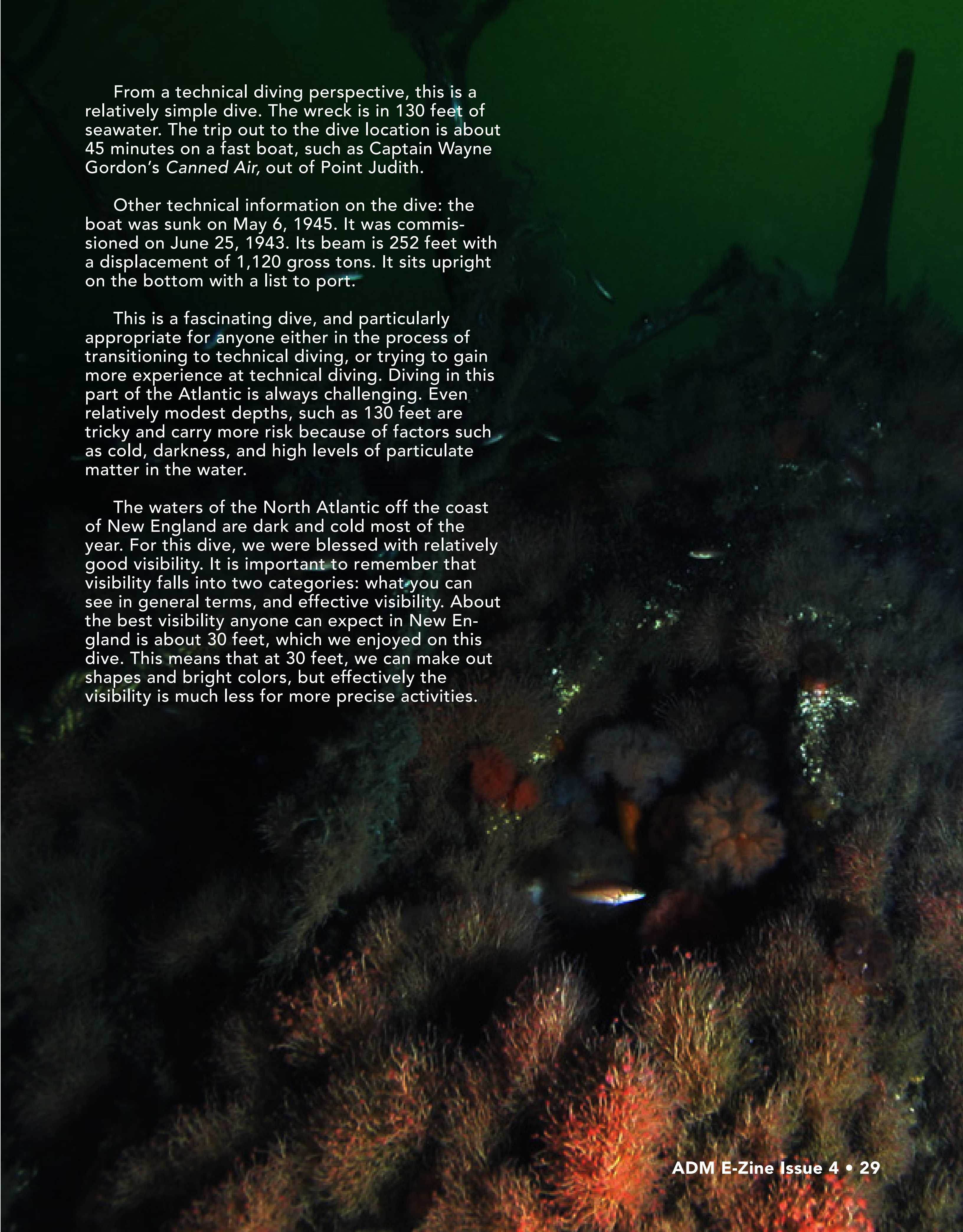
The *schnorkel* was a provocative design that allowed the submarine to operate its diesel while remaining at periscope depth. This, in turn, gave U-853 nearly unlimited underwater range. But the *schnorkel* design had significant drawbacks. The boat was limited to about six knots while submerged. Because the diesel was running constantly, the boat was also nearly deaf, increasing its vulnerability. The constantly running diesel engine also presented another problem: with the boat nearly always submerged, the engine had to suck air from inside the hull. While the *schnorkel* provided plenty of air, the constant suction caused ear problems for the crew.

There were also other problems associated with a boat that runs underwater nearly all the time. For example, the accumulated garbage could not be easily dumped, leading to obvious safety and health concerns. Crew morale was also problematic for men who often did not see the sun for long periods of time. While U-boat crews were often hand-picked for their loyalty to the Reich, basic human nature also comes into play.

Diving the U-853 Today

New England weather is unpredictable, and this dive to the *Tightrope Walker* had been postponed five times because of storms. Apparently, the sixth time was the charm; and, on a beautiful spring day in May, a team of divers headed out from Point Judith to the U-853. The diving team for this trip included team leader Rick Marshall, Roup Baker, Tony Fiore, Deb Greenhalgh, Jerry Wilkens, Joe Romeiro, and Armando Hernandez. Marshall and I would be diving Classic KISS rebreathers, the other divers were diving various single and double configurations. The only mishap of the trip occurred when a small fish called a cunner attached itself to Baker's upper lip. The water temperature was a balmy 47 degrees Fahrenheit, and drysuits made for a comfortable dive.





From a technical diving perspective, this is a relatively simple dive. The wreck is in 130 feet of seawater. The trip out to the dive location is about 45 minutes on a fast boat, such as Captain Wayne Gordon's *Canned Air,* out of Point Judith.

Other technical information on the dive: the boat was sunk on May 6, 1945. It was commissioned on June 25, 1943. Its beam is 252 feet with a displacement of 1,120 gross tons. It sits upright on the bottom with a list to port.

This is a fascinating dive, and particularly appropriate for anyone either in the process of transitioning to technical diving, or trying to gain more experience at technical diving. Diving in this part of the Atlantic is always challenging. Even relatively modest depths, such as 130 feet are tricky and carry more risk because of factors such as cold, darkness, and high levels of particulate matter in the water.

The waters of the North Atlantic off the coast of New England are dark and cold most of the year. For this dive, we were blessed with relatively good visibility. It is important to remember that visibility falls into two categories: what you can see in general terms, and effective visibility. About the best visibility anyone can expect in New England is about 30 feet, which we enjoyed on this dive. This means that at 30 feet, we can make out shapes and bright colors, but effectively the visibility is much less for more precise activities.

The U-853 sits upright, leaning slightly to the left. The conning tower is intact and offers a solid perspective of the boat. The boat's torpedo tubes are visible, as are the mounting brackets for extra diesel fuel. Off the starboard side are a navy anchor and other wreckage, but they are normally impossible to see from the wreck of the U-853 itself.

Like many military wrecks, this boat is rich in history and lore. But this boat offers something more than a link to our naval past; it raises questions the answers to which will most likely forever be obscured by the waves of time. If war is Hell, then dying either by mistake or intention after a war has effectively ended must be one of the lowest circles in Hades. That is the fate of the brave sailors of the U-853 who walked the final tightrope on May 6, 1945.

Jeff Toorish is the Chief Photojournalist for Advanced Diver Magazine and ADM E-zine. He lives in North Yarmouth, Maine.

Special thanks to the U.S. Navy War College in Newport, Rhode Island.

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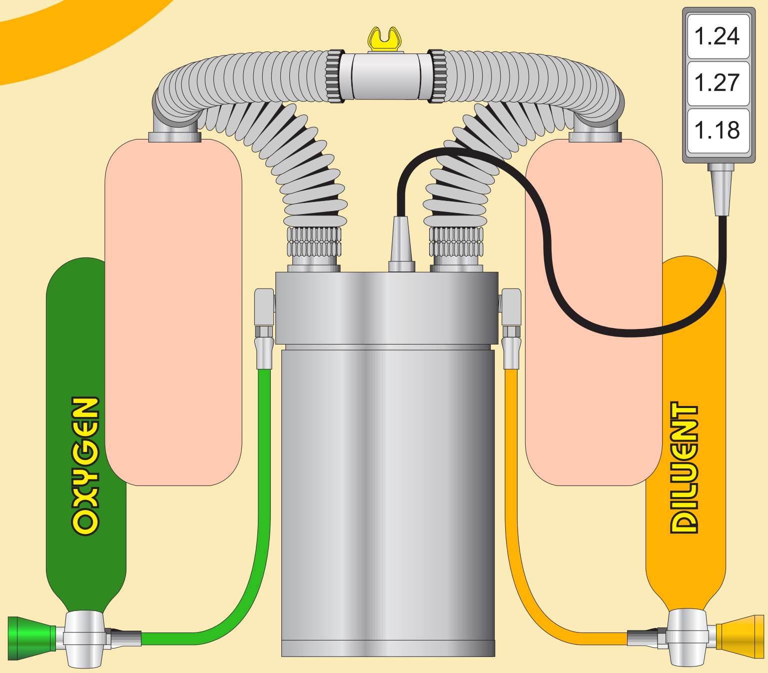
CCR Configuration & Bailout

By Curt Bowen

Rebreathers come in all different sizes, shapes, and even colors; but, if you were to break them down into the most basic components, they all contain the same fundamental parts. The difference between rebreather models is the manufacturer's design, and how they have chosen to place these basic parts into their CCR configuration. Other features are merely the bells and whistles added to the manufacturer's package to complete the same basic tasks of simply adding desired amounts of oxygen, scrubbing out unwanted carbon dioxide, and monitoring gas partial pressures within the system.

The new rebreather diver researches the different models and manufacturers and purchases the unit he/she feels best suits the type of diving that is anticipated. As most CCR divers gain experience, become comfortable, and move on to more and more demanding dives, the standard rebreather often ceases to provide the diver with the best configuration for the increased dive exposure.

This editorial is designed to enlighten those divers who have reached this critical stage of rebreather diving, and provide some alternative CCR configuration ideas which may better fit these extended or remote rebreather exposures.



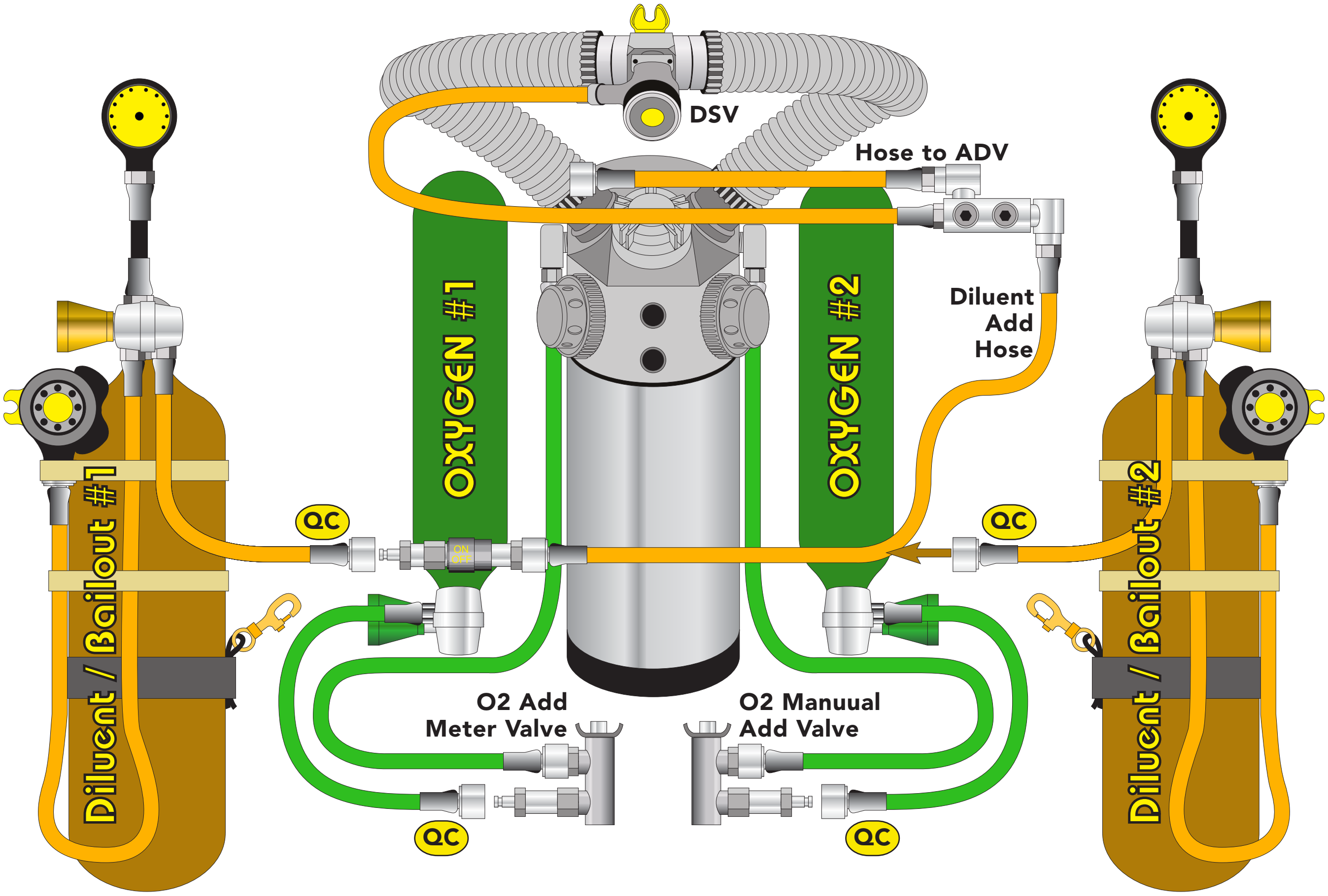
BASIC CCR CONFIGURATION

The above drawing illustrates the most basic rebreather design containing only the simplest parts that all rebreathers are designed from.

- Scrubber container
- Expandable breathing bags
- Continuous Loop
- Mouthpiece
- Oxygen add
- Diluent add
- PPO2 monitoring system

Exploration CCR

Back Mounted Counterlungs

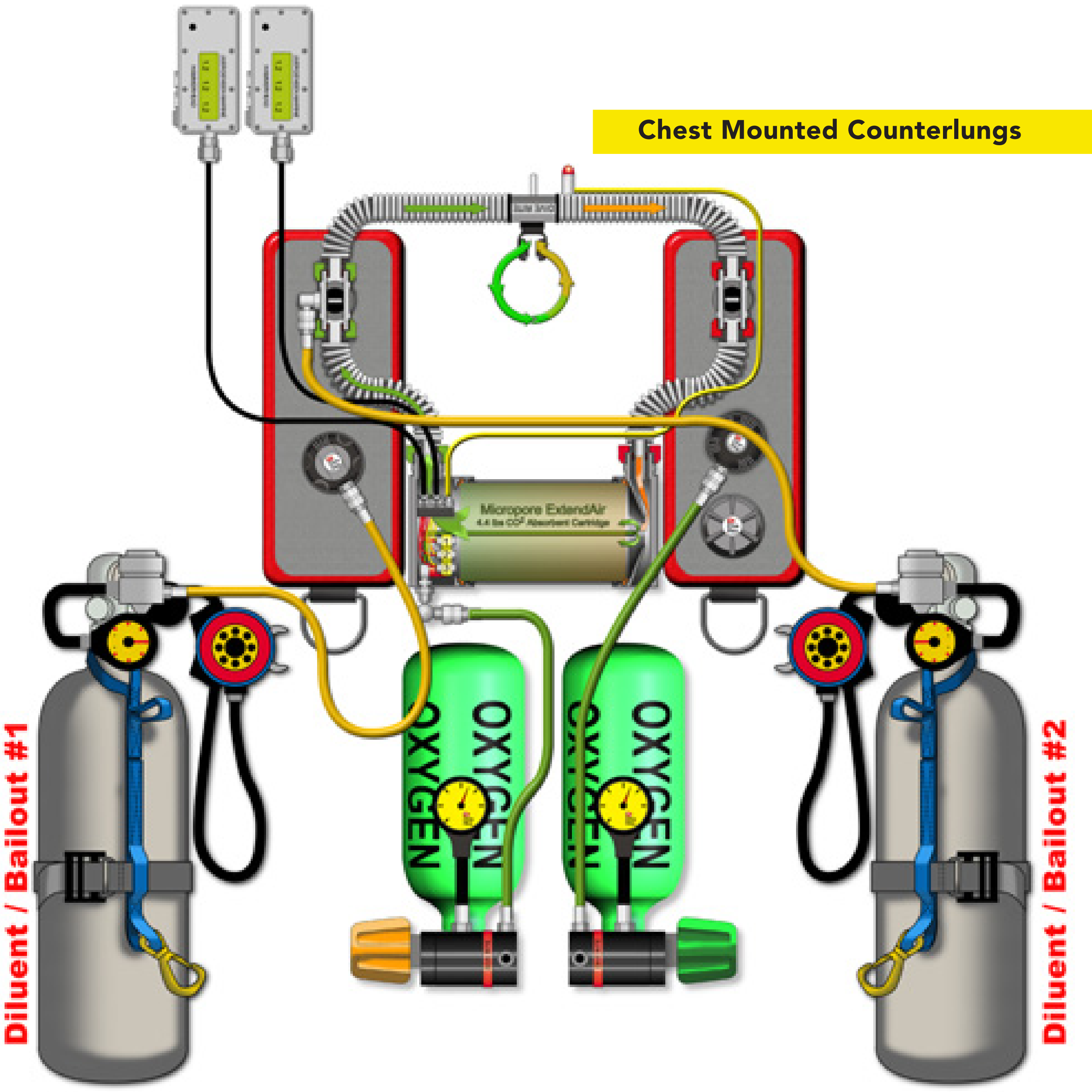


Exploration CCR

The exploration CCR is configured to allow the technical explorer the full possibilities of extreme depths and long dive durations that the rebreather is designed to provide.

Oxygen: One main ingredient that is needed to make a closed circuit rebreather work is oxygen. Without it, the advantages of maintaining a constant PPO2 to maximize bottom time and minimize decompression times are lost. On a standard rebreather configuration, an oxygen and diluent cylinder normally ranging between 13 and 18 cubic feet each are attached to the unit. At extreme depths or lengthy cave / wreck penetrations, this small amount of diluent is essentially worthless in an emergency. On the exploration CCR, the small diluent cylinder is replaced by a second oxygen cylinder that is connected into the loop via a totally separate port than the main oxygen addition valve. This doubles the amount of oxygen carried during a dive, and adds a totally redundant oxygen addition method into the rebreather loop. Additional oxygen from off-board stages can be connected easily into the expedition unit at any time through quick-connect ports.

Diluent: If a failure should occur at any point during a dive, the diver is required to either switch to a semi-closed mode or, in worst-case scenarios, to open circuit. If the diver has planned his/her diluent correctly by selecting a gas mix containing the optimal oxygen percentage at the planned depth, semi-closed mode will slightly increase the decompression obligations. The main problem with switching to open circuit is the amount of gas required to return safely to the surface along with the heavily increased decompression obligations that will result from losing the optimal PPO2. *(See CCR bailout table example on page 38.)*

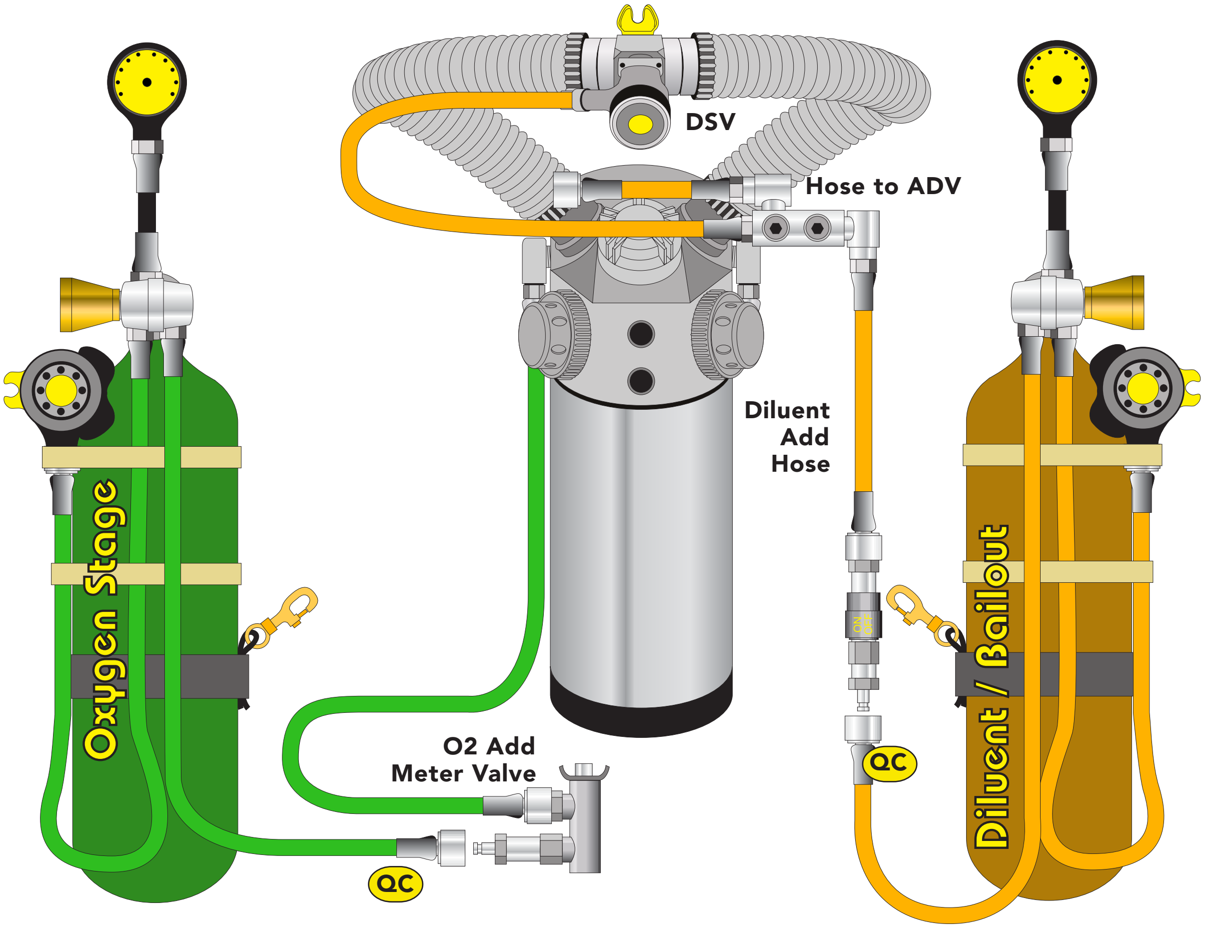


The main difference between the two illustrations above is the location of the rebreather's counter lungs. The KISS Classic illustration on the left has back-mounted counter lungs while the Dive Rite O2ptima contains chest-mounted counter lungs. On the KISS Classic unit, the diver is required to install some extra hoses and fittings to add the second oxygen cylinder and a simple quick-connect hose attached to the rebreather's gas manifold block for off-board diluent addition. On the O2ptima (as on most chest-mounted counter lung rebreathers), the manufacturer has already added manual oxygen and diluent quick-connect ports onto the chest-mounted counter lungs making adding off-board gas simple. Both front- and back-mounted counter lung units work equally well; the only difference is the diver's preference for the counter lung location.

With the rising airline weight restrictions and added baggage fees, traveling with anything more than your underwear has become exceptionally expensive — let alone attempting to pack in a rebreather, dive equipment, and rebreather cylinders with valves.

Like mountain climbers, traveling rebreather divers are required to cut out every pound possible from their baggage in order to just get the basics to the final destination.

Expedition Travel CCR



Typically, the locations we are traveling to have some type of scuba cylinders, be it actual rebreather bottles or, more commonly, 80 cubic foot aluminums. The simplest method to reduce weight in checked baggage is to forego flying with rebreather cylinders, and just use whatever cylinders you can locate at your destination.

Expedition Travel CCR

We have termed this rebreather configuration as the expedition travel CCR.

The drawing above illustrates how simple it is to convert a KISS Classic into an expedition travel CCR by simply adding a quick-connect onto the oxygen add valve and a quick-connect hose onto the gas block. (See bottom two images on right page.) Whatever size cylinders have been attained are simply quick-connected into the rebreather and side-mounted during the dive.

Chest-mounted counter lung rebreathers such as the Megalodon, CopisMeg, Evolution, and O2ptima are simply converted by adding an oxygen quick-connect to the solenoid injection, and quick-connect into the automatic diluent add valve (ADV). (See top two images on right page.)

One of the other major advantages of the expedition travel CCR is the reduced weight of transporting the unit while at the dive location. Lugging a heavy, equipment-laden rebreather with attached tanks and weights from trucks, onto docks, into rocking boats, or, God forbid, over rocky terrain is extremely difficult and can cause injury.

The expedition travel CCR can be carried easily in one hand or over a shoulder, and handed off without difficulty onto a rocking boat — even without the assistance of two strong men and a boy.


KISS


KISS

CCR Bailout

As stated previously, closed circuit rebreathers are designed to provide the diver with the optimal breathing partial pressure of oxygen continuously throughout the dive. This minimizes decompression requirements, and maximizes breathing gas conservation.

Another very important factor that most rebreather divers seem to overlook is the heating advantages of closed circuit diving. The warm moist air from exhalation travels through the rebreather and is warmed even more by the natural heating reaction of the CO2 absorbent material. The diver inhales this heated gas throughout the dive, providing a massive heating advantage that closed circuit cannot.

Without a doubt, rebreathers have bridged the gap into new exploration possibilities that open circuit diving only dreamed of. But with the good can sometimes come the bad.

Equipment Failure

Due to the complexity of many manufactured rebreathers, equipment failure is a high possibility. Depending on what part of the rebreather fails, the diver normally has a list of emergency procedures to fall back on. In most instances, the failure can be managed and the diver can remain on closed circuit for the exit. The next option the CCR diver can fall back on is called semi-closed mode. This is a procedure where the diver can maintain loop integrity by exhaling a percentage of the loop gas into the water and replacing it with fresh open circuit gas. Even though this does not maintain optimal oxygen partial pressures, it does conserve large amounts of gas that would be wasted if the diver had gone completely to open circuit. The last and least desired emergency procedure is for the diver to come completely off the rebreather and go onto 100% open circuit. This procedure loses all the advantages of maximizing decompression, gas conservation, and, in many cases, the critical thermal protection.

The following tables illustrate the increased decompression obligations incurred should a diver be required to bailout onto open circuit from a serious rebreather dive.

CCR Bailout Comparison Table #1
CCR Dive to 180 fsw for 45 minutes at 1.2 (ppO_2)

180 fsw - 45 Minutes

Decompression Stop Depths (fsw)	NO Bailout	Bailout Tx10/50	Bailout Tx10/50 Ean50%	Bailout Tx10/50 Ean50% 100% O2	Bailout Ean50%
	No Bailout Required	Bailout to Tx10/50 Only	Bailout to Tx10/50 and Ean50%	Bailout to Tx10/50, Ean50%, 100% Oxygen	Bailout to Ean50% Only WARNING High PPO2
	min	min	min	min	min
180’	45.0	45.0	45 .0	45.0	45.0
130’	-	-	1.5	1.5	1.5
120’	-	0.5	1.5	1.5	1.5
110’	-	1.5	3.0	3.0	1.5
100’	0.5	2.5	4.0	4.0	1.5
90’	1.5	3.0	4.0	4.0	1.5
80’	2.0	3.5	7.0	6.5	1.5
70’	2.0	6.5	2.5	2.5	2.5
60’	3.5	7.5	3.0	3.0	3.0
50’	4.0	8.5	4.5	4.5	3.0
40’	4.0	15.0	7.5	7.5	5.0
30’	7.0	18.5	8.5	6.5	8.5
20’	8.5	29.0	14.5	11.5	10.5
10’	11.0	43.0	21.5	17.0	18.0
Total Deco (min)	44	139	83	73	65
Total Dive (min)	89	184	128	118	110
CNS	45%	15%	29%	23%	88%
OTU	117	51	66	103	102
Bailout Gas Required (cuft)		217	156	144	93

Table 1

Table 1 illustrates a closed circuit rebreather dive to 180 feet, maintaining a constant PPO2 of 1.2 for a bottom time of 45 minutes. The left khaki green column calculates the total decompression requirements if the rebreather continued to work properly for a decompression time of 44 minutes, CNS of 45%, OTU of 117, and a total dive time of 89 minutes.

The next column to the right, “Bailout TX 10/50,” calculates the increased decompression requirement if the CCR diver is required to bailout to a trimix of 10%O2/50%HE/40%N2 only. Most likely, if the diver had planned his/her emergency gas procedures properly, this would never happen — unless he/she were planning team bailout and had become separated from the team diver carrying the needed nitrox or oxygen cylinder. Note that the decompression obligation tripled from 44 to 139 minutes. The CNS and OTUs dropped because of the lack of higher oxygen percentages, and the required open circuit gas supply skyrocketed to over 200 cubic feet.

The third column, “Bailout Tx10/50 & Ean50%,” calculates the increased decompression requirement if the CCR diver should be required to bailout to a trimix of 10%O2/50%HE/40%N2 and a 50% nitrox mix. Note the decompression obligation almost doubled from 44 to 83 minutes. The CNS and OTUs rose slightly while the open circuit gas supply still remained high at 156 cubic feet.

The fourth column, "Bailout Tx10/50, Ean50% & 100%O2," calculates the increased decompression requirement if the CCR diver should be required to bailout to a trimix of 10%O2/50%HE/40%N2, a 50% nitrox mix and 100% oxygen. Note the decompression obligation increased from 44 to 73 minutes. The CNS and OTUs rose slightly while the open circuit gas supply still remained high at 141 cubic feet.

The last column in pink, "Bailout Ean50%," illustrates the same dive if the diver were to bailout onto Ean50% only. Note the decompression time was reduced from the "Tx10/50, Ean50% & 100%O2" table, but a high partial pressure of oxygen warning occurred which could increase the risk of oxygen toxicity resulting in possible convulsions underwater.

Table 2

Table 2 illustrates a closed circuit rebreather dive to 250 feet, maintaining a constant PPO2 of 1.2 for a bottom time of 25 minutes. The columns depict the same gas decompression mixtures as Table 1, illustrating the extreme increase of decompression obligations should the diver be forced to switch onto open circuit. Note the decompression time obligation increases from 45 minutes to 153, 89, and 80 minutes.

CCR Bailout Comparison Table #2
CCR Dive to 250 fsw for 25 minutes at 1.2 (ppO_2)

250 fsw - 25 Minutes

Decompression Stop Depths (fsw)	NO Bailout (No Bailout Required) min	Bailout Tx10/50 (Bailout to Tx10/50 Only) min	Bailout Tx10/50 Ean50% (Bailout to Tx10/50 and Ean50%) min	Bailout Tx10/50 Ean50% 100% O2 (Bailout to Tx10/50, Ean50%, 100% Oxygen) min
250'	25.0	25.0	25 .0	25.0
190'	-	-	0.5	0.5
180'	-	0.5	0.5	0.5
170'	-	0.5	0.5	1.0
160'	-	1.0	1.0	1.5
150'	0.5	1.0	1.5	1.5
140'	0.5	1.5	1.5	1.5
130'	1.0	1.5	2.5	2.5
120'	1.0	2.5	3.5	3.5
110'	1.5	3.0	3.5	3.5
100'	1.5	3.5	4.0	3.5
90'	2.0	3.5	4.5	4.5
80'	2.0	5.5	7.0	7.5
70'	2.0	7.5	2.5	2.5
60'	4.0	8.0	3.0	3.0
50'	4.0	8.5	4.5	4.5
40'	4.0	16.5	7.0	7.0
30'	5.0	18.5	8.5	6.5
20'	8.0	29.0	13.5	10.5
10'	8.5	41.0	19.0	15.0
Total Deco (min)	45.5	153	88.5	80.5
Total Dive (min)	70.5	178	113.5	105.5
CNS	0.35	0.11	0.23	0.64
OTU	93	35	68	105
Bailout Gas Required (cuft)		279	286	194

Table 3

Table 3 illustrates an extreme closed circuit rebreather dive to 350 feet, maintaining a constant PPO2 of 1.2 for a bottom time of 15 minutes. The columns depict the same gas decompression mixtures as Table 1, illustrating the extreme increase of decompression obligations should the diver be forced to switch onto open circuit. Note the decompression time obligation increases from 51 minutes to 197, 109, and 100 minutes. The open circuit gas supply requirements basically become unmanageable.

CCR Bailout Comparison Table #3
CCR Dive to 350 fsw for 15 minutes at 1.2 (ppO_2)

350 fsw - 15 Minutes

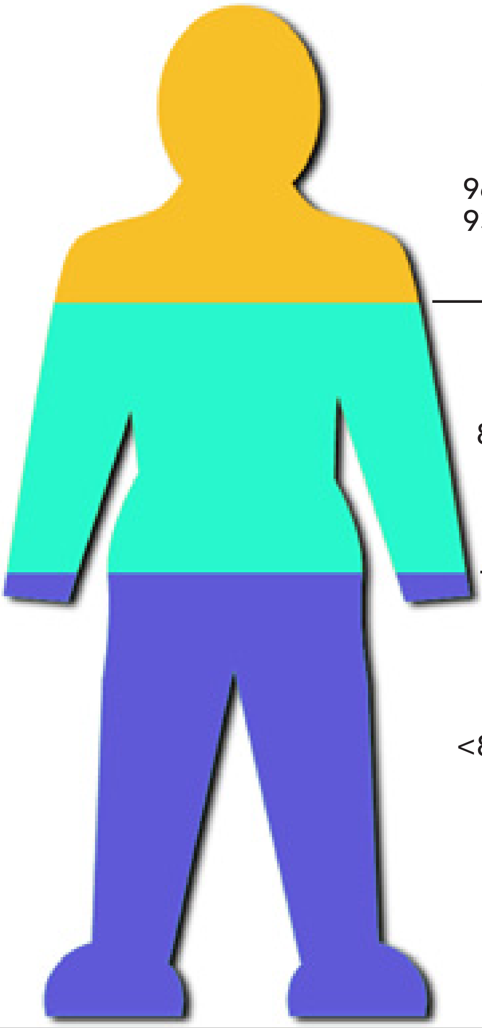
Decompression Stop Depths (fsw)	NO Bailout (No Bailout Required) min	Bailout Tx10/50 (Bailout to Tx10/50 Only) min	Bailout Tx10/50 Ean50% (Bailout to Tx10/50 and Ean50%) min	Bailout Tx10/50 Ean50% 100% O2 (Bailout to Tx10/50, Ean50%, 100% Oxygen) min
350'	15.0	15.0	15 .0	15.0
260'	-	0.5	0.5	0.5
250'	-	0.5	0.5	0.5
240'	-	0.5	0.5	0.5
230'	-	0.5	0.5	0.5
220'	-	1.0	0.5	0.5
210'	0.5	1.0	1.5	1.5
200'	0.5	1.5	1.5	1.5
190'	0.5	1.5	1.5	1.5
180'	0.5	1.5	1.5	1.5
170'	1.0	1.5	1.5	1.5
160'	1.0	2.0	1.5	1.5
150'	1.0	2.5	3.0	3.0
140'	1.0	3.0	3.0	3.0
130'	1.0	3.5	3.5	3.0
120'	1.5	3.5	3.5	3.5
110'	1.5	4.0	4.0	4.0
100'	2.5	5.5	5.0	5.5
90'	2.0	7.0	7.0	6.5
80'	2.0	7.5	7.5	7.5
70'	3.0	7.5	2.5	2.5
60'	3.5	11.0	4.0	4.0
50'	3.5	16.0	6.0	5.5
40'	4.0	17.0	7.0	7.0
30'	5.0	26.0	7.0	8.0
20'	7.5	30.0	14.0	11.0
10'	8.0	41.0	20.5	15.0
Total Deco (min)	51	197	109	100.5
Total Dive (min)	66	212	124	115.5
CNS	32%	9%	29%	76%
OTU	85	25	80	121
Bailout Gas Required (cuft)		444	308	293

Thermal Considerations

Reviewing the increased decompression obligation of the previous three tables clearly illustrates that even if it were possible to supply the increased open circuit gas quantities required, the increased extreme thermal exposures could become more than humanly possible to overcome. A CCR diver wearing a drysuit in 55 degree Fahrenheit water can easily maintain body heat for the simple exposure dive of 250 feet for 70 minutes. However, if the increased thermal advantages of the closed loop were lost, and decompression times were increased to over 170 minutes, it is doubtful any human could survive the added exposure.

The chart below illustrates the effect that cold has on humans.

Progression of Clinical Signs and Symptoms of Hypothermia



Core Body Temperature	Signs and Symptoms
Mild 96.8° F (36° C) 93.2° F (34° C)	• Increased Metabolic Rate • Maximum Shivering • Impared Judgment • Slurred Speech
Moderate 86° F (30° C)	• Respiratory Depression • Myocardial Irritability • Bradycardia • Atrial Fibrillation
Severe <86° F (<30° C)	• Basel Metabolic Rate - 50% • Loss of Deep Tendon Reflexes • Fixed Pupils • Spontaineous Ventricular Fibrillation

Golem Gear Dual CCR

Deep exploration diving on a rebreather eventually reaches a point where carrying adequate bailout becomes counterproductive. A person can not carry and stage enough OC bailout gas without help of a large support team.

An alternative solution might be carrying a completely redundant dual rebreather. This practice was successfully used in the past for extreme exploration dives – WKPP and Oliver Isler.

We have configured two Hammerhead CCRs into dual - completely redundant - rebreather setup not much bigger than a set of doubles.

Two stock Hammerhead CCRs are banded together using 7" SS twin bands and mounted on the wing/backplate kit the same way as a set of doubles would be. A 3L Oxygen bottle is attached on each side using standard Metalsub brackets. Each O2 tank is feeding one HH CCR solenoid and Manual Add Valve (MAV) on the exhalation counterlung.

The trick to keeping the whole kit relatively streamlined is use of the Backmounted Counterlungs (BMCLs) for one of the CCRs. This way the chest area is not overcrowded with counterlungs and profile is as low as possible.

The Omni swivel Manual Addition Valves for BMCLs are attached to the harness shoulder straps just below the chest D-rings for easy reach. Each MAV (O2 and Dil) has a high flow quick disconnect plumbed in to allow

attachment of appropriate gas sources. Either oxygen source can be used with either rebreather as does to diluent or stage gas source.

Two diluent bottles of varying sizes - AL80s to Steel 130s, depending on a mission - are carried in sidemount configuration attached to ArmadilloCCR kit. Each Diluent tank also feeds one of the BOVs. To reduce bulk in the breathing hoses, either of the BOVs can be reduced to a DSV with removal of the OC regulator and use of BOV blanking plate. Hammerhead vibrating heads up display (DIVA) is attached to each BOV. Each loop and corresponding handsets and DIVAs are color coded for easy identification underwater and during assembly.

The above described configuration provides diver with two completely independent closed circuit rebreathers with interchangeable gas sources and access to up to 260cuft+ of independent Open Circuit gas without any stages.

This configuration might be a viable alternative to carrying and staging only OC bailout gases, although the management of two independent loops is more difficult than swapping OC bailouts. Although dual rebreathers were successfully used for long range exploration in the past, this configuration must be viewed as purely experimental. There is not enough information on its reliability to recommend it for mainstream use.

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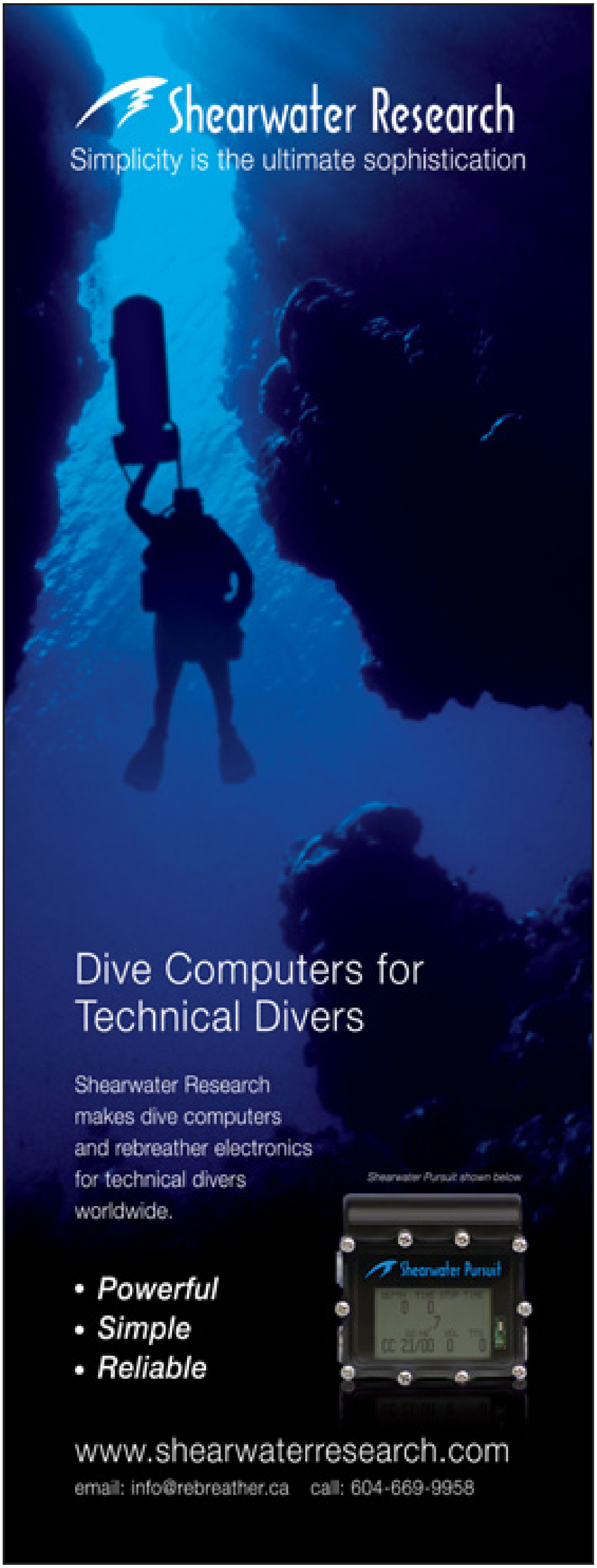

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TO BURN OR NOT TO BURN

HIGH OXYGEN MIXTURES

Photo by Curt Bowen

By: B.R. Wienke
C & C Dive Team Ldr
and
Tim O'Leary
Director, NAUI Technical Diving

The use of enriched oxygen breathing mixtures in recreational and technical diving is on the increase, and reports about oxygen combustion and explosions are documented. It is also commonly known that flammable materials are more easily ignited as oxygen concentration increases. It is also well known that many systems in the diving industry were designed for high pressure air flows (oxygen percentage below 21%), and that accidents have occured in such systems with higher concentrations of oxygen. In the recreational realm, concerns thus surface for nitrox diving, while in the technical realm, concerns center on all enriched mixtures of nitrogen and helium, plus the use of pure oxygen for decompression.

Before launching off into a detailed analysis of oxygen combustion, explosions, and related risks, some observations on enriched oxygen diving and equipment are interesting:

1. The safety record for nitrox diving with recreational scuba equipment is excellent, literally millions of dives without mishap;
2. The safety record for technical diving on enriched breathing mixtures, plus pure oxygen, is even more impressive than the recreational record;
3. When nitrox was introduced to recreational diving, it was greeted with much skepticism;
4. Enriched oxygen breathing mixtures and pure oxygen in the technical diving community has always been business as usual;
5. Nitrox, helitrox, and pure oxygen usage are advanced diver topics, and require special training and education;
6. Recommended training measures in mixed gas courses include verification that the equipment is suitable to exposures with high oxygen content, cleaning to remove combustible contaminants such as lint, oil residue, flammable dirt, and metal chips, and substitution of components and lubricants with oxygen compatible materials;
7. Across the board, training agencies permit interchangeable use of equipment for air and nitrox diving when oxygen fractions are below 40%;
8. Oxygen cleaning requirements for the USN and OSHA are also in effect for mixtures with more than 40% oxygen.

Oxygen doesn't burn itself, obviously, but chemical oxidation (by *O2*) is what causes fires and explosions. The higher the oxygen concentration, the higher will be material flammability and explosive risk. Many studies have established that common substances that do not burn in air will burn at higher pressures and oxygen concentrations. Included in this category are neoprene, silicone rubber, nitrile rubber, and nylon. Though the frequency of fires in systems with less than 40% oxygen is less than than those with 100% oxygen, incidents in the former case have been recorded in aluminum and carbon steel compressor blocks, aluminum filter towers, fill station panel valves and regulators, and continuous blending systems.

Bench Tests

Within the diving industry, systems with oxygen concentrations greater than 41% are treated as 100% oxygen regarding cleaning and oxygen service. Systems with 21% to 26% oxygen require no special cleaning. Between 40% and 25%, opinions and procedures vary widely. Most know that fires occur in 100% oxygen systems, but less known are fires in 46% oxygen systems, such as NASA's Neutral Buoyancy Laboratory (NBL). So a big question centers around the 25% to 40% oxygen concentrations and potential combustion risk. Many materials that are not flammable in air are flammable in 25% to 40% nitrox environments, as seen in Table 1 compiled by Forsyth and Durkin. Though the frequency of nitrox fires with oxygen fractions below 40% is far less than 100% pure oxygen, many have been reported. The most common occurrence is fill stations. Hyperbaric chambers are other sites experiencing fires at higher oxygen pressures, *ppO*2s.

From Table 1, PEEK, neoprene, PVC, silicon rubber, nitrile rubber, nylon, and EPDM may not support combustion in ambient air, but likely would in 40% oxygen mixtures. As pressure, *P*, increases up to a point, oxygen index (OI) generally decreases, so that some typical scuba materials like PTFE and PCTFE may become flammable. Fire hazards are real, even in systems with lower oxygen concentrations than 40%.

Table 1. Material Flammability And Oxygen Index (Fraction)

Material	Oxygen Index (%)
EPR	21%
EPDM	20 - 25%
nylon	21 - 38%
nitrile rubber	22%
silicone rubber	25 - 39%
PVC	31%
neoprene	32 - 35%
PEEK	35%
vespel	53 - 61%
viton FKM	56%
kel PCTFE	95 - 100%
teflon PTFE	95 - 100%

Both contaminant ignition and pneumatic impact bench studies have been conducted in scuba assemblies and breathing gas delivery systems by NASA for 50% and 100% oxygen systems. No ignitions occured during impact tests, though assembles contained gross amounts of particulates and hydrocarbons. Ignition studies were conducted in stainless steel tubes contaminated with hydrocarbon oil. Upon pneumatic impact, ignitions were observed in both 50% and 100% oxygen mixtures for concentrations as low as 10 *mg/ft*2, and drive pressures as low as 1000 *psi*. No ignitions were observed at drive pressures below 500 *psi*.

Ignition And Propagation Simulations

The question of oxygen combustion in high pressure flows is important in mixed gas diving. Reports of cylinder and regulator explosions with enriched and pure oxygen breathing mixtures abound. Using sophisticated 3D hydrodynamics codes with oxygen combustion chemistry embedded, it is also possible to quantify some explosion scenarios under high pressure pneumatic impacts of combustible particles (dirt). Mixed gas flows (variable oxygen fraction) down a short stopped tube can be analysed for variable volatile and nonvolatile particle densities in an impact region (stopped end with a small opening simulating the first stage seat of a regulator). Drive pressures were varied from 50 *psi* to 5000 *psi*, with dirt particle densities ranging from 5 *mg/ft*2 up to 300 *mg/ft*2, and oxygen fractions from 0.21 up 1.00 (air to pure oxygen). Some results are given in tables 2 - 4 to the right. The KIVA code of Amsden and Ramshaw was employed for numerical simulations, using the previous combustion equations.

Flow schemes are typical of impacted pneumatic gas hydrodynamics. At the stopped orifice, a slug of compressed gas is heated by both shock formation and inertial implosions (compressive and non-adiabatic). Dust is assumed to be metal, plastic, glass, grit, rubber, and fiber, with particle sizes ranging 5 *£gm* to 250 *£gm*. Plastic, fiber, rubber, and hydrocarbons are combustive. Reaction oxygen chemistry is assigned to the dust, and rapid heat conduction from the slug ignites assembly constituents.

1000 psi

Table 2. Drive Pressure 1000 *psi*

dirt (*mg/ft2*)	O^2 20%	O_2 40%	O_2 60%	O_2 80%	O_2 100%
50	💧	💧	💧	💧	💧
100	💧	💧	💧	💧	💧
150	💧	💧	💧	💧	💧
200	💧	💧	💧	💧	💧
250	💧	💧	💧	💧	💧
300	💧	💧	💧	💧	🔥

3000 psi

Table 3. Drive Pressure 3000 *psi*

dirt (*mg/ft2*)	O^2 20%	O_2 40%	O_2 60%	O_2 80%	O_2 100%
50	💧	💧	💧	💧	💧
100	💧	💧	💧	💧	💧
150	💧	💧	💧	💧	💧
200	💧	💧	💧	🔥	🔥
250	💧	💧	💧	🔥	🔥
300	💧	💧	🔥	🔥	🔥

5000 psi

Table 4. Drive Pressure 5000 *psi*

dirt (*mg/ft2*)	O^2 20%	O_2 40%	O_2 60%	O_2 80%	O_2 100%
50	💧	💧	💧	💧	🔥
100	💧	💧	💧	💧	🔥
150	💧	💧	💧	🔥	🔥
200	💧	💧	💧	🔥	🔥
250	💧	💧	💧	🔥	🔥

Tables 2 - 4, with 🔥 underscoring ignition and burn, and 💧 denoting no ignition and burn.

For drive pressures in the 3000 *psi* and above range, and across all dust densities supporting combustion, oxygen mixtures below 70% (oxygen fraction) did not ignite in these simple simulations. Above 70%, impurity densities around 200 *mg/ft2* were requisite to support combustion in the 3000 *psi* range. Below 3000 *psi*, ignition and burn were only sustained with high oxygen fraction (90% or so).

These are ignition studies. Deflagration and sustained burn are not guaranteed following ignition. In cases above, sustained burn requires rich oxygen mixtures, somewhere in the 70% range, and for dirt densities above 200 *mg/ft2*. In the above, ignition and sustained burn produced 90% combustion of particulate matter. Only hydrocarbons (plastic, silicone, nylon) ignited in the simulations. Glass, titanium, and aluminum did not ignite. Two component mixtures, with hydrocarbon particulate density above 200 *mg/ft2* ignited, but the quenching component of the distribution (metal, glass) reduced the burn wave intensity. Below 5 *mg/ft2* dirt density, ignition and burn were not observed.

What does all this add up it to?

The suggestion is that, in both recreational and technical diving communities, combustion of enriched oxygen mixtures during diving does not occur, and statistics suppport the same. During filling, pure oxygen is to be treated carefully, with combustive risk increasing with oxygen percentage, but spontaneous explosions are also highly unlikely below 5,000 *psi* drive pressures. The early, highly emotional, fervor against enriched oxygen diving (nitrox, helitrox, pure oxygen in the shallow zone, etc) has subsided today. Thanks, divers, for being party to this.


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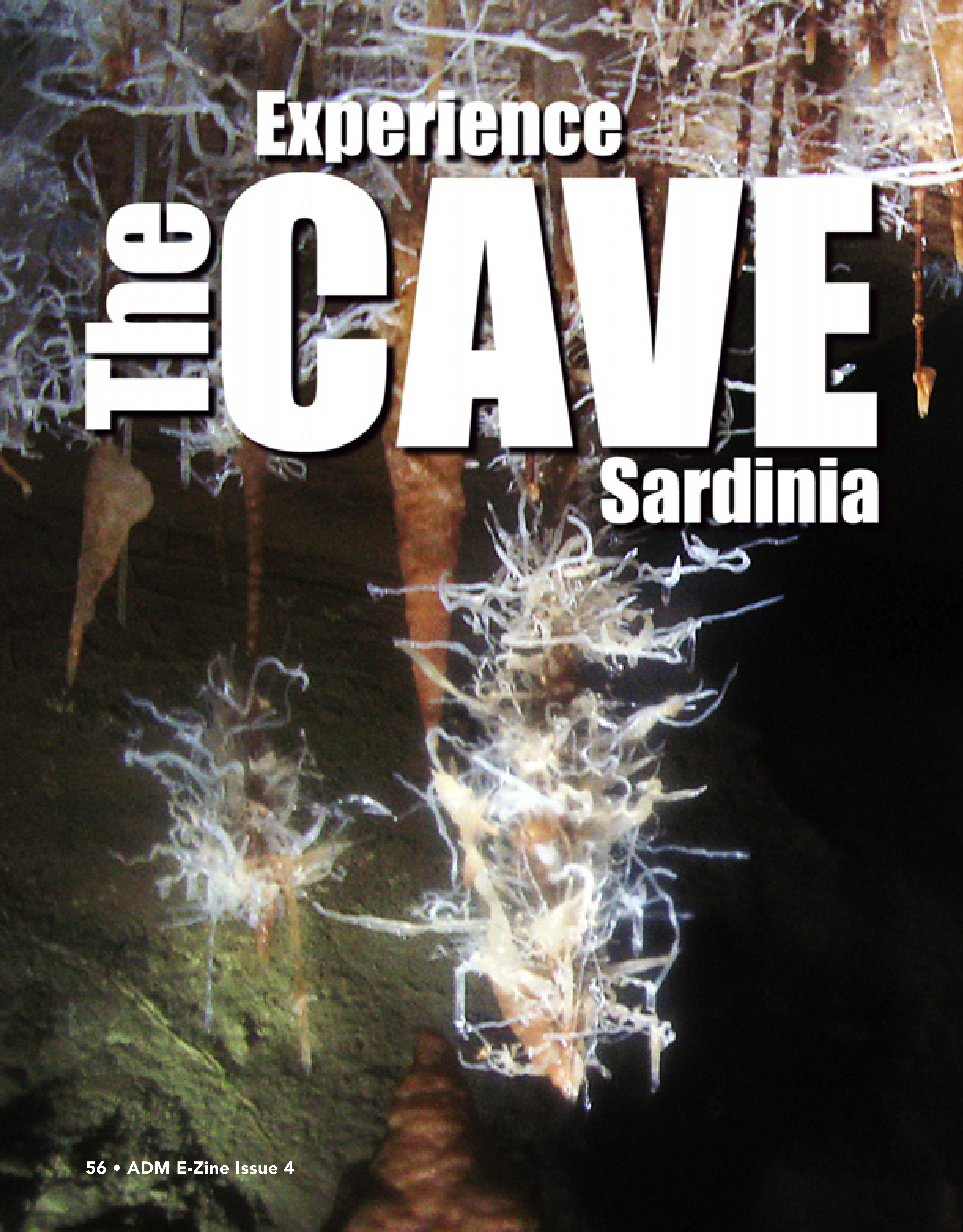

Experience The CAVE Sardinia

By Patrick Wiget

After diving and instructing in several different countries I chose to improve my cave and technical diving skills by developing my techniques and adapting my configuration according to the environment, and familiarising myself with the different philosophies of other experienced cave divers and instructors.

I opened a technical cave diving facility in the heart of the European caves in Sardinia 4 years ago where, with my business partner Thorsten, we teach programs according to the standards of recognised agencies like NACD, NSS-CDS, IANTD and TDI. I have learned to appreciate the various differences between our cave systems which are located almost on our door step!

The variety of the cave environments makes it necessary to adapt your dive plan, equipment, or techniques in order to execute a safe dive within a team!

Caves along the Gulf of Orosei are accessed by boat and caves in the mountains of the nearby karst mountain chain ('Supramonte') are reached by car and rope support, giving Sardinia a unique position in terms of cave diving locations around the world.

I would like to give you an overview of the specific environmental conditions you can encounter on the island of Sardinia!

- Hydrogen sulphate is a substance that can be recognised by its 'rotten egg' smell. It affects the visibility and necessitates different communication procedures, team and environmental awareness, and guideline control.

• Haloclines are encountered in all our ocean-accessed caves that reach deep into the mountains. Haloclines also appear in a lot of systems in Mexico, and other caves where the fresh water from the inland hits the salt water level from the ocean. Salt water is denser than fresh water, and so light beams are diffracted when they pass through the halocline. This creates visual effects. A diver's finning motions will stir up the salt and fresh water like oil and water. Because of the impact on visibility haloclines need to be understood and the team needs to shift properly on the line to supply the team members swimming or scootering at the rear with good visibility. If sediments get in the mix of fresh and salt water proper communication and reel handling can be particularly demanding for the diver who has never experienced such situations.

• Beginners appreciate the cave systems that have no flow, and an average depth of 35ft that allows a relaxed dive if desired. These dives include the opportunity for complex navigation, the discovery of the bones of animals that reach back 5000 years, and the possibility to surface to enjoy the stunning formations covering the ceilings and walls of the vadose areas.

• Search. Once you go out on the boat the ocean can be rough and you will discover that finding a location for the primary tie off in open water and a safe location to exit the water can be demanding. The proper positioning of the tie off and knowledge of the water movements is the key to a relaxed dive under these circumstances. The diver and the team need to understand the water movements in order to place a tie off without losing a lot of energy while working or finning against the current.

• Current can be encountered in several systems in Florida or the Bahamas where the tidal changes need to be considered to avoid finning against the flow on the way in and out of the system! Depending on the season or tidal changes in Sardinia the flow may need to be included in the air planning and calculations prior to the dive.

• Depths that reach down over 300 feet require complex gas planning and management. The staging of decompression tanks and dive rig management by the surface support team of ProTec Sardinia are an important part of the dive plan for the divers or the students taking a technical cave course.

• Navigation comes in to the plan when tie offs and jumps are made to explore the different side passages of the systems and to enjoy the circuits. The sumps are also quite an experience as the diver has to leave the water and hike through the cave until reaching the water again; alternatively the equipment can be placed at the surface to explore the cave on foot. Different considerations need to be taken into account when planning to leave equipment in the water or on the surface and to continue the exploration of dry passages!

• Sediments are a major concern while cave diving: gravel; sand; organic materials; mud and clay can all be encountered in our cave systems. Correct dive technique and good trim are essential as they allow the diver to traverse passages where zero visibility can be encountered.

• Weather conditions. When diving ocean caves the weather has to be closely watched. When entering the cave the ocean can be flat and calm, whereas upon exiting the weather could have changed and the primary tie off could be in an unsafe location. Our experienced staff monitor the weather forecast and know which cave entrances are accessible. As we have many different caves there is always an option that ensures a safe and enjoyable dive.

• Side Mount: Excellent side mount diving can be encountered in the Sardinian caves and the full advantage of this configuration can be experienced.

Where restriction after restriction requires the side mount diver to remove the tanks in order to pass through the cave this makes the side mount configuration a must!

- Stages: In Sardinia there are caves where miles of line have been laid and more passages wait to be explored. Here stage diving can be enjoyed, involving both restrictions which require the stage to be pushed in front of the diver, and vertical passages where the trim and the balance of the diver is a major factor in enjoying a relaxed dive.

- DPV: After the first year we realized that the caves in Sardinia are much more complex and longer in terms of penetration distance than we originally thought. The DPV was the only option. From big caves with a diameter of 90ft to others that just allow the diver to steer the scooter through tubes and occasionally push it through restrictions, divers are given the opportunity to experience DPV diving with all its facets and difficulties.

• CCR: Once the cave drops down to 120 feet and stays constantly at that depth for 2 km before a further drop to 180 feet then a Rebreather is the right tool to use! A detailed bailout plan is of great importance and needs to be discussed with the team prior to cave exploration.

Explorations are performed in almost every cave system we have on the island. Some caves are virgin, and as there are not a lot of cave divers active on the island, once we are out cave diving we hardly see other divers! We are already laying miles of new line and exploring new passages.

Phreathic meets Vadose. We are working with the local speleological organisations in the mountain terrains, where over 2000 caves have been registered, and this gives us a wide variety of caves where the dry passage hits a phreathic area that needs to be explored. With the years of experience and know-how of the local organisations we are able to execute tours into the caves and transport equipment vertically through the dry cave until the phreathic zone has been reached!

If you have further questions please contact us at: info@protecsardinia.com or visit our website at www.protecsardinia.com.

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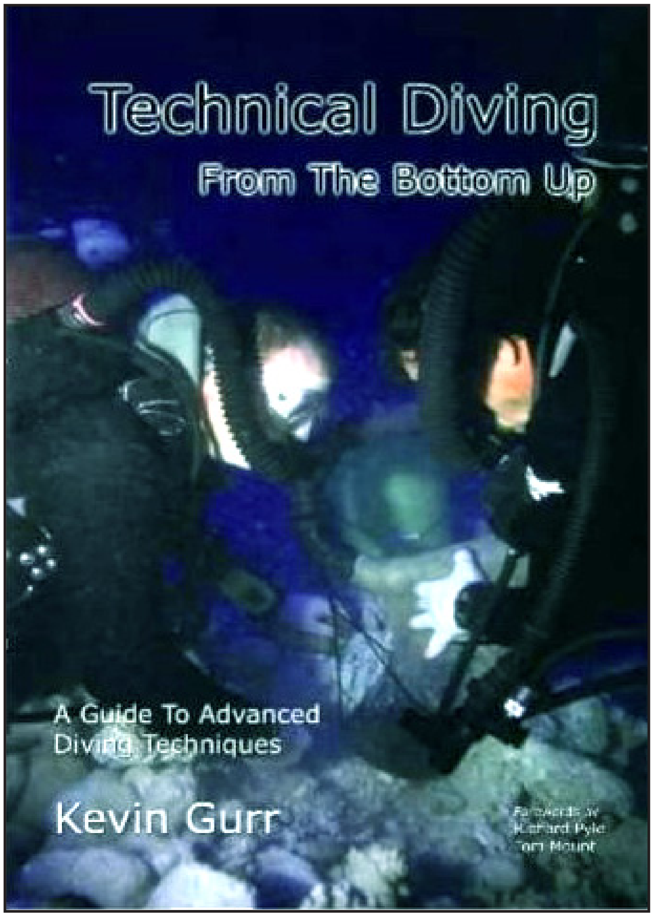

Technical Diving from the Bottom Up

By Kevin Gurr

"Technical Diving From The bottom Up" is a guide to both 'would be' and experienced technical divers. Covering a range of topics, it is designed to guide the reader through the basics such as physiology and equipment configuration, before moving onto deep mixed gas decompression diving and the use of rebreathers.

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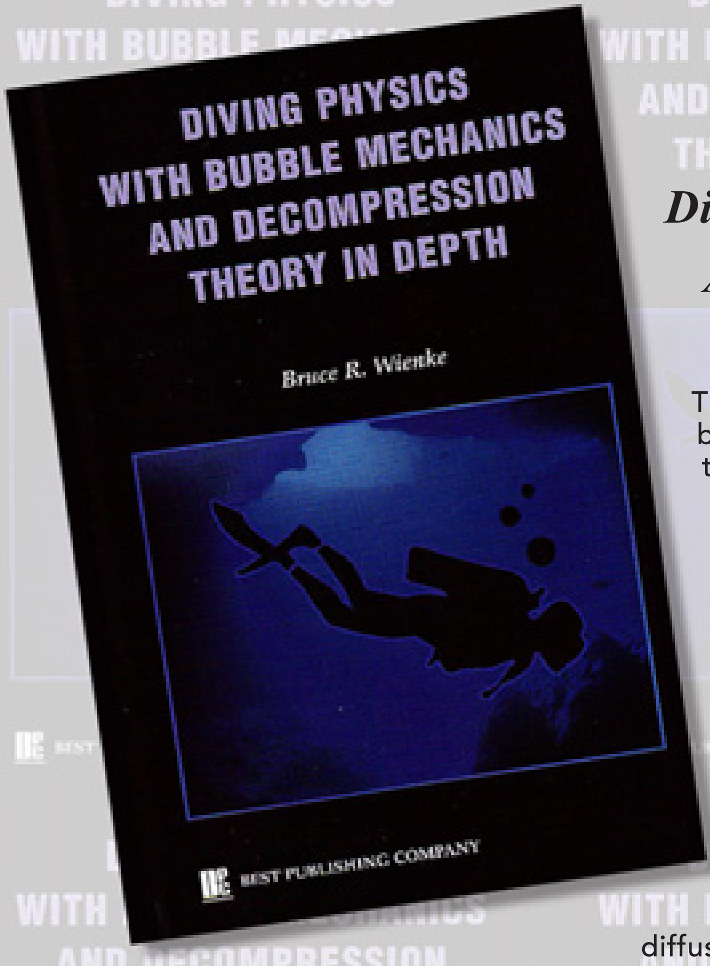

Diving Physics with Bubble Mechanics And Decompression Theory in Depth

By Bruce R. Wienke

This book focuses on hyperbaric and diving physics, bubble dynamics, decompression theory, applications, and associated mathematical relationships. Basic principals are first presented, and then practical applications and results are detailed. Statistical methods are also included for diving data analysis, with application to bubble models. Geophysical concepts impacting diving are presented for completeness.

The intent here is to present a working view of physical phase mechanics, then followed by application to decompression theory in diving. It is directed toward the diver and reader with a basic understanding of decompression. Basically the mechanics of tissue gas exchange, bubbles and nucleation, supersaturation, perfusion and diffusion, and related mechanisms are discussed. Popular and widely used diving models are described, and staging criteria are delineated, particularly those found in decompression meters, released tables, and dive planning software. Deep stops, helium diving, isobaric counterdiffusion constraints, and other contemporary mixed gas protocols are examined from various physical perspectives. Modern tables for air, nitrox, heliox, and trimix are appended for OC and RB diving, tables with a safe and lengthy usage record.

The targeted audience is especially the doctor or physiologist, physicist, chemist, mathematician, engineer or biologist by training and also the commercial diver, technical diver, instructor, hyperbaric technician, underwater researcher, looking for greater detail in diving physics, bubble mechanics, dual phase decompression theory, and statistical validation techniques. This publication extends and updates earlier monographs.

Bruce Wienke is a Program Manager in the Nuclear Weapons Technology/ Simulation and Computing Office at LANL, and heads up the C&C Dive Team. He contributes to decompression workshops, symposia, educational publications, and technical periodicals. He is the author of seven books, and over 200 technical journal articles.

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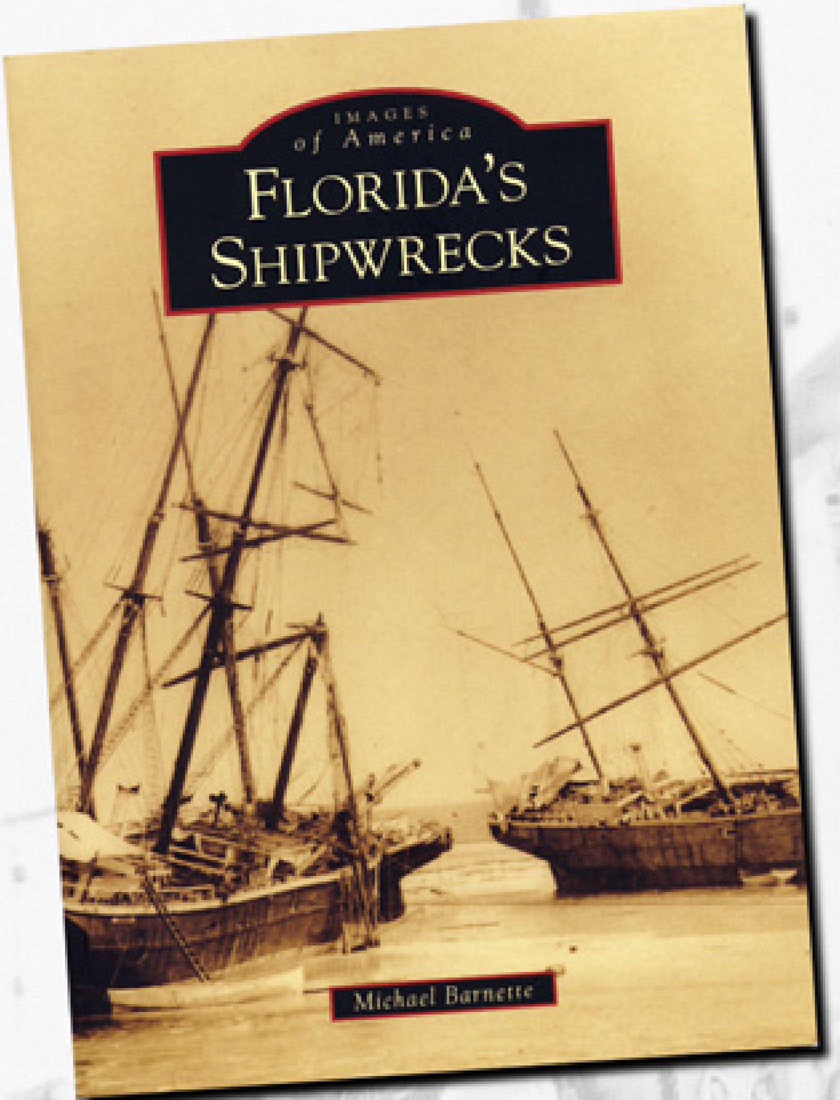

Images of America Florida's Shipwrecks

By Michael Barnette

The Sunshine State has a rich maritime history spanning more than five centuries. Tragically, part of that history includes thousands of ships that have met their fates in Florida waters. Potentially more than 5,000 shipwrecks reside off Florida's 1,200 miles of coastline, with hundreds more lost in the state's interior rivers. In and of itself, the Florida Keys archipelago, consisting of approximately 1,700 islands stretching 200 miles, is littered with the remains of close to 1,000 shipwrecks. In fact, many features of the Florida Keys were named after various shipwreck events, such as Fowey Rocks, which earned its name after the 1748 wrecking of the British warship HMS Fowey, and Alligator Reef, where the schooner USS Alligator met her demise in 1822. Florida's Shipwrecks utilizes captivating images to illustrate dramatic stories of danger and peril at sea, introducing readers to a fascinating cross-section of Florida's shipwreck history.

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Author Michael Barnette has been actively researching and exploring shipwrecks for almost 20 years, resulting in the identification of more than 17 shipwrecks. He has dived on numerous historic shipwrecks, including the ironclad USS Monitor, the liner Andrea Doria, the battleship USS Virginia, and the HMHS Britannic, a sister ship of the fabled RMS Titanic.

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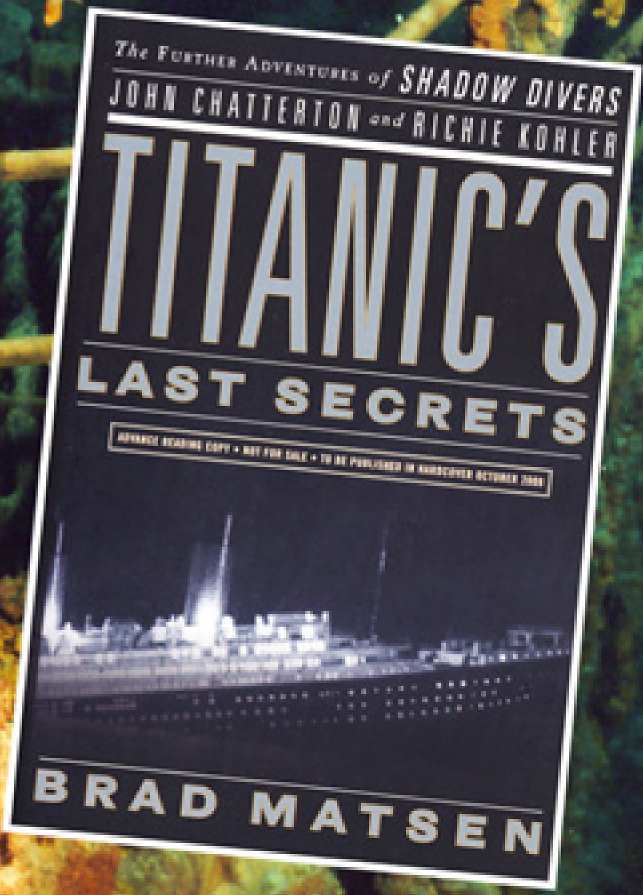
The Further Adventures of SHADOW DIVERS
John Chatterton and Richie Kohler

TITANIC'S LAST SECRETS

By Brad Matsen

After rewriting history with their discovery of a Nazi U-boat off the coast of New Jersey, legendary divers John Chatterton and Richie Kohler investigate the enduring mystery of history's most notorious shipwreck: Why did Titanic sink as quickly as she did? If Titanic had remained afloat for just two hours longer, more than two thousand people-- instead of just seven hundred and six-- would have survived the shipwreck that stunned the world. To answer that question, they assemble a team of experts to conduct new forensic research, explore Titanic, and dive to the wreck of its sister ship, Britannic. Weaving their way through a labyrinth of clues, they discover a shocking historical cover-up.



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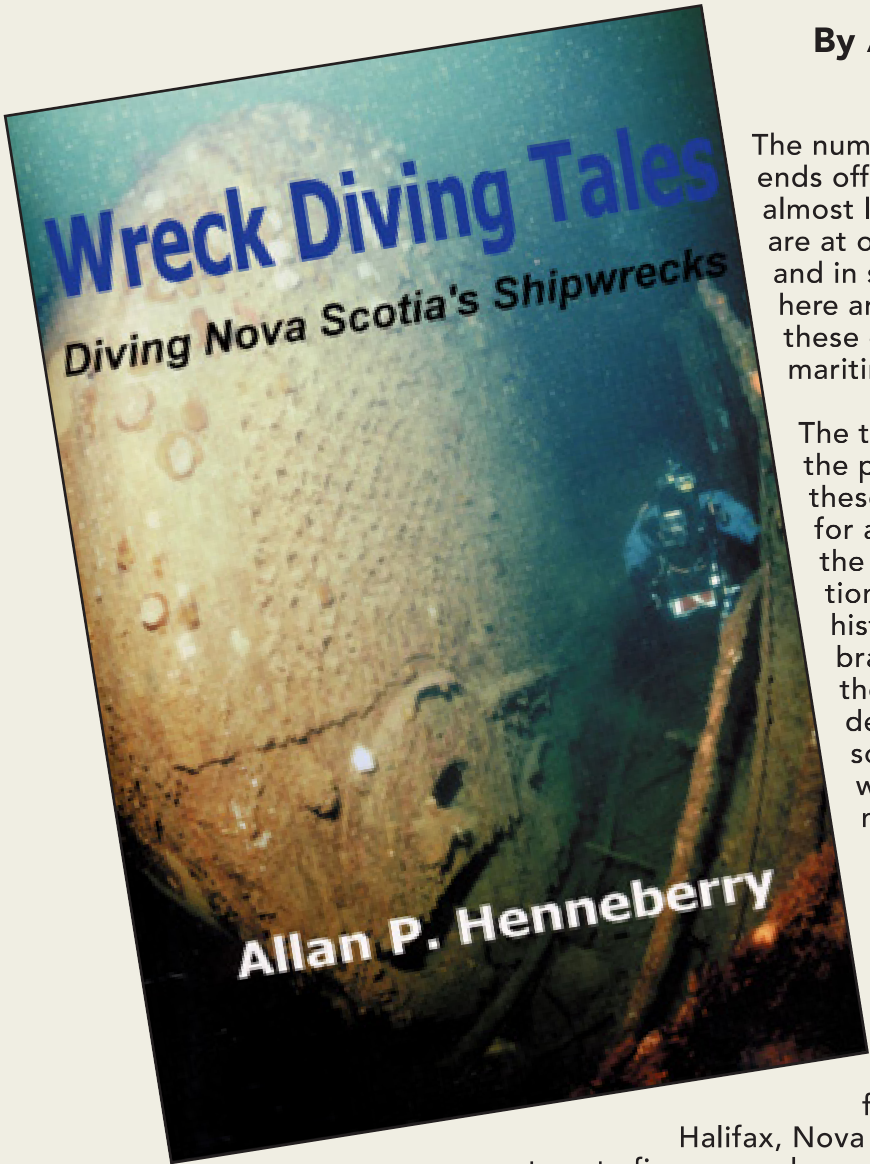
Wreck Diving Tales
Diving Nova Scotia's Shipwrecks



By Allan Henneberry

The number of ships that have met their ends off Nova Scotia's rugged coast is almost limitless. Their stories and histories are at once both interesting and tragic, and in some cases, mysterious. Collected here are the accounts of just a few of these events, footnotes in the long maritime history of the province.

The tragedies of the past have become the playgrounds of divers, who visit these underwater time-capsules, not for any monetary gain, but rather in the development of a deep apprecia-tion of maritime history. It is the history of those who came before, braved unimaginable hardship, laid the foundations of Canada, and defended its freedom. There is something about touching a ship-wreck that makes history much more real and powerful.

Wreck Diving Tales is a compelling read for divers, maritime history lovers, and armchair adventurers alike.

Allan Henneberry is a commercial fisherman and diver living near Halifax, Nova Scotia. He has spent more than twenty-five years above and below the waters of the North Atlantic, working as a fisherman, tug-boat bosun, and commercial diver. Since 2001, he has also been engaged as a marine specialist in the film industry, employed on such productions as K-19: The Widowmaker, Bridget Jones: The Edge of Reason, and the television series Survivor.

Allan began diving in 1992 and quickly discovered a passion for wreck diving and shipwreck research. Mixed-gas tech-nology allowed him to explore little visited wrecks in depths greater than traditional air diving allowed.

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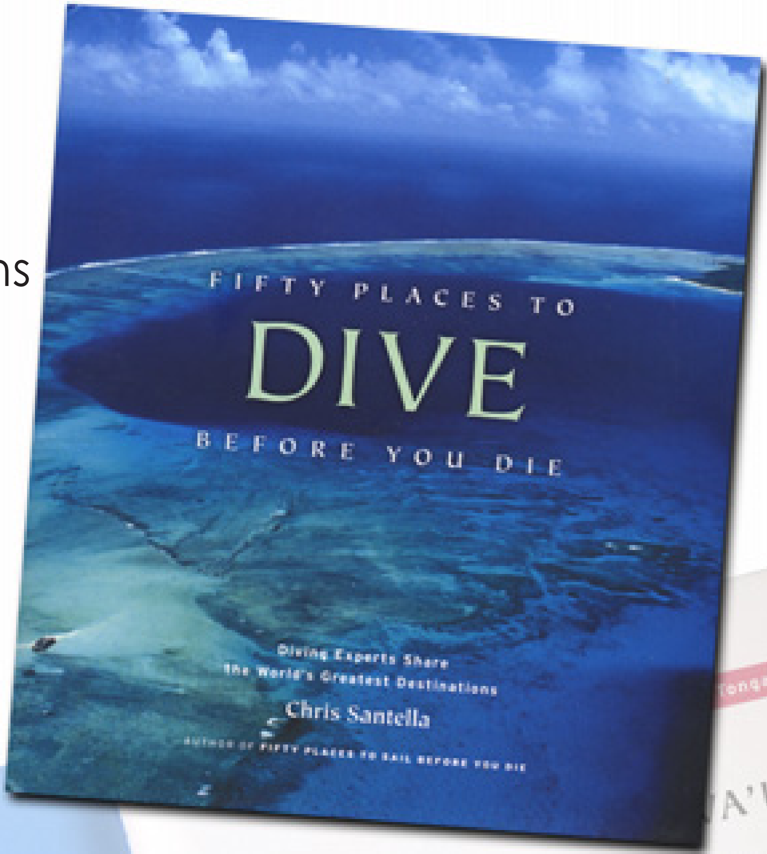
Fifty Places to Dive Before You Die:

Diving Experts Share the World's Greatest Destinations

By Chris Santella



The earth's oceans hold many wondrous surprises—be they the small, colorful "critters" off the coast of Papua New Guinea, opportunistic red demon squids in the Sea of Cortes, or naval wrecks in the lagoon of Bikini Atoll. In Fifty Places to Dive Before You Die Chris Santella has invited diving experts from around the world to share some of their favorite destinations, so ardent divers can experience these underwater wonders for themselves—either on location in their SCUBA gear, or at home in their armchair.

The fifth in Santella's bestselling "Fifty Places" series, the book takes divers from hot-spot destinations like Raja Ampat (off the coast of West Guinea) to old Caribbean favorites like Grand Cayman Isles. Readers will swim among whale sharks off Myanmar, befriend wolf eels off the coast of Maine, and marvel at the giant mola mola of Lembognan, Indonesia. These wonderful creatures—plus the brilliant coral reefs that often provide their backdrop—are captured in 40 gorgeous color photos from the world's greatest underwater photographers. And for readers who want to travel to these breathtaking locales, Santella provides complete "If You Go" suggestions to help you plan your trip.

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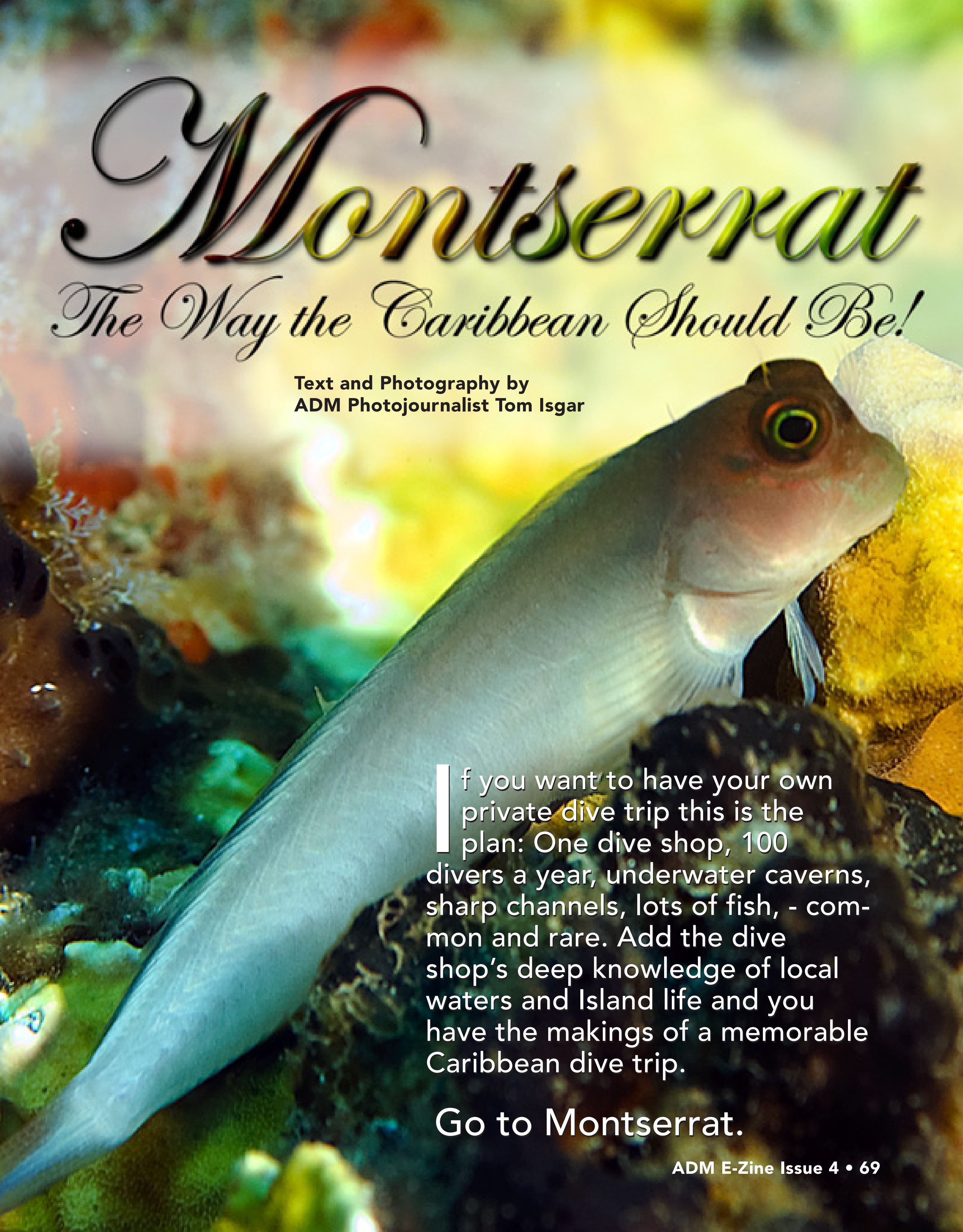


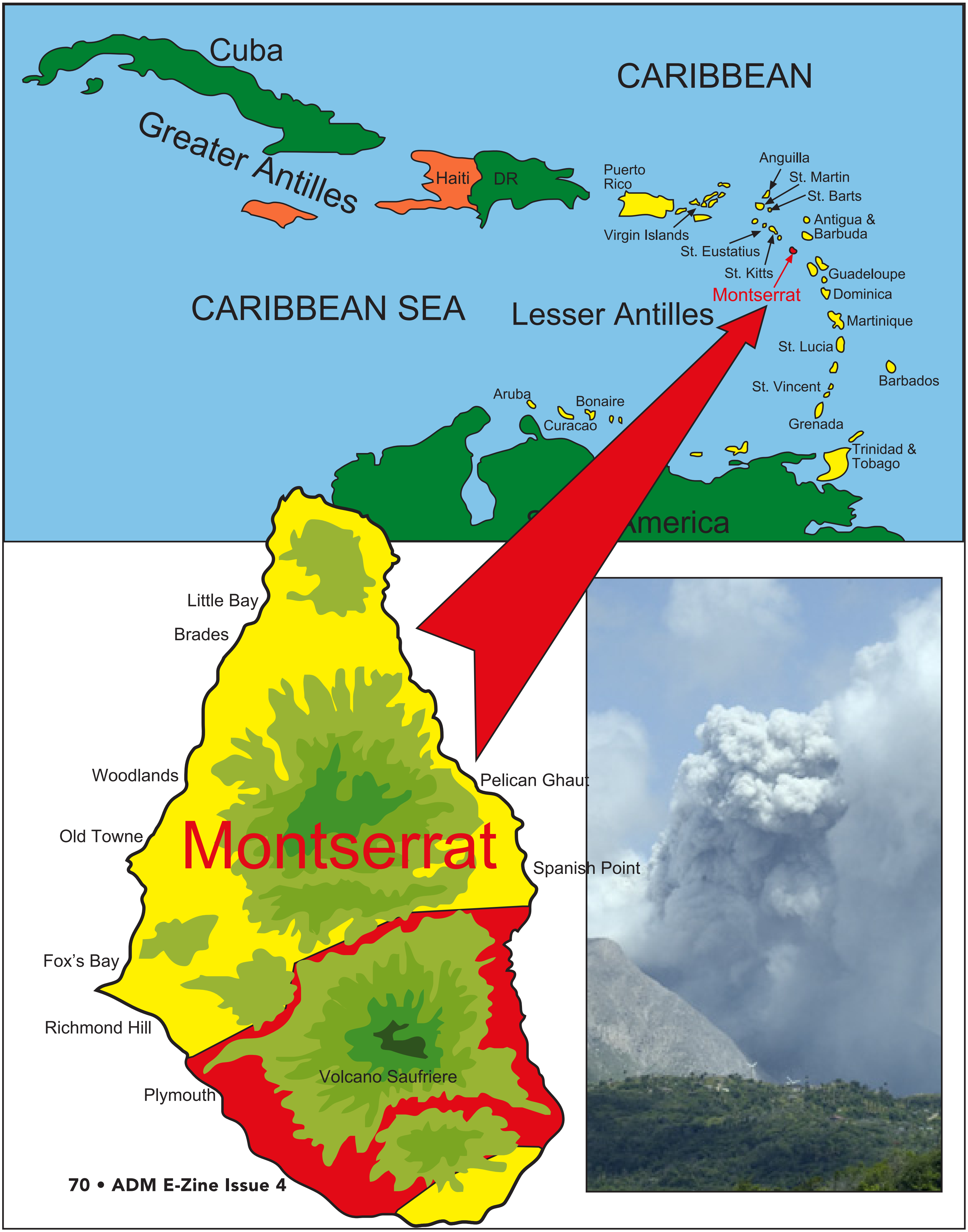
Montserrat

The Way the Caribbean Should Be!

Text and Photography by
ADM Photojournalist Tom Isgar

If you want to have your own private dive trip this is the plan: One dive shop, 100 divers a year, underwater caverns, sharp channels, lots of fish, - common and rare. Add the dive shop's deep knowledge of local waters and Island life and you have the makings of a memorable Caribbean dive trip.

Go to Montserrat.



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Fox's Bay
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Plymouth
Pelican Ghaut
Spanish Point
Montserrat
Volcano Saufriere

When I mention Montserrat people get a puzzled look and ask, “Why do I know that name?” They know it because a decade ago Mount Soufriere erupted with a fury burying the entire capital city of Plymouth and displacing 60 percent of the locals. The current population is around 5000. The volcano had been active for a few years but the 1997 eruption lasted several days before giving way to ashes and smoke. Today there are occasional ash showers.

Montserrat is in the Lesser Antilles very close to Puerto Rico. The route is an easy flight to Antigua and a 15-minute flight to Montserrat.

Like many Caribbean countries, Montserrat began as a sugar island and was disputed by England and France. The island came under English control in 1783 and today shows the strong influence of the Irish who came as early settlers. St. Patrick’s Day and green beer reflect that heritage. Today Montserrat is a British Overseas Territory.

I arrived in the middle of the weeklong Calabash celebration (Middle July). The Calabash is a tree used for a variety of items. The main one is the Calabash - a musical instrument. The festival offered a domino tournament, a cricket match, which included the halftime tug-o-war championship. And there was the 'limin tour.' This is Montserrat's version of a pub-crawl as the bars are referred to as limeries or rum shops. A bus takes you between drinking spots.

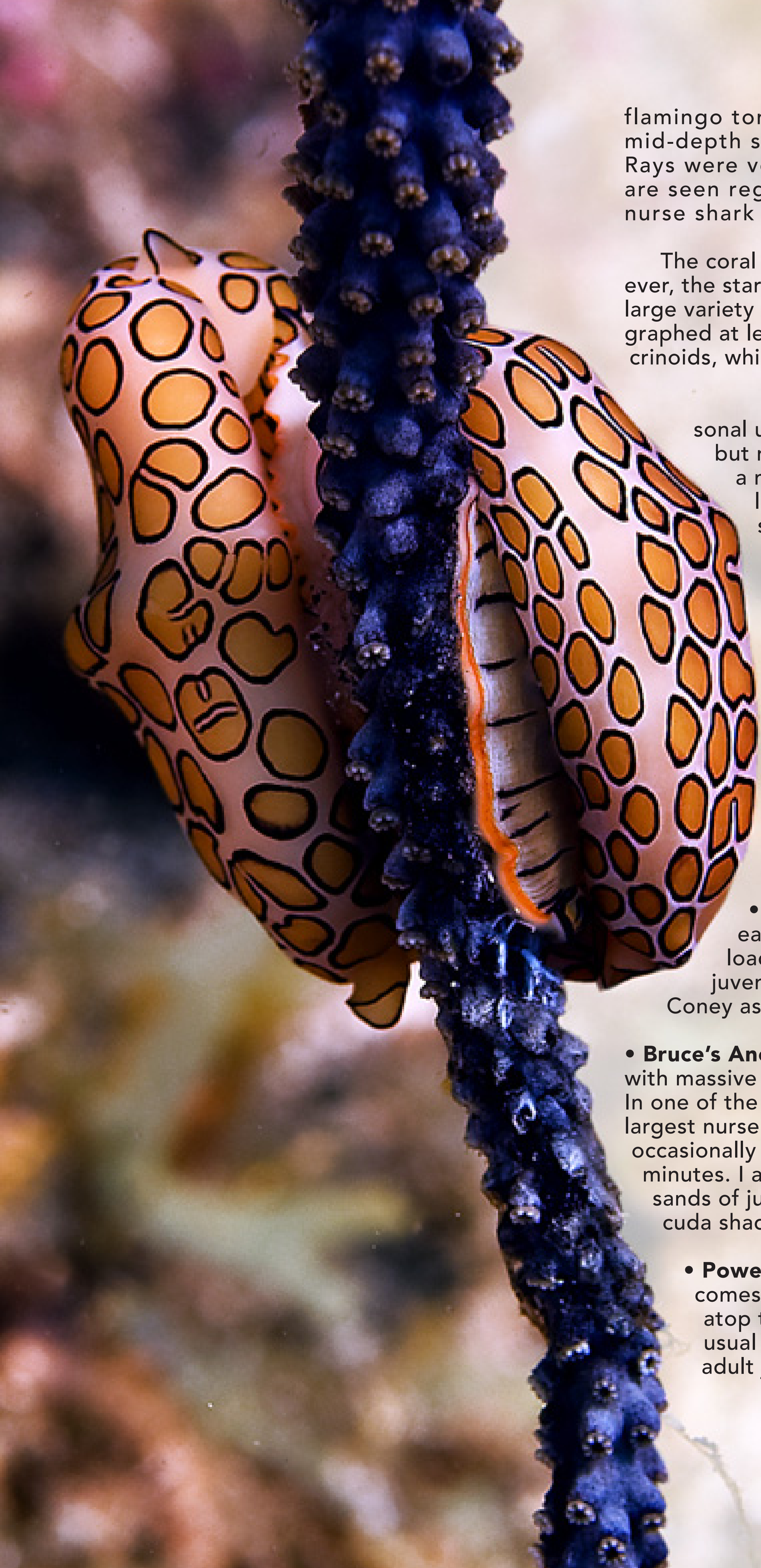
The Diving

The Green Monkey dive shop was my diving host for the week. Troy and Melody Deppermann have operated it in Montserrat three years. Troy has over 20 years in the dive industry. The Green Monkey is a PADI shop, which offers a variety of courses as well as boat diving, shore diving and snorkeling. They have a lovely one-bedroom apartment in their home which is rented to divers and other guest. They work with local hotels and B&BS for additional accommodations.

When I asked Troy and Melody why divers should come to Montserrat their answer was emphatic - no crowd, no rush, no tourists, set your own schedule, influence the choice of dive sites, learn to dive with one to one instruction. They also emphasized the quiet, serenity, friendliness and safety on the island. Melody said. "As a woman there is no place on the island I don't feel safe to walk by myself."

Diving is basically easy Caribbean - good visibility, little current, short boat rides and a nice underwater environment. The dive boat, powered by two engines makes reaching Rodonda, a volcanic up-thrust 14 miles offshore a comfortable ride. The boat also has a permanent cover to protect from sun and rain.

I was struck by the abundance of some fish species, which are fairly rare in other places. For example, I saw Hihats, Jacknife fish and spotted drums on nearly every dive. I also saw



flamingo tongues on every dive with a mid-depth sandy bottom. Southern Sting Rays were very common and eagle rays are seen regularly. I also saw the largest nurse shark ever.

The coral is healthy and abundant. However, the stars of the underwater may be the large variety of healthy sponges. I photographed at least a dozen species. I also saw crinoids, which are fairly rare in the Caribbean.

The locals fish, mostly for personal use, so some species were scarce but not fished out. There is talk about a marine park and the head of the local fisherman's cooperative seemed very supportive, recognizing that a nursery would help the fisherman as well as tour operators.

Some of my favorite dive sites

• **Rodonda** - 65 ft. – Rodonda is a sloping seamount which in the past was mined for phosphate. There is an old submerged barge and numerous anchors from past anchoring. Sea fans exceed five feet and provide cover for turtles and eels.

• **Carr's Bay** – 50 ft. – This is an easy site near the dive shop. It is loaded with sponges and a variety of juvenile species. I saw schools of Coney as well as several Soapfish.

• **Bruce's Anchor** – 55 ft. – This is a huge site with massive coral heads and narrow canyons. In one of the canyons we encountered the largest nurse shark I have seen. It would flutter occasionally and ruin the visibility for ten minutes. I also saw three turtles and thousands of juvenile fish. Several large barracuda shadowed us for most of the dive.

• **Power Station** – 45 ft. – The name comes from the power station sitting atop the nearby bluff. We saw the usual Caribbean fish as well as several adult jackknife fish.

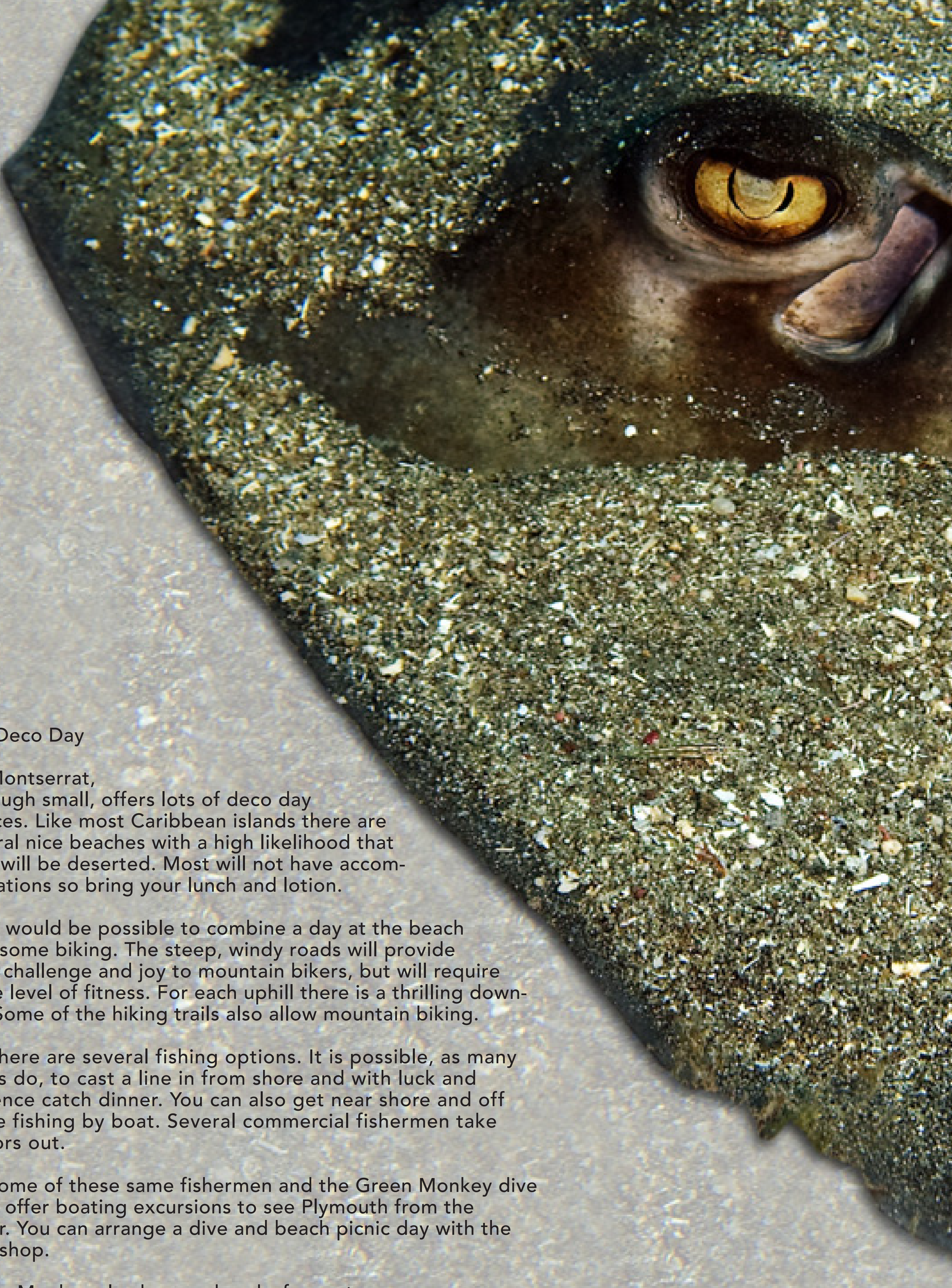
• **Sea Studio** – 65 ft. –This was a great site with large rocks and coral heads on a sandy bottom. It is loaded with several varieties of sponges. We had an octopus swimming in the open as well as a small Southern Sting ray.

• **Pinnacle Rock** – 80 ft. – This site is near an island point with some current, which draws schools of jacks. There are huge rocks, which have flaked off the wall as well as several small pinnacles. There were grunts under the overhangs, including Black Margate. We saw four eagle rays swim by. In the shallows on top of the pinnacles red lipped blennies were abundant and posed in all colors of coral.

• **Bat Cave**, with a shore swim back to the dock – 45 ft. – The highlight of this dive is the ability to surface in the cave and observe the fruit bats which hang from the ceiling. The cave also contains a school of Glassy Sweepers and a large lobster.

For me the swim back to the dock in about 25 feet of water was very productive – several species of Cardinal fish, jackknife fish, rays and arrow crabs.

One interesting dive note is that in the area off shore from Plymouth, the city destroyed by the volcano, the fish disappeared but recently brittle stars are being frequently observed.



The Deco Day

Montserrat, although small, offers lots of deco day choices. Like most Caribbean islands there are several nice beaches with a high likelihood that they will be deserted. Most will not have accommodations so bring your lunch and lotion.

It would be possible to combine a day at the beach with some biking. The steep, windy roads will provide both challenge and joy to mountain bikers, but will require some level of fitness. For each uphill there is a thrilling downhill. Some of the hiking trails also allow mountain biking.

There are several fishing options. It is possible, as many locals do, to cast a line in from shore and with luck and patience catch dinner. You can also get near shore and off shore fishing by boat. Several commercial fishermen take visitors out.

Some of these same fishermen and the Green Monkey dive shop offer boating excursions to see Plymouth from the water. You can arrange a dive and beach picnic day with the dive shop.

Green Monkey also has sea kayaks for rent

Because of the volcanic nature of the island there are a number of hiking trails - some taxing. All are marked and described in the local tourist guide. With the assistance of a guide it is possible to see the Montserrat Oriole an endemic bird that lives nowhere else. It took me two hikes but I got some fair shots of the Oriole.

Finally, this is one of the only islands where you can observe a belching volcano, Soufriere, see the results of its destruction and talk to scientists about the future of the volcano.

A visitor can observe the volcano's ash and steam plumes as well as have opportunities to see first hand the impact of the volcano's eruptions. The day I was scheduled to go into the Forbidden Zone and the city of Plymouth with a police escort the volcano spewed steam and ash and the visit was cancelled.

There is one major hotel on the island - Tropical Mansion Suites. It was very comfortable, offered meal service, free internet and a great view from the outdoor pool and deck. Another way to manage accommodations is at one of the numerous villas for rent. They are furnished, many have pools and some have staff. The usually sleep at least six and allow you to prepare some meals. It is an ideal way for a group to vacation on Montserrat.

www.tropicalmansion.com
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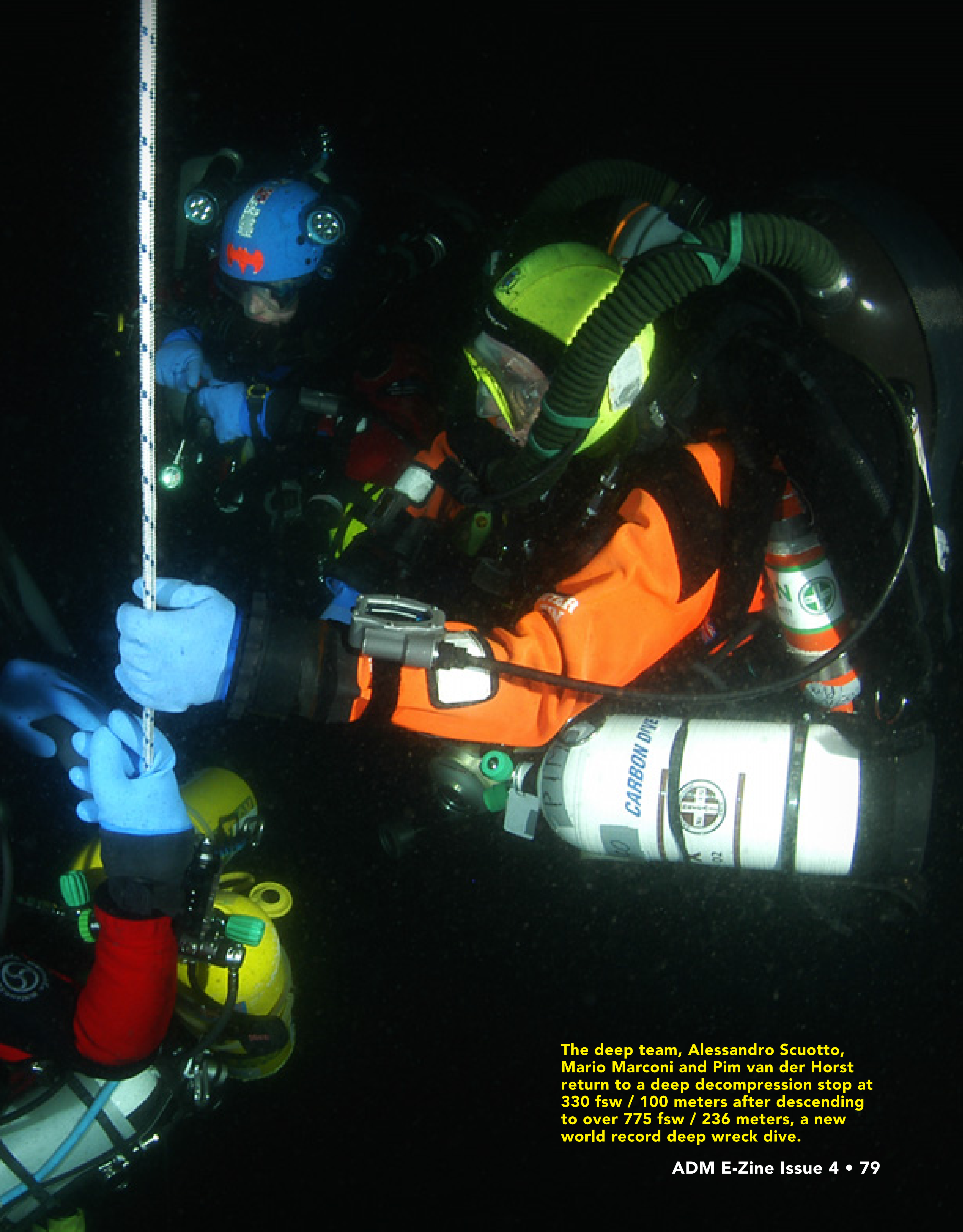
775 FSW / 236 METERS
WORLD RECORD DEEP WRECK DIVE

Text by Pim van der Horst
Photography by Marco Sieni and Christian Mueller

On the 10th of January 2008 my mobile phone started to buzz: I was receiving a SMS mes sage. I pushed the button on my phone and read the message: "Pim, do you like to come to the DDE show in Italy in May? Mario". My friend and (extreme) dive partner Mario invited me to join the Dynamic Dive Exhibition at Lago Maggiore in Italy. I answered: "When I have time, I will be there." That was the start of a big adventure and a big dive....

The preparation

Marco Braga, program manager of DDE and president of the Italian diving organization PTA (Pure Tech Agency) sent me by email the preliminary program of the show. He was planning to add also some "tech" events. At that time the scope of the tech event was not known yet. But a couple of days later Marco send me a video link: the fire department of Verbiana has bought a ROV (Remote Operated Vehicle): a small unmanned submarine, and they discovered and filmed a wreck in (very) deep water. It was the wreck of a ship called the Milano. She lays in a depth of 775 fsw / 236 meters. According to Marco that could be a nice subject for a tech diving event: a world record wreck dive (the old record was set on 672 fsw / 205 meters), and more: on Closed Circuit Rebreathers in cold fresh water with three divers at the same time!



The deep team, Alessandro Scuotto, Mario Marconi and Pim van der Horst return to a deep decompression stop at 330 fsw / 100 meters after descending to over 775 fsw / 236 meters, a new world record deep wreck dive.

Is such a dive feasible? What are the risks? I started to play with a special version of GAP and with V-planner (diveplaning software). I generated some diving and decompression schedules. The outcomes didn't make me very happy… long runtimes… high CNS percentages…. Then Mario came up with a dive plan (generated with V-planner B/E conservatism +4) taking into account Open Circuit decompression in a diving bell. Starting at 21 meters on EAN50 and from 12 meters on pure oxygen, generating a total CNS of 23,000%. It would take the bottom divers about 3 hours from the bottom to reach the bell. The deco in the bell would take another 4 to 5 hours. There was room for four divers in the bell so the team invited also Alessandro Scuotto and Cedric Verdier to participate.

Over email we started to work on the dive plan (equipment, gasses, emergency procedures, etc.). Fabio Manganelli was the dive marshal and as such responsible for the logistics of the dive itself and the Standard Operating Procedures. Every week there was a new version of the SOP document which was reviewed and commented by the bottom divers, Cedric and Marco. Also the list with support divers (shallow, deep and very deep) and surface support was completed.

One of the biggest hazards of the dive was hypothermia: the water in Lago Maggiore is 5 degrees Celsius from 30 meters deep. At the surface the temperature was about 13 degrees. Staying in the water for three hours at 5 degrees is doable. But no longer than that, given the heavy decompression to do. The scrubber duration of the rebreathers is affected by the cold water. Also the depth of the dive has a negative effect on the scrubber duration (because of the high flow of gas through the breathing loop): so three hours on the canister was the absolute maximum.

Two weeks before the dive Cedric had to cancel: his diving equipment was stolen when he returned home from a DIRrebreather expedition to the wreck of the Victoria in Lebanon. Now the bottom team consisted of three divers: Mario Marconi, Alessandro Scuotto and myself.

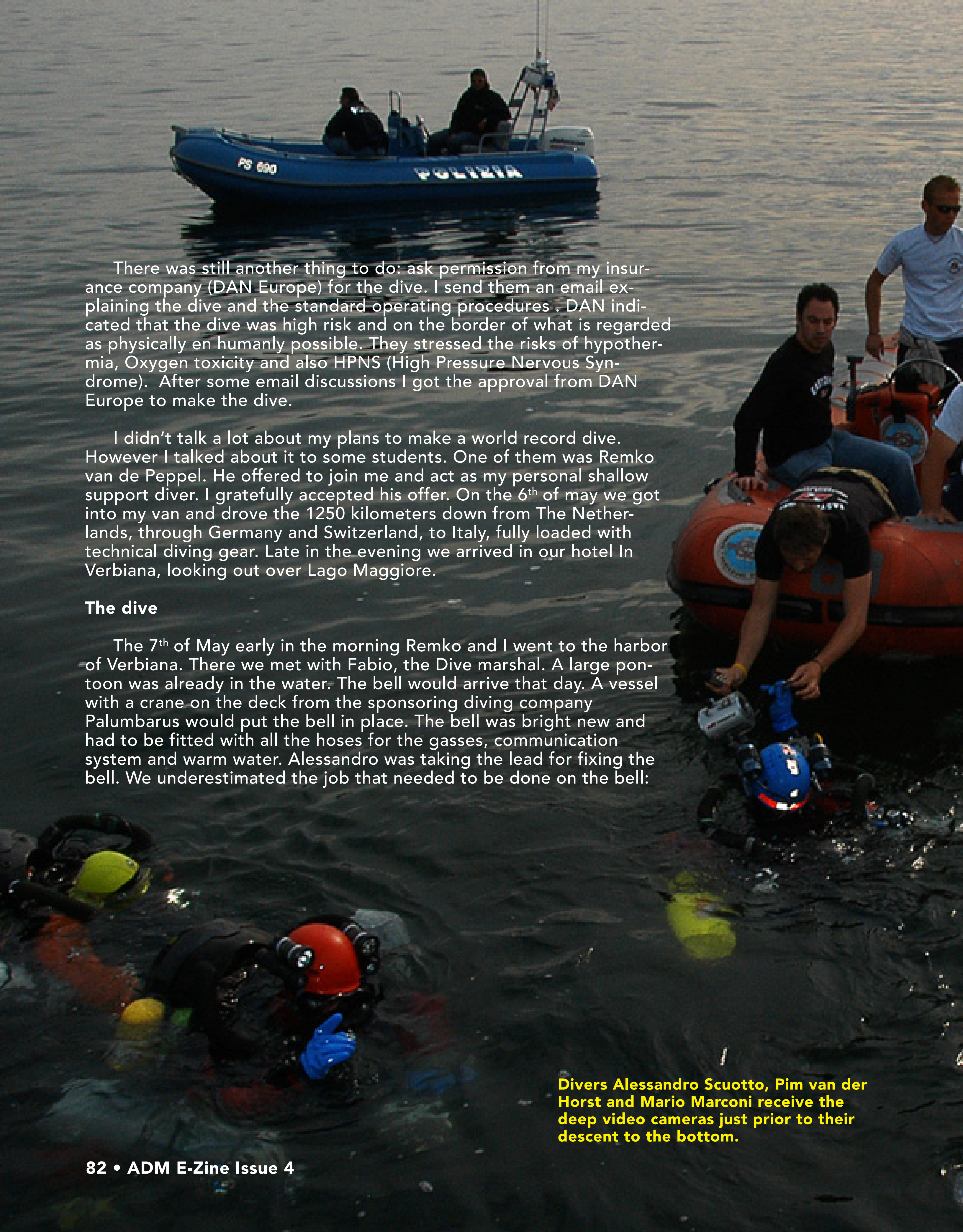
One week before the dive the final version of the SOP was ready. On paper it all looked like a dive that would be feasible to do. All possible risks had been evaluated and measures had been taken accordingly. But… paper is very patient… reality can and will be different: diving and decompression is not an exact science. How would our bodies and minds react on the great depth, the partial pressures of the gasses, the low temperature? How would our equipment stand the great pressure? Very few or even no data was available to assure a safe dive.

Below: The dive pontoon, safety vessels, and press boats positioned above the Milano wreck.

Right page inset: Deep team members, Alessandro Scuotto and Pim van der Horst rig for the big dive.

We calculated a bottom time of four minutes and a descent speed of 25 meters per minute: we had to reach the bottom in ten minutes. On a rebreather that's very fast. (During my descent my automatic diluent valve (ADV) was constantly injecting gas into the loop. All the time during the descent I had a pressure alarm on the rebreather. My Ouroboros CCR was thinking that there was a leak somewhere…).

My personal preparation consisted of taking care of my physical condition (training program and food diet) and making some deep dives (I went with Cedric to the Victoria in Lebanon and dived there on a Megalodon CCR to 142 meters). I was not sure which rebreather I was going to dive on the Milano: the Meg or the Ouroboros. I decided to prepare both rebreathers and take them to Italy. I was going by car: so no problem of overweight (when taking a plane). The deep divers prepared their own on board gasses and personal bailout gasses (**). We decided to carry our own bailout to bring us up to about 135 meters, where the other bailout gasses were staged. The staged bailout gas was calculated for two divers, because the risk of all three divers to bail out was regarded as low. Two days before the dives I made the decision to dive the Ouroboros. The reasons were the fact that Mario and Alessandro were also diving a Boris, the fact that the Boris has a radial scrubber and the (first stage) regulators were Extremes regulators (certified for great depths). And for the Meg it is advised to fill the handsets with mineral oil when making extreme dives.



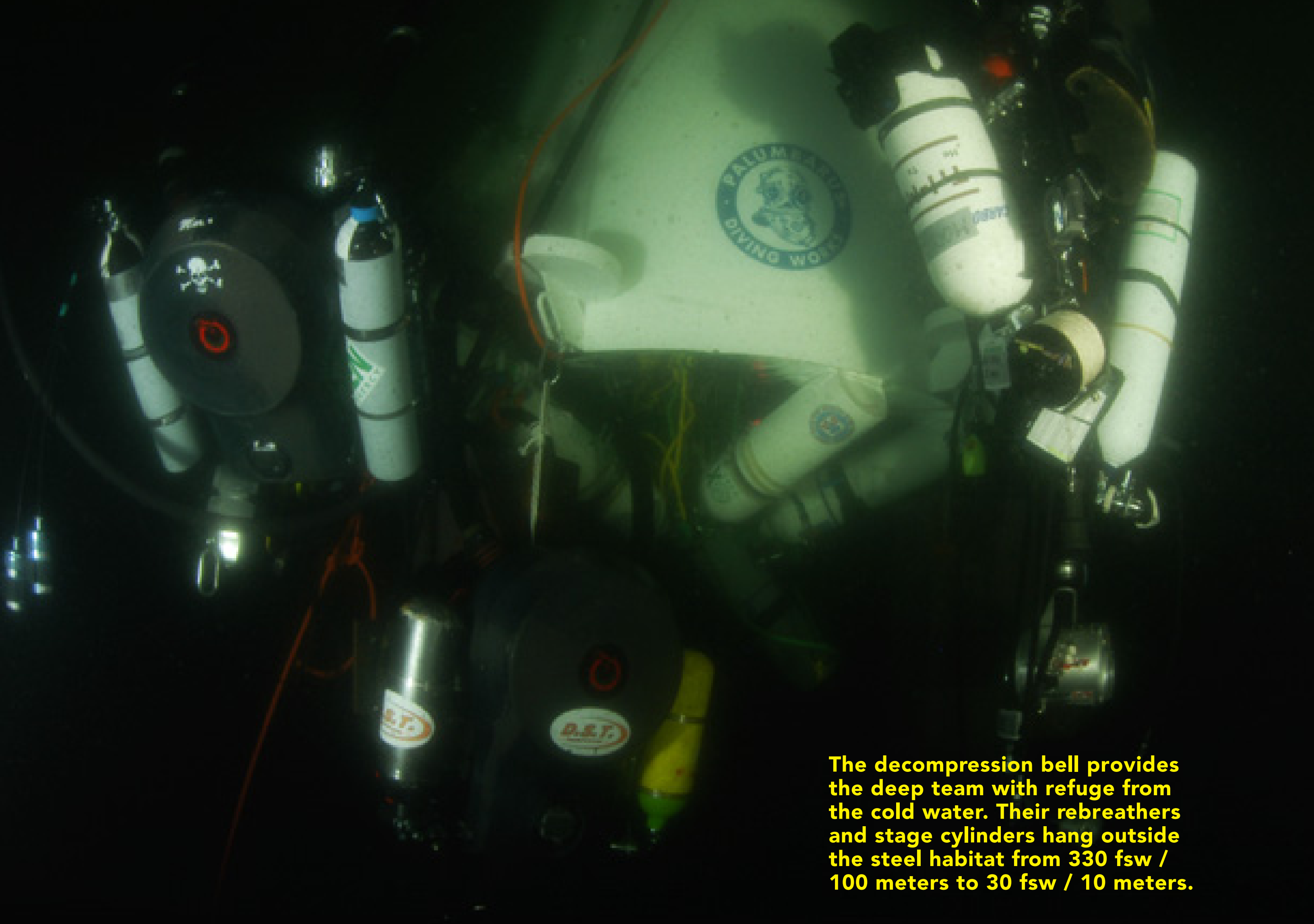
There was still another thing to do: ask permission from my insurance company (DAN Europe) for the dive. I send them an email explaining the dive and the standard operating procedures . DAN indicated that the dive was high risk and on the border of what is regarded as physically en humanly possible. They stressed the risks of hypothermia, Oxygen toxicity and also HPNS (High Pressure Nervous Syndrome). After some email discussions I got the approval from DAN Europe to make the dive.

I didn't talk a lot about my plans to make a world record dive. However I talked about it to some students. One of them was Remko van de Peppel. He offered to join me and act as my personal shallow support diver. I gratefully accepted his offer. On the 6th of may we got into my van and drove the 1250 kilometers down from The Netherlands, through Germany and Switzerland, to Italy, fully loaded with technical diving gear. Late in the evening we arrived in our hotel In Verbiana, looking out over Lago Maggiore.

The dive

The 7th of May early in the morning Remko and I went to the harbor of Verbiana. There we met with Fabio, the Dive marshal. A large pontoon was already in the water. The bell would arrive that day. A vessel with a crane on the deck from the sponsoring diving company Palumbarus would put the bell in place. The bell was bright new and had to be fitted with all the hoses for the gasses, communication system and warm water. Alessandro was taking the lead for fixing the bell. We underestimated the job that needed to be done on the bell:

Divers Alessandro Scuotto, Pim van der Horst and Mario Marconi receive the deep video cameras just prior to their descent to the bottom.



The decompression bell provides the deep team with refuge from the cold water. Their rebreathers and stage cylinders hang outside the steel habitat from 330 fsw / 100 meters to 30 fsw / 10 meters.

it took one day more than expected. And because we wanted to test the bell in a proper way, we decided to postpone the date of the dive with one day. The bell was suspended under the pontoon. So it could not be lifted out of the water. That meant that we had to exit the bell through the water. Because of the risk of oxygen convulsions it was decided that the deep divers would exit the bell on open circuit, using full face masks.

On the 9th, the pontoon was towed to the location of the wreck. The wreck had been located the day before by the fire department and a shot has been put into place. With the help of the ROV the shot was placed 30 centimeters from the wreck. Next to the shot a decostation was put into the water, which started at 80 meters. On the decostation also the bailout gas was staged. I made a short dive to 60 meters along the shot to test my descent speed, check the visibility and the water temperature. The tests of the bell showed that the bell was working perfectly.

In the evening the whole team assembled in the harbor for the final big briefing. Laminated task lists and decompression tables were distributed amongst the team members. After the briefing I went to bed for a short night…

At 6 AM we got up and went to the harbor. In the harbor I had a light breakfast and tried to clear my mind. At 7 AM we went on board of the vessel which would take us to the pontoon. We would gear up on the vessel and go into the water from the vessel: the pontoon was about two meters above the water. I did my usual rebreather checks. Mario, Alessandro and I had a short final talk: when during the ascent one diver has to abort, the other two divers would continue the dive. When one diver has to abort the dive on the bottom, all three divers would ascent together. At 8.30 AM we were ready to enter the water. The swim to the shot was a short one. At the shot we got our video cameras. We made the last OK sign and we started the descent.

I was letting the rope of the shot slide trough my fingers. It made a sizzling noise. In the meanwhile my ADV was inflating the loop continuously . I was continuously inflating my drysuit and adding gas to my BCD. I passed two shallow support divers who were checking the decostation. Suddenly at 140 meters I got a low pressure alarm: my on board 2 liter diluent tank was almost empty! So I switched on my off board diluent and I continued my descent: still 100 meters to go. I also switched to my high setpoint (1,5). Switching earlier to the high setpoint would have caused spikes in the PO2.

At 220 meters I saw a dim light coming from the bottom: the ROV was illuminating the wreck. I didn't wear a helmet like Alessandro and Mario. I only carried a Metalsub LED light. Mario and Alessandro were swimming around the ROV and the wreck. They both signaled that they were OK. I took my video camera en taped them. I was touching the bottom and took some images of the two divers from below. At 14 minutes runtime the three of us started the ascent. The ascent speed was relatively high until 150 meters. From 150 meters up, the ascent speed was the "normal" 10 meters per minute. I was feeling good and very pleased with the new world record. The only thing left was a long deco of almost eight hours... But then at 120 meters I felt water coming in into my drysuit. I immediately felt the cold through my body. I was suspecting a leak on my OPV (over pressure valve). Later (after the dive) I discovered that the membrane of the OPV had shifted. It went through my mind that it would be a tough ride to the surface. In the meanwhile however, I made some films of the divers and also of the deep support divers on 100 meters. We were signaling them from below that we were OK and that we were coming up. It always feels good to know that support is close. I indicated that I was getting pretty cold... and heavy. My drysuit started to get really flooded. I used a lot of Argon and diluent. Around 80 meters we went off the shot to the decostation. There I saw that Alessandro was having problems. Mario was already assisting him. At a depth of 60 meters Alessandro had to bail out. He stayed on open circuit until the bell. I was getting more and more cold. My sight turned bad: I had difficulties to read my decompression tables. My fingers felt numb and pressing inflators and holding onto the decostation was getting difficult. At 40 meters I met Remko. In the meanwhile I ran out of Argon, with still one hour to go before entering the bell. I told myself to hold on for another thirty minutes: I skipped thirty minutes to enter the bell earlier. I decided to compensate the skipped in water decompression time when I was in the bell.

Remko accompanied me to the bell. Together with another shallow support diver he took of my Ouroboros. I could barely move. I was trying to get into the bell, but almost every power has left my body. Only when Remko signaled that the other divers needed to enter the bell, I was able to push myself inside. In the bell I opened the oxygen valves and put on a breathing mask. I felt very dizzy and had to vomit once. Ten minutes later Alessandro and Mario were entering the bell. Alessandro was not in a good shape and he vomited frequently. Every thirty minutes we did our airbreaks and after a while the bell moved up to the next decolevel. After almost five hours I was going to be the first diver to exit the bell. I putted on a rec BCD with Full Face Mask. Two fire department divers guided me to the surface. There a large crowd was waiting for me. Surface support laid me down on the warm deck of the vessel. My wet suit was removed and a medic checked my blood pressure and did some "sanity" tests. I was feeling pretty dizzy and getting up on my feet was not easy. I was wrapped up in an aluminum blanket to prevent loss of body heat. Cameras were clicking and zooming. TV teams from Italy, Russia, US and South-Africa were filming the whole event. With a couple of minutes interval Alessandro and Mario emerged. Alessandro was taken care of immediately by the medics. In spite of his physical condition he was smiling and waving to the crowd. He was put on transportation to the nearest decompression chamber. Mario and I gave some interviews and posed for pictures. Slowly the people were leaving the vessel and the pontoon. Mario and I were transported back to the harbor… We had a lot to talk about, but we saved it for later. It took me another two days before my dizziness had disappeared completely.

Official World Record Wreck Dive 236 meters (241 meters height compensated) During all the time Nuno Gomes (World Depth Record Holder was there, as witness for "World Guinness of Records". A list of official record dives can be found on:

www.nunogomes.co.za/rec.htm

Mario Marconi assists partner diver Alessandro Scuotto with some minor gear readjustments at 330 fsw / 100 meters.

Pim van der Horst

Pim started diving in 1983 at the University of Tilburg (The Netherlands). He came in contact with technical diving when nitrox was introduced in The Netherlands in the early nineties. A next step was rebreather diving. He had to seek technical training abroad (UK and the US). Technical diving and especially rebreather diving got the interest of Pim and he continued his technical training. He started up his own technical diving school in The Netherlands: Pim's Tekdiving (PTD). PTD has several facilities in The Netherlands and instructors abroad. Pim is Tri-Mix Instructor Trainer Closed Circuit (more then 10 different rebreathers) and Open Circuit for several agencies (DIRrebreather, ANDI, IANTD, PADI, PTA/CMAS and WOSD).

www.tekdiving.nl

Mario Marconi

Mario began his diving activities in 1993. In 1997 he has accomplished his first diving training with IANTD. In 2001 he became a PSA Advanced Deep Air Instructor and then started with his deep caves explorations, with open circuit first and then moving to closed circuit. He is also using and studying the advantages of Heliox diluents for closed circuit deep cave exploration. In 2002 he co-developed and tested the SCR Passive addiction EDI2002 specially projected for cave dives in extreme conditions. Mario is a P.T.A./C.M.A.S Extended Technical Instructor, Full Cave Instructor Trainer and Ouroboros Rebreather Instructor.

mar.marconi@libero.it

Alessandro Scuotto

Alessandro had his first dive at 6 years old, and his first scuba certification at 12. At 18 years old he already was a recreational diving instructor. In 1996 he had his military underwater certification with "Com.Sub.In" from the Italian Navy. In 1997 he achieved his first technical Instructor certification. Using Rebreather from the very beginning, he experienced lots of hours on different machines. Next to that Alessandro is an OTS (Commercial Diver), Hyperbaric Chamber Operator, R.O.V. pilot, UW submarine pilot. Now he is the vice chief of Napoli's section of the underwater team of the Italian Police. He is also the chief executive officer of Deep Sea Technology (commercial diving company). Alessandro is Instructor Trainer for PTA/CMAS, NASE and PSA.

www.deepseatechnology.com

Further information of the preparation and execution of the dive can be found on:
www.ddexhibition.org/DVD_Video.html
www.ddexhibition.org/Foto.html

Footage of wreck discovery (by ROV of VVF), wreck history and general information:
www.ddexhibition.org/RecordMondiale.html
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www.ddexhibition.org/SponsorUK.html
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Author and deep team diver, Pim van der Horst is assisted out of the water and stripped of his gear after over eight hours of required decompression.

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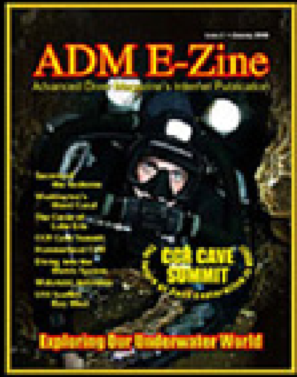

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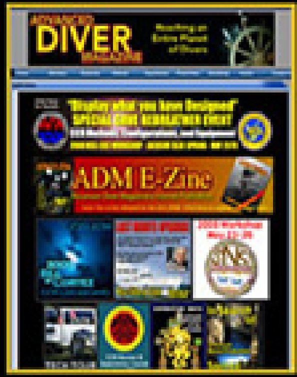

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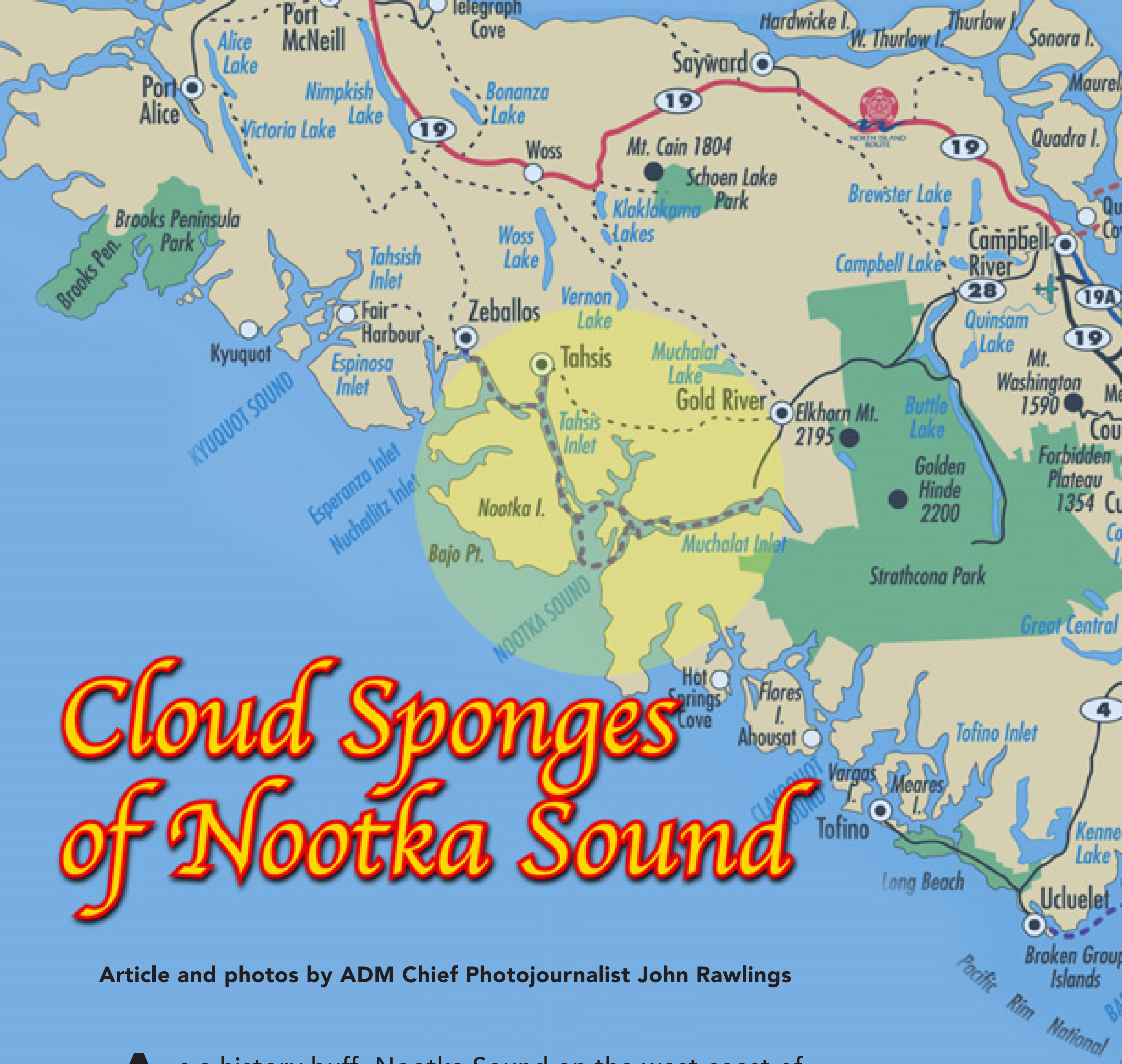


Cloud Sponges of Nootka Sound

Article and photos by ADM Chief Photojournalist John Rawlings

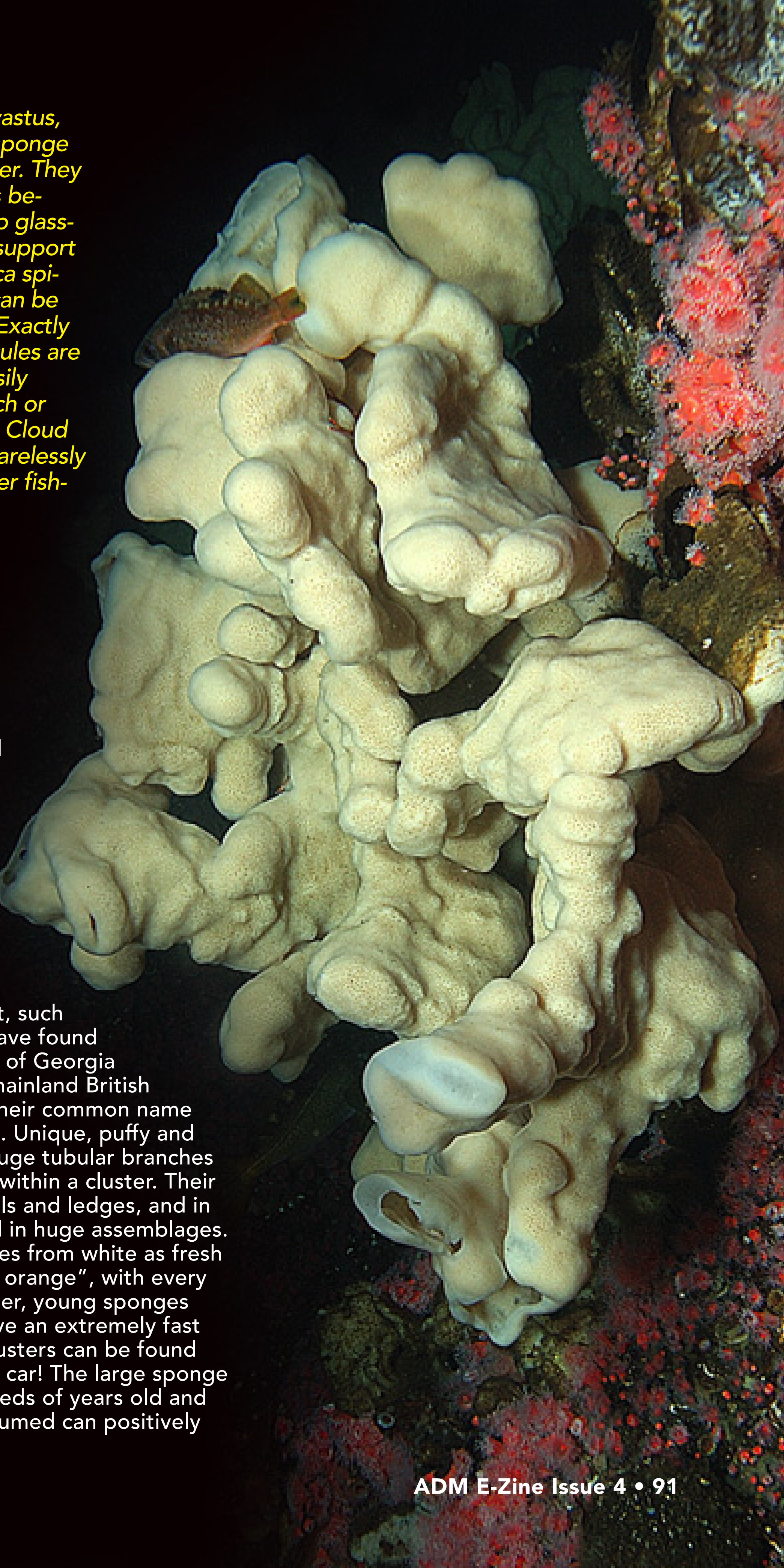
As a history buff, Nootka Sound on the west coast of Vancouver Island has always intrigued me. Ever since Captain James Cook of the Royal Navy first landed there in 1778, it has been considered the "birthplace" of modern British Columbia. As a diver and underwater photographer the area also has been a real lure for me in the endless quest to find and photograph amazing and unique cold-water species. One species that is among the most beautiful and amazing to be found in Nootka Sound is the Cloud sponge.

This melding of two photos clearly shows the raw beauty of Nootka Sound, both above and below the surface. The stunning snow-capped peaks high above are rivaled by the gorgeous snow-colored cloud sponges deep below. A Hairy-Spined Crab, Acantholithodes hispidus, can just be seen peering out from the large opening on a branch of the sponge.

Left Page: Mist dances across the face of the green forest beyond as the light beacon at Mozino Point stands its lonely sentinal duty. Photo by Valerie Lyttle

Right Page: An intricate and beautiful cloud sponge grows from a wall covered with Strawberry anemones off Mozino Point. Many species make their homes on or around the sponges - in this photo a Rockfish can be seen nestled near the top.

Cloud sponges, Aphrocallistes vastus, are "glass" sponges, a class of sponge typically found only in deep water. They are referred to as glass sponges because they have extremely sharp glass-like spicules made of silica that support the sponge structure. These silica spicules are as sharp as glass and can be extremely irritating to the skin. Exactly like fine glass, however, the spicules are extremely fragile and can be easily damaged with the slightest touch or careless kick of a fin. Frequently Cloud sponges are also damaged by carelessly dropped anchors and deep water fishing or shellfish equipment.



Cloud sponges can be found from the Bering Sea southward to Mexico, usually in extremely deep water. In the waters of British Columbia, however, they can frequently be found at shallower depths, beginning at some sites around 80 FSW and appearing in denser numbers as the diver goes deeper. The species is typically found in areas of minimal current, such as inlets, although I personally have found examples on wrecks in the Strait of Georgia between Vancouver Island and mainland British Columbia. Cloud sponges take their common name from their cloud-like appearance. Unique, puffy and convoluted, they often display huge tubular branches protruding in all directions from within a cluster. Their favored habitat is steep rock walls and ledges, and in such locations they can be found in huge assemblages. The color of these sponges ranges from white as fresh snow up through "jack-o-lantern orange", with every color variation in between. Smaller, young sponges often abound, and appear to have an extremely fast growth rate, while older large clusters can be found that approach the size of a small car! The large sponge clusters are thought to be hundreds of years old and the myriad shapes they have assumed can positively defy description.

Nootka Sound is on the west coast of Vancouver Island, and trips there from the U.S. involve crossing the US/Canadian border and catching a ferry from Vancouver on the mainland across to Nanaimo on the east coast of the island itself. There are three options for reaching Nootka Sound from the east Coast of Vancouver Island – by seaplane - by ship, (the Uchuck III, a small freighter that serves the coastal communities), or by driving the length of the island and cutting across the mountains to the village of Tahsis on long, winding roads. Divers traveling with the extensive amount of gear necessary for cold water diving as well as underwater photography most often choose the driving route. No matter which method of travel selected, the scenery is absolutely breathtaking and at a level that will be remembered forever.

The tiny village of Tahsis is located at the northern end of Tahsis Inlet – a long, fjord-like body of emerald-green water stretching off to the south into Nootka Sound, surrounded by rocky cliffs and dense forest. Tahtsa Dive Charters is the only dive charter operator in the village, and owners Scott and Jude Schooner run an excellent operation. Tahtsa is a Cheslatta T'en (First Nations) word meaning "Waters Far Off", a name very applicable to their location! They run a full service dive shop providing both air and Nitrox, (Trimix is planned for the future), know the local waters well, and have a great deal of experience working with recreational, technical and CCR divers.

Tahtsa Dive Charters has two dive boats available, the 30 foot Notorious and a small 18 foot runabout used for individual divers or small groups. With a large open forward deck, the Notorious was the one for us, and it seemed as though the excessive amount of dive gear and camera equipment brought by the ADM team filled her forward area. As we pulled away from the dock I found myself gazing around at the mountainous peaks around me, only briefly appearing through the ever-present fog and mist. Some of the taller peaks had a whisper of snow on them already, and the beauty of our surroundings was breathtaking. As Scott steered Notorious into the Tahsis Narrows, a channel leading to Esperanza Inlet, a small unmanned light beacon came into view on shore. This marked our destination – Mozino Point – a site well known for a large and healthy population of Cloud sponges.

Once again, I found myself grinning in anticipation at the thought of what we were about to see and of the images I intended to get from these dives. After gearing up each of us strode off the side of the Notorious and splashed into the rich green water, the sound of the wind coursing through the Narrows the only other sound. Scott handed my heavy camera system down to me, and after a quick equipment check on the surface, our team began our descent. A steep rocky wall plunged downward and we followed its contours past dense clouds of Yellowtail Rockfish. Plunging deeper downslope into the clear emerald waters, our lights slashed out into the darkness like sabers and I again found myself astonished at the gorgeous colors that were on display before us. Much of the rocky surface was covered with a coating of absolutely gorgeous bright red and pink Strawberry Anemones resembling a thick, fuzzy pink blanket. They gave me a mental sense of warmth even though we were immersed in water that grew colder with each foot we descended. Giant rock scallops seemed to be everywhere in clumps, each of them as large as a dinner plates, and hundreds of bright red and purple sea urchins clung to the rocky wall, their fluorescent colors in stark contrast to the soft pink of the blanketing strawberry anemones.

As we approached 100 FSW, I began to see large bright "clumps" materializing beneath me…..almost ghost-like. I knew what I was seeing – Cloud Sponges – and lots of them. Both beautiful and incredibly fragile, as they grow Cloud sponges can assume extremely bizarre shapes, some specimens almost seeming to resemble the skeletons of whales or mythical beasts. At Mozino Point we were astonished to see not just one or two of these beautiful sponges, but dozens upon dozens of them – from tiny sponges obviously just getting started to huge clusters possibly hundreds of years old. At one point I think that I probably had 20 to 25 of them in view, their pale yellow colors and shapes seeming to dance in the beam of my light. The size of the specimens appeared to increase with depth.

Happily humming to myself, I slowly drifted over the clusters of cloud sponges, taking care not to touch them or even to kick in their vicinity. My shutter-finger worked as fast as I could line up each shot, my Ikelite DS-125 strobes recycling each second and the images

ADM Team Member Valerie Lyttle glides alongside a wall literally awash in bright colors at Mozino Point. The primary species noticeable in this photo are Strawberry anemones (Corynactis californica), Giant Rock Scallops (Crassadoma gigantea), and Red Sea Urchins (Strongylocentrotus franciscanus).

piled up – each one appearing first in my mind, next in my viewfinder, and finally within the memory card of my Nikon d-SLR camera. From out of the corner of my eye I could see ADM Team members Valerie Lyttle and Vel Wilson gliding over a series of sponges. Valerie especially had eagerness glinting in her eyes as her camera also recorded the beautiful scenes all around us.

Many other species can be found associated with Cloud sponges, often making their homes among the intricate shapes. Juvenile and adult rockfish of various species swim around the sponges continuously, and can often be seen contentedly resting inside the folds or tube of a sponge. One particular species, the Quillback rockfish, Sebastes maliger, is especially noted for this habit. Here a pair would be hovering near the base of a sponge, there a single adult would be nestled at the top of a sponge as if on a throne, and over there a juvenile quillback would peer out at us from inside one of the tubes as if seeking sanctuary. Decorator crabs also abounded, their long thin legs walking gracefully across the surface of the sponges seeking nooks and crannies to escape from the glare of our lights. On many of the sponges we found Spiny

Lithode Crabs, Acantholithodes hispidus. These crabs, also known as "Red Fur Crabs" have what appear to be a furry body and possess bright red claws. They also scurried here and there to avoid the glare of our lights but refused to leave the body of their host, eventually finding a spot they could wedge themselves into to escape our unwanted attentions. Trying to get photos of these crabs, we found ourselves laughing at their antics.

As always, all too often our series of dives at Mozino Point came to an end and we found ourselves heading back toward Tahsis and an evening spent downloading images and diner with good friends. The engine of the Notorious rumbled beneath our feet as we turned northward up the inlet, its sound intruding on the silence of the wilderness around us. I noticed a Harbor Seal resting on shore near the base of the beacon, irritated at the disturbance and looking up sleepily as we passed. The rays of the departing sun glistened off the water as we rumbled past and slowly the seal's head sank back down into a dreamy sleep....the loud humans were leaving and serenity once again ruled this portion of the inlet.....like us, his day had ended well.

Information on diving in Nootka Sound can be found by visiting the following websites:

Tahtsa Dive Charters
www.tahtsadivecharters.com/

Tourism Vancouver Island
www.vancouverisland.travel/outdoor/divingsnorkeling/

Just getting to Nootka Sound can be half the adventure! Here are some links that will provide useful travel information:

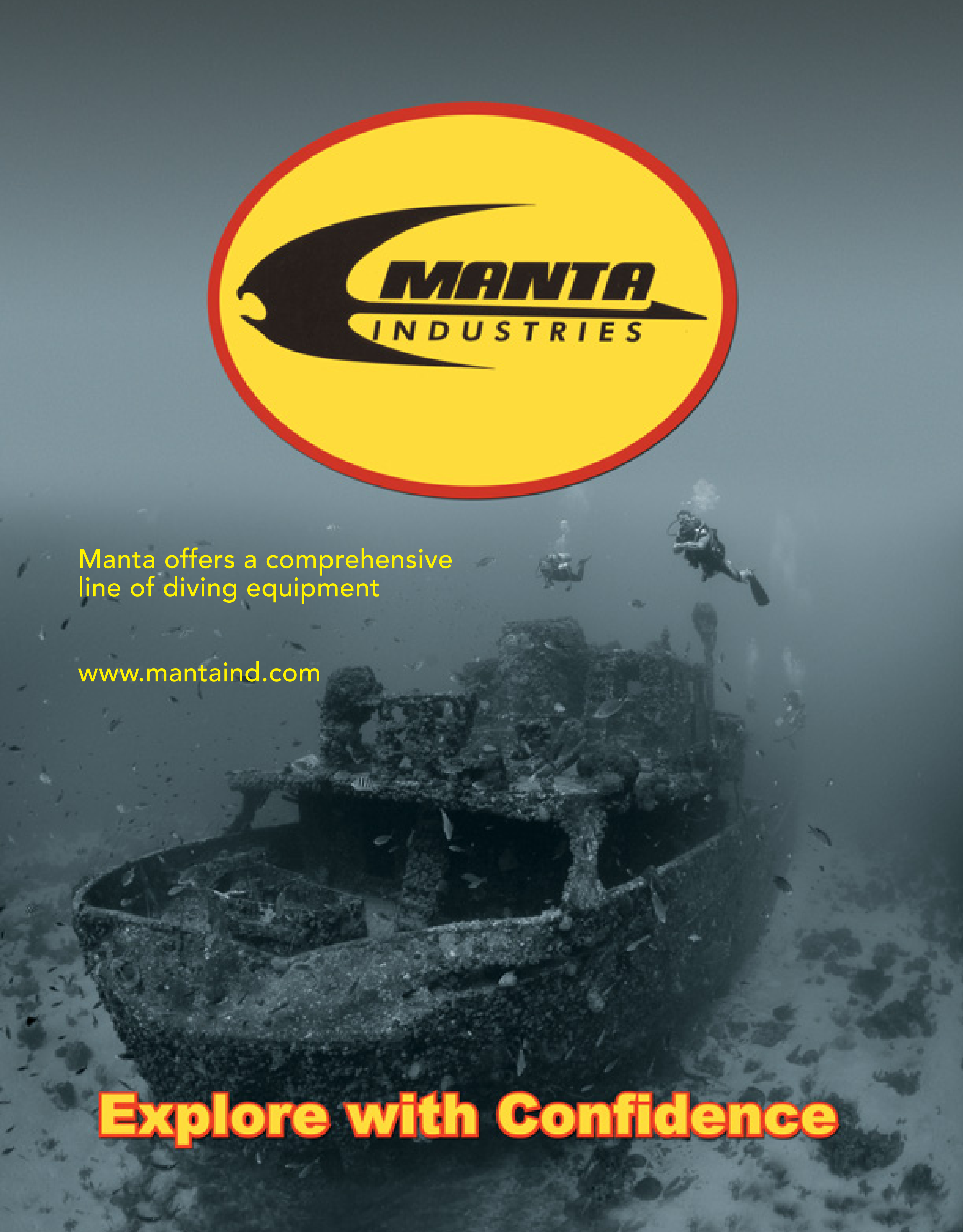
British Columbia Ferry System
www.bcferries.com/

Nootka Sound Service, Ltd.
www.mvuchuck.com/

Additionally, there are several seaplane companies that fly directly into Tahsis from points in both British Columbia and Washington.

Left Page: A colony of Orange Zoanthids, Epizoanthus scotinus, coats an undercut wall near Mozino Point. The currents present here lead to an endless variety of species thriving in the nutrient-rich waters.

Right Page: A pair of Longhorn Decorator crabs (Chorilia longipes) cling to the opening of a Sharp Lipped Boot sponge (Rhabdocalyptus dawsoni) jutting out from the edge of a Cloud Sponge. Two Yellowtail Rockfish (Sebastes flavidus) have also decided that this is a good place to "hang out".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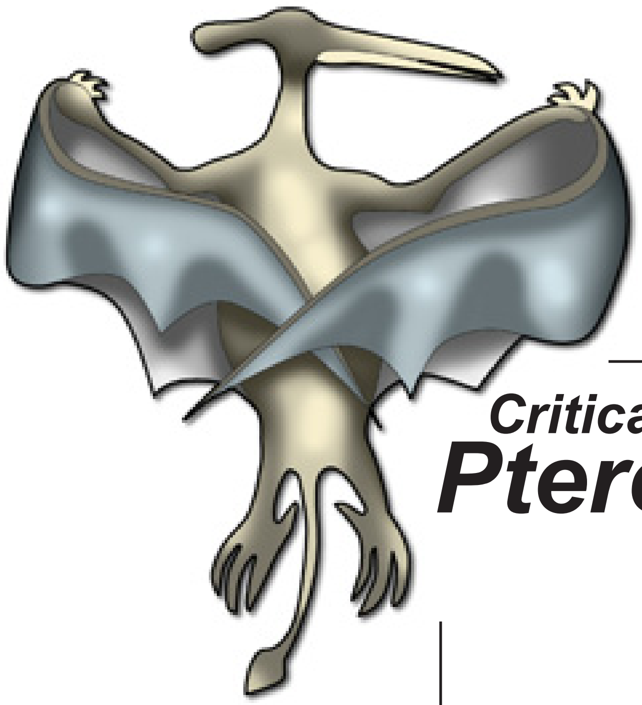


Critical Aspect's

Pterodactyl Backplate

ADM Product Review

by ADM Staff Writer John Rawlings

There I was in Orlando, wandering down one of the many aisles at DEMA. My feet hurt and it had been a long day....when you're a technical diver looking for new products and opportunities the very size of DEMA represents a challenge. I had seen what seemed like hundreds of flashy booths full of gorgeous, colorful posters of white sandy beaches, T-Shirts, bikinis and fluorescent pink or green masks or snorkels. Exhibitors in pirate costumes or Hawaiian shirts seemed to be everywhere and the hubbub of music and the dive business cascaded my ears constantly.

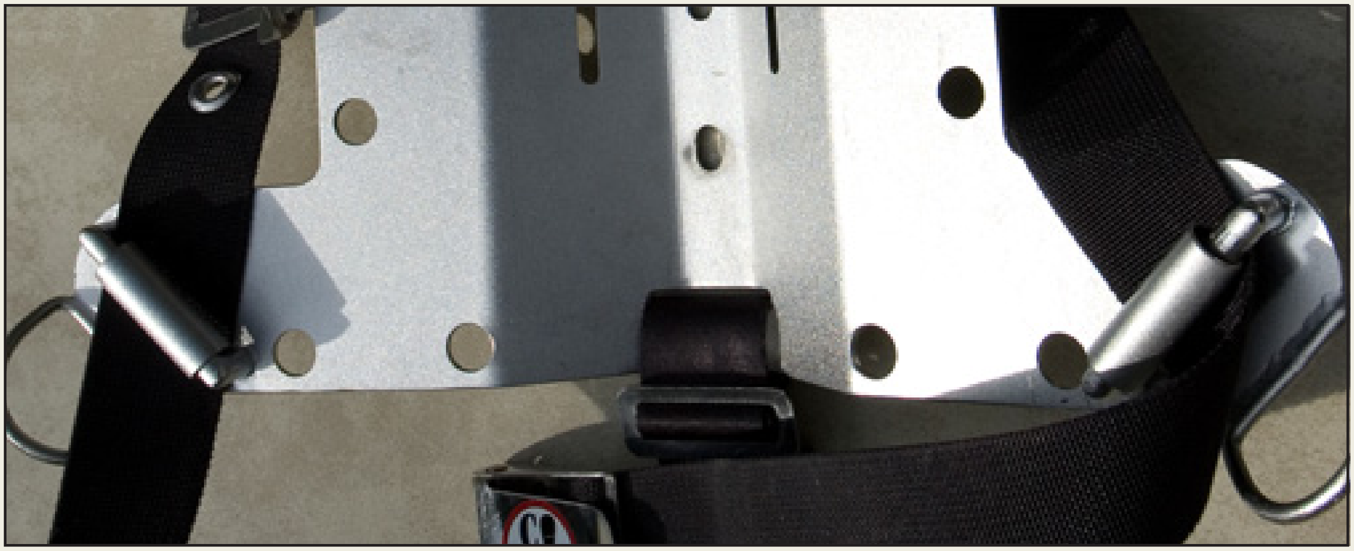
Then, I turned a corner and saw something unique amidst all of the glitz and noise – a man standing in a fairly unobtrusive, out-of-the-way booth, with a single product on display: a steel backplate. Not exactly what you'd expect to see at a DEMA show. That backplate drew me into the booth as if it was a magnet, but it was the man talking about the uniqueness of his product that kept my interest piqued. Gary Cresswell and his company, Critical Aspect, Inc. have come up with a winner.

Now, I have more than a few backplates out in my garage from various manufacturers, all of them extremely useful and more or less the same. This one was different, though, and some of the differences were visible from 50 feet way. For one thing, the plate comes with a two inch "D" ring welded to each of its lower corners. Immediately alongside these "D" rings are patented "harness rollers", which are welded to the plate's lower corners. These corners extend slightly out from the body, almost like tiny wings, and give the Pterodactyl an extremely unique appearance. The harness rollers allow the diver to don/doff the harness with an ease not known with other backplates and harnesses. I tried one on at the booth and was immediately struck by how easy it was – almost as though I was using webbing that could "grow on command"! The rollers allow the harness to adjust automatically to differences in the bulkiness of the diver's exposure suit from one dive to another. I've been diving for 32 years now - call me an "Old Fart" if you will - and I find that the older I get the more I look for easier ways of doing things. These harness rollers really caught my attention and the moment I slid one of these backplates on at the show I arranged to get my hands on one.

The plate itself is made from Marine Grade 316 stainless steel and is guaranteed never to rust. Additionally, it has a beautiful sand-blasted finish that also enables the diver to get a good solid grip due to the textured surface. The plate has two sets of tank band bolt mounting holes allowing for a range of 1 and 1/2" vertically. The lower two mounting holes are cut as vertical ovals to accommodate varying alignment of the tank bands. The plate is 1/8" thick and weighs approximately 6 and 3/4 pounds. The plate also has two pairs of slots near the center for sliding cam bands through for mounting a single tank. Alternately, the diver may use a single tank adapter – one of the many available on the market or one specifically designed for the Pterodactyl by Critical Aspect, Inc. The equipment mounting holes along the sides and bottom of the plate are 5/8" in diameter.

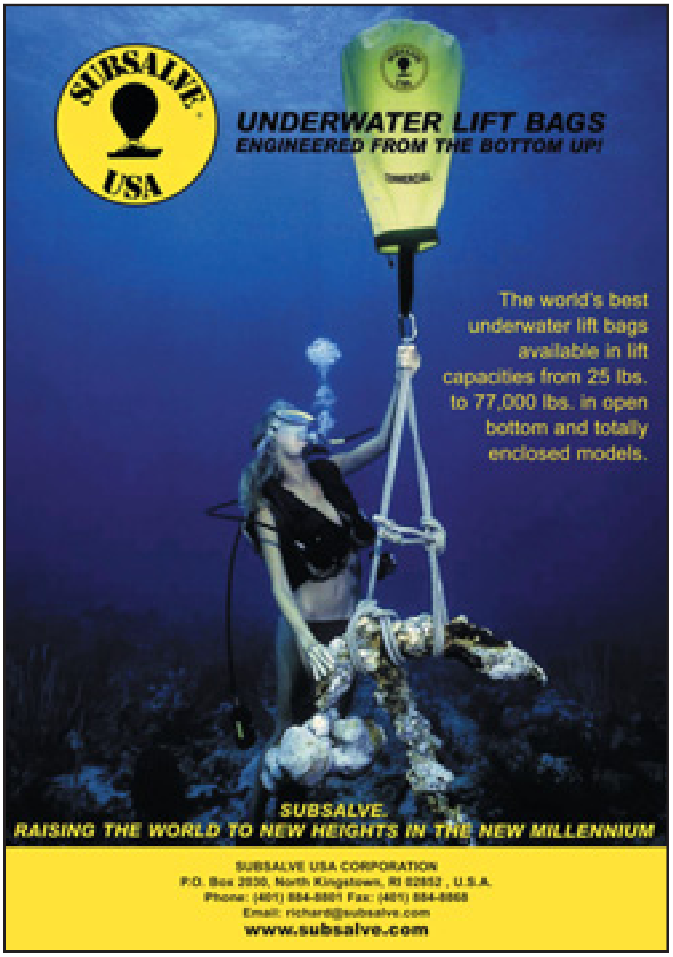
The harness hardware consists of three sets of D-rings and two belt buckles. The smaller upper D-rings are positioned high on the diver's chest and are used for securing items before the dive. The middle D-rings are for general use during the dive. The lower D-rings are the ones that I found especially interesting – intended to serve as the upper attachment point for stage bottles, they are designed to lock into the harness itself. This patented design, "Harness Lock", is actually quite simple – one of those things that when you look at it you kick yourself for not thinking of it first! The Harness Lock system is a post welded onto the D-ring that engages with grommets set into the harness. Once the lock is engaged, it is literally impossible for the D-rings to slide down the harness no matter how heavy your stage bottles are. Four of these grommets are built in on each side of the harness (set two inches apart) to accommodate divers of different sizes. All of the D-rings provided with the Pterodactyl are "fixed angle" for ease of use underwater.

A plastic "secondary belt buckle" is attached to the right end of the waist belt to prevent that end from pulling-out of the right harness roller while gearing-up. Once into the harness, the diver simply opens the gate of the "secondary belt buckle" and slides it over to the right harness roller and closes its gate. This serves as a "safety" in the unlikely event that the "primary belt buckle" should open during the dive and can also be used to keep a light canister solidly against the diver's right hip. Critical Aspect, Inc. uses what they call the "Mega Buckle" as the primary buckle. This is actually two belt buckles welded together back-to-back with their gates facing in opposite directions. This allows the diver to re-position the buckle on the left end of the waist belt quickly and easily, without having to deal with feeding the harness through the narrow slots as with other buckles. The Mega Buckle comes with a stainless steel quick link welded to its underside as a front "attachment point" for the crotch strap. The crotch strap is two inches wide and made from soft, pliable seatbelt material, (very "genital-friendly"). This strap comes with a side-squeeze quick release buckle and a two inch stainless steel DPV towline ring. The harness is standard two inch wide nylon webbing and is available in black or red. The harness hardware weighs approxi-



mately 1 and 1/2 pounds. The total product weight of the Pterodactyl system is thus approximately 8 and 1/4 pounds.

Flat out, the Pterodactyl backplate system is designed for use by divers in cold water. Though realistically it is too heavy for use in the tropics and for flying, its rock-solid construction and robust design make it uniquely suited for the cold waters of North America and Europe. Several of my fellow staffers at ADM questioned my interest in the Pterodactyl, not seeing any use for it in the caves of Florida and Mexico, but I immediately saw some REAL benefits in the design for "my style" of diving in the Pacific Northwest. My Pterodactyl arrived only a few days prior to my departure on a trip to the Queen Charlotte Strait in British Columbia, and I eagerly anticipated putting it through its paces in a variety of situations. I easily used it with my KISS Classic CCR throughout, but it clearly would have easily worked with a set of doubles as would any quality backplate. We dived in the "whirling dervish" currents of the Nakwakto Rapids, the deep walls of Browning Pass, a pinnacle in extremely low visibility, and on a dive in swirling currents futilely searching for a wreck from the 1800's. We dived in glass-like water in protected coves, swift-running water spawned by tidal currents, and "lively" surfaces created by the influx of rivers. We dived from both a small skiff – low to the waterline with benches to match - and a large aluminum dive boat with benches approximately 3 feet off the deck and a steep ladder. "Tweaking" the harness as the days went by, I found that the Pterodactyl delivered what had been promised and I grew increasingly satisfied with it throughout the week. I'm a tall guy, yet I found that I could easily slip into my harness no matter HOW low the seat was. The envious glint in the eyes of a few of my buddies was further testimony to the intelligence behind the design. I think that this is an excellent, rock-solid system – one that I would wholeheartedly recommend to divers requiring robust equipment coupled with ease of use. For those of us diving in the "cooler climes", the Pterodactyl is worth extremely serious consideration.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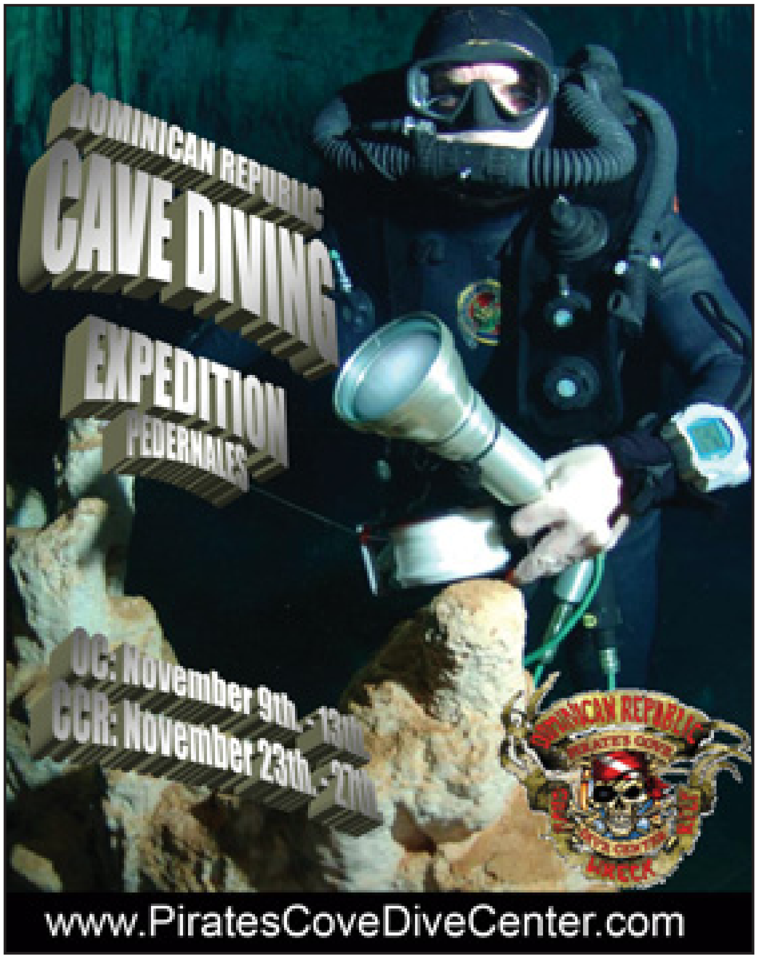
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Discovery of the Frenchman's Barge Wreck

Art Riedel, Sr.

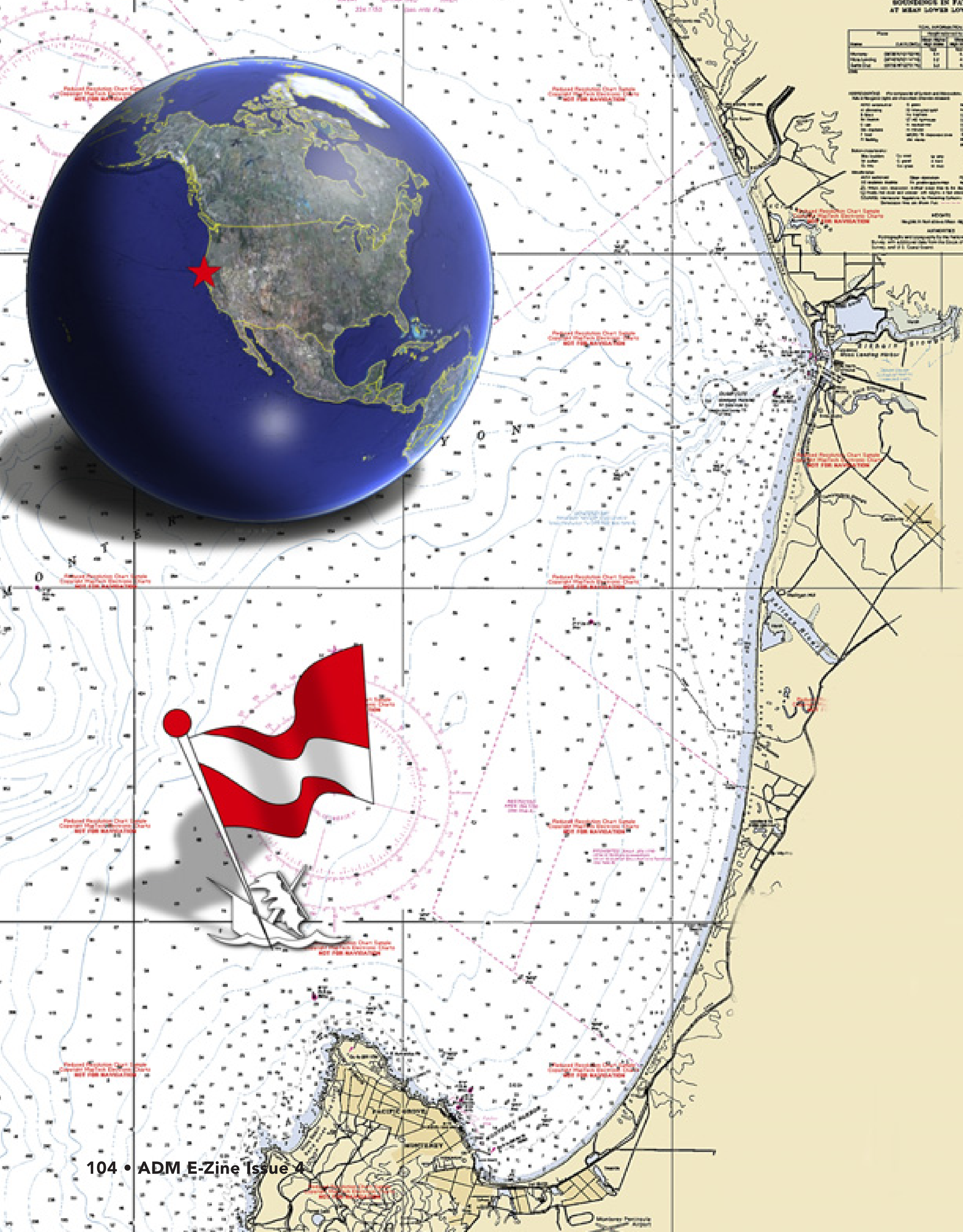
By Kenneth Gwin

In the background noise of the diving world, the constant hum persists of stories and rumors of lost ships and wrecks, and things the sea claimed for her own.

It is no different here in Monterey. But for a coastline littered with wrecks, California is not a mecca for wreck divers. Our coast lacks the warm, romantic, aquarium-blue waters of the Caribbean, the graveyard expanse of East Coast shipping lanes, the history and antiquities of the Mediterranean, the quiet calm of a Western Pacific lagoon.

The old Spanish and English tall ships that once sailed these waters are buried in time, and any that may have gone down here were ground into infinity by big, cold seas and perpetual shifting sands. There are carcasses of steel and wood smashed beyond recognition sitting off any point of land you choose. Anything the rocks and reefs don't pound to pieces, the abyss just swallows whole.

Artistic rendering of the wreck of the Art Riedel, Sr. resting on its side:
Illustration by Kenneth Gwin




Team diver, Denzil Wessels on deco with scooter: photo by Phil Sammet

Still, if you asked around, there were faint rumors of some ship that had foundered off Point Piños. Somebody said it had broken up and been towed back out a few miles and left to sink. How long ago wasn't clear. Some said it had been salvaged. Others said it was a huge barge. Why it might have gone down, they couldn't really say.

Encouraged by more local rumors and sketchy memories of a ship or barge that had gone down sometime in the late 80s, our small group of sport divers set out in the spring of 2005 to search for what truth might be behind this veiled but inviting tale.

Captain Phil Sammet, local deep diver and boat guru, started our little adventure. Always one to keep track of such lore, he mentioned in passing one day that he thought he'd seen a wreck noted on an old NOAA chart, or at least a mark of something lying somewhere offshore of Point Piños.

Marcos Perreau Guimaraes, our ever-questioning Frenchman, began comparing the various maps and charts carefully for any unusual sign or mark. On just one edition of the NOAA charts, he finally found the map notation indicating an unnamed wreck just as Phil had reported.

This little glitch in documentation gave Marcos some encouragement that this might be something unexplored — something that might have been forgotten or overlooked by others. None of the newer charts had any marks or notes, or had shown any indications of any unnamed wreck for years.

Using detailed bathymetric maps recently available online, Marcos made a three-dimensional search of the topography of the area. (Bathymetric maps are slowly becoming part of everyday dive planning, and can show a diver a clear picture of the ocean floor within a few meters resolution.) Examining this data closely, a funny little blip showed plainly just off Point Piños, 500 yards from the NOAA designation. It was shaped just like a boat.

Whale watchers set off for a day on the Bay: photo by Kenneth Gwin

Marcos called Phil on the phone that evening, dangling the bait of a promising adventure.

A few days later on the way back from diving the deep pinnacles out of Point Lobos, Marcos casually mentioned to me that he thought he'd found something interesting. And, with one of his mischievous faraway looks he added, "It may be manmade."

Then, with Denzil Wessels, another buddy, the dive planning was soon a whirring discussion.

With all of us huddled over a computer, a little tweaking of the bathymetric software produced a three-dimensional projection of the seafloor map, generating a sketch of what the site might look like underwater. Clean lines, angles, and curves certainly didn't look like a natural formation. The spot we were looking at for our next dive was a sharp bump that came up to 265, sitting alone on the sand at a depth of 310 feet. That was deep; but, conveniently, it was only a couple of miles offshore, and just a short boat ride from the harbor in Monterey.

Preliminary onsite verification was easy with our friend, Tom Mesch, his boat, and a simple depth finder. Just twenty feet in front of the exact GPS numbers provided by the USGS maps, running over flat sand, a clear spike came up, dropping away just as fast — it was a narrow target, and a long way down.

Maybe this wreck is real.

The wreck of the Art Riedel, Sr. sits on the bottom, 2 miles off the picturesque rocks of Point Piños: photo by Kenneth Gwin

Marcos Perreau Guimaraes finishing his deco after a successful dive past 300 feet: photo by Phil Sammet

For our first dive on this mystery spot, we needed to keep it as simple as possible using open circuit scuba. This also meant a "quick" dive with a planned bottom time of only 15 minutes. We would be carrying all of our breathing gas with us throughout the entire dive — back gas, travel mix, EAN 50, and oxygen.

Exposed to offshore conditions, we would need to rely on our experience in diving in remote locations, and pick ideal days for weather and times of dead slack tide. We waited a few months for the perfect day.

We launched from the Breakwater. Losing sight of Pacific Grove and points south in the lingering coastline fog, we quietly motored out into sunny skies opening to glassy seas and slowly cycling swells. Near our spot, we cut the engines and drifted, all eyes fixed on the depth finder.

We idled in circles for some time, getting a sense of things down there. Marcos and Phil quietly discussed the readings on the depth finder. We were over a solid bottom at 300-plus. There were intermittent spikes to 265, eerie scattered images, then a sharp drop back to 305, 310, 300. We dropped our marker line and geared up.

Phil went on again about more rumors and stories about this huge barge being towed in during a storm. They said it filled with water and went down so fast that it nearly sank the tow vessel. A team of salvage divers was called in to make an attempt at recovery. The story goes that this expensive A-Team of professionals said it was undiveable. He thought tethered hardhat divers had been lowered on a platform and complained the currents were ripping so hard they wouldn't take the chance. The idea of a platform full of divers blown off a site 300 feet down into black nowhere seemed blood curdling.

Our drop line was running down, straight and clean. We might be lucky. And we weren't getting paid.

Following Denzil (always make the kid go first) and Marcos, I dropped through their clouds of bubbles, followed the line down past rings and spirals of endlessly long siphonophores, solitary small comb jellies, ghost-like leucothea. Below the layer thick with jellyfish, it was clear blue water.

Quickly losing daylight, we penetrated the still sunless depths. All I could see now were the shiny reflections off the tanks below me, and the waving explorations of their lights probing the darkness.

Then, below us and to the left, the distinct outline of a pattern of giant white metridiums came into view.

This was a structure.

Past 300 feet we hit the bottom.

It only took a second to realize that this was the barge.

Lying over on its side, its guts and derrick structure spilled out in a heap across the ocean floor, the wreckage had created a giant steel clamshell filled with goodies hidden inside. Tools, shackles, and metal girders lay in tangled disarray. A huge anchor, awash in spotlights, was outlined below.

Easing gently along our new discovery, we peered inside the ruins. We found a healthy population of big canary and copper rockfish swimming within the protection of cavernous walls and twisted girders. Fat vermilion rockfish paced slowly between encrusted columns and eyed us from the safety of deep shelter.

We only got a glimpse.

Our time was quickly gone.

Left: Snapshot of white metridiums and small rockfish along the hull side and railings: photos by Denzil Wessels

Right Page: Portrait of a young copper rockfish (sebastes caurinus) living in the rubble on the deck side of the Art Riedel, Sr.: photo by Phil Sammet

Phil met with Scott Kathey at NOAA and the National Marine Sanctuary offices in Monterey trying to find out more about the history of this barge. Scott happily pointed to the detailed shipwreck database maintained by Robert Schwemmer

Documents showed our barge was built for the U.S, Navy by the Pointer Willamette Company in Edmonds, Washington, and launched in July of 1943. It was built as a 165-foot long, 923-ton diesel-electric hydraulic dredging barge, and designated the *BD-1066*. It was sent on its first work assignment to the Wrangle Narrows of Alaska.

It was rebuilt in 1950, increased in length to 236 feet and re-named the *H.W. McCurdy*. It now weighed in at 1200 tons with 6000 horsepower. With a crew of 35, running night and day, this complex of machinery was the largest privately operated hydraulic dredge of its kind, and was capable of pumping material two miles through a two-foot diameter pipe.

Sold again in the mid-sixties, and again in 1980, it was finally re-christened the *Art Riedel, Sr*.

Digging deeper, Phil reached the last owner of our mystery barge, Art Riedel, Jr., of Riedel International. He was amazed that anyone would actually find it or would even be interested. He recalled its colorful history, describing service as far afield as Kwajalein Island in the Western Pacific.

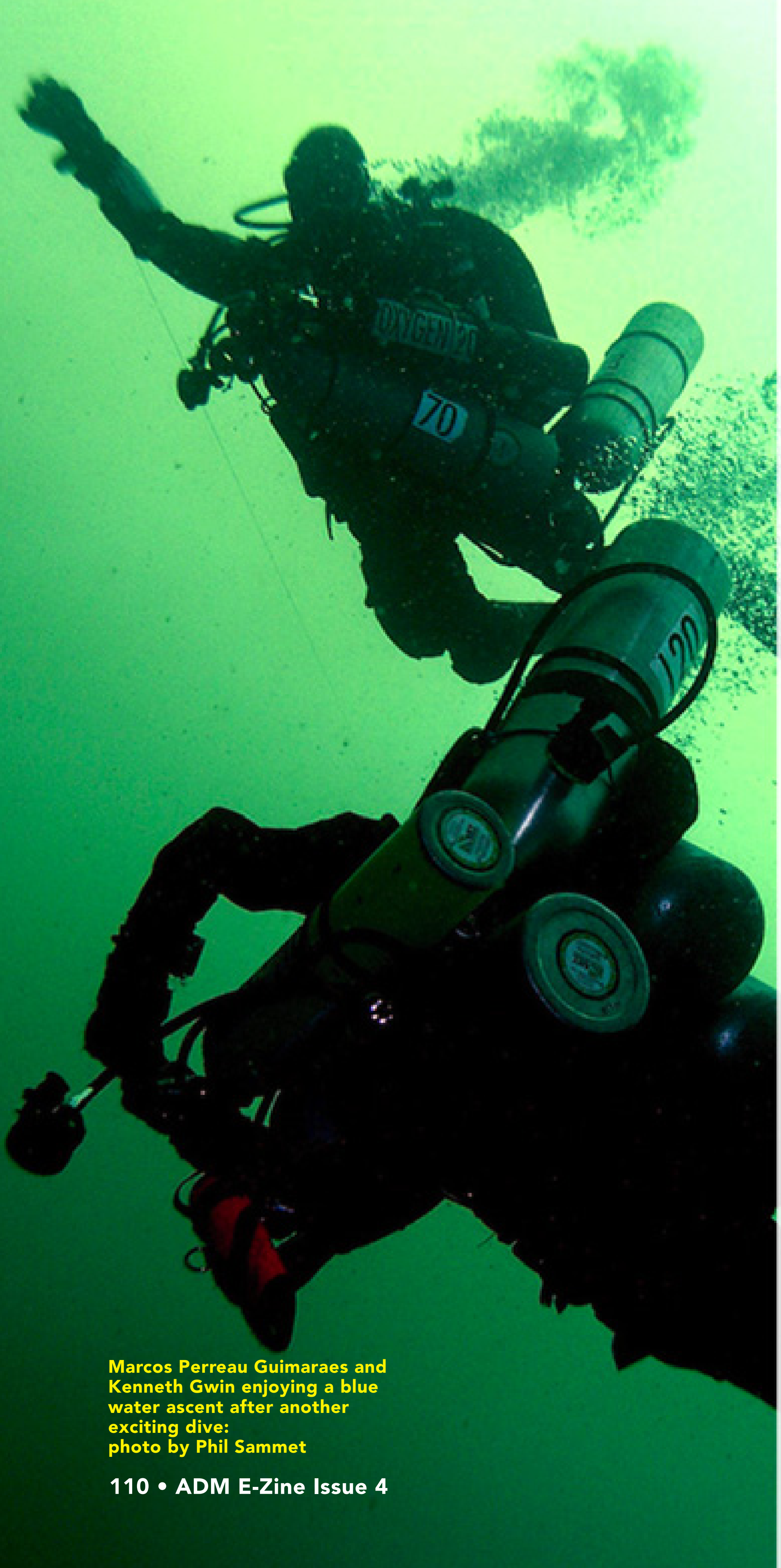
Its last assignment was working on the docks near the Queen Mary in Long Beach. It was being towed north on its way to the delta town of Rio Vista, on the Sacramento River when it ran into rough seas off Point Sur. Traveling light, top heavy, and unstable, it pitched easily, tossed from side to side, and began to take on water. A distress call went out as it was towed toward Monterey, closer to shore and into shallow water. It went down just before midnight on Tuesday, October 16, 1990.

Nobody died.

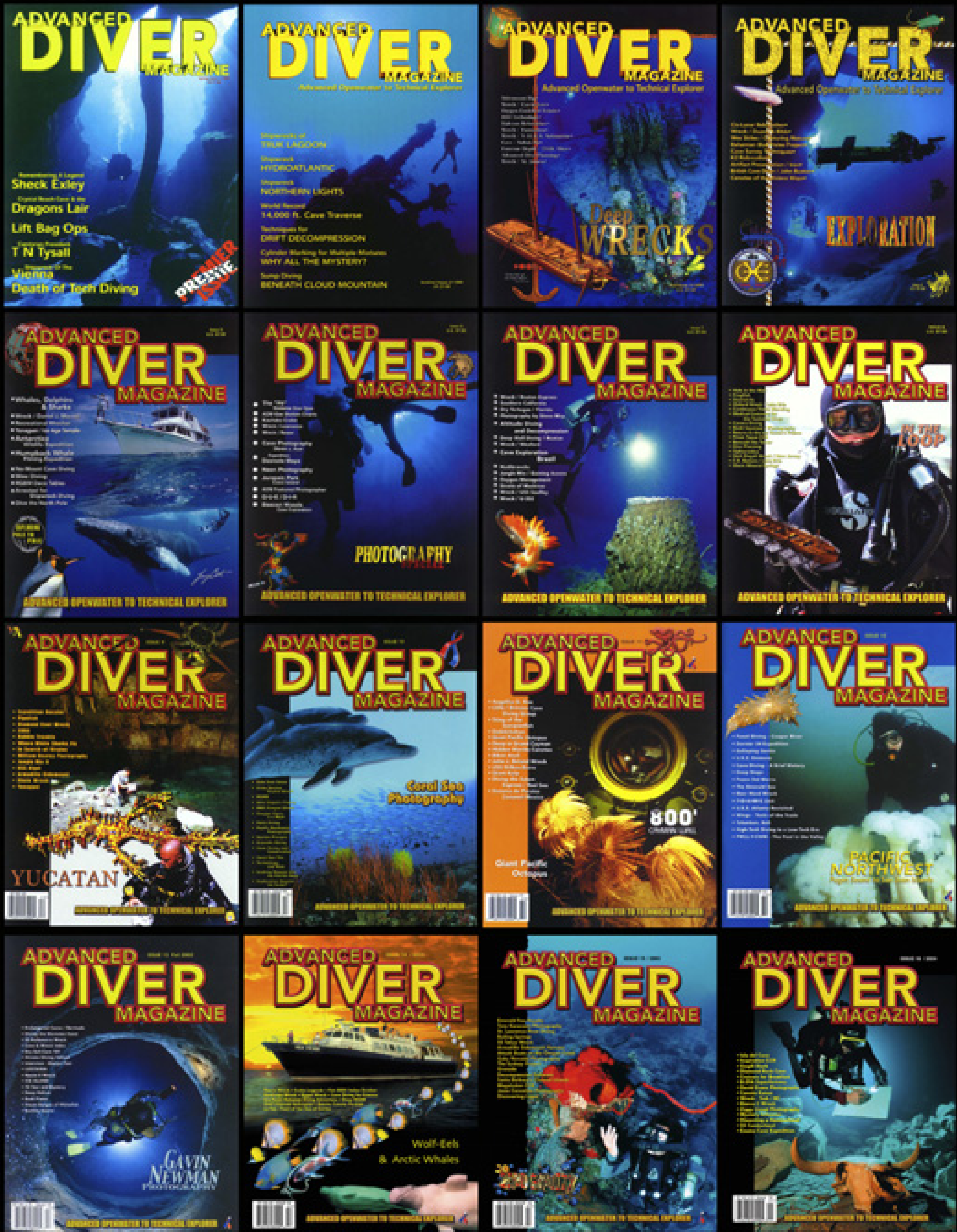
After a number of dives, we were able to explore the hull side, the corners at both ends, as well as the area around the house-like superstructure. We have noted a prolific number of juvenile and adult rockfish living on the site. We have observed schools of half-banded, rosy, and yelloweye rockfish, as well as wolf eels, lingcod, and other deep and cold-water fish. But, hidden among the white metridiums, we were most surprised to find scores of giant white vase sponges. Although not rare locally in depths past 200 feet, these sprouted in strange and bizarre shapes, growing to exceptional sizes through the broken rigging, gantries, and catwalks.

All of this growth and life has accumulated since 1990 when the Frenchman's Barge (as we like to call it) went down. This clarifies the amazing growth rate of these sponges as deep-water currents sweeping across the bottom of Monterey Bay bring in rich sources of food.

In the summer and fall of 2007, NOAA and a research team from the National Marine Fisheries Service made a submarine survey in the area following our discovery. They made three complete circular passes at three separate depths around the wreck. They noted that the structure was crumpled but intact, and confined to one location (producing no significant debris field). The Frenchman's Barge will remain a rich monitoring site for future studies of deep-water habitat (especially for rockfish) and artificial reefs.



Marcos Perreau Guimaraes and Kenneth Gwin enjoying a blue water ascent after another exciting dive: photo by Phil Sammet



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ICELAND
Fracture Crack Exploration

By Gísli A. Gudundsson

For the exploring diver, few things are more exciting than underwater wrecks and cracks. Recently, a few divers from a small town in northern Iceland went pioneering into one such crack, in an area not commonly known but to a few divers. As far as we know, this crack hasn't been explored before — and definitely not photographed with a professional camera.

The whole area is quite exotic and one of a kind. Positioned in the midst of Kelduhverfi at the bottom of Öxarfjör_ur, with the national park in Jökulsárgljúfur and the famous Ásbyrgi nearby. The landscape was designed by volcanic action and glacial movement since the latter part of the last ice age, which was about 10-700 thousand years ago. Active volcanoes are not far away, and the area still is seismically active with minor earthquakes occurring every now and then. The last major drift in Kelduhverfi occurred in 1975-1976, changing and forming many of the cracks there, which belong to the same fracture zone as Krafla, one of Iceland's well-known volcanic areas.


24°
22°
20°
18°
16°
14° W
66°
64° N
Arctic Circle
Grimsey
Raufarhöfn
NORWEGIAN
SEA
Bolungarvík
Ísafjörður
Siglufjörður
Ólafsfjörður
Dalvík
Húsavík
Þórshöfn
Hólmavík
Sauðárkrókur
Akureyri
Blönduós
Mývatn
Vopnafjörður
Hvammstangi
Borgarfjörður
Egilsstaðir
Seyðisfjörður
Neskaupstaður
Lagarfljót
Ólafsvík
Stykkishólmur
Hofsjökull
Hvítá
Langjökull
Borgarnes
Djúpivogur
Þjórsá
Vatnajökull
Akranes
Þórisvatn
Höfn
REYKJAVÍK
Mosfellsbær
Keflavík
Kópavogur
Hafnarfjörður
Njarðvík
Grindavík
Selfoss
Þorlákshöfn
Hvolsvöllur
Mýrdalsjökull
ATLANTIC
OCEAN
Vestmannaeyjar
Surtsey
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50 km
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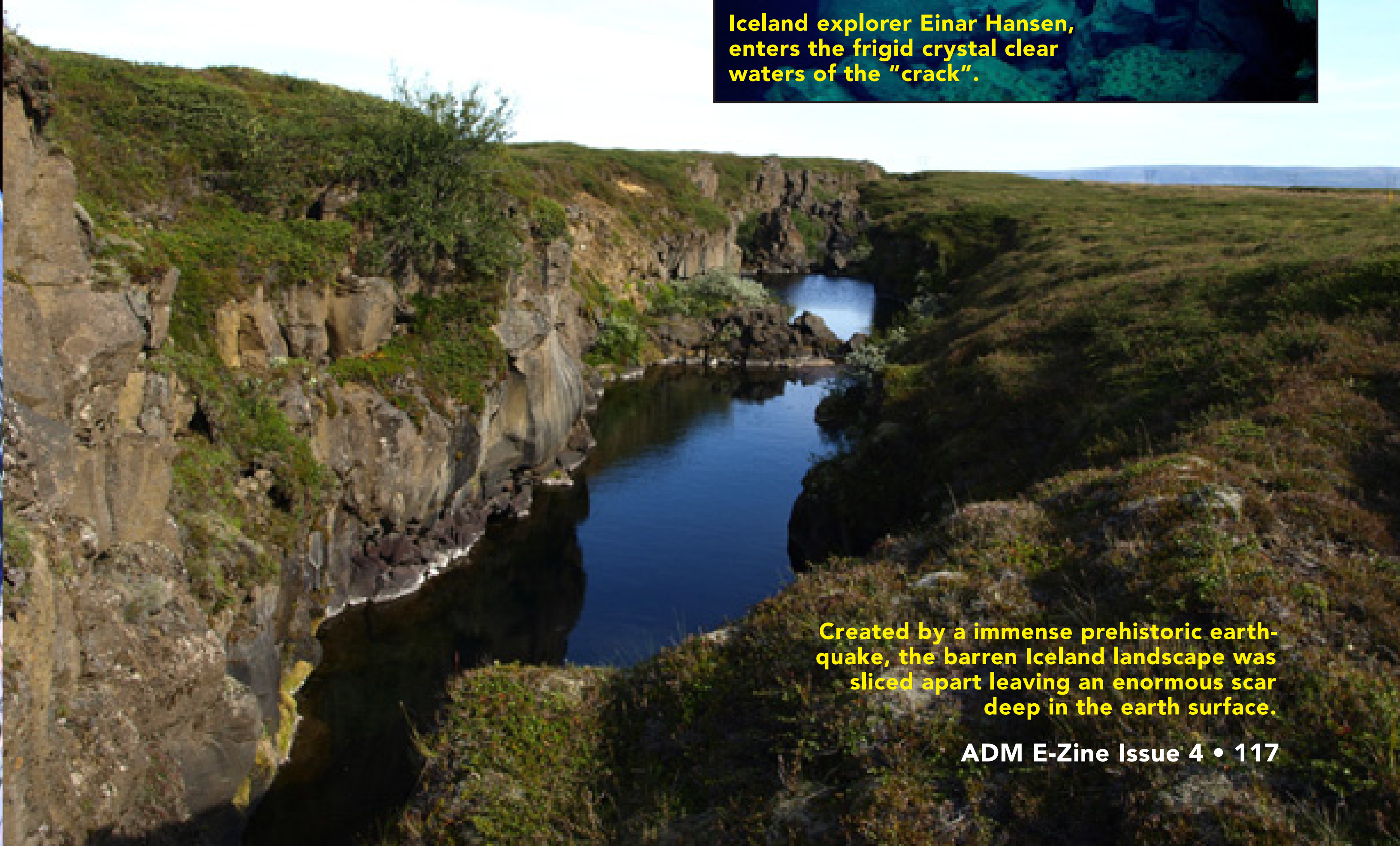
The day before our trip, we contacted the landowner to explain our plans. Fortunately, he was almost as excited as we were, but emphasized that diving on his land was totally at our own risk. By 9:00 a.m. the next morning, we stood in front of the farm in such wonderful weather. His daughter guided us to the cracks positioned on both sides along the road to the farm, which we had passed a few minutes earlier without noticing them.

At first our hopes went sour because of the amount of sediment afloat in the biggest crack. But with some exploration in the area, we found one bit with especially clear water, similar to the famous lake at _ingvellir with the Silfra crack, a favorite spot for many divers. The formation of the area here is of the same geological sort as in _ingvellir, lying on the North Atlantic Ridge where the North American and Eurasian plates drift apart. The water is very cold, varying from 2-6°C, because of the glacial origin of the groundwater. The brilliant clarity of the water suggests a current through the crack from underwater springs. We decided to have a go at it and save the rest of the area for later.

Iceland explorer Einar Hansen, enters the frigid crystal clear waters of the "crack".



Created by a immense prehistoric earthquake, the barren Iceland landscape was sliced apart leaving an enormous scar deep in the earth surface.

Crystal springs feed this section of the crack creating an air clear dive over massive boulders and between towering canyon walls.

It can be difficult to climb - or slide rather - down to the water with all the equipment, and a careful approach is very important to make sure nothing goes wrong. With our heads just above water, we were ready to go down into a world hidden between steep cliffs on both sides. It was a unique experience to drift between the edgy cliffs with those striking colors of blue, green, and brown all around us, and the water so extraordinarily clear. We only went down to about 14.5 meters, but the total depth must be at least 10 meters more in some places. We noticed some tunnel and cave openings as we went, but those will wait for later exploring, which only well-trained and experienced cave and wreck divers are certified to do. The crack is about 0.8-1 kilometers long, but the clear part is only about 4-500 meters. Not one but three huge rocks lie stuck between the cliffs, and swimming under them while thinking about earthquakes and volcanoes is not for those who are weak-hearted.

The crack is divided by rock slips in several places. In the south end, we could swim under the hanging rocks into quite small and shallow bits, though it can be very dangerous. Surprisingly, we saw small trout swimming curiously around us, though not coming too close. Later, the landowner told us that as a young boy he used to fish there with some results, but the catch was never big. Thirty to forty years have now passed since the last fish was caught there.

Before returning home, we thanked the 83-year-old farmer for sharing his knowledge of the area and great hospitality, and showed him the photos we had taken.

We are determined to go back for better photos and stay for a longer period of time. One more hidden treasure has now been found, and simply must be explored further.

Above: Ancient tectonic forces split the earths crust creating a deep narrow gorge. House sized boulders have dislodged from the walls and sometimes hang free, suspended between the canyon walls.

Right: Iceland explorers Einar Hansen and author Gísli Gudmundsson prepare for a photo dive inside the "crack".

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World Record Deep Open Circuit Dive

1083 FSW / 330 METERS

Pascal Bernabé

Article by Pascal Bernabé
Translated by Aurelie Brun
Photography by Francois Brun.

Tuesday, July 5th. Propriano, Corsica. 9 a.m.

It has been years that I have waited for this moment: I am comfortably sitting on Denis Bignand's U-Levante Diving Center's boat. Under my fins that are already in the water, a 1312 fsw / 400-meter drop off!

The Valinco waters are unexpectedly quiet! We had to push back this dive so many times because of the wind!

The realization of this dive had become an obsession, an idea stuck in my head.

At a short distance, on the coast, we can see Porto Polo.

At my feet is the big buoy, attached to which is the 350-meter rope weighted with 110 lbs / 50 kilos, plunging into the abyss… and waiting for me.

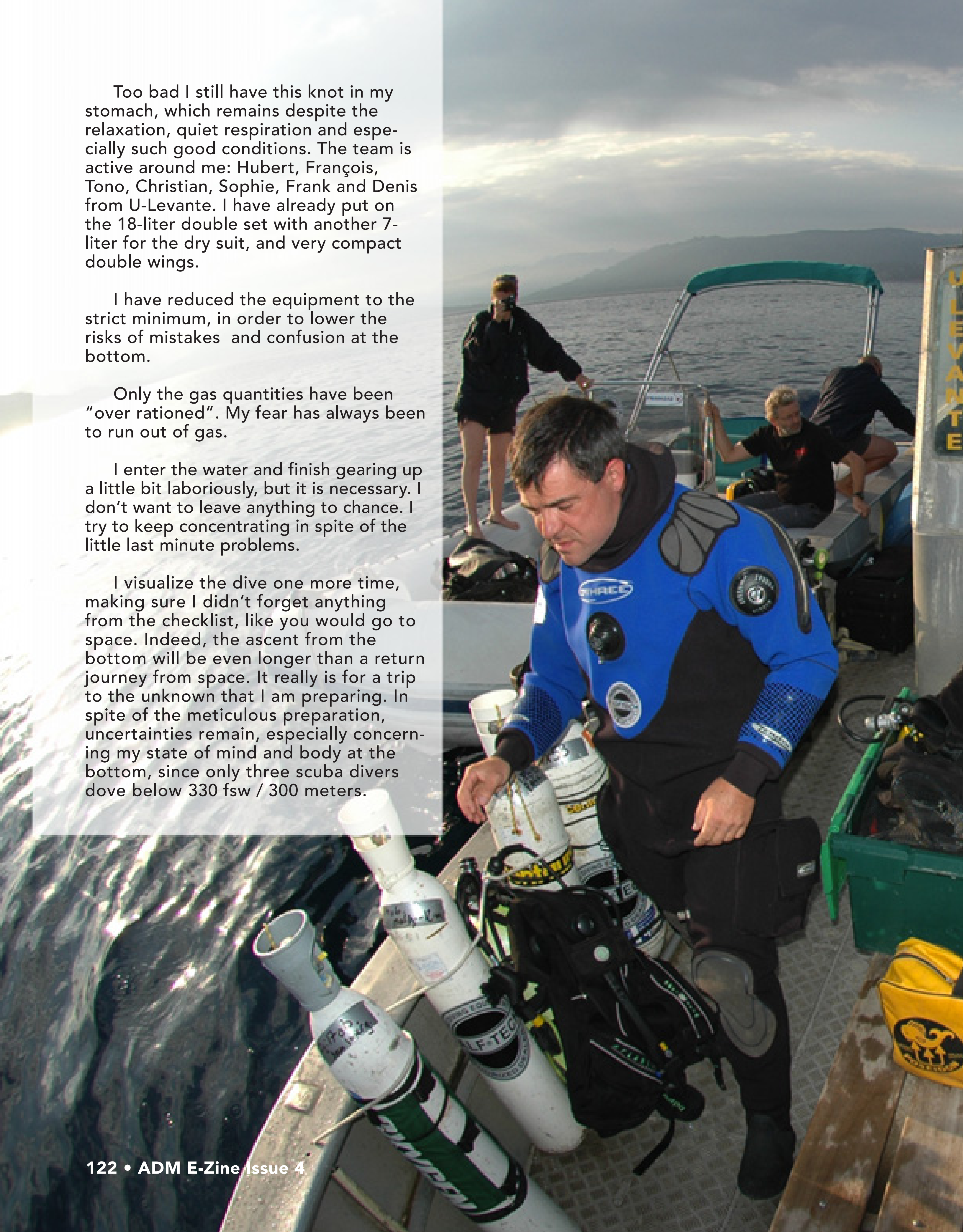
Too bad I still have this knot in my stomach, which remains despite the relaxation, quiet respiration and especially such good conditions. The team is active around me: Hubert, François, Tono, Christian, Sophie, Frank and Denis from U-Levante. I have already put on the 18-liter double set with another 7-liter for the dry suit, and very compact double wings.

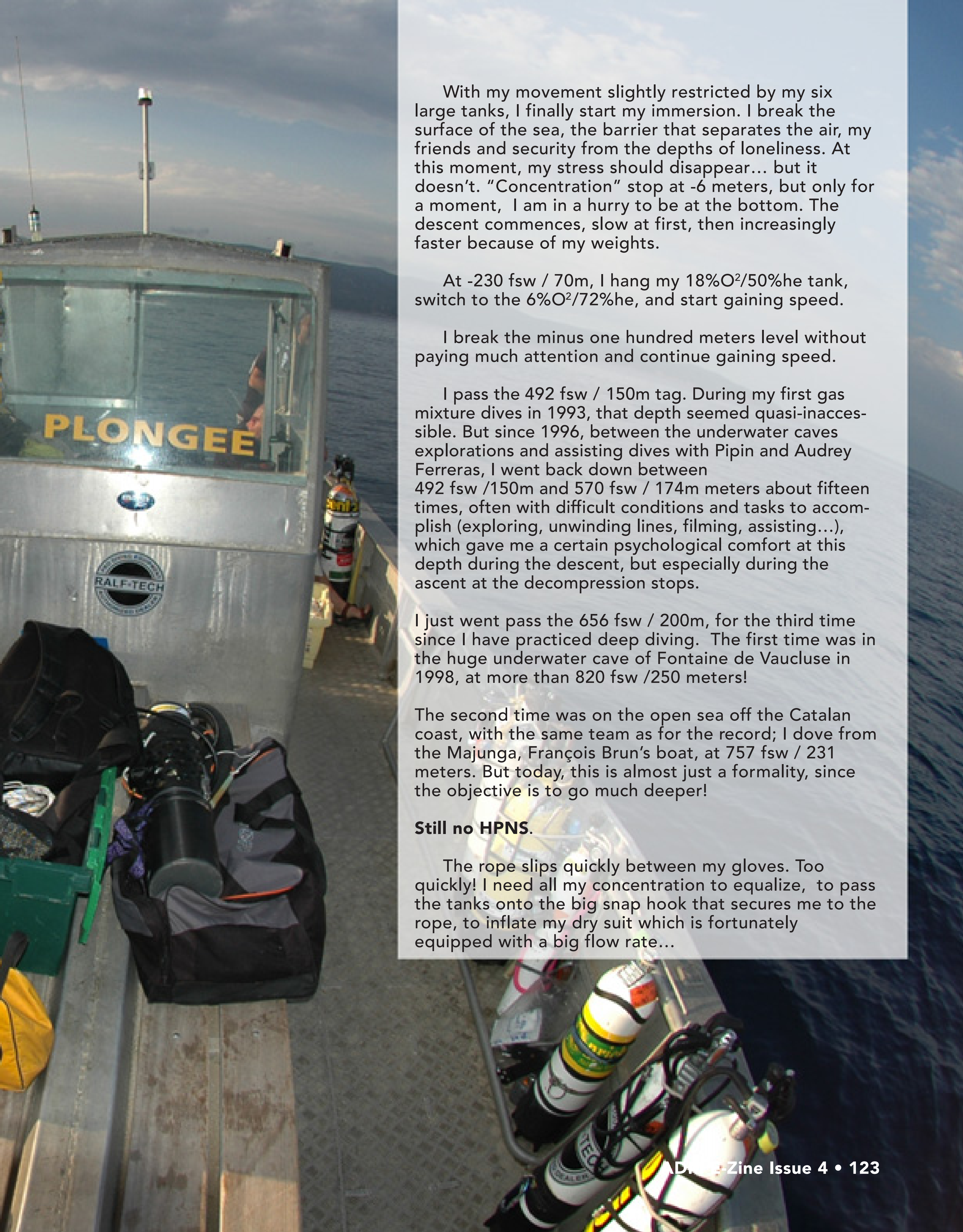
I have reduced the equipment to the strict minimum, in order to lower the risks of mistakes and confusion at the bottom.

Only the gas quantities have been "over rationed". My fear has always been to run out of gas.

I enter the water and finish gearing up a little bit laboriously, but it is necessary. I don't want to leave anything to chance. I try to keep concentrating in spite of the little last minute problems.

I visualize the dive one more time, making sure I didn't forget anything from the checklist, like you would go to space. Indeed, the ascent from the bottom will be even longer than a return journey from space. It really is for a trip to the unknown that I am preparing. In spite of the meticulous preparation, uncertainties remain, especially concerning my state of mind and body at the bottom, since only three scuba divers dove below 330 fsw / 300 meters.





With my movement slightly restricted by my six large tanks, I finally start my immersion. I break the surface of the sea, the barrier that separates the air, my friends and security from the depths of loneliness. At this moment, my stress should disappear… but it doesn't. "Concentration" stop at -6 meters, but only for a moment, I am in a hurry to be at the bottom. The descent commences, slow at first, then increasingly faster because of my weights.

At -230 fsw / 70m, I hang my 18%O^2/50%he tank, switch to the 6%O^2/72%he, and start gaining speed.

I break the minus one hundred meters level without paying much attention and continue gaining speed.

I pass the 492 fsw / 150m tag. During my first gas mixture dives in 1993, that depth seemed quasi-inaccessible. But since 1996, between the underwater caves explorations and assisting dives with Pipin and Audrey Ferreras, I went back down between 492 fsw /150m and 570 fsw / 174m meters about fifteen times, often with difficult conditions and tasks to accomplish (exploring, unwinding lines, filming, assisting…), which gave me a certain psychological comfort at this depth during the descent, but especially during the ascent at the decompression stops.

I just went pass the 656 fsw / 200m, for the third time since I have practiced deep diving. The first time was in the huge underwater cave of Fontaine de Vaucluse in 1998, at more than 820 fsw /250 meters!

The second time was on the open sea off the Catalan coast, with the same team as for the record; I dove from the Majunga, François Brun's boat, at 757 fsw / 231 meters. But today, this is almost just a formality, since the objective is to go much deeper!

Still no HPNS.

The rope slips quickly between my gloves. Too quickly! I need all my concentration to equalize, to pass the tanks onto the big snap hook that secures me to the rope, to inflate my dry suit which is fortunately equipped with a big flow rate…

I am approaching the last 20-liter tank, which is attached to the 820 fsw / 250m tag, although it is actually situated at 865 fsw / 265m (because of the elasticity of the rope) with a chemical light stick, like for all cylinders at a depth.

Difficult moment: I abandon the 6%O^2/72he 20-liter travel gas that I have been breathing since 230 fsw / 70 meters, start breathing on the bottom mix, make the knot… too many things to do at the same time: the High Pressure Nervous Syndrome is well developed, in the form of light shivers, but especially with difficulty to concentrate.

Moreover, the travel gas tank that I was supposed to attach slips on the rope and gets away from me! My friends get it back a few minutes later without really understanding what is going on and not without a certain apprehension.

For me, of course, things are not getting better with the depth.

I now feel comfortable with ***only four big tanks filled with bottom mix.***

Strangely, passing 656 fsw / 200 meters I am shaking less than I was at the Fontaine du Vaucluse. I am not having any obvious visual disturbance (distance problem) either, except for an advanced "tunnel vision" effect: my visual field seems restrained, without much peripheral vision. My Apecks regulators and my Aqualung titan work wonderfully well. I hardly notice the 984 fsw / 300 meter tag that really should grab my attention. A flasher is blinking, indicating the very deep zone. I reach the minus 1050 fsw / 320 meter tag (situated at more than 1099 fsw / -335 meters) when a big deflagration happens in my right ear, along with a sharp pain. My stress, that was gone since 656 fsw / 70 meters, suddenly returns. At the time, I am sure that I had a big lesion on my eardrum. I quickly inflate my wings and begin the ascent. The pain in my ear doesn't get worse. I avoid thinking about what is next, concentrating only on the ascent.

At 869 fsw / 265 meters, I happily reach the decompression tank for my first deep stop. Then the ascent starts again, slower (33 fsw / 10 meters/min). Here again lies a big difference with the Fontaine du Vaucluse dive: THERE, the HPNS had touched me earlier, while leaving me later, around 230 fsw / 70 meters. Today, I feel as though from 721 fsw / 220 meters, few or no symptoms remain. At 705 fsw / 215 meters, I make the second deep stop while I hang the second deco tank on. And it is even slower (16 fsw / 5m/min) that I reach the 541 fsw /165 meter deco stop and the next tank. My ear doesn't hurt as much as I thought it would and I am in a familiar area. From 492 fsw / 150 meters, the

ascent becomes extremely slow (10 fsw /3 meters/min) especially with all of the tanks accumulating around me, on the rope and on my harness.

When I get to 230 fsw / 70m, there are nine 20-liter deco/travel tanks that I have to manage. At 213 fsw / 65m, I get onto the second rope. There, I am happy to find François Brun, with whom I usually explore deep shipwrecks, one of them in particular, situated off the Catalan coast at 360 fsw / 110m. Our last journey was a training exploration three weeks ago. He's using a Buddy Inspiration rebreather. He comes for an update and provides me with food and drink. I let him know about my pain in the ear and a light nausea. He helps me to get rid of four tanks by taking them and after spending a little while with me, goes to his own deco stops.

Hubert Foucart relieves him at 164 fsw / 50m. He is a follower of what he calls "baroque" diving: deep dives either in caves or on the open sea, down to 692 fsw / 211 meters (not bad!), then assisting Pipin. He gives me a mix of water and vogalene in order to prevent nausea. Then, it is Denis' its his turn to come to see me, also with his rebreather and brings me Sophie' s good little purees and soups, in giant syringes. This salty food is a good alternative to condensed milk, sweet chestnut puree, marmalade, jelly and water already absorbed. Then he brings me a rebreather that won't work. Therefore, the rest of the ascent will be done in open circuit, but without any particular technical problem, in spite of the high percentages of helium.

From 98 fsw / 30 meters, I start to feel more and more the effects of the strong surface swell. The pain in my ear increases and soon, each movement of the rope is going to become a nightmare. The decompression turns into torture. Moreover, at about 40 fsw / 12 meters, the seasickness begins. Dealing with the pain and the nausea begins to exhaust me. The end of the decompression is with Christian, Pierre, Lolo, Théo, Francis and his wife Sylviane who stay with me up to 10 fsw / 3 meters and to the surface that I break after an 8 hours and 47 minutes dive.

The return to the surface that I dreamed of during the whole time of the decompression is brutal: I am shaken by the swell, which doesn't help my seasickness. My friends help me get rid of my equipment, while I raise myself with difficulty on the Zodiac.

There, I am taken care of and quickly rushed to the shore by my old buddies Tono and Deit. Still exhausted, I keep breathing the oxygen for another half hour on the ground while rehydrating myself abundantly (water and water + Adiaril).

I should be happy. But I just feel a little bit more serene, and a little bit frustrated by the vertiginous, but too short descent… already a memory.

The GAME has worked today; my blood analysis wasn't too bad.

However, I am already thinking about what could be improved.

Technical decompression:

Several fundamental points:

• Some initial 1 to 2 minute very deep deco stops were observed from 869 fsw / 265m. And from that depth, the ascent speed decreased in order to avoid serious accidents of type 2: vestibular / neurological accidents whose symptoms may start deep in that type of dive, like the accident that John Bennett had after his 1010 fsw / 308m dive: dizziness, vomits from 216 fsw / 66m and during the whole decompression (9h37min). It is important to note that the 30m/min ascent speed used to be typical!

• This slow speed and those deep deco stops needed a big quantity of gas. That is why we used 20-liter tanks at

870 fsw / 265m,
705 fsw / 215m,
541 fsw / 165m (8%O^2/62he),
475 fsw / 145m,
377 fsw / 115m, (13%O^2/57he),
311 fsw / 95 m,
262 fsw / 80m (18%O^2/50he),

and also on a second line that was about 196 fsw / 60m long: at

196 fsw / 60m (20%O^2/50he),
167 fsw / 51m (25%O^2/50he),
127 fsw / 39m (25%O^2/50he),
99 fsw / 30m (38%O^2/33he),
69 fsw / 21m (50% O^2),
50 fsw / 15m (60% O^2)

and we also used two O2 sets of surface supply diving equipments at minus 6 meters.

• We will note the big quantity of helium used in the decompression mixes, easier to eliminate in the last deco stops. We avoided exceeding 30% of nitrogen during the ascent up to 69 fsw / 21m.

• All those elements allowed me to have a relatively short decompression, compared to the 12 hours decompression that figures on my longest diving tables and is also Nuno Gomes' decompression time, when he dove at 1043 fsw / 318 meters, 3 weeks earlier in Dahab, in the Red Sea.

• Therefore I opted to use those tables, because of the water conditions, the pains and the seasickness. I thought that staying longer would overexpose me to the risk of exhaustion.

• Moreover, I could feel reassured knowing that in the 60's, Keller had only a 3 hour decompression (in a chamber) after a 984 fsw / 300m dive! Plus, in 2004, Mark ELL YATT came out of a -1026 fsw / 313m dive in only 6h36. So I was using plenty of time.

In order to limit narcosis deeper than 131/164 fsw / 40/50 meters, we put in the gas mix some Helium whose proportion increases with the depth. But this helium facilitates the cooling and especially the High Pressure Nervous Syndrome (HPNS).

This syndrome, basically, is aggravated by helium below 492/590 fsw / 150/180 meters, and by the high speeds of descent specific to those dives.

About helium, many experiences in a chamber and a few ultra deep TEC dives showed that the presence of a narcotic gas, usually nitrogen, masked the effects of the HPNS: shaking of the extremities and then of the whole body, visual problems, difficulties to concentrate and diminution of performances.

A few years ago, I had thought about adding hydrogen but I gave up the idea because of the danger of manipulating this gas, and remaining uncertainty concerning the decompression and the effects of a fast compression.

But of course, the more nitrogen we add, the greater the risk of falling too much under the effect of narcosis… or even the risk of combining the effects of narcosis and HPNS! Everything is therefore in the dosage: too much helium means too much HPNS; too much nitrogen means too much narcosis.

In the practice, while attempting relatively fast descents in the chamber
(33 to 99 fsw /10 to 30 meters / min), it seems like doses of 13% to 18% nitrogen appreciably decreased the HPNS effects, without causing too much narcosis. On extremely deep TEC dives, the equivalent air depth of the divers at the bottom was situated between
230 & 328 fsw / 70 & 100 meters.

A equivalent air depth of 196 fsw / 60 meters maximum seemed reasonable to me, associated to a partial oxygen pressure of 1.4 to 1.5 bars.

That didn't prevent a significant HPNS to affect me from 853 fsw / 260 meters. However, that mix probably decreased its impact, and helped me avoid a dangerous narcosis.

Francois Brun Pascal Bernabe Frank Huygues

Concerning the descent speeds it seems, according to the experiences in the chamber, that descending one meter/min or even slower, notably increases the performances.

But it doesn't seem useful to reduce the speed from 30-40 m/min to 10 m/min. On the contrary, it is possible that the HPNS has more time to settle. On the other hand, it will considerably increase the already very long deco stops.

The equipment:

It is just simply vital, on such an important dive that the equipment is simple, very solid and extremely high performing! \

Aqualung:
One of the regulators that I used at the bottom was a Titan, which worked admirably. Le Gend regulators (the top of the line) were settled on all decompression tanks, even the deep ones.
aqualung@airliquide.com

Apeks
All bottom regulators were Apeks ATX 100
www.apeks.co.uk

AGA
AGA supplied ten Helium tanks and six O2 tanks.

Petzl
Fifty snap hooks specifically for each situation were used: locking snap hooks to secure the deco tanks as well as quick opening ones for delicate/fast operations.
www.petzl.com

Tortec
Tortec supplied the 7 to 18 liter tanks used at the bottom and during the decompression.

Béal
Béal supplied all the ropes: descent, decompression, shot line, etc. More than one kilometer in total, as well as the cord and lines.
www.beal-planet.com

O3 Drysuit (ri2-100 model)
www.othree.co.uk

Custom Divers double wings
www.customdivers.com

Patrick Tonolini Hubert Foucart Sophie kerboeuf Christian Deit

Partners in Corsica:

Diving Center U Levante, in Propriano

Without the help of Denis Bignand who knows the bay like the back of his hand and all the best places, and who organized everything there, without his competence and his efficiency, we might still be looking for a site. He and his friendly instructors were a precious help to us, and I thank them.
www.plonger-en-corse.com
plonger-en-corse@wanadoo.fr

Vigna Maggiore Camping, in Olmeto Beach -

Location with beautiful view.
Jacques Bidani the friendly owner, welcomed us with opened arms and put us in two comfortable bungalows. He also entertained us with hearty local stories.
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The Maritime Agency Sorba, in Propriano, which really facilitated the Marseille-Corsica crossing.
VOYAGES-SORBA@wanadoo.fr

La Compagnie Méridionale de Navigation (the meridional navigation company)

Prima gaz company, Barcarès Yatching, the Banque Populaire Toulouse Midi-Pyrénées (and the association of customers of this bank), Mr. Bordes and Mr. Mézergues and the Echelles Centaures, Mr. Vinsonneau and Mrs. Demoor, for the precious financial help.

The Socex, in Castanet (31): Eric and Frank: oxygen and inspection.

The team:

16 people in total, divers or mariners.

From Toulouse and from Catalonia: they have followed this project (and other projects: shipwrecks, cave diving...) and have carried it on their shoulders since the beginning; everyone has his own specialty but continues to multitask.

Preparations, cancellations, and doubts have all been common since my 757 fsw / 231m dive in 2003. Without these people or the patience of their families, none of this could have been done. I will never thank them enough for their kindness, efficiency and devotion.

François Brun, well-known shipwreck explorer.

Christian Deit, specialized in raiding, cave diver, canyon exploration, scuba diving.

Hubert Foucart, cave diver and shipwreck explorer, with his passion for the deep dive...

Sophie Kerboeuf, highly skilled diver who cooked good little dishes for me.

Patrick Tonolini, cave diver and rebreather diver, who mixes everything with his Bauer-Purus.

And all the ones who were not able to come, amongst whom were Laurent, Paco...
In Propriano:

Denis Bignand and his instructors from U-Levante

Francis Machecourt from the CREPS of Ajaccio and his wife Sylvaine
Théo Laumonier

Laurent Grillot (Lolo)

Pierre Schiffer and Christian Gay-Capdeville from Aquasport Contois

Pascal Vieux and Jean-Louis Léandri, mariner from U-Levante.

Louis Lari from the Pilotine Santa Maria and his son Jean-Marie, pilote of the port.

Thanks:
To Henri Benedittini who brought us all of his help one more time.

To Bernard Gardette, the Comex scientific director, for all his valuable advices.

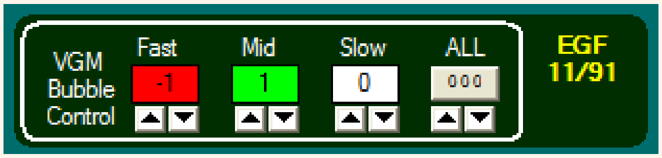
To the Professor Bourbon, from the Nervous System Functional laboratory (CHU Toulouse-Rangueil) for his formation in mental preparation.

VRX Dive Computer and Variable Gradient Model VGM Decompression Algorithm

Following the huge success of the VR3 dive computer VR Technology will be launching the VRX dive computer at DEMA this month. The latest in advanced dive computer design and incorporating the latest decompression algorithm.

The Variable Gradient Model (VGM) algorithm is available exclusively in the new VRX dive computer from VR Technology. Free download software to complement the product is also soon be available at

www.technologyindepth.com.

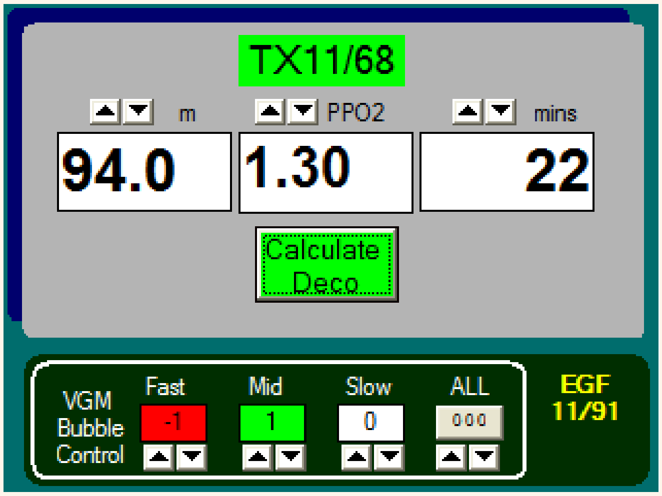


VGM - Decompression philosophy
The VGM algorithm has been built on recent practical dive planning and diving techniques as well as the scientific and theoretical understanding over the past 100 years. It combines better theoretical understanding of bubble physics together with known diving practices that help decompression and well being after and during decompression diving.

VGM also gives the user the ability to change the conservatism of the decompression to make it more conservative, but also more aggressive. Some technical divers find they feel good after a decompression with less in water time than others. The equivalent gradient factor for the VGM setting is displayed for comparison with other dive planning software and computers.

We feel the default settings will suit many experienced divers, and it is the input of real technical divers in the choice of these settings that has made VR Technology and its team at the forefront of technical diving product design for over 20 years.

Decompression is a physiologically complicated event. There are many factors that affect how well the human body decompresses and how well it is able to withstand pressure exposures. All dive algorithms have been devised to combine the complexity and risk of staying in the water with the risk of decompression sickness after surfacing. Things like hydration before a dive, and rest and hydration and even oxygen after a dive all help reduce the risk of DCS. So bear in mind that as with all decompression planning there needs to be a balance and understanding of the risk of reducing decompression times and the impact of DCS. Please refer to your training agencies' information and advice on these issues.



VGM incorporates 5 main features:

- Haldane decompression model
- Modification of tissue over pressure tolerances or M values for the faster tissues to create a decompression profile similar to a bubble model like VPM
- Further modification of over pressure tolerances for deep or long exposure dives, especially in the fast and middle order tissues
- Automatic adjustment of the above parameters to allow the default settings to give common decompression and No Stop times across the range of diving from 10m to 120m
- User adjustable parameters so the diver can use his/her experience to further modify the decompression to that which suits him/her. The equivalent gradient factors are displayed for a particular dive for ease of comparison with other dive computers and dive tables, although because this system goes beyond gradient factors certain adjustments may only give an estimate of the nearest GF equivalent.

A basic version of PC dive planning software VGM ProPlanner is available free from the web site. This allows a quick way to see what decompression the VRx dive computer will give and allow specific conservatism factors to be tried out on the PC before then choosing the right ones for a dive on the VRx. The PC software also gives print outs and an output in common spreadsheet style format for use in creating back-up tables.

The VRx gives an Equivalent Gradient Factor (EGF) after a dive. Because it is an adaptive variable system, the gradient factor can not be calculated until after decompression has started. The expected EGF is displayed in the dive summary screen accessed by using a long press of the right button from the main dive screen. It is the screen displayed after running through the decompression stop look ahead. The EGF is also shown on the DivePlan exit screen and the dive log in the VRx.

Summary

VGM is able to adapt to the dive actually dived – the gradient factor is essentially adjusted on a dive by dive basis automatically. The safety factors can be adjusted from the default settings to adapt a decompression to the required profile based on the diver's experience though.

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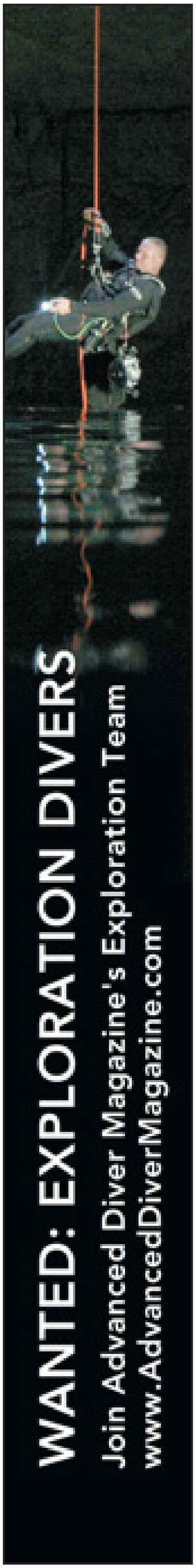

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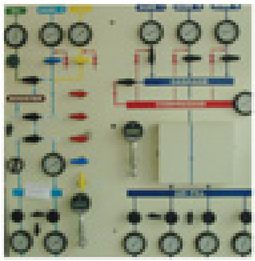

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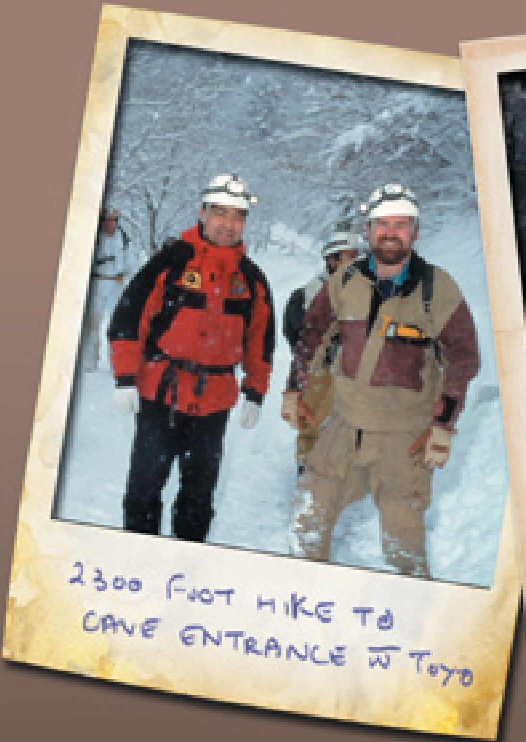

In the remote mountains of Japan, Dive Rite founder and CEO, Lamar Hires, devised a harness that would hold up to the rigors of exploration diving. He needed something that would support the weight of heavy steel tanks, yet be flexible enough for sidemount squeezes. His solution: the TransPac harness. And since then...Lamar has never worn anything else.

Dive Rite

Learn more about Lamar's explorations and other gear solutions at **www.DiveRite.com.**

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