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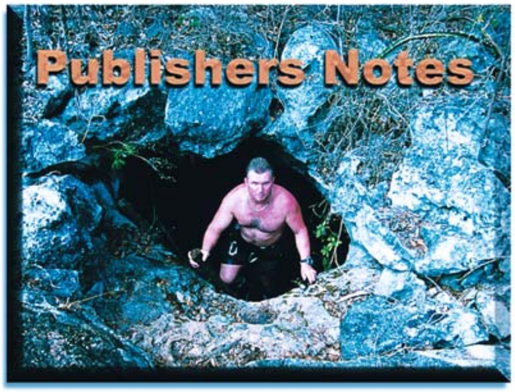

The interior of Mexico's Yucatan is opening up for discovery. Thousands of unexplored cenotes dot the scrub brush landscape awaiting exploration.

Dan Malone's M/V Ocean Explorer scouts the outer reaches of the Bahamas for massive blue holes.

Brazilian cavers push the envelope in southern Brazils unique solid marble caves.

WKPP divers design new rebreather technology to push back the furthest reaches of cave exploration.

Sidemount divers expand Florida's cave passages by thousands of feet.

Great Lake shipwreck hunters discover new unexplored wrecks with the use of high technology sidescan equipment.

Northeast wreckers push deeper to discover new shipwrecks with the use of mixed gas technology.

The whole world is bustling with exploration and discoveries. This is truly an exciting time for the explorer in all of us.

In May, 2001, I was elected to the Board of Directors of the National Speleological Society Cave Diving Section (NSS-CDS), the foremost cave training organization.

ADM continues to expand quickly, reaching the whole world with the news of underwater discovery.

ADM is now available in your local Books-A-Million stores.

Curt Bowen
Publisher Advanced Diver Magazine

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Jon Bojar and Andreas Matthes.
Photos: Curt Bowen / Tom Isgar

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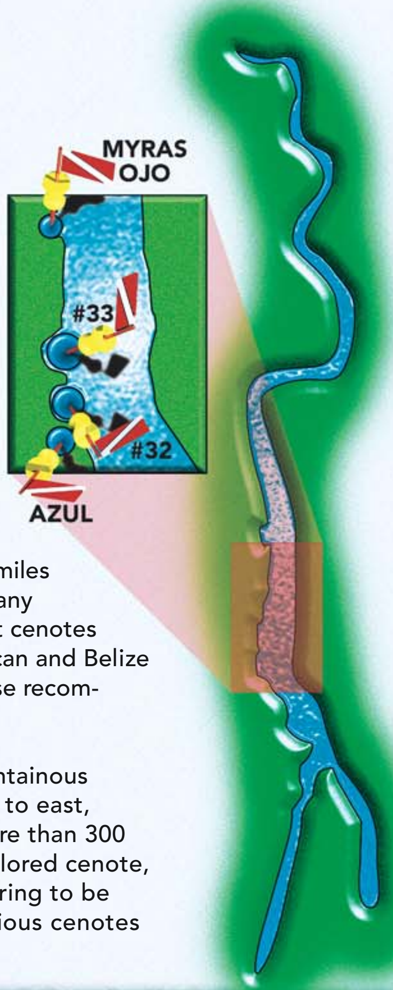
Expedition BACALAR

By Linda Bowen

In a constant search for discovery, Advanced Diver Magazine's staff writer Jim Rozzi coordinated an exploration expedition that stretched from the south of the Riviera Maya to just north of the Belize border in search of several fabled cenotes. Joining the expedition was one of Mexico's foremost explorers, Matt Matthes, along with a group of merry cavers. The following is a description of their journey.



Just three hours south of Tulum lies Lake Bacalar, a giant natural fresh water lake which ranges more than 50 miles to the north and south and extends up to a half mile wide. Lake Bacalar is noted for its beautiful turquoise water that is created by its high mineral content.

Renting a small airplane from the local airport in Chetumal, a large city located about 50 miles south east of Lake Bacalar, the exploration team scouted the lake and surrounding jungle for any signs of hidden cenotes. The pilot of the small aircraft also gave the group hints of more giant cenotes he had spotted earlier, which were located approximately 70 miles southwest along the Mexican and Belize border. After finding more than 13 possibilities along the lake, the team decided to fly to these recommended areas to check out these giant cenotes.

The southwest terrain quickly changed from a sort of flat limestone plane to more mountainous rolling hills. It wasn't long before the group identified the giant river basin that flowed west to east, separating Mexico from Belize. On the basin's northern side lies a giant ridge that rises more than 300 feet from the river. Across this ridge, the exploration team spotted the first potential unexplored cenote, then another and another, until more than 15 cenotes had been cataloged with some appearing to be more than 800-feet-wide. With only one road into this area, the exploration of these mysterious cenotes would be extremely difficult and time consuming--truly an expedition all its own.

Azul Bacalar
N 18°38.841
W 88°24.774
Max Depth 237 ft.

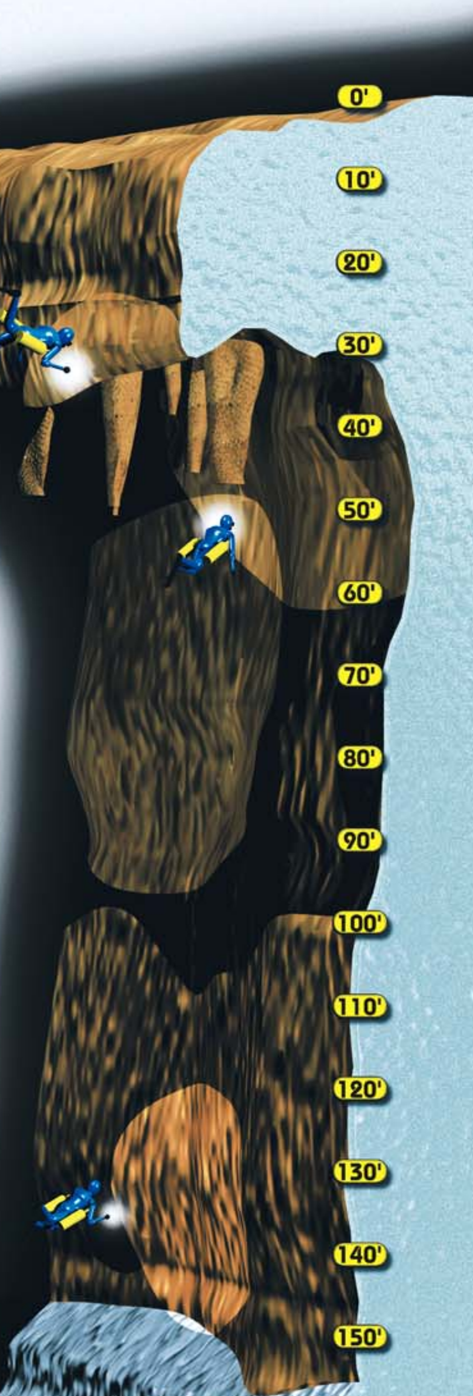
Returning back to Lake Bacalar, Cenote Azul appeared to be one of the most promising cenotes. Cenote Azul Bacalar, a swimming hole and restaurant for the locals and tourists that visit this area, measures more than 600 feet in diameter and was prime territory for virgin exploration. Divers Matt Matthes, Marike Jasper, Scott Carnaham, Benja Sacristan and Linda Bowen explored this system for several days determining its maximum depth of 237 feet with no discovered cave passage.

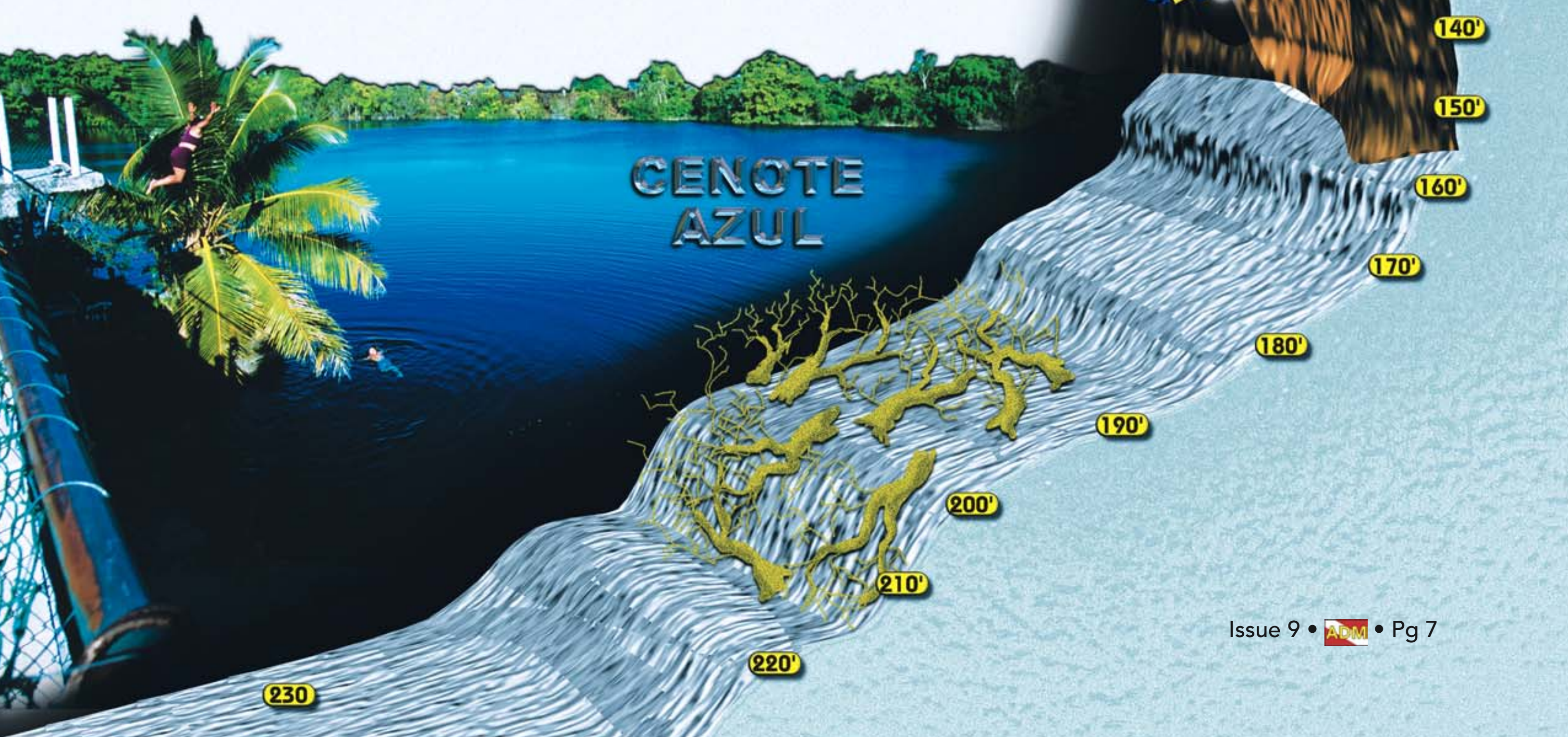
Still, this cenote provided interesting scenary. The walls of the cenote dropped straight down 165 to 170 feet with an undercut at 20 feet. Flow stone formations hung from the ceiling and in some places undercut more than 30 feet. Made up of sand, silt and hundreds of decaying trees, the bottom sloped towards the cenote's center. Visibility was about 60 feet on the surface but cleared to more than 100 feet below a depth of 140 ffw. Due to its size, much more exploration and survey data will eventually be needed for this cenote.

Cenote 32 and 33 were located on the shore of Lake Bacalar and were influenced by the natural erosion and filtering of the lake's sand. Both were giant sand bowels with no walls, flowing water vents, or cave passage. Cenote 32 had a maximum depth of 117 ffw and cenote 33 bottomed out at a maximum depth of 160 ffw.

Cenote Myras Ojo was the second most promising. With just a small opening from the erosion effects of the lake, Myras Ojo had steep walls, which dropped to around 100 ffw. Again, the sand in this cenote sloped toward the center and a maximum depth of 170 ffw was discovered. Divers Matt Matthes, Dan Lins, Jim Rozzi and Curt Bowen explored this cenote's interior walls and sandy bottom. No cave passage was found, although they did discover some water flowing through rock fractures. Visibility in Myras Ojo never exceeded 40 feet.

The exploration also included two trips south along the Mexican and Belize border for dives to take a closer look at the giant cenotes spotted by the team from the air. The first reconnaissance (recon) trip included divers Jim Rozzi, Benja Sacristan and Linda Bowen. Obtaining a guide and several sherpas from the small village of Union, the team attempted to access one of the cenotes spotted from their earlier aerial view. Gaining access was very difficult due to the 250 feet high sloping banks and thick vegetation that surrounded the cenote. Because of this, only depth soundings with a survey line and reel where taken, and an estimated depth of 70 ffw was discovered.





The second recon trip included divers Matt Matthes, Curt Bowen and Scott Carnahan who returned to an unexplored cenote discovered by the first recon team the prior day. Cenote Azul Union (pictured below) was easily accessible by vehicle with a short 300-yard walk to the water's edge. A medium-sized stream of water flowed out of the cenote and into the nearby river. Cliff walls surrounded two-thirds of the cenote and small floating islands of grass moved around on the cenote's surface. According to the local guide, a rumored large crocodile inhabited the cenote. The guide kept an eye out for the creature while the team was underwater.

The cenote turned out to be only 54 feet deep with lots of fallen trees, debris and grasses. Several water vents along the walls and sand boils were also discovered. Visibility ran between five and 20 feet, which made spotting the crocodile a little difficult and somewhat frightening between all the fallen logs and thick grasses.

With the exploration time coming to an end, the team successfully discovered and explored more than 16 new sites, although only two ended up being interesting. With the proper dive facility available, Cenote Azul Bacalar--above all the other cenotes that had been investigated--was found to be a perfect location for future advanced and technical training.

Special Thanks to:
Roberto Hashimoto
and Matt Mickey

Cave Explorer Matt Matthes prepares for an exploration dive into Cenote Azul Union.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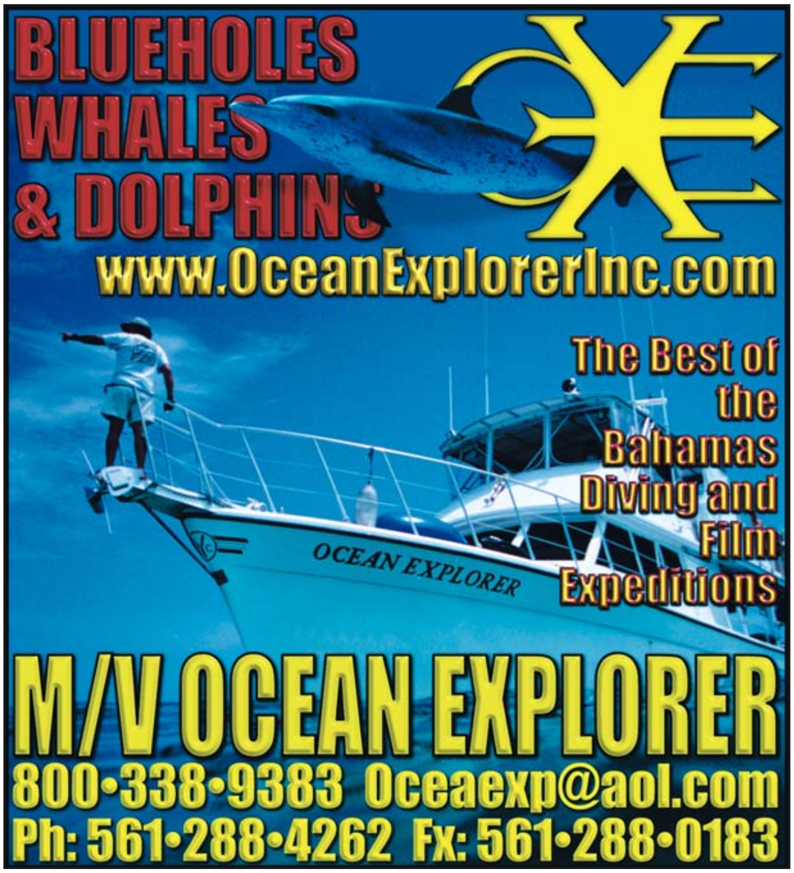
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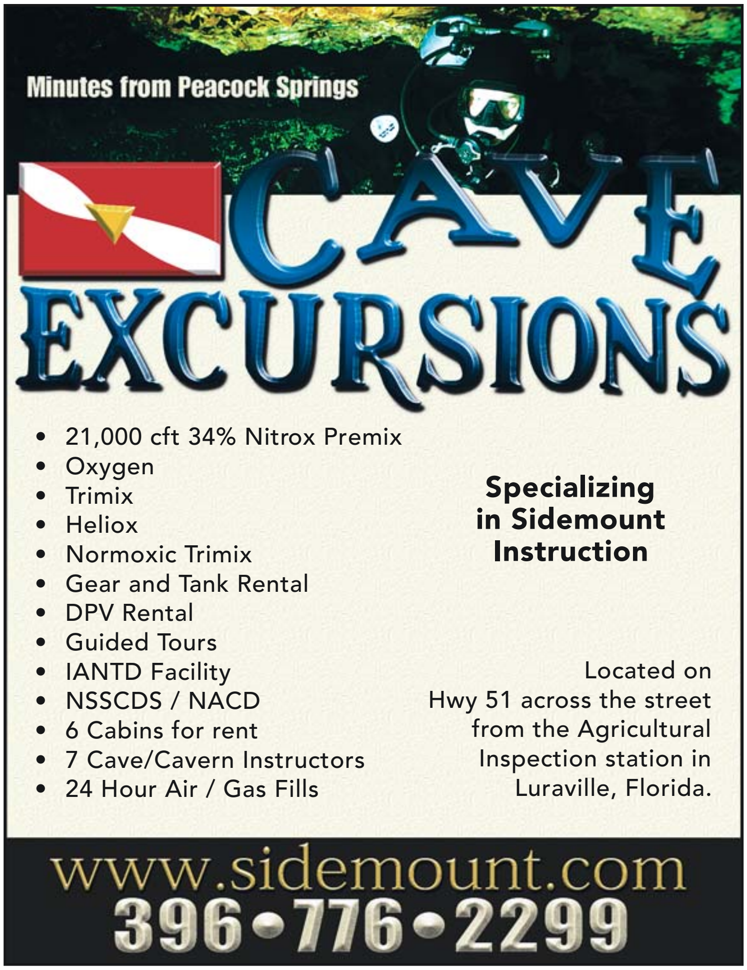
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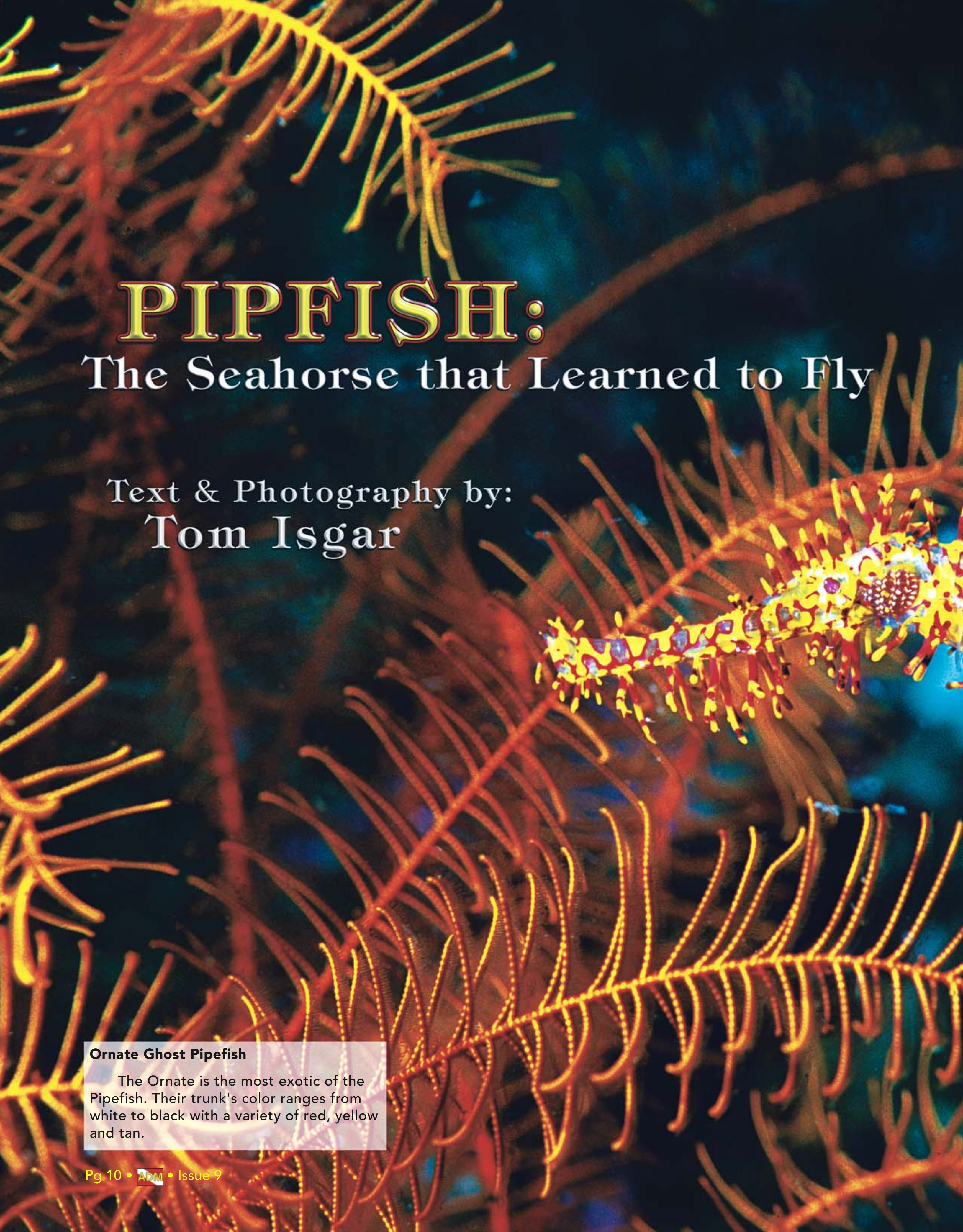
PIPFISH:
The Seahorse that Learned to Fly

Text & Photography by:
Tom Isgar



Ornate Ghost Pipefish

The Ornate is the most exotic of the Pipefish. Their trunk's color ranges from white to black with a variety of red, yellow and tan.

"I saw a snake!" exclaimed a diver coming aboard the boat. "It was about five inches long, and it hid in the coral." Unless this diver was somewhere in the Pacific, he saw a Pipefish. Members of this diverse group of fish can be found in most waters across the world and come in a wide variety of shapes and colors. On one end of the spectrum are the small, snake-like varieties and at the other end are the beautiful, ghost-like Pipefish, sometimes confused with seahorses. At first glance Pipefish and seahorses do not look alike. However, the resemblance becomes more obvious when a seahorse stretches out in the water or the Pipefish tips its head down to touch its belly.

Numbers and Identification of Pipefish

While there is no firm number, scientists agree that there are more than 50 genera containing more than 200 species of Pipefish, (order Gasterosteiformes, suborder Syngnathiformes) with 15 genera and 37 species identified in micronesia The suborder is divided between Pipefish (Syngnathidae) and Seahorses (Hippocampinae). The lack of a precise number stems from at least two sources: color and pattern. Many of the species change colors with both age and habitat. Color also varies between males and females. Some species spot while some Pipefish's ring patterns around the trunk change slightly with maturity. In many cases the only way to determine the species is in a laboratory. To actually determine a species, one can count the number of rings on the trunk, the number of rings on the tail and the number of rays on the dorsal fin--a challenging task underwater!

It becomes more confusing when many of the common Pipefish have different names in different locations and in different reference books. In addition, when comparing photographs in the reference books, the same fish occasionally has different scientific names.

United States Coastal Waters

A few species of the snake-like Pipefish exist in U.S. coastal waters. They feed on small invertebrates and live near the ocean's bottom, swimming within debris or corals. These Pipefish rely on camouflage and usually remain undetected by divers. Just over 70 sightings have been reported from 27,000 surveys in the REEF database for the Western Atlantic. There is one sighting of a banded Pipefish, 47 for the Harlequin (Micrognathus ensenadae) and 25 for the Whitenose (Cosmocampus albirostris). However, with 18 sightings of the Harlequin in Bonaire, there is a high likelihood of multiple sightings of the same individual. Harlequins are usually brown with yellow bands. The Whitenose, as the name implies, has a white snout on a brown body. The Gulf Pipefish (Syngnathus scovelli) has been reported in both the Gulf and Western Atlantic, as well as in freshwater estuaries along the Texas and Louisiana gulf coast. Caribbean Pipefish (Syngnathus caribbaeus), which can be seen from Central America south, is tan to yellow with narrow white bands and is similar to the Florida Pipefish (Syngnathus floridae)

On the Western coast of the United States, including Hawaii, there have been 19 sightings reported from 1,500 surveys. The Kelp Pipefish (Sygnathus californiensis) has regularly been reported in the California kelp forest. In Hawaii the Bluestripe has been reported. There have also been sightings of the Barcheek, Barred, and Chocolate from the Pacific Northwest. The Bay Pipefish (Syngnathus leptorhynchus) has been reported from the Sea of Cortez and as far north as Southeastern Alaska.

All of these Pipefish are part of the snake-like species. Ranging in length from less than one inch to 12 inches, the determination of the specific species depends on being able to count the number of trunk rings, tail rings and dorsal fin rays in many cases. As a diver, it is unlikely that one individual would be able to make this determination. The best bet for identification is to look in local fish books.

Other Locations for Pipefish

Nearly half of the known species of Pipefish have been reported in Australian waters. Six species have been reported in British waters. In addition, the Eastern Pacific and Micronesia are home to many of the Pipefish. This is where the really exotic members of the family (Ornate Ghost, Robust Ghost, Filamented Ghost and Velvety Ghost) will be found. While many of the snake-like Pipefish exist in these waters, it is the Ghost Pipefish family that attracts divers and photographers. Ghost Pipefish have been reported from southern Africa to the northern Red Sea, from western Australia and Fiji to the north to Japan.

Network Pipefish (Corythoichthys flavofasciatus)

This is one of the more common Pipefish in the Pacific. Its pattern is easily spotted. These Pipefish can usually be seen along the tops of rock and corals, growing only to about four inches in length.

Shorttailed Pipefish, also known as Stick Pipefish (Trachyrhamphus bicoarctatus)

The Stick Pipefish is one of the larger Pipefish and can grow up to 16 inches. Their colors are variable, ranging from yellow to dark brown. They sit in the water resting on three to four inches of tail, which they can anchor using the rays of the caudal fin. The rest of the body raises upward. From this posture they capture passing plankton. The Stick Pipefish is slow moving and easy to approach.

Continued on Page 45

1. **Stick Pipefish (Trachyrhampus bioarctatus)**
2. **Filamented Ghost Pipefish (Solenostomide species 2)**
3. **Network Pipefish (Corythoichythys Flavofasciatus)**
4. **Robust Ghost Pipefish (Solenostomus cyanopterus)**

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DIAMOND KNOT WRECK



"Jewel of the Emerald Sea"

Text and photography by John Rawlings

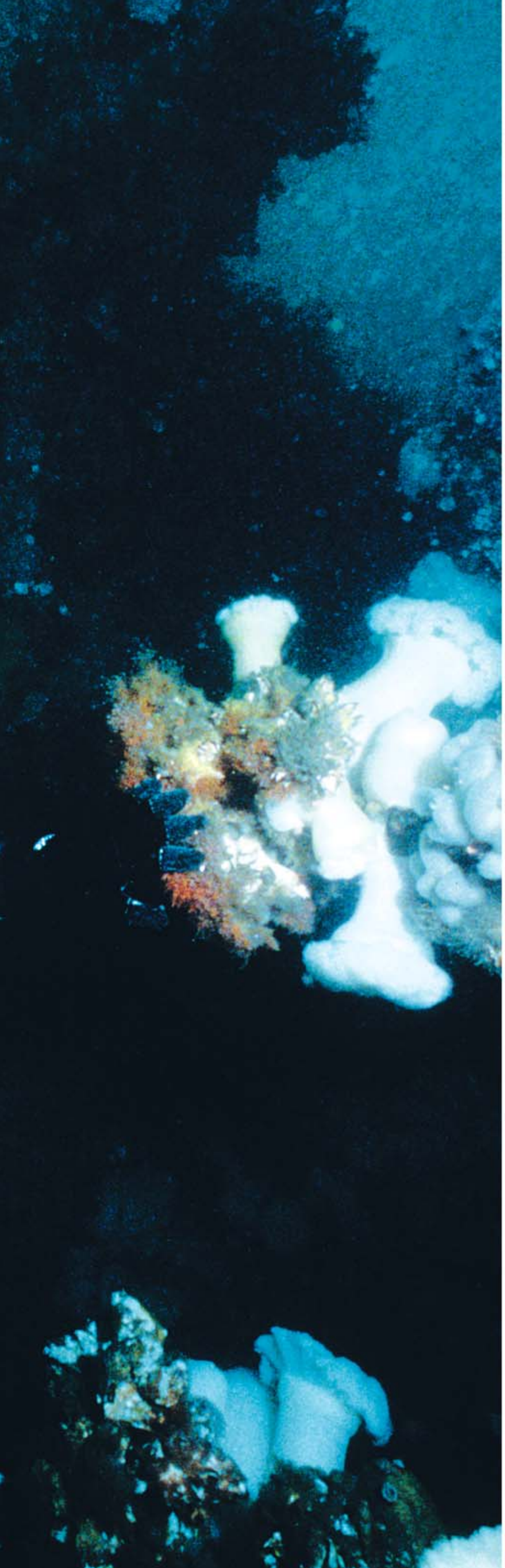
The dense fog off the waters of Washington's Olympic Peninsula made even the brightest of lights appear dim as the 326-foot Diamond Knot slowly steamed her way through the Strait of Juan de Fuca toward Seattle. Most of the crew was below deck, with only a handful on watch peering into the darkness. The ship was fully loaded with a cargo more precious than gold to a hungry post World War II population.

The 5,525-ton freighter carried more than seven million cans of salmon from Bristol Bay, Alaska. Although the fog was particularly thick this night, the Diamond Knot was not unaccustomed to hazardous voyages. During the war, the ship had endured potential air attacks, submarine-infested waters, invasions and numerous storms. Although she had survived those threats, she would not be able to sustain herself past the events of this night--August 13, 1947.

Steaming in the opposite direction of the Diamond Knot toward the mouth of the strait and the Pacific Ocean was the 10,681-ton freighter, Fenn Victory. Outbound from Seattle, she had off-loaded much of her cargo and only carried approximately 200 tons. Lightened of much of her load, she was riding high in the water and moving fast.

To the crew of the Diamond Knot, the first sign that something was amiss was when the bow of the Fenn Victory suddenly appeared to starboard, like a huge apparition through the thick mist. At 1:15 a.m., the Fenn Victory's bow crashed into the starboard side of the smaller freighter, slicing more than 14 feet into her and locking the two vessels together. At this time, the two ships were approximately six miles north of Port Angeles in the shipping lanes mid-way between the Olympic Peninsula and Vancouver Island.

Distress calls immediately went out from the two vessels, and tugs were hurriedly dispatched from both nearby Port Angeles and Victoria, British Columbia. Upon arrival, the tugs found a scene of complete confusion. Everything seemed to be in chaos as both crews struggled desperately to cut their ships free, fighting the entangled booms, masts and crosstrees. The Fenn Victory had cut so deeply into the Diamond Knot that the smaller freighter's main deck was awash and her holds were filling with the bone-chilling waters of the strait. While the desperate battle continued, the ebb



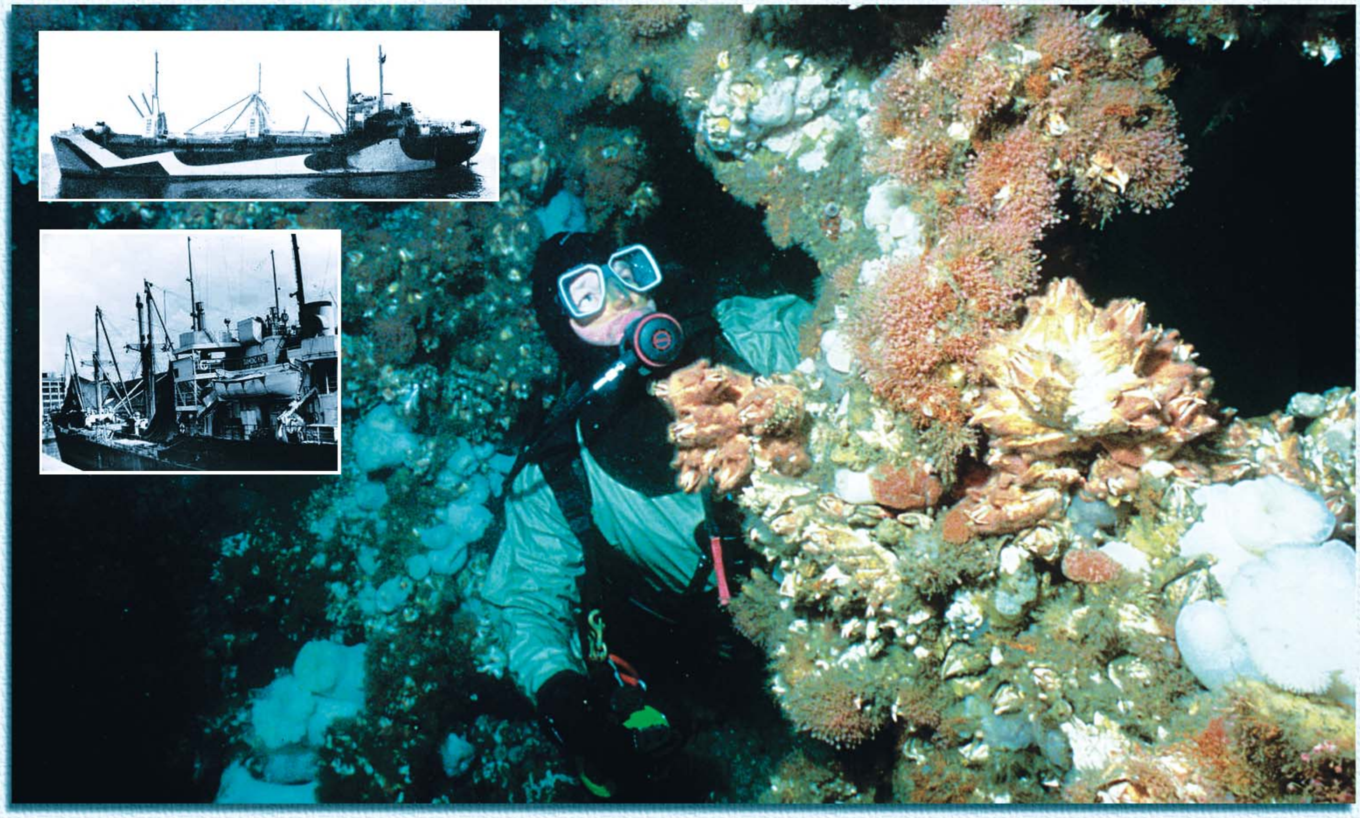
tide pushed the interlocked ships steadily westward. After hours of struggle involving the cutting away of huge chunks of entangled metal, the two ships were finally free of each other. The Fenn Victory, in no danger of sinking, managed to limp back to port under her own power. But for the Diamond Knot, the struggle had just begun.

In a desperate attempt to save the vessel and her precious cargo, the tugs placed the Diamond Knot in tow and headed directly toward Crescent Bay, where it was hoped the sheltered waters would serve as the ship's salvation. This proved to be a forlorn hope as the combination of the seawater rushing through the huge gap in her side and the massive currents at the mouth of Crescent Bay proved to be too much for the Diamond Knot and those who struggled to save her. Only about one-quarter mile from shore, the freighter began to roll on her side, allowing a massive influx of water into her remaining holds. At 8:57 a.m., the Diamond Knot sank below the surface, coming to rest on its starboard side in 135 feet of water just off of Tongue Point.

This was one of the largest cargo losses ever on the West Coast; and within hours, salvage efforts were being organized. Because of the type and value of the cargo, new methods of salvage had to be tried. Surface divers cut their way through the sides of the vessel into its holds to gain access to the precious salmon. Huge siphons were devised that were used to vacuum the cans to the surface and onto waiting barges. It was one of the greatest and most innovative salvage jobs in history. By the end of October, more than 5,700,000 cans had been recovered to help feed the impoverished, war-torn world. Finally, the salvagers returned to their homeports and the Diamond Knot was left to the ravages of the sea.

Today, the Diamond Knot has become a gold mine for Pacific Northwest Technical Divers and advanced recreational divers who have the knowledge and skills to experience her. In addition to the damage inflicted by the collision with the Fenn Victory, the massive cutting operations involved in the salvage efforts further weakened the hull and much of the wreck has collapsed upon itself over time. Penetration of the wreck is still possible at some points, but such a venture requires extreme levels of training, skill and caution.

Time and the nutrient-rich waters of the Strait of Juan de Fuca have taken their toll on the Diamond Knot. Today, the vessel is covered with a thick encrustation of anemones, scallops, sponges, giant barnacles and hundreds of other underwater denizens of the Pacific Northwest. Throughout most of the wreck, it is only the straight and regular edges obviously created by man that mark it as a sunken ship and not a marvelously intricate rocky reef. Serving as



an artificial reef, the Diamond Knot hosts huge numbers of various species of Northwest Rockfish and Greenling that often will curiously approach divers. The Diamond Knot is a dream for both the macro and wide-angle photographer, with life literally covering almost every square-inch of the wreck. Huge LingCod, Cabezon, Red Irish Lord and Wolf Eel can be found on the wreck and make marvelous photo opportunities when they can be convinced to pose.

Visibility on the Diamond Knot is never constant and is heavily dependent on current conditions, occasionally dropping to 10 feet or less (at times, far less!). Divers would do best to explore the ship and reef with the attitude of accepting whatever visibility "Old Juan de Fuca" decides to allow, planning ahead for all possible conditions.

Just as they brought the Diamond Knot to her eventual demise, today the tidal currents sweeping over the wreck can still be fierce, and dives should be planned for slack water or periods of low tidal exchange. While exploring the wreck, structure can be used to block much of the force of the current. However, divers need to be constantly aware that those same currents can drastically affect their ascent and should plan accordingly.

CUBA

Liveaboard Oceanus

Text & Photography by Rusty Farst

"It's the dive of a lifetime, Rusty; and besides, someone has to represent the magazine."

"When have I heard that before?" I thought, as the scratching voice of Curt Bowen came over my cell phone.

"There's only one catch," he said. "You have to be in Cancun in three days. You can't go to Cuba from U.S. soil."

There's nothing like a little notice, but that's what we dive bums live for--adventure and spontaneity. The next thing I knew I was standing in my doorway with regulators draped over my shoulder and my camera in hand. Kissing my beautiful wife goodbye on the cheek, I pleaded for forgiveness for leaving her in her third trimester of pregnancy and missing our first scheduled birthing class--praying to God that my first-born son wouldn't arrive while I was off diving the untouchable waters of Cuba. If anyone would understand, I knew little Zachary was toothlessly mumbling, "Go for it Dad!"

The Oceanus representative welcomed me to Cancun and proceeded to cram me, my diving gear, as well as the bodies and gears of eight other divers into his van. This, however, seemed to be a great "getting to know each other session." My aching back welcomed the relief of knowing that was the last time I had to lug my bags and equipment around. The crew of Oceanus carried everything from that moment on. From Cancun we were off to Cuba via a 12-hour boat ride. On this particular passing half the passengers became very familiar with the ship's heads. (I guess they should have accepted the Dramamine the captain was handing out before leaving port. I cry uncle every time when it comes to rough seas.)

Cuban officials are extremely meticulous in the screening process when it comes to who enters and exits their country. Upon arrival in Bahia de Corrientes (The Bay of Currents), there were seven military personnel boarding our vessel. Each passport was thoroughly inspected and hand copied by diligent and intimidating officers.

When satisfied with passport identification, each passenger and member of the crew was asked to stand by him or herself in front of the inspectors for photo comparison. The Cuban government takes this process very seriously. Since my arrival was spur of the moment, my passport was taken ashore to have a copy faxed to Havana for a background check. It was returned to the ship later that same day.

The diving started that day we arrived. It was more of a check out dive in 80 feet near a pretty coral head, and I guess we all passed because dive number two was all wall. And a beautiful wall it was. Hanging mid-water at a 130 feet beside a barrel sponge the size of the bed of my pick-up truck, I gazed downward to 4,000 feet.

If divers are looking for pretty fish, the now-protected waters of Bahia de Corrientes is a great place. All the tropical fish live in this bay, including damsels, butterfly fish, parrots and so many more. It was a virtual swim through one of Paul Humann's fish identification books. Underwater Cuba possesses all the colors of the rainbow both in the fish life and in the coral and sponge. Our night dives brought out the hiding creatures, the lobster, the spotted morays, large crabs and the ever-so-popular octopus. Once back on board, a big cup of hot chocolate was in my hand before my regulator could drop from my mouth.

The other divers and I enjoyed the benefits of nitrox on every dive, and a seasoned captain put us on the reef without error. Two chase boats enabled wall divers to maximize deep bottom time by drift diving. Even a tech diver, like myself, found underwater Cuba extremely gratifying.

Now what would going to Cuba be without actually going to Cuba? Oceanus had scheduled a day tour of the island, which was the highlight of the trip. We boarded an air-conditioned bus with a knowledgeable guide, and what started out as a bumpy ride through sea grape trees on unkempt roads slowly evolved into a smooth two-lane avenue through the lush valleys of the Vinales. Here, Cuba boasts the most productive and best-tasting tobacco fields in the world. We drove into the Pinar del Rio province and into the town of Vinales, touring the rum and cigar factories. Almost everyone purchased Cuban souvenirs; and me, being a U.S. citizen, what could I do? While exploring Cuba that day, I felt as giddy as if I had my hand in the cookie jar and got away with something. And yet, I never felt unsafe.

Lunch and dinner was provided at scenic vista restaurants where the beauty of the valley and majestic mountains were awe inspiring. Sky reaching royal palms were growing wild amongst the green landscape. Hibiscus and sweet acacia lined the streets of every little town. Most public transportation was walking, bicycling and mopeds. Most homes had electricity and some had television. Most everyone seemed busy and had somewhere to go. There was no outward sign of suppression. We did visit a dry cave that turned into a boat ride through tunnels of decorated passages that brought us out and into the other side of the mountain. The two-hour ride back to the ship was interrupted many times to avoid hitting cows standing on the roadway. We saw no fences to contain the livestock.

Two more days of diving would reveal one manta ray, schools of large dog snapper, many schools of tarpon and a cave dive that started in 40 feet and exits the wall face at a 120 feet. The reef atolls are littered with canyons that emerge on the deep side of the abyss. Here, large trees of black coral can be found. Large, green, "organ pipe" sponge and plate coral cover the seascape.

By the time the trip was over, was I tired of seeing pretty fish? Absolutely! Would I go back for a second visit? Absolutely! When our baby is born, will I be handing out Cuban Cohibas? Absolutely!

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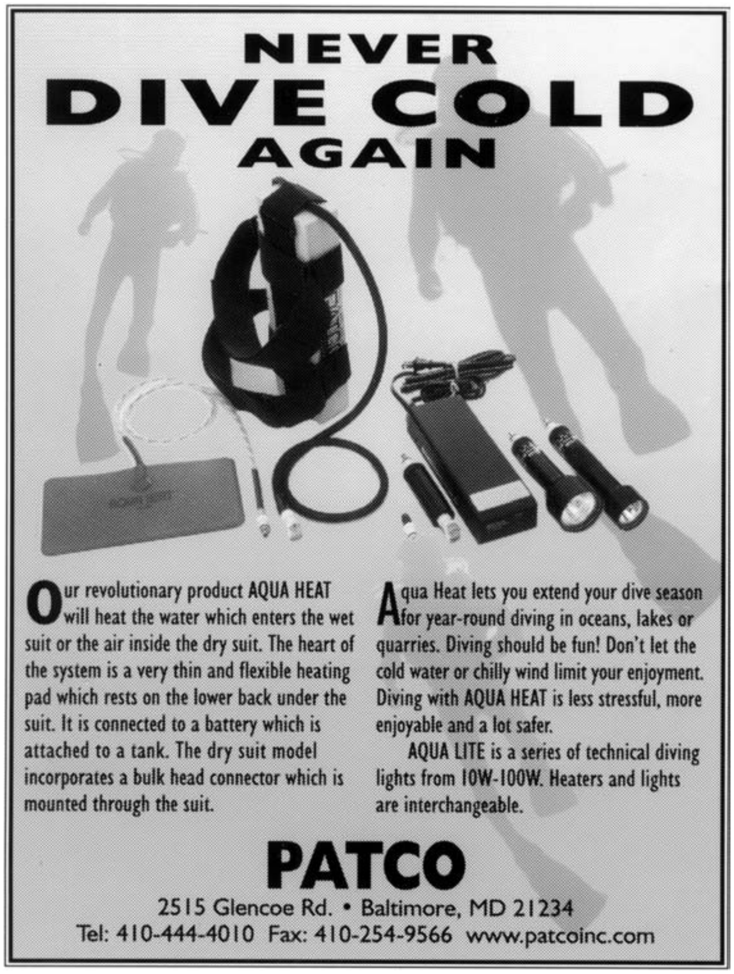
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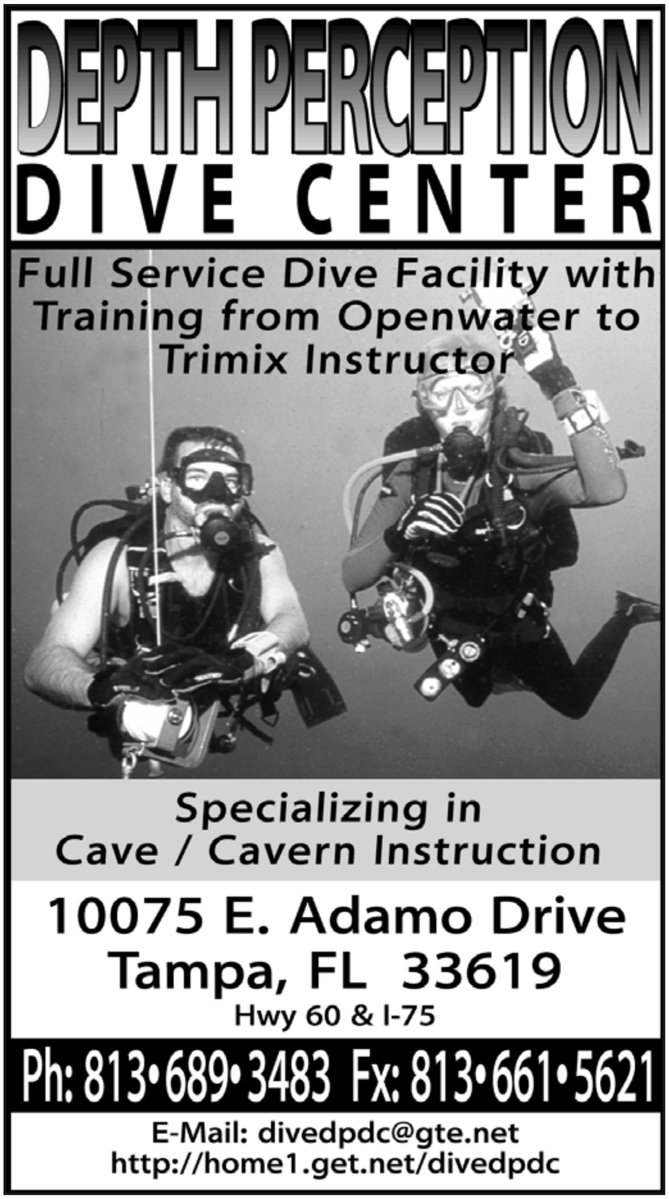
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THE MANY SIDES OF BUBBLE TROUBLE

Bruce R. Wienke and Timothy R. O'Leary • NAUI Technical Diving Operations

Empirical Practices

Utilitarian procedures, entirely consistent with phase mechanics and bubble dissolution time scales, were developed under duress and with trauma by Australian pearl divers and Hawaiian diving fishermen, for both deep and repetitive diving with possible in-water recompression for hits. While the science behind such procedures was not initially clear, the operational effectiveness was always noteworthy and could not be discounted easily.

Pearling fleets, operating in the deep tidal waters off northern Australia, employed Okinawan divers who regularly journeyed to depths of 300 fsw for as long as one hour, two times a day, six days per week, and 10 months out of the year. Driven by economics and not science, these divers developed optimized decompression schedules empirically. As reported by Le Messurier and Hills, deeper decompression stops, but shorter decompression times than required by Haldane theory, were characteristics of their profiles. Such protocols are entirely consistent with minimizing bubble growth and the excitation of nuclei through the application of increased pressure, as are shallow safety stops and slow ascent rates. With higher incidence of surface decompression sickness, as might be expected, the Australians devised a simple, but very effective, in-water recompression procedure. The stricken diver is taken back down to 30 fsw on oxygen for roughly 30 minutes in mild cases, or 60 minutes in severe cases. Increased pressures help to constrict bubbles, while breathing pure oxygen maximizes inert gas washout (elimination). Recompression time scales are consistent with bubble dissolution experiments.

Similar schedules and procedures have evolved in Hawaii among diving fishermen, according to Farm and Hayashi. Harvesting the oceans for food and profit, Hawaiian divers make between eight and 12 dives a day to depths beyond 350 fsw. Profit incentives induce divers to take risks relative to bottom time in conventional tables. Three repetitive dives are usually necessary to net a school of fish. Consistent with bubble and nucleation theory, these divers make their deep dive first, followed by shallower excursions. A typical series might start with a dive to 220 fsw, followed by two dives to 120 fsw, and culminate in three or four more excursions to less than 60 fsw. Often, little or no surface intervals are clocked between dives. Such types of profiles literally clobber conventional tables, but, with proper reckoning of bubble and phase mechanics, acquire some credibility. With ascending profiles and suitable application of pressure, gas seed excitation and any bubble growth are constrained within the body's capacity to eliminate free and dissolved gas phases. In a broad sense, the final shallow dives have been tagged as prolonged safety stops, and the effectiveness of these procedures has been substantiated in vivo (dogs) by Kunkle and Beckman. In-water recompression procedures, similar to the Australian regimens, complement Hawaiian diving practices for all the same reasons.

While the above practices developed by trial-and-error, albeit with seeming principle, venous gas emboli measurements, performed off Catalina by Pilmanis on divers making shallow safety stops, fall into the more scientific category perhaps. Contrasting bubble counts following bounce exposures near 100 fsw, with and without zonal stops in the 10-20 fsw range, marked reductions (factors of four to five) in venous gas emboli were noted when stops were made. If, as some suggest, venous gas emboli in bounce diving correlate with bubbles in sites such as tendons and ligaments, then safety stops probably minimize bubble growth in such extravascular locations. In these tests, the sample population was small, so additional validation and testing is warranted.

Bubble Issues

Recent years have witnessed many changes and modifications to diving protocols and table procedures, such as shorter nonstop time limits, slower ascent rates, discretionary safety stops, ascending repetitive profiles, multilevel techniques, both faster and slower controlling repetitive tissues, smaller critical tensions (M values), longer flying-after-diving surface intervals and others. Stimulated by observation, Doppler technology, decompression meter development, theory, statistics, or safer diving consensus, these modifications affect a gamut of activity, spanning bounce to multiday diving. Of these changes, conservative nonstop time limits, no decompression safety stops, and slower ascent rates (around 30 fsw/min) are in vogue and have been incorporated into many tables and meters. As you might expect, recent developments support them on operational, experimental, and theoretical grounds.

But there is certainly more to the story as far as table and meter implementations. To encompass such far reaching (and often diverse) changes in a unified framework requires more than the simple Haldane models we presently rely upon in 99 percent of our tables and dive computers. To model gas transfer dynamics, modelers and table designers need address both free and dissolved gas phases, their interplay, and their impact on diving protocols. Biophysical models of inert gas transport and bubble formation all try to prevent decompres sion sickness. Developed over years of diving application, they differ on a number of basic issues, still mostly unresolved today:

1. The rate limiting process for inert gas exchange, blood flow rate (perfusion) or gas transfer rate across tissue (diffusion);
2. Composition and location of critical tissues (bends sites);
3. The mechanistic of phase inception and separation (bubble formation and growth);
4. The critical trigger point best delimiting the onset of symptoms (dissolved gas buildup in tissues, volume of separated gas, number of bubbles per unit tissue volume, bubble growth rate to name a few);
5. The nature of the critical insult causing bends (nerve deformation, arterial blockage or occlusion, blood chemistry or density changes).

Such issues confront every modeler and table designer, perplexing and ambiguous in their correlations with experiment and nagging in their persistence. And here comments are confined just to Type I (limb) and II (central nervous system) bends, to say nothing of other types and factors. These concerns translate into a number of what decompression modelers call dilemmas that limit or qualify their best efforts to describe decompression phenomena. Ultimately, such concerns work their way into table and meter algorithms, with the same caveats.

The establishment and evolution of gas phases, and possible bubble trouble, involves a number of distinct, yet overlapping, steps:

1. nucleation and stabilization (free phase inception);
2. supersaturation (dissolved gas buildup);
3. excitation and growth (free-dissolved phase interaction);
4. coalescence (bubble aggregation);
5. deformation and occlusion (tissue damage and ischemia).

Over the years, much attention has focused on supersaturation. Recent studies have shed much light on nucleation, excitation and bubble growth, even though in vitro. Bubble aggregation, tissue damage, ischemia, and the whole question of decompression sickness trigger points are difficult to quantify in any model and remain obscure. Complete elucidation of the interplay is presently asking too much. Yet, the development and implementation of better computational models is necessary to address problems raised in workshops, reports and publications as a means to safer diving.

Computational Issues

The computational issues of bubble dynamics (formation, growth, and elimination) are mostly outside the traditional framework, but get folded into halftime specifications in a nontractable mode. The very slow tissue compartments (halftimes large, or diffusivities small) might be tracking both free and dissolved gas exchange in poorly perfused regions. Free and dissolved phases, however, do not behave the same way under decompression. Care must be exercised in applying model equations to each component. In the presence of increasing proportions of free phases, dissolved gas equations cannot track either species accurately. Computational algorithms tracking both dissolved and free phases offer broader perspectives and expeditious alternatives, but with some changes from classical schemes. Free and dissolved gas dynamics differ. The driving force (gradient) for free phase elimination increases with depth, directly opposite to the dissolved phase elimination gradient which decreases with depth. Then, changes in operational procedures become necessary for optimally. Considerations of excitation and growth invariably require deeper staging procedures than supersaturation methods. Though not as dramatic, similar constraints remain operative in multiexposures, that is, multilevel, repetitive, and multiday diving. Other issues concerning time sequencing of symptoms impact computational algorithms. That bubble formation is a predisposing condition for decompression sickness is universally accepted. However, formation mechanisms and their ultimate physiological effect are two related, yet distinct, issues. On this point, most hypotheses makes little distinction between bubble formation and the onset of bends symptoms. Yet we know that silent bubbles have been detected in subjects not suffering from decompression sickness. So it would thus appear that bubble formation, per se, and bends symptoms do not map onto each other in a one-to-one manner. Other factors are truly operative, such as the amount of gas dumped from solution, the size of nucleation sites receiving the gas, permissible bubble growth rates, deformation of surrounding tissue medium, and coalescence mechanisms for small bubbles into large aggregates, to name a few. These issues are the pervue of bubble theories, but the complexity of mechanisms addressed does not lend itself easily to table, nor even meter, implementation. But implement and improve we must.

1. Perfusion And Diffusion

Perfusion and diffusion are two mechanisms by which inert and metabolic gases exchange between tissue and blood. Perfusion denotes the blood flow rate in simplest terms, while diffusion refers to the gas penetration rate in tissue, or across tissue-blood boundaries. Each mechanism has a characteristic rate constant for the process. The smallest rate constant limits the gas exchange process. When diffusion rate constants are smaller than perfusion rate constants, diffusion dominates the tissue-blood gas exchange process, and vice-versa. In the body, both processes play a role in real exchange process, especially considering the diversity of tissues and their geometries. The usual Haldane tissue halftimes are the inverses of perfusion rates, while the diffusivity of water, thought to make up the bulk of tissue, is a measure of the diffusion rate.

Clearly in the past, model distinctions were made on the basis of perfusion or diffusion limited gas exchange. The distinction is somewhat artificial, especially in light of recent analyses of coupled perfusion-diffusion gas transport, recovering limiting features of the exchange process in appropriate limits. The distinction is still of interest today, however, since perfusion and diffusion limited algorithms are used in mutually exclusive fashion in diving. The obvious mathematical rigors of a full blown perfusion-diffusion treatment of gas exchange mitigate table and meter implementation, where model simplicity is a necessity. So one or another limiting models is adopted, with inertia and track record sustaining use. Certainly Haldane models fall into that categorization. Inert gas transfer and coupled bubble growth are subtly influenced by metabolic oxygen consumption. Consumption of oxygen and production of carbon dioxide drops the tissue oxygen tension below its level in the lungs (alveoli), while carbon dioxide tension rises only slightly because carbon dioxide is 25 times more soluble than oxygen.

Arterial and venous blood and tissue are clearly unsaturated with respect to dry air at one atm. Water vapor content is constant, and carbon dioxide variations are slight, though sufficient to establish an out gradient between tissue and blood. Oxygen tensions in tissue and blood are considerably below lung oxygen partial pressure, establishing the necessary ingradient for oxygenation and metabolism. Experiments also suggest that the degree of unsaturation increases linearly with pressure for constant composition breathing mixture, and decreases linearly with mole fraction of inert gas in the inspired mix.

Since the tissues are unsaturated with respect to ambient pressure at equilibrium, one might exploit this window in bringing divers to the surface. By scheduling the ascent strategically, so that nitrogen (or any other inert breathing gas) supersaturation just takes up this unsaturation, the total tissue tension can be kept equal to ambient pressure. This approach to staging is called the zero supersaturation ascent.

2. Bubbles

We do not really know where bubbles form nor lodge, their migration patterns, their birth and dissolution mechanisms, nor the exact chain of physicochemical insults resulting in decompression sickness. Many possibilities exist, differing in the nature of the insult, the location, and the manifestation of symptoms. Bubbles might form directly (de novo) in supersaturated sites upon decompression, or possibly grow from preformed, existing seed nuclei excited by compression-decompression. Leaving their birth sites, bubbles may move to critical sites elsewhere, or stuck at their birth sites, bubbles may grow locally to pain-provoking size.

They might dissolve locally by gaseous diffusion to surrounding tissue or blood or passing through screening filters, such as the lung complex, they might be broken down into smaller aggregates or eliminated completely. Whatever the bubble history, it presently escapes complete elucidation. But whatever the process, the end result is very simple, both separated and dissolved gas must be treated in the transfer process.

Bubbles may hypothetically form in the blood (intravascular) or outside the blood (extravascular). Once formed, intravascularly or extravascularly, a number of critical insults are possible. Intravascular bubbles may stop in closed circulatory vessels and induce ischemia, blood sludging, chemistry degradations, or mechanical nerve deformation. Circulating gas emboli may occlude the arterial flow, clog the pulmonary filters, or leave the circulation to lodge in tissue sites as extravascular bubbles. Extravascular bubbles may remain locally in tissue sites, assimilating gas by diffusion from adjacent supersaturated tissue and growing until a nerve ending is deformed beyond its pain threshold. Or, extravascular bubbles might enter the arterial or venous flows, at which point they become intravascular bubbles.

Spontaneous bubble formation in fluids usually requires large decompressions, like hundreds of atmospheres, somewhere near fluid tensile limits. Many feel that such circumstance precludes direct bubble formation in blood following decompression. Explosive or very rapid decompression, of course, is a different case. While many doubt that bubbles form in the blood directly, intravascular bubbles have been seen in both the arterial and venous circulation, with vastly greater numbers detected in venous flows (venous gas emboli). Ischemia resulting from bubbles caught in the arterial network has long been implied as a cause of decompression sickness. Since the lungs are effective filters of venous bubbles, arterial bubbles would then most likely originate in the arteries or adjacent tissue beds. The more numerous venous bubbles, however, are suspected to first form in lipid tissues draining the veins. Lipid tissue sites also possess very few nerve endings, possibly masking critical insults. Veins, thinner than arteries, appear more susceptible to extravascular gas penetration.

Extravascular bubbles may form in aqueous (watery) or lipid (fatty) tissues in principle. For all but extreme or explosive decompression, bubbles are seldom observed in heart, liver, and skeletal muscle. Most gas is seen in fatty tissue, not unusual considering the fivefold higher solubility of nitrogen in lipid tissue versus aqueous tissue. Since fatty tissue has few nerve endings, tissue deformation by bubbles is unlikely to cause pain locally. On the other hand, formations or large volumes of extravascular gas could induce vascular hemorrhage, depositing both fat and bubbles into the circulation as noted in animal experiments. If mechanical pressure on nerves is a prime candidate for critical insult, then tissues with high concentrations of nerve endings are candidate structures, whether tendon or spinal cord.

While such tissues are usually aqueous, they are invested with lipid cells whose propensity reflects total body fat. High nerve density and some lipid content supporting bubble formation and growth would appear a conducive environment for a mechanical insult.

To satisfy thermodynamic laws, bubbles assume spherical shapes in the absence of external or mechanical (distortion) pressures. Bubbles entrain free gases because of a thin film, exerting surface tension pressure on the gas. Hydrostatic pressure balance requires that the pressure inside the bubble exceed ambient pressure by the amount of surface tension. At small radii, surface tension pressure is greatest, and at large radii, surface tension pressure is least.

Gases will also diffuse into or out of a bubble according to differences in gas partial pressures inside and outside the bubble, whether in free or dissolved phases outside the bubble. In the former case, the gradient is termed free-free, while in the latter case, the gradient is termed free-dissolved. Unless the surface tension is identically zero, there is always a gradient tending to force gas out of the bubble, thus making the bubble collapse on itself because of surface tension pressure. If surrounding external pressures on bubbles change in time, however, bubbles may grow or contract.

Bubbles grow or contract according to the strength of the free-free or free-dissolved gradient, and it is the latter case which concerns divers under decompression. The radial rate at which bubbles grow or contract depends directly on the diffusivity and solubility, and inversely on the bubble radius. A critical radius, rc, separates growing from contracting bubbles. Bubbles with radius r > rc will grow, while bubbles with radius r < rc will contract. Limiting bubble growth and adverse impact upon nerves and circulation are issues when decompressing divers.

3. Bubble Seeds

Bubbles, which are unstable, are thought to grow from micron size, gas nuclei which resist collapse due to elastic skins of surface activated molecules (surfactants), or possibly reduction in surface tension at tissue interfaces or crevices. If families of these micronuclei persist, they vary in size and surfactant content. Large pressures (somewhere near 10 at m) are necessary to crush them. Micronuclei are small enough to pass through the pulmonary filters, yet dense enough not to float to the surfaces of their environments, with which they are in both hydrostatic (pressure) and diffusion (gas flow) equilibrium. When nuclei are stabilized and not activated to growth or contraction by external pressure changes, the skin (surfactant) tension offsets both the Laplacian (film) tension and any mechanical help from surrounding tissue. Then all pressures and gas tensions are equal. However, on decompression, the seed pockets are surrounded by dissolved gases at high tension and can subsequently grow (bubbles) as surrounding gas diffuses into them. The rate at which bubbles grow, or contract, depends directly on the difference between tissue tension and local ambient pressure, effectively the bubble pressure gradient. At some point in time, a critical volume of bubbles, or separated gas, is established and bends symptoms become statistically more probable. On compression, the micronuclei are crunched down to smaller sizes across families, apparently stabilizing at new reduced size. Bubbles are also crunched by increasing pressure because of Boyle's law, and then additionally shrink if gas diffuses out of them. As bubbles get smaller and smaller, they probably restabilize as micronuclei.

4. Slow Tissue Compartments

Based on concerns in multiday and heavy repetitive diving, with the hope of controlling staircasing gas buildup in exposures through critical tensions, slow tissue compartments (halftimes greater than 80 minutes) have been incorporated into some algorithms. Calculations, however, show that virtually impossible exposures are required of the diver before critical tensions are even approached, literally tens of hours of near continuous activity. As noted in many calculations, slow compartment cannot really control multidiving through critical tensions, unless critical tensions are reduced to absurd levels, inconsistent with nonstop time limits for shallow exposures. That is a model limitation, not necessarily a physical reality. The physical reality is that bubbles in slow tissues are eliminated over time scales of days, and the model limitation is that the arbitrary parameter space does not accommodate such phenomena.

That is no surprise when one considers that dissolved gas models are not suppose to track bubbles and free phases. Repetitive exposures do provide fresh dissolved gas for excited nuclei and growing free phases, but it is not the dissolved gas which is the problem just by itself. When bubble growth is considered, the slow compartments appear very important, because, therein, growing free phases are mostly left undisturbed insofar as surrounding tissue tensions are concerned. Bubbles grow more gradually in slow compartments because the gradient there is typically small, yet grow over longer time scales. When coupled to free phase dynamics, slow compartments are necessary in multidiving calculations.

5. Venous Gas Emboli

While the numbers of venous gas emboli detected with ultrasound Doppler techniques can be correlated with nonstop limits, and the limits then used to fine tune the critical tension matrix for select exposure ranges, fundamental issues are not necessarily resolved by venous gas emboli measurements. First of all, venous gas emboli are probably not the direct cause of bends per se, unless they block the pulmonary circulation, or pass through the pulmonary traps and enter the arterial system to lodge in critical sites. Intravascular bubbles might first form at extravascular sites. According to studies, electron micrographs have highlighted bubbles breaking into capillary walls from adjacent lipid tissue beds in mice. Fatty tissue, draining the veins and possessing few nerve endings, is thought to be an extravascular site of venous gas emboli. Similarly, since blood constitutes no more than eight percent of the total body capacity for dissolved gas, the bulk of circulating blood does not account for the amount of gas detected as venous gas emboli. Secondly, what has not been established is the link between venous gas emboli, possible micronuclei and bubbles in critical tissues. Any such correlations of venous gas emboli with tissue micronuclei would unquestionably require considerable firsthand knowledge of nuclei size distributions, sites, and tissue thermodynamic properties. While some believe that venous gas emboli correlate with bubbles in extravascular sites, such as tendons and ligaments, and that venous gas emboli measurements can be reliably applied to bounce diving, the correlations with repetitive and saturation diving have not been made to work, nor important correlations with more severe forms of decompression sickness, such as chokes and central nervous system (CNS) hits.

Still, whatever the origin of venous gas emboli, procedures and protocols which reduce gas phases in the venous circulation deserve attention, for that matter, anywhere else in the body. The moving Doppler bubble may not be the bends bubble, but perhaps the difference may only be the present site. The propensity of venous gas emboli may reflect the state of critical tissues where decompression sickness does occur. Studies and tests based on Doppler detection of venous gas emboli are still the only viable means of monitoring free phases in the body.

6. Multidiving

Concerns with multidiving can be addressed through variable critical gradients, then tissue tensions in Haldane models. While variable gradients or tensions are difficult to codify in table frameworks, they are easy to implement in digital meters. Reductions in critical parameters also result from the phase volume constraint, a constraint employing the separated volume of gas in tissue as trigger point for the bends, not dissolved gas buildup alone in tissue compartments. The phase volume is proportional to the product of the dissolved-free gas gradient times a bubble number representing the number of gas nuclei excited into growth by the compression-decompression, replacing just slow tissue compartments in controlling multidiving.

In considering bubbles and free-dissolved gradients within critical phase hypotheses, repetitive criteria develop which require reductions in Haldane critical tensions or dissolved-free gas gradients. This reduction simply arises from lessened degree of bubble elimination over repetitive intervals, compared to long bounce intervals, and need to reduce bubble inflation rate through smaller driving gradients. Deep repetitive and spike exposures feel the greatest effects of gradient reduction, but shallower multiday activities are impacted. Bounce diving enjoys long surface intervals to eliminate bubbles while repetitive diving must contend with shorter intervals, and hypothetically reduced time for bubble elimination. Theoretically, a reduction in the bubble inflation driving term, namely, the tissue gradient or tension, holds the inflation rate down. Overall, concern is bubble excess driven by dissolved gas. And then both bubbles and dissolved gas are important. In such an approach, multidiving exposures experience reduced permissible tensions through lessened free phase elimination over time spans of two days. Parameters are consistent with bubble experiments, and both slow and fast tissue compartments must be considered.

7. Adaptation

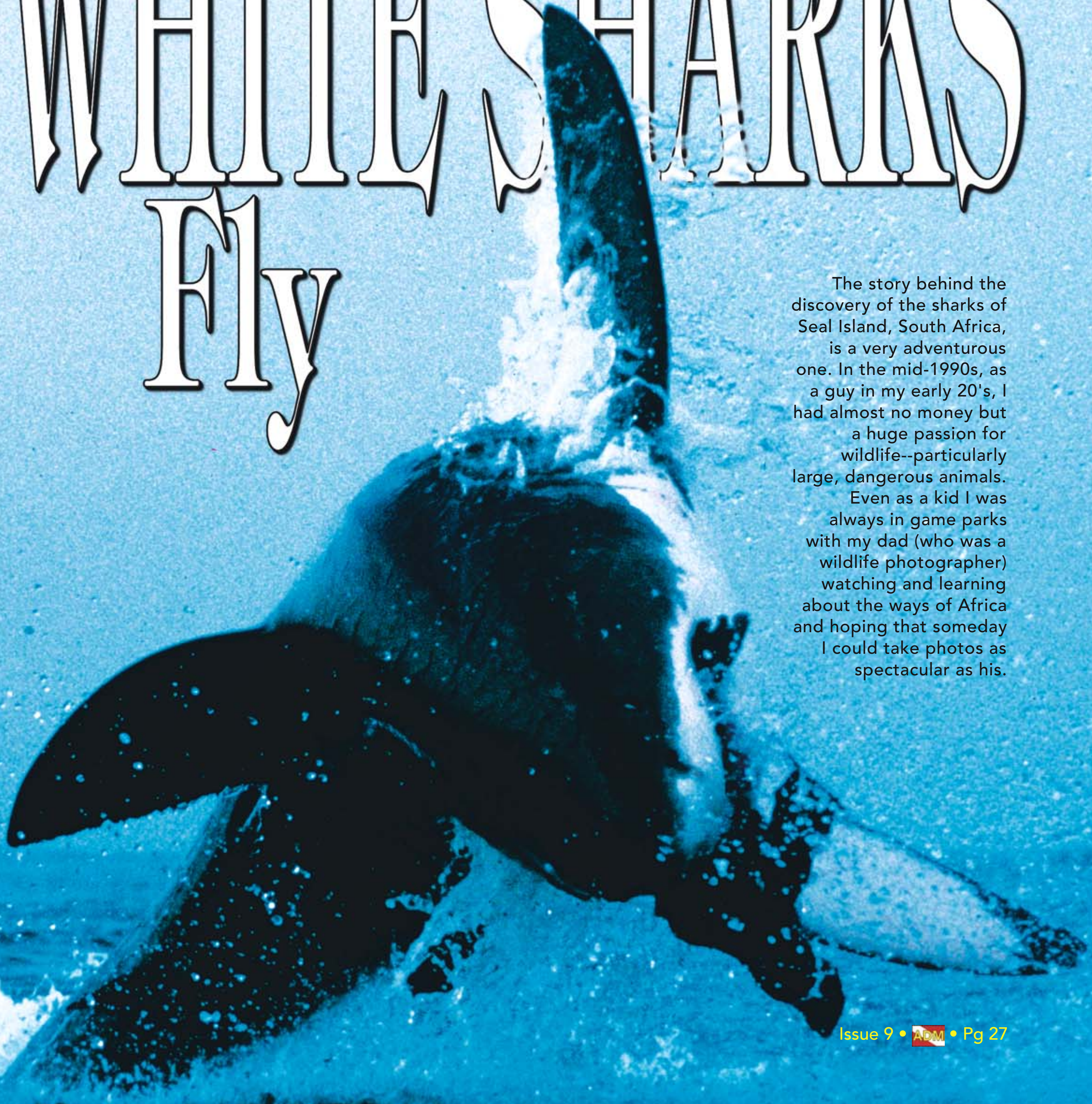
Divers and caisson workers have long contended that tolerance to decompression sickness increases with daily diving, and decreases after a few weeks layoff, that in large groups of compressed air workers, new workers were at higher risk than those who were exposed to high pressure regularly. This acclimatization might result from either increased body tolerance to bubbles (physiological adaptation), or decreased number and volume of bubbles (physical adaptation). Test results are totally consistent with physical adaptation.

Yet, there is slight inconsistency here. Statistics point to slightly higher bends incidence in repetitive and multiday diving. Some hyperbaric specialists confirm the same, based on experience. The situation is not clear, but the resolution plausibly links to the kinds of first dives made and repetitive frequency in the sequence. If the first in a series of repetitive dives are kept short, deep, and conservative with respect to nonstop time limits, initial excitation and growth are minimized. Subsequent dives would witness minimal levels of initial phases. If surface intervals are also long enough to optimize both free and dissolved gas elimination, any nuclei excited into growth could be efficiently eliminated outside repetitive exposures, with adaptation occurring over day intervals as noted in experiments. But higher frequency, repetitive and multiday loading may not afford sufficient surface intervals to eliminate free phases excited by earlier exposures, with additional nuclei then possibly excited on top of existing phases. Physical adaptation seems less likely, and decompression sickness more likely, in the latter case. Daily regimens of a single bounce dive with slightly increasing exposure times are consistent with physical adaptation and conservative practices. The regimens also require deepest dives first. In short, acclimatization is as much a question of eliminating any free phases formed as it is a question of crushing or reducing nuclei as potential bubbles in repetitive exposures.

NAUI Technical Operations

Where WHITE SHARKS Fly

Chris Fallows



The story behind the discovery of the sharks of Seal Island, South Africa, is a very adventurous one. In the mid-1990s, as a guy in my early 20's, I had almost no money but a huge passion for wildlife--particularly large, dangerous animals. Even as a kid I was always in game parks with my dad (who was a wildlife photographer) watching and learning about the ways of Africa and hoping that someday I could take photos as spectacular as his.

Chris Fallows Photography

When we moved close to the ocean, my interest for the African bush continued, but I began to direct more of my attention to what lived in the sea. At first I spent my time tagging smaller sharks and taking photos of them. Slowly, the sharks got bigger until one day I free-tagged a Great White Shark off one of our beaches. This began my fascination with these amazing animals--the ultimate of predators--and made me want to study them more. In the back of my mind, I wondered what, if any, sharks lived at Seal Island, and I decided to find out.

Seal Island was an area close to home and rumored to be infested with Great White Sharks, although people had only seen glimpses of the animal. No one had ever made the effort to actually go and explore the area to see if this legendary fish was actually there. In 1995, as a crazy young guy with nothing to loose, I broke the rules by taking my small, 10-foot inflatable raft five miles offshore to Seal Island to look for the infamous Great White Sharks.

Since I did not have any bait with which to attract the shark, I towed a life jacket behind our boat. The result was spectacular, to say the least, with a 3-meter Great White blasting out of the water with the jacket in its jaws. When it spat out the jacket, I tried the trick not more than 30 seconds later and got the same result--although this time a far bigger shark latched on, showing more interest in my inflatable raft than in the life jacket. I left Seal Island exhilarated. My dream to see the lord of the ocean had come true. To work with and photograph this animal was my calling in life.

Together with my partner we then formed African Shark Eco-Charters and started our operation with a small 18-foot boat that we used to take

mostly backpackers to Seal Island. In the meantime, I started saving up for a good camera. In 1997, I got my first really good breach shot, which quickly hit the headlines of National Geographic, the BBC, CBS and others. At the end of last year, I met Monique le Sueur, who at the time was a top tennis player ranked in the top 500 in the world. She too loved the outdoors and a relationship developed around our mutual interests. Together we started going to the bush and taking photographs and she quickly fell in love with all nature had to offer. As well as loving nature, she was a good photographer with an eye for perfection and together with my nature of taking risks we quickly formed a formidable team. We decided to become full-time wildlife photographers specializing in Jumping Great White Shark images, knowing that if we got the right shot (bearing in mind the notoriety of the Great White) our images would probably become among the most sought after wildlife images in the world.

In May 2000 it happened! The shot that epitomized all that people thought about sharks was captured as a big Great White blasted out of the water. That one, heart-stopping moment was captured on film and struck the imagination of all those who saw it. After we showed our photos to the Discovery Channel they sent down their top crew to produce "Air Jaws," a two-month documentary which is the longest in their history. This documentary is now the main feature for their programming in 2001. With this documentary, it is our hope to inspire others to respect the Great White, while helping them realize that all people can achieve even their most unreachable desires, if they are just willing to set their mind on their goal and pursue their dream to the fullest.

Visit Chris Fallows web site for more information on his photography and photo expeditions available.

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Yucatan Expedition 2001 / Part 3
November 10th - 18th
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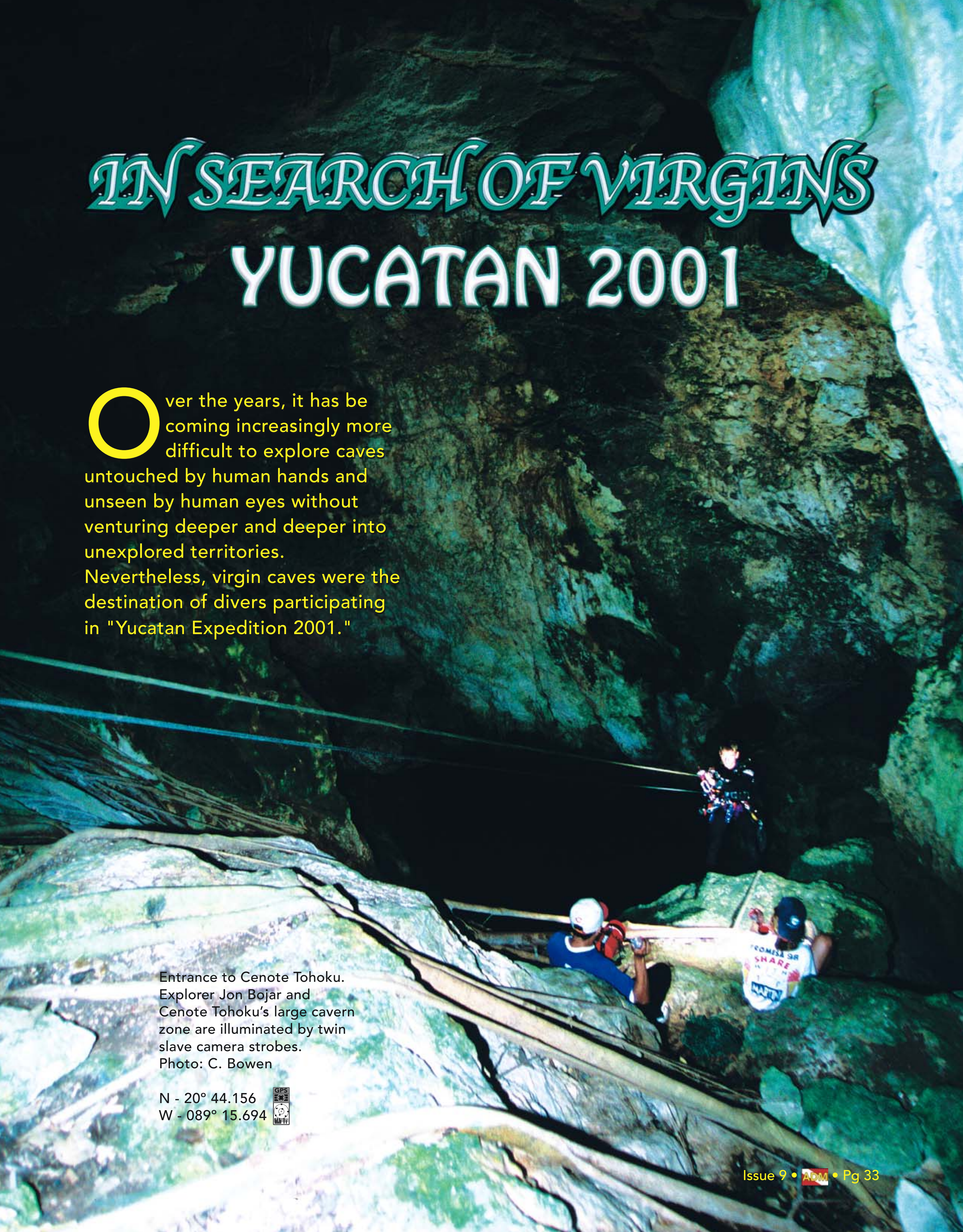
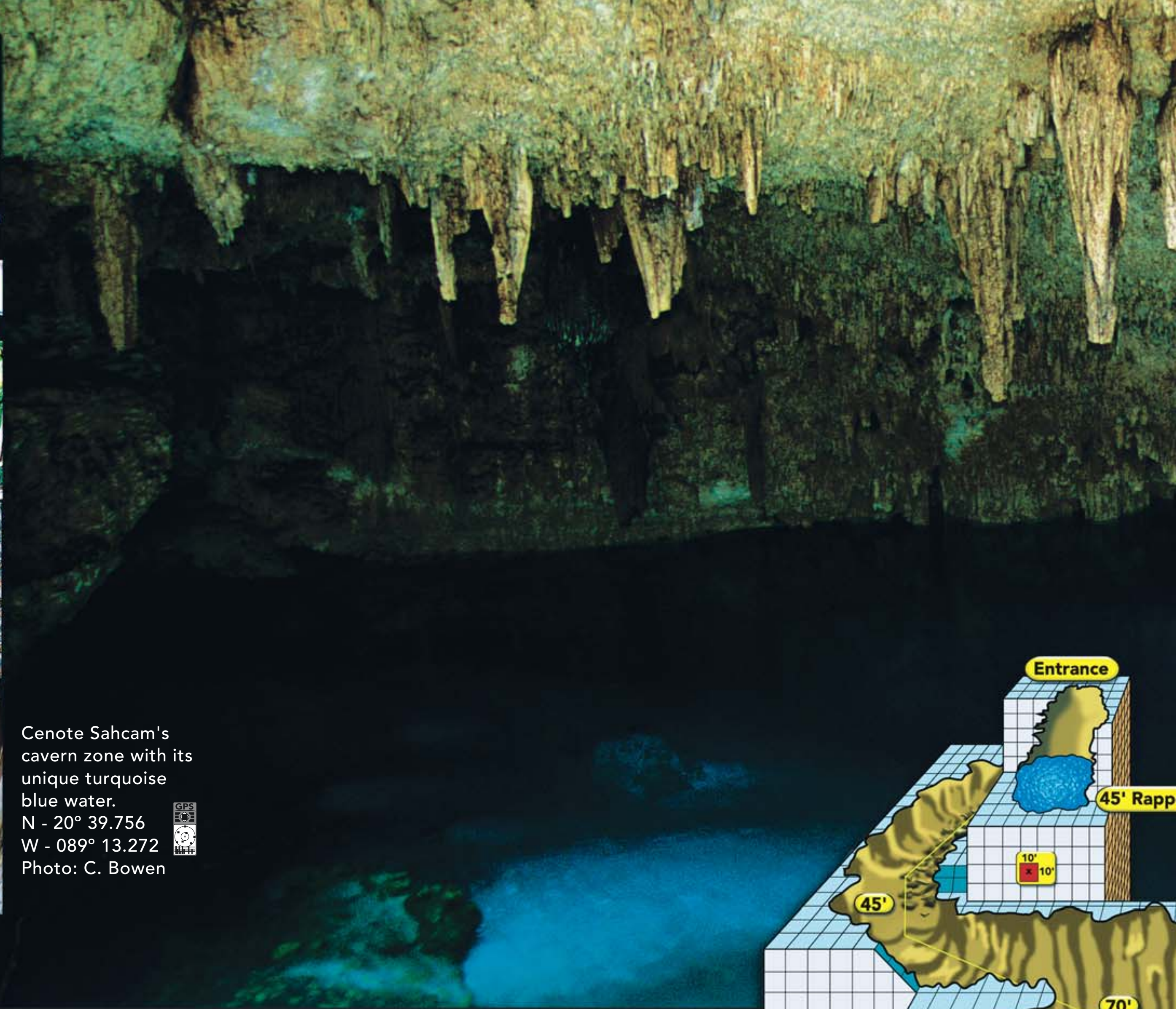


IN SEARCH OF VIRGINS
YUCATAN 2001

Over the years, it has be coming increasingly more difficult to explore caves untouched by human hands and unseen by human eyes without venturing deeper and deeper into unexplored territories. Nevertheless, virgin caves were the destination of divers participating in "Yucatan Expedition 2001."

Entrance to Cenote Tohoku. Explorer Jon Bojar and Cenote Tohoku's large cavern zone are illuminated by twin slave camera strobes. Photo: C. Bowen

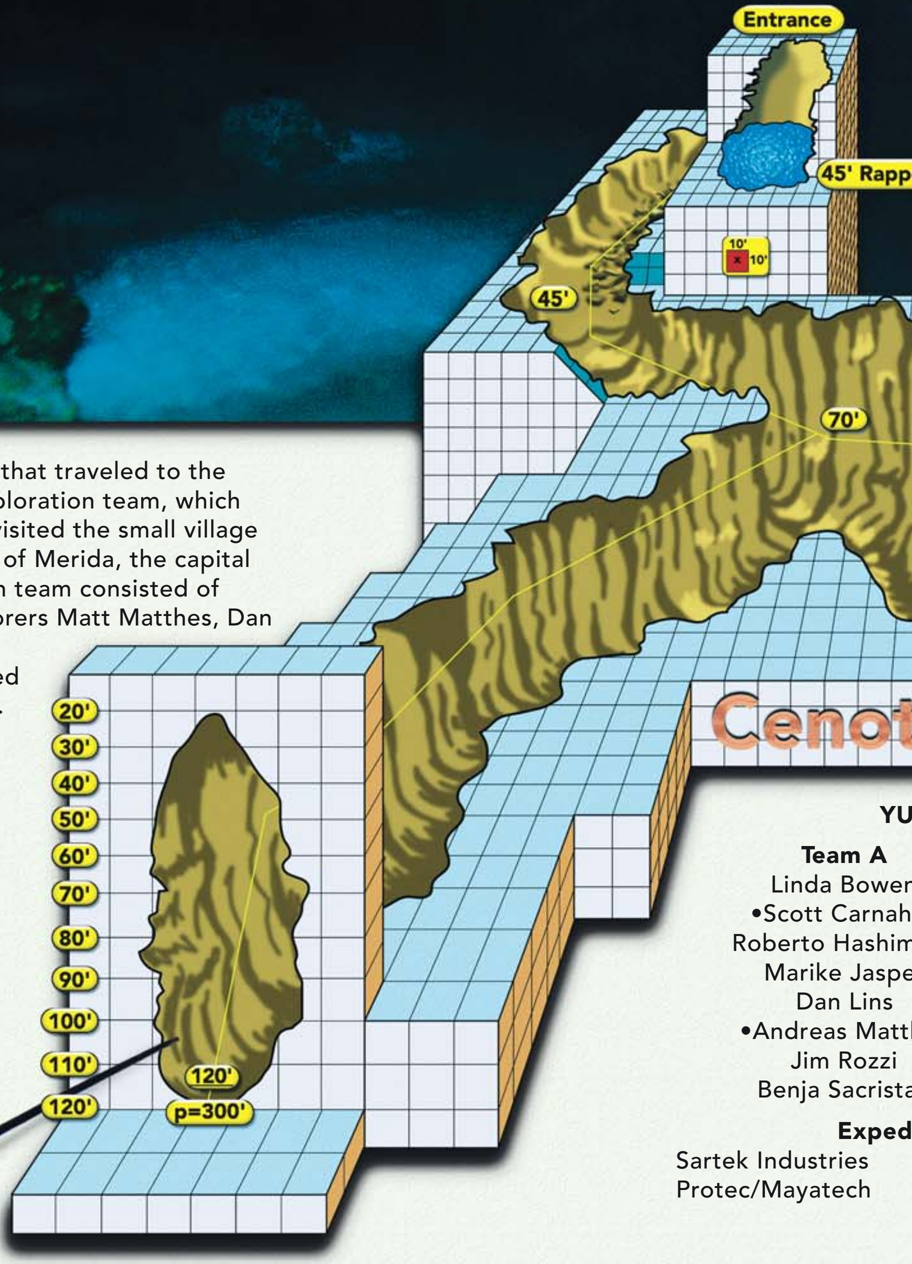
N - 20° 44.156
W - 089° 15.694



Cenote Sahcam's cavern zone with its unique turquoise blue water.
N - 20° 39.756
W - 089° 13.272
Photo: C. Bowen

The expedition consisted of two teams that traveled to the Yucatan at two separate times. The first exploration team, which traveled to Mexico from March 27-April 1, visited the small village of Homun, located 60 miles east, southeast of Merida, the capital city of the state of Yucatan. This exploration team consisted of group coordinator Jim Rozzi, Mexican explorers Matt Matthes, Dan Lins, Roberto Hashimoto, Scott Carnahan, Benja Sacristan, Marike Jasper and Advanced Diver Magazine staff Curt and Linda Bowen.

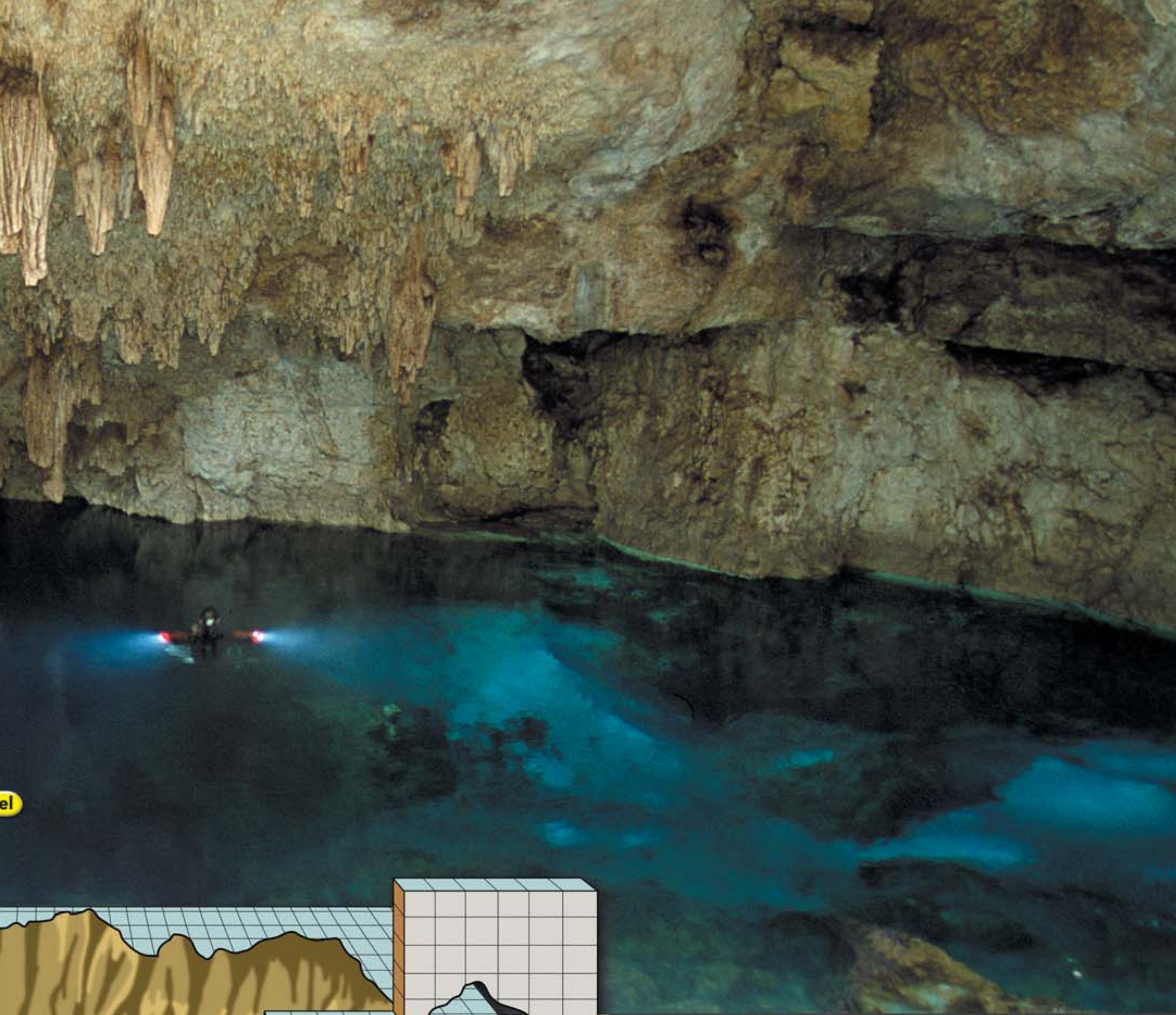
Tailless Whipscorpion (Tarantula spp.) Found in the dry cavern zones of the central Yucatan cenotes, these giant whipscorpions can span up to eight inches in diameter with their legs extended. Giant, nonpoisonous and arachnid-related, whipscorpions rely on stealth and quickness to capture their prey with specially-designed pinchers.

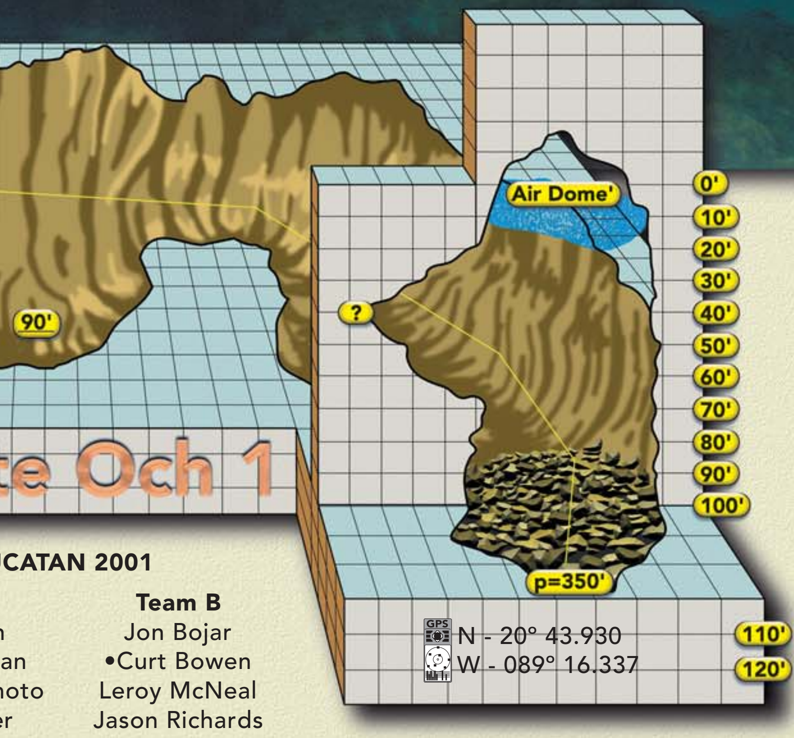


YU

Team A
Linda Bower
•Scott Carnah
Roberto Hashim
Marike Jaspe
Dan Lins
•Andreas Matt
Jim Rozzi
Benja Sacrista

Exped
Sartek Industries
Protec/Mayatech





Artist rendition of the Cenote Och 1 cave system: Although short in linear passage, this cave appears quite impressive due to its passage's immense size, measuring between 20-40 feet wide and 80 to 140 feet tall.

UCATAN 2001

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Team B
Jon Bojar
•Curt Bowen
Leroy McNeal
Jason Richards
Chip Wuerz

•Participated in both expeditions

ition Sponsors
Ocean Management Systems
Villa DeRosa / Aquatech

This region of the Yucatan is composed of a giant, limestone bed, which was perfect for cave formation. The Yucatan State of Ecology has documented over 2,000 cenotes in this region and believes 3,000 to 5,000 are yet to be discovered. Only about one percent of these cenotes has ever been explored below the water line.

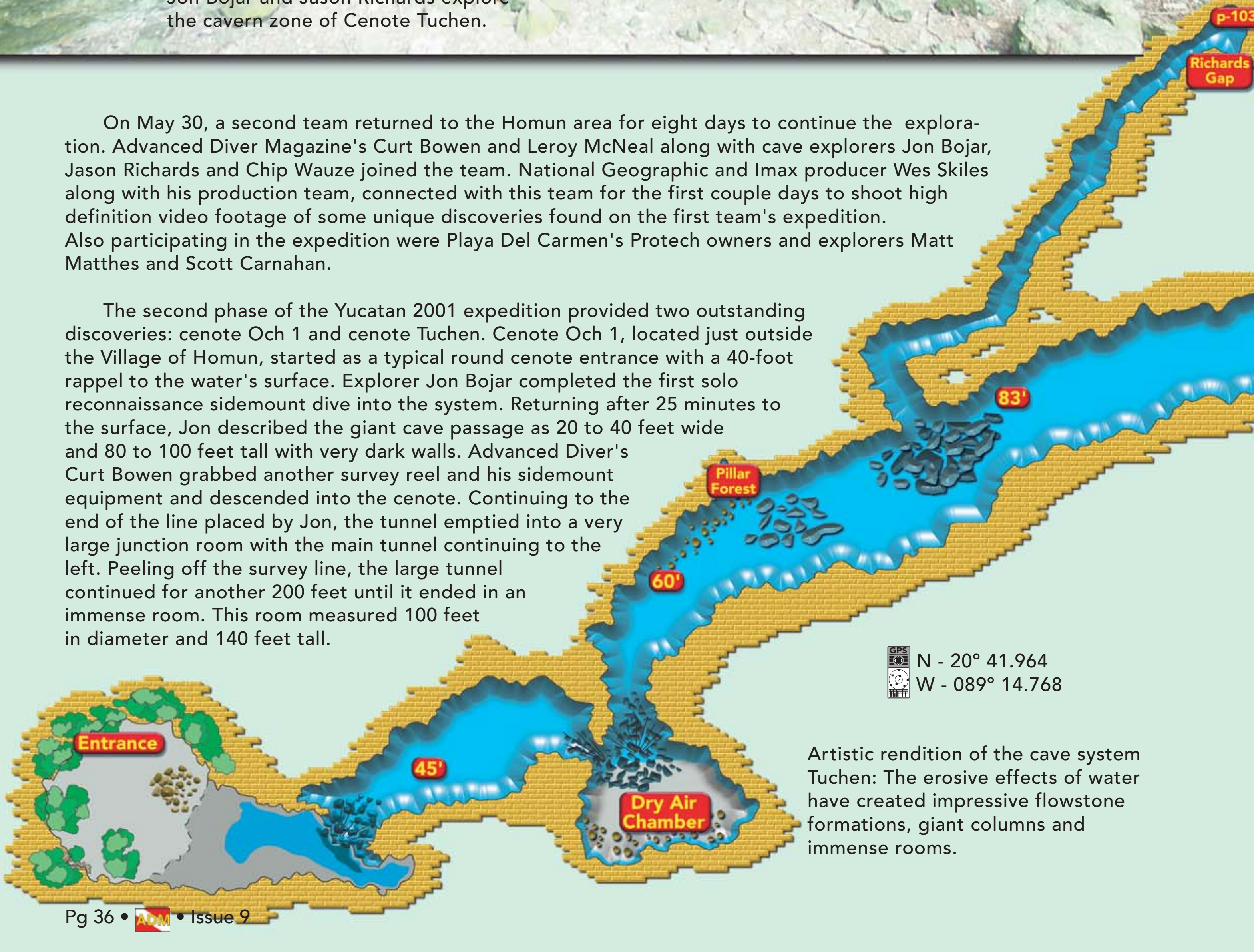
For five days, this team's efforts concentrated on discovering, photographing and documenting as many cenotes as possible within the short time period. These attempts were hampered due to the fact that 90 percent of the cenotes discovered required rope rappelling and climbing skills to obtain access.

After more than five days of exploration, the team discovered and documented 38 new cenotes. Many of these cenotes contained significant flow stone formations, blind cave inhabitants and some Mayan artifacts. No linear cave passage was found during this phase of the expedition with the exception of one possible deep sink hole with unexplored passage appearing to be running at a depth of 240 feet that would require a return trip with proper helium and decompression mixes.

Jon Bojar and Jason Richards explore the cavern zone of Cenote Tuchen.

On May 30, a second team returned to the Homun area for eight days to continue the exploration. Advanced Diver Magazine's Curt Bowen and Leroy McNeal along with cave explorers Jon Bojar, Jason Richards and Chip Wauze joined the team. National Geographic and Imax producer Wes Skiles along with his production team, connected with this team for the first couple days to shoot high definition video footage of some unique discoveries found on the first team's expedition. Also participating in the expedition were Playa Del Carmen's Protech owners and explorers Matt Matthes and Scott Carnahan.

The second phase of the Yucatan 2001 expedition provided two outstanding discoveries: cenote Och 1 and cenote Tuchen. Cenote Och 1, located just outside the Village of Homun, started as a typical round cenote entrance with a 40-foot rappel to the water's surface. Explorer Jon Bojar completed the first solo reconnaissance sidemount dive into the system. Returning after 25 minutes to the surface, Jon described the giant cave passage as 20 to 40 feet wide and 80 to 100 feet tall with very dark walls. Advanced Diver's Curt Bowen grabbed another survey reel and his sidemount equipment and descended into the cenote. Continuing to the end of the line placed by Jon, the tunnel emptied into a very large junction room with the main tunnel continuing to the left. Peeling off the survey line, the large tunnel continued for another 200 feet until it ended in an immense room. This room measured 100 feet in diameter and 140 feet tall.

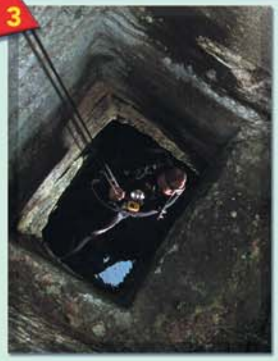


GPS N - 20° 41.964
W - 089° 14.768

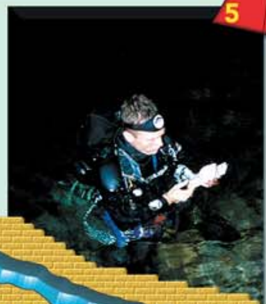
Artistic rendition of the cave system Tuchen: The erosive effects of water have created impressive flowstone formations, giant columns and immense rooms.

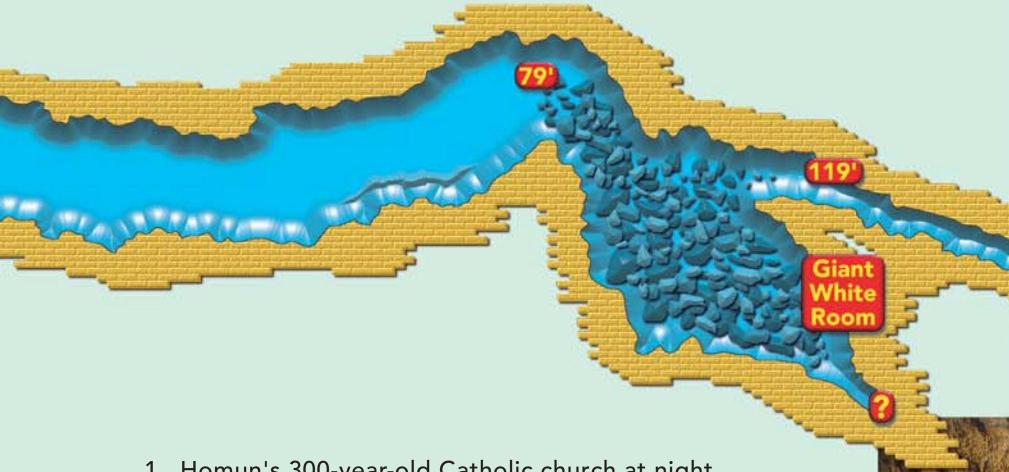
It contained a large air dome at its surface and dropped to a maximum depth of 123 feet. While gathering survey data on the way out of the cave, Bowen noticed another tunnel on his left. Attaching his survey reel to the primary line, he found that this tunnel continued through a large passage with a sloping floor until it came to a prompt end some 200 feet from the tie off. The team determined that future exploration of the site was needed to fully research and document the cenote.

Cenote Tuchen was located down a dirt road several miles from Homun through the Yucatan jungle. This cenote's entrance drops 25 feet into a dry pit and into a large cavern zone. Jason Richards conducted the first reconnaissance dive and found an extremely large passage, impressive flowstone formations and a large dry air dome chamber. Passing the air dome, Jason reeled out knotted line down a massive tunnel leading deeper into the unexplored cenote. Once his exploration reel ran out of line, Jason returned to the exit with the news of his discovery.



Jon Bojar and Curt Bowen gathered more knotted survey line and returned to the end of Jason's line. Tying off, they continued down the massive tunnel. Dipping under a low ceiling the divers entered into what they called the White Room. The water visibility increased to more than 150 feet with a slight blue tinge. This giant room stretched more than 100 feet wide and 150 feet long. Massive white limestone breakdown filled the floor as the team's 18-watt Sartek HID lights flooded the room. Noticing a water tunnel on the left floor of the white room, the team dropped into a 20-foot diameter solution tube running towards the east at a depth of 120 feet. The water tunnel continued for more than 300 feet and abruptly ended in a small white room. Turning back, the team gathered the survey data as they exited the cave. Several tunnels and possible continued leads were noted upon the team's exit. Much more exploration of this system is required. Overall, the two teams explored, surveyed and documented over 50 new cenotes.





1. Homun's 300-year-old Catholic church at night.
2. Linda Bowen emerges back to the Yucatan's surface from Cenote Acrachen Daz.
3. Wes Skiles drops through a farmer's well and into the ceiling of giant cavern zone.
4. Jason Richards prepares for the first recon dive into Cenote Och III.
5. Jon Bojar scribbles down data on his survey slate after returning from a recon dive into Cenote Sahcam.
6. Videotographer Leroy McNeal
7. Explorer Jason Richards sketches the dry cavern zone of Cenote Sahcam.

see www.AdvancedDiverMagazine.com for additional survey data

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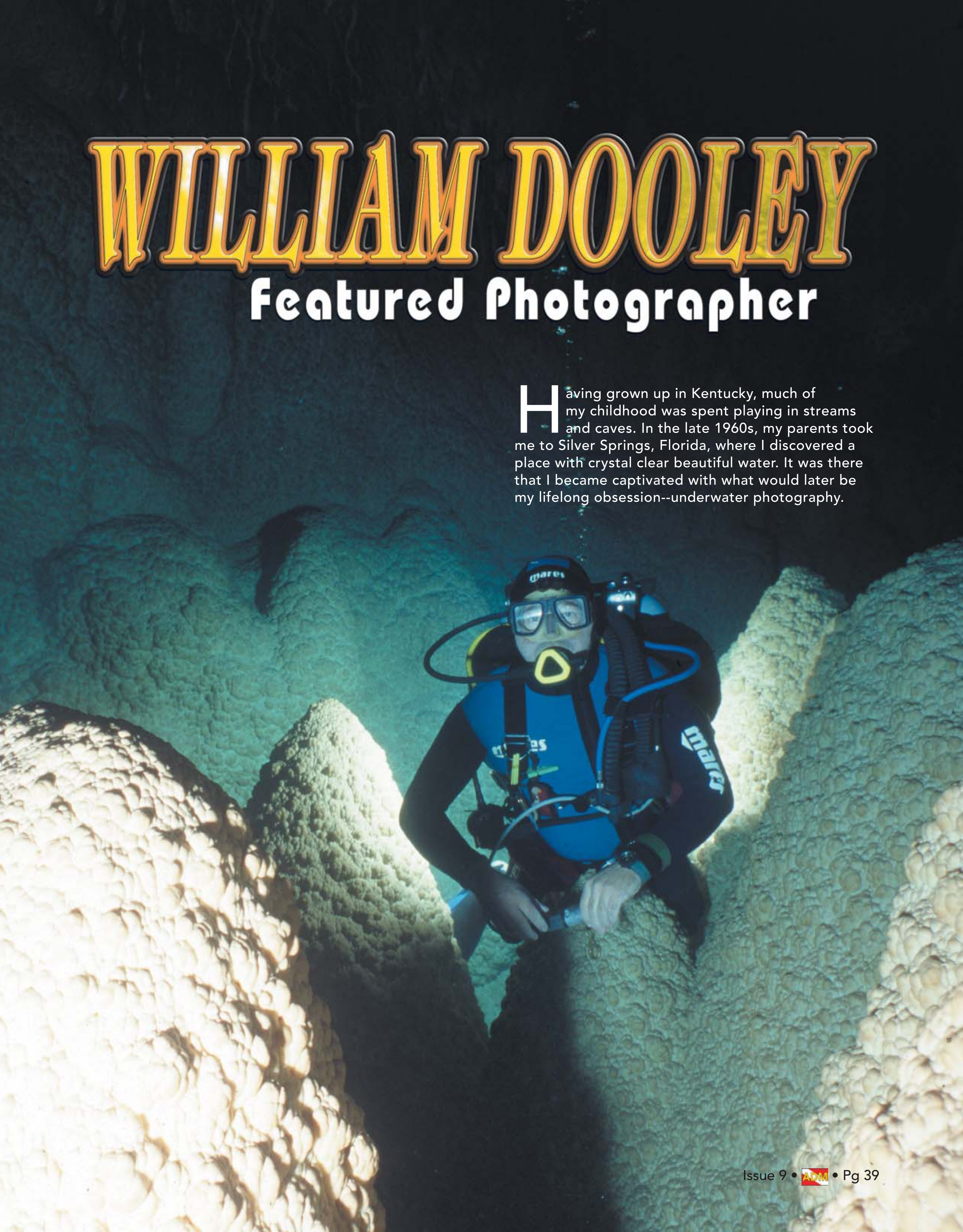
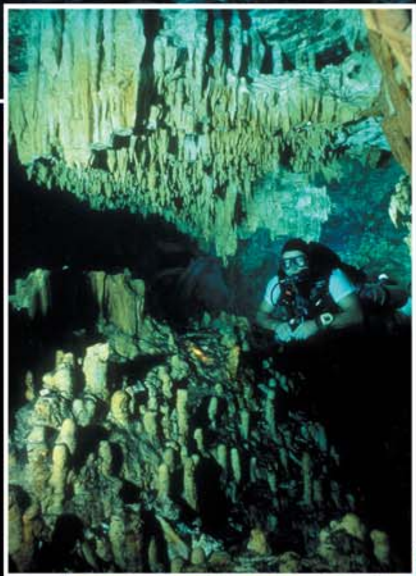
WILLIAM DOOLEY
Featured Photographer

Having grown up in Kentucky, much of my childhood was spent playing in streams and caves. In the late 1960s, my parents took me to Silver Springs, Florida, where I discovered a place with crystal clear beautiful water. It was there that I became captivated with what would later be my lifelong obsession--underwater photography.





In the mid-1980s, I started shooting still photos and video primarily as a hobby. At this time I also owned a Scuba training facility and was taking my open water classes to Florida, the Cayman Islands and Mexico on a regular basis. The clarity of the water in those locations was so impressive that I became more and more driven to try to capture the beautiful images on film. Upon a move to north Florida in 1992, I began photographing the local underwater caves. After connecting with Bill Rennaker, a diver who was mapping new cave passages, I began photographing his projects. This experience gave me the foundation for much of my still photography and video work.

When some people think of caves, especially those that are underwater, they envision dark, dirty and dull places. In my cave photography, I attempt to portray

the beauty of this virtually hidden environment. I feel it is very important to show the non-diving community the beauty of our natural resources while documenting pollution sources and the existence of indigenous wildlife. Photographing caves in Brazil and Mexico have been particularly rewarding.

Becoming involved in cave education as a cave instructor has not only also enriched my photography, but it has provided me with many opportunities to photograph these unique environments. Various equipment companies, dive magazines and boating magazines are among my photo credits. I have also had the great opportunity to work on exploration projects with fellow instructors and students. My hope for the future remains that underwater cave enthusiasts will work toward keeping dive sites open and free from sources of pollution, which threaten not only our recreation but also our natural resources.

Deep Breathin in the Abyss

I just love going to DEMA. Each year I walk around with my press pass on and ogle or sneer at the myriad of new equipment that junk dive manufacturers seem to think divers want to buy. For those of you not in the loop, DEMA is the Diving Equipment and Marketing Association. It used to be Diving Equipment and Manufacturing Association, but because so many companies no longer make their own equipment, they changed the name. This year the DEMA convention was New Orleans -- my kind of town -- great food, great music and a chance to get my hands on the latest goodies. As you can see, I don't put a by-line on my articles, I just write them. It's more fun this way. You don't know who I am, but if a piece of equipment has been panned, I probably panned it. If it got a great review, I probably did that, too. That's the fun of being an independent reviewer.

This year DEMA was showing a lot of hype. This year's show is the only trade convention for 22 months, with the next one scheduled for October of 2002 in Las Vegas. Because of this the exhibitors went all out this year. ScubaPro, of course, had the biggest display (heck it's an $80 million dollar division). PADI was the next largest. Nevertheless, as I roamed the floors with some great coffee I bought outside the convention center, I saw that little had evolved in the areas of regulators, which was my mission for the day. Mares put a new top on the same old second stage; Dacor clipped some stuff from Mares and put a new label on it. At least a dozen

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A
Boulder, USA

companies had the same Italian or Taiwanese knock off regulator with a different cover. One company even attempted to make their regulator the size of a small Dunkin Donuts Munchkin®, which would probably work for a kid, but I doubt it would do well for an adult. Out of the corner of my eye, I spotted a booth that was jammed packed with people: Abysmal Diving.

A few years ago at DEMA, I met this guy with a little booth that was hawking dive-planning software. It was then that I was introduced to the concepts of decompression planning and technical diving by the developer of the software who also runs the Boulder, Colorado, based company--funny place for a dive company, but what the heck. Over the years I have had many exchanges with the people at Abysmal Diving on using their software, which I have seen become the number one dive software product in the world. Hoping to get in to see what all of the hubbub was about, I poked my head in to this huge display of people and equipment and hooked up with Chris, the bearded gent who had always given me such good service. He remembered me instantly, took a squirt of his Chloraseptic and proceeded to give me the tour of what he and his new partner put together. They went full line. Pretty risky I thought for the current economy, but what do I know? I'm a trust fund baby and don't have to work for a living. I do this for fun.

When we got to the regulators he had me put a yellow mouthpiece cover on the regulator and asked me to "breathe on it" (Wow! What a concept.) and actually try out a regulator while on and. Without even looking at it, I held on to it in my mouth for a few more breaths just to make sure it was on. I took it out of my mouth and saw a relatively large, black regulator that looked like nothing special, but I had a feeling there was something to it. Then Chris told me the story of why it breathes so well.

With typical second stages, the only way to make them breathe easier and flow better is to give the regulator a very high input pressure. Most SCUBA manufacturers also think the diver wants a smaller second stage, so they end up making a smaller one only to have to force higher intermediate pressures into them to get any kind of decent flow. To achieve this, most regulator manufacturers set the first stage intermediate pressure between 145 and 180 psi of 140-175 psi. The high pressure pressing against the seat in the second stage allows it to open easier; the result is a "blast" of air. To make a "smoother" breathing regulator, some put in an "adjustment vane" to deflect the air and smooth it out. The problem is that when the IP is set so high, the high pressure seat in the first stage wears out fast and eventually the seat fails, forcing HP air into the second stage and causing it to open in a non-controllable free-flow. Since most of Abysmal Diving's customers actually do extreme diving, they set out to make a better regulator. Looks were not important, but performance was critical.

Chris Parrett, the company's founder and president remarked, "Everything we make has to work to 200 meters. From there, the diver can use it shallower, and it will work even better."

That's an interesting approach, I thought.

He explained that when Abysmal Diving decided to make the move to full line, they knew early on that tooling up to actually make a regulator would be enormously expensive, so the company found specific engineering and manufacturing firms who could make what was needed. What they did do was take the data that they knew about diving and seek out the best manufacturers of deep-water regulators.

Chris explained that they had contracted with Poseidon to have first stage made for Abysmal Diving but had made some changes to the regulator to meet their needs. The first stage is designed to work with pressures from 4350 psi (300 bar) all the way down to 300 psi (20 bar). Also the second stage is designed to take inlet pressures as low as 100 psi and as high as 250 psi. These pressure ranges make this regulator one that will work under most any conditions, weenie dive to deep extreme.

They then went to the deep water experts--the commercial guys who make the diving helmets for working in extremely deep, deep environments; sometimes as deep as 1600 fsw. These are the engineers who have made the famous Kirby Morgan SuperLite® deep water diving helmets.

The Abyss Explorer Adjustable Second Stage is a venturi-assisted demand regulator design. The large diaphragm allows for minimal breathing resistance at any depth. The "Dial-a-Breath®" control allows the diver to fine-tune the breathing resistance whether on a shallow reef dive or a 300-foot open ocean wreck dive. The housing is made of high-impact, dimensionally stable, Noryl® plastic and a polymer diaphragm. The inner workings are chrome-plated, yellow machine brass which allow for smooth adjustments and help assist in resisting freeze-up in cold water. The adjustment knob is large enough to use with heavy gloves, yet smooth enough to be used with the most delicate fingers, and the face place is easy to remove as well. While the second stage is robust and looks a bit bulky, divers find it extremely comfortable while in their mouth. This may be due to the fact that there is virtually zero breathing resistance while inhaling and next to no exertion needed to exhale.

Okay. Enough of the product data. If you want more you can find it on their web site. So with a glimmer in my eye and a secret hand shake voice, I said to the guy: "So, what do I have to do, to get one of these to try out?" hoping I might be in-like-flint with my press pass for a demo unit.

The answer was pretty clear. "You can buy one, though two would serve you better," was the reply from Chris. "Since we introduced these here at DEMA three days ago, every unit we have here is reserved for a new dealer who just bought them. DEMO units won't be available for the press for at least 6 months," he added.

So, with journalistic integrity, I flipped out my wallet, slid out my credit card and proceeded to pony up for what was supposed to be the best breathing regulator on the market. With a smile on his face, he helped me over to the counter where another cheery Abysmal Diving representative took my order, added on a few accessories and some new pressure gauges, gave me a catalog, a receipt and told me my box would arrive in about a week.

About 9 days later a box arrived from Abysmal Diving, neatly packed in heavy-duty plastic. Each regulator was assembled and came with warranty cards, and an extensive instruction manual. Included were all the items I ordered: a stack of tank stickers, and two free RiteBite mouthpieces. I ripped open the pack and proceeded to read the manual. Even though I know how to use a regulator there must be a reason it had a manual. The manual covered everything from how to use the yoke adapter to how to keep the regulator clean. All the hoses were already in the correct places (I told them how I wanted it set up) and I was really ready to dive. And a good thing for that, I was leaving in two days for Truk Lagoon.

Four days later I arrived in Truk and headed out to dive. The first day the guides took us to the Fujikawa Maru, which is in 130 feet with most about 60 feet to the decks. It was a nice, easy dive. We did this on singles and from the first breath while descending this regulator breathed exceptionally well. I did not like using it with the yoke adapter since it put the first stage too close to my head, but I am sure with DIN valves it's perfect. For kicks and grins I started to do a marathon swim around the deck and through the cargo holds just see if the regulator would keep up with me. With a simple adjustment to the Dial-a-Breath® knob I was impressed with the performance.

Two more dives later that day and I was hooked. Later we dove with doubles. But before I head down that road there were some things I didn't like about the reg. The LP hose was a little short for singles but was fine for doubles. I realized it was important to tune the reg down when finished, so the next time I turn it on I'm not in positive flow mode. At first I did not like the exhaust T, but after a few dives I found it rested nicely on my chin, and I had no jaw fatigue at all after a days worth of diving.

While I was on the road working on this article, I pinged on the people at Abysmal and asked for some test data. They had just finished a new set of tests using the ANTSI machine and came back with some impressive results. The ANTSI testing machine simulates work load, depth, and ventilation rates. The Abyss Explorer SuperFlow® adjustable regulator was set to simulate a dive to 241 fsw (73.6 msw) With a ventilation rate set at 37.4 lpm which would be someone swimming at a slightly higher than average pace, the regulator produced a "Work of Breathing" value of 1.08 J/L. On a less extreme depth they had set the ventilation rate set to 62.5 lpm the regulator produced a "Work of Breathing" value of 1.22 J/L. These are some of the lowest resistance rates of all regulators on the market today.

So between the actual dives and test data, these regulators will probably become the standard for tech diving sometime soon.

They are available at professional dive retailers worldwide or by contacting Abysmal Diving Inc. at 6595 Odell Place, Boulder CO 80301 or by telephone at (303) 530-7248 and at www.AbysmalDiving.com.

ADM Performance Evaluation

Advanced Diver Magazine conducted an extensive series of shallow salt water excursions to deep cave decompression dives to evaluate the performance of the Abyss Explorer regulator.

Our Evaluation showed that the Abyss Explorer regulator performed extremely well delivering high gas flow at all depths and diver work loads. Performance was enhanced by the Abyss Explorers continuous ease of breathing and quick flow adjustment knob.

Pipefish Continued from page 13

Double-ended Pipehorse, also known as Alligator Pipefish (Syngnathoides biaculeatus)

The pipehorses are in the Syngnathidae side of the order. While they resemble the Pipefish, they have horse in their name because their heads are at an angle to their body.

Ghost Pipefish (Solenostomidae)

Ghost Pipefish have a short body (three to six inches long), a long snout, two dorsal fins, a large anal fin and large pelvic fins. The female's pelvic fins are larger than those of the male and are connected to the body and form a pouch. With their bodies enclosed by bony plates, Ghost Pipefish are comparable to the snake-like Pipefish.

Ghost Pipefish are usually found in pairs. They may form lifetime bonds with their mate. These fish remain inactive when divers approach and will allow close inspection, as opposed to the snake-like Pipefish. Finding them is often difficult due to their ability to blend with their environment.

The Pipefish's Habitat

Although some divers have reported seeing Ornate Ghost Pipefish as deep as 80 feet and as shallow as five, all of the other Ghost family members are usually reported in waters less than 30 feet. The Robust Pipefish are known to drift over sandy bottoms, looking like dead leaves drifting with the current. The Filamented Pipefish, Longtail Pipefish and Velvety Pipefish all seem to live near algae or other material that provides a background for the animals.

Ornate Ghost Pipefish, also known as the Harlequin Ghost Pipefish (Solenostomus paradoxus)

The Ornate is the most exotic of the Pipefish. Their trunk's color ranges from white to black with a variety of red, yellow and tan. Females are larger than males and can be recognized by their modified pelvic fins, which are joined together to form a brood pouch. While the ornate Ghost Pipefish inhabits many different types of underwater terrain, it is almost always found hanging among the arms of crinoids.

Robust Ghost Pipefish (Solenostomus cyanopterus) AKA Armoured

The Robust are usually seen in pairs, with the female being larger than the male. They are generally found in shades of brown or green, but have sometimes been reported as gray or yellow in color. Some of these have even been spotted with yellow to orange blotches and others with pink blotches that look like encrusting algae. The Robust is the largest of the Ghost Pipefish.

Filamented Ghost Pipefish (Solenostomus sp. 2)

The Filamented Pipefish is pale green with brown and white patches and filaments. The filamented Ghost Pipefish is covered with short filaments.

The Pipefish's Diet

Pipefish have a relatively small, "tube" mouth which they use to suck food. The Ghost Pipefish feed mostly on small shrimp and other invertebrates, whereas many of the snake-like fish feed on plankton. Their jaws are fused together to form the tube. In fact, their Latin genus name Syngnathus means "same jaw." When they see their prey, they shoot forward and suck it in.

Reproduction of Pipefish

Snake-like Pipefish

The snake-like Pipefish's courtship can be fairly quick. It ends when the female transfers eggs to the male. In some species the males incubate the eggs in a brood pouch. In others, the eggs are attached to the underside of the male's body, or in some cases are embedded in spongy pockets on the male's surface. Newly hatched Pipefish are born as juveniles, able to swim and feed on their own. The reports of male Pipefish carrying eggs of different sizes suggest that more than one female has deposited eggs. Males have been observed mating the day after releasing a brood.

Ghost Pipefish

During courtship, which may last two to three days, the male approaches the female, swims back and forth and circles her. While performing this ritual, the male quickly erects and lowers its dorsal fin toward the female. In at least some species, the coloration of the male intensifies during these displays. The courtship can last as long as three days and ends with the two pressing their venters together. The female contracts and expands the pelvic pouch in order to draw sperm to the eggs. Then, the female uses her modified pelvic fins to carry fertilized eggs. There is a small opening on the right side of the brood pouch, between the upper most pelvic fin ray and the "belly." Numerous eggs hatch in about three weeks.

Both Pipefish and seahorses have been captured for the aquarium trade. In scanning the Internet, many of the sites located were, in fact, places to buy Pipefish for aquariums. Pipefish have also been killed and used for Asian medications. Some believe they help reduce skin wrinkling.

Web Sites

www.austmus.gov.au
www.coralrealm.com
www.elib.cs.berkeley.edu
www.fishbase.org
www.fs.broward.cc.fl.us
www.ourworld.compuserve.com
www.zo.utedas.edu
www.REEF.org

The Pipefish featured in this article were photographed in Sulawesi, Indonesia.

HISTORY

The cargo ship James Baine, also known as the "Steamin Demon," was launched on Feb 17, 1943. In December of that same year, the James Baine was refitted and renamed the USS Algol. This naval vessel (AKA-54) was now an auxiliary cargo attack ship that packed a punch of her own. Her 459-foot hull was armed with four double 40mm and six 20mm gun mounts along with a 5-inch gun. She proudly carried into battle supplies, tanks, trucks, artillery and American troops. Additionally, 22 landing crafts were available in her lethal arsenal. These heavily-armed, versatile crafts shuttled brave American troops into battle.

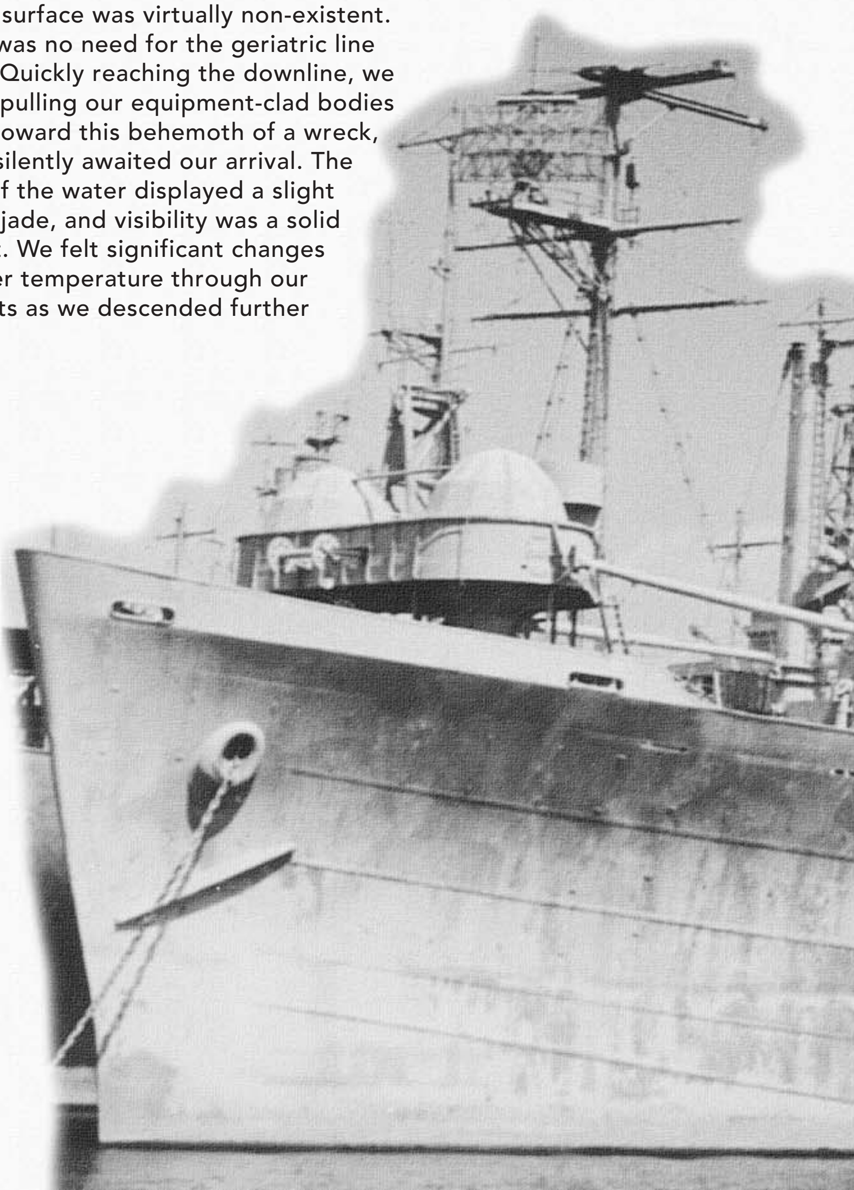
The USS Algol was fully commissioned on July 21, 1944, and immediately placed into active duty status. She first saw action in the Lingayan Gulf, followed by a tour at the Zambales of Luzon. After supporting three invasions off Okinawa without a scratch, she was deployed to Korea to supply needed personnel and provisions for the U.S. Marines. She further pulled duty at Inchon and at Wonson, and finally, Algol aided in the evacuation of Chinnampo. This workhorse of the U.S. Naval fleet was awarded two WW II stars and five Korean battle stars before being decommissioned on January 2, 1958, and spending the next 25 years in dry dock.

In 1983 it was decided that the USS Algol would be placed back in service. This time, her orders were to provide the state of New Jersey with an artificial reef. Offering protection and housing for the vast amounts of marine life found in New Jersey waters, her huge steel structure would now be a safe haven for thousands of organisms. On November 21, 1991, the USS ALGOL was prepared for her final mission. After a thorough cleaning inside and out of hazardous oils and fluids, this highly decorated ship was towed 14 miles offshore, rigged with explosives and sent to her final duty station—the bottom of the Atlantic Ocean.

By Jeff Barris

The sun was shining and the Atlantic was as calm as a millpond. No one aboard the dive boat Lady Grace, based out of Manasquan, New Jersey, had ever seen the ocean so at peace, especially in October. Headed for the fantastic wreckage of the cargo attack ship, the USS Algol, I rode to our dive site aboard a former crew boat, which had been ingeniously transformed into one of the most diver-friendly conveyances I have ever seen. The 42-foot aluminum-hulled boat is designed with both diver comfort and safety as its top priority. From the extra wide "gearing up" benches, to its spacious passenger compartment, a diver could not ask for anything more.

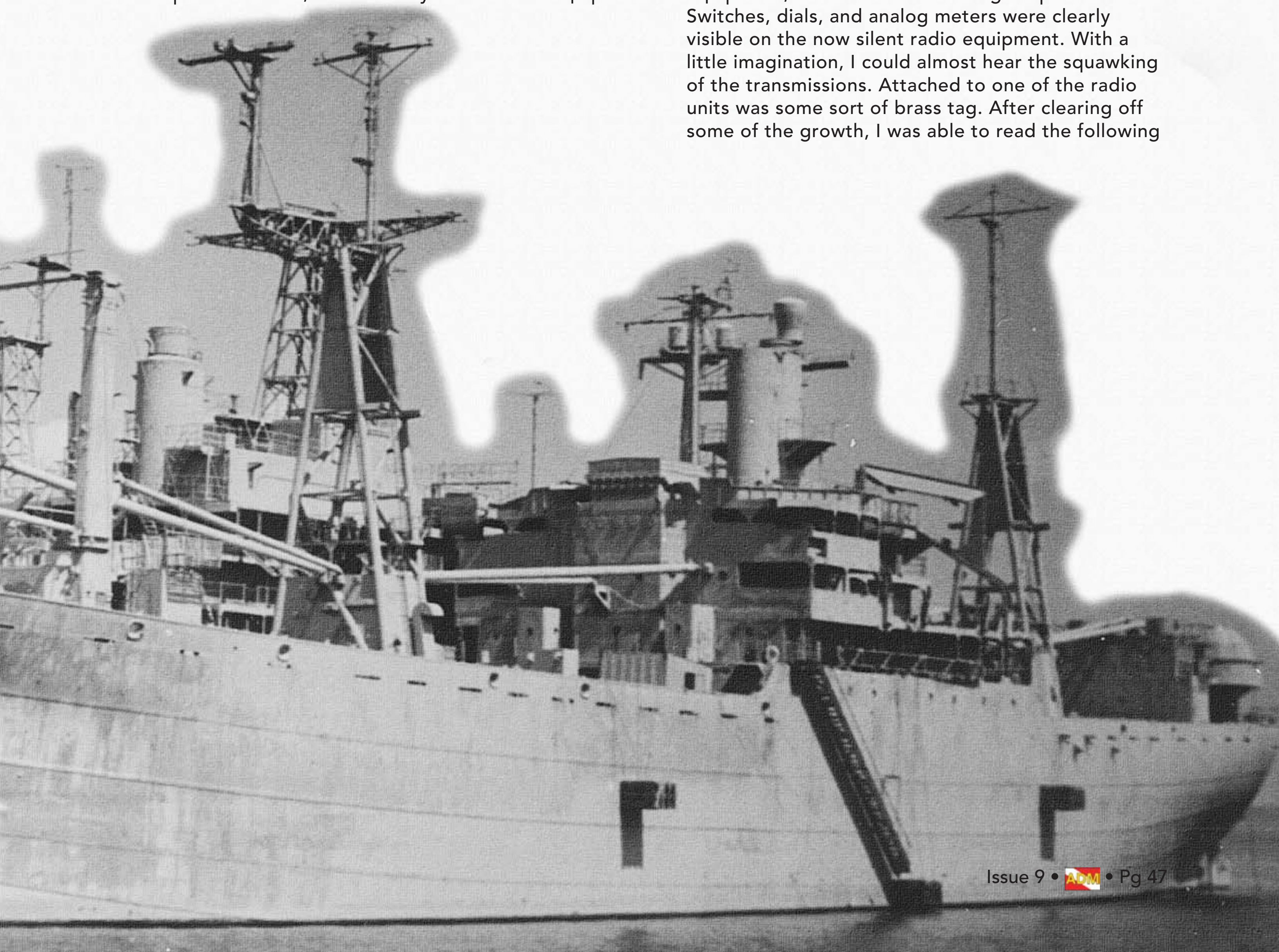
After what seemed to be a brief ride, I—along with my close friends Eric Henhaffer and Ed Braun—and 10 other fully-geared wreck divers, arrived at the position of the esteemed USS Algol, which sits poised upright, rising high off a clay bottom in 140 fsw. With the hook dropped, our mate entered the water to tie us in. All 13 of us were fully geared up and ready to go. The float broke the surface indicating it was "GO" to dive. One by one, we shuffled to the side entry door and stepped off into the flat, calm sea. Current on the surface was virtually non-existent. There was no need for the geriatric line today. Quickly reaching the downline, we began pulling our equipment-clad bodies down toward this behemoth of a wreck, which silently awaited our arrival. The color of the water displayed a slight hue of jade, and visibility was a solid 25 feet. We felt significant changes in water temperature through our dry suits as we descended further



USS ALGOL
NEW JERSEY

into the abyss. Several small clouds of silvery bait fish abounded as we approached her huge superstructure. Suddenly, from out of the green gloom, appeared several small schools of two and three-foot bluefish. Voracious by nature, they systematically devoured the small prey without prejudice and appeared unconcerned with our presence. Many other species, including bergalls, tautog, and Black Sea bass were also busy in their search for food. Along with the immense fish population, pods of mussels and frilly sea anemones encased the majority of the wreck.

Leaving the line, we gently settled onto the first deck on the starboard side, just outside of what appeared to be the ship's radio room, and carefully checked our equipment. My computer displayed 75 fsw. Although we had planned on first exploring the massive ship, our plans soon changed as we spotted large clusters of mollusks hanging from the eaves of the steel superstructure, seeming to await harvest. In no time at all, we fully loaded our catch bags with the famous Algol mussels. Leaving the engorged bags next to the anchor line, we proceeded to explore the ship. With her doors and hatches removed we could easily penetrate the massive ship. Lights in hand, we peered into the first doorway off the first deck. There, covered in marine growth, were old wireless sets, along with other electrical components and equipment, still secure in their original positions. Switches, dials, and analog meters were clearly visible on the now silent radio equipment. With a little imagination, I could almost hear the squawking of the transmissions. Attached to one of the radio units was some sort of brass tag. After clearing off some of the growth, I was able to read the following



inscription, "RESTORED BY PORTSMOUTH NAVAL SHIPYARD MARCH 1957." This was less than a year before the Algol's official decommission. Moments later, I removed the tag and placed it safely in my b.c. pocket. Several fallen cabinets, debris and a very large conger eel prevented us from further penetrating into the already tight compartment, so we decided to find another less confined room. Slowly, we finned our way forward towards her immense bow, which in the past, housed tons of equipment and landing craft. We then descended a dark stairway leading down one deck, which led us through a small breezeway. Slowly we passed the bridge, which was once the nerve center for ship operations, and found it now occupied by scaly residents. Another hatch led to an additional space that still housed electrical equipment. Among the stacked electrical components, we spotted a keyboard indicating it must be the ship's Teletype. I could only wonder about the content of the messages that were sent during her time spent in battle. Several minutes were spent looming over the marine encrusted equipment that was now strangely suspended in time. We then drifted out of this space and continued deeper into the attack vessel's voluminous interior.

At 105 fsw we exited another hatch and arrived at the main deck. Directly in front of us were two very large cargo holds, which led down to her keel to a maximum depth of 150 fsw. Unfamiliar with this area of the ship, we opted to drop over the side in search of lobster. Supposedly, 30 feet off the hull lay a colony of lobsters with their homes built in the clay substrate. The huge vertical hull dwarfed us as we descended further into the dark murkiness. This is probably the closest thing to wall diving New Jersey has to offer. At 140 fsw we touched down on the clay bottom. The lack of ambient light, poor visibility, combined with our diminishing bottom time, led us to abort the lobster hunt and start back to the anchor line. We slowly ascended back up the anemone-covered hull towards the main deck. We made our way back into the darkness of the ship and finally exited at our starting point. There, the huge bags of mussels that we had left earlier were rigged and sent to the surface by way of lift bags. We carefully ascended the line, satisfied our decompression and surfaced.

Back aboard the Lady Grace, other divers were sharing their finds. Many brass items, such as equipment tags, cage lamps and other assorted components were being cleaned and closely inspected. Sea bass, Tautog, and bluefish, along with lobster, and mussels were added to the plentiful bounty. Captain Diaz, an avid wreck diver himself, quickly joined in the festive deck activity. The USS ALGOL, along with our many other New Jersey artificial reef systems, is living proof that marine development leads to the proliferation of abundant undersea environments. These havens truly provide everything that a diver could possibly desire.

Contact Capt. Dan Berg at WWW.Aquaexplorers.com

 See advertisement on page 38.

Yonaguni
Continued from Page 63

they were still "sporty." Diving on the stage, by comparison, was a walk in the park. There was no current and there was no surge, although the visibility hadn't fully recovered from the storm.

Our approach to the Stage was over a plateau of flat, closely aligned rocks. Between the rocks were narrow, straight crevices or indentations. In front of us was a straight wall approximately 100 feet long, ten feet wide, and about 25 feet high that approached the surface of the water. We rounded the right side and before us was a symmetrical pathway 12 to 15 feet wide running the entire length of the wall. Aratake and Kimura call it the "Highway."

Across the highway was a large cube-shaped structure with an attached narrow rectangular platform raised above the flat bottom of surrounding rock. When seeing this, I realized The Stage had been well named. On the right corner was the unmistakable visage of the face. The left corner, however, appeared to have suffered some damage as its surface was broken and irregular. The raised platform was perfectly flat. There were no loose rock fragments anywhere.

As Tom and C, eyes glued to their viewfinders, were moving back and forth, and in and out, in their attempts to get the best shots, Aratake swam up to the eyes and pointed to the pupils carved in them. Tom zoomed in for a close-up while C stayed back trying to get the entire scene on tape.

C panned to the right, recording the entire side of the huge block behind the face. She thought she had seen something etched into rock. Later, at our hotel, we all sat in the director's room and viewed the day's footage. Again and again, as we replayed that part, we saw what appeared to some of us as a headdress. Behind that, Doug Bennett, our trip coordinator, saw the image of a bird with its wings spread, which in ancient Japanese culture was a representation of a god that carried away the souls of the dead.

On a subsequent trip, on the back of the monument, C video-taped a double cross etched into the rock. It would be stretching it to say it was the Greek Orthodox variety, but the vertical line was probably six feet long and the horizontal ones were two feet across.

The face on the Stage is, I think, the smoking gun of the Yonaguni mystery. It flies in the face of assertions that the angular structures around that small island were produced by a whim of nature. Nature normally doesn't etch eyes and mouths into corners of huge rock cubes and then leave absolutely no debris. In addition, the highly angular stage is perched on what appears to be a much larger natural stone platform. The contrast is striking. It's pretty convincing evidence that some kind of complex society existed in that far corner of the world thousands of years before the advent of the Mesopotamian culture. The implications for world history are enormous.

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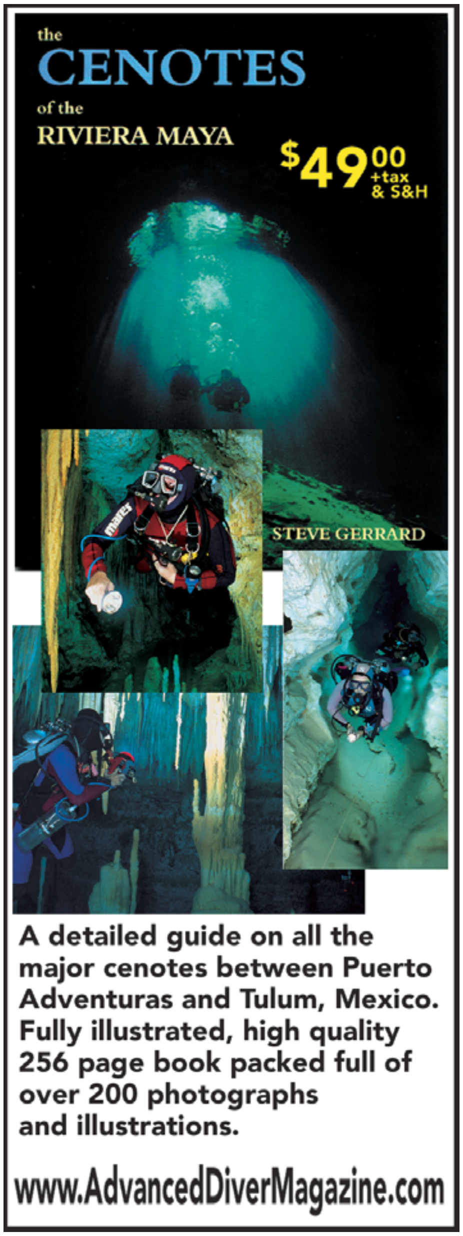
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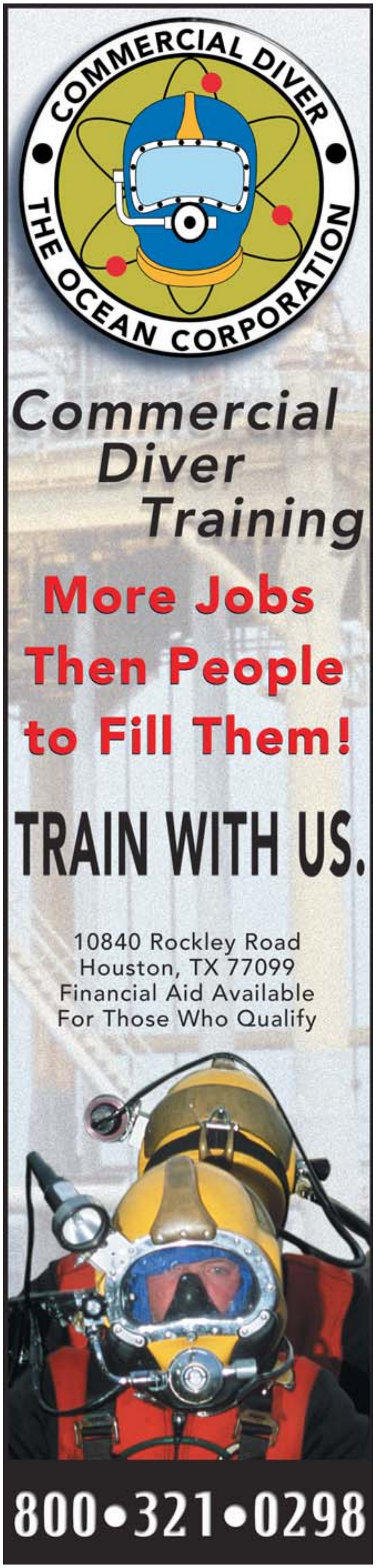
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ARMADILLO Side Mount Rig

By Brett Hemphill

Side mounting tanks were originally used as a secondary configuration for exploring underwater caves too small to be accessed by standard back-mounted cylinders. But in the past years, cave divers that had no interest in pushing through low, forbidding passage have found the use of side mount configurations convenient in standard cave exploration, open water wreck diving and solo diving.

Side mount systems offer increased easy of handling and mobility with dives that require transports in thick jungles, dry cave sections or any other location that requires divers, sherpas or pack mules to tote cylinders over long distances. Remote dive locations seldom have double cylinders available for technical diving, but often have a large supply of single cylinders that can be easily converted into side mount tanks.

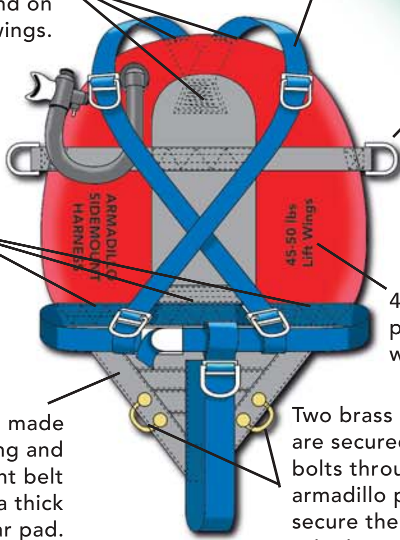
Since the earliest side mount divers, such as Woody Jasper, Wes Skiles, and Lamar Hires, began this type of underwater exploration in the United States, many variations have been created and most ideas have been borrowed, tried and accepted or left behind. The first explorers to use sidemounted tanks were English sump cave divers. That phrase, sump cave, refers to a system where the passages are semi-dry or completely submerged under water. At this time, body harnesses used for repelling into or ascending out of the cave began serving a third purpose. By clipping cylinders to the waist or hip area of the harness, divers could traverse submerged sections of the cave without needing to haul extra scuba equipment throughout the dry tunnels. After traversing the sump into the dry chamber beyond, the side mount cylinders could be easily removed and transported to the next sump.

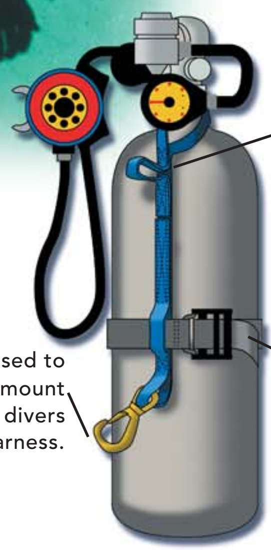
Training and gear configurations relative to cave diving have undergone many changes since their conception, and sidemounting is no different. The aspect that has undergone the most change, however, is the connection point of the cylinder. Configurations using large aluminum plates with fixed D-rings to moving hinges attached to waist and bottle, point of attachment seems to be reinvented most often. The most important thing a diver should take into consideration is how any given configuration will function in a worse case scenario.

Known as the Armadillo, this side mount rig allows two layers of two-inch webbing to form a firm and supportive point of connection. This enables the diver to easily remove tanks, in and out of the water. Underwater, the Armadillo pad keeps the tanks from shifting position even if the diver should completely invert. On rare occasions, side mount divers may have a need to back out of a small passage. In this situation, plates and other types of rigid metal connec

SIDEMOUNT-DILLO

Armadillo Side Mount Harness





tions have a tendency to pull up causing tanks to rise, possibly causing the plate to become wedged and thus making a bad situation worse. For this reason alone, the Armadillo was conceived. How it is attached to the diver and its shape makes backing out safer. The buoyancy control device (BCD-wings) are intentionally flipped over and the low-pressure inflator hose comes over or under the divers right shoulder. This helps to protect the connection point--where the low-pressure inflator enters the BCD--from impacting or rubbing along the cave surface in tight restrictions.

The simplicity of the shoulder harness, waist belt and crotch strap keep the system very clean and streamlined while eliminating needless straps, buckles and D-rings. Because the BCD-wings are sewn directly into the harness, the sidemount becomes extremely easy to transport and comfortable to wear prior, during and after the dive. The primary cave light canister can either be mounted on the diver's waist strap or butt mounted with quick release snaps. Snaps on the light enable it to be removed should it ever become stuck in a restriction.

Two methods of strapping the cylinder neck to the underside of the diver's arms have been tested. One incorporates a looped bungee that crosses the diver's middle back and can be slipped over the valves. The second is the use of attached D-Rings just below the diver's arms on the edge of the harness wings. A secured bungee on the cylinder neck is looped through the D-ring and stretched across the diver's chest to the opposite d-ring. This method also pulls the edge of the wings tight against a diver's sides.

The only downfall of the Armadillo harness is that they are all handmade and only available through Brett Hemphill or Advanced Diver Magazine. That is, of course, unless a diver owns his or her own industrial-size sewing machine. For more information see ADM's web site at www.AdvancedDiverMagazine.com

Jungle Mix II
The Ascent

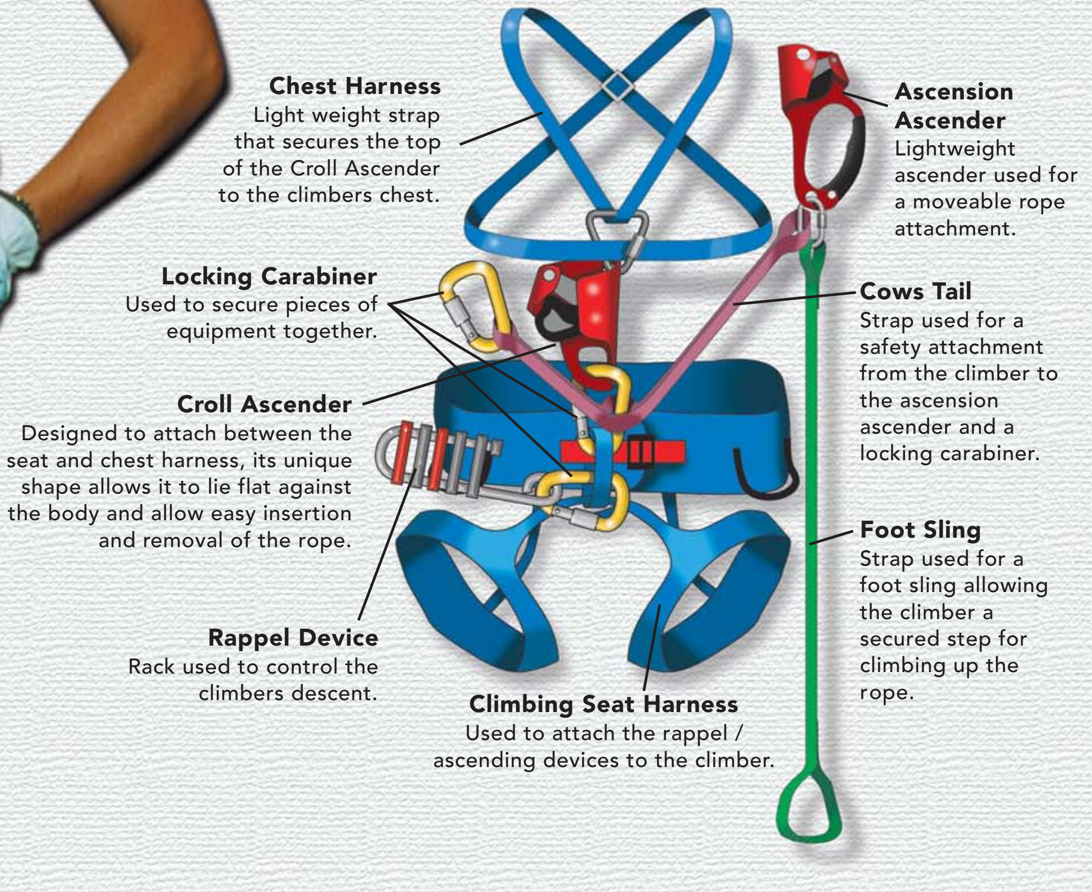
By Linda Bowen

Gaining access into a dive site (see Jungle Mix I, ADM issue 6) that requires rappeling or rope work can be difficult, but in no way compares to the complexity and man power needed to climb back out or retrieve equipment.

Ascending back to the surface can be completed by two separate methods; self climb or assistance with mechanical advantage devices. The self climb requires the climber to use his / her own power to ascend to the surface. This method can be very strenuous and unsafe for climbers with little experience in climbing. It is also suggested to avoid strenuous work loads immediately after a dive requiring decompression obligations.

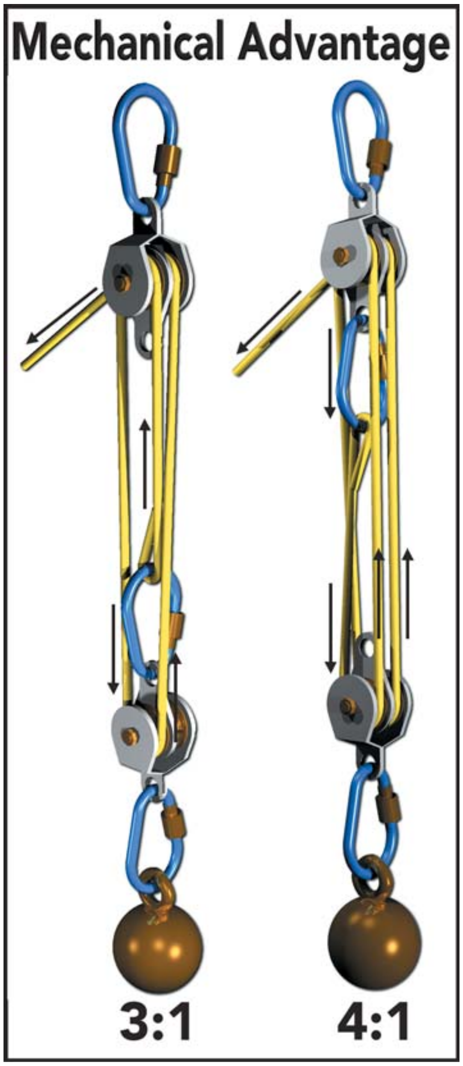
Anatomy of a climbing harness below illustrates one commonly used system for ascending safely on a rope. After the climbing harness and

Anatomy of a Climbing Harness

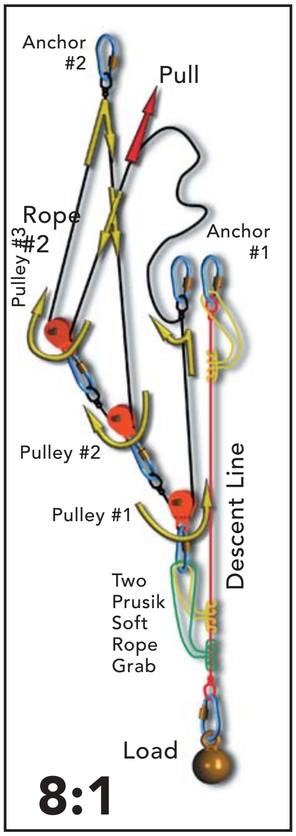


hardware have been correctly donned and double checked for safety. The rope is locked into the chest croll ascender and ascension ascender. These devices allow the rope to slip freely when ascenders are slid upwards but grip tightly onto the line when pulled downwards, creating a climbing method called frogging.

Mechanical advantage method use ropes and pulleys to create a 2 to 1, 3 to 1, 4 to 1 or higher lifting advantage. The mechanical advantage is designed to reduce the amount of force required to lift an object by dividing its weight by the lifting advantage. Example: An object that weighs 200 pounds is attached to a 4 to 1 mechanical advantage pulley system. The force required to lift the object would be divided by 4 making the 200 pound load feel like 50 pounds.



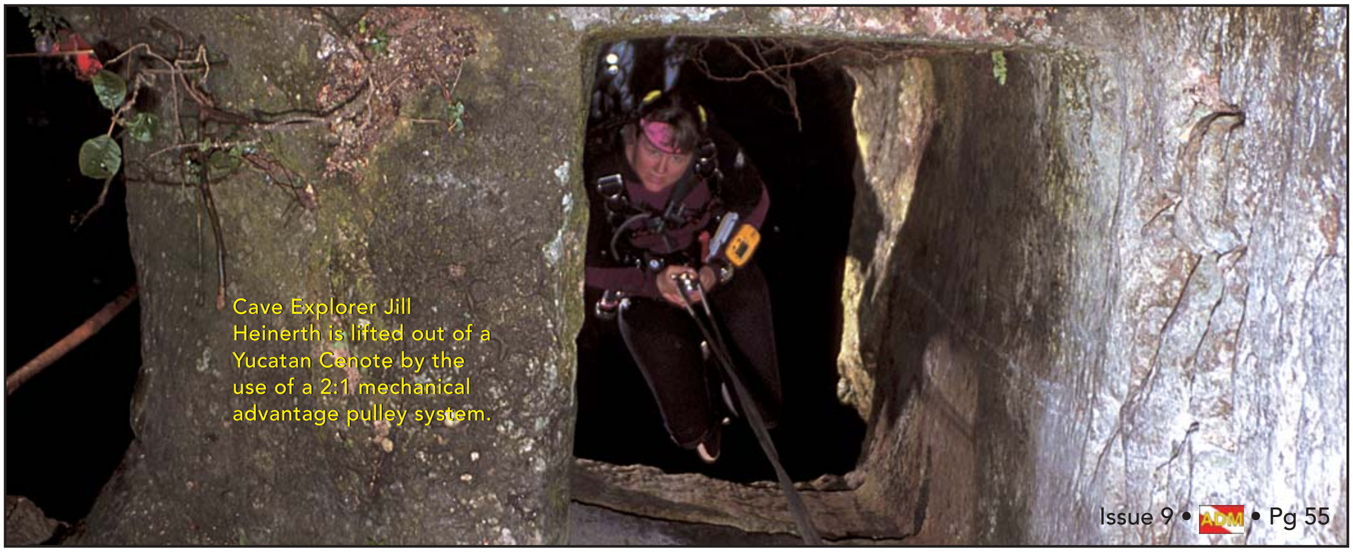
The illustration on the right deplicts a 3 to 1 and a 4 to 1 mechanical advantage with the use of double pulleys. For extreamly long pulls or extra heavy loads a two rope system can be employed. Illustrated below to the left is a 8 to 1 mechanical advantage system. The descent rope can be any length of climbing rope. The second line uses 3 single pulleys and two anchor points to create an 8 to 1 advantage. Rope number 2 pulls up rope number 1 by grabbing it with a two prusik soft rope grab. The disadvantage of this system is that it's extreamly slow and is required to be reset multiple times during a single lift.



There is an endless number of mechnical advantage configurations that can be used in the field, each with their own advantages. Learning just a few simple systems can provide an exploration team with all the lifting assistance required. Of course, none of these systems are needed if one is exploring someplace where the help is cheap has an extra four to eight large, knuckle-dragging, silver-backed men on the surface.

Several organizations offer basic rope training. Your closest location can be loacted on the world wide web.

A free basic rope course is planned for the 2002 NSS-CDS conference. (see page 31) Jungle Mix part III (see issue 10) will cover basic portable equipment needed to mix dive gases while in remote locations such as gas boosters, small compressors, membrain systems and more..



Cave Explorer Jill Heinerth is lifted out of a Yucatan Cenote by the use of a 2:1 mechanical advantage pulley system.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MS Rhein
Dry Tortugas, Florida

By Michael C. Barnette

In 1940 much of the world was focused on the growing hostilities in Europe. However, numerous countries had yet to enter the war, preferring neutrality to a repeat of the bloodshed they encountered in World War I. While the American population opted to ignore and isolate itself from the European problems, the Roosevelt administration recognized that Hitler was a clear and present danger to national security. Neutral at the time, the United States government fully supported Great Britain and her allies. The Declaration of Panama, adopted on October 3, 1939, ordered belligerent nations to stay out of a 300-mile neutrality zone off the coasts of the United States and Latin America. However, this declaration was unilaterally enforced and never applied to those countries fighting the Axis powers. Neutrality Patrols were established in order to assist with the war effort against Germany, while the United States remained officially neutral.

The MS Rhein was a 439-foot long freighter, built in Hamburg, Germany, by the Hamburg-America Line in 1926. The latter months of 1940 found the freighter in the neutral port of Tampico, Mexico, separated from the safety of German waters by the expanse of the Gulf of Mexico and the Atlantic Ocean, both filled with prowling Allied warships. November 29, 1940, also found a U.S. Neutrality Patrol consisting of the destroyers USS Simpson (DD-221), USS Broome (DD-210), and USS McCormick (DD-223) on station off Tampico.

At 8:35 a.m., the Rhein and Idarwald, another German merchant ship, were observed leaving port and steaming south, staying within Mexican territorial waters. The USS Broome pulled anchor and slowly shadowed the German freighters. On December 7, 1940, the USS McCormick was ordered to relieve the Broome and keep the Rhein under surveillance as she steamed east towards the Florida Straits and the open Atlantic. As the Rhein steadily approached Florida, the USS MacLeish (DD-220) was given emergency orders and hastily sailed from Key West at 2:05 p.m. to rendezvous with the McCormick in the Gulf of Mexico. At 3:50 p.m., the Dutch man-of-war Van Kinsbergen, sailing under the British flag, was sighted by the MacLeish and informed of the approaching German freighter. The two warships sped westward to rendezvous with the McCormick and intercept the Rhein. Nearing the Dry Tortugas, the 6,050 ton Rhein was finally intercepted by the Van Kinsbergen on the morning of December 11. As the U.S. warships moved off, the Van Kinsbergen turned on her spotlights and fired a warning shot across the bow of the Rhein. With no escape possible, the crew of the Rhein attempted to scuttle their vessel and set fire to the ship. A boarding party from the Van Kinsbergen attempted to salvage the freighter but abandoned efforts due to the fire that raged out of control, as well as armed resistance from the German crew. After the skirmish, the MacLeish reported observing an empty lifeboat riddled with bullet holes and stained with blood. That afternoon, the HMS Caradoc arrived to receive the German prisoners from the Van Kinsbergen. The Caradoc then proceeded to fire 22 six-inch projectiles at the still-burning freighter, eventually sending her to the bottom at 3:56 p.m.

Photo of MS Rhein © Hapag-Lloyd

Not visited by divers until 1991, the wreck was eventually found upright and intact in 250 feet of water, her main deck situated at a depth of approximately 200 feet. Her kingposts and forward mast were still proudly pointing skyward, reaching to within 140 feet of the surface. Unfortunately, the forward mast has since fallen to the deck and lies dangling off the portside of the wreck. On the first few dives, Billy Deans and Frank Benoit located the ship's bell still standing on the bow and returned with an underwater cutting torch to recover the brass prize. The forepeak of the wreck presents several rooms for exploration, and many are filled with miscellaneous hardware and extra fittings for divers to investigate.

Heading aft, the remains of the midship superstructure can easily be penetrated as the vertical bulkheads on the boat and main decks have collapsed in many places. Large bronze portholes are found lying loose throughout this portion of the wreck. However, the interior of the upper decks appear to be barren of other artifacts, possibly due to the raging fire that swept through the ship. Several portions of the superstructure, including the bridge area, are extensively damaged, most likely the result of the Caradoc's attack. Gaping holes in the middle of the ship allow divers to work their way past twisted steel down into the boiler and engine rooms. Back on deck, railing can still be observed lining several portions of the wreck, particularly as one travels aft towards the stern. A traumatic fracture separates the extreme stern section, which is kicked over to port at an extreme angle. The rudder and half-buried bronze screw can be observed on the starboard side of the wreck. Rounding the fantail and heading forward, a line of closed portholes can be followed back to the fracture in the hull, underneath the collapsed aft mast, which protrudes off the starboard side of the vessel.

While the wreck is impressive due to its sheer size, the impact of which is exaggerated by the 100-foot average visibility, the prolific marine life exponentially increases the enjoyment of a dive on the Rhein. Constantly bathed by the warm tropical waters, the entire wreck is heavily encrusted by luxurious invertebrate growth. The forward cargo hold is magnificently enshrouded with pink and white gorgonians that drape off support beams like ivy. Large sea turtles and rays frolic about the wreck, while copious amounts of grouper and snapper move about the decks. The amount of marine life is only surpassed by the massive average size of the observed specimens. Due to its remote location, the wreck site supports a balanced and thriving marine ecosystem that is seldom experienced on wrecks closer to Florida's heavily-fished coast.

The MS Rhein is a spectacular Florida wreck; there are simply not enough superlatives to describe a dive on this site. The historical background of the vessel, artifact potential, abundant marine life, and exceptionally clear and warm waters off the Dry Tortugas culminate to create a truly fantastic experience that any technical diver will relish.

Michael C. Barnette is the Founder and Director of the Association of Underwater Explorers (http://www.mikey.net/aue), a coalition of divers dedicated to the research, exploration, documentation, and preservation of submerged cultural resources. Employed as a marine ecologist with the National Oceanic and Atmospheric Administration (NOAA), he is currently working on a book documenting the numerous shipwrecks found around the State of Florida.

Underwater Video Images: Andrew Donn

TEK-DPV

Submerge™

By Rodney Nairne

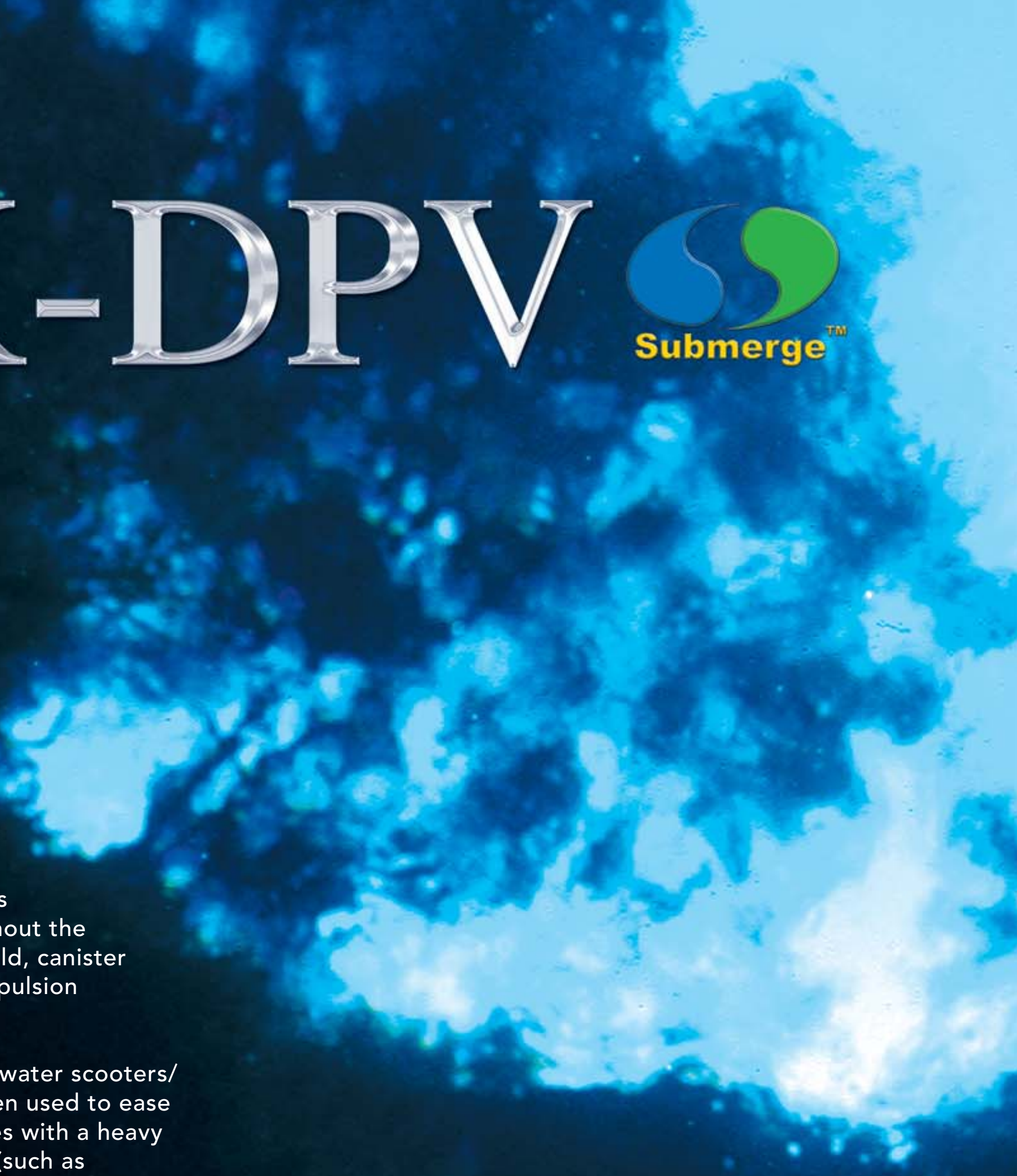


Photo: Evie Dudas

For decades the warm, clear waters of North Florida have enticed cave diving explorers to push their equipment to the limit. More often than not, the caves they explored extended well beyond where their equipment could take them, resulting in an active culture of innovation. With the recent popularity of technical diving, the results of innovative minds can be seen throughout the world whenever a stage cylinder, manifold, canister light, backplate or even underwater propulsion vehicle is used.

Over the years many types of underwater scooters/ diver propalsion vehicles (DPV) have been used to ease the drudgery of swimming long distances with a heavy equipment load. Ride-on style scooters (such as Farrallon and Aquazepp) were previously the only scooters with depth capability; but the tow-behind Tekna scooter, which debuted in 1985, is now regarded to have a clear edge in motor/propeller efficiency, maneuverability and ease of operation.

Furthermore, divers needed a tow-behind scooter that had the added features of depth capability and longer burn times. It was fairly simple to build a deep-rated structure for the Tekna motor, using readily available PVC pipe and plate. That design has been fundamental to the recent increase in Floridian record-breaking cave dives.

Two years ago, Submerge Inc. was started to develop a state-of-the-art scooter framework with the goal of taking the concept several steps forward. The objective was to be as simple as possible in the scooter's design. The UV (underwater vehicle) scooter is primarily made of almost indestructible polyethylene, with no parts molded or glued. The hull is five-eights of an inch thick, yet is not heavy, as the material has a low specific gravity compared to PVC or aluminum. Internally, bulkheads of one-inch thick polyethylene and three-eights of an inch polycarbonate provide the strength to withstand 300 or more feet of water. Marine grade aluminum is used for the motor compartment to add rigidity to plastic sealing surfaces and to withstand the heat dissipation of the direct drive 24-volt permanent magnet DC brush motor. Efficient design enabled the number of components to be reduced by machining out of a single block of material. The main hull has only two points that can leak and these are sealed by large section O-rings, which are less affected by small amounts of contaminates or small surface scratches on sealing surfaces.

All three of the scooter's sizes, which use the identical nose and motor end sections, have the batteries placed in a way that compensates for the torque of the propeller, reducing diver fatigue. Additionally, because the nose and tail sections are identical, it is easy to change the battery and hull sections to any of the three available sizes in minutes with no tools.

An important advancement was the new design for the handle. All previous handles had been designed for two-handed operation, with the handles at the three and nine o'clock positions. Experience had shown the ideal method was to use a tow rope, rather than be pulled along by both arms, and to use only one hand to guide or "fly" rather than muscle the scooter--keeping one of

Model	Batteries	Weight	Overall Lenght	Speed	Run Times	Distance Range	Price
UV-18	Yuasa NP18-12B	70 lbs 32 kg	28" 711mm	1.3-2 mph 2-3.5 kph	60-90 minutes	2 miles 3.2 km	$3635 (*$2570)
UV-26	Yuasa NP26-12 or NP24-12	93 lbs 42 kg	35" 890mm	1.3-2 mph 2-3.5 kph	90-150 minutes	3 miles 5 km	$3725 (*$2660)
UV-38	Yuasa NP38-12	120 lbs 54 kg	43" 1100mm	1.3-2 mph 2-3.5 kph	120-200 minutes	4.5 miles 7 km	$3815 (*$2750)

- Re-wound, hi-performance motor standard equipment on all complete scooters.
- Prices (in brackets) are for Tekna/Mako trade-ins only, trade in price includes new batteries. Conditions apply.

the handles at the 12 o'clock position. In the past, divers had to contort the position of their hands when operating the machine, since the handles had not been designed properly.

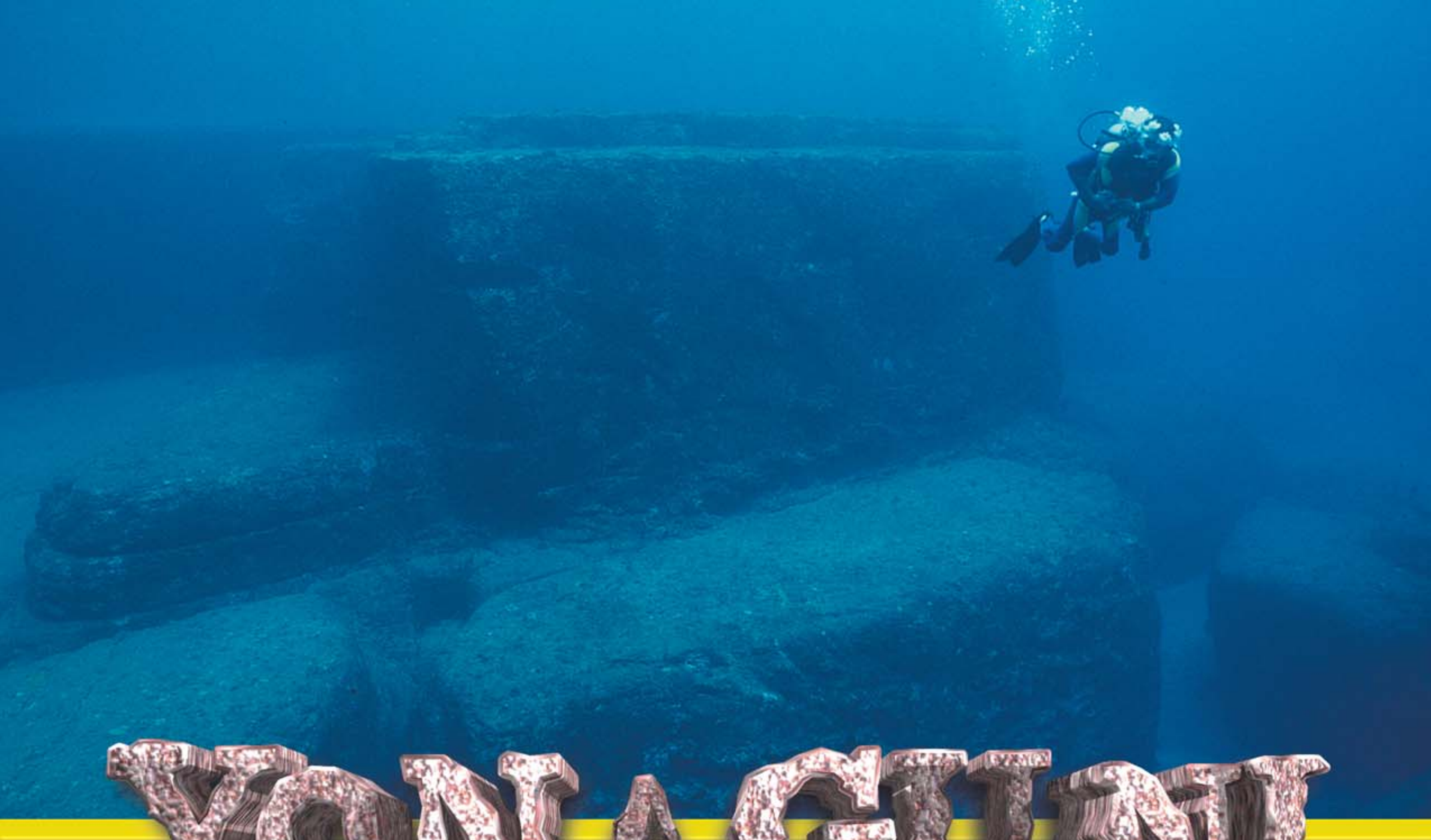
Underwater vehicle scooters are the first to incorporate a motorcycle-style handle, which is ergonomically correct for single-handed operation at the 12 o'clock position. The first inch of the handle is a trigger which, when rotated against a spring loading, moves a magnetic reed switch/relay circuit that activates the scooter. This method of activation requires no through hull penetrations, and, therefore, no point that can leak. A thumbscrew can be used on this trigger to offer a cruise control feature, or when tightened, a lock off feature. An added benefit of this handle is the elimination of many small moving parts included in previous designs.

The motors used in the UV scooters are quiet compared to many other makes of scooters, which use a noisy gear reduction drive. Previously, this was just an annoyance, but with the advent of closed circuit rebreathers, this has turned into a safety feature. Many divers report they are unable to hear the oxygen addition valve fire when using other makes of scooters. This is vital to safe-closed circuit rebreather diving. Of course, a noisy scooter destroys the serenity of silence found with a rebreather.

Scooter diving is not new. But it can add a level of enjoyment to a dive that is impossible to replicate with any other piece of diving equipment. Whether a diver wants to easily descend to a deep wreck and then effortlessly circumnavigate that wreckage in only a few minutes or gracefully glide through miles of underwater caverns, a scooter can make the difference between a great dive and an arduous one.

Rodney Nairne
President
Submerge Inc

www.silent-submersion.com



YONAGUNI The Stage

by Gary Hagland

"Incredible," I thought to myself as I hovered 30 feet below the surface. With a sense of awe and wonder, I stared at the image while waiting for cameraman, Tom Holden, and my wife, "C", to finish shooting footage of one side of the structure. Two narrow, elliptical-shaped eyes-both about four feet wide-were carved in this underwater rock. One eye was cut across the corner while the other had been chiseled out three feet to the right. Both had pupils inside. Several feet below, a narrow mouth, about as wide as the eyes, had also been cut through the rock corner.

The face was primitive, somewhat in the style of the "Moai" on Easter Island. It did not even begin to approach the intricate artistry of statues and stele found in places like Angor Wat, Egypt, or Central America. However, it was clearly a face and it had been cut into the edge of the angular structure we called the "Stage" by unknown, ancient stonecutters who lived on Japan's Yonaguni Island thousands of years ago.

The first underwater structure at Yonaguni was discovered in 1985 by Kihachiro Aratake, a local dive guide and shop owner. (See ADM Issue #5) He had been scouting new sites to view hammerhead sharks. At the time, the chance to view the sharks was the primary reason divers came to Yonaguni. He labeled the 300-foot long structure, "the Monument," and renamed the area, "Iseki Point." In Japanese, "iseki" means "ruins."

In 1996, Professor Masaaki Kimura, a geologist from the University of the Ryukyus, began publishing his studies. After examining the angular corners, flat terraces, large steps, symmetrical channels, and other geological anomalies, he concluded that the Monument might have been a foundation for a castle or shrine because of similarities to known structures on Okinawa. Others thought it might have been a quarry or possibly some sort of ancient port facility.

To detractors who maintained that the Monument was actually the result of natural geologic forces, he offered strong evidence of human modification. Excised rock fragments were absent or not in the areas they should have been if they had naturally fallen. There were many contrasting features close together. Symmetrical, angular trenches were found on the structure. There were series of steps on both sides. There was a crude limestone wall bordering the south-western side of the monument with a rectangular-shaped tunnel through it. Limestone is not found on that part of the island.

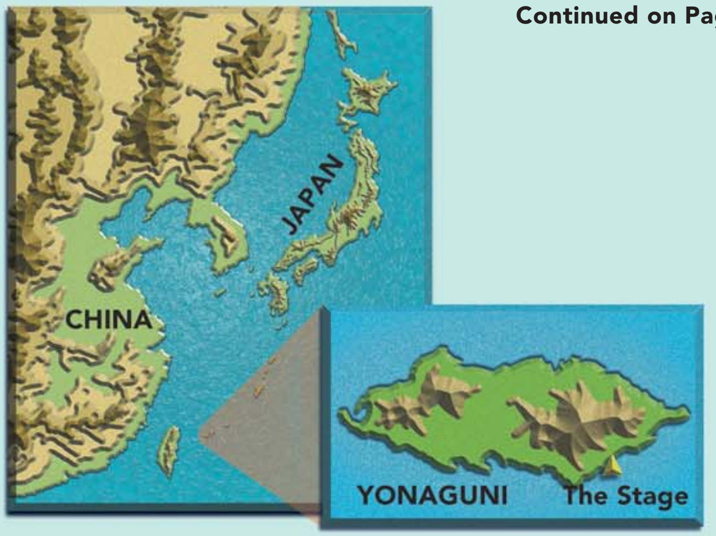
He also offered evidence of the method of cutting rock. On the terraces, for example, I could see straight lines etched into the rock face. Every foot or so was a hole. Professor Kimura theorized that wooden wedges wrapped in cloth or leaves were inserted in the holes and water applied. The water would then cause the wood to swell and the resulting force would excise the rock in angular patterns. More than 5,000 years earlier, the Egyptians had employed this technique when constructing their structures.

Professor Kimura says the structure is at least 6,000 years old, and believes it to be probably much older. Others think it's at least 8,000 years old because it would have been above sea level at that time. The level of the oceans changed with the melting ice cap during the last ice age. Approximately 18,000 years ago, ocean levels were 300 feet lower than now. Ten thousand years ago they were 130 feet lower.

After the Monument, other structures were discovered. Among them was the Stage. In the summer of 2000, we were the first western film crew to visit it. About a mile and half up the coast from Iseki Point, it sits in 30 feet of water in front of Yonaguni's most prominent coastal rock feature, Tachigami-iwa, a sandstone monolith that towers above the sea below. If the structure had indeed been used as some type of stage, the view would have been impressive with Tachigami as the backdrop. Curiously, Tachigami-iwa means "Standing God Rock" in Japanese.

Our task in Yonaguni was to make a documentary for the History Channel, which was to be the first special on the Yonaguni phenomenon on American television. We had already dove the Monument several times in both severe and good conditions. Our initial dive had to be aborted because of incredibly strong currents and equally strong surge action caused by a developing tropical storm that had just left the area. Conditions improved in the days that followed, but

Continued on Page 48



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