Adventure Diving Magazine - Issue 4 - December/January 2013

Adventure

Adventure Diving Magazine

EAR INJURIES IN DIVING

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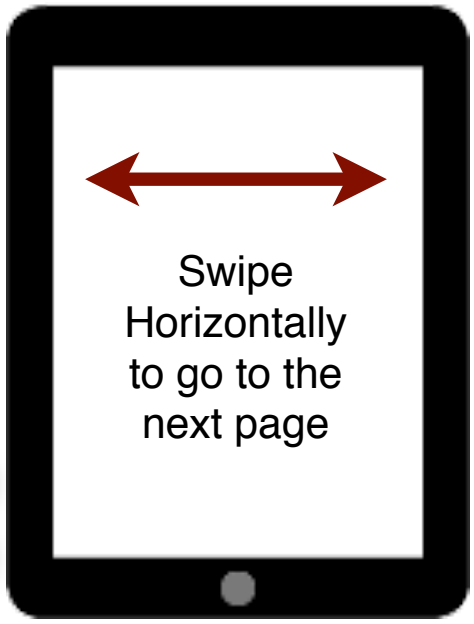

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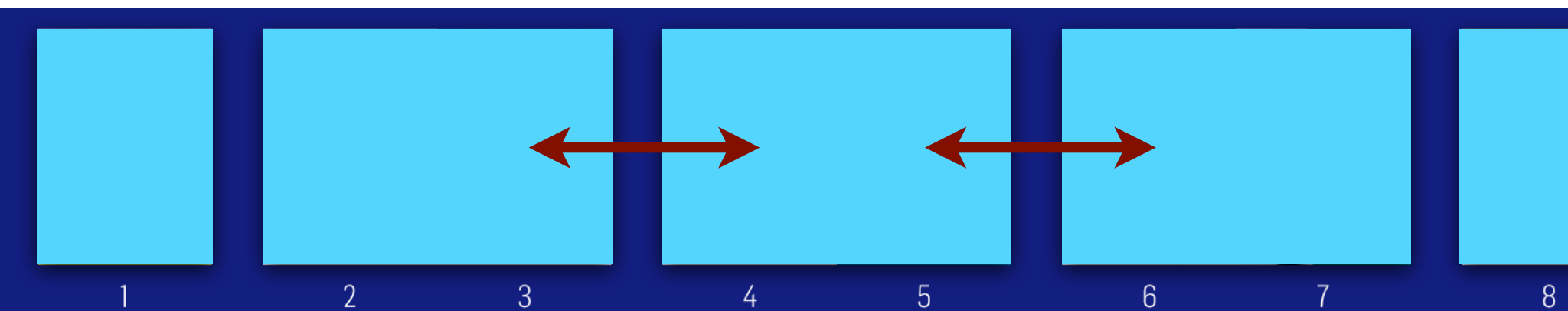

From The Editor

You may have noticed that we named this issue as a December/January magazine. Don't worry, there will still be an issue in January, but it will be named February. When the first issue was submitted to Apple for approval it took them 6 weeks to approve it. This essentially messed with our publication dates.

In this issue Dr Rothschild discusses the most common dive related ear injuries and how they are treated, as well as how to prevent ear injuries whilst diving. We show you the spectacular underwater caves of Florida with some memorizing photos and where are the best caves dive spots. A must read article about accident analysis and prevention by a well known technical dive instructor and writer Steve Lewis is a must read for everyone, no matter their dive experience.

Thanks once again to everyone that contributed to this issue and to Chris Milowka for helping me put Agnes' articles and photos together.

Please Like our Facebook Page and share the page with all your friends.

Enjoy the issue.

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We are always looking for engaging content from people that are passionate about scuba diving. If that's you, and you have content you'd like to share with our readers, contact Scott Barnwell ... If we think it fits in well with our publication, we'll add your article, video, or audio to a future issue!

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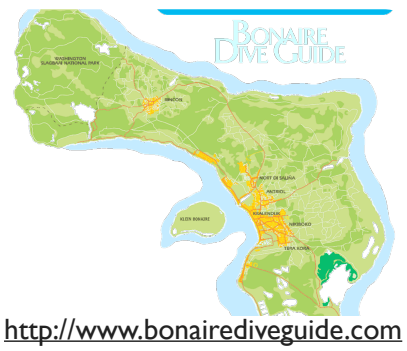

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Ear Injuries In Diving

By Michael Rothschild, MD

As a medical moderator for an online scuba forum, I answer more questions about dive related ear problems than anything else. The ear is uniquely positioned to be vulnerable to both external and internal injury when diving. Furthermore, there is a great deal of confusion about the nature of these problems - the relevant anatomy, the causes of symptoms and the best treatment.

To make things worse, even people who have obtained medical care may have no better understanding of the source of their pain, dizziness or hearing loss. This is because even for many brilliant and experienced general physicians, the ear can be very difficult to examine. I realize that this sounds arrogant on my part - believe me, I am humble about my own skills and deferential to GPs who must be able to manage a wide range of life threatening conditions. However, the fact remains that many doctors who are not otolaryngologists (ENTs) do not have the specialized equipment or experience necessary to clean the ear thoroughly, to examine the eardrum under high magnification, and to test hearing in a comprehensive manner.

One of the greatest sources of confusion is the fact that the outer ear, middle ear and inner ear - which are completely different systems that have very little to do with each other - often can give rise to similar symptoms such as ear pain, vertigo or hearing problems. So let's review each of the three main parts of the ear, and see how diving can affect them.

OUTER EAR

The outer ear refers to the part that sticks out of the head (the pinna) and the hole that leads to a tube (the ear canal) that ends at the eardrum. It is basically a pocket of skin, and it is where earwax (cerumen) is created and accumulates. Cerumen is a normal substance which protects the ear canal - it is generally just a thin layer coating the walls, but some people accumulate large amounts of it. It consists mostly of dead skin, mixed with various oily secretions from glands in the outer ear.

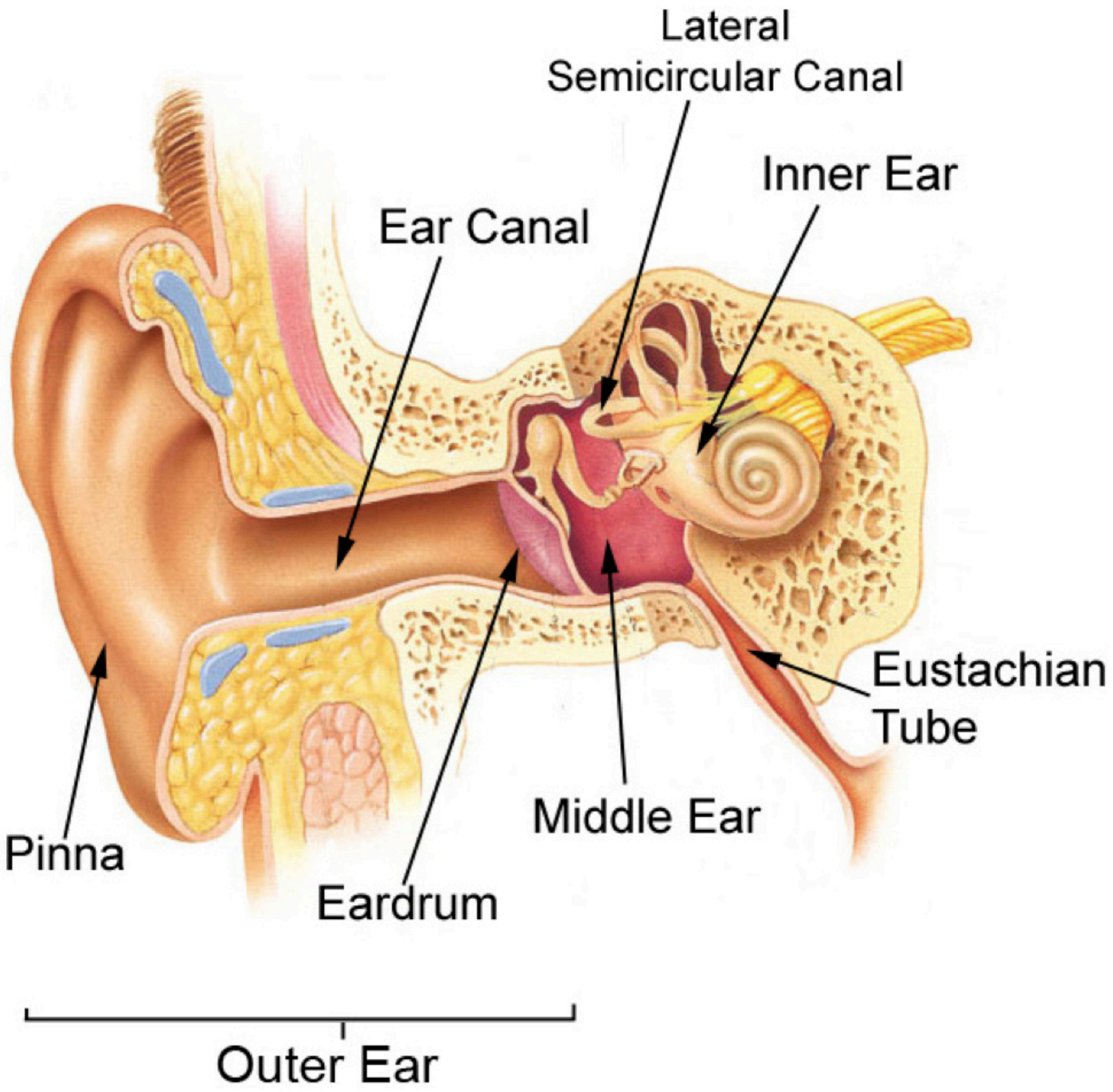
When water gets into the ear from swimming or diving, it gets into the ear canal. This is an important concept - unless there is a hole in the eardrum, the water from swimming or diving does not enter the middle ear.

Water from swimming or diving can get stuck in the external ear canal, especially if there is a lot of earwax. Furthermore, wet earwax takes a long time to dry out. Just like in cases of diaper rash or athlete's foot,

when an area of the body is kept damp and dirty, it leads to chronic inflammation and swelling, with skin breakdown and infection (usually with the pseudomonas bacteria that normally lives in this area). This inflammatory condition of the outer ear is called “swimmer’s ear” or otitis externa, and it can be extremely painful.

People who spend a lot of time in cold water can get bony growths in their ear canals (osteomas, or "surfer's ear"). These can trap earwax and water if they get big enough. The growths occasionally require surgical removal.

Treatment of swimmer’s ear is helped by carefully cleaning the wet debris from the ear canal to allow the ear to dry. This is best done by an ENT doctor using a microscope and small ear tools, under direct vision. This will also allow for a high magnification inspection of the eardrum, to rule out a perforation or other middle ear problems. Once the ear is clean, medicated ear drops are used, generally those containing an antibiotic to kill the bacteria, and a steroid to help with the swelling and pain.



A number of things can be done to prevent swimmer's ear. Disimpaction of large accumulations of wax (under direct vision, ideally with a microscope) will help avoid water trapping. But overly aggressive and frequent ear cleaning can actually make the situation worse, by removing the protective layer of cerumen. Drying the ear after swimming can help as well. A good way to do this is with a dedicated ear dryer, which blows a gentle stream of warm air into the ear canal.

Another approach to prevention of swimmer's ear is the use of 5-10 drops of a solution of rubbing alcohol and white vinegar after diving. Add three tablespoons of the vinegar to a pint of the alcohol. Unlike the 50-50 mixes which are sometimes recommended, this makes a mixture that does not have a lot of water in it. The alcohol dries the ear, and the vinegar makes the ear canal more acidic, which makes it harder for the pseudomonas bacteria to grow. Avoid overuse of this solution, as it can overdry the ear, breaking down the protective layer of earwax and causing irritation - no more than once or twice a day. A few drops of glycerine in the mix can help prevent overdrying. Cotton tipped applicators should never be used - they tend to pack the wax into the ear canal, and can cause permanent injury if they touch the eardrum.

MIDDLE EAR

The middle ear is the space behind the eardrum. It is lined with mucosa, which is the same sort of "skin" that lines the mouth and nose. It also contains the three bones of hearing, which carry sound vibrations from the eardrum to the inner ear (see below). The middle ear is basically an extension of the upper airway, and is connected to the back of the nose by a tunnel called the Eustachian tube (ET). The walls of this tunnel are supported by cartilage, which tends to spring back into the normally closed position after being forced open (either by muscle action or by pressure changes in the airway from diving or from ear clearing maneuvers).

Diving injuries to the middle ear are the result of barotrauma, which is damage caused by pressure changes. As every certified diver knows, diving requires equalization of the pressure outside of the body with that inside, otherwise a big pressure gradient occurs causing pain and eventually damage. Since fluid is essentially not compressible, there are only significant pressure gradients in the air filled spaces of the body.

Most of the air in the body is in the airways - the lungs, the windpipe, the larynx (voicebox), the throat, mouth and nose. All of these spaces are connected by wide passages, so pressure changes occur everywhere at once in the airway, as a regulator delivers gas at ambient pressure (proportional to depth).

There is also a small amount of air in other spaces in the body - the middle ears, the nasal sinuses, and sometimes the teeth (especially underneath dental work). These spaces are connected to the airways as well, but by small passages that may be blocked at times. Therefore, it is possible to build up a big pressure gradient in these spaces during descent, if a diver is not careful to equalize fully.

To equalize the ears, the diver must allow the ET to open against a pressure gradient. This can be done by a number of maneuvers taught in basic open water scuba instruction. Pinching the nose and blowing (Valsalva maneuver) and pinching and swallowing (Toynbee maneuver) are common methods for equalization, but many divers learn to open a blocked ET by other approaches, such as moving the jaw, tensing the roof of the mouth, etc...

A failure to equalize on descent can result in a block - a situation when the pressure gradient itself makes it harder for the ET to open, which results in a further gradient if descent is continued, leading to a "vicious cycle". The solution here is to stop the descent (or ascend a bit if necessary) until equalization is possible. A less common situation is a reverse block, which happens on ascent. The reason this is less common is that with a poorly functioning ET, the change in middle ear gas pressure with ascent or descent lags the change in ambient pressure. Therefore, with ascent you have

higher pressure in the middle ear than in the airway. This pressure gradient tends to overcome a blocked ET - the air “forces” it’s way out. It’s something like the fact that it is easier to squeeze toothpaste out of a tube than to put it back in.

A prolonged or significant pressure gradient in the middle ear can result in some type of barotrauma. This can be a perforated eardrum (the eardrum acts like the burst disk in the scuba tank, and gives way when subjected to enough pressure). If the eardrum doesn’t perforate, fluid with or without blood can accumulate in the middle ear space. Unlike the middle ear infections that young children get, this fluid is clean with no bacteria. Clear fluid is called an “effusion”, and a bloody effusion is called a “hemotympanum”. The effusion is actually the result of fluid in the bloodstream (plasma) filtering into the middle ear when following the pressure gradient.

Fluid in the middle ear causes a temporary hearing loss by preventing the normal vibration of the eardrum with sound. It is a “conductive” hearing loss - the problem is that the mechanism that conducts sound into the inner ear is not working well. There is nothing wrong in this case with the sensory organ (the cochlea) or the nerves to the brain - if there were, it would result in a (usually permanent) “sensorineural” hearing loss, which we will discuss in the next section.

Some people have more trouble with this than others, due to dysfunction of the Eustachian tube (ETD). Many divers always need a long time to descend and ascend since their ETs don’t work very well at baseline. Other people may have no problem equalizing in general, but find it more difficult when a cold or other infection causes congestion of the lining of the ET. This is often oversimplified as the ET being "small" or "narrow" - the true problem is more of a functional issue with the structure of the tube istelf (for example, with the muscles that normally open the tube). Another common misconception is that fixing nasal obstruction, for example by straightening a deviated nasal septum, will help the function of the ET. While there is some overlap between overall nasal blockage and ET function as mentioned above, most of the areas of the nose which require treatment to improve breathing are nowhere near the ET opening.

A single eardrum perforation related to barotrauma (without a history of ear disease) usually heals by itself over weeks to months, but no diving is allowed until the eardrum is once again intact. In some cases, surgery will be needed to seal the hole in the drum. Middle ear effusion typically resolves over time, and can be helped to resolve by the same sort of ET opening maneuvers described above. Antibiotics are generally not necessary.

Many divers swear by the use of decongestants and/or nasal steroid sprays to treat this problem or prevent its development. While these drugs can help prevent barotrauma of the nasal sinuses, there is not much data to suggest that they help middle ear disease any more than time and the ET maneuvers alone. Oral steroids can help the ears drain an effusion, but these drugs have many side effects and are rarely used in this situation. Motrin and other non-steroidal anti-inflammatory drugs may help with the pain, but have little effect on ET function. In some cases (when no more diving is planned for a long time) an ENT doctor can make a small hole in the eardrum to drain the effusion if it is causing severe symptoms (hearing loss, a blocked sensation in the ear, or dizziness).

There is not a lot that can be done directly to treat a poorly functioning ET. If the ETD is caused by a temporary problem (like a cold or other infection), then ear ventilation usually returns to baseline when the airway congestion resolves. Divers with longstanding baseline ETD usually address the problem by finding a maneuver that works to allow them to equalize. Although there are some experimental treatments involving procedures to stretch the ET open, there isn't a lot of data at this point about the risks and benefits of such operations.

INNER EAR

The inner ear is deep inside the skull, and is an extension of the brain. It contains the cochlea, which is the organ of hearing (like the retina in the eye) that converts sound vibrations into electrical impulses that the brain can interpret as sound. It also contains the labyrinth, which is the organ of balance. The inner ear is behind a bony wall at the back of the middle ear, and connects with the middle ear through two small holes in the bone, which are normally sealed to prevent leakage of fluid or gas. Unlike outer and middle ear problems, inner ear injuries cannot be seen by looking into the ear canal.

Diving related inner ear problems are very rare, but have the potential to cause permanent hearing loss. There are two types that can result in serious injury- inner ear decompression sickness (IEDCS) and inner ear barotrauma. These require immediate attention, and in the case of barotrauma, emergency surgery may be necessary.

A thorough discussion of IEDCS is beyond the scope of this article, and the exact mechanism of this condition is still unclear. However, every certified diver has learned about the risk of bubble formation in the tissues with ascent, especially when inert gas (e.g. nitrogen) loading is high. Like other forms of decompression illness, IEDCS results in hearing loss or vertigo (a sensation of the world spinning around) due to bubble formation. It is not known for sure whether the bubbles form in the inner ear fluid directly, or form in the veins of the bloodstream and are carried to the inner ear through abnormal connections between the veins and the arteries (e.g. a patent foramen ovale or other shunts in the lung circulation).

Inner ear barotrauma can happen in two ways, but they both involve a sudden pressure change in the inner ear fluid (known as perilymph). A rapid increase in middle ear pressure happens when a blocked ET suddenly opens during equalization. This can cause the stapes (the bone that connects the middle and inner ear spaces) to pull sharply out of its normal position, resulting in the inner ear fluid being sucked inward, breaking the seal at the round window. Also, a forceful Valsalva maneuver can cause an increase in inner ear pressure, pushing the round window membrane outwards, into the middle ear. The resulting “perilymph fistula” (PLF) with leakage of inner ear fluid can cause nausea, vertigo, and a progressive and often permanent sensorineural hearing loss.

Diagnosis of inner ear problems can be difficult, as the eardrum looks normal on exam. DCS may be suggested by the dive profile and other associated symptoms, and rapid treatment with oxygen, hydration and recompression in a hyperbaric chamber are essential. However, recompression may make inner ear barotrauma worse, so careful evaluation by a specialist in this area is crucial.

A formal hearing test can distinguish between conductive and sensorineural hearing loss, and therefore should be a part of the evaluation of any diving related ear injury. Other tests include an assessment of the function of the balance mechanism, which can be measured in a special lab. A CT scan is rarely helpful, as a PLF cannot be seen on an x-ray.

When there is enough of a suspicion of a PLF, an operation is usually recommended; this condition can only be definitively diagnosed by surgical exploration of the ear. The procedure involves lifting up the eardrum to visualize the middle ear directly. If what looks like inner ear fluid is seen leaking from the space around the round window (or anywhere else), fat grafts are used to seal the area. This leakage can be very subtle, as the volume of perilymph is small. However, early closure of a PLF can mean the difference between a recovery of hearing and a progression to complete deafness. Since the operation itself involves very little risk, it should be strongly considered in cases where PLF is a possibility.

There are two other ways that the inner ear can be abnormally stimulated during a dive, causing dizziness - cold caloric responses and altenobaric vertigo (ABV). Both of these are due to the balance portions of the left and right inner ears being stimulated to different degrees. When the nerve from one inner ear has more activity than the other, the brain gets "confusing" inputs - normally both inner ears send the same information when the body moves in three dimensional space. The brain's response to this assymetric input is vertigo.

The caloric phenomenon is the result of a sudden temperature change in one of the diver's inner ears. The semicircular canals are a part of the balance mechanism in the inner ear, and one of them (the lateral canal) is near the eardrum. Cold water entering one of the outer ear canals can result in motion in the fluid inside that lateral canal as the cooled fluid sinks. This results in activity in the nerve to the brain from that inner ear. ABV is due to assymmetric equalization during the dive, where the middle ear pressure (transmitted to the inner ear) is greater on one side than the other.

Both of these conditions are generally temporary, and resolve as the temperature stabilizes and the flow stops, or as equalization is completed in both ears, but it can be very disconcerting to have sudden dizziness during a dive. Awareness of this phenomenon and taking any steps necessary to address it (such as careful and thorough equalization) can prevent a spiral into panic and bad decisions.

CONCLUSION

The vast majority of ear pain after diving goes away by itself in a short time. However, without an examination, a diver may not be able to tell whether the problem is in the outer or middle ear, and treatment depends on accurate diagnosis. Hearing loss after diving should be evaluated soon, and by formal testing. Thorough evaluation of persistent ear problems should be done by a doctor with the tools and experience necessary to distinguish outer, middle and inner ear disease.

Dr. Rothschild obtained his undergraduate and medical degrees at Yale University. He trained in otolaryngology at Mt. Sinai Hospital in New York City, and was a fellow in pediatric otolaryngology in Cincinnati, Ohio under Dr. Robin Cotton. On the attending staff at Mt. Sinai since 1994, Dr. Rothschild is clinical professor and director of Pediatric Otolaryngology at the School of Medicine. He is the author of a book and more than sixty articles and chapters in his field. He has also edited two multi-authored textbooks.

Dr. Rothschild has been involved with computers in medicine for many years. In addition to his book on medical Web sites, he has authored a number of articles and chapters on this subject. He has served as both the Internet editor for the AMA journal*Archives of Otolaryngology-Head and Neck Surgery* and as the chairman of the Technology Infrastructure committee of the National ENT Academy (the AAOHNS) and the American Society of Pediatric Otolaryngology. He was also the president of the American Bronchoesophagological Association for 2010-2011.

Dr. Rothschild is an avid scuba diver and an award winning underwater photographer. His images and writing have been published online and in print, and he serves as the dive chair for his local dive club (the New York City Sea Gypsies). He also serves as a medical moderator for the popular online scuba community at scubaboard.com, and lectures widely on underwater photography and videography.

IDC And Divemaster Class In Costa Rica

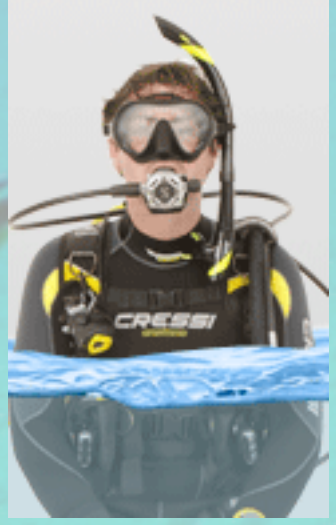
By Georgia King

My original decision to become a scuba diving instructor was not something I took lightly. Having originally been sent to Costa Rica to complete my masters degree and shortly afterwards making the move to Roatan for training and then work as a Divemaster. Once the "dream" of the perfect conservation job fell through, the idea of living and working in the scuba dive industry seemed like a logical stop gap whilst I figured out my next move.

What started as a couple of months, soon extended, but I was still under the impression that I wanted to stay as a Divemaster, and not move on any further up the PADI ladder. The Divemasters had all the fun and adventure, whilst the instructors taught. However, after watching and working with some incredible instructors I decided to take the leap. Seeing different classes and students come through, I knew it was less of the "stop gap" and more of the adventurous job that I was looking for. Of course I could integrate my own conservation element into that myself, especially considering I had spent 4 years working towards that goal back at University (thank you Mum and Dad!). So, off I went onto my path to Instructor.

All was going wonderfully on Roatan, but then the island fever and the itch to move onwards and upwards kicked in. So Costa Rica beckoned once more and it is here, still, that I find myself after 7 years. I am forever looking for the new challenge, and so with that in mind, I have continuously kept myself on the learning band wagon, eventually reaching the dizzying heights of PADI Course Director. It was the idea of teaching and molding fresh new excited instructors, exactly how I had been, in the beautiful waters of Costa Rica, that got me on that track, and the day I received my acceptance email was a very large celebration dive day.

Anyway, it is forever on that learning curve that brings me to one particular dive day in our wonderful diverse waters around Isla Del Cano, AKA Cano Island. The excitement and non-stop schedule that is a PADI Instructor Development Course (IDC) can prove to be a fun, yet very stress filled few days for both diver and Course Director. I like to mix up my scuba instructor training programs, and as much as possible have some extra dive days included, as I say to "blow off some bubbles" as apposed to the proverbial "blow off steam". This particular IDC was going really well, both class and in-water points and scores were being hit, and we had arrived at the point where most imaginative training aid was the mission of the day. To blow off some bubbles for the day, I decided to take the group to Cano Island. Maybe just to swim with the sharks, but maybe also to visit the mystical stone spheres and get some good karma before the pending instructors exam.




SHERWOOD SCUBA

Cano Island is a National Park and marine reserve located around 20 miles off of Drake Bay, on the southern pacific coast of Costa Rica. It has been described by many as a mini "Cocos Island" and for the many of us scuba divers that hold that on their "bucket list" of dives, this is the next best thing. As it is a marine reserve, diving group numbers are restricted, and the number of sites itself are also limited. With scuba diving only permitted on the north side of the island, there is a smaller number of dive sites to explore, around 8 which can easily all be covered in a couple of days. As we were only running day trips at the time, on each trip we would try and hit the dive sites that most suited the group. One of my favorites is a site called "El Ankla" (the anchor). It is a large sandy area with various rock reef sections dotted around. Always home to a large number of white tip reef sharks and very oversized southern stingrays. I have even managed to find the elusive frog fish there, which was definitely an achievement and warranted a squeal underwater.

The site we picked on this particular day was "Bajo del Diablo" or Devils' Reef. Now don't automatically assume that all things with the word devil in it are going to be bad. I have discovered a general trend that in the world of dive sites it is instead wickedly fun. This dive site at Cano is positioned at the far West Point of the island, away from the shore and the rest of the sites. This has its definite pros and cons. Pro wise, we are looking at some ripping currents converging, bringing in plenty of nutrients and fish. With that comes the inevitable pelagics and that is what we want to see. Con would be ..... let me see....currents! For those of you that have had the joy of drift diving, there is a certain element of timing and planning that needs to be done on entry into a drift dive, especially when you must descend at a certain point only, otherwise you will miss the whole dive.

So, briefing begins, planning the entry. We drop a float to see how fast it is moving,reasonably quickly, but with a group of instructor candidates, they should certainly be able to rise to the challenge and handle it. Everyone kitted up, and 3,2,1.....Go! Into the water and a quick descent down a steep rock face to the entrance of the large canyon that is Bajo. A vast canyon looms in front and on all sides you are surrounded by schools of fish, from Snapper and Grunts, to even large schools of Butterfly and Angel fish. We get a very brief moment to hang and take it in, quick "oks" all round, then whoosh, you are off being pushed through the Canyon.

One of my favorite things about Cano Island, when people ask is that I can pretty much guarantee a shark. It seems to be a slight illusion amongst your average resort diver sometimes with the "what do I see?" question, that as a dive professional we have this unnerving ability to magic sea creatures out of water. Alas we do not on an every day scuba dive basis, but at Cano I can ! You want sharks, I can deliver. Now they are generally hanging out very peacefully on the sand patches, but at least they are there!

At Bajo though, they are more often than not, free swimming. More exciting I hear you cry, yes indeed! So as we are floating on our merry way down said Canyon I can see the sharks, hanging out around me. Everyone is pointing in all directions, enjoying the sea life collage as it drifts past, definitely a step up from the previous dive which was open water presentations on a 15ft sand patch. With the canyon walls looming on either side it almost has that aquarium feel, as you float by. I am just admiring a couple of devil rays swoop majestically past when I see a couple of low air signals being communicated around our small group. Dang it ! I was just starting to get into the groove down here and love it. So I make a decision, with just under 2000 psi still in my tank, I buddy the guys up, and up we head, a quick safety stop and we are back on the surface.

As everyone climbs in the boat, my ever wonderful boat captain, asks if I have ever managed to reach the end of the canyons? I unfortunately have not, so I make the Solo diver choice and decide to jump back in. Spare air in tow, just in case. He drives the boat to the far end of the reef and I drop back in, only down to about 60ft (18m), checking my computer all the way. Now, the site is beautiful enough every time you dive it, but suddenly being back in, with just you and the fish for company is a different feeling entirely.

A group of Crevally Jacks are cruising past, they come into investigate, few circles around before they head off into the blue. I was told once that they are attracted to scuba diver bubbles, and seeing how close they circle, sometimes I completely believe it. I have had my fair share of jumpy moments underwater in the past by Jacks cruising close by. I have already been back down 10 minutes and I decide I'll give it another 5 before heading back up. There are 2 white tips swimming around close by. Now, I had noticed these guys on the first drop in, but suddenly being by yourself puts a completely different prospective on the situation. I know they are a harmless shark, I know they are only around 5 foot long, but, they are still a shark, and 5 foot is nothing really to be sniffed at. I hover in the middle of the Canyon and just watch them swim majestically by. Yes, they are swimming around me...hmmm. just curious I know but still.

After so many encounters with them over the years in Costa Rica it was a nice, refreshing , if somewhat unnerving moment. Even a harmless shark, in all his glory makes you feel quite small and truly appreciate the beauty of the ocean and all its life. I shared my moment, just hovering with them, before starting my ascent. Back to the boat and back to the classroom. Shark diving in Costa Rica, not bad for a day at the IDC !

Written by **Georgia King**

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Discover Wreck Diving Along The West Coast of Sabah, Borneo

> *Wreck diving is a popular form of diving amongst many divers. Wrecks can make exciting dive sites due to their history, the treasures they are home to, the volume of marine life and the skills they help divers develop.*

By Joanne Cotterill

There are many wreck dives around the world. This article provides an overview of wreck diving in Sabah, Borneo. Situated along the west coast of Sabah are four large World War 2 wrecks. The wrecks are all ~150m WW2 Japanese cargo ships home to historic treasures, stunning coral gardens and teaming with marine life. Find out more about these wrecks and wreck diving along the west coast of Sabah, Borneo.

Whilst there are believed to be many wrecks in the South China Sea (from World War 2), there are currently four WW2 wrecks identified off the west coast of Sabah which are also suitable for scuba diving. All of the wrecks are Japanese cargo ships - meaning they are large (~150m - 200m) and have historic 'treasures' that were being transported at the time they went down. Due to the length of time they have been sunk (~65 years) they are all covered in stunning soft coral gardens, hard corals, teeming with fish life and home to an amazing range of tropical water marine life. Find schooling Barracuda, Nurse Sharks, large Groupers and large shoals of Yellow Snappers and Fusiliers.

Three of the wrecks are located in Usukan Bay (Rice Bowl Wreck, Upside-Down Wreck and the Usukan Wreck) which is located 30 nautical miles north west from Kota Kinabalu, Sabah. The fourth wreck, the Gaya Wreck, is located ~ 20 minutes west of Pulau Gaya (outside Tunku Abdul Rahman Marine Park near Kota Kinabalu, Sabah). The wrecks offer both non-penetration diving (i.e. swimming over and around the wreck) and limited penetration diving, within the "light zone". The rest of this article provides an overview of the wrecks to be dived along the west coast of Sabah.

The Rice Bowl Wreck- So-called because a cache of rice bowls was found in the bow when it was first dived, this is a relatively long vessel (~150m) lying in a North Easterly direction in 40m at its deepest and 26m at its shallowest. The depth of this wreck makes it suitable for minimum PADI Advanced Open Water Divers and is best dived recreationally using nitrox (EANx30). The superstructure is punctured in many places, making some exploration possible and interesting, and the metalwork is robust. The soft coral garden is memorable. During the 'Dry Season' you can often enjoy stunning visibility on the wreck of 30m+.

The Upside-Down Wreck- The name gives away the orientation of this ship, which lies in the same direction and at similar depth to the Rice Bowl wreck. This wreck has good swim-throughs, though a torch is essential and is good for exploring as well as a training ground for Wreck Diver specialty.

The Usukan Wreck- This is the deepest of the three Usukan Bay wrecks at 35m - 45m and consequently only available to technical divers (divers certified for decompression diving). It is a good wreck for diving on rebreathers or diving twin-tanks / Trimix. The wreck is interesting and has a spectacular whip coral coverage that can give it a frosted appearance in a certain light.

The Gaya Wreck - The large Gaya wreck is a deep wreck and sits upright in 36m - 50m of water. The wreck is generally intact and there are lots of interesting exploration and wreck penetration opportunities for technical divers with suitable experience and training (rebreather divers of twin-tank divers). Whilst the identify of the wreck has not been confirmed, it is believed to be the Nittetsu Maru. On October 14th 1944, Submarine Dace (SS-247) sank two Japanese merchant tankers, the Eikyo Maru and Nittetsu Maru, and damaged merchant ore carrier Taizen Maru off North Borneo, 06°05'N, 115°55'E". The description of this wreck matches that of the Nittetsu Maru. Post action reports state the Dace sunk the Nittetsu Maru (a cargo ship of 5,993 tons), the Eikyo Maru (an oil tanker of 6,948 tons) and heavily damages the cargo ship Taizen Maru (5,396 tons).

Wreck diving is a popular form of scuba diving amongst leisure divers. Diving along, or inside, a shipwreck is attractive to divers for several reasons. Shipwrecks have a history to them which provides a different perspective when diving along one. Wrecks also quickly become an artificial reef, which creates a habitat for many types of marine life - they are normally surrounded by fish and home to critters. Scuba diving along a wreck also presents new skill challenges for scuba divers.

Find out more about wreck diving in Sabah, Borneo at http://www.borneodream.com

I was born in North West England and spent my childhood there. I achieved a MA Hons Economics from Cambridge University and subsequently spent time working for in England, Europe, the Seychelles and now in Sabah, Borneo.

I spent 15 years working for a Global Clearing Bank and was involved in both launching new businesses and running the operations for established businesses. I left the banking world behind to follow one of my passions in life - scuba diving - and, along with my partner, to create Borneo Dream.

Borneo Dream is an authorised PADI, SDI, TDI and BSAC Dive Operator based in Kota Kinabalu, Sabah, Borneo. We provide the best range of scuba diving trips and courses along the west coast of Sabah.

Find out more about us at http://www.borneodream.com

Article Source: http://EzineArticles.com/?expert=Joanne_Cotterill

Staying at Bonaire's Buddy Dive Resort

By Peter Bucknell

Bonaire is a must see place for all divers alike. For pure diving convenience and time in the water, this is one of my favorite dive destinations and I always leave the island after a 7 day stay having logged at least 30 hours underwater.

The last three years running I've been the videographer on club dive trips during coral spawning in September which is an interesting week with lectures and presentations from Ned and Anna DeLoach who always stay at Buddy Dive.

Buddy Dive is a slick and safe operation with a very experienced and well qualified dive staff. Nitrox was always consistent and available during my visits.

Here are some insider tips:

It's a fantastic place to spend a week of stress-free shore diving, with nitrox and air available right on the dock, or at a drive-thru located right in the resort where you can pick up a couple of tanks each and head out in your "buddy dive pickup truck" to one of the many shore dive sites marked by yellow rocks all the way along the island.

[Tap To See Dive Site Map]

Watch for other divers exiting the water and ask about currents which might change on you during your dive.

- Weights and tanks are provided.
- All equipment is available for rent.
- Towels provided
- Safe is also provided in your room.
- Leave most of your gear hanging in the room on the dock, computer stays with you in your room.
- Take a torch, preferably two, as night diving right in front of the resort is rewarding. You can rent one of course.
- Ocean view rooms are available and it's worth asking when making your booking.
- Enquire ahead of time for a room near the dock if you are camera-laden or tend to forget stuff, it'll save leg-work.

The resort will pick you up at the airport, and take your bags to your room while you are checking in. You might get a few mosquito bites in Bonaire if you are prone, so be prepared.

To save time, watch their orientation video before you fly.

Print and fill out the forms at home, go early to the dive shop on the dock to sign in, and you'll be geared up and in the water same day:
Liability Release
Nitrox Release
Dive Log Sheet

Dawn dive is a must-do; be in the water just before the sun comes up to watch the sea life change shifts. Same goes for twilight dives.

Plan to dive 4 times a day, and also plan to go on the custom boat dives, as they take divers to some really beautiful reefs, wrecks and beaches, and guides will point out the good stuff if you want them to. The boats are well equipped, fast and comfortable.

Take your own lunch if you are doing the three tank day on the boat. You can have a nice picnic on the beach.

Get to know the staff, they are lovely people and their smiles are real. The food service can be on island time, but if you learn a few names, things can move a lot quicker... and there's a new kitchen which may change things for the better.

Their instructors offer Open Water completion courses to students from SSI and NAUI and others along with all levels of instruction in several languages including all the standard PADI specialties.

The dive-op is rebreather friendly and can handle all manner of tech diving, training and fills.

Scuba divers staying at Buddy Dive are usually very friendly and chatty. There's a wealth of information in their heads as many many of them come back every year and really know the place, so ask questions.

General age group is 40 - 60, so if you want young people, take your own group.

Watch the sunset from the deck chairs near the bar, and remind yourself to relax...

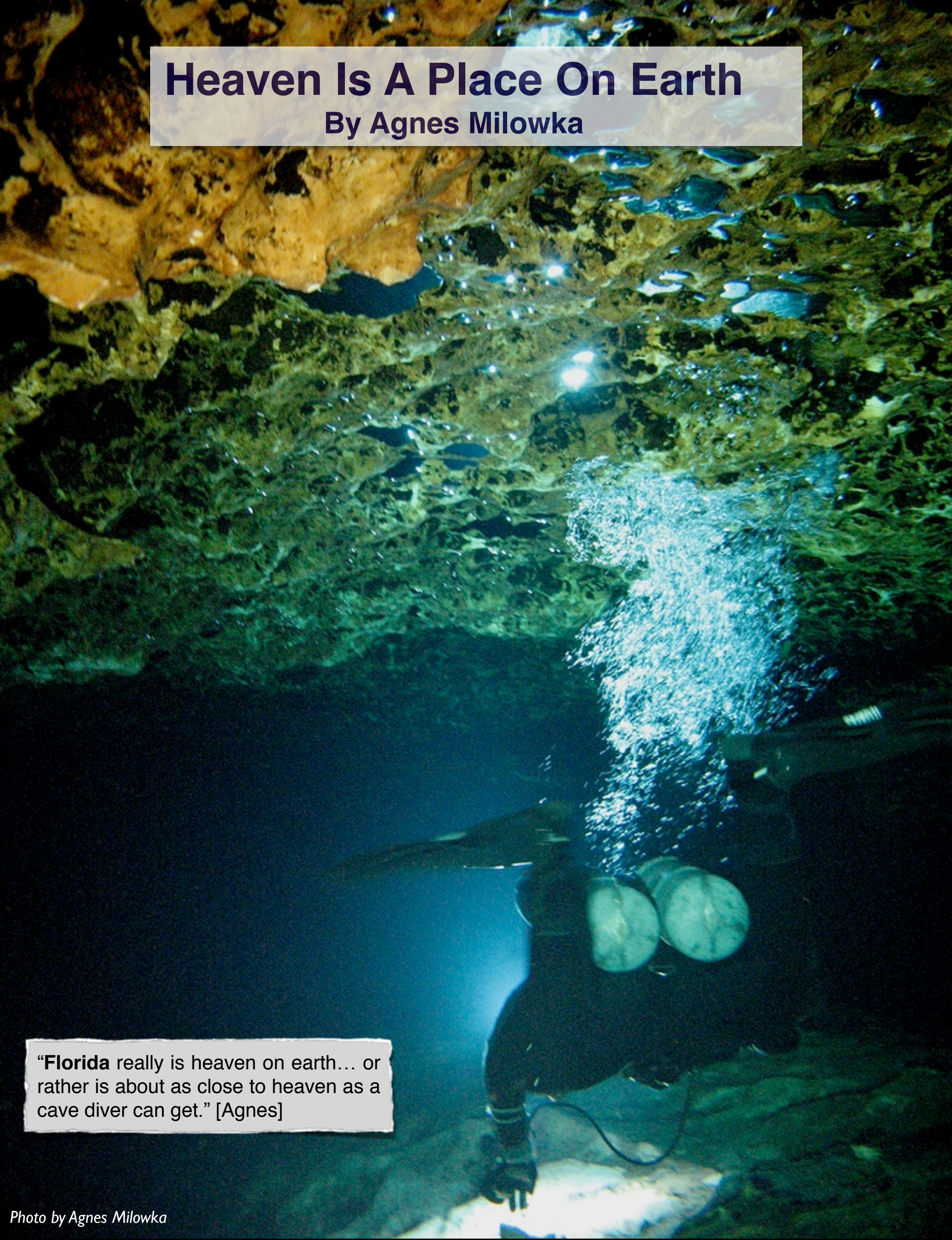
Peter Bucknell runs the New York Video Service http://www.NYvideo.US. He's most happy immersed, shooting wrecks, divers and sea creatures producing videos for a wide variety of clients. His corporate film making for Audi, Martha Stewart, Discovery and others enabled the transition from being a music professor to film maker.

He is currently raising funds for a documentary:
http://www.peterbucknell.com/styled/

Bonaire - A Quick Glimpse

Heaven Is A Place On Earth

By Agnes Milowka



"**Florida** really is heaven on earth… or rather is about as close to heaven as a cave diver can get." [Agnes]

Photo by Agnes Milowka

I thought writing this article would be dead easy as I'd just re-use the emails I sent from abroad, stitch them together and voila – I'd have a ready-made article. I arrived home and figured that perhaps this might not be the brightest of ideas. My emails sound like I'm on some serious drugs… or perhaps I should be on even stronger medication. So I'll make an attempt to restrain my enthusiasm just a tad here… but just quickly - the Florida caves are bloody awesome!!!

Florida really is heaven on earth… or rather is about as close to heaven as a cave diver can get without abstaining from drinking and spending their entire life helping little old ladies across the road. It is home to some very pretty caves, with beautiful clear tunnels that allow for wonderfully long penetrations and very long dives. It seems that any old cave in Florida resembles a map of our very own Tank cave, with tunnels that just go and go forever… it is hard not to be impressed.

Summer is usually not the time to hit the caves in Florida as the sweltering heat equals much pain, sweat and suffering whilst gearing up. On the upside many of the caves are virtually deserted which means you can have a whole cave system to yourself. Mind you this type of peace and serenity does not apply to weekends. The hot weekends mean that every man and his dog along with a li-lo and perhaps a beer seem to seek out a watering hole. Thus popular caves become popular swimming holes which means divers have to dodge much traffic and many flinging legs to get to the cave entrance… I'm thinking here of Ginnie in particular. Having said that, swimmers can be a source of much amusement on long deco hangs.

Photo by Agnes Milowka

Ginnie Springs

Photo by Agnes Milowka

Scott Byars descending into Ginnie

Still, you can't go to Florida and not visit the infamous Ginnie Springs. The place is definitely impressive, not just because of its infinite visibility but also because of the sheer size of the tunnels – you can easily drive a bus through some of them! Further, Ginnie is famous for its flow… if you decide to do your deco in the Ear, be prepared to hang on to the log for dear life. To get into Ginnie without blowing all their gas divers tend to clamber Spiderman style along the ceiling and across the walls. Do as the locals do!

The gold line is great, but so is the flow, so it is not ideal to stay on the main line. Swimming against the current for over 2000 feet is, from personal experience, rather tiresome. The smart thing is to do a jump at the 'park-bench' (don't worry you can't miss it, this is about the time you feel like resting and catching your breath… and conveniently it looks just like its name sake) and head towards the Hillier Tunnel where you will be safely away from the roaring flow. On your way you will find the infamous bats which are very amusing, and also if you look really carefully a bunch of small fossils in the walls and on the floor of the cave. Another nice place to visit is the white room – welcome to the disco! As long as your torch is pointing at the roof and illuminating the hundreds of air pockets you and your buddy can have a little dance.

Another cave with a great deal of flow is Little River and again most people jump off the main line and head through the Mud Tunnel in order to get into the guts of the cave. The recent droughts have reduced the flow, which made my dive here a pleasant dip as opposed to a marathon swim. While spectacular, the cave is a bit spooky with a lot of high vertical fissures and reminded me of a dungeon with so many tunnels all merging into one another. The low flow made the numerous finger marks on the walls seem very out of place and made it seem like something horrific had happened in the tunnels rather than divers simply using the walls to pull themselves against the flow.

Photo by Agnes Milowka

Andreas in Ginnie

Now Peacock is their so called ‘training site’ but don’t be discouraged by this, as it is a very, very distant cousin of Gouldens. Those two are about as related as a centipede is to a unicorn. The Grand Traverse is particularly fun, you descend into Orange Grove and follow a crystal clear tunnel for over 4600 feet before finally exiting in Peacock I. Along the way are various small sinks or ‘emergency exits,’ which allow you to recalculate your thirds as you go… or if you’re like me and have a small bladder, let you jump out for a quick toilet stop. Now, if you left your car at Orange Grove and did the grand tour, guess what, it’s a long walk back. Unless of course you can hitch a ride with a bunch of friendly Floridians on the back of a tray – many thanks to the boys!

The grand tour allows you to see some of the best parts of the Peacock system but don’t ignore Peacock III. This cave is a bit tighter and a lot more silty than its counterparts, with that thick dark mud that you’d see in Stinging Nettle or Fossils back home, but it’s definitely worth a look.

Further up the road is Madison Blue and it is an amazing cave that goes through more ‘costume’ changes than Whoopi Goldberg hosting the Oscars. Every bit of this cave is different and around each corner is a little surprise; really the place just gets more and more stunning. The biggest surprise for me was that the gold line does not in fact lead all the way through to the famous Rocky Horror and big drop off and instead I found myself jumping off to the Roto-rooter tunnel. This mind you was not the end of the world as taking this jump and following even this small tunnel was still rather extraordinary. But the moral of that story is, if you don’t care much where you want to go then it doesn’t really matter, but if you’re keen to head somewhere in particular… invest in a half decent map!

Photo by Agnes Milowka

Madison Blue

Photo by Agnes Milowka

Madison Blue

Cow is a truly wonderful cave and is my personal favorite, if for no other reason that it reminded me of home… you could actually get to the end of the line in this one! Actually cow is my favorite for a number of reasons, its smaller tunnels and various restrictions are challenging but most importantly it is incredibly beautiful. Some parts of it reminded me of Iddlebiddy back home in Oz, as it has some beautiful multi-colored stratified clay banks. To top it off a turtle was visiting the cavern, which made for a perfect distraction during the long deco hang.

At the back of Cow I had my not so smart moment. At the end of the line is a plastic moo cow and for a few seconds I thought to myself, what the hell is a cow doing all the way back here? Then it hit me, like a freight train… duh!

So far I talked about the caves in the Suwanee River Basin, where's a bit of a drive from these caves and part of the Woodville Karst Plain are Jackson Blue and Hole in the Wall. WKP might sound familiar as it's the home of the famous Walkulla Springs. While Walkulla is off limits to divers, Hole in the Wall is not a bad consolation prize. It is a great dive and offers the added attraction of a boat ride through the rather stunning Merritts Mill Pond area. The best part, you get to drive the boat yourself! Jackson Blue is also a beautiful, big and extensive cave and it is certainly worth the drive to this part of the State to dive these two caves.

Apart from the great diving one of my favorite things about the Floridian cave diving scene are the fill stations. Not only do they stock 32% as a standard gas of choice, not only do they charge by the litre rather than by the tank, but you can drive your car up to the filling station, chuck a whip on your tanks and get a fill without dragging the damn gear out or stripping it all off. To top it all off, the gas goes on the tab if you're a regular! Like I said, heaven… One thing's for sure, Mud Hole is definitely off my list of favorite cave sites and the crystal clear, beautiful and seemingly endless tunnels of Florida are definitely on!

I'd like to extend a huge thank you to Lamar Hires and the wonderful bunch at Dive Rite who were all incredibly generous, helpful and truly wonderful. A big thank you also to Scott and Kathleen Byars who took me under their wings and made sure I got wet and to Lamar English who kindly let me use some of his dive gear. It was these guys who made much of my trip possible and I am most grateful.

And of course hats off to the fabulous dive buddies who led the way, or led me astray as the case may be - Scott, Kathleen, Kevin, Lee-Ann, Lamar and Mike!

Photo by James Axford

By Agnes Milowka

If you are interested in scuba diving and wrecks check out http://www.AgnesMilowka.com The site features articles, photographs and video of diving adventures and exploration from around the world.

Facebook:
https://www.facebook.com/Agnes.Milowka.Project

Accident Analysis

By Steve Lewis

The Niagara Escarpment is the limestone-capped rim of a huge bedrock bowl running west and north from Rochester, in upstate New York, through the Canadian province of Ontario, across the top of Lake Huron and then curving back into Michigan, Wisconsin and Illinois. On its way from the southern shores of one Great Lake to frame the western shore of another, it forms the cliffs of Niagara Falls, dissects Ontario's wine county and forms the tree-covered spine of the Bruce Peninsula.

The escarpment submerges there, at the end of the Bruce Peninsula, and for about 50 kilometers, until it surfaces at Manitoulin Island to continue its arc back through the United States, there is a navigable waterway connecting the main body of Lake Huron with the expansive waters and approximately 30,000 islands that constitute Georgian Bay. This waterway is part of the network of commercial shipping lanes that opened North America to European settlers, but more important to divers, thousands of ships, from simple gaff-rigged fishing boats to gigantic steel freighters passed through there, many of them meeting their end in the process.

At the southern end of this gap at the very tip of "The Bruce" is a small fishing village called Tobermory. On Highway 6 just at the edge of town is a sign welcoming visitors to "The Scuba Diving Capital of Canada." While the local chamber of commerce may be guilty of optimistic overstatement, the clear, cold water off Tobermory, and Fathom Five National Underwater Park, attracts divers to the area by the boatload in the summer and fall. It's a rite of passage for sport divers from southern Ontario and neighboring American states to make the long trek north to dive on one of twenty or so shipwrecks broken and torn apart on the sharp rocks that ring that coast.

In many spots along the coast of the Bruce, vertical dolomite cliffs take an almost vertical plunge 100 metres or more beneath the waves. Outside the boundary of the national park, there are also a few wrecks far too deep for sport divers but appealing enough to bring technical divers to the village in great numbers. Oddly enough, these deep and somewhat remote dive sites account for very few diver fatalities. The bête noir in this area is a small wooden barque sunk within sport diving's limits, and a twenty-minute boat ride from Tobermory's Big Tub Harbor.

Since the discovery of the sailing vessel Arabia in the early 1970s, more than 14 divers have perished on her. Far more than any other wreck in the Province of Ontario and perhaps any single spot in Canada and the USA, including any individual Florida cave or the

fabled wreck of the Andria Doria off America's Atlantic coast.

Every dive season there are countless near misses on this little wreck as well. Divers make ballistic ascents. They lose contact with their dive buddy and panic. They forget to make required safety stops. They get lost, run low on air, and make mistakes that could snuff out their lives and add to the grim statistic that has earned the Arabia the somewhat sexist nickname "The Widow Maker."

The real challenge is explaining why a rather ordinary wreck sitting in a fairly sheltered spot, with moderate visibility and light current, is so dangerous. Based on the records of diver deaths in this region, deeper dive sites protected by tougher environmental conditions and offering many more opportunities for grief are comparatively benign.

One guess is that too many people are looking for a shortcut and the Arabia is an assessable "challenge" visited by a number of suitably-equipped charter boats and therefore readily available to wreck divers, even those capable of faking a logbook and embellishing their experience. Without doubt the unfortunate history of the wreck exudes a kind of morbid attraction to this last category of fools.

We live in a society promising magic pills to make us fitter, thinner, younger, more attractive, and smarter: so much so that the expression "paying one's dues" and all it suggests is considered out of touch. Subscribing to a philosophy that promotes earning privilege by hard-won experience and the slow accumulation of skill is considered "old school" and unfashionable.

The diving community certainly has members who are looking for shortcuts to "class dive sites" without prerequisite experience and skill. However, diving is not a pastime for shortcuts, and the Arabia was the stage for one incident that confirmed this dictum with blinding clarity.
One summer's day a few years ago, a young man, who we'll call Bob, decided to pay the wreck of Arabia a visit. Bob had just finished his open water scuba diver certification and the site was not one he had any business visiting. Apparently some friends warned him about attempting the dive, but according to later accounts, he was resistant to the meaning of caution. The site's reputation as a potentially dangerous one was said to be a huge part of the lure. Bob had visions of diving all the well-known wrecks off the North East coast the following year and this adventure on Arabia was to be a warm-up.

Arabia sits broken but essentially upright in about 32 metres of water… approximately twice the depth Bob's freshly minted open water card certified him to dive. Outfitted in rental dive gear he unfortunately found a boat willing to take him to the site. Since his was going to be a deep dive, and he'd heard that decompression gas was a good idea on deep dives, Bob strapped a stage bottle of nitrox to himself — a gas he was not certified to use — and, diving alone without the help and support of a buddy, went exploring.

We will never know what he saw or learned on his dive because Bob was found a couple of days later lying on the lake bottom less than a hundred metres from the wreck, long dead.

As truly extraordinary the symmetry of its stupidity, and as sad its outcome, this was not a particularly unique or isolated incident. Another death around the same period, involving an equally inexperienced diver on the Forest City, a deeper more challenging wreck in the same area, illustrates that. Every year there is a miserable list of equally dreadful cases where over-confidence, poor judgment and ill-informed choices result in the thinning of the herd.

And we should remember that such acts of folly are not restricted to beginners. Highly experienced divers seriously injure themselves and sometimes die too.

Jennifer Hunt, in a study published in Psychoanalytical Quarterly in 1996, focused on "Sam," a pseudonym for a well known New Jersey wreck diver and author. Her article, entitled Diving the wreck: risk and injury in sport scuba diving, explored Sam's motivations

for continuing to conduct technical dives following a near fatal accident. Sam had suffered a very serious decompression episode the year prior to her interviews with him — an incident he documented as a sidebar in a best-selling book written later. Disregarding the physical injuries caused by the incident, he continued to engage in deep wreck diving in a high-risk environment ignoring medical advice not to.

Hunt draws an interesting and somewhat disturbing picture of how unresolved psychological conflicts may influence a person's approach to diving. She also teased out of many months of research an explanation of what compels divers to ignore evident risk.

"Like Sam," she wrote, "a number of deep divers appear to link masculinity to involvement in high-risk activity. This unconscious link between risk-taking and masculinity is given cultural support within the deep diving community."

I know Sam well enough to believe Hunt's assessment of him is off the mark. After conversations with him, I read his motivations as having little if anything to do with perceptions of masculinity or influences drawn from his peer group. Sam's decompression blunder was no accident but the direct result of carelessness and oversight. Sam's actions were not driven by testosterone-soaked myopia, but a different flavor of foolishness — complacency of the experienced.

I think Hunt drew the wrong conclusion about Sam but I do not think she is wrong in all cases. Certainly her reasoning explains why some divers – experienced and inexperienced – attempt things outside the purview of their personal limits; even when they have full knowledge that what they intend to do is risky. Some misguided link between "being a man" and taking foolish risks certainly helps to account for the behavior that resulted in Bob's death on Arabia… but what else is there and what steps can each of us take to manage and control our own behavior in order to lessen the chances of suffering a similar fate? Step one is to identify and then avoid things that cause serious dive accidents.

ACCIDENT ANALYSIS

The simplest way to stay out of the statistics column is to have a realistic grasp of your personal limits and the limits of your gear and then to stay well within those limits. It's that simple; however, most of us need some help being honest and well informed about where our limits actually lie.

Cave diving remains the purest form of high profile, complicated diving. It's also the branch of diving that offered the original properly organized training and certification for what we now call technical divers. The first recorded scuba dive into a cave in the USA was conducted by National Speleological Society divers in 1948, and the Florida chapter of that organization held the first cave training sessions for divers five years later in 1953. By the late sixties and early seventies, cave diving was being taught actively in North Florida by two groups, the NACD (National Association for Cave Diving) and the NSS-CDS (National Speleological Society – Cave Diving Section).

Cave diving, as with any form of extreme sports, carries considerable additional risk on top of the list of commonplace ones attached to the ordinary, everyday version of the sport… in this case, open water scuba diving. As the popularity of cave diving grew, so too did the number of diver fatalities in Florida's caves. Pretty soon, cave training programs included modules on Accident Analysis, during which students and their instructors, in an attempt to avoid a similar fate, engaged in detailed discussions about divers going into caves and dying in there.

This "accident analysis" segment of diver training was radical stuff… a complete departure from the candy-coated puff being delivered to the mainstream dive-industry customer.

In his seminal writings on dive safety, Basic Cave Diving: A Blueprint for Survival, Sheck Exley was among the first to identify that most fatal and near fatal incidents in caves are the result of people ignoring one or more of the five safety procedures. Exley, pioneer cave diver

and explorer, originally recorded these five principles or best practices as: Training; Guideline; Gas; Depth; Lights. (A mnemonic to remember them is Thank God, Good Divers Live.) This translates into: Do not exceed or ignore the limits of your training (and experience by implication); Always maintain a continuous guideline to open water / the surface; Plan dives around adequate gas volumes and oxygen partial pressure; Stay within the working depths of your equipment, your level of concentration, nitrogen partial pressure, and comfort zone; Carry backup lights to preserve safety and comfort in the event of primary light failure.

In a 1992 article in Aquacorps Journal, Michael Menduno, the magazine's founder and editor-in-chief, used Exley's accident analysis technique to pick apart eight diver deaths that had occurred in the United States dive community inside a 12-month period. The fatal sites were a mix of caves and deep wrecks and one deep open-water location.

At Alachua Sink, considered an advanced Florida cave dive, a newly certified cave diver became lost in the cavern zone and drowned. An experienced cave diver suffered a CNS (Central Nervous System) oxygen toxicity episode diving Devils Eye, also in Florida. The wreck of the Andrea Doria claimed two lives in separate incidents; one diver simply ran out of air, the other became lost inside the wreck's maze of cabins and companionways. On the Arundo, a wreck off New Jersey, a diver experienced an oxygen toxicity event and died. The Chester Polling, off Massachusetts, claimed the life of an experienced wreck diver conducting a dive to 52 metres (170 feet) on air. And two buddies attempting a 75 metre air dive (250 foot) wearing only single 11 litre cylinders (aluminum 80s) and with only sport-diving gear and training, died in La Jolla Canyon, off California's southern coast.

Menduno, who is credited with coining the term technical diving, wrote "Unfortunately in most of these cases, experienced divers violated one or more basic safety principles and died as a result."

He went on to explain "the predominant causal factor was the lack of a "continuous guideline" (line system) to the surface that serves as a critical navigation device in the overhead environment of a cave or wreck and an important staging tool during open water staged decompression. Even in the absence of rough sea conditions executing a five to ten stage open water hang in the absence of a decompression line is hazardous and tricky particularly when using hyperoxic mixtures for decompression where depth control is critical."

He identified that the second most predominant factor in the 1992 deaths was "inadequate gas management," and stated that in the instance of one Andrea Doria incident and the ridiculous depth attempt at La Jolla, divers entered the water with insufficient gas to conduct the dive safely and handle an emergency.

"They were," Menduno wrote. "In effect conducting suicide missions."

A couple of months following the publication of Menduno's article, and ironically during a workshop on diver safety that boasted a panel made up of many of the top advanced divers and dive-trainers of the period, came news of deaths nine and ten: those of Chris Rouse Senior and his son Chris Rouse Junior on the wreck of the U-Who, later identified as the U869.

Exley's ideas had gained general acceptance and had stood for several years unchanged and unchallenged but shortly before his own tragic death in April of 1994, exploring a deep cave in Mexico, Exley revisited his work on accident analysis and expanded his safety procedures to reflect massive changes in the world of technical diving and to accommodate the widening appeal of technical diving with divers outside a cave environment. In addition, a veritable who's who of advanced diving adding their input and suggestions to Exley's framework, and the results now, almost a generation later, is a Risk Management Process intended to help prevent unnecessary deaths, and to help drive home to a growing audience of enthusiastic divers, all ready and willing to push the envelope, that while

technical diving is fun, it is totally unforgiving of the foolhardy.

Risk Management is the identification, classification, avoidance and mitigation of risk. In order for it to work, it requires honest and detailed answers to some straightforward questions and following some common-sense guidelines organized into eight categories: Attitude, Knowledge, Training, Gas Supply, Gas Mix, Exposure (the combination of Decompression and Depth), Equipment, and Operations… let's take a look at them.

ATTITUDE

The fundamentals of diver safety really all boil down to attitude. If we pick through the cascade of events that led to a diver's death or serious injury we find common mistakes and rash decisions were the catalyst for disaster. In the majority of cases, these events began and decisions where made before the dive took place and were the result of recklessness (Sam's example) or machismo (Bob's example). Before every dive, technical divers should ask themselves this question, "Why am I doing this?"

There is no room for a cavalier attitude. There is no time for bullshit. And technical diving is no place for people trying to prove their manhood. If you recognize these traits in your attitude, take up golf and stay the hell away from technical diving.

KNOWLEDGE / WISDOM

Mark Twain said that it ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so. That's pretty succinct, because most of the targets in diving are moving rather than stationary, and there's more alchemy than science to it. And so it follows: No dogma; No absolutes; only an open mind.

Knowledge is also understanding that you need to have options when things don't turn out the way you expected. And wisdom is having the insight to choose the option most appropriate for whatever the current circumstances may be.

Both knowledge and wisdom also contribute to the technical diver's mindset, which accepts that there is always more to learn and often a better way to accomplish one's goals.

TRAINING

Stay within the limits of your training and you will weight the odds in favor of survival; exceed or ignore your training and the odds very rapidly swing in the opposite direction.

Scuba diving is a pastime built on and driven by training. It starts with certification as an basic open-water diver and progresses from there. Technical training is an ongoing process and never stops. A diver never "has enough" training. In this regard the situation is similar to training for an athletic event.

Graduation from a formal course is a good first step, but it is only a first step and carries no guarantee that a diver is prepared to make a specific dive. There's more to technical diving than holding a c-card. One key element in a diver's development is practice. Well-directed and well-accessed practice builds muscle memory, familiarity and competence… it is what prepares a diver for a particular dive.

Experience is the other key component. Exposure to specific environmental conditions is the only preparation that counts towards preparing for dives in that environment. For example, extensive wreck diving experience does not qualify a diver for cave diving and visa-versa

Even the most cursory glance at the growing list of dive "accidents" tells us that any recreational dive can morph into a nasty situations when someone attempts a dive they are not trained to do in an environment that is unfamiliar to them. A workable analogy would be attempting Parkour off a three-storey balcony to see if the sport's to your fancy. Either option is going to land you in the emergency department.

Buoyancy Compensators:

Ranger BC

The Ranger has been at the “top of the charts” for nearly ten years– for some very good reasons:

The Ranger was the first BC to combine high quality heavy duty construction, weight integration, and rear flotation. It’s introduction created a new category of buoyancy systems, and it is without doubt the most imitated BC in history! But it’s the Ranger’s incredible versatility that keeps knowledgeable divers recommending it year after year. Zeagle’s modular construction allows the Ranger to transition between tropical travel diving, rugged cold water diving in wet or dry suits, single or twin cylinders, and even (with optional bladder assemblies having up to 2 X 85-LB lift and easily mounted backplates) technical diving!

Constructed of heavily reinforced 1050 denier ballistic nylon, the Ranger is compatible with a variety of options and accessories, including bladders, pockets, hard backplates, and custom gear attachment components.

If you are a diver who wants a rugged recreational buoyancy system, but also want one that can adapt and change to meet different diving needs, the Ranger is a system you won’t outgrow.

Ranger Standard Features

- 44 lb lift capacity Ballistic bladder (standard, other capacities available as options)
- 36 lb capacity Ripcord® weight system
- 16 lb capacity rear trim weight system
- Personal Fit System (PFS) Sizing
- Heavily reinforced 1050 denier Ballistic nylon construction
- 11” grommets for mounting twin cylinders
- Two Zippered utility pockets at sides
- Adjustable elastic waist panels
- 4 Stainless angled D-rings on shoulders (two adjustable)

Ranger Sizing

Vest: Measure waist size		**Shoulder:** Measure shoulder to waist	
XS	Custom	**XS**	Custom
SM	25”-35”	**SM**	14”-18”
MD	33”-41”	**MD**	18”-22”
LG	37”-45”	**LG**	22”-26”
XL	42”-50”	**XL**	26”-29”

- 2 Stainless D-rings on vest
- Adjustable Sternum Strap
- Single or twin tank capability.
- 8 optional Trim Colors available
- 8.4LBS dry weight

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GUIDELINE

In a cave this simply means that a dive team must maintain a continuous guideline to open water: think Ariadne, Theseus, the Minotaur, a ball of string and the Labyrinth. Explored caves — that's to say the vast majority of caves visited by recreational divers — have a network of permanent lines in their passageways. These guidelines are placed strategically throughout the cave's main tunnels and branch lines. At regular intervals, markers — usually plastic, but metal or tape in rarer cases — are attached and indicate the distance to and direction of the nearest exit. Cave divers also carry reels of line with them to gap any breaks in the permanent lines — intentional or otherwise. By following this rule, a cave diver always knows where he and his team is in relation to open water and fresh air. 'Loosing the line' or not having one to start with, has been a contributing factor in many, many cave fatalities.

The same guideline rule holds true for wreck divers penetrating wrecks, with the difference that wrecks seldom have fixed permanent lines so wreck divers install as they go and retrieve as they exit. But the comfort and security of a continuous guideline out of the overhead is paramount.

In an open water, non-overhead environment, 'Guideline' can be translated to mean three things: the first always having a bearing on the preferred exit — such as a friendly shoreline or boat — which is a case of knowing where to surface rather than where the surface is.

Secondly, it is knowing where the team is at any moment in relation to the planned route, including entry and exit points. Since there is no actual line and no specific markers with distances to the exit written on them, this exercise can be more complex in open water than in a cave, because there is no easy or apparent 'map' to follow. However, natural navigation and noting distinct landmarks helps immensely.

Lastly, complex decompressions in open water are made less stressful, and more controlled, with the simple addition of an ascent line. This can be fixed in place and have contingency gases staged at various points in the water column. It can be a DSMB (Delayed Surface Marker Buoy) deployed by individual divers or by the team, or it can be a full-blown decompression staging platform complete with contingency gases, surface supplied oxygen, refreshments and piped music.

Getting lost in a cave is usually fatal. Getting lost on a dive in the open ocean, on a wreck or otherwise, can be equally serious. Currents, big seas and fog can make surfacing at the wrong end of a 120 metre wreck more than embarrassing. The simple and most supportable solution is to use an upline.

GAS SUPPLY

There are lots of bad things that can happen underwater but the worst thing of all is running out of something to breathe. Where there is no direct access to the surface — such as in a cave or when there is a decompression obligation — this is a total show-stopper.

It follows then that technical divers make sure there is a sufficient volume of gas for everyone to get back to the surface, and there is some redundancy built into each diver's gas delivery equipment. For this, they use techniques originally developed by cave divers.

In its simplest, unmodified form, The Rule of Thirds (one third of the staring volume for entry, one third for exit, and one third for contingencies) is a bare minimum approach to gas volume management, and not by default the best option in a hard overhead environment. For example, if a cave diver looses back gas just as he and his buddy reach thirds — the worst-case scenario — they will most likely not make it out of the cave, but will exhaust their gas supply within a short distance of the cave entrance. The logic here being that the journey out will require slightly more gas than the journey in on account of several factors, such as one or both divers being stressed — breathing harder — the journey taking longer since both divers are tethered by a long hose, and silt-outs are a

distinct possibility with one or both divers distracted by the stress of sharing gas for a longish swim.

But the rule of thirds is a fine starting point to plan from. In essence, there should be sufficient reserves for the dive team to exit safely in the event one diver suffers a catastrophic gas loss. In open water this means the plan should include contingencies for all the team to reach the first gas switch with a comfortable cushion. Generally, this is accomplished by the team's penetration or bottom time being governed by the gas volume of the team member carrying the least number of litres or cubic feet. This volume is used in gas supply calculations.

The situation with decompression gas is similar in that contingency volume must be planned for. The consensus seems to be that each team member carries sufficient deco gas to allow two divers to complete the optimal decompression schedule.

Except in exceptional circumstances, an open-water technical diver must carry all the gas he will need for the dive. Unlike his cave-diving buddy, there are few options for reliably staging primary gases in open water.

Having gas and not being able to access it accomplishes nothing as so in addition to gas volume management, technical divers dive with a gear configuration that provides a backup gas delivery system. In the open circuit arena this may be a set of doubles with two first stages, a stage bottle of bottom gas with its own regulator, or a sidemount rig. When diving a rebreather, this means carrying an independent bailout cylinder with its own regulator.

GAS MIX

The next to worst thing that can happen to underwater is only having something inappropriate to breathe or breathing a gas that is 'toxic' at depth. For example, breathing a mix delivering an oxygen partial pressure higher than convention dictates… which is a maximum of 1.6 bar. This also covers breathing mixes that have high narcotic loading, are hypoxic — deliver a low oxygen partial pressure — or — in exceptional exposures — mixes that may encourage counter diffusion issues.

The rule is to always dive the safest possible mix(es) for the planned dive; always analyze and label gas before making the dive. Above all, make sure that you know what you are breathing and that you are sure of its Maximum and Minimum Operating Depth(s).

Clear labels stating MOD should be visible on both sides of any stage bottles taken into the water. Permanent labels and touch identification on regulators for conditions of zero visibility are all well and good but are secondary to clear markings based on analyzed contents.

Keep oxygen partial pressures lower than 1.4 bar for the working phase of a dive. On deeper dives, knock this back to 1.3 or 1.2 bar. During decompression, increasing oxygen levels to a maximum of 1.6 bar must be done with care and attention to stay within 80 percent of NOAA's oxygen single exposure limits. In the event of multiple dives over multiple days, track daily/24-hour limits as suggested by NOAA. Do not exceed them. There have been several 'unexplained' CNS toxicity incidents that seem to point to issues with these particular limits.

Keep nitrogen partial pressures within supportable limits. Personal comfort zones may vary depending on the type of dive and environment, but 3.1 to 3.5 bar is becoming a standard acceptable narcotic dose.

EXPOSURE

Decompression Sickness (DCS) is a predictable sidebar to all forms of scuba diving. The potential for risk of DCS is greatly increased during the sort of deep and long dives typical of technical exposures. Prudent technical divers always use proven decompression methods and the most up-to-date tools for dive planning. They dive conservatively and make ample allowance in their ascent schedules for working dives, dives

in cold water, exceptionally deep dives and dives using helium. They carry tables for lost gas contingencies, and use hyperoxic mixes (either nitrox or high-oxygen content trimix) for decompression, never bottom gas, and optimize their final stops (at 6 and 3 metres) by breathing pure oxygen or something close to it. Air is an inefficient decompression gas and has a poor record at reducing decompression risk (Vann, 1992), so they avoid its use in all but the most extreme circumstances.

Another good practice many adopt is keeping detailed notes of decompression schedules and their 'health' after their dive compared to the way they felt before the dive. They refer to these notes when planning future dives.

Thanks to decompression planning software, personal dive computers actually intended for use during staged decompression, and a growing data set cataloging successful dives in the top-end range of 75 metres (about 250 feet), the number of serious decompression incidents among technical divers at these depths is surprisingly low… far from totally acceptable but nevertheless the risk is tolerable to many weekend divers. However, technical divers have to accept that dives deeper than 100 metres (about 330 feet) seem to engage a whole new level of vulnerability to DCS, which puts dives to these depths beyond the scope of all but the most careful of divers, and those who have planned dives with the additional security of in-water and surface support.

In conditions where there are strong or variable currents, cold water and the possibility of limited visibility above or below the surface — when wreck diving for example — bottom times should be kept as short as practical to ensure that total in-water exposures do not add factors such as thermal stress and the possibility of losing contact with the surface support to the risk .

DEPTH

Better expressed as Personal Depth Limits, this rule primarily reminds divers to factor into their plans the effects of narcosis, and a variety of other issues that negatively effect their personal performance.

To the majority of experienced divers, deep is a relative term, and one used with some caution. For example, deep in cold, murky water with strong currents begins when the reading on a depth gauge is much shallower than it does in warm, clear, calm water. A very well known cave explorer says that deep is any water he cannot stand up in and breathe fresh air. Deep can actually be shallow, it just depends.

The same can be said for the Count Dracula of tech diving — narcosis — because it too is a relative term.

The biophysics of inert gas or nitrogen narcosis are pretty much solid state. The actual changes made to the nervous system would suggest a constant effect that while not completely understood would most likely be linear. But narcosis is wildly variable and its effects oddly unpredictable. The function of partial pressure — expressed in bar and increasing at a steady rate as a diver sinks further beneath the surface — does not account fully for the dramatic variations in the risk and severity of narcosis that divers experience. The only logical explanation is that factors aside from nitrogen partial pressure play an important role in narcotic loading. These factors certainly include stressors such as cold, poor visibility, carbon dioxide retention, mental stress, task-loading, tiredness and poor cardiovascular fitness. All these exacerbate narcosis and work independent of depth. Helium is the crucifix and garlic necklace that can combat narcosis, but thinking it alone makes deep diving 'safe' simplifies a complex issue and trivializes other important factors.

One factor that is a real concern for 'deep' diving is concentration… by which is meant being focused on the task at hand. Of course concentration can be negatively affected by narcosis but if there is little attention paid to being focused to begin with, the situation can get out of hand quickly. One can regularly see divers who have plenty of helium in their mix, but who are as incapacitated as the regulars at a Grateful Dead concert as soon as their heads disappear under the water.

Being unfocused and letting one's concentration drift around like a ten-year old in Hamleys Toy Shop seems to signal every venerable piece of kit to loosen, break or fall off… or so it seems. The poor diver is brought back from his reverie to find the first stage of his deco regulator floating off into the abyss or something even worse.

Concentration, like buoyancy control and a reverse frog kick, is a learned skill and can be worked on… should be worked on just like any other. Car racers are big on concentration because of the importance of being focused as you approach a 90-degree corner at killing speeds. Their rule is that an additional 10 miles per hour requires 20 percent more concentration. That's not a bad rule for divers: 10 feet 20 percent more focus.

EQUIPMENT

Under Exley's original safety guidelines aimed at someone diving in a cave, light was an essential. Without light, finding the way out would be a serious challenge. Because of this, cave divers each carry one primary light and two backups. A dive is aborted if a primary light fails.

Within the expanded guidelines, lights is code for equipment: specifically having the right gear for the job and appropriate backup.

A diver's equipment is his life support system. It should be treated with respect. Most divers who want to avoid surprises, have gear serviced at least as often as recommended by its manufacturer, and inspect their dive gear before every dive, paying particular attention to hoses and Orings. All regulators, lights, and subsystems such as spools and surface signaling devices should be tested before the start of every dive.

In technical diving, there are no accessories. If a piece of kit is carried into the water, it's because it is an essential tool for the dive, so it must be inspected and tested. Everything that's essential should be backed up: either carried by the diver himself or as part of his buddy's kit.

OPERATIONS

The primary mission of all technical dives is that every member of the team finishes the dive in no worse shape than when they started it, and so it follow that safety is always the first priority.
The most successful technical divers look at their dives as complex entities that require some considerable degree of organization that includes, planning, preparation, the correct equipment choices, teamwork, efficient execution, and the capacity for any and all team members to respond to any emergency effectively and immediately.

Above all, technical diving is a team activity. The buddy system works OK for sport diving, but technical diving often goes more smoothly with a team of three or more. A team extends to those left on the surface, which includes, in the case of boat diving, a minimum of the captain and crew. For complex dives, support divers may be required as well as additional surface personnel. Communications within this group at all phases of the dive is vital. Often, complex dives require an operations manager or a 'diving officer.' This person oversees diver safety, sees that protocols and procedures are followed, keeps records and, in the event of a mishap, takes charge of the response.
At no time should any diver be pressured to attempt to dive outside their "comfort zone," and each diver carries the responsibility for their own safety. Because of this, the cardinal rule of all technical dive operations is that anyone can call a dive for any reason without fear.

A FINAL WORD

Fatal dive accidents frequently have multiple and complex, often interconnected, root causes. While each accident has unique qualities about it – in part because of the individuals involved – most accidents can be characterized as a chain of events that lead to disaster.

This chain of events very often starts with a minor challenge… a failure in communications, a broken strap. But like dominoes, one event

triggers something more serious, and this in turn results in more escalating calamities until all the dominoes have all fallen down. Technical divers need to get pretty slick at removing a domino early on and breaking the chain. Often something as simple as calling a dive early, before anyone gets close to the edge, can change the outcome radically and turn a nasty epiphany into a positive learning experience.

Unfortunately, the more challenging the dive and the greater the distance between it and mainstream sport-diving limits, the more risk is involved. This is the price we have to pay to experience something out of the ordinary and truly exceptional. No amount of training, experience, equipment or good luck will completely mitigate this risk, and sometime sooner or later, many of us will get our fingers burned. We do well to remind ourselves often that if we participate in technical diving, there is always a risk of serious injury or death.

Steve Lewis is a well-known technical instructor and writer. He has written several textbooks and instructor manuals for technical diving and has served on the training advisory panel for a leading training agency. In 2011 he published the best-selling book The Six Skills and Other Discussions available at Amazon or https://www.createspace.com/3726246 and is currently working on the follow-up titled: Deep Diving in the 21st Century. In addition to his writing, teaching, and lecturing, Lewis works as a consultant for a leading rebreather manufacturer.

The Lighter Side

We have created a fun way to test your knowledge on scuba equipment. Within each issue we will publish a cropped high resolution image of a scuba gear item. All you need to do is to identify the item and the manufacturer.

Email your guess to:
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The two images are from the same item.

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