Choosing a BCD :: Shipworm & Wooden Wrecks :: Risk & Uncertainty :: Masayo Fukuda Portfolio

X-Ray Mag

GLOBAL EDITION
May 2019
Number 91

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Arctic & St Lawrence River

Mexico
Maya Cenotes

Southeast Asia
Timor-Leste

Guadalupe
Great White Sharks

WWI Wrecks
Scapa Flow Centenary

UW Photo
Fibonacci

CAVE DIVING IN SWEDEN
Bjurälven

COVER PHOTO BY IRENA STANGIERSKA

DIRECTORY

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COVER PHOTO: *Cave diving in Bjurälven, Jämtland, Sweden*
Photo by Irena Stangierska

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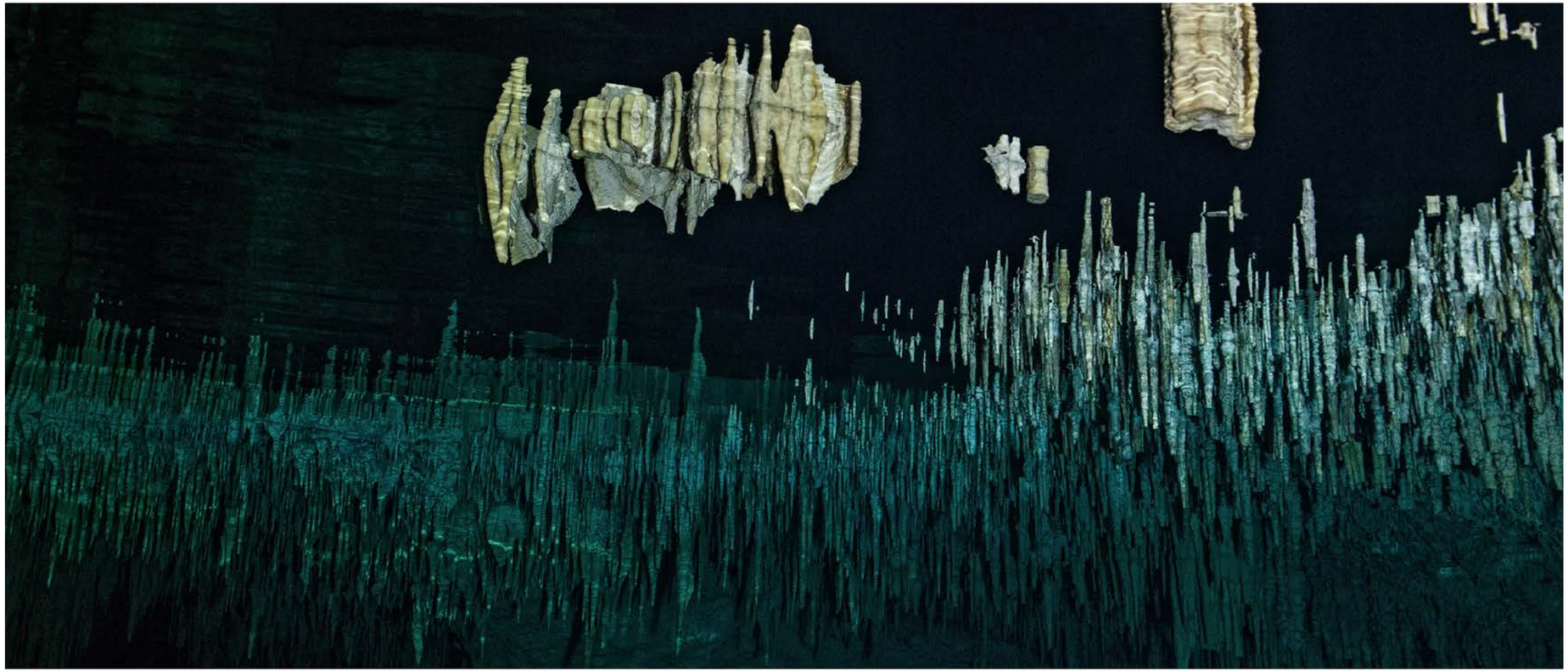
Stalactites seem to float in Dreamgate cenote, Riviera Maya, Mexico. Photo by Andrey Gorodissky.



columns...

plus...

Shame as a driver for positive change

Shame has gripped us. We have become ashamed of flying, of using plastic and consuming red meat. We are changing our daily habits in a personal response to the growing concerns over climate change, which now appears to be accelerating faster than even the forecasts made just a few years ago predicted.

In the relatively short time span of just a year or two, single-use plastics have become socially unacceptable, veganism has become trendy, and perhaps you have heard of #trashtag—collecting trash in nature on your day off. In Sweden, *Bloomberg* reports, shame connected with travelling on airplanes that guzzle fossil fuels is now having a real impact on travel patterns; airports are seeing passenger numbers drop while state trains are enjoying a surge in travellers citing a "big interest in climate-smart travel."

It is not like the threat of climate change or plastic pollution is new; the scientific community has known and warned us about these developments and their consequences for several decades. But it is only now, when we are at last and inescapably witnessing how nature and the weather are regularly going out of whack, causing unprecedented floods, droughts, wildfires and severe storms, that the severity of these issues seems to have finally sunk in. As the 16-year-old Swedish climate activist Greta Thunberg, who has become a global celebrity overnight, told the EU parliament and world leaders at Davos: "You should be panicking."

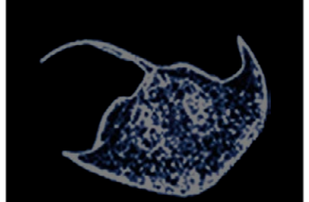
In light of this new-found awareness, and confronted with an onslaught of increasingly frequent news reports and distressing footage of rivers overflowing with plastic refuse carried out to sea in countries where sanitation and recycling leaves much to be desired, we are, albeit woefully belatedly, rising to face the challenge of taking action.

As these calls for action and a change of direction arise from the bottom up—from consumers and voters—and become louder, there is a good chance that our politicians and the corporate world will realize which direction these new winds are blowing.

In fact, it may be our last chance. While it is surely important that each of us, individually, put our shame to work and limit our carbon footprints and impact on nature, lawmakers need to take heed and make sweeping changes. Similarly, corporations need to step up, innovate and implement technologies that are sustainable—in particular, transitioning quickly and substantially to renewable energy on a global scale.

We can still do it—capitalism and ecology are not incompatible entities. On the contrary, they can work together. But we need to keep up the effort and stay the course.

— Peter Symes
Publisher & Editor-in-Chief



News edited
by Peter Symes

from the deep

NEWS

The Mediterranean mesophotic coral reef found off Puglia extends for at least 2.5km.

First coral reef off Italy discovered

The reef found off Puglia on Italy's Adriatic coast is the first mesophotic coral reef—a term applied to ecosystems with low levels of light—to be found in the Mediterranean.

The discovery of the first coral reef in Italy was made at a depth of 30-55m two kilometres off the coast of Monopoli in Apulia by researchers from the University of Bari. While the reef is unique, similar structures could be widely distributed in the Mediterranean, the scientists suggested in the scientific journal *Nature* in which they published their findings.

Coral reefs mainly occur in waters of the western Atlantic and Indo-Pacific regions, within the latitude of 30°N and 30°S. In the Mediterranean Sea, coral reefs were widely distributed in the past, but they currently have a reduced extension and distribution, and remnants of some of these older reefs are only still visible in a few locations.

The mesophotic coral reef is built by non-symbiotic scleractinians.

Mesophotic coral reefs are found at depths ranging from 30 to 40m, up to 200m. Mesophotic reefs are very rare, because they manage to survive and grow despite the lack of light. Unlike more well known coral reefs, such as the Great Barrier Reef, mesophotic reefs are built up from "non-symbiotic scleractinians"—stony corals that feed on organic matter floating around in the water. Being without the photosynthetic algae, which gives other reefs their vibrant colours, the coral reef in Puglia are more subtle.

The reef is unusually thick in some areas as well, the scientists said—up to two metres in certain places—and this all makes the newly identified reef a fascinating one for biologists.

Up until recently, these kinds of reefs have been largely overlooked in scientific research because they have usually been located too deep for scuba divers to explore but not deemed deep enough to warrant the expense of deep-water exploration techniques.

New technology, such as more affordable remotely operated vehicles (ROVs) and advances in technical diving (i.e. rebreathers) is now finally allowing divers better access to this "middle ground," resulting in this discovery.

The discovery of this unique reef has prompted the researchers to call for the establishment of a protected marine area, which would prevent fishing that could damage the reef. ■

SOURCE: NATURE

Hydrothermal vent fluid collects under these ledges and provides the chemical energy that drives the entire ecosystem of microbes, scale worms and riftia.


ROV SUBASTIAN / SOI

Pink mineral towers and vents discovered at the bottom of the Gulf of California

Scientists aboard Schmidt Ocean Institute's research vessel *Falkor* recently discovered and explored a hydrothermal field at 2,000m depth in the Gulf of California where towering mineral structures serve as biological hotspots for life.

The expedition was an unprecedented study of hydrothermal and gas plumes, with researchers using advanced technology including 4K deep-sea underwater cameras and radiation tracking devices, as well as sediment and fluid samplers, working via a remotely operated vehicle, ROV *SuBastian*.

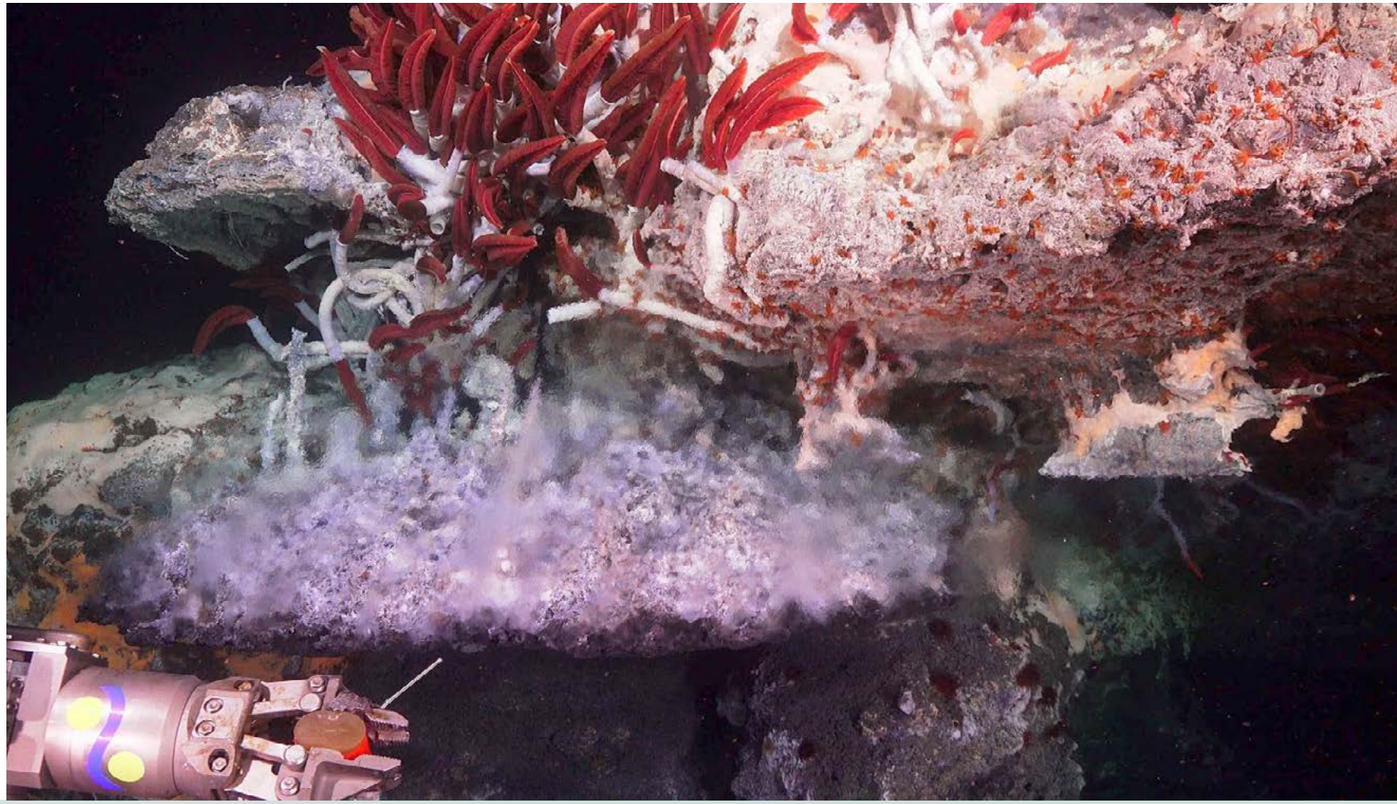
Besides their unquestionable beauty, these hydrothermal vents were found to be teeming with biodiversity and potentially undiscovered fauna.

While exploring hydrothermal vents and cold seep environments, Dr Mandy Joye and her interdisciplinary research team were witness to amazing geological, chemical and biological discoveries. From large venting mineral towers with volcanic flanges holding pools of superheated (366°C) hydrothermal fluids, to areas teeming with biodiversity and potentially novel fauna, this expedition has been full of amazing sights.

"This is an amazing natural laboratory to document incredible organisms and better understand how they survive in extremely challenging environments," said Joye in a press release.

"We discovered remarkable towers where every surface was occupied by some type of life. The vibrant colors found on the 'living rocks' was striking, and reflects a diversity in biological composition as well as mineral distributions," said Joye. "Unfortunately, even in these remote and beautiful environments, we saw copious amounts of trash including fishing nets, deflated Mylar balloons and even a discarded Christmas tree. This provided a stark juxtaposition next to the spectacular mineral structures and biodiversity." ■ SOURCE: SCHMIDT OCEAN INSTITUTE

ROV *SuBastian* measuring the temperature at a hydrothermal vent in the Guaymas Basin (below). This black smoker vent was named "Falkor's Fountain."



Ocean currents are changing

Thermohaline circulation drives a global-scale system of currents called the "global conveyor belt." The global ocean conveyor belt is a constantly moving system of deep-ocean circulation driven by temperature and salinity.

The Atlantic meridional overturning circulation (AMOC) is a large system of ocean currents that carry warm water from the tropics northwards into the North Atlantic—a deep-ocean process that plays a key role in regulating Earth's climate and keeps Europe warm.

As warm water flows northwards, it cools as it heats the atmosphere in the cold northern latitudes and some evaporation occurs, which increases the amount of salt. Low temperature and a high salt content make the water denser, and this dense water sinks deep into the ocean.

Upwelling

The cold, dense water slowly spreads southwards, several kilometres below the surface. Eventually, it gets pulled back to the surface and warms in a process called "upwelling" and the circulation is complete.

This global process makes sure that the world's oceans are continually mixed, and that heat and energy are distributed around the earth. This, in turn, contributes to the climate we experience today.

Overturning

The North Atlantic has the largest reservoir of anthropogenic carbon. Overturning carries vast amounts of this carbon deep into the ocean, helping to slow global warming.

A new international study finds that AMOC is primarily driven by cooling waters west of Europe. The study shows that most of the overturning and variability is occurring not in the Labrador Sea off Canada, as past modelling studies have suggested, but in regions between Greenland and Scotland. Overturning variability in this eastern section of the ocean was seven times greater than in the Labrador Sea, and it accounted for 88 percent of the total variance documented across the entire North Atlantic over the 21-month study period.

Industrial-era effects

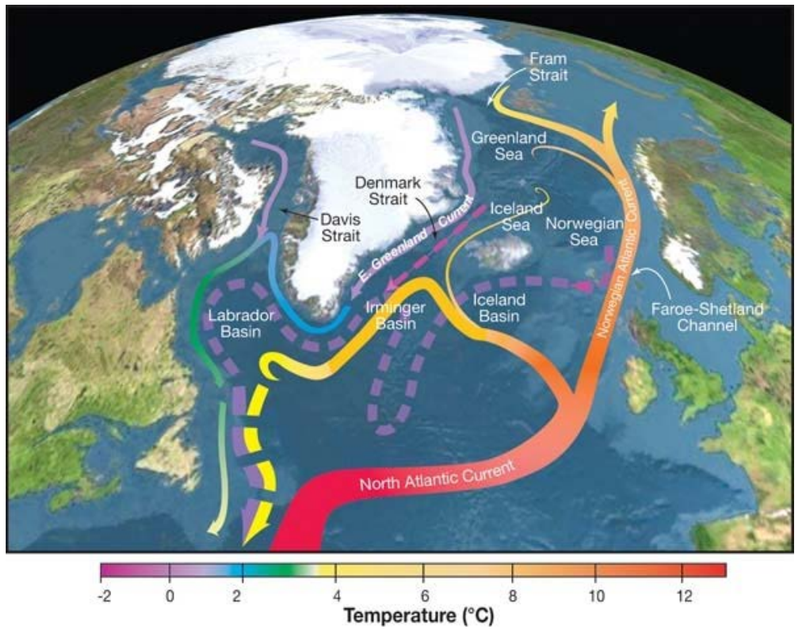
Two new studies suggest that the AMOC is the weakest it's been in over 1,600 years, with the most drastic changes taking place in the last 150 years. One study of sediment cores suggests that the AMOC began weakening in 1850, the beginning of the industrial era. The other study used state-of-the-art climate models and a century of ocean sea surface temperatures. These models suggests that the AMOC flow has weakened since the mid-twentieth century as a result of human-induced climate warming. It should be noted, however, this record did not extend as far back as the sediment study.

Researchers expect future changes in global climate will cause further slowdowns of the Atlantic overturning.

Murray Roberts, who studies ocean temperatures at the University of Edinburgh tells Gill that even if AMOC changes do not meddle with overall climate, these changes could wreak havoc on delicate ecosystems in the Atlantic.

"The deep Atlantic contains some of the world's oldest and most spectacular cold-water coral reef and deep-sea sponge grounds," he said. "These delicate ecosystems rely on ocean currents to supply their food and disperse their offspring. Ocean currents are like highways spreading larvae throughout the ocean and we know these ecosystems have been really sensitive to past changes in the Earth's climate." ■

R. CURRY / WOODS HOLE OCEANOGRAPHIC INSTITUTION / SCIENCE / USGCRP / WIKIMEDIA COMMONS / CC BY 3.0



This topographic map of the Nordic Seas and subpolar basins shows the circulation of surface currents (solid curves) and deep currents (dashed curves), which form a part of the Atlantic meridional overturning circulation (AMOC). Approximate temperatures are indicated by colors of the curves.

Coral reefs near Equator less affected by ocean warming

Thermal-stress events associated with climate change cause coral bleaching and mortality that threatens coral reefs globally. Yet, coral bleaching patterns vary spatially and temporally.

A new study finds coral bleaching is most common in localities experiencing high-temperature stress, as one would expect

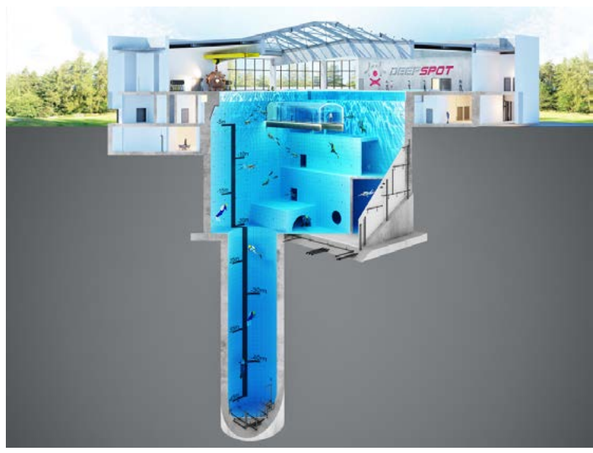
Yet, it was significantly less common in those places with high monthly variation in temperatures. ■ SOURCE: FLORIDA INSTITUTE OF TECHNOLOGY

Deepspot will feature an underwater tunnel for spectators, as well as conference, training and hotel rooms that look into the interior of the pool.

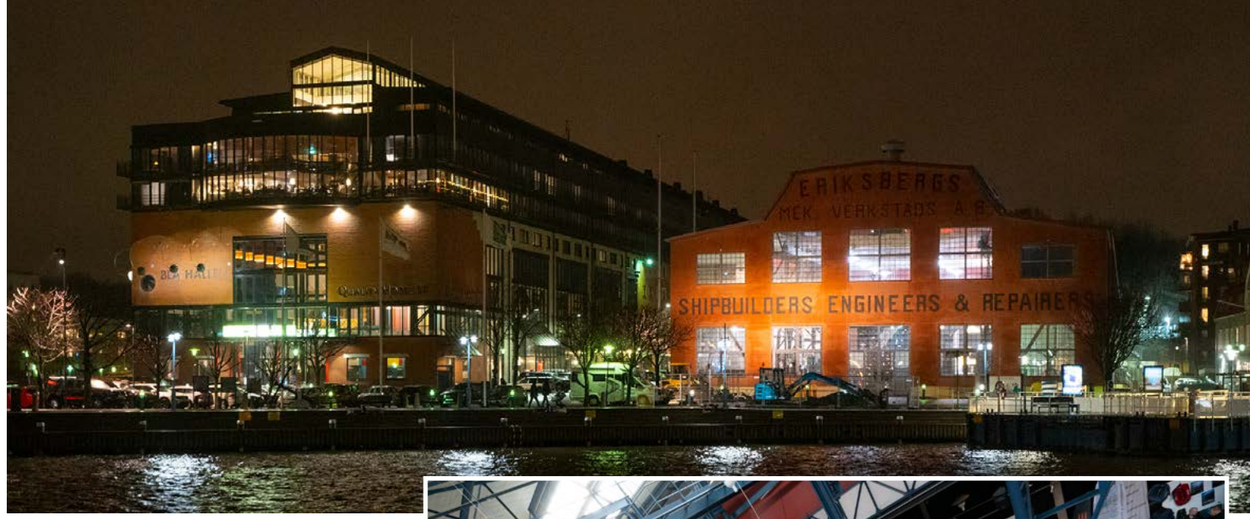
World's deepest pool to open in Poland

What will become the world's deepest swimming pool will open in Poland this autumn. Called the Deepspot the 45m-deep pool is currently being constructed in Mszczonów, about 40km southwest of the Polish capital of Warsaw.

The pool will hold 8,000 cubic meters of water, or roughly 27 times the volume of an average 25m pool. The Deepspot will feature underwater caves and overhangs to explore. Designers say it will suit both beginners and more experienced divers. The water in the pool will be warmer than in traditional swimming pools, so that divers will not have to wear wetsuits. DeepSpot will also include an underwater tunnel, hotel rooms overlooking the pool, as well as restaurants and conference rooms. ■



Deepspot will reach a total depth of 45m.



Eriksberghallen, on the right, once housed a machining company. The associated hotel is seen on the left.

Dykmässan 2019

Text and photos by Peter Symes

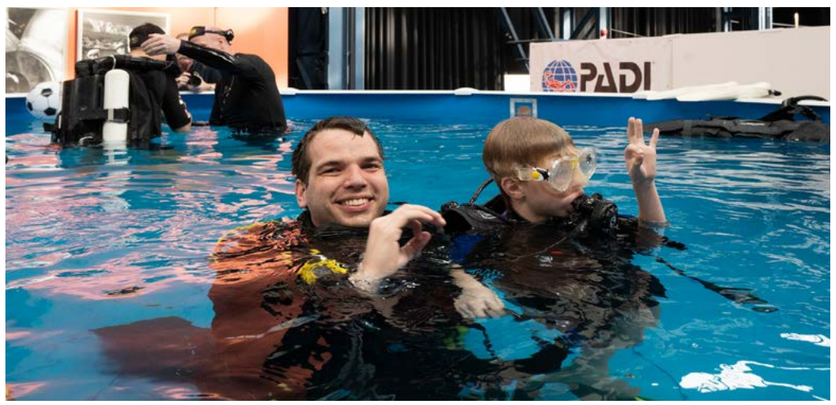
"Dykmässen" means "The Dive Expo" in Swedish, and while it is indeed held in Sweden, this time in Göteborg (Gothenburg) on the Swedish west coast, the event seemed poised to become a dive show for all of Scandinavia.

There are no real dive expos left in neighbouring Denmark or Norway, and by moving the venue from Stockholm to Göteborg, which is so much closer to both Denmark and southern Norway, the intention was to attract visitors from the neighbouring countries as well. Both the Danish and Norwegian capitals, Copenhagen and Oslo, and their associated metropolitan areas, are only about three hours' drive away, and somewhat ironically, much closer than Sweden's own capital of Stockholm.

While the drive there and back from either Denmark or Norway is just a tad too far for a Sunday family excursion, it is not so far for members of the dive industry who come to network, and in many cases, come to stay for the whole weekend.

After being held in Stockholm for the first number of years, also in a quaint location, I liked the new location and venue much better. The hotel and expo hall are right next to each other, so it is just a matter of crossing the alley, and both facilities are excellent. The venue, Eriksberghallen, used to house a metal and machining company, and has since been converted and rebuilt into a quite nice exhibition facility. It appeared to be substantially bigger than the Stockholm venue, but I was informed that it was actually about the same size. It is probably the big, airy, hangar-like space, with its high ceilings, that creates this impression. In any case, the space is quite pleasant to be in, with good acoustics and natural light coming in through the tall panoramic windows, which look south over the bustling port.

With about 70 exhibitors, I would say it is a medium-sized event but with an absolutely decent attendance of 3,500, considering the size of the population of the catchment area.



No good dive show runs without a try-dive pool for happy youngsters getting their first sweet taste of diving, and perhaps the start of a new pastime.

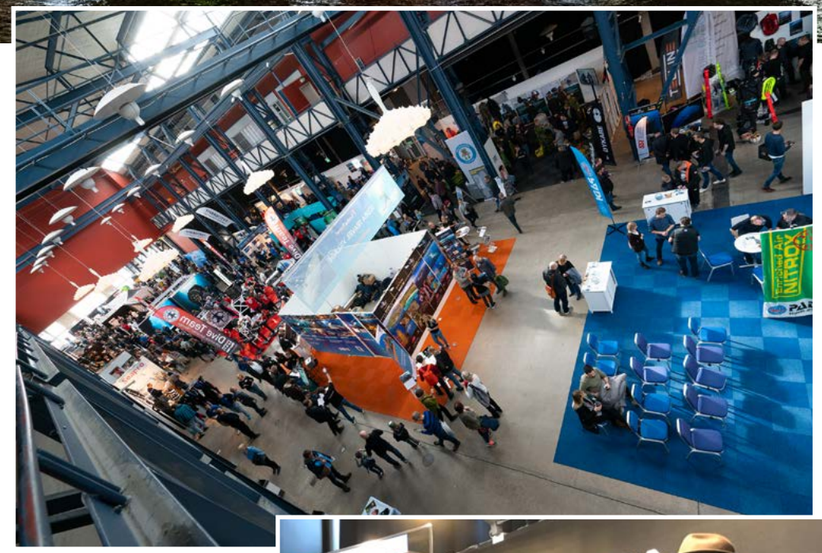
Well-received

An entrance fee was charged at the door, but it was still busy with visitors and all exhibit space was sold out—which Tommy Jarnbrink, the organiser, was obviously quite pleased about. After witnessing the sad decline and ultimate collapse of the dive show in Copenhagen, which was held as a section under a much bigger general travel expo, it is quite uplifting to note that this newer dive show now seems well established and growing. According to Jarnbrink, all the exhibitors signed up again for 2020.

The exhibitors comprised both dive operators (mostly local but also international), manufacturers, tourism offices, armed forces, museums and scientific institutions and various associations. Many of these exhibitors, as well as photographers, held well-attended presentations—about 40 in total. The try-dive pool was also quite busy, mostly with elated youngsters getting a taste of the pleasures of diving as well as adult divers trying out rebreathers.

Worth attending

Is it worthwhile for international exhibitors to attend? The populations of the Scandinavian countries are relatively small—there are about 20 million between the three countries—but they are avid travellers and outdoors people, and have good dispensable income, plus more paid vacation time than any other country (five to six weeks). Hence, the quality of the audience, and not just the quantity, should be taken into consideration. I spoke with several of the international exhibitors, all of whom said they were quite pleased with the reception and plan to come back next year. So do we. ■



Rick Stanley of Ocean Quest, New Foundland, gave several presentations to fully-packed audiences and made good business.

Björn Ehlme, CEO of Waterproof, does not look too displeased with the whole thing.

WDHOF 2019 grant and scholarship awardees span the globe

PHOTO COURTESY OF BRANDI MUELLER

X-Ray Mag's regular contributor Brandi Mueller received a WDHOF Advanced Dive Training Grant towards technical dive education, which will allow her to reach, photograph and write about new locations and deep wrecks for a wide audience.

This year's 59 awardees of the scholarship and training grants by the US non-profit organization Women Divers Hall of Fame came from several countries around the world. With a record number of applications, there was stiff competition for over US$75,000 in scholarships and grants.

Regions in which recipients of awards resided or conducted research included the United States, Canada, Mexico, Great Britain, the Netherlands, Japan, Indonesia, Australia, the Caribbean, the Persian Gulf and Antarctica.

Advanced dive training

X-Ray Mag's own regular contributor Brandi Mueller received an Advanced Dive Training Grant for technical diving education and gear, which is sponsored by WDHOF. An instructor and boat captain with an M.S. degree from the University of Hawaii, Brandi is a popular and prolific dive writer and underwater photographer, author of *The Airplane Graveyard*. She intends to use the grant to continue her technical dive training so she can reach, photograph and write stories about new places and deep wrecks to share with a wider audience.

Two others were awarded the same grant, including Jeanne Bloomberg, a graduate student at Louisiana State University, where she studies coral reproduction and population connectivity of mesophotic reefs deeper than 30m; and Californian Tiffany Sih, a researcher with a doctorate in marine biology currently based in Australia, who will use her grant towards becoming accredited as a Scientific Diver, working in remote locations.

Diverse fields and levels

Fifty-six other scholarships and grants were awarded in the areas of underwater archaeology; undergraduate, graduate and doctoral studies and post-doctoral research in higher education in the fields of marine biology, ecology and conservation, and environmental and ecological sciences; leadership in ocean conservation, adaptive scuba, healing and wellness; hard-hat commercial diving; underwater photography; dive medicine and public safety; basic dive training for professionals, college, high school and primary school students; advanced recreational dive training; advanced technical dive training; and disabled diver training. For a full list, click on: **WDHOF 2019 Scholarships**.

Mission

The mission of the Women Divers Hall of Fame includes "recognizing women divers who have made outstanding contributions to the exploration, understanding, safety and enjoyment of our underwater world" and "supporting the underwater world and its associated careers by promoting opportunities for women and men in diving through scholarships, internships and mentorship opportunities and a worldwide network of industry contacts." ■

For more information, please visit: ***wdhof.org***.

ADEX 2019 report

Text by Catherine GS Lim

I look forward to ADEX every year. It is a chance to reconnect with old friends, make new ones and to catch up with industry developments and trends.

This year is special for ADEX, as it celebrates its 25th anniversary, and the organisers clearly decided it was time to pull out all the stops. Visitors were presented with a stellar cast of acclaimed individuals who eagerly shared their insights and experiences, be it in recreational or technical diving, photographic techniques, or environmental awareness and sustainability. Talks and discussions were also held with regard to the business of diving and conservation. Highlights included the TEK Festival, image/film festival, try-dives, freediving tryouts, book launches, virtual reality 360° films, mermaids, and underwater hockey and rugby.

Plastic-free future

Even with so many activities going on, ADEX apparently decided it would go one up and look towards the future—this year, it was promoted as "the first dive show to move towards a single-use plastic free expo." What's more, it aims to be completely free of single-use plastic by 2021. And rightfully so. Think about it—would you want to swim through a sea of discarded plastic bottles and plastic bags on your next dive? Hence, amidst the glitz of the opening ceremony and performances, the push towards being plastic-free was always on the forefront. There were fashion shows featuring models wearing recycled materials, and some even took to walking the aisles alongside the visitors.

CATHERINE GS LIM

Beside the stage was an area where visitors could refill their water bottles. Outside the exhibition hall was a long installation art display of an underwater scene, made up entirely of plastic packaging and plastic bags. Those with time to spare could even partake in some treasure hunting—rather, microplastic hunting. Debris from a local beach was laid out on a long table, and visitors with patience (and sharp eyes) could try to pick out the microplastics amidst the rubbish. In addition, the event hosted exhibitors involved in coral planting, beach clean-ups, as well as marine conservation and outreach, presenting visitors with a myriad of ways to make a difference.

CATHERINE GS LIM

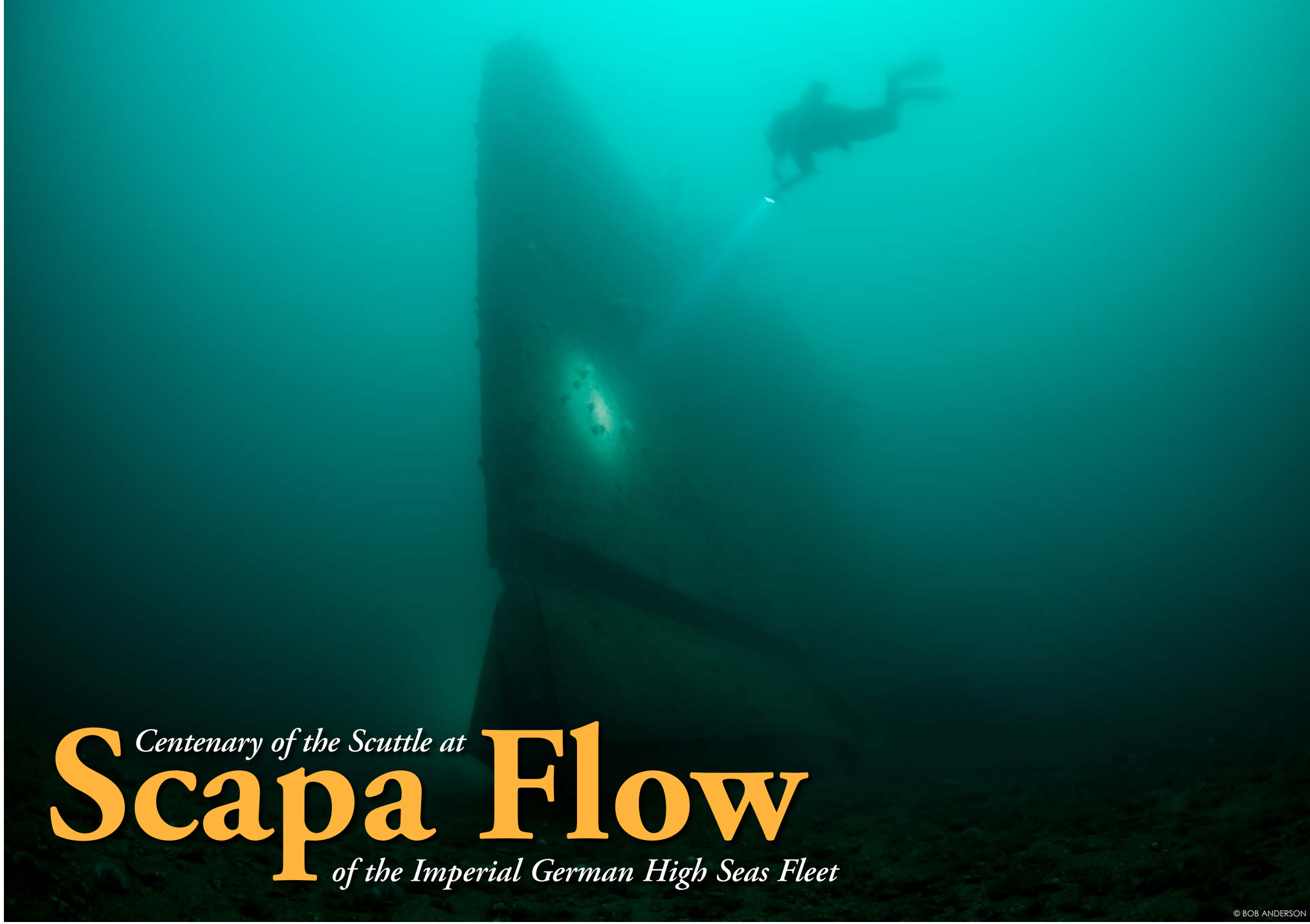
CATHERINE GS LIM

CATHERINE GS LIM

Admittedly, there was room for improvement: For instance, single-use plastic crockery and cutlery were still being used and there were limited plastic recycling bins. Nevertheless, it was a valiant effort towards a future free of single-use plastics. ■

THIS PAGE: Scenes from ADEX 2019 (top to bottom): Panel forum draws full audience; Art installation made of plastic packaging; Models wearing recycled materials; Depiction of coral bleaching using yarn

wreck rap



The massive upturned stem of the battleship *Markgraf* rises 10 metres vertically from the sea-bed at 45msw.

Text by Rod Macdonald
Photos by Bob Anderson and Rod Macdonald. Underwater wreck scans courtesy of Professor Chris Rowland

One hundred years ago this year, on 21 June 1919, 74 warships of the Imperial German Navy High Seas Fleet were scuttled en masse at Scapa Flow, the deep natural harbour set in the Orkney Islands of northern Scotland that was the WWI base for the Royal Navy Grand Fleet. The scuttle was the greatest single act of maritime suicide the world has ever seen.

The 74 German warships had not been surrendered—they had been interned at Scapa Flow under British guard seven months earlier as a condition of the Armistice, which had halted the hostilities of the Great War in November 1918.

The majority of the sunken German warships were salvaged in the 1920s and 1930s, but three 25,390-ton *König*-class battleships—*König, Kronprinz Wilhelm* and *Markgraf*; three 5,531-ton light cruisers—*Dresden, Cöln* and *Karlsruhe*; the 4,315-ton minelaying cruiser *Brummer* and the 924-ton torpedo boat destroyer *V83* were left on the bottom, along with the four great 1,020-ton 15-inch gun turrets of the battleship *Bayern* and assorted masts, spotting tops, guns, pinnaces and other pieces of ships deemed not worthy of salvage. This profusion of submerged German WWI naval history has made Scapa Flow a world-renowned dive location—a "must" for serious wreck divers.

By late 1918, Germany had almost lost her major allies and her land forces were being pushed back on the Western Front. Large numbers of American troops had begun to arrive, and a sailors' revolt had begun during October, which had lit the fuse of revolution. The civilian population was starving as a result of the Royal Navy blockade of the North Sea from its Scapa Flow base.

Historical photo of the Imperial German High Seas Fleet vessels at anchor, taken from above Houghton Bay

The Armistice

German military leaders were pressing for surrender terms with the Allies, but the High Seas Fleet had survived the war relatively intact and therefore, as a condition of the Armistice of 11 November 1918, 74 of the newest ships of the High Seas Fleet—ten battleships, six battlecruisers, eight cruisers and 50 destroyers—would be interned at Scapa Flow with their guns disarmed under close British guard until a final peace agreement was reached. In effect, the High Seas Fleet was being held hostage.

With the Armistice finally called on 11 November 1918, the five battlecruisers *Seydlitz, Moltke, Von Der Tann, Derfflinger* and *Hindenburg*; the ten battleships *Baden, Bayern, Friedrich der Grosse, Grosser Kurfürst, Kaiser, Kaiserin, König, König Albert, Kronprinz Wilhelm, Markgraf* and *Prinzregent Luitpold*; the six light cruisers *Cöln, Dresden, Emden, Frankfurt, Karlsruhe* and *Nürnberg*; the two mine laying cruisers *Brummer* and *Bremse*; and fifty 900-ton torpedo boats began to arrive at Scapa Flow under Allied guard and were moored up in neat rows.

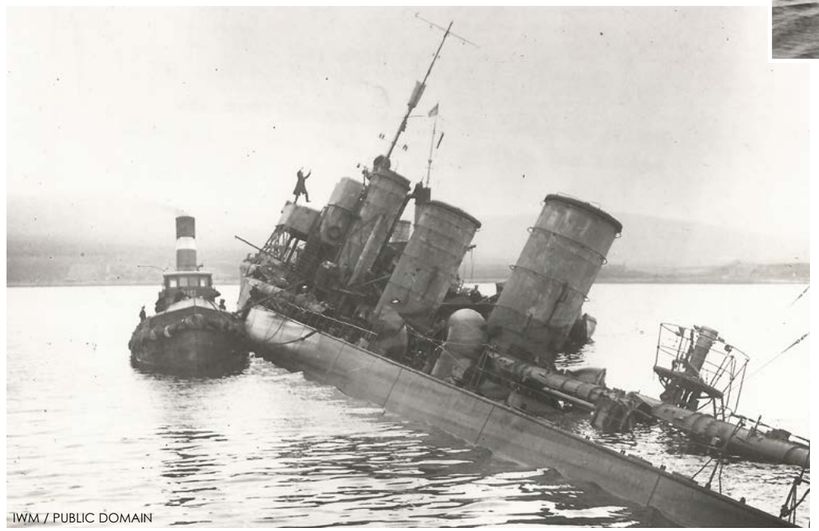
The bulk of the German crews—some 20,000 sailors—were then repatriated to Germany, leaving only skeleton care-taking crews. The warships, although under Allied guard, remained German property and there were no British guards on board. The ships were prohibited from flying the Imperial German Navy ensign—with its black cross and eagle—and all wireless receivers had been taken away. The ships were cut off and isolated from Germany.

The First Battle Squadron of the British Grand Fleet of five battleships, two light cruisers and nine destroyers was stationed at Scapa Flow and would keep a watchful eye on the 74 interned German warships.

Peace negotiations

The peace negotiations dragged on without resolution from November 1918 through the winter of 1918/19, into the early summer. The once proud grey German warships slowly became streaked with surface rust and marine growth from their long stay at anchor.

The British provided the Germans with four-day-old newspapers, in the belief that nothing sensitive could be gleaned from them. These papers were avidly read by the German sailors as they were one of the few means they had of keeping up with what was going on in the outside world. The German sailors were not allowed ashore and could not obtain any information from local sources.

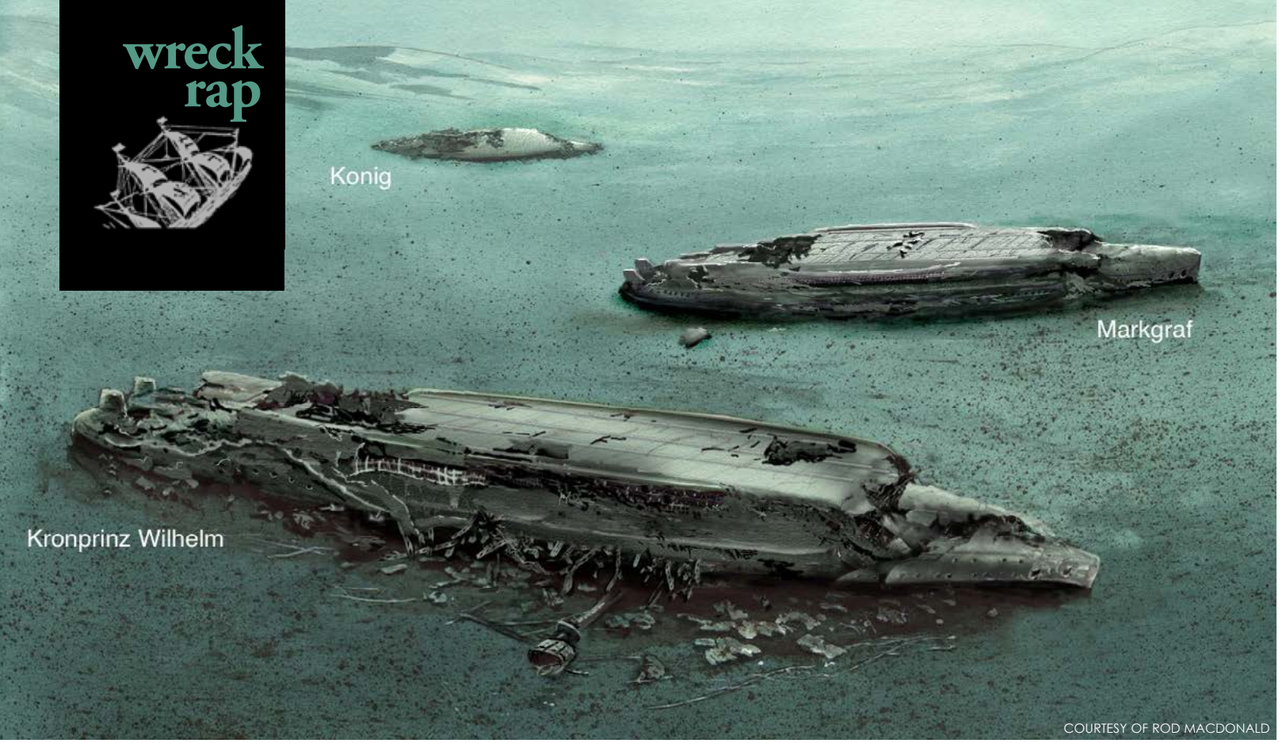


The 28,080-ton battleship *Bayern* (above) goes down by the stern during the scuttle of the Fleet; The 25,796-ton *König*-class battleship SMS *König* (top center); A British tug alongside the scuttled destroyer *G102* (left). A British rating is pulling down the German flags and prohibited ensign, raised before the scuttle began in a gesture of defiance.

After seven months of negotiation, the Allies gave the Germans five days—ending on 21 June—to accept their peace terms, failing which a state of war would exist again. On 20 June, the German commander Rear Admiral Ludwig von Reuter read the German counter-proposals to those Allied peace terms in the latest four-day-old newspaper, The Times of 16 June. The Times of 17 June was then delivered—and this carried the official response of the Allies to the German counter proposals.

The Allies had refused to accept any of them, and from the British speeches reported in *The Times*, it seemed to von Reuter that there was little chance of a peace deal being agreed. He felt it likely that the Armistice would end on 21 June and a state of war be resumed—and that the British would then immediately seize the precious but powerless vessels of his Fleet. With only skeleton crews aboard and all guns disarmed, the seizure of the most modern and powerful ships of the High Seas Fleet could not be prevented—he could not let that happen. (The Armistice had in fact been extended by two days, to 7 p.m. on Monday 23 June—but after the scuttling, von Reuter claimed he had not been advised of this; the British counter-claimed that he had been told. The jury is still out on that one).

At 9 a.m. on the morning of 21 June 1919, the British First Battle Squadron left Scapa Flow for the first time in the seven long months of internment, to carry out a long-range torpedo-firing exercise at sea. They were under orders to be back in Scapa Flow by the extended deadline of 23 June to deal with any trouble that might arise should the Armistice not be further extended. A small guard-force of three British destroyers—*Vegar, Vesper* and an unserviceable destroyer, *Victorious*—was left behind.



The three *König*-class battleships *Kronprinz Wilhelm, Markgraf* and *König* lie close together on the seabed of Scapa Flow.

Giving the order to scuttle

At 10 a.m., von Reuter, now apparently believing that war would restart that day, appeared in full dress-uniform on the quarterdeck of his flagship, the light cruiser *Emden*. He could hardly believe his luck when he learned that the British guard squadron had left the Flow on exercise earlier that morning.

At 10:30 a.m., a string of command flags appeared over *Emden*, even though this was well outside the set times permitted by the British for issuing signals. The order read: "PARAGRAPH 11. BESTÄTIGEN"—which translates to "Paragraph 11. Confirm."

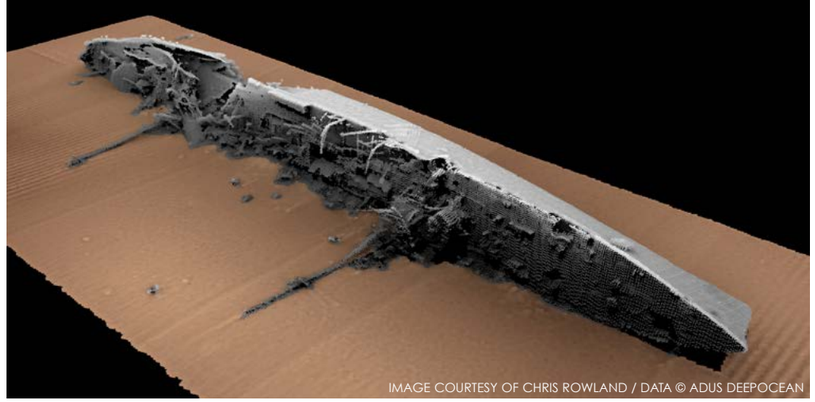
This simple command was the pre-arranged coded order to the commanders of the other ships in the Fleet to initiate the scuttling of their vessels. Unbeknownst to the British, for the last four days, von Reuter's trusted officers and sailors on each of the ships had been taking steps to ensure a speedy and unstoppable scuttle if this order was given. Doors and hatches had been secured in the open position—some being welded open—so that the ships would flood more easily. Seacocks had been set on a hair turning and lubricated thoroughly. Large hammers had been placed beside any valves that would allow water to flood in if knocked off, and bulkhead rivets had been pried out.

Now that the order to scuttle had been given, seacocks were opened and disconnected from the upper deck to prevent any British boarding parties from closing them if they boarded before the ship went under. Seawater pipes were smashed, and condensers opened. As valves and seacocks were opened, their keys and handles were thrown overboard, so that they could never be closed again. Once the vessels started to scuttle, there was no way to stop the ships sinking other than by taking them in tow and beaching.

The signal to scuttle was repeated from ship to ship by semaphore and by Morse code on signal lamps—and travelled slowly around the German Fleet. The southernmost ships of the long lines of torpedo boats were not visible from the *Emden*, and it took a full hour before the order reached them.

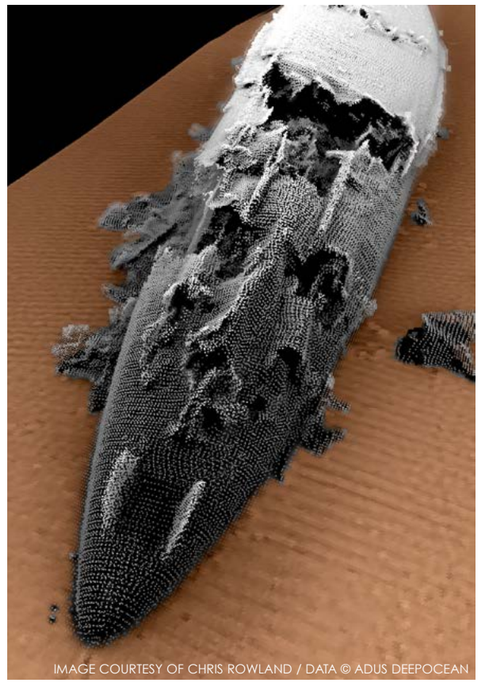
The pre-arranged responses started to come back slowly—the first reaching *Emden* at about 11:30 a.m., just as the original signal to scuttle reached the last of the destroyers: "PARAGRAPH ELEVEN IS CONFIRMED."

In a patriotic gesture of defiance, many of the German ships ran up the Imperial Navy ensign at their sterns. The prohibited white flag, with its bold black cross and eagle, had not been seen at

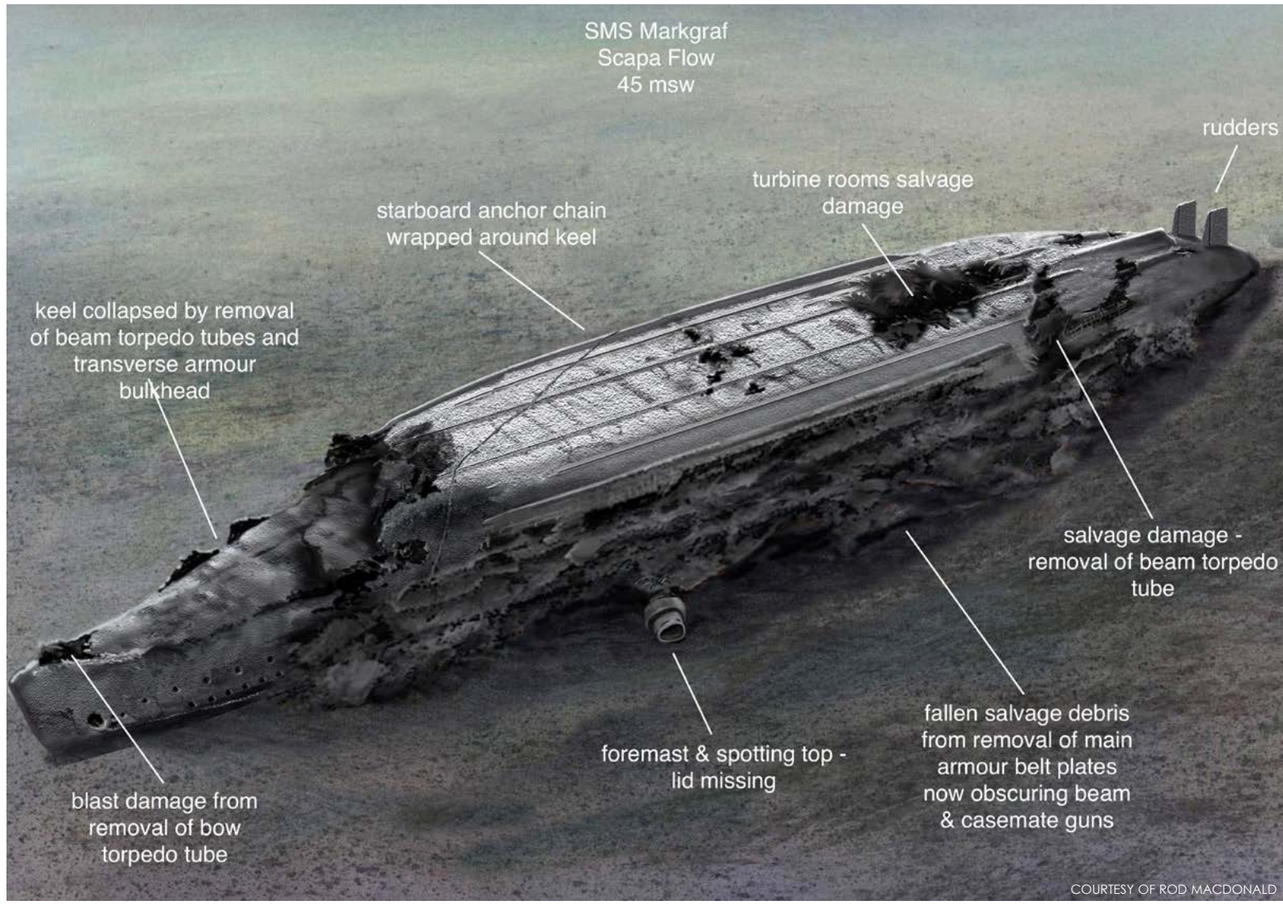


Scapa Flow

The light cruiser *Cöln* lies on her starboard side in 35m of water.



The delicate fantail of *Markgraf* is hard down on the sand. Note her twin rudders and blast damage caused by removal of prop tubes, and farther forward, the two beam torpedo tubes can be seen. Docking keels are visible before the turbine room main blast damage.



The battleship *Markgraf* lies upside down in 45m of water.

A diver gives a sense of scale to the twin rudders of *Markgraf*.

Scapa Flow before. Others ran up the red flag, the letter "Z," which in international code signalled: "Advance on the enemy."

Sinking ships

At noon, an artist who had hitched a ride on one of the patrolling Royal Navy drifters to sketch the German Fleet at anchor noticed that small boats were being lowered down the side of some of the German ships, against British standing orders. He alerted a British officer, but only 16 minutes later, the first of the warships to sink—the former flagship of Admiral Scheer at the Battle of Jutland, the *Kaiser*-class battleship *Friedrich der Grosse*—turned turtle and went to the bottom. Hundreds of German sailors now began to abandon their ships into lifeboats.

Some of the great warships settled into the water on an even keel, whilst others rolled slowly onto their sides. Some went down by the bow or stern, forcing the other end of the ship to lift high out of the water. The top-heavy battleships moored in deeper water listed and then turned turtle as they sank. Those ships moored in shallower water settled onto the seabed, leaving their masts, top hamper and smokestacks standing above the water's surface.

The German ships began to sink in quick succession. Of the battleships, *König Albert* disappeared at 12:54 p.m., *Kaiser* at 1:25 p.m., followed closely by the almost simultaneous sinking of *Prinzregent Luitpold* and *Grosser Kurfürst* five minutes later at 1:30 p.m. *Kaiserin* went at 2 p.m., followed 30 minutes later by *Bayern* at 2:30 p.m.

The first of the battlecruisers to sink was *Moltke* at 1:10 p.m. On the nearby battlecruiser *Seydlitz,* the entire crew stood proudly to attention on the deck singing the German national anthem and watching as *Moltke* sank beside them. The crew of *Seydlitz* then had to abandon their own ship, and 40 minutes later at 1:50 p.m., *Seydlitz* followed *Moltke* to the bottom.

As each ship sank, a whirlpool was created in which debris swirled around, slowly being sucked inwards and eventually being pulled under into the murky depths. Oil escaping from the submerged ships spread upwards and outwards to cover

Fractured turbine blades (left); Searchlight iris (lower left); The delicate stern of *Karlsruhe* (below) with deck planking still visible and kedge anchor resting on the seabed to the left. The upper section of this deck collapsed in 2015/16.

Scapa Flow

the surface of the sea with a dark iridescent film. Scattered across the Flow were lifeboats, hammocks, lifebelts, chests, spars, gratings and all the debris of a ship's passing.

British response

When it was realised that the entire German High Seas Fleet had started to scuttle, Sir Sydney Fremantle, now far out to sea with the First Battle Squadron, was advised and he immediately ordered his Squadron to return to Scapa Flow at full speed.

The two serviceable British guard destroyers *Vegar* and *Vesper* fired warning shots with their main guns and fired with machine guns and small arms as they closed on the sinking ships. Three German sailors in a lifeboat containing 13 men were killed and four were wounded. The others were ordered back aboard their ships and forced by threats of further shooting to turn off the flood valves.

At 2 p.m., the vanguard vessels of the British First Battle Squadron, returning at full speed from their aborted exercise, entered Hoxa Sound, the main entrance to Scapa Flow from the south. Many of the German capital ships were already at the bottom of Scapa Flow, whilst those remaining afloat were in the advanced stages of sinking.

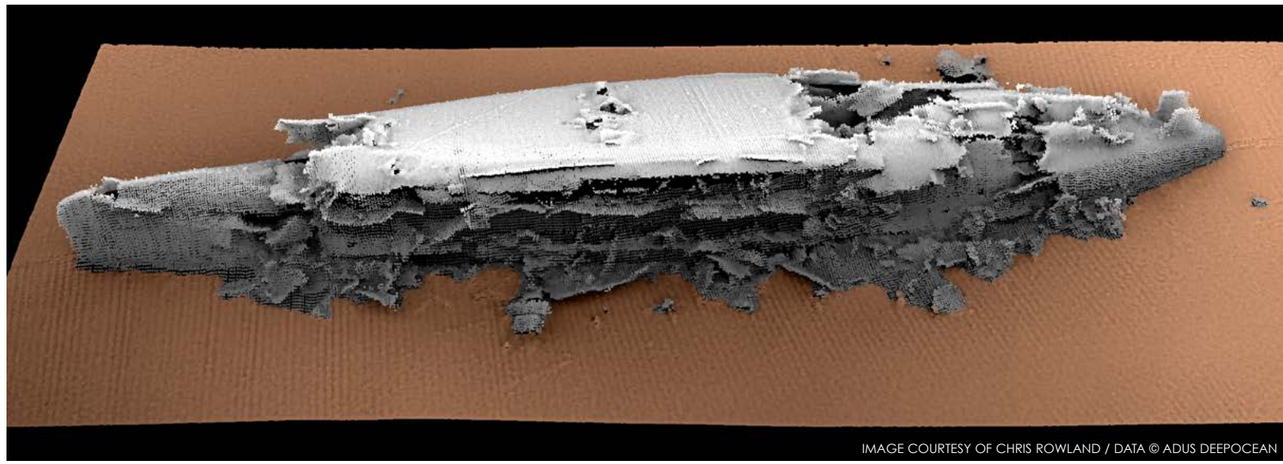
One Royal Navy destroyer immediately broke off from the Squadron and using explosives, cut the anchor cable of Reuter's flagship, *Emden*, and successfully towed her to the shore where she was beached. Other British destroyers fired warning salvoes of shells from their main guns. Armed boarding-parties went aboard the battleship *Baden* where they managed to restart the diesel generation units, restoring power and lighting, and enabling systematic pumping to start. She was driven ashore and beached in Swanbister Bay in sinking condition.

A British drifter put an armed boarding-party aboard the battleship *Markgraf* to try and stop her flooding. The *Markgraf's* captain, Lt-Cdr Walther Schumann, delayed as long as he could before emerging to meet the boarding party waving a white flag. He refused to obey an order from the boarding-party to have his own men go below and shut off the flood valves or to allow the Royal Navy boarding-party to do so. The British boarding-party attempted to force their way below decks to halt the scuttle. A scuffle broke out in which Schumann was shot through the head and died immediately, and another officer was seriously wounded. But enough had been done to ensure *Markgraf* went to the bottom at 4:45 p.m.

Here and there, small ship's boats full of German sailors rowed through the flotsam, and in each, a sailor held a single white flag. Elsewhere, empty lifeboats rocked in the calm sea. Every now and then, a bubble of trapped air would escape from one of the submerged ships to break the surface and reveal the position of the ship below. British patrol boats moved slowly around, sometimes taking wallowing lifeboats in tow. Of the capital ships, only *Baden* would fail to be sunk.

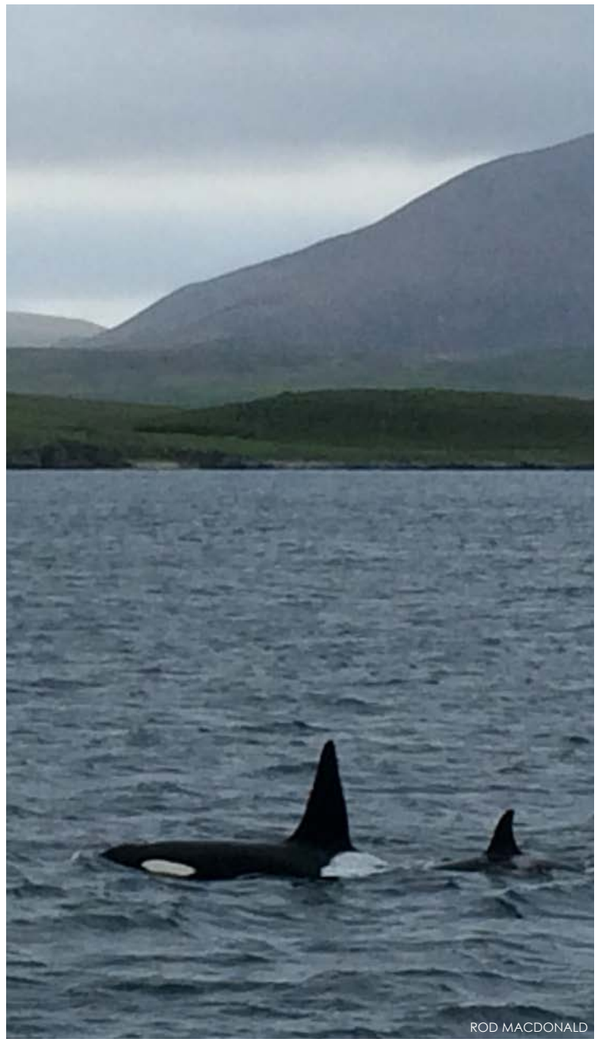
WWI's last German POWs and casualties

The 1,744 now homeless German officers and men were sent to prisoner-of-war camps in the north of England. After seven months incarceration, on 29 January 1920, von Reuter and the remaining POWs were taken by train to Hull, where they boarded the German steamship SS *Lisboa*, which took them home across the North Sea to Wilhelmshaven. They were the last German POWs of World War I to be repatriated—14 months after the rest of the combatants laid down their arms on



Starboard side of *Markgraf*. The bow is to the left.

Rod Macdonald surfaces after a dive on one of the wrecks, with the dive boat MV *Halton* in the background (below); Ready to splash in, on a blustery day in Scapa Flow (right)



Orcas in front of the hills of Hoy

Armistice Day, 11 November 1918.

The 13 German sailors who had been shot that fateful day, 21 June 1919, were the last casualties of the First World War, which ended on 28 June 1919—seven days after the might of the German High Seas Fleet had sunk dramatically to the bottom of Scapa Flow.

Salvage

The majority of the scuttled German warships were raised intact in the coming decades, in a monumental feat of ground-breaking salvage work that would be hard to replicate today. Those ships left, that we dive today, were considered to be in water too deep or to be sitting at difficult angles that made sealing all their openings for lifting by compressed air impractical.

Prolific wreck site

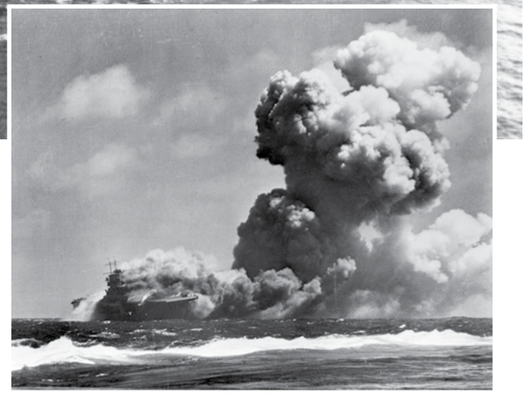
Today, the historical importance of the High Seas Fleet ships that were left, coupled with the many other shipwrecks in the area, make for one of the world's most prolific wreck sites. After all, where else can you dive three German WWI dreadnought battleships and four cruisers all lying in depths suitable for recreational scuba divers?

When you come to dive Scapa Flow, you are immediately struck at what a centre for diving Orkney is. When you step off the ferry from the mainland at Stromness, you will see the harbour packed with rugged but well-equipped dive boats with groups of divers of up to 12 aboard, each fettling over their kit. Racks of scuba cylinders and closed circuit rebreathers of every variety line the kitting up benches on dive decks whilst compressors clatter away, filling tanks for the next day's dive.

Scapa Flow attracts divers from all over the world, but there are so many wrecks that there is never any diver saturation on a particular wreck. Most times, you have the wreck to yourself. It takes years to get to know the German shipwrecks properly, to become familiar with these amazing shipwrecks, and to understand the sense of history that still pervades Scapa Flow both beneath and above the waves. ■

Rod Macdonald is the author of the book, Dive Scapa Flow, *published in 2017 by* ***Whittles Publishing*** *Ltd. Available also on* ***Amazon****.*

US NAVY



The US Navy aircraft carrier USS *Wasp* in May 1942 (above). *Wasp* burning on 15 September 1942, after being torpedoed (right).

Wreck of WWII aircraft carrier USS Wasp found

The aircraft carrier USS *Wasp* was located only a month after discovering another World War II-era shipwreck, the USS *Hornet*, which sank nearby, off the Solomon Islands.

The carrier sits upright in 4,345m (14,255ft) of water, though parts of the hull appear to have split.

The *Wasp* played a pivotal role on multiple fronts during WWII, providing defensive fighter cover for American army planes landing in Iceland and aiding missions to Malta, a location hit daily by German and Italian planes. On her final voyage, *Wasp* was under way in the Coral Sea, escorting transports carrying the Seventh Marine Regiment to reinforce US troops on Guadalcanal, where Japanese forces were pushing back against American efforts to seize the Solomon Islands.

Hit by four torpedoes

On Tuesday, 15 September 1942, US carriers *Wasp* and *Hornet* and battleship *North Carolina,* with 10 other warships, were escorting the transports carrying the 7th Marine Regiment to Guadalcanal, when USS *Wasp* was hit by four Japanese torpedoes from the Japanese submarine I-19.

Explosions ripped through the flight deck forward as *Wasp's* ammunition magazines and aviation gas stores caught fire. Only when assured the *Wasp* had been successfully abandoned did Capt. Forrest P. Sherman leave the burning ship.

Scuttled

USS *Wasp* remained crippled but afloat, and the destroyer USS *Lansdowne* received the order to scuttle her. After three torpedo hits from *Lansdowne,* she went below at 2100 hours. All but one of her 26 airborne aircraft made a safe trip to carrier *Hornet* nearby before *Wasp* sank, but 45 aircraft went down with the ship. One hundred and seventy-six men of the 2,248 aboard perished in the attack. ■ SOURCE: PAULALLEN.COM

Wreck of US WWII B-24 bomber discovered off Bermuda

The remains of a US World War II bomber, which crashed into the sea moments after take-off from Bermuda, has been found by a team from the University of Delaware.

A spokesperson for the Bermuda Institute of Ocean Sciences said the heavily-loaded aircraft had just taken off on what was expected to be a routine ferry flight from Bermuda to Lagens in Portugal when it crashed into Castle Harbour on the northeastern end of Bermuda's main island. Four of the flight's nine crew members were rescued from the sea, and the bodies of two others were recovered, but three more were never found.

Seventeen undergraduate students from the University of Delaware's College of Earth, Ocean and Environment (CEOE) spent winter session at the Bermuda Institute of Ocean Sciences (BIOS). Besides taking classes, the students benefited from hands-on experience using an autonomous underwater vehicle (AUV) and a remotely operated vehicle (ROV).

This active experience led the students to discover parts of the B-24 lying in 50ft of water a few hundred meters from what was the end of a runway during WWII. Before setting out with the AUV to look for the plane, the students investigated reports about the plane crash and weather conditions on the night of the crash. They compared newer maps against older maps and were able to guess coordinates to plug into the AUV for the search.

Since the B-24 was one of the most widely produced planes of WWII this discovery may not be of significant historical significance, but it will help to bring closure to the families of the missing crew members. ■

U.S. AIR FORCE

The Consolidated B-24 Liberator is an American heavy bomber, which was used extensively in World War II. It served in every branch of the American armed forces, as well as several Allied air forces and navies, and saw use in every theater of operations.

(File photo) Additional ancient Greek shipwrecks will soon be made available to the public.

Greece to allow recreational diving on still more wrecks from antiquity

Greece's culture ministry has announced that some of the country's vast heritage of ancient shipwrecks will be accessible to the public for the first time.

Greece's rich underwater heritage has long been hidden from view, off-limits to all but a select few, mainly archaeologists. Now, that seems to be changing, with a new project to create underwater museums.

For many years and until 2004 or so, Greece had largely banned recreational diving except within very few restricted areas, out of concerns that undersea ancient artefacts would be pillaged. But now the country has begun granting access to still more of its rich underwater heritage.

Peristera shipwreck

Near the northern Greek island of Alonissos lies the remains of a massive ancient cargo ship, which will become the first ancient shipwreck to be made accessible to the public in Greece, including to recreational divers.

Significant wreck

The Peristera shipwreck, named for the uninhabited Greek island opposite Alonissos, is the largest ship of its time to have been found, and its discovery was of major significance to historians. Researchers had previously believed a trading vessel of that type did not exist until the Roman era some 400 years later. So when it was discovered 40 years ago, it completely changed our understanding of shipbuilding in the ancient world.

4,000 amphoras

The cargo ship was laden with thousands of amphoras, or vases, probably containing wine, when it sank in the late 5th century B.C. All that survives is the cargo, the exposed parts of the wooden ship having long since rotted away.

The thousands of amphorae and other artifacts created a 25m-long, 10m-wide and 3m-high mound. Only a small part has been excavated, and experts have yet to determine how or why it sank, or what other treasures it might have carried beneath the estimated 4,000 amphoras in its hold. There are indications a fire had broken out on board, but its unclear whether that contributed to its sinking.

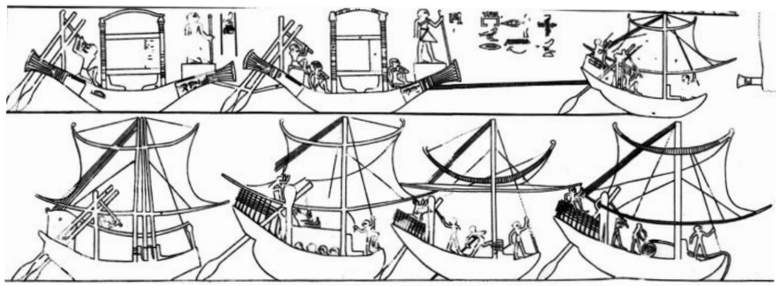
Surprise

"Up to then, we thought that large ships that were carrying 1,500 amphoras and were up to 70 tons, they were built by the Romans in the 1st century B.C.," said Elpida Hadjidaki, the first archaeologist to excavate the site. "Well, now we have a ship that was not built in the first century B.C., it was built in the fifth century B.C., it carried 4,000 amphoras and God knows what else, and it's 126 tons."

Important sea route

The large number of wrecks found around these islands by the Greek Department of Maritime Antiquities indicate that this sea route has been favoured since prehistoric times for trade between Macedonia, Byzantium and the Black Sea.

■ SOURCES: ASSOCIATED PRESS, BULLETIN DE CORRESPONDANCE HELLÉNIQUE



A mysterious river barge that famed Greek historian Herodotus described nearly 2,500 years ago has finally been discovered.

Unique 2,500-year-old wreck found in the Nile

Archaeologists in Egypt have discovered the wreck of an extremely rare vessel, which was described by the Greek chronicler Herodotus about 2,500 years ago.

The ship, known as a *baris*, and its unique method of construction was first described by the Greek historian Herodotus about 450 B.C., who noted how the builders "cut planks two cubits long [around 100cm] and arrange them like bricks". He added: "On the strong and long tenons [pieces of wood] they insert two-cubit planks. When they have built their ship in this way, they stretch beams over them… They obturate the seams from within with papyrus."

But until now there was no actual archaeological evidence of such vessels and as a result, historians have spent centuries arguing over Herodotus' account of the vessels.

The baris would have been used to transport goods and may have also carried troops along the Nile. The barge is one of more than 70 wrecks found in what is described by experts from the European Institute for Underwater Archaeology (IEASM) as the world's largest "graveyard of ancient ships."

The ship found, known as "Ship 17," measures up to 28m in length. It was constructed using an unusual technique to join thick wooden planks together, and had a distinctive steering mechanism with an axial rudder passing through the hull.

According to Herodotus, the rudder passed through the keel of the boat. The axial rudder was known in Egypt from the 6th Dynasty (c. 2323–2150 B.C.) and can be traced through representations and models till the end of the Pharaonic period and beyond; however, no archaeological evidence for this type of rudder had ever been found.

Herodotus was right

"It wasn't until we discovered this wreck that we realised Herodotus was right," Damian Robinson, the director of Oxford University's Centre for Maritime Archaeology, told *The Guardian*. "What Herodotus described was what we were looking at." ■ SOURCES: THE GUARDIAN, INTERNATIONAL JOURNAL OF NAUTICAL ARCHAEOLOGY

wreck rap

Astrolabe discovered in 516-year-old Portuguese wreck off Oman

While searching for shipwreck remains near Oman in the Arabian Sea in 2014, divers discovered an unusual metal disk that has since proven to be the world's oldest known mariner's astrolabe, British researchers report.

Guinness World Records have independently certified an astrolabe excavated from the wreck site of a Portuguese Armada Ship that was part of Vasco da Gama's second voyage to India in 1502-1503 as the oldest in the world, and have separately certified a ship's bell (dated 1498) recovered from the same wreck site also as the oldest in the world.

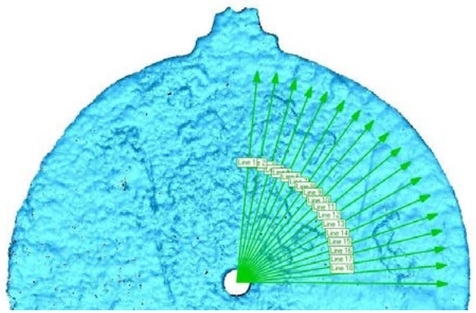
Astrolabes are considered to be the rarest and most prized of artefacts to be found on ancient shipwrecks—only 108 have been recovered by archaeologists.

The astrolabe in question was located during an excavation of the wreck of the *Esmerelda* in 2014. The vessel was part of an expedition to subdue local merchants along India's Malabar Coast undertaken by Da Gama in 1502, several years after the Portuguese explorer had successfully pioneered a trade route around the tip of Africa to India in 1497.

The artefacts were discovered by David Mearns of Blue Water Recoveries, the oceanographer who in 2001 located the wreck of the Second World War Royal Navy battleship HMS *Hood*, and *Bismark*—the German ship, which sunk it.

"Without the laser scanning work performed by WMG [Warwick] we would never have known that the scale marks, which were invisible to the naked eye, existed," he said. ■

SOURCES: WARWICK UNIVERSITY, INTERNATIONAL JOURNAL OF NAUTICAL ARCHAEOLOGY



A metal disk found at a shipwreck site near Oman is the oldest known mariner's astrolabe, a device for navigating at sea.

Bronze Age shipwreck discovered off Turkey could be the world's oldest

A 3,600-year-old shipwreck has been discovered off the shores of southern Turkey's Antalya Province, the provincial governor's office has announced. The shipwreck, found by the Akdeniz University (AU) Underwater Research Centre teams, is reported to be the oldest in the world.

The 14m-long shipwreck was found at a depth of 50m, with 1.5 tons of copper bullion inside of it. The typology of the ingots shows that it is a merchant ship of the 16th century B.C. "This discovery is the Göbeklitepe of underwater archaeology," said Antalya Governor Münir Karaloglu, referring to the earliest known temple found in Turkey's southeast.

Associate professor Hakan Öniz and director of Akdeniz University's Underwater Research Centre speculated that the ship was probably caught in a storm on its way from the island of Cyprus to an Aegean region 3,600 years ago. ■

The Scourge of Wooden Wrecks

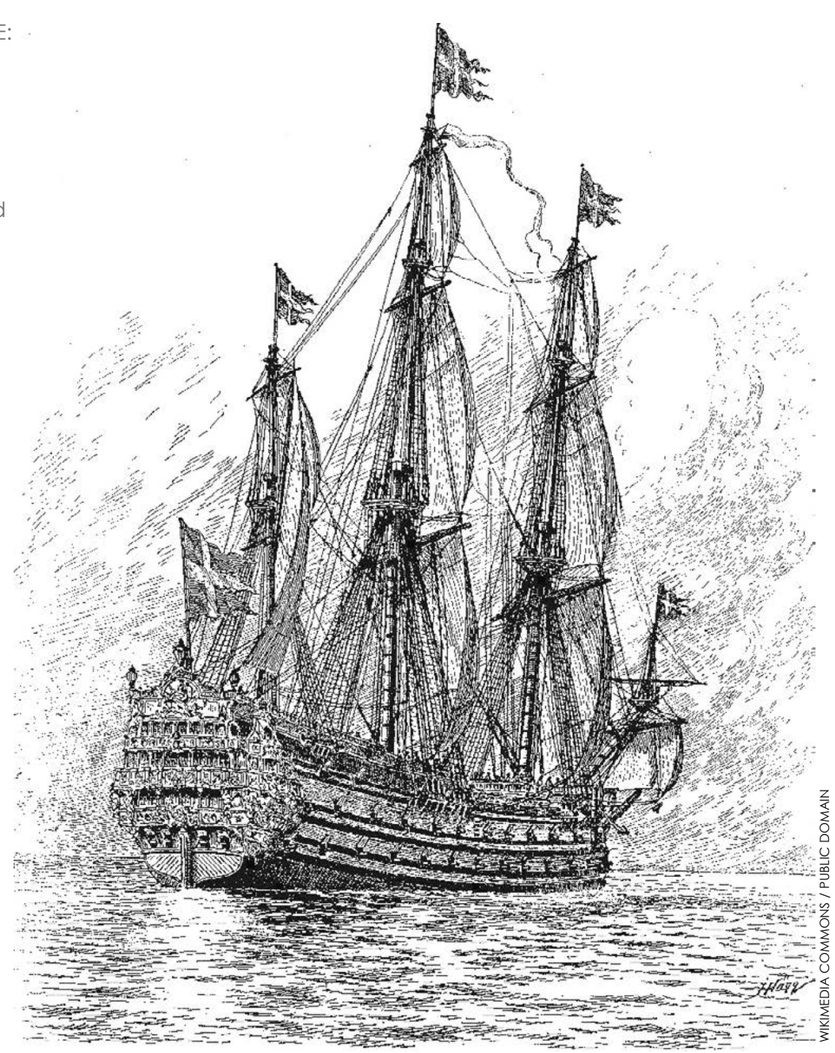
Shipworm

Is Really a Mussel

Text and photos
by Christian Skauge

wreck rap

PREVIOUS PAGE: Diver on a wooden wreck in the Baltic Sea; Shipworm holes bored into a piece of wood salvaged from the sea (inset)



WIKIMEDIA COMMONS / PUBLIC DOMAIN

Historical illustration by Jacob Hägg (1839-1931) of the 17th century wooden Swedish ship of the line HMS *Stora Kronan*

Shipworm holes (above and right) in a salvaged piece of wood. The *Teredo navalis* species of shipworm usually grows up to 30cm long, but has been known to reach up to 60cm in length and 1-2cm in diameter.

Have you ever wondered why some bodies of water, such as the Baltic, have so many wooden wrecks in great condition while other areas have almost no wooden wrecks at all? It has something to do with salinity; however, it is not the salt in seawater that consumes the wrecks but a mussel, which somewhat confusingly is called a worm—and it only lives in saltwater.

In fact, shipworms are not worms at all, but rather a group of unusual saltwater clams with long, soft, naked bodies. Sometimes called "termites of the sea," or pileworm, the shipworm is a group of approximately 65 species of marine bivalve mollusks, which are responsible and notorious for boring into and eventually destroying wood that is immersed in seawater—and not just wrecks but also piers, dykes, bulwarks and other submerged wooden structures. Even today, when most ship hulls are made of steel and leisure boats of glass fiber, these mollusks continue to be a major cause of damage to infrastructure worth billions.

During the Age of Sail (from the mid-16th to the mid-19th century), ships' wooden hulls were under continuous attack by shipworm, which posed a significant problem for shipping. Many different methods were tried in order to protect ships against being eaten by shipworm, and in the late 1750s, the British Royal Navy conducted the first experiments with copper sheathing in which copper plates were affixed to the outside of the hull. The copper performed very well, both in protecting the hull from worm invasion and in preventing weed growth.

The best known species, *Teredo navalis*, is found in both temperate and tropical seas and oceans worldwide. It may have originated in the northeast Atlantic Ocean, but it is difficult to establish where it originally came from because it has spread so efficiently around the world on debris and the hulls of ships.

The shipworm's body is cylindrical, slender, naked and superficially vermiform, meaning "worm-shaped." It lives in a burrow (in wood or clay), which it rasps out with its small trilobed shells and lines with a calcareous secretion. When shipworms bore into submerged wood, they digest the exposed cellulose in the fine particles created by the excavation in a special organ called the gland of Deshayes.

Up to 60cm long

Shipworms have a pelagic larval stage when they drift freely in the water before they attach to wood and undergo a metamorphosis. In the beginning, the shipworm is small and only makes millimeter-sized holes in the wood,

Shipworms dig burrows into wood and line them with a thin layer of lime, which remains even after the animals die.

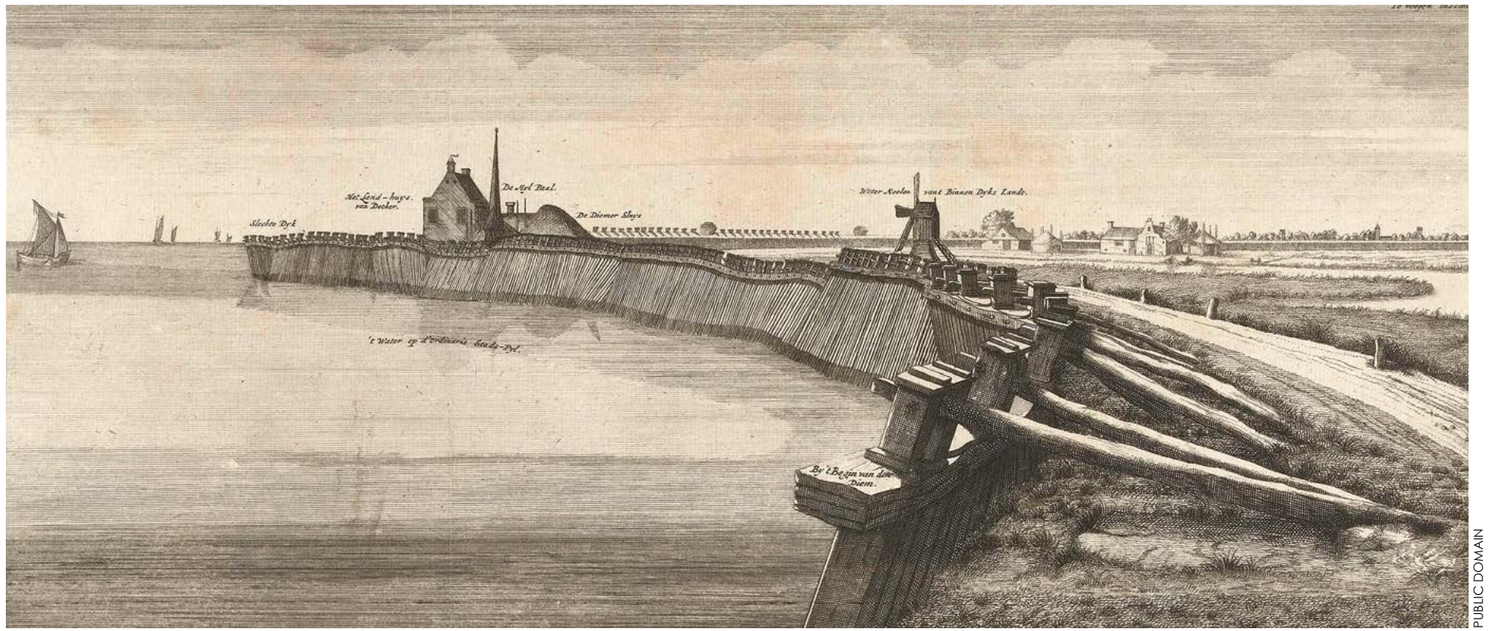
but when it grows, the burrows can become several centimeters wide. *Teredo navalis* normally grows up to 30cm long, but specimens of a full 60cm in length and 1 to 2cm in diameter have been observed in Danish waters. The lifespan of a shipworm is two to three years, and it lives all its adult life inside wood at depths where it is available. It can therefore be found from the surface down to significant depths.

The inside of the burrows it digs in the wood is clad with a thin lime layer, and this remains even after the animal itself is dead. The lime layer provides protection against the environment, just like a shell, and the passage is sealed at the end with a plug called the septum. In the plug, there is a small hole where the shell's breath or siphon can be inserted to breathe in freshwater. The siphons can be quickly withdrawn in case of danger, and are protected under a pair of 0.5cm long, lime-like tentacles.

Clever adaptation

Shipworms can survive in water temperatures of up to 30°C, but grow little if in waters warmer than 25°C. It can live in waters with a salinity of 5 to 45ppm (parts per million), but thrives best waters with normal salinity of 33 to 37ppm. A salinity of less than 5ppm is lethal to the larvae, and if salinity drops below 20ppm, the shipworm does poorly. Wrecks that are found in sea areas with these conditions are therefore usually left in peace. At the bottom of the Baltic Sea in the Gulf of Bothnia and the Gulf of Finland, there is a salt content of only 2 to 7ppm, and the wrecks found there are often incredibly

Shipworms include around 65 species of marine bivalve mollusks, of which *Teredo navalis* is the best known.



Historical illustration from 1705 of a wooden dike in the Netherlands. Shipworm attacked the wooden dikes in the 18th century causing massive damage, threatening to flood large parts of the country. This led to the replacement of all wooden dikes with stone dikes along the entire North Sea coast; A specimen of shipworm (left)

PUBLIC DOMAIN

USGS / WIKIMEDIA COMMONS / PUBLIC DOMAIN

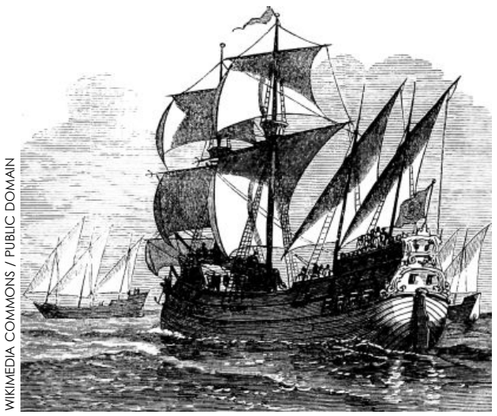
The termite of the sea

The shipworm is often called the "termite of the sea" and is notorious for digging times in piers, wooden boats and other wooden structures in the water. Thanks to a symbiosis with special bacteria, the shipworm is able to digest cellulose, and thus it can feed on wood.

Shipworm is perhaps the worst invasive species of all time and is responsible for enormous destruction. In the 1800s, wooden ships could be eaten to pieces in as short a time as eight years, and the shipworm was a serious limiting factor for shipping. Many different methods were used to defend against the attacks, and one of the most common was to dress the hull with copper plates on the outside. The ships of Christopher Columbus were among the first to use this protection.

Nowadays, with steel ships and concrete wharfs, the problem is less, but still present.

Shipworm can survive for periods of up to six weeks without oxygen, by not eating and living on stored glucose in the body. This allows it to survive within the wood of a ship visiting waters that would normally not provide good survival conditions for the shipworm.



WIKIMEDIA COMMONS / PUBLIC DOMAIN

Historical illustration from 1880 of Christopher Columbus' ships: the *Niña*, the *Pinta*, and the largest, the *Santa Maria*, in the foreground

Enormous destruction

When the shipworm was introduced to the western coast of the United States by visiting sailing ships in 1913, it led to a serious invasion, which in 1919 to 1921 destroyed an unknown number of wharfs, piers, docks and other wooden structures in the port of San Francisco. Calculations estimated the damage to be somewhere between US$2 and US$20 billion in today's currency.

As recently as 1946, damage by shipworm on ships and port facilities in the United States alone was estimated at US$55 million a year.

Most devastating was perhaps the massive attack on the Dutch dikes of the 18th century. The ravages of shipworm threatened to break down the dikes and put large parts of the Netherlands under water. A commission called the shipworms a "terrible plague," which led to the wooden dikes being replaced with dikes of stone along the entire North Sea coast.

For divers who love diving on wrecks, the shipworm is an "enemy," which eats up cherished wooden shipwrecks. But the shipworm also has an important ecological function in tropical areas that have a lot of mangroves. Here, it helps to break down large amounts of organic matter faster. However, in the Western world, the shipworm is first seen as a pest.

Cosmopolitan

The shipworm has been transported by ship around the world for so many hundreds of years that the original site of its propagation is no longer known. Some believe it originally came from Europe, but there is also a theory that it originated in Southeast Asia.

In the Philippines, the shipworm is called *tamilok*, and is considered a delicacy. They eat it raw with vinegar or lime juice, chopped chili and onion. The taste has been compared to everything from milk to oysters. The use of it as food in this region supports the theory that it has its origin here, but the fact that it thrives best in water colder than 25°C points to Europe as its origin.

Regardless of where the shipworm originally comes from, it is reasonable to say that it has been introduced to both coasts of the North American continent, and the first shipworm was reported on a visiting wooden ship in Massachusetts in 1839. Within a hundred hundred years, the species was common all the way from Nova Scotia to the Caribbean. Nowadays, shipworm is widespread in both tropical and temperate waters around the world.

J. LINDSTRÖM / STATENS MARITIMA MUSEER / CC BY 3.0

Wooden planks of the Dalarö wreck site in Sweden are still intact.

In Norway in the 18th century

In my home country of Norway, the shipworm must have been observed for the first time in the 1700s, while it first came to Kattegat (an area of sea between Denmark and Sweden) in the 1800s. It was first described by the

Swedish botanist and zoologist Carl von Linné in 1758. Today, the species is listed on the Norwegian blacklist of alien and unwanted species in Norwegian waters.

None in the Baltic Sea

Thanks to the low salinity in the central and northern parts of the Baltic Sea, this sea area provides the best conditions for the preservation of the wooden wrecks, because the shipworm is not found here. Finds like the *Vasa*, *Kronan* and Dalarö wrecks and several other well-preserved ships from the 16th and 17th century show clear evidence of this. In fact, despite many efforts, humans have not yet come up with a better method of preserving wood than hiding it in the Baltic Sea and letting nature take its course.

In the open waters of the Baltic Sea, the salinity is also low, at 10 to 16ppm. In the outflow of Øresund (the strait between Denmark and Sweden), the salinity rises to 20 to 23ppm, and here the shipworm has recently established itself, as we will see later.

Despite the fact that shipworm has traditionally not thrived in the Baltic Sea, since 2000, more and more discoveries have been made of infested timber in the southern parts of the sea. Since earlier times, it has been known that the shipworm has multiplied every two to three years along the German Baltic Sea coast, but now it has been reported that over a hundred wooden wrecks are infected by shipworm from the inlet of the Baltic Sea and east to the island of Rügen.

Salinity or temperature?

It is not known what has caused the shipworm to have established itself in this area, and both changes in salinity and the shipworm's adaptability have been mentioned as possible factors. Other theories propose that the shipworm may have come with the ballast water in ships, or is introduced through Øresund with saltwater in connection with storms. It is also speculated that it may not actually be the salinity that is the determining factor for shipworm propagation, but rather, it is temperature.

It is known that shipworms do not thrive in waters that are too cold, an example of which includes the northern parts of the Norwegian coast. In Finnmark, which is located in Arctic waters, the shipworm is rare or not present at all.

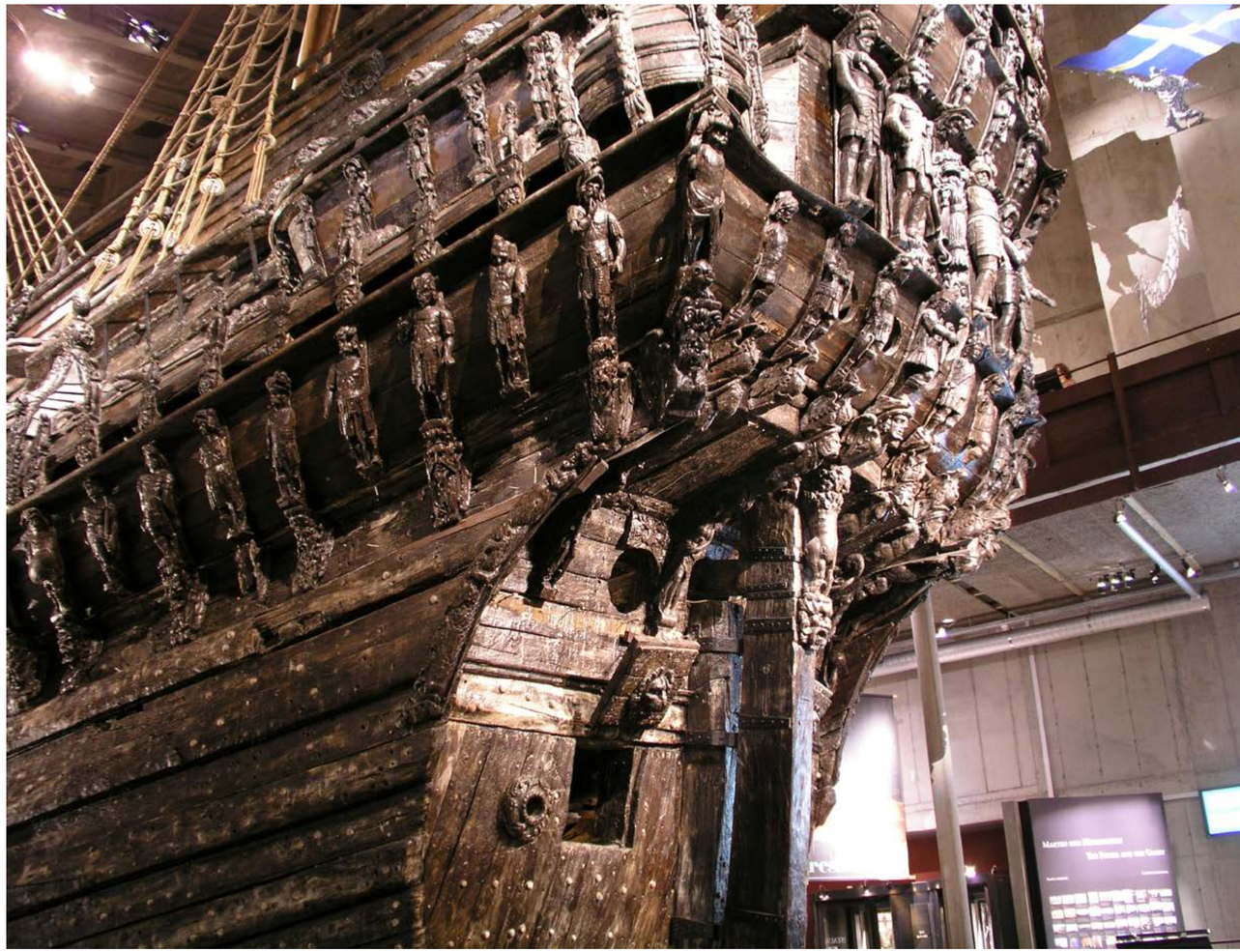
German scientists are now investigating whether a combination of warmer summers with higher sea temperatures, milder winters, and a greater supply of nutrients from agricultural runoff may have led to the shipworm being able to establish itself in the southern area of the Baltic Sea.

Global warming threat?

If the German researchers are right in their assumptions, this means that only a slight increase in temperature (and hence the salinity, due to greater evaporation) will give the shipworm better opportunities to survive. The environment in the Baltic Sea can thus be severely threatened with global warming, and many marine archaeologists (and divers) fear that the shipworm in time will invade the whole of the Baltic Sea and destroy the many amazing treasures found here. ■

Christian Skauge is an award-winning underwater photographer based in Oslo, Norway, and is the owner and editor of the Norwegian dive magazine, Dykking. He is particularly interested in photographing macro life, but also enjoys wide-angle wreck photography. For more information, please visit: ***Scubapixel.com****.*

SOURCE: WIKEPEDIA.ORG



THIS PAGE: *Vasa* is a wooden Swedish warship built between 1626 and 1628, housed in the Vasa Museum in Stockholm.

Komodo Island rumoured to close to tourists for one year in 2020

Reports of rampant smuggling of endangered Komodo dragons have compelled Indonesian authorities to close Komodo to tourists for a year, according to local media reports. Dive operators dispelled the information as just rumours so far and no closures affecting dive activities have been announced.

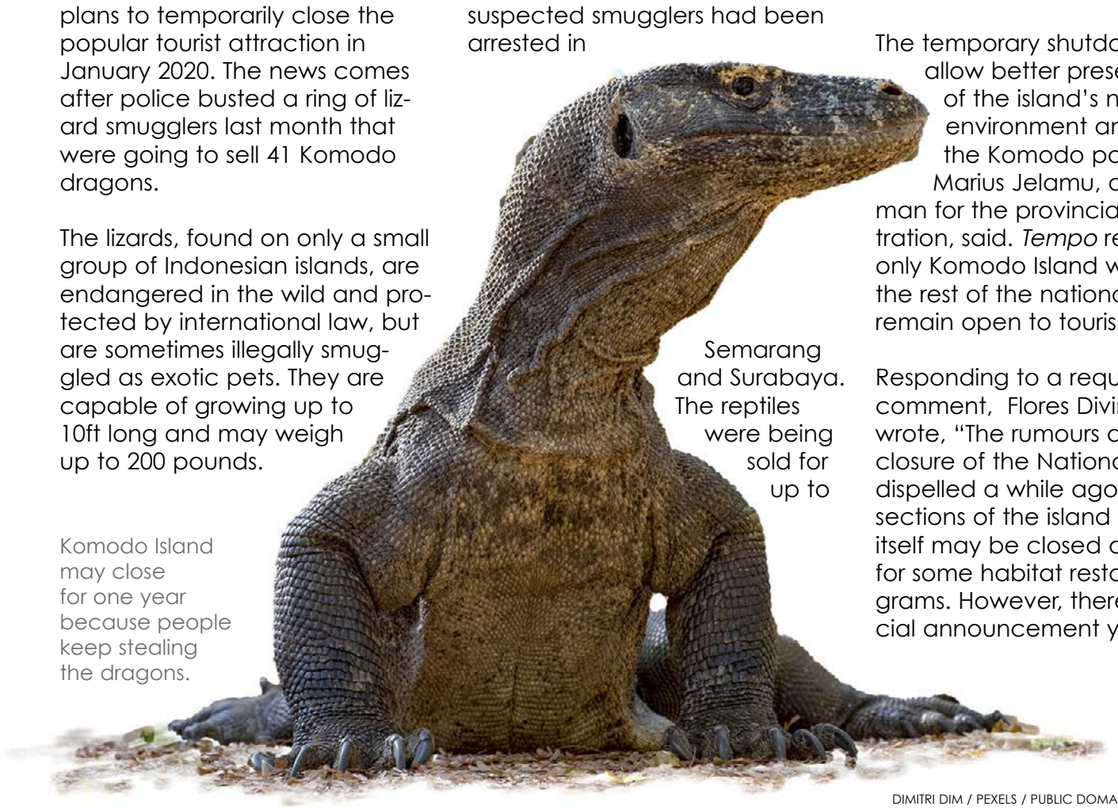
According to Indonesia's *Tempo* newspaper, the government plans to temporarily close the popular tourist attraction in January 2020. The news comes after police busted a ring of lizard smugglers last month that were going to sell 41 Komodo dragons.

The lizards, found on only a small group of Indonesian islands, are endangered in the wild and protected by international law, but are sometimes illegally smuggled as exotic pets. They are capable of growing up to 10ft long and may weigh up to 200 pounds.

According to the BBC, a police spokesman in East Java said five suspected smugglers had been arrested in Semarang and Surabaya. The reptiles were being sold for up to US$1,400 (GB£1,000) each, officials said.

The temporary shutdown will allow better preservation of the island's nature and environment and increase the Komodo population, Marius Jelamu, a spokesman for the provincial administration, said. *Tempo* reported that only Komodo Island will close; the rest of the national park will remain open to tourism.

Responding to a request for comment, Flores Diving Center wrote, "The rumours about the closure of the National Park were dispelled a while ago, though sections of the island of Komodo itself may be closed off in 2020 for some habitat restoration programs. However, there is no official announcement yet." ■



Komodo Island may close for one year because people keep stealing the dragons.

DIMITRI DIM / PEXELS / PUBLIC DOMAIN

US restricts travel to Cuba as part of a new policy

Travel to Cuba for reasons other than family visits will be limited, in an effort to restrict travel deemed as "veiled tourism," said a high-ranking official who spoke to the *Miami Herald* on condition of anonymity. That could signal the end of cruises, which started to operate during the Obama years because of an expansion of the categories of travel allowed.

The re-tightened restrictions also could impact air travel because of a reduction of passengers. US law currently allows only 12 categories of travel, among them educational visits, to promote people-to-people contacts and for professional and research work. ■ SOURCE: MIAMI HERALD

STEVE SIMPSON / FLICKR / CC BY 2.0

Hyperbaric facility to reopen

Isle of Man's facility, which came into service in 1984 and was closed in June 2018, is set to reopen before the end of the year under new ownership.

From 31 March 2019, the Hyperbaric Medicine Facility on the Isle of Man is operated by a new charity in the name of HBOT IOM. The charity hopes to raise GB£400,000 to replace the old chambers, which were both closed after faults were discovered.

The facility's website states, "The site is under construction and will be developed and be updated as per media releases and as services are reestablished." ■ SOURCES: HBOT, BBC

Are your bags going to fit?

Measure your luggage with an app

The size allowance for carry-on bags differs from airline to airline and sometimes even change with little or no notice, mostly becoming more restrictive. Keeping track of all the different rules can be a real headache.

Various new apps use augmented reality technology to quickly scan your carry-on bag, determine its dimensions and verify if you will be able to take it in the cabin with you or if it will have to be checked in, depending on the airline company. Some apps also compare the checked baggage fee policies of all the airlines they track, so you can make sure you meet the exact measurements of whatever carrier you are flying with. ■

A submerged jumbo jet is to be the centrepiece of what is claimed will be the world's largest underwater theme park off the coast of Bahrain.

Jumbo jet to become artificial reef in Bahrain

Bahrain is in the process of building the world's largest underwater theme park, which will ultimately cover 25 acres, and developers plan to submerge a Boeing 747. The site is set to open by this summer.

Along with the jet aircraft, the underwater theme park will also feature a replica of a traditional Bahraini pearl merchant's house along with other artificial coral reefs and structures. The incorporation of a replica pearl merchant's house is a nod to the kingdom's plentiful oyster population and, flowing from that, its pearl diving history.

The decommissioned plane is already in Bahrain and is being prepared to take its place under the sea.

The 70-meter-long plane will be subjected to a high-pressure wash with eco-friendly detergents to ensure all post-production coatings, oil and grime are removed. The airliner is expected to be the largest ever to be submerged, the Abu Dhabi-based newspaper *The National* reported.

The Bahrain Tourism and Exhibitions Authority said, "Fully decontaminated from toxic substances, every effort has been taken to limit the project's environmental footprint and to ensure delivery in the most environmentally sound manner."

The Gulf nation hopes the underwater theme park will further its reputation as a "distinct tourist destination, enhancing its presence on the global tourism stage and international diving scene." ■

Sunset Divers has a new boat, and more are on the way

Sunset Divers—Grand Cayman's longest-running dive operation—has announced that it is revamping its fleet. After 60 years of diesels and v-hulls, the renowned Caribbean dive centre is moving to custom-built catamarans and outboards.

The first Aventura 36 catamaran—*Eagle Ray*—was delivered just before Christmas. Mike Pinnington, General Manager at Sunset House stated, "...this new fast catamaran has twin 250hp outboard engines, so she can easily do 30 knots. It has meant that we have been able to cut down on our transit times and extend our range of dive sites.

"Our guests have commented on the fact that *Eagle Ray* is a quiet boat. It is a real pleasure not having to shout over noisy diesels.

"We recognise that in the main dive instructors are not trained on how to maintain boat engines, therefore we have a dedicated technical manager on the staff. When you have a fleet of six boats, you also have a lot of engine husbandry to ensure that the boats run smoothly." ■

Timor-Leste

— *Off the Beaten Path*

Text and photos by
Brandi Mueller

View from the Cristo Rei of Dili monument in Timor-Leste (above). PREVIOUS PAGE: Anthias, damselfish and anemonefish with staghorn, leather and brain corals

After climbing over 500 stairs, one can visit the seventh tallest Jesus statue on earth, Cristo Rei of Dili.

Admittedly, I knew almost nothing about Timor-Leste until I started seeing a lot of great underwater images online of the diving that could be found there. I became curious and started following a local dive operator's Instagram feed, watching them post daily photos of cuttlefish, nudibranchs, peacock mantis shrimp and beautiful reefscapes. Where was this place and how did I not know about it?

Other research on the Internet did not give Timor-Leste's dive secrets away. Located within the Coral Triangle, which contains the most marine biodiversity on the planet, it was boasted to be some of the most pristine diving left on earth—an untouched area and mostly not dived. But there were so few dive reports or pictures; it seemed like few people were diving there, or even going into the country. I wanted to find out about this off-the-beaten-path destination and experience it for myself.

Where is Timor-Leste?

In the weeks leading up to my trip, anytime I said I was headed to Timor-Leste, I was greeted to blank faces and the question of, "Where is that?" Initially, all I knew was that it was somewhere in the vicinity of the islands of Indonesia (but was its own country).

Northwest of Darwin, Australia, the island of Timor hosts two countries. Timor-Leste is mostly situated on the eastern side of the island, and to the west, is the Indonesian province of East Nusa Tenggara. Often, the Indonesian side of the island is called West Timor, but there is also a small enclave of Timor-Leste within the Indonesia side of the island, which is also often called West Timor. Confused yet?

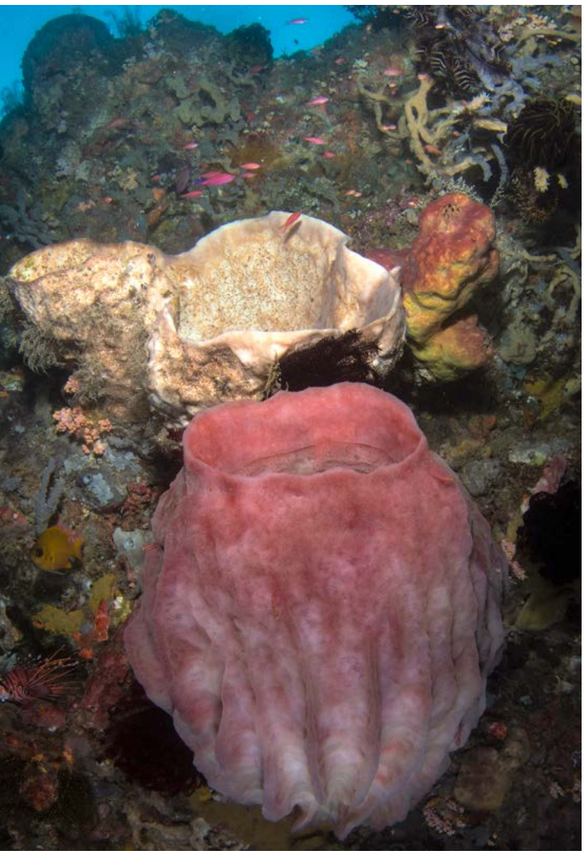
What is now Timor-Leste used to be called (and is sometimes still referred to as) East Timor. Timor means "east" in Bahasa Indonesian, so the name translates to "East East." Now officially named Timor-Leste, "Leste" translates to "east" in Portuguese. The Tetum (local language) version is Timur Lorosa'e (which it is also sometimes called) and "Lorosa'e" means "east" in Tetum. So, no matter how or in what language you say it, the country is "East East." The longer, most official name is the Democratic Republic of Timor-Leste.

Brutal past

One cannot discuss the current state of this country without remembering the brutal, not-so-long-ago, past. Colonized by

Pink anemonefish

A healthy reef with many different types of corals and sponges



Large barrel sponges on reef

the Portuguese in the 16th century, it was a colony of Portugal until 1975 (except for a short while when the Japanese took over during WWII). After the Carnation Revolution in Portugal, the Portuguese began withdrawing from its colonies, included East Timor. In 1975, as the Portuguese left, there was a revolution for independence won by a party known as the Fretilin. This lasted for nine days before Indonesia launched an invasion backed by American, Australian and British support. Provided with weapons, Indonesia easily took the province as its own.

For 25 violent years, Indonesia occupied East Timor with an estimated 45 percent of the population being killed in genocide, as well as from lack of resources resulting in death from diseases and malnutrition. Guerrilla forces fought back against Indonesia throughout that time, but the country was essentially kept silent about what was happening within it until 1991 when the world saw reports of the Dili Massacre. This demonstration against Indonesian occupiers started off peacefully and ended with over 250 demonstrators killed in the Santa Cruz cemetery. Journalists broadcast the events, showing the rest of the world what was happening in this small country.

Finally, in 1999, after Indonesian President Suharto resigned, the United Nations was able to take over East Timor though the United Nations Transitional Administration in East Timor. The year 2001 saw the first election, and the new constitution was approved in 2002, which was also when it was recognized as inde-

Lionfish on reef (above); Pregnant male seahorse (right)

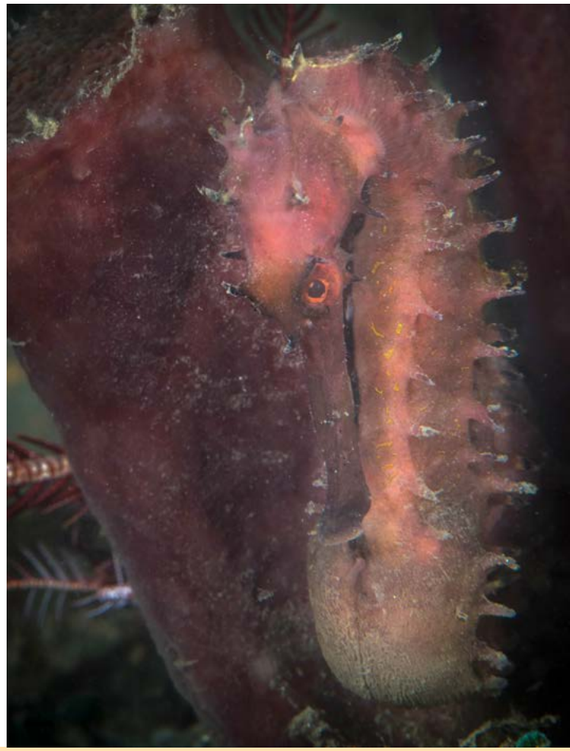
pendent by the UN. The UN ended its peacekeeping mission in 2012. With the revolution behind them and gaining their much-deserved independence, the country today seems to be one on the upturn.

Dili

While my direct flight from Bali to Timor-Leste's capital city of Dili was on time (and less than two hours flight time), my previous flights from North Sulawesi to Bali had been such a mess of flight delays and missed connections, I just barely made the flight to Dili. I arrived in a traveler's daze of exhaustion and disorientation, but soon found myself at Dive Timor Lorosae and its on-site accommodations.

The dive center offers several lodging options to suit all types of travelers, including backpacker-dorm-style rooms, a guesthouse with several rooms to rent with shared facilities, as well as studio apartments. I stayed in one of the spacious, well-furnished studio apartments, and it was great. There was a small grocery store just down the road, so I was able to get the basics and make myself breakfast in the morning as well as a few lunches. It was nice to have this option, and it gave my stay a bit of a homey feel, which was really nice.

There are not a lot of accommodation options in Dili (or the rest of the country) as tourism has not yet taken off, and Dive Timor Lorosae is rated as one of the best places to stay. There is a hotel in town, but it seems like more guesthouses and small hotels are popping up, which is a good sign, suggesting tourism is increasing.



THIS PAGE: Woven mats were laid out for divers to prepare their gear—a brilliant way to keep sand off the equipment; The dive center's van drove right up to the surf for a beach dive (right); Fishing boat on the beach (below); Curious children stopped by to watch divers prepare their equipment and enter the water (lower left)

Diving

After going to sleep quite early, I woke up refreshed from my travels and ready to dive. I became aware quite quickly that it was the rainy season and probably not the best time of the year to dive here, but that meant it was also the slow season and I was the only diver at the dive center for most of the week. With my private dive guide (the perks of being the only diver) and our driver, we loaded up a van with tanks and gear, and set off east of Dili along the coast.

Being no stranger to the bad roads of the third world, the roads outside of Dili were some of the worst I had ever seen. We bumped and jolted along the unpaved, pot-holed road, often with sheer cliffs (and no guard rails) on our right side and occasionally slammed to a stop, dodging children, motorbikes and livestock. The question, "Where am I?" rolled through my mind more than once.

But after about 90 minutes and both the inside and outside of the van being covered in dust, we arrived at an entirely empty beach, and the driver backed up and parked just a few feet from where the waves were breaking the shore. Two woven mats were laid out in the sand,

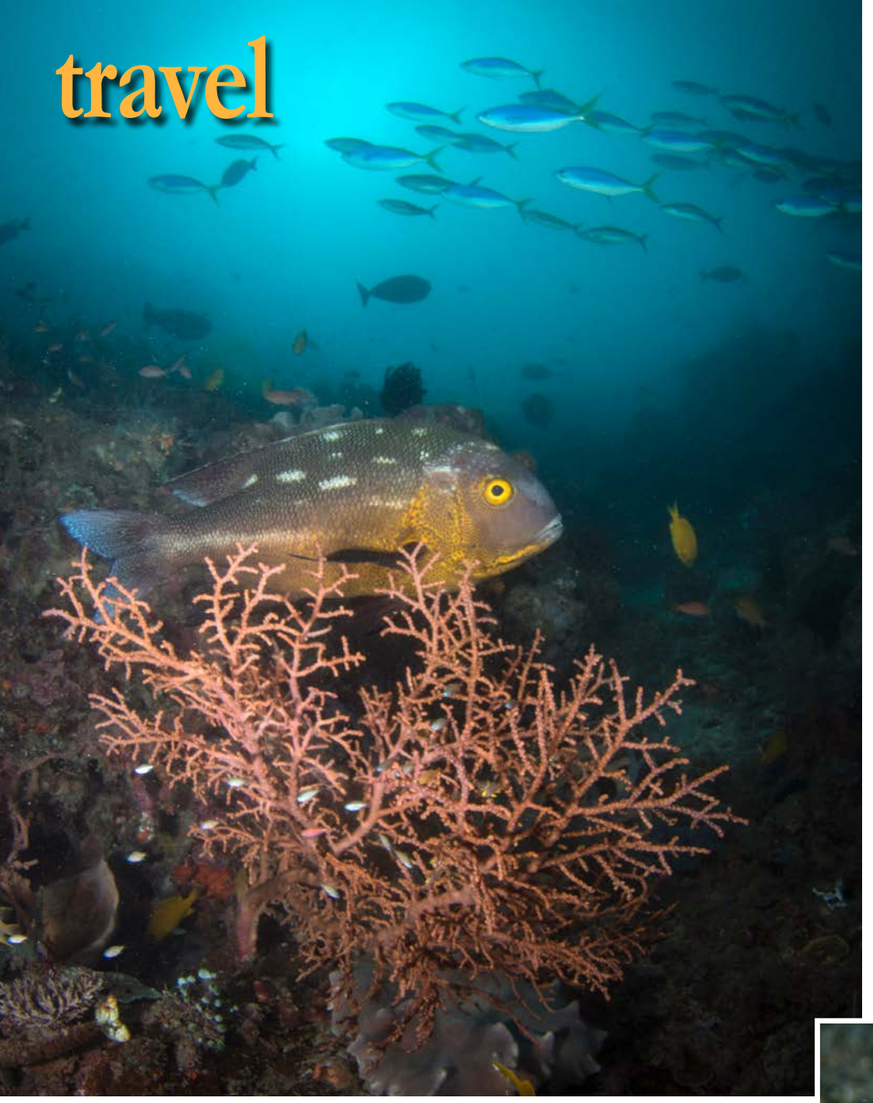
and we assembled our gear on the mats (what a brilliant way to try to keep the sand off everything).

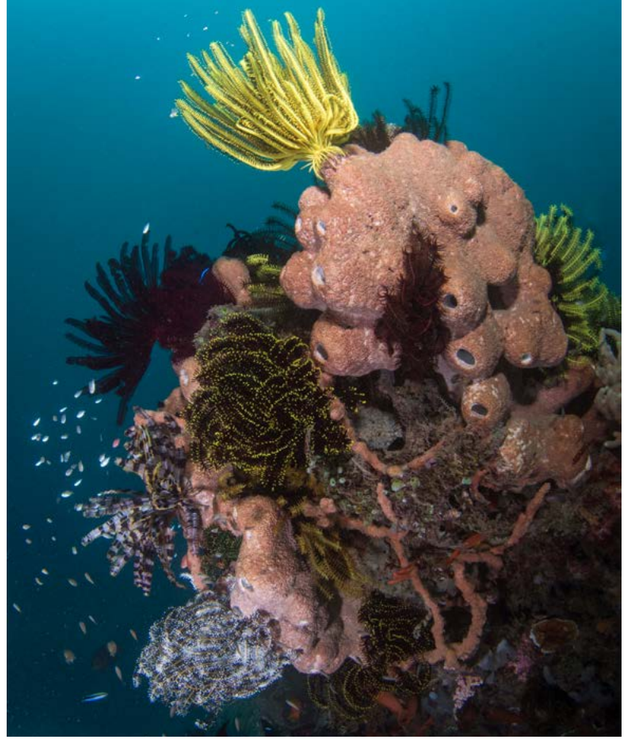
The driver helped us into our gear, and we walked right into the waves. The bottom quickly sloped downward, and not far from shore, it dropped off into a mini-wall on either side. I had been warned there might be some current and that we would decide which way to go based on those conditions. But there was no current, so we went in the direction my dive guide said was his favorite.

The seasonal rain and wind contributed to poor visibility, but even with only about 10m of viz, the reef was nothing short of glorious. It really did look untouched, with many different species of coral growing like a beautiful garden of color and variety. And the fish were huge! I was shocked by moorish idols as big as dinner plates and a midnight snapper that was probably two feet long.

We swam past a gorgonian sea fan that was over 12ft across, and I saw my guide stop to look for pygmy seahorses. I thought to myself, "The fan is too big—there's no chance of finding this fingernail-sized seahorse on such a big fan." Huge barrel sponges and other sea fans all seemed to be super-sized and covered in many colored crinoids.

The reef looked very different from many other beautiful reefs I had seen within the Coral Triangle and around the Indonesian islands. Trying to put my finger





CLOCKWISE FROM LEFT: Midnight snapper and sea fan on reef; Crinoids in many different colors on sponge; "Shawn the Sheep" nudibranchs; Pikachu nudibranch; Napoleon snake eel

on what was different, it dawned on me: The difference was there were very few divers. It may be just my personal assumption, but with no people to accidently kick and damage the reef—especially in the high numbers popular locations like Komodo and Raja Ampat see—I wondered if this was what all the reefs would look like without divers.

We did three shore dives in the eastern coastal dive area, and they were all lovely. Heading back towards Dili on the bumpy road, I was excited for the rest of my week diving Timor-Leste.

Dining

Just upstairs from the dive center is the very popular Castaways restaurant and bar known for its western cuisine and expat patrons. I enjoyed a few meals there during the week and also headed next door to Osteria, an Italian restaurant with excellent pizzas, as well as Arriba, a Mexican restaurant. A bit farther away, there was a popular Chinese restaurant. In Timor Plaza, the small shopping center in Dili, there was Thai food, Indian cuisine and several fast food options.

While walking around the waterfront area in front of the dive center, just a five-minute walk away, I found a small coffee shop, Letefoho Specialty Coffee Roaster, serving locally grown and roasted coffee. Coffee is the second largest export for Timor-Leste, and you can find it in many Starbucks blends. As someone who quite enjoys coffee, I made this little spot a daily afternoon stop to chase away the post-dive sleepiness.

Muck diving

The weather turned against me on day two with more wind and rain, so we decided to stay closer to Dili and check out Tasi Tolu, which is known for having excellent black-sand muck diving.

Tasi Tolu. The sandy beach made for a slightly easier entry than the rocks on the western coastal dive sites, and with there being larger waves, this was a good thing. Visibility was not very good, but it did not matter, because we were critter hunting—and we did not have to look too hard. The list of critters we found is too long to name in its entirety, but we found a Napoleon snake eel, Pikachu nudibranchs, a beautiful purple seahorse, frogfish and more "Shawn the Sheep" nudibranchs (*Costasiella kuroshimae*) than I have seen in all my previous muck dives combined.

Dili Rock. Our second dive was at Dili Rock, which had a nice reef and lots of the muck critters. Leaf scorpionfish seemed to be everywhere, and an orange mantis shrimp peered out at us from its hole in the sand. We found several teeny-tiny juvenile yellow box-

Juvenile yellow boxfish (above); Leaf scorpionfish (top left); Frogfish on sponge with crinoids (left)

School of striped catfish (above); A pink leaf scorpionfish (top left) tries to hide behind coral, but its bright color gives it away.

fish darting about the reef and a school of small striped catfish.

One little area around 20m (60ft) was bursting with life. Anemones, sea fans, black coral and barrel sponges were home to quite the busy marine community. Perched within the branches of the black coral were two leaf scorpionfish. False clownfish, porcelain crabs and cleaner shrimp filled up the anemone, and there was an orangutan crab as well as several nudibranchs nearby. Not bad for a day we thought might be lost to bad weather.

In the next few days, we came back to the same beach and dived Dili Rock and Tasi Tolu as well as the areas around it, because it was our best option due to high winds, which created rough surf entries. The diving was still very good. One of my favorite aspects of diving here was how the local kids would stand around us as we assembled our dive gear, and they would walk into the water with us (and be splashing around when we came back). It was fun to have an audience.

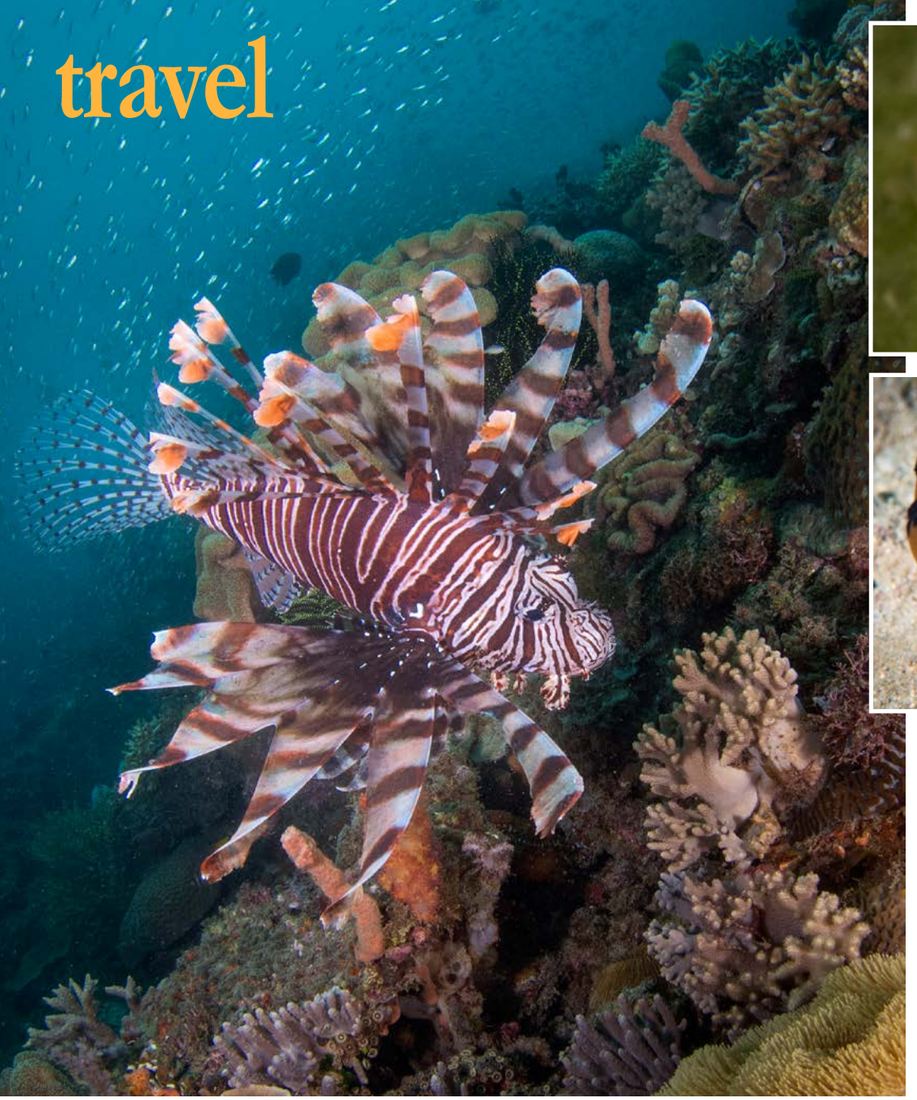
We headed to the coastal dives sites to the west of Dili one day, but visibility was very poor, so we decided to do only one dive there and went back to Tasi Tolu again.

Boat diving and certifications

Travel by dive boat to Atauro Island is available when conditions are good and there are enough divers. I did not get to dive the island this trip, but it is said to have excellent visibility (it does not suffer from the river run-off from the mountains of Timor) and great marine life. It is something to come back for on my next trip.

The dive center offers a variety of dive

Orange mantis shrimp



Tiny cuttlefish (top); *Berthella martensi* sea slug (above); Skunk anemonefish and domino damselfish on large anemone (right)

Lionfish (top left) and scorpionfish (above) on reef

courses from Discover Scuba and Open Water to instructor certifications. My dive guide became certified as an instructor with Dive Timor Lorosae; it is always nice to see places that train and then employ its own students—it shows the dive shop and location are worth sticking around for.

Should've been here last week

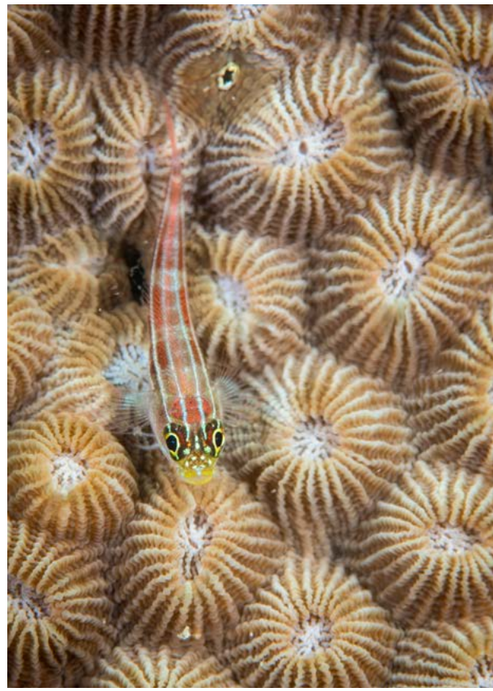
This is the story of my life. In fact, I should have been here a month before. Sometime between October and December, migrating pygmy blue whales and sperm whales passed by the island of Timor, close enough to see them (and sometimes snorkel with them) from shore. While preparing for my trip, I had seen the social media posts of these beautiful massive mammals and held some hope that maybe a few strays would swim by once I got there, but unfortunately, I had missed them.

I also arrived during the rainy season, which, again, due to the shore-diving nature of the location, made for some bad visibility. Many rivers and drainage from the mountains run directly into the ocean, bringing with them silt and other things to mess up the visibility. Winds are also stronger November through February, which can stir up sand and make it murky. Winds prevented us from going out for a boat dive or to Atauro Island, which is supposed to be a very nice diving location.

Dugong sightings are not uncommon. In some areas where the dugongs live, there are also saltwater crocodiles and not necessarily the ones that like having their photos taken. Several beaches are known for dugong sightings. I was told the best way to see them was to stay on the beach and watch for the dugongs to surface for a breath and then going snorkeling to see them underwater. But choppy seas make dugongs hard to spot, and it is unlikely they will swim over to you while diving (or that I would notice if they did while my head was in the sand, searching for nudibranchs).

Surface interval

A trip to the Resistance Museum is a must for anyone visiting Timor-Leste. For the small fee of one dollar, you can spend several hours in the air conditioning, reading and seeing images from East Timor, mostly from 1975 to the present. The brutal treatment throughout 25 years of resistance to Indonesia shows the strength and resilience of the people of Timor-Leste. I do not think you can understand the country without learning about its past.



Goby on hard coral

Timor-Leste

CLOCKWISE: Cuttlefish; Skunk anemonefish; Bubble coral shrimp with eggs; Indo-Pacific sergeants guard eggs laid on a wall; *Phyllidiella pustulosa* nudibranchs

Just a few miles out of town is the Cristo Rei of Dili. The seventh tallest Jesus statue on earth looks out over the ocean and can be seen from miles away on many of the beaches in Dili. Climbing over 500 steps takes you to the top, and it is lit up at night (although petty crimes have been reported after dark, especially to women, so it is not recommended that one venture there alone). Timor-Leste is one of only two countries in Asia that are predominantly Christian, and around 97 percent of the population is reported to be Roman Catholic. The statue was a gift from Indonesia in 1996, and it is a popular place where locals like to exercise.

The future

Timor-Leste seems to be bursting at the seams for the future, and I can see where it could become a popular spot on the Asian diving list, as well as for adventurous travelers. It seems to be just starting up, and tourism overall seems to be heading in the right direction with more accommodations opening up, as well as several dive shops and hospitality features like eco-lodges and cultural stays.

Some of the reefs I saw, especially those outside of Dili, were exceptionally healthy. Many different types of corals, large fish and tons of marine life went on for as far as we could dive, in either direction. It is clear these reefs have not felt the pressure of scuba divers as seen on many of Asia's other reefs. I hope that Timor-Leste realizes the fragility of this precious resource and takes early precautions to protect it—not only for the environment's sake, but also because dive tourism could be useful income for the economically struggling country. With a population growing rapidly and tourism bound to increase, the reefs could very easily be destroyed before they even have a chance to be seen. The runoff from the island (directly into the areas divers would go) could easily cover the reefs in silt and pollution, destroying them quickly.

As a well-traveled diver, it is rare to be able to dive a place not many people have visited, about which not a lot of information exists. I enjoyed checking out this untouched, little-known area. If you happen to find yourself in Timor-Leste, I encourage you to call up the friendly staff at Dive Timor Lorosae and let them take you out on a few dives. ■

*Special thanks go to Dive Timor Lorosae (**divetimor.com**).*

*Brandi Mueller is a PADI IDC Staff Instructor and boat captain living in Micronesia. When she's not teaching scuba or driving boats, she's most happy traveling and being underwater with a camera. For more information, visit: **Brandiunderwater.com**.*

SOURCES:
DIVETIMOR.COM, WIKIPEDIA.ORG

fact file

Timor-Leste

SOURCES: US CIA WORLD FACTBOOK, CDC.GOV, OSAC.GOV, STATE.TRAVEL.US, WIKIPEDIA.ORG, XE.COM, DIVETIMOR.COM

History East Timor was colonized by the Portuguese in the 16th century until 1975. After the Carnation Revolution in Portugal, the Portuguese began withdrawing from overseas colonies. In 1975, the Fretilin (Revolutionary Front for an Independent East Timor) declared the territories independent. Nine days later, Indonesia invaded with the help of the United States, Australia and Great Britain. Indonesia occupied East Timor until 1999—a particularly brutal and violent time—until it relinquished control, and East Timor joined the United Nations and the Community of Portuguese Language Countries. Timor-Leste became independent in 2002. Government: republic. Capital: Dili

Geography The country of Timor-Leste resides on part of the island of Timor, with the other part belonging to Indonesia. It consists of 15,410 km sq (5,950 sq mi). The mountainous island with submarine volcanic activity has plenty of coastline with a fringe reef and many dive sites being accessible from shore. To the southeast, the Timor Sea separates Timor-Leste from Darwin, Australia. To the north are other Indonesian islands and the Ombai Strait, Wetar Strait and the Banda Sea. Terrain is mountainous. Highest point: Foho Tatamailau 2,963m. Coastline: 706km

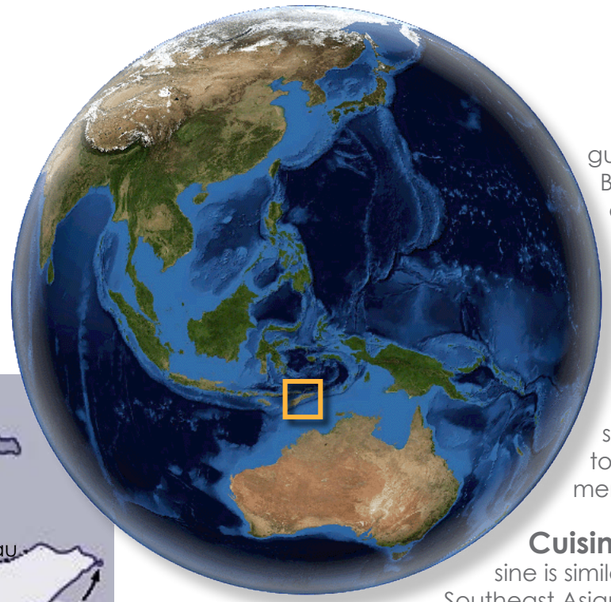
Climate May through September is the dry season and best for visibility and low winds. October through November is whale season; pygmy blue whales and sperm whales are known to migrate past the island. November through March is the rainy season, and as most of the diving is done from shore, river-runoff and wind contribute to lower visibility. The climate is tropical with air temperatures of 26-32°C (78-90°F) year-round and high humidity. Water temperatures are 27-29°C (80-84°F). Air temperatures in the mountains can be much cooler. Natural hazards include earthquakes, tsunamis and tropical cyclones; floods and landslides are common.

Environment Timor-Leste's population is increasing dramatically, which is likely to put more pressure on natural resources and further contribute to pollution issues. Climate change brings the threat of stronger and more frequent natural disasters such as typhoons and more coral bleaching events due to increased water temperatures. Deforestation is an issue as land is being repurposed for coffee and other agricultural uses, which is contributing to excess pollution runoff and sediment deposits flowing directly into costal environments. Mangrove ecosystems are being replaced with urban development. Overfishing and trade in threatened species such as shark fins and turtle eggs are a problem. Waste management in many forms is an issue, including garbage ending up in the ocean due to lack of sewage treatment.

RIGHT: Location of Timor-Leste on global map

BELOW: Location of the capital city of Dili on map of Timor-Leste

NASA



US CIA WORLD FACTBOOK / PUBLIC DOMAIN

Economy Timor-Leste is one of the poorest countries in Asia. Petroleum is the largest export, although there are complicated and disputed previous agreements with Australia and Indonesia over petroleum and natural gas deposits in the Timor Sea. Coffee is the next largest export, with Starbucks being a large purchaser, and on a smaller level, cinnamon and cocoa. The country receives donations from foreign donors, many NGOs and aid programs.

Population 1.2 million in 2015 but rising. Ethnic groups: Austronesian (Malayo-Polynesian), Papuan, small Chinese minority. Religions: Roman Catholic 97.6%, Protestant/Evangelical 2%, Muslim 0.2% (2015 estimate). Internet users: 318,373 or 25.2% percent of the population (July 2016 estimate).

Currency The US dollar is the official currency. There are ATMs in Dili, but they often run out of money. There are no ATMs outside of Dili.

Language The official languages are Tetum and Portuguese, although Bahasa (Indonesian) is still spoke by some of those who survived the Indonesian occupancy. Basic English is spoken in some tourist establishments.

Cuisine Local cuisine is similar to other Southeast Asian cuisines with rice, noodles, pork, fish, vegetables and fruits. In Dili, there are several western-style restaurants including a few well-known fast food options like Burger King. Outside of Dili, expect basic options.

Phone/Internet Wifi internet is available (but slow) at some restaurants and hotels in Dili. It is easy to get a local SIM card for unlocked cell phones with data, although Internet service is generally slow and coverage is spotty outside Dili.

Voltage 220V, Schuko socket (two round pins).

Travel/Visa A visa on arrival good for up to 30 days is available at the airport for US$30.

Getting There There are flights from Singapore, Bali and Darwin, Australia, to Presidente Nicolau Lobato International Airport in Dili.

Transportation Taxis are easy to find in Dili. Outside Dili the roads are atrocious (including the ones getting to some of the coastal dive sites). The further you go from Dili, the worse the roads get.

Security In spite of its violent past, the current situation in Timor-Leste is peaceful. There are still occasionally demonstrations, but most are not violent. It is a good idea to avoid public demonstrations as they have become violent in the past. Petty crime can be an issue and it Is best to not go out alone at night.

Health There is a very high degree of risk for food or waterborne diseases such as bacterial and protozoal diarrhea, hepatitis A, and typhoid fever as well as vectorborne diseases such as chikungunya, dengue fever and malaria (2009). Routine vaccinations are suggested as is typhoid and hepatitis A. Malaria prophylaxis is recommended by the CDC, although cases of malaria have been few in the past five years. Avoid mosquito bites as dengue, zika and other mosquito-borne viruses are an issue. Do not drink tap water. Travel insurance is highly recommended as local healthcare options are not usually up to Western standards, and for any major concerns, evacuation to Darwin or Singapore is the best option.

Decompression Chambers
There is no chamber in Timor-Leste. The closest chambers are in Darwin, Australia, and Bali, Indonesia.

Royal Darwin Hospital
Hyperbaric Medical Unit
Rocklands Drive Tiwi NT 0810
Phone: 61 8 8922 8230

Sanglah General Hospital
USUP Sanglah Denpasar Jl.
Diponegoro, Denpasar 80114
Bali, Indonesia
Phone 62-361-227911 ext. 232

Diving With Great White Sharks *of Guadalupe Island*

Text and photos by Scott Bennett

"You're crazy; I don't get in the water with bitey things!" The announcement of my impending great white shark trip drew a variety of such responses from horrified friends. The undisputed bad boys of the shark world, great whites are the largest of all predatory sharks, reaching lengths of up to 6m and weighing in at over 2,000kg. The concept of seeing them up close, even from within a cage, invoked a variety of additional gems including "Oh my God," "I hope you come back with all your limbs," and "Come back alive."

The blatant sensationalism of the Discovery Channel's *Shark Week* notwithstanding, the movie *Jaws* has not done the image of sharks, and great whites in particular, any favours. Unfortunately, perception overrides facts. "Sharks are dangerous and eat people," say those who know better. Certainly, there have been attacks and people have died or been seriously injured, but a healthy dose of perspective is required. One is more likely to get struck by lightning or win a lottery (or both) than be attacked by a shark. My phobic friend has never even seen a shark outside of the Toronto's aquarium, yet will not even go into the ocean. Surely, a movie from more than 40 years ago cannot prompt such irrationality, can it? Apparently, it can.

Although many shark attacks can be attributed to great whites, new research has revealed them to be naturally curious, "test biting" their potential prey before releasing it. Many attacks are not fatal, indicating humans are not a preferred menu item. Unfortunately, the naysayers' minds are already made up. In fact, a recent scientific study revealed that selfies kill 20 times more people than sharks!

I previously had the opportunity to see great whites off Cape Town in South Africa. Although shark numbers were high, low visibility combined with a shark cage as long as my sofa and no air supply made photography difficult. Despite this, observing these magnificent creatures in the wild was extraordinary. There was no fear, only exhilaration; I could not wait for another opportunity. Five years later, that chance arose at Mexico's Guadalupe Island.

View of the Baja coast, looking south towards Ensenada; Great white shark at Guadalupe Island in Mexico (top left and previous page)

Early morning at Guadalupe Island

Guadalupe Island

Situated in the Pacific, 240km off Mexico's Baja California peninsula, Guadalupe is one of the world's premier locations for observing great white sharks. Volcanic in origin, the island measures 35km long and 5.9km across. A chain of high, volcanic ridges ascends to 1,298m at its northern end and 975m at the southern end. The southern part of the island is barren, although pine forests are found in the interior.

Although located in a biosphere reserve, approximately 200 people reside on the island, most of them abalone and lobster fishers. Ironically, they had no idea about the sharks, as humans and sharks reside along opposite sides. A Mexican naval base is also found on the island.

The island is also home to three pinniped species: California fur seals, California sea lions and northern elephant seals. Ruthlessly hunted, the northern elephant seal was believed extinct in 1884 until a remnant population of eight individuals was discovered on Guadalupe in 1892. Granted protection by the Mexican government in 1922, the species has made a remarkable recovery. Today, the population has recovered to over 100,000, ranging from Mexico to Alaska.

It is this abundance of food that lures the sharks in such large numbers. Unlike in South Africa, Guadalupe's visibility is crystal-clear, sometimes in excess of 30m. Although the sharks are present most of the year, the prime viewing season is between August and November, when sea conditions are calmest.

Getting there

According to Ralph Waldo Emerson, "It's not the destination, it's the journey"—an adage that proved especially true when travelling to Guadalupe. From my home in Toronto, it was an easy five-hour flight to San Diego, where I stayed a night at the Hampton Inn, the tour departure point. A beautiful city with a laid-back vibe, San Diego quickly won me over, and I had a pleasant afternoon exploring the area.

The following morning, everyone assembled in the lobby prior to the 10:30 a.m. departure. The group consisted of 15 people (14 men and one woman) from Germany, France, United Kingdom, United States and Canada. Unsurprisingly, there was a lot of luggage—a good deal of which I suspected was camera-related.

From the hotel, a chartered bus took us to the departure point in Ensenada, a 90-minute drive south of the border. Although the

Elephant seals lounging on the beach

View of Ensenada Harbour (above); *Solmar V* at Ensenada (left); The lounge on the *Solmar V* (right)

border at Tijuana was a mere 20-minute drive away, I surmised crossing it would take a LOT longer. The world's busiest land border crossing, fifty thousand people pass through daily and I expected nothing short of pandemonium. Once there, everyone had to disembark, taking all their luggage with them. A short walk led to immigration, where an official greeted me with a cheerful "Hola" and a smile. As the company had filled out all entry paperwork in advance, I presented my arrival card, she stamped it and I was in Mexico. I have had more difficulty entering my own country!

Back on the bus, it was a scenic 90-minute drive down the coast to the town of Ensenada. En route, we stopped at a 7-Eleven for some snacks. Upon perusing the bakery's diabetes-inducing pastries, I opted for a coffee with *canella* (cinnamon), a combination I immediately savoured.

Farther along, the drive was quite scenic, the rugged coastline interspersed with swanky expat homes and the occasional resort town. The sight of high-rise condos along the barren coast was decidedly incongruous. While not the palm-fringed shores of tourist brochures, the pristine beaches stretched for untold kilometres.

Passing by the Fox Baja studios, I just managed a glimpse of the massive water tank used during the filming of James Cameron's film Titanic. Further south, we stopped at a scenic viewpoint. The coastline's rugged arc faded into the midday haze, as fish pens stocked with tuna for the Chinese market punctuated the cobalt ocean.

We soon arrived in Ensenada, a bustling port city that is the third-largest in Baja California. An important commercial, fishing and tourist port, its extensive marina harboured a wide variety of vessels from small fishing boats to a monster cruise liner. Also waiting was the MV *Solmar V*, our home for the next five days.

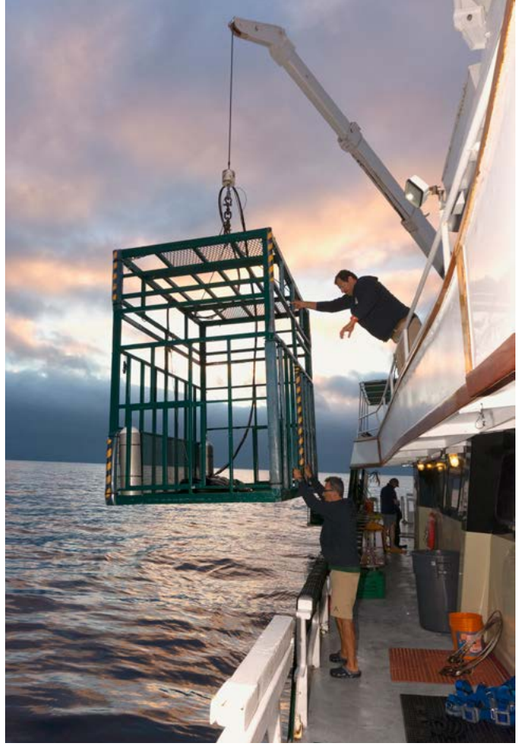
The liveaboard

A member of the Pelagic Fleet, the *Solmar V* is a 34m long exploration vessel that is one of the pioneers of Guadalupe cage diving. Ornamented with mahogany, brass and granite table tops, the carpeted salon featured a large-screen HDTV with VCR, DVD player and stereo system. Lunch was waiting in the saloon, and everyone quickly tucked into a sumptuous spread of shrimp, salsa, guacamole and tortillas.

Afterwards, I was taken to my cabin, which I shared with John from Florida. Compact but comfortable, it featured two bunks, en suite bathroom with shower and air-con. For possibly the first time ever, I managed to secure the lower bunk.

With everyone settled and fed, it was then time to meet the crew. On hand were Captain Gerardo, chief engineer Aurelio, chef Tony, steward Bernie, deck hands Andres, Javier and "Crazy" Luis (yes, that is what everyone called him), and divemasters Daniel, Nacho and Jake. First up, Captain Gerardo gave a talk about the vessel's safety features and was followed by Daniel, who gave a rundown on the following days' activities.

No scuba certification was neces-



Southern coast of Guadalupe Island (left); Lowering the shark cage (above); Entering the shark cage can be tricky (right); Departing view of the island (lower left)

sary, although a certification card was required for the submersible cage, which is lowered to a depth of 10m. Participant ages have ranged from ten to 80. However, rules are strict: no hands or feet outside the cage (why you would want to?), absolutely no touching the sharks, and no alcoholic beverages until after you are done in the cage. No problem there.

The rest of the afternoon was spent readying my photo gear and getting acquainted with my fellow travellers. Virtually everyone had camera gear, but fortunately, the large table on the lower rear deck had plenty of room for the small mountain of equipment.

The next morning, I awoke to some disheartening news. An unexpected mechanical difficulty left us with a sole working propeller and our mid-day arrival had been pushed back to 9:00 p.m. Unfortunately, things do happen, but then again, this was more of an expedition than a simple pleasure cruise. Having already assembled my camera gear, all I could do was sit back, relax and dream of sharks. In the evening, we watched an old Jacques Cousteau episode featuring the elephant seals of Guadalupe. It was surreal to think we would be there in the morning.

Dramatic scenery

Arising at 6:00 a.m., it was still dark outside, so I grabbed a coffee and headed for the rear deck, which was already bustling with activity. The two rear cages were already in the water and being secured while the submersible cage was being positioned by crane off the starboard side. Despite its far-flung location, Guadalupe was not exactly serene. Off in the darkness seals bellowed; if there were seals, there would be sharks!

The rising sun finally peered above the horizon, and I had my first look at the island. Anchored off the southern west coast, the scenery was dramatic. The upper ridges blushed with colour, rugged cliffs cascaded to the water's edge, as a cloud bank draped over the summit reminiscent of Cape Town's Table Mountain. As the sun rose, the colours intensified. Vivid hues of red and orange contrasted with the cool tones of the water and sky, the only vegetation an occasional tuft of scraggly grass. Unfortunately, there was no time for photography; according to the board, I was slated for the first group. Gulping down my coffee, I geared up in anticipation of the morning's adventure.

Cage diving

A maximum of four guests is allowed in each cage for one hour in duration. Getting into the cage looked a lot more difficult than it turned out to be. Once attired in wetsuit, hood, mask, boots and gloves, I made my way for the rear deck to be fitted with a weight harness and "hookah," the surface supplied air system. After stepping down to the dive platform came the tricky part: sliding down a small horizontal ladder (over the water) on my backside, one rung at a time, to the cage. Despite visions of falling between the rungs, it proved easier than expected. Then, it was a short climb down into the cage. Once everyone was inside, the top was secured.

It proved to be a bit tight—picture four

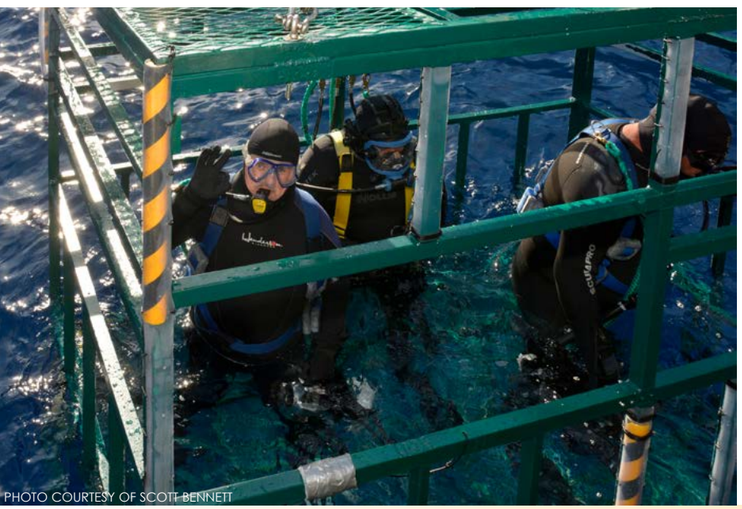


PHOTO COURTESY OF SCOTT BENNETT

CLOCKWISE FROM FAR LEFT: A shark lunges for the bait; A shark swims just below the surface, near the shark cage; At the surface, a shark just misses the bait; Divers being lowered in the submersible cage

photographers of varying sizes and heights with cameras and strobes trying not to collide. I was reminded of an underwater clown car. I initially entered with a 20kg harness but promptly floated like a wayward balloon. Additional weight was necessary, so I climbed back out to change to the heftier harness. This time I sank like a stone. With everyone primed, all that was missing were the sharks.

Shark encounter

We did not have to wait long. Within ten minutes, the first shark appeared. Swimming past, it paid us no heed, exuding a serenity and grace completely at odds with its rapacious image. Mind you, I suspected things would be different if I was OUTSIDE the cage.

Everyone was mesmerized. I did not even take a single photo, watching instead, this incredible creature only a few metres away. At only 3m in length, it was small by great white standards. But hey, it was a great white!!! The ensuing hour proved amazing, with several sharks passing near the cages. They were definitely curious but exhibited no aggression whatsoever. Before we knew it, it was time for breakfast. No one wanted to leave!

For the remainder of the day, the schedule was more relaxed. As long as there was not a queue, guests could remain inside the cage as

WHITE SHARK CAFÉ

Great white sharks spend autumn and winter at Guadalupe Island before journeying to an isolated stretch of the Pacific Ocean between Baja California and Hawaii dubbed the "White Shark Café." Beginning in late winter, this pilgrimage has long baffled scientists, not just because it takes the sharks a month to get there, but the area does not seem to possess food to support their diets.

However, scientists have recently discovered the area to be teeming with squid and small fish in "midwater," a deep-water expanse positioned just above the deepest areas of the sea where there is complete darkness. Here, the sharks engage in "bounce dives," down to 1,400ft during the day and 650ft at night, to feed. ■

CLOCKWISE: A shark lunges for the bait right beside the cage; Guadalupe's superb visibility offers spectacular views of the sharks; A shark comes in for a closer look.

long as they liked. Being just under the surface, there was no danger of nitrogen buildup. The shark action ebbed and flowed throughout the day, with a flurry of activity followed by quiet spells. On one occasion, I signalled I wanted to exit. Just as I started to climb out, a pair of sharks appeared out of nowhere, heralding a new burst of action. Back in I went!

Bait

The sharks were not actually fed; to entice them, the wranglers tossed out lures hooked with tuna heads. The guys were experts at yanking the bait away in the nick of time, although the sharks did win on occasion. Compared to other sharks, great whites have somewhat refined dining habits. Once the bait hit the water, it was not a voracious free-for-all. If several sharks were present, they sized each other up. The biggest one fed first as the others patiently waited their turn. "I've seen worse table manners at an all-you-can-eat buffet," said Jake with a smile.

The mackerel were another story, with swarms of them attacking the bait with wild abandon. They seemed to possess a sixth sense, charging towards the bait before it even hit the water.

Alas, every so often, it was necessary to emerge for a meal or bathroom breaks. As getting in and out of a 7mm suit is one of my least favourite things, I opted to keep it on between cage stints. Fortunately, it was Bernie to the rescue, bringing lunch right to me on the dive deck. Talk about service!

THIS PAGE: Close encounters are common, with individuals coming to within a metre of the cage.

Behaviour

Even topside, there was still plenty of action to photograph. Watching the wranglers proved to be great fun. A telltale whistle from Crazy Luis indicated a lunge was imminent. Most of the time, the bigger sharks swam up to the bait before veering off at the last second. It was the younger males that were more aggressive, in particular, one smaller male whose snout was heavily scarred. I hoped for a classic shark-head-out-of-water shot with jaws agape, but that proved easier said than done. It was astonishing how such big animals could move so fast.

At the end of the afternoon, I opted for a stint in the submersible cage. The setup with the weight harness and hookah system was the same, but this time, the hoses were connected to tanks sitting on the cage floor. There were only two of us in the cage, with Nacho along to keep an eye on things. With everyone aboard, the door was shut, and the crane swung us over the side to the water.

Within minutes, we descended to approximately 10m, which provided a totally different viewpoint of the action. Although lighting conditions were dim for photography, it was fascinating to watch the sharks' behaviour. One came fairly close to the submersible cage, but most focused on the cage above, each with their own routine to approach it. Some would first circle around the *Solmar V*, while others swam out to the blue before doubling back for a pass. Seeing the sharks alongside the cage really gave a sense of scale. I later discovered the biggest one was nearly 5m long.

Research

The Marine Conservation Science Institute, a nonprofit research organization, has been studying great white sharks at Guadalupe since 2000. In 2002, a shark identification program was initiated. To date, approximately 241 individuals have been identified boasting such names as Bruce (naturally), Cream Puff, Gums, Stimpy, Kaiser Wilhelm, Pius Maximus, and my personal favourite—Mr. Valuelink. During our two days at the island, ten individual sharks were observed—six individuals the first day joined by four new ones the second. Although most were not in the ID book, one specimen was recognizable: a large male missing the top of his tail, identified

Guadalupe

Location of
Guadalupe Island
on map of Mexico

as Andy. Most individuals visited repeatedly, with two or even three animals visible at one time.

At dinner, there was good news: The mechanical issue had been remedied. As no one had a connecting flight the next day, the captain generously allowed a late-day departure to make up for our missed afternoon. There was lots of celebrating that night. It was a good thing the Mexican beer and Chilean wine were complimentary! Bernie also made a wicked mango margarita, but I limited myself to one.

Photography equipment and challenges

With regard to gear, I brought two camera bodies: a Nikon D7100 for topside images and a D810 for underwater images. Lenses consisted of a Sigma 10-20mm for the D7100, and a full-frame Nikon 16-35mm, 24-120mm and 80-400mm for the D810. The 16-35mm was used for the underwater images. With a zoom gear attached, I was able to get wider images of the cage interior at the 16mm setting, with the majority of the shark images shot at 35mm.

Nevertheless, photographing within the cage presented some challenges. Despite their large size, the cages were buffeted by the surface conditions. A few of the guests said it made them dizzy. Remaining steady was initially difficult, but it did not take long to get into the rhythm of the movement. A corner spot proved the most coveted, allowing an unobstructed view of two sides of the cage.

However, it was not the bobbing cage or people in it that created the biggest challenge; it was the mackerel, perpetually swarming around the cage or even through it. More often than not, a great image was marred by mackerel covering a shark's eye, dorsal or tail fins. They also positioned themselves between the cage and shark, giving the impression of shark-sized mackerel.

Exposure was also an issue, especially if a shark was nearer the cage. Even though the ambient light was bright, I used strobes for most of my images. The output was dialed down to a setting of -1 or more, so as not to blow out the highlights. Some shots were taken at higher shutter speeds in available light. Being near the surface, there was no colour loss due to depth.

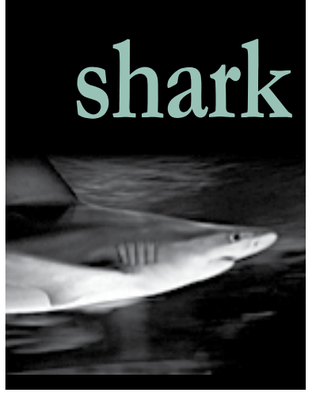
Afterthoughts

Even with the long return trip on rough seas, the effort was worth it and then some. Seeing these magnificent creatures up-close in the wild proved a dream come true. I wished my shark-phobic friends could see them as they really are, rather than the monsters they are portrayed to be.

Although a contentious issue to some, cage diving does help support shark conservation efforts. With shark populations plummeting worldwide, a change of perspective is essential. Once people experience them firsthand, harmful misconceptions can be cast aside. Rather than the ravenous eating machines of the movies, sharks are vital ocean predators and an essential part of marine ecosystems worldwide. Their demise would be a tragedy beyond comprehension. ■

The author with underwater camera rig prepares to enter the submersible cage.

A shark with its attendant mackerel (above); Swimming just below the surface, a shark is dappled with sunlight (top left).



shark tales

Blacktip reef sharks know each other as individuals and often travel with favoured companions.

Sharks: Still Misunderstood

PIXABAY

Text by Ila France Porcher

The first time I met a shark, I was struck by silence. Having observed the wildlife of the Canadian mountains all my life, my knowledge of sharks was limited to the information gained from watching the movie *Jaws* many years before. All that remained from that brief education was that they bit—and badly. Very badly. Essentially, if you met one, you died.

But now I was living in Tahiti. I had been told that there were no sharks in the lagoon, and they were far from my mind as I roamed one morning upon the barrier reef. The sunshine ran in golden lines across the coral and flashed upon the fish. It was mesmerising.

When I raised my eyes, a grey shark of about my size was moving languidly towards me and all my lights went on. Everything about her was just right—her curves, her fins, her face—nothing had prepared me for the sight of that splendid creature gliding forth through the rushing landscape, as graceful as a snake.

Expecting her to fly into attack mode at the sight of me, I held my breath and drifted behind a coral. But she paid me not the slightest attention as she passed just a metre away. Her smug little face actually looked bored. I moved to keep the coral between us, and when I peeked out to see her again, she was gone as if she never had been there.

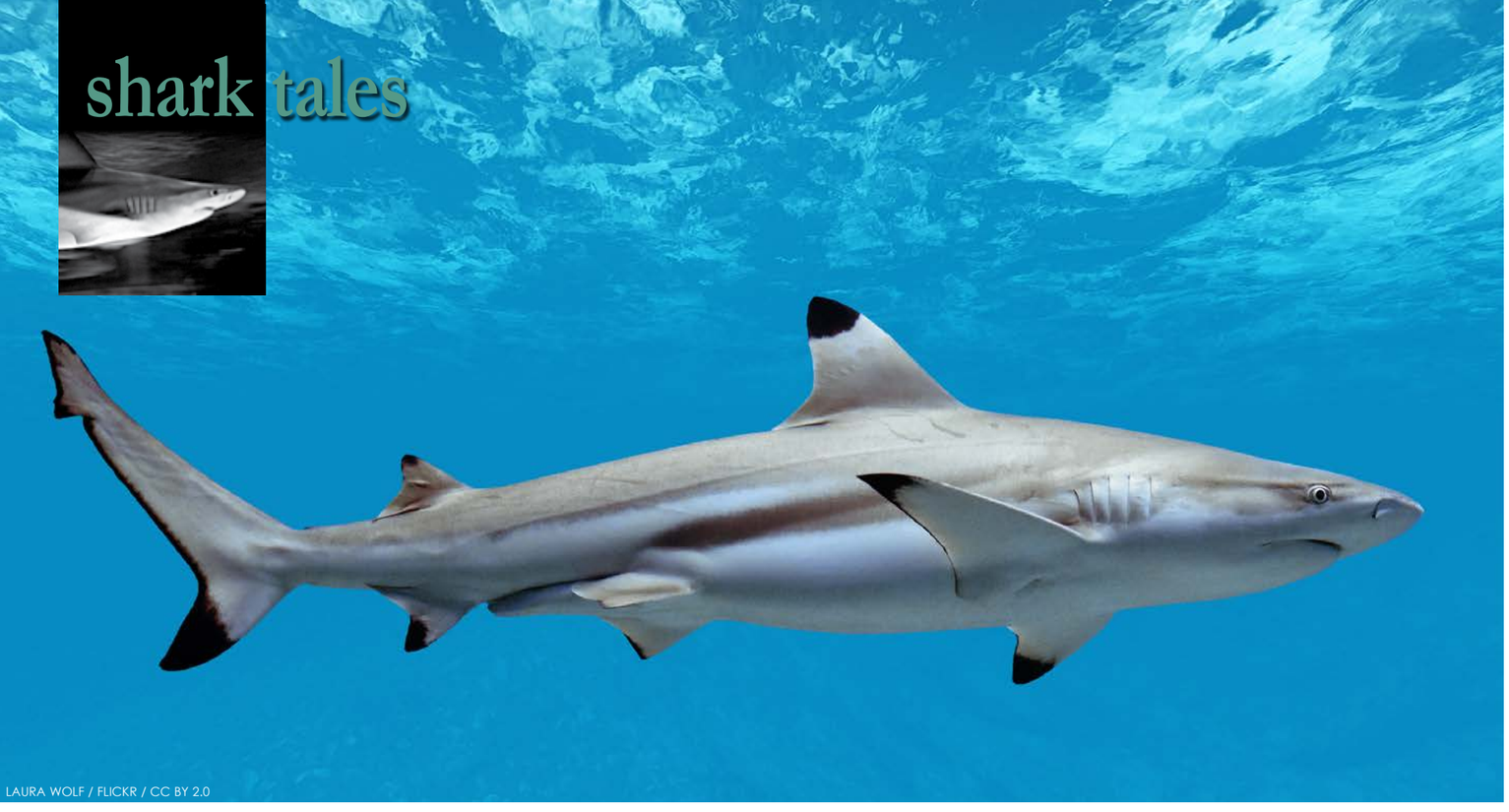
Not brainless

After a few more sightings, I found that if I remained very quiet in the water, the blackfin reef sharks would come to look at me, and I began to seek them out each day on my underwater forays. They were the first wild animals I had met that came, instead of fleeing.

It was soon clear that their complex and flexible behaviour was very different from the other wild animals I had known. I was especially intrigued by their intelligence, having learnt in university that they, as well as other animals of the "low" and "cold" variety, were practically brainless.

Individuals and social animals

So, I launched an intensive study of the local blackfins, identifying each one by its markings, and keeping track of subsequent sightings. I wanted to find out what they were like, not only as animals, but as individuals, and visited them several times a week, whenever I could. The ability to recognize them as individuals revealed a whole new dimension of their lives, and I had the feeling of a window opening onto another world, one so sep-



LAURA WOLF / FLICKR / CC BY 2.0

THIS PAGE: Blacktip reef sharks are social and emotional animals that seek the companionship of others and display complex behaviours, including anger, affection and attachment.

Misunderstood

arate from human life that it might just as well have been on another planet.

Soon the resident sharks, often accompanied by visitors, were waiting for me to arrive; they could recognize the sound of my kayak from far away. They were social animals and those in the lagoon were the females, each spending much of her time in a region about 500m across—her home range. They knew each other as individuals and often travelled with a favoured companion when they left home. Some roamed away often, for weeks or months at a time, while others were stay-at-home creatures and were only absent twice a year, once to mate, and once to have pups. There were a few males who regularly passed through that part of the lagoon but mostly they remained in the ocean on the other side of the barrier reef.

Display of emotion

The blackfins were emotional animals. During one episode, the entire group got mad at me, and for several weeks, they would slam my kayak hard, from multiple directions, when I arrived. Yet, I never saw them fighting, and speculated that this was because they were not territorial, so greeted visitors to their region with friendliness instead of hostility.

Then a company from Singapore got set up throughout the far-flung archipelagoes of that island nation and began slaughtering the sharks for their fins. My sharks fled at first, and when some returned, their society was in disruption. It was two years before the divers, with the help of international pressure, were able to convince the government to protect them; French Polynesia is now the largest shark sanctuary in the world.

Affection and attachment

During the period in which they were being finned, because of personal difficulties, I was unable to get out to see them, and when I finally made it back, two months had passed. As I crossed into the sharks' lagoon, I paused to drink some water and suddenly, there was a blackfin drifting past the boat, with more coming beyond, and they began to undulate against it. One slid against the paddle, and all around me they placidly glided, dorsal fins above the surface, pushing the curves of their bodies against my boat, moving beneath and pressing against it, again and again. I reached down and stroked them as they passed, instinctively responding to what could only be interpreted as an affectionate gesture.

The sharks did this each time they met me after that. One was always first to swim slowly beneath my hand as I sat in the low kayak and I would stroke her. She would spend some time drifting back and forth while being caressed, then undulate against the kayak and disappear below.

On one evening of perfect calm, through the flawless clarity of the water, I saw the group of sharks shoot straight upwards from two metres beneath, undulate against the boat, and go straight down again, so that their tails flashed above the surface around me momentarily like the wings of birds, droplets flying. There were several of them on each side. Then they returned to the surface and slid against the boat, the paddle, and oscillated from one to the other.

They revealed this emotional attachment on another occasion too. Instead of staying for an hour and a half as I usually did, I just came to give them some treats, and then had to rush home. As soon as I approached the kayak, and they understood that I was about to get into it, they all soared over and began to circle me. Then, as I paddled home, they followed. Thirty-six sharks accompanied me out of the lagoon and some distance down the deep bay towards my house before they began to turn back, one after another, circling back towards the lagoon, returning, then finally returning to the shallow turquoise waters where they lived.

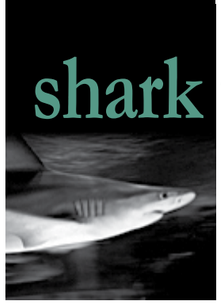
Deserving of protection

The difference between true shark behaviour, and their awful reputation, is very exaggerated, but sharks are ordinary animals with high intelligence and a repertoire of behaviours that is still misunderstood and mostly unknown.

Divers, being the only people to meet them in their own environment, need to take the lead in insisting that they be protected from further depletion through overfishing, and especially from the shark fin market that is driving them towards extinction. ■

Ila France Porcher, author of The Shark Sessions *and* The True Nature of Sharks*, is an ethologist who focused on the study of reef sharks after she moved to Tahiti in 1995. Her observations, which are the first of their kind, have yielded valuable details about their lives, including their reproductive cycle, social biology, population structure, daily behaviour patterns, roaming tendencies and cognitive abilities. For more information, please visit:* ***ilafranceporcher.wixsite.com/author***

GEOFF SHUETRIM / FLICKR / CC BY 2.0



shark tales

Queensland ordered to suspend controversial shark control program

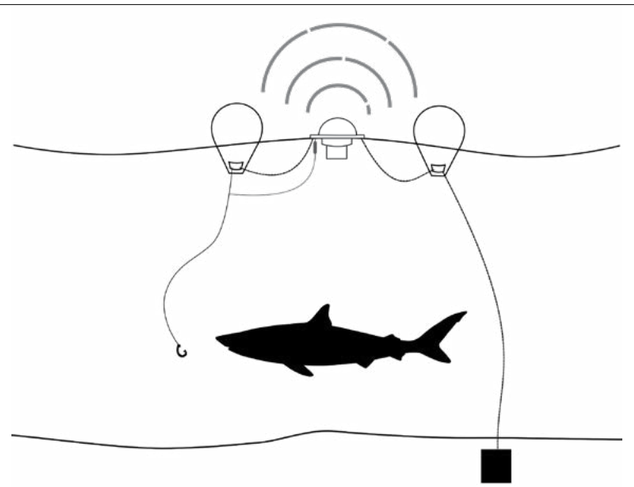
The Great Barrier Reef shark control program has been suspended after a tribunal ruled sharks found alive on drum lines must be released.

The decision has come after Humane Society International (HSI) earlier this year launched a challenge to the shark control program run by the Queensland Department of Agriculture and Fisheries.

It is ineffective

In its decision, the Administrative Appeals Tribunal said the scientific evidence about "the lethal component" of the shark control program "overwhelmingly" showed it does not reduce the risk of unprovoked shark attacks. Humane Society International campaigner Lawrence Chlebeck said non-lethal technology was the way forward for shark control in the Great Barrier Reef. "This is a massive victory for sharks and marine wildlife," he said in a statement.

The Great Barrier Reef Marine Park will now only be permitted to authorise the euthanasia of sharks caught on drum lines on animal welfare grounds, "specifically when a shark is unlikely to survive release due to its condition or an injury, or which cannot be safely removed alive due to weather conditions or hooking location". Furthermore, contractors must attend to caught sharks within 24 hours, and all tiger, bull and white sharks to be tagged before release. ■



G.MANNAERTS / CC BY-SA 4.0

Drum lines have been deployed with the intent of preventing shark attacks in Queensland, Australia, since 1962. In January 2014, drum lines were introduced in Western Australia to catch potentially hazardous sharks. The topic of shark culling became a nationwide controversy and sparked public demonstrations and vocal opposition, particularly from environmentalists, animal welfare advocates and ocean activists.

A drum line is an unmanned aquatic trap used to lure and capture large sharks using baited hooks. They are typically deployed near popular swimming beaches with the intention of reducing the number of sharks in the vicinity, and therefore, the probability of shark attacks.

Since the objective of the drum line is to prevent sharks from approaching popular beaches (and not to attract them) only about 500 grams of bait are added to each hook. Thus, sharks are only attracted to the baits from the immediate vicinity.

Drum lines have been cited as not being an effective strategy to keep people safe, while simultaneously killing thousands of sharks and other wildlife in the marine ecosystem.


PETER SYMES

(File photo) Can electrical deterrents make sharks back off when they are getting too close for comfort?

How effective are commercial electric anklet shark deterrents really?

Shark researchers from The University of Western Australia tested the effectiveness of the Electronic Shark Defence System (ESDSTM) and found it unlikely that the device would significantly reduce the risk of a negative interaction with a white shark.

Personal shark deterrents offer the potential of a nonlethal solution to protect individuals from negative interactions with sharks, but the claims of effectiveness of most deterrents are based on theory rather than robust testing of the devices themselves.

Whether or not these kinds of devices actually do anything is the subject of a new study published in *PLOS One*, and unfortunately, it seems that there are some pretty huge differences, depending on which brand you choose. To determine just how effective the device is, the researchers tested it against a large population of white sharks (*C. carcharias*) in a shark hotspot in South Africa. The device tested was a commercially available anklet called the Electronic Shark Defence System, or ESDS, which produces an electrical field that the manufacturer claims drives sharks away.

The team recorded 395 encounters with 44 individual white sharks. The researchers found the ESDS had limited meaningful effect on the behaviour of white sharks.

Barely any effect

An active ESDS was no more capable of keeping sharks at a "safe" distance than an inactive ESDS. Sharks would routinely approach within 20 to 30cm of the device, whether it was active or not. There was no significant reduction in the proportion of sharks interacting with the bait in the presence of the active device.

Only very close up (< 15.5cm), did the active ESDS show a significant reduction in the number of sharks biting the bait, but this was countered by an increase in other, less aggressive, interactions. By comparison, an active Shark Shield deterrent (which was previously tested by the team using the same methodology), effectively deterred white sharks by an average of 1.3m from the device.

"Although the effectiveness of the ESDSTM may vary between species, due to species-specific differences in electroreceptive ability, the fact that white sharks are implicated in the majority of fatal incidents globally suggests that a device that cannot effectively deter this species should not be considered an effective shark deterrent," said Dr Ryan Kempster, lead researcher of the study. ■

SOURCE: PLOS ONE

Shark's electrical sense is finely tuned to detect prey

It has been known for many years that rays and sharks are able to detect minute changes in electric fields, much like the way our ears react to sounds, as they swim and use this sense to detect prey.

A network of organs, called ampullae of Lorenzini, constantly survey the electric fields sharks swim through. Electricity enters the organs through pores that surround the animals' mouths and form intricate patterns on the bottom of their snouts. Once inside, it is carried via a special gel through a grapevine of canals, ending in bunches of spherical cells that can sense the fields, called electroreceptors.

But as the electrical fields emanating from nearby prey are very weak, how do they pick up these tiny changes against the backdrop?

Much like humans can pick out certain specific sounds or voices in an otherwise noisy environment, a shark's electrosensing organ is finely tuned to react to the minute changes in electrical fields emanating from nearby prey in a sudden, all-or-none manner, as if to say, "attack now." ■

Great whites have high tolerance to heavy metals

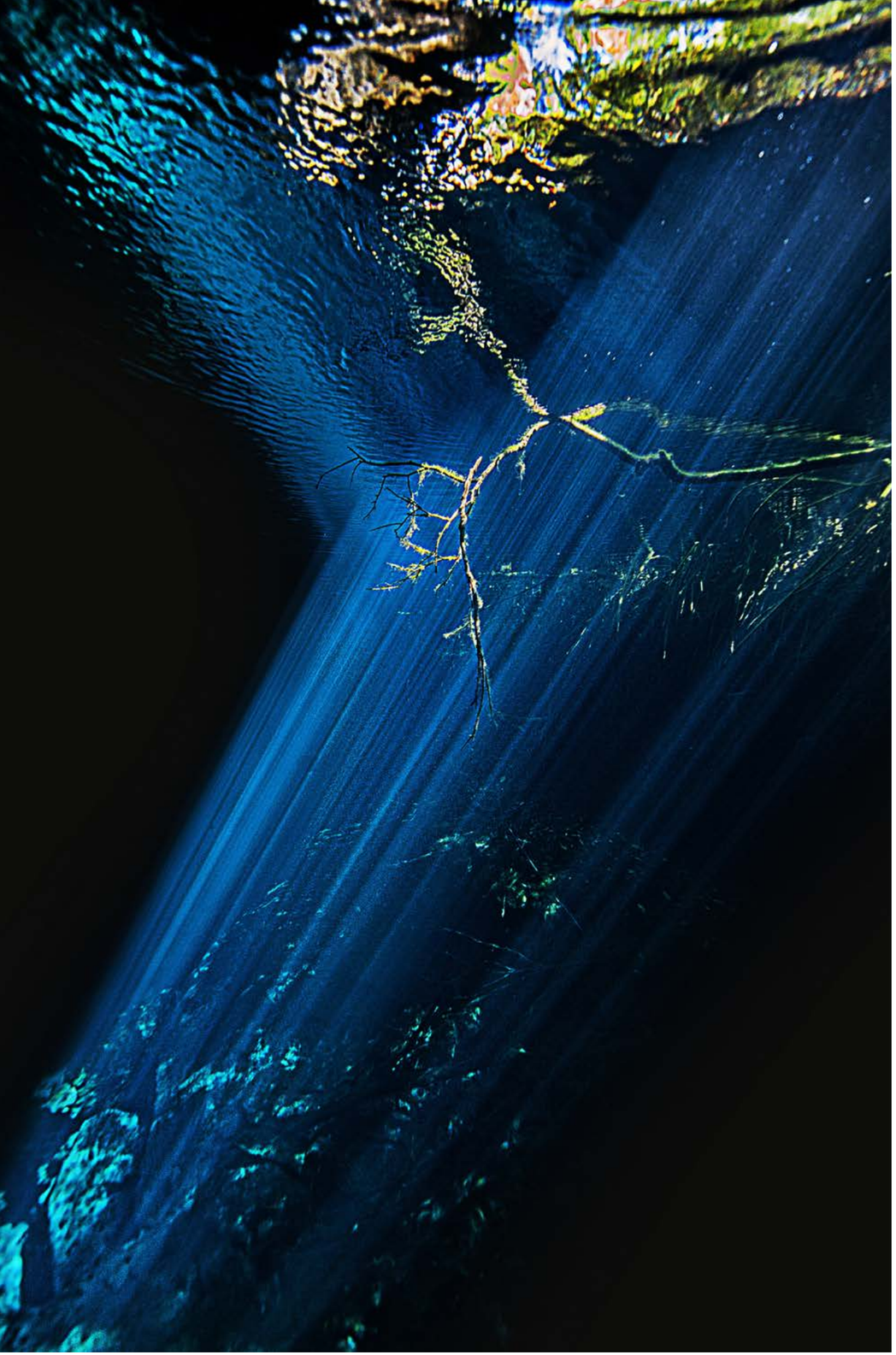
Great white sharks off South Africa have been found to contain quantities of heavy metals that would be dangerously toxic to other forms of marine life, according to a newly published study in which researchers screened the blood samples for concentrations of 12 trace elements and 14 heavy metals.

The results showed high concentrations of the metals, including mercury and arsenic, which did not correlate to a shark's sex, body size or condition. The results suggest that the apex predators have a built-in ability to tolerate the negative effects of the heavy metals. ■

Maya Cenotes

— *Light, Shapes & Reflections*

Text and photos by
Andrey Gorodissky



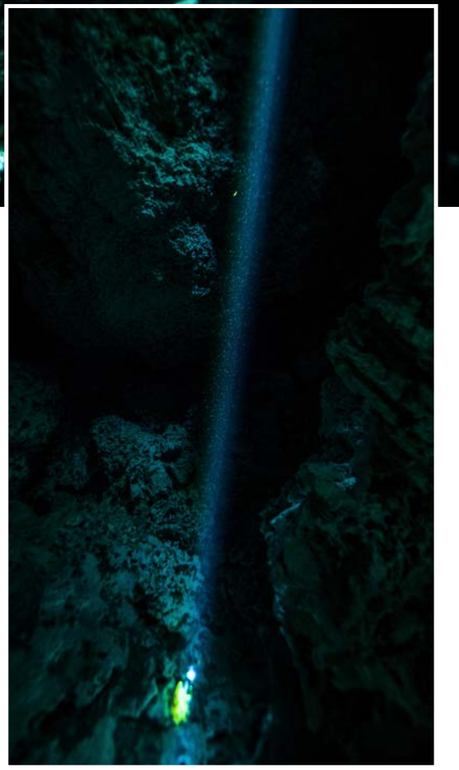
PREVIOUS PAGE: In Dreamgate near Xel-Ha, stalactites and their reflections hang in dark space

THIS PAGE: Shafts of light refract in the waters of Light Curtain, a cenote in Mexico's Yucatán Peninsula.

A huge ramified system of freshwater-filled sinkholes in the Yucatán Peninsula of Mexico comprise what is known locally as the Maya Cenotes. The ancient Maya used them for sacred offerings and sacrifices. The term "cenot" comes from the language of the Maya, who called these sinkholes "ts'onot" or "dzonot," which means "sacred well" or "something very deep and terrible." The Maya also called the sinkholes "gates into the kingdom of the dead" or "gods' lips."

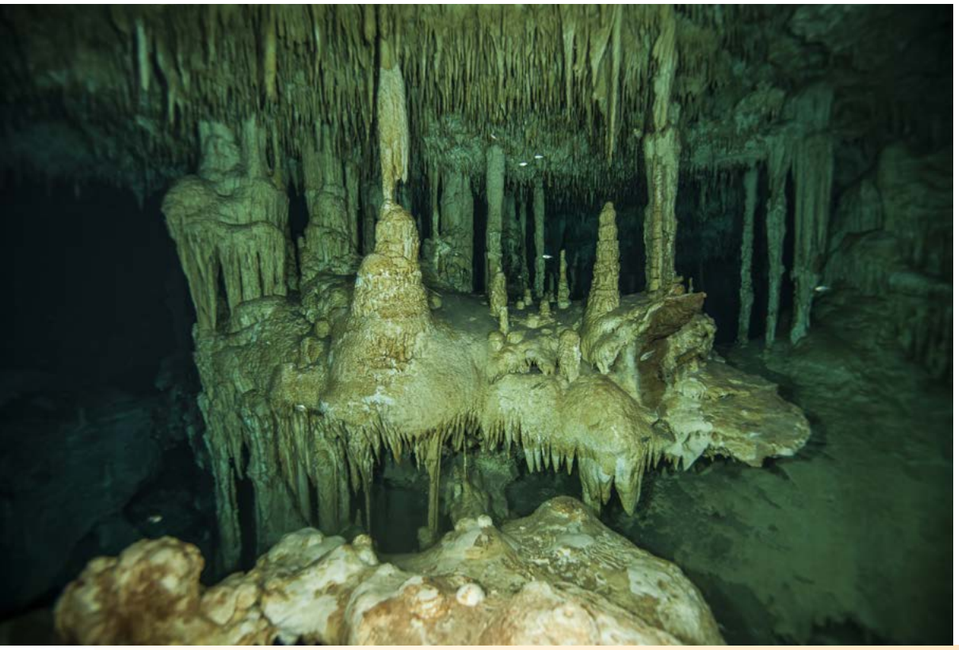
This huge karst system of underground caves and rivers has a combined length of about 350km and consists of around 7,000 cenotes. The cenotes were formed more than 200 million years ago by the dissolving of limestone into sinkholes, which then filled with underground waters. Scientists usually connect the formation of this system with the regular influence of natural forces. However, there is another theory that says this system was formed by the impact of a giant meteorite 65 million years ago.

I first visited Yucatán to dive its cenotes in 2005. Since then, I have returned five more times and cannot stop dreaming of going back for another photo session in the cenotes, because I know of no more surrealistic and fantastic place on earth than this one.

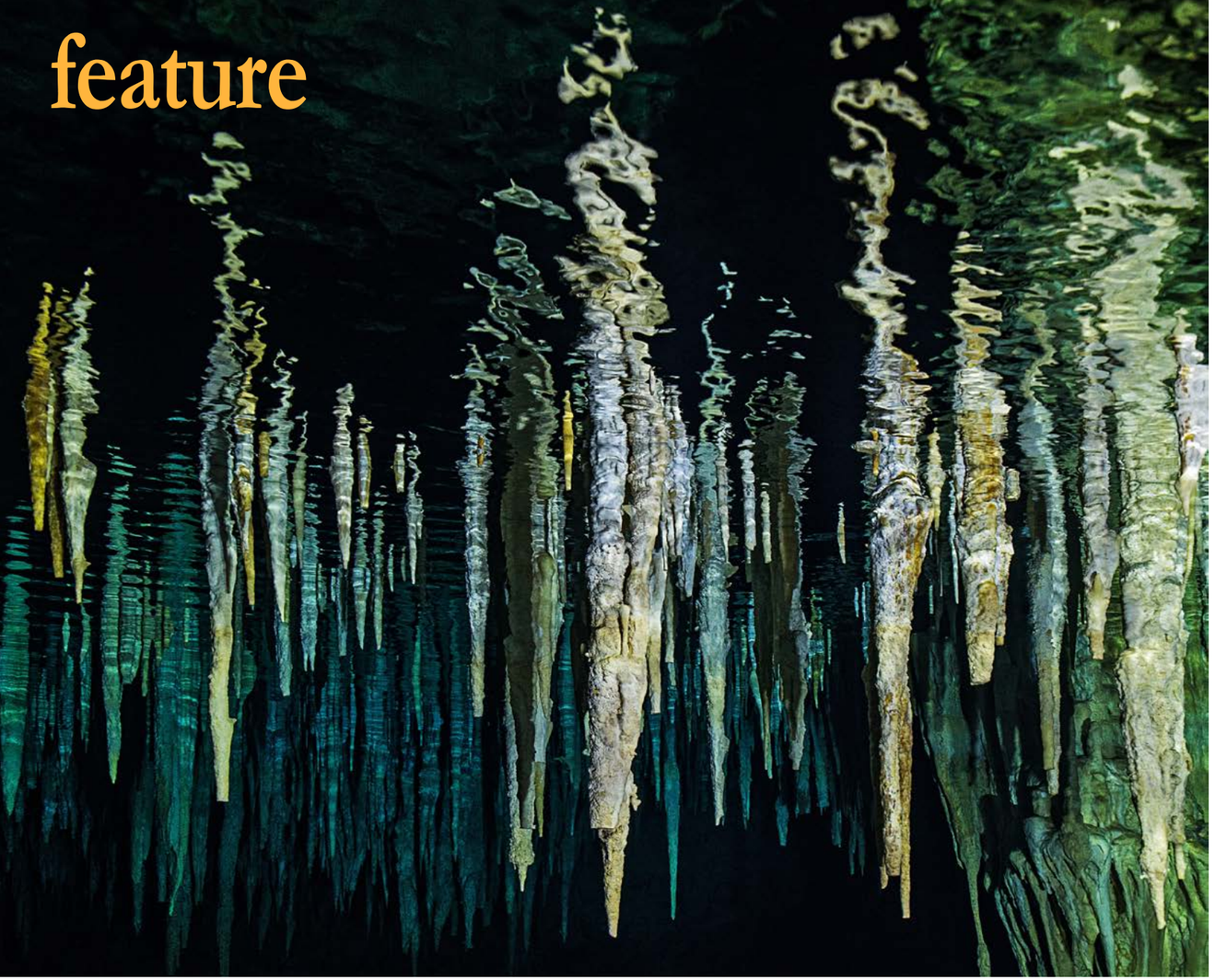


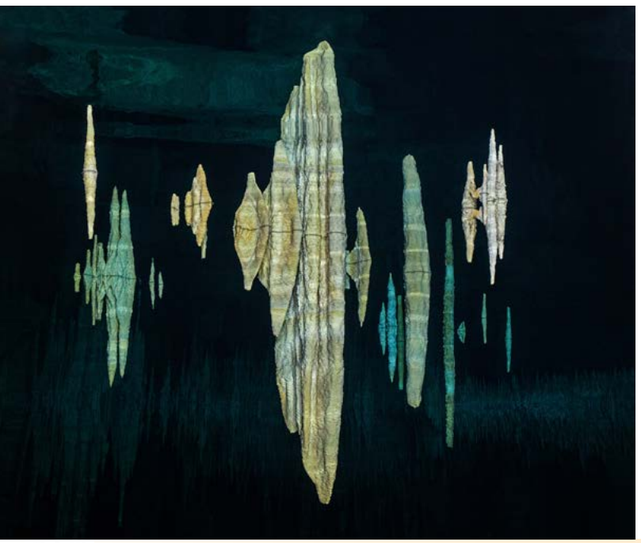
Cenote El Pit (The Pit), south of Xel-Ha

THIS PAGE: A laser show of light in Light Curtain, where vast caverns are filled with strange formations (below and lower left) in crystal clear waters



Light Curtain and The Pit. Stalactites and stalagmites of incredible shapes and sizes formed millions years ago in these cenotes, when the caves were still dry. The fascinating "laser show" of the light curtain in these cenotes is generated by sunbeams refracting in the water. Vast caverns with unearthly scenery and crystal clear water gives divers the illusion that they are "flying" in a gravity-free environment on another planet.





Dreamgate. A mirror-world reflects off the black surface of the water under the roof of this cave, which absorbs all the light from dive torches and reflects only the stalactite forms that seem to be hanging in a black cosmic space—I call this the "black mirror" effect. In Dreamgate, located 2km south of Xel-Ha, the underwater photographer experiences an interesting optical illusion. Stalactites hang vertically from the roof of the cave with their reflections in the "black mirror" most certainly at 90 degrees on the water's surface under the cave's roof; however, the stalactites with their reflections look uncannily like cosmic objects hanging in the emptiness of space.

Zapote. Cenote Zapote in Puerto Morelos—or "Hell Bells," as it is called by divers the world over—must be one of the most unique places on earth, as it has stalactites that have formed into the shape of bells. Some of them have grown up to two meters in size. It is still not clear how or

THIS PAGE: In Dreamgate, stalactites and their reflections look like strange cosmic objects floating in space.

In Cenote Zapote, divers run into thick sulfur clouds at depths below 35m.

why the stalactites are shaped like bells. Scientists continue to discuss the issue.

This place is rather difficult to dive, since there is not a single photon of natural light inside the cave, and any photo session here has to be conducted at depths of 25 to 35m. Unfortunately, it is unrealistic to dive deeper because of thick sulfur clouds. For any underwater photographer spending extra time taking photos at this depth, it is worthwhile to bring an additional tank of nitrox with you, or placing the tank of nitrox 6m under the surface of the cave entrance for your use on your return.

To capture the bells, I decided to take panoramic images. This was a tremendously difficult job, since I had to make seven consecutive shots, which could be compiled into one larger image later in post-production, i.e. the images had to be taken strictly on one plane in order for this to work. This meant that my buoyancy had to be absolutely neutral. It was an exciting exercise to do in complete darkness, with the ever-bouncing rays of dive torches and light strobes dancing about, and no frame of reference or objects in the pitch black cave with which to orientation oneself.

In the Maya cenotes, I use a Sony A7rII camera in a Nauticam housing, with Subtronic strobes and five powerful dive torches for permanent light. ■ SOURCES: WIKIPEDIA, DIVECENOTESMEXICO.COM

*Andrey Gorodissky is the managing partner of Andrey Gorodissky & Partners (**agp.ru**), one of the oldest leading law firms in Russia. Over the past 19 years, he has traveled the world's oceans to capture underwater images, winning awards at the Golden Dolphin and the Golden Turtle festivals, and exhibiting in six solo exhibitions.*

The bell-shaped stalactites in Cenote Zapote in Puerto Morelos can grow up to two meters in size. The panarama shot (top) of these strange formations was compiled using several images.

From the Tip of an Iceberg to My Tap Water

— Diving the Arctic Underworld & the St Lawrence River

Text by Nathalie Lasselin. Photos by Nathalie Lasselin, Mjee De Carufel and Benedicte Lasselin

Dramatic scenery in the Great Canadian North. PREVIOUS PAGE: Ice forms into strange shapes in the Arctic.

Award-winning underwater cinematographer and documentary producer Nathalie Lasselin reflects upon her dive expeditions in the Arctic and her epic project to raise awareness about the state of fresh water in the St Lawrence River, closer to home in Montreal.

It was the end of April, and it was supposed to be the end of winter. But once again, I had to refrain from putting my thick winter coat on the very top shelf of my wardrobe. I was already looking for the first barbecue party with friends, but the north was calling me—the Great Canadian North—and how could I say no to going back to the floe edge? So, I packed my winter coat, my diving and filming gear, and headed to a small village in the remote north called Pond Inlet. It was one of the isolated hamlets where the only road was the sea of either water or ice.

A polar bear is filmed by the author's Arctic expedition team.

The journey was a long one, taking three flights from my home town of Montreal and then embarking on a *qamutik* (a sled towed by a snowmobile) to reach the ice floe edge nearly 80km away.

The minute one sees the endless white sheet of ice, punctuated by some iceberg raising from the frozen sea, the magic just starts. Each time, I arrive here, I must admit, I become a bit emotional, feeling the cold dry air on my face, hearing what I consider the real world of silence. The minute I step down from the sled. I feel like an astronaut putting her feet on a new planet—an ephemeral planet upon which the landscape is continuously changing, becoming one of the biggest warning signs of climate change on earth.

I was in the most harsh, yet pristine environment in which, each day, the cold, wind and sun carved the home of amazing animals like polar bears, walrus and, of course, narwhals. With a bit of luck, patience and ancient Inuit knowledge of the territory, I would be the witness of a world one cannot tame. Each day, fellow divers and I drove on the ice, sometimes for hours, looking for the best seat in the house to enjoy the display of nature, animal watching and floe edge diving alongside magnificent icebergs.

Diving in the Arctic

When guiding tours or filming nature in the Arctic, I look for the best spot to dive. If I find a big crack that seems to be stable, or an iceberg that is somehow anchored to the bottom of the ocean and the floe, then we test the edge to verify it is solid enough to support a safe entry into the water.

We geared up and attached ourselves onto a line. In case the current pushes us too far under the ice, or any other kind of problem, it was safer to be on a rope that does not limit our descent to the bottom, around 30m or so below.

As we descended in the -2°C water, we crossed below the ice upon which algae and marine life from the base of the food chain stick in wintertime. From the first second, the colors and shapes of the ice mesmerized us. As we dropped

View under the Arctic ice where one can witness the illumination of an iceberg's inner world

into the darkness of the ocean, we witnessed the illumination of the iceberg's inner world.

Reaching the bottom and looking up, we stood in front of a giant iceberg that would eventually melt as it made its way south to Newfoundland via what is called the Iceberg Alley. Some of them would simply melt in the salty water, while others would be mined, so vodka and beer could be produced with the unique, rich fresh water of the iceberg.

Each year, the Inuits and the scientific community restate the same eye openers: Temperatures are rising, ice is forming later in the season, and there are less animals. But still, if we can enjoy the Great North, maybe we will be moved to save it. Every time I dive there, I realize how privileged I am not only to see it but to experience it, to feel it. So, I bring back images, films and stories to be shared on the big screen.

Diving the St Lawrence River

Heading back home, ready to share my Arctic iceberg stories, I flew over Montreal. My hometown is actually an island of two million people on the St Lawrence River. I looked down at the greenish-brown body of water and wondered what I could possibly find down there. It was certainly not the most sexy or inviting place to dive. In fact, it was such an uninviting thought, that I tried to put away that curious question, but I wanted an answer.

It was a bit crazy to want to traverse underwater, this formidable river, which had stopped even great Europeans explorers. It was filled with deadly rapids, eight bridges, two tunnels, and occupied by heavy maritime traffic and recreational boating. But one day, I just couldn't help it anymore. I had to know what it would be like to be a single drop of water and follow that 70km journey alongside Montreal.

A daring undertaking

So, I started the Urban Water Odyssey Project. Not only it would be an underwater traverse that nobody had ever dared to try before, but it would be a scientific mission, and most importantly, it would be a project to raise awareness.

The melting glaciers and icebergs are the best distress signal of the Arctic, and more generally, of the environmental health of the planet. Unfortunately, so

Lasselin descends down the wall of a giant iceberg in Arctic waters

MJEE DE CARUFEL

Lasselin snowshoes across the floe edge in the Great Canadian North.

Lasselin takes a selfie under the Arctic ice; Top view of an iceberg floating down to Newfoundland in Iceberg Alley (top)

few of us can see what is actually happening; and well, as so often happens with human nature, if we do not see it, it does not quite exist. But it was what had awakened me and made me even more aware of the fresh water situation in the world.

The Great Lakes and the St Lawrence River hold nearly 25 percent of the earth's surface fresh water. On top of that, 50 percent of the population in Quebec drink it, and our waste water goes back into it after treatment.

Beyond the feeling that it was not looking so great to become a freshwater diver, I was going to face the most challenging dive of my life. Despite my experience diving deep caves and wrecks, I did not know what to expect and could not ask for advice from the dive community about this body of water, which I wanted to traverse. Most parts of it had not been dived by anybody. The rapids were supposedly undivable, and they complicated the logistics. In order to be followed by support staff for the distance, I would need more than one boat and one team.

After a proof of concept of 21km—which I completed in six hours using a closed circuit rebreather, underwater scooter and surface communications, so I could figure out which azimuth (direction) to follow—I felt confident I could do the traverse. I was also supported by several manufacturers who were willing to help with redundancy of equipment and adapting my equipment for such an unconventional dive.

For those wondering what kind of equipment I used, the dive was done on a close circuit rebreather from AP Diving, plus a modified heated scrubber canister from Kiss. I used a Kirby Morgan mask and a bidirectional communication system. I also used a heated undergarment system by DTEK and an Aqualung Fusion drysuit. The dive was monitored on a Shearwater computer, and I was propelled mainly by Submerge scooters with my own personal modified seat. Crossing the rapids was done on open circuit with an Apeks regulator.

An epic journey

Last September, in the last hot and sunny week of the summer, I started my epic journey of 70km in the St Lawrence River, scootering underwater for more than 30 hours. The entire expedition took over 40 hours, during which time I had to navigate in low visibility—most of the time, less than a meter—through a series of high currents, counter-currents and swirls. In the shallows, I had to escape the maritime traffic and try to avoid the aquatic plants that had grown too long over an overly hot summer, which had allowed them to grow all the way up to the surface.

During the last step of the

BENEDICTE LASSELIN

For her dives in the St Lawrence River, Lasselin used a rebreather by AP Diving, a modified heated scrubber canister from Kiss; Kirby Morgan mask; bidirectional communication system; DTEK heated undergarment system and Aqualung Fusion drysuit; Shearwater computer; Submerge scooters with a modified seat. Crossing the rapids was done on open circuit with an Apeks regulator.

project, after having traveled 350km, I took samples of the water and sediment at over 40 sites in order to find out how much emerging contaminants were in the water, such as pesticides, herbicides, drugs, etc. What I discovered was frightening: Not only did we need to clean up the river of debris of all sorts, including plastic, but we were now at a point where we had a big new invisible tasteless enemy—those emerging contaminants, of which we know only the tip of the iceberg about their negative effects on not only the river, but also on the marine life we eat, the water we drink, and ultimately, the state of our health.

Afterthoughts

My series of dives that weekend in the St Lawrence River was the most challenging project I had ever led in terms of the logistical, technical and mental aspects. I could not do a continuous dive for many reasons, including the high-traffic boating, which pushed me off my original plan. But with the help of my team—which included 24 people, five boats and 30 partners from ten countries—I was able to complete the traverse and reach the finish line. More importantly, the project was able to raise awareness in the general public about the state and use of fresh water in our region.

Through the project, I realized that we often look for adventures in exotic places on the other side of the world, and forget that right on our doorstep, there is still a lot to discover and document. Diving in our own surroundings often becomes diving with a purpose, putting ourselves in a position in which we can make a difference. It may not be the best warm blue waters with beautiful wrecks or the most colorful marine life, but in many cases, it may be the most precious body of water we have—the blue gold—our drinking water. ■

If you want to know more about the project and its next phase, including the publication of the Urban Water Odyssey book and film, please visit: ***Nathalielasselin.com****.*

BENEDICTE LASSELIN

Lasselin submerged in the murky low visibility of the St Lawrence River

Edited by
Peter Symes

POINT & CLICK ON BOLD LINKS

Equipment

Recycled nets

First it was rash guards and swimwear manufactured from recycled ghost fishing gear. Now you can augment your outfit with a pair of sunglasses. Waterhaul, a Cornish social enterprise has launched a range of eyewear produced from 100 percent recycled fishing nets. The resulting eyewear—the Fitzroy and the Kynance—have been designed to suit both male and female faces. Each pair of glasses is fitted with Barberini mineral Platinum-Glass UV400 polarised recyclable lenses. Waterhaul is keen to make sure its sunglasses never end up in landfill; hence, it operates a "circular economy" system. In the event that your glasses break, send them back to Waterhaul, and the item will then be washed, sorted, shredded and recycled into a new pair of sunglasses.

D5

The Nordic tradition for taking the combination of aesthetic minimalistic design and practical functionality to a higher level clearly manifests itself in Suunto's new mid-range wrist computer, which has been designed with a clear and intuitive color screen and easy-to-use interface. The D5 offers four dive modes and a menu, which is easily browsed, using three buttons to switch between views and settings. Features include a digital compass. Wirelessly pairing the D5 with a Tank POD will display gas pressure and consumption on the screen. The D5 is depth-rated to 100m. After a dive, the log, which can hold up to 200 hours or 400 dives in its memory, can be transferred via Bluetooth to a mobile phone or tablet. The app is available for both Android or iOS. Fully charged, the battery will last for six to 12 hours of diving, or up to six days in time mode. Straps are easily changed with a quick release system, and a variety of colors are available to match dive gear or casual wear.

EOS torches

Mares has announced two new torches in the EOS line: the EOS 10R and the EOS 10RW—which offers advanced light output in a very compact, rugged, lightweight model! The 10R is intended for use as a handy-sized primary torch, but also makes an excellent backup. The 10RW version is designed to be used with Mares Video Set, which includes two flexible torch arms and a camera tray, and offers a wide-beam angle.

ProPlus

Oceanic's new ProPlus 4.0 dive computer is the first in its line of 2019 computers that boast ultimate user adjustability, thanks to Bluetooth 4.0 technology. The new ProPlus 4.0 is designed with 22 percent larger digits than the previous version, making it clearer and easier-to-read both in and on the water. The ProPlus connects to your smartphone through the free DiverLog+ App, which is available for free from the app store. Divers can adjust the dual nitrox mixes, switch the dual algorithm, gas mixes, user display and alarms before, during and after the dive.

Ocean S1

The Swedish company Oceans has launched a dive computer called Oceans S1 Supersonic, which features built-in underwater communication. Making use of ultrasonic sensors, the S1 enables divers to send messages to each other with just a tap of a button, within a range of 15 to 20m (50-60ft) or more, depending on terrain. The name of the sender is displayed on the high-resolution color display. The S1 features a digital 3D compass, silent haptic feedback, and wireless charging and syncing of dive data over Bluetooth to the free Oceans app for iOS and Android.

XP Pack Duo Update

Scubapro's lightweight rolling dive bag now offers two main compartments and internal mesh pockets for organizing smaller items. The volume of 118 liters (31.2gal) is big enough to accommodate both dive gear and some clothes. A telescopic tow handle and a pair of wheels allow for easy rolling transport of gear through airports.

The OrcaTorch D570 (right) has a green laser beam that is bright and easy to see (far right) and the unit works very well as a dive torch on deeper, darker dives (below).

Review of the OrcaTorch D570

Text and photos by Kate Jonker

How many times, whilst diving, have you seen the most exciting, unusual or incredible critter and wanted to show it to your buddies? You have finally managed to grab their attention and pointed at the critter, only for them to look in the direction of your pointed finger and then stare blankly back at you. You point closer, you waggle your hand and still they don't see it, by which time, the critter has disappeared, your buddies have given up the search, shrugged their shoulders and swum off.

This can be really disappointing and sometimes happens to me when guiding customers or diving with buddies who are not accustomed to our marine life. I realised that to prevent any future disappointments, I needed to find a noninvasive way of pointing out those critters. I am not keen on pointers or muck sticks after seeing a few over-enthusiastic divers knock or dislodge creatures from the reef with their sticks.

Enter the laser pointer

I had heard about laser pointers, and they sounded like the ideal solution, but as I already dive with quite a bit paraphernalia attached to my BCD (including a torch), I was not keen to add yet another item, or have to fumble between laser pointer and torch depending on what was needed at that moment in time.

I recently came across the OrcaTorch D570, a two-in-one dive light, which has a 1000 lumen torch as well as a laser pointer. This sounded like the perfect solution, and I decided to try one out for myself.

The torch comes in two versions: the D570-GL, which has a green laser; or the R570-RL, which has a red beam. I ordered the D570-GL.

OrcaTorch products are internationally available and my torch arrived very quickly from my local supplier.

My dive buddy used the OrcaTorch D570's green laser pointer (left) to show me a well-camouflaged cuttlefish on the reef. It can also be used as a spot beam for underwater photography (right), which I did to capture the frilled nudibranch (above) using ISO320, F5.6 and 1/125.

I used the narrow beam of the OrcaTorch D570 to photograph this common octopus with a snooted effect, using ISO320, F8 and 1/160.

It arrived nicely packaged with a rechargeable battery, a lanyard, USB battery charger, warranty card, two spare O-rings and a user manual.

Quality

Upon unpacking, the first thing that struck me was how well-made the torch was. According to OrcaTorch, it is made from aircraft-grade aluminium and coated with a diamond-grade, hard-anodized finish to protect the torch from seawater corrosion. It is built to withstand a drop of 1m (great for clumsy people like myself) and can be taken to depths of 150m. It is sealed with two O-rings.

Measuring 134mm in length and 26mm in diameter and clocking in at 225g in weight, the torch felt very solid and compact in my hands. An added bonus is the battery level indicator that lights up around the on/off button to ensure that you will not be left in the dark on a dive!

Ease of use

Operating the torch is incredibly easy. To use the laser pointer, you hold down the button and to turn it off, you simply release the button. To switch on the torch beam, you double click the same button. It then stays on until you double click it again. As the two light sources can be controlled independently, you can even use the laser pointer whilst the torch is on.

I have used the OrcaTorch D570 for a couple of months now, and it does everything I hoped it would—and more. The beam of the torch has an eight degree angle, is nice and bright and has been very useful for scouring the reef on deeper, darker dives—and for signalling to wayward buddies. I love the green laser pointer as it easily picks out the critters on the reef. Using the torch is very simple and totally fumble-proof.

Battery life

The battery life has been very impressive and not once has the torch ever let me down. OrcaTorch specifies a 111-minute run time for the torch. I do charge the battery every evening, just to make sure it has enough power for the following day and have not yet experienced the "low battery" warning.

Although not sold as such, I have even used it as a source of constant lighting for underwater photography. With a bit of jogging of camera settings, the results have been more than satisfactory. However, there are other OrcaTorches, such as the D900V, that work really well for photography, but it can be done with the D570 if needed!

Recommendation

Would I recommend the OrcaTorch D570 to my dive buddies and fellow dive guides? Absolutely. It is the ideal underwater tool—whether you want to use it as a torch or to point out critters, it does the job perfectly, and with its sturdy build, gives the impression that it will last forever. ■

Kate Jonker is an underwater photographer and writer based in South Africa. She teaches underwater photography, is an assistant instructor and dive boat skipper for Indigo Scuba in Gordon's Bay, Cape Town, South Africa and leads dive trips across the globe. For more information, please visit: ***katejonker.com****.*

VLAD TCHOMPALOV / UNSPLASH

Choosing a BCD

— Solutions for the Slight

Text by Simon Pridmore

— This issue's column is adapted from a chapter in Simon's latest book Scuba Exceptional: Become the Best Diver You Can Be.

In 2014, off the Coromandel Peninsula in New Zealand, a diver on a discover-scuba experience died when she became separated from her group and ran out of air. She was discovered on the surface, floating face down. The inquest found that the dive operation involved was to blame because they had failed to supervise her properly. They were also criticised for having given her a BCD that was too large and that made it "difficult for her to lift her head and breathe", as the verdict read.

The chief health and safety inspector who conducted the investigation into the death was quoted as saying: "… the ill-fitted equipment compromised the victim's ability to try and breathe when her air supply ran out. It also meant she couldn't tell anyone she was in distress or get help."

Evidently, the diver ran out of air but actually made it to the surface alive, where she then drowned because of her over-sized BCD. The lack of supervision put her in difficulty, but it was the BCD that killed her—a tragedy that was completely preventable.

A solution for the slight

Poorly-fitting rental equipment is all too common, and BCDs are the main problem, especially for slimmer adults and children. You often see smaller-framed individuals and teenagers on scuba try-dives and courses for beginners, floating on the surface in a pool or the ocean, lost inside their inflated BCD with the shoulder harness straps hovering above their ears and their heads partly submerged. Over the years, a number of people have told me that their first experience of scuba diving was so unpleasant

A boy with a jacket-style BCD, which is too large for him. The shoulder straps ride up past his ears when they should be snug around his shoulders.

SIMON PRIDMORE

because of an over-sized BCD that they never dived again.

An answer that fits the problem

It is a systemic problem within the dive industry, but there is a solution and it is being adopted widely in Asia, where scuba diving is still relatively new, and many scuba divers are of smaller build. I should mention here that the diver who died off the Coromandel Peninsula was Asian, and she was diving in a country where the majority of the diving population is probably not small of build. It may well be that the BCD that was too big for her was the smallest size the dive operation had.

The solution to the problem is a harness that hugs the body, with straps over the shoulders, around the waist and between the legs, attached to a back mounted air cell. The common terminology for this style of BCD is a harness and wing. The air cell is the wing.

A little history

A couple of decades ago, the first harness and wing systems were developed by cave divers and quickly became the standard for technical divers of all disciplines. Their versatility, the uncluttered design and the increased freedom of movement they offered swiftly led to interest from non-technical divers too. Mainstream industry players, conservative and resistant to change as always, reacted with disdain. "They are unsafe; they will throw you on to your front at the surface and you will drown," said people who had never even tried using this type of equipment. "Divers will find it difficult to vent air from them," they complained.

As is often the case, divers did not listen to the naysayers and decided that they would make up their own minds. They found that all they needed was a little practice in the use of a back-mounted air cell and they could benefit from a design that held the head higher on the surface than a conventional jacket-style BCD, was actually easier to control and did not squeeze their ribcages and inhibit breathing when the air cell was fully inflated.

They also discovered that a harness permitted every diver, whatever his or her shape and size, to have a BCD that fitted perfectly, as all the straps could be lengthened or shortened to match the individual. They could also be easily adjusted when a diver switched between using a wetsuit and a drysuit. Inevitably, BCD manufacturers followed the demand and more options appeared on the market.

The story today

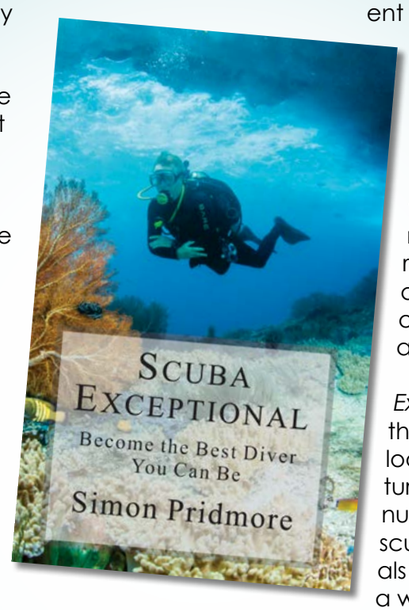
This all took place several years ago but, today, standard jacket-style systems are still more commonly seen, particularly in dive centre rental fleets. Why is this, when a harness and wing offer so many advantages?

A number of factors are responsible. First, harness-and-wing designs have always been more expensive than jacket-style BCDs. This means that, for financial reasons, dive centres have continued to buy jacket-style options for training and rental use. Therefore, not only do new divers get used to using jacket-style BCDs, they are often unaware that an option even exists.

Second, many harness-and-wing sys-

A New Book for Scuba Divers!

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



PIXABAY

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

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

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

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

A boy in a harness-and-wing system, which is adjustable, so it fits him perfectly. The system allows the head to be held higher on the surface of the water than a conventional jacket-style BCD does. It is easier to control and does not squeeze the diver's ribcage and inhibit breathing when the air cell is fully inflated.

tems have a solid aluminium or stainless steel backplate and those developed to date have been mostly one-size-fits-all and uncomfortable to wear, unless your body contours match the plate exactly and you wear plenty of neoprene.

Third, where manufacturers produce more comfortable soft backpacks for back-mounted air-cells, they tend to sacrifice versatility in the harness design. Strap length and buckle and D-ring placement are often fixed and non-adjustable. This removes one of the most important advantages of a harness and wing.

Fourth, to date, very little thought has been given to creating wings for the wider market of divers who do not dive with multiple cylinders. Wings designed for use with double cylinders are much too big for single cylinder diving.

Finally, despite the fact that several years ago, scuba diving entered an era where the majority of new divers were women, smaller men or teenagers, few manufacturers have responded with designs that suit the body shapes of this new market.

New thinking

This has changed. At a dive exhibition in Asia recently, I noticed a crowd around one of the stands and stopped to see what the excitement was all about. I saw a small teenage boy standing there in a wetsuit and wearing a harness-and-wing system that fitted him perfectly. Most of the people drawn to the stand were discussing how well the harness would fit them and how unobtrusive and streamlined the wing looked.

In a region where almost everyone has to fly somewhere to scuba dive, the onlookers were also impressed by how little this harness-and-wing system weighed. Despite the fact that the wing had both an outer and inner bladder; all the D-rings, slides and the harness buckle were premium stainless steel; and it had two cylinder bands—the total weight was under 3kg (7lbs). There were a variety of shapes and sizes of backplate available, to accommodate different body shapes, and the wing was sized and designed specifically for use with a single cylinder.

A few months later, I noticed another manufacturer in Europe selling a wing and harness, sized for what they referred to as a "youth" market. It looked perfect too for adults who find that extra-small European and US sizing is still too big for them.

Karen's story

I close this chapter with a much happier tale than the one I began it with. A while ago, I mentioned the advantages of harness-and-wing systems to a friend named Karen, who is a petite, slim, fit New York lawyer. She was complaining that, in all her 20-plus years of diving, she had never been able to find a BCD that fit her well. She had tried extra small options from a variety of brands, as well as BCDs supposedly designed for ladies, and had found that they were either still too big for her or did not offer sufficient stability.

I suggested a harness with a small wing, gave her a (short) list of manufacturers and did not give the conversation any further thought until I met up with her again a year or so later, when she threw her arms around me in an unusually enthusiastic welcome and said she wanted to thank me.

Her new BCD had transformed her diving life. She said she had never experienced anything so effortless and comfortable. What is more, she was delighted to find that now she only needed to carry 2kgs (4.5lbs) of weight with her 3mm wetsuit, instead of the 4kgs (9lbs) she had required before.

I am sure there are many other Karens out there who may need a similar transformation in their diving life. If you know one, please pass on the message. ■

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

When the thumb goes up, divers expect to ascend. But what if they do not?

Risk & Uncertainty

— Why Numbers Do Not Mean Much When It Comes to Your Behaviours!

Text and photos by Gareth Lock

Gareth Lock writes the first of a series of articles, which are extracts from his recently published book *Under Pressure: Diving Deeper with Human Factors*. In this piece, he looks at risk management in diving and shows that most of the risks we manage are not actively managed at all. They are subject to emotions, biases and mental shortcuts, and we are actually managing uncertainty.

I remember watching a presentation by Sami Paakaarinen on the recovery of two divers who were his friends who had died while diving in the Plura cave system in northern Norway in February 2014. He put up a slide that said, "We took a calculated risk. Unfortunately, we were not very good at maths." He was referring to the dive where the two divers became trapped and panicked at a depth of more than 130m below the surface. They died and others on the dive were lucky to make it out alive. You can see the story here: **http://divingintotheunknown.com/en**. I would highly recommend watching the film too.

Unfortunately, humans are pretty poor at risk management when it comes to uncertain or novel situations. To understand why, we need to look at the how we make decisions. The first part of decision-making is "information gathering," which primarily refers to situational awareness. The topic of "situational awareness" will be covered in a later article in more detail, but suffice to say that we perceive information with our senses, determine if it is relevant and/or important, process it, and then we look to the future, using the mental models we have created to predict what is likely to happen. Once we have collected the information, we make a decision and the research has shown there are three main performance modes to this decision-making process.

1. Skills-based
2. Rules-based
3. Knowledge-based

Performance Modes

Skills-based: When we are operating in the skill-based performance mode, we are operating almost on autopilot. We are unconsciously competent. This could be when you do not think about your buoyancy control or know what your gas consumption rate is without looking at

Novel situations increase the likelihood of error. Clearing nets is not a simple task.

Uncertainty

your gauge. Errors happen here when we are distracted, and our autopilot jumps too far into the future and we miss steps.

Rules-based: When we are operating in the rule-based performance mode, we pattern match against previous experiences and training as well as what we have read. We pick up cues and clues, match them against previous patterns of life or expectation and make a decision based on this pattern. Errors happen here when we apply the wrong rule because we have misinterpreted the information (cues/clues), which leads to the wrong pattern being matched.

An example for this might be spending a week cave diving in large cylinders and getting used to the consumption rates at certain depths, and then spending a few days ocean diving with much smaller cylinders and at greater depths. The diver checks their gauge at the intervals they were used to but does not "notice" the consumption rate is actually much higher. As a consequence, they run out of gas on a 30m dive!

The more practiced we become, the more patterns we have to match, and the less we are actively directing our attention to make decisions. We often use the frame of reference: "It looks the same, therefore it is the same, and the last time we did it, it was ok." This is human nature—we are efficient beings!

Knowledge-based: The final mode is when we are operating in a knowledge-based performance mode, and this is where we start to encounter major issues when it comes to the reliability of the decision-making. The reason being that we are now trying to make a best fit, using mental shortcuts, pattern-matching and emotional drivers/biases. At this point we are not actively thinking through the problem. We are not logical.

Letting go of the line in zero visibility

An example from the book relates to Steve Bogaerts' exit from a cave survey where he had transited through a zero-visibility section of the cave, using line touch contact. However, on the way back, as he followed the same line out, the line disappeared into the silt. He kept following it until his shoulder was touching the floor of the cave and it kept going deeper. He returned to a point a little back into the cave, dropped his scooter and markers on the line and reached back for his safety spools. They were not there, having been dropped somewhere in the cave without him realising it, as he was surveying the cave.

He decided to let go of the line and swim in a straight line where he thought the line was. Unfortunately, he hit the wall of the cave without finding the line. He carefully turned 180 degrees and swam back. He found the scooter and marker. He set off again, this time in a slightly different direction and found the exit line. As he was swimming out, he thought to himself: "Why didn't I swim back into the cave, cut some of the permanent line, wrap that around an empty survey reel and use that as a safety spool?"

Unless we sit down and review our decision-making processes in detail, we are likely to be subject to outcome bias. For example, if we end up with a positive outcome, we judge that as a success, because we have not looked at how we got to the decision. We often judge ourselves or others more harshly if the same decision-making process ends up with an adverse outcome.

The problem with good outcomes, especially on the first attempt at something, is that you think that was the only way of solving the problem because you succeeded. Unfortunately, the error rates for the knowledge-based performance mode is in the order of 1:2 to 1:10. Not great odds for when you are dealing with potential life-threatening situations. Think about Steve's incident and how it might have been reviewed if he had not made it out alive to tell his tale? What about events you have had where you were close to the line and now look at things differently.

Ditch the irrelevant —make stuff up!

As we operate within these performance modes, we have developed a great way of dealing with the vast amount of information we have available to us and the fact we cannot process it all—we ditch what we do not think is relevant and/or important and we fill the gaps with what we think is happening or will happen with previous experiences, and we just make stuff up!! This is why risk management is not very good in novel situations, we do not know what was important and/or relevant until after the event. After the

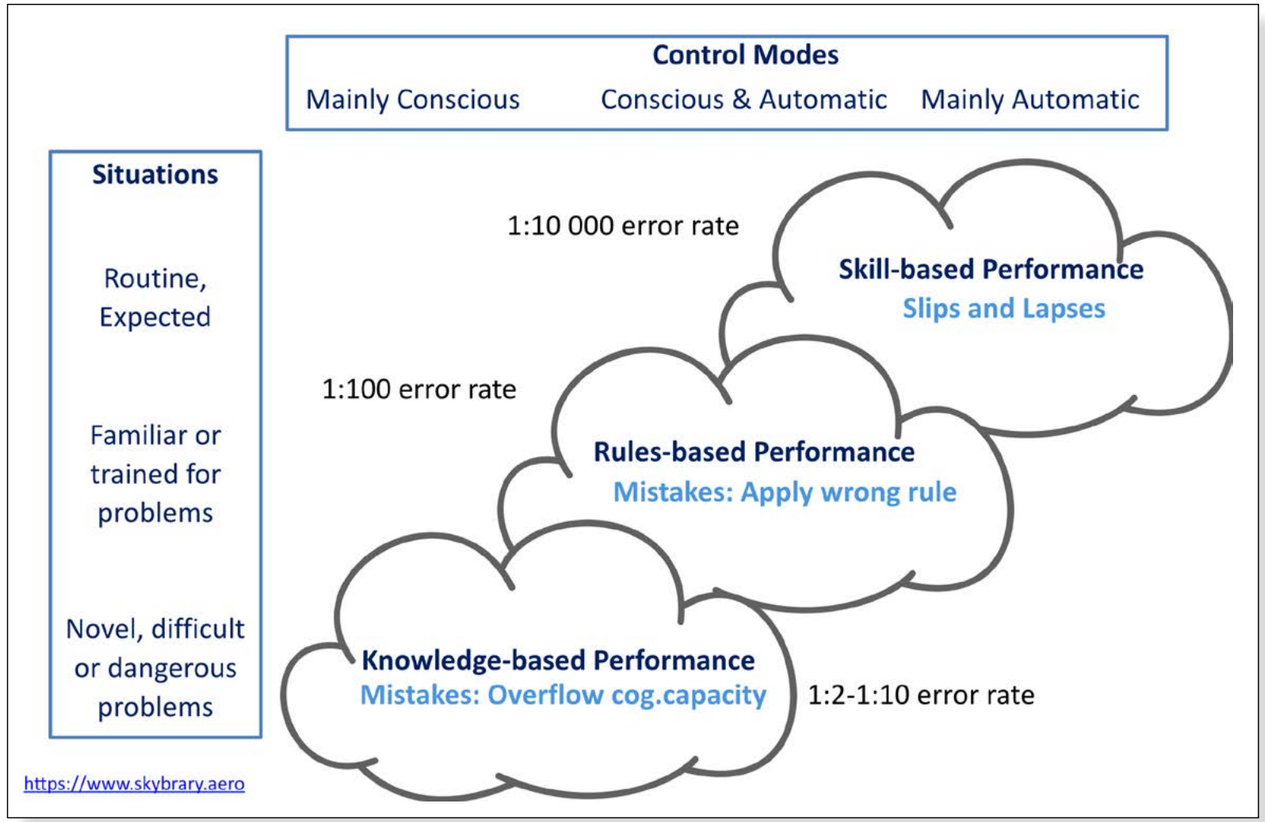
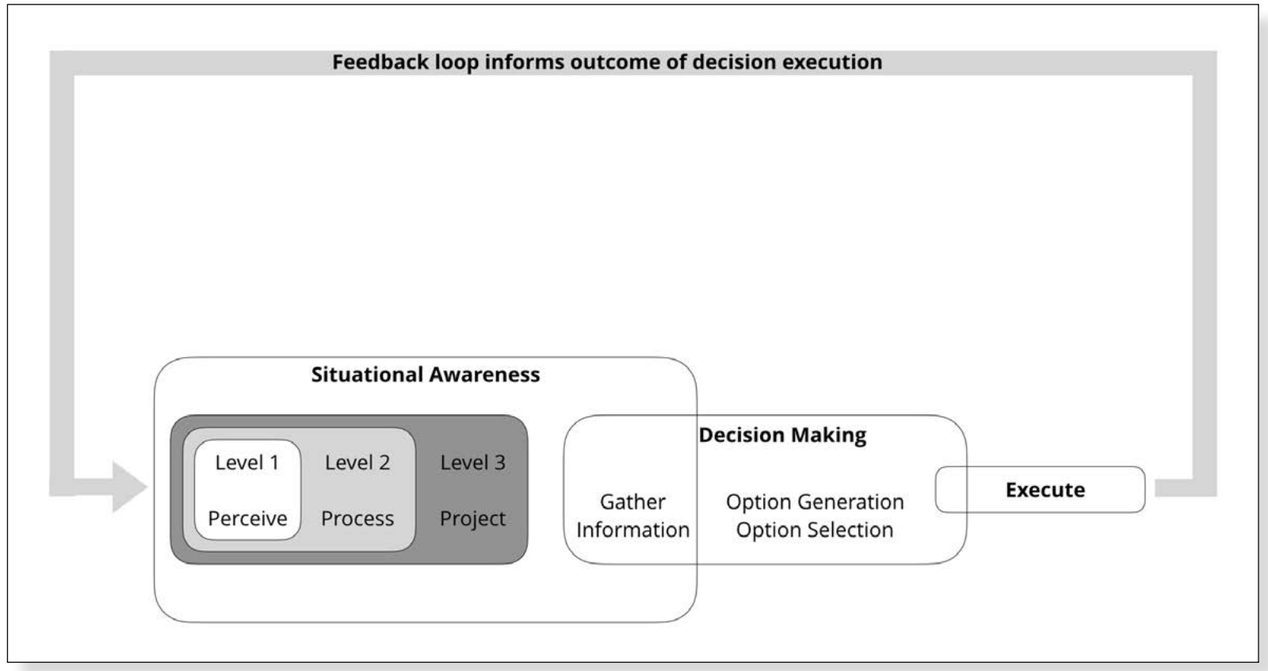


Diagram showing performance modes and their associated error rates

Diagram showing how situational awareness links to decision making



event, we can join the dots, working backwards in time and identifying what we perceive to be the causal factor.

When it happens to others, we often ask: "How could they not see that this was going to happen? It was obvious that that was going to be the outcome." If it was that obvious, i.e. with 100 percent certainty it was going to happen, then surely the diver would have done something about it to prevent it from happening. This brings me to one of my favourite quotes when it comes to risk and uncertainty:

"All accidents could be prevented, but only if we had the ability to predict with 100 percent certainty what the immediate future would hold. We can't do that, so we have to take a gamble on the few probable futures against all the billions of possible futures."

— Duncan MacKillop

Takeaways

We are all running little prediction engines in our head. We are predicting what is going to happen in the future. These engines are fuelled by experiences, knowledge and training. The more emotive the memory, the more likely it will be used to predict the future, even if it is not relevant!

For example, in the United States, there are approximately 300 to 350 general aviation fatalities every year (light aircraft, not commercial carriers). These happen in ones and twos, and rarely make the media headlines. But what if three regional jets crashed every year… do you think the perception of air travel would change?

The same applies to diving. In the United Kingdom, the risk of a diving fatality is approximately 1 in 200,000 dives. This is a very small number. However, you cannot be a fraction of dead when it happens to you or your buddy.

We use numerous biases to help us make decisions when facing uncertainty. Most of the time, they are fine; the challenge is learning to recognise when critical decisions are being faced, and we need to apply more logic and slow down. The numbers game will catch you up at some point.

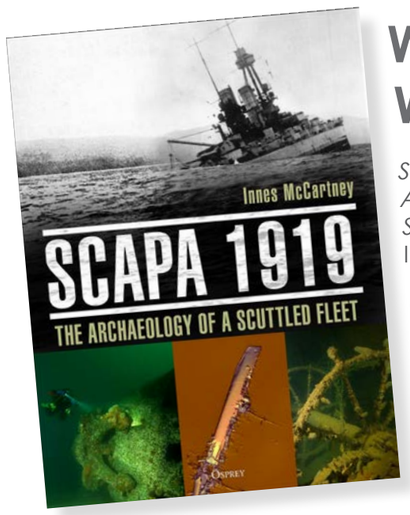
High-reliability organisations in high-risk sectors like aviation, oil and gas, nuclear and healthcare all have a chronic unease towards failure. They believe that something will go wrong, they just do not know when.

Take the same attitude to your diving: Service your gear; keep your skills to the level where you do not have to think about executing them—especially emergency or contingency skills; look for the failure points and where errors will trip you up; try not to use the mindset, "It worked ok last time;" and finally, when you have finished a dive or trip, ask yourself the question, "What was the greatest risk we took on that dive?" and address it before the next dive. ■

Gareth Lock is a diver, trainer and researcher based in the United Kingdom, who has a passion for improving dive safety by teaching and educating divers about the role that human factors play in diving—both successes and failures. He runs training programmes across the globe and via an online portal. In 2018, his online programme won an award for innovation in diving. You can find out more at: ***Thehumandiver.com****.*

Skills-based performance means lots of deliberate practice.

media



WWI Wrecks

Scapa 1919: The Archaeology of a Scuttled Fleet, by Innes McCartney

What happened to the lost ships of Jutland? In this book by marine archaeologist Dr Innes McCartney, the wreck sites of all 25 WWI German warships scuttled at Scapa Flow in 1919 are revealed for the first time, after nearly a century of being shrouded in mystery. One of the most powerful naval forces in the world at the time, the German High Seas Fleet faced a stalemate with the Royal Navy at the battle of Jutland in 1916. When fighting ended after the Armistice was signed, it surrendered to the British, and was held in Scapa Flow awaiting the outcome of the Treaty of Versailles. To avoid being divided up as prizes of war, the entire fleet tried to sink itself in July 1919. Fifty-two of the 74 ships were sunk, while 22 others were saved by the British or by circumstance. McCartney examines the factors and affairs behind each vessel's demise.

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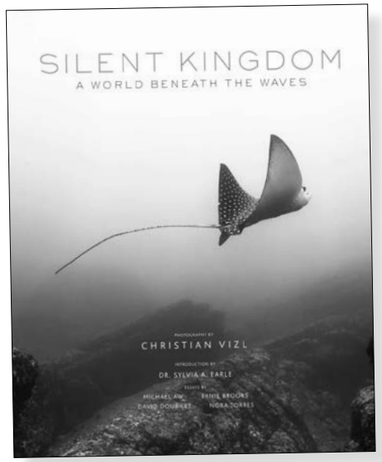
ISBN-13: 978-1472828903



Underwater Photography

Silent Kingdom: A World Beneath the Waves, with photographs by Christian Vizl and text by Dr. Sylvia A. Earle, Ernie Brooks, Michael Aw, Nora Torres and David Doubilet

Through an ethereal collection of black-and-white underwater photography, award-winning photographer Christian Vizl reveals the fragile beauty and sublime grace of the underwater world and its inhabitants—from playful dolphins to dynamic sharks. Go deeper into the watery space of our planet where human beings do not rule, one of the last true wild frontiers left on earth.

Hardcover: 224 pages
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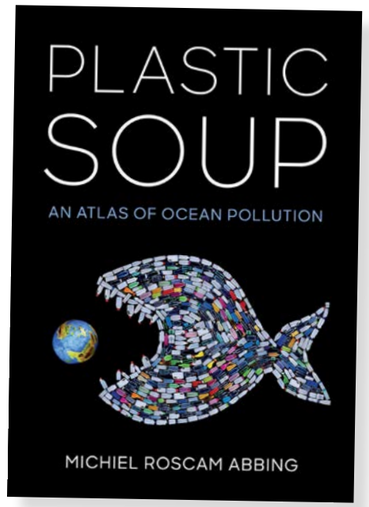
ISBN-13: 978-1683835844



Save Our Oceans

Plastic Soup: An Atlas of Ocean Pollution, by Michiel Roscam Abbing

At the rate we are producing plastic waste, by the year 2050, there will be more plastic than fish in the sea, according to some estimates. In this book, Michiel Roscam Abbing of the Plastic Soup Foundation sheds light on the depth of the problem of plastic pollution, yet serves up examples of inspirational initiatives tackling the issue—from innovative laws and art installations to plastic-free grocery stores. With striking images and graphics, *Plastic Soup* shows the impact of plastics, but also sends a message of hope—that where there is a will, there is a way.

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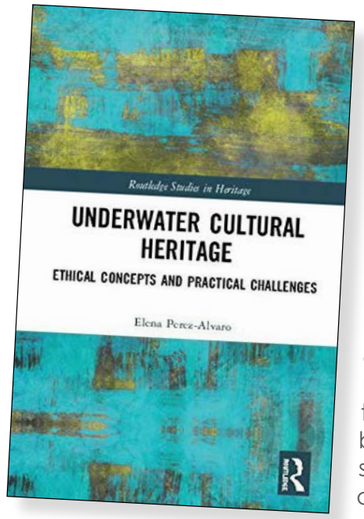
ISBN-13: 978-1642830088



Underwater Archaeology

Underwater Cultural Heritage: Ethical concepts and practical challenges, by Elena Perez-Alvaro

Climate change, current events and population growth have led to the revelation of new archeologicial sites, wrecks, monuments and even entire cities underwater. Drawing on case studies from around the world, this book takes a look at the new underwater cultural heritage being created and the ethical issues that surround it, which have never been studied before. These issues are important in shaping policy and legal frameworks that will manage and protect these sites in the future.

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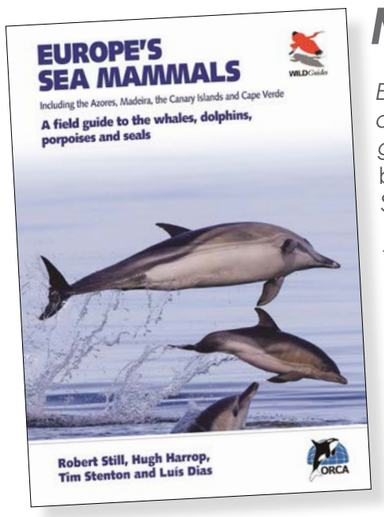

Marine Mammals

Europe's Sea Mammals Including the Azores, Madeira, the Canary Islands and Cape Verde: A field guide to the whales, dolphins, porpoises and seals, by Rob Rob Still , Hugh Harrop, Luís Dias and Tim Stenton

This one-of-a-kind photographic guide of Europe's 39 species of whales, dolphins and porpoises and nine species of seals boasts over 180 color photos, maps and graphics, highlighting key identification features and important information about each species' range, behavior, ecology and conservation status. Produced by the marine conservation charity ORCA, the guide is written and illustrated by a team of professional tour guides who have extensive experience presenting the marine mammals of the region, which covers the eastern Atlantic from Iceland to Macaronesia as well as the Mediterranean, Baltic and Caspian seas.

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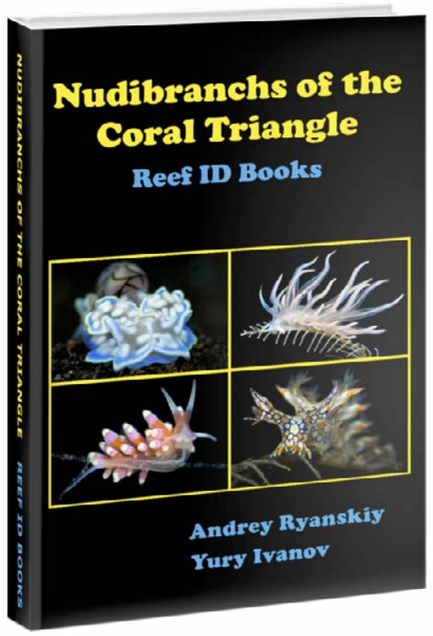

Text by Peter Symes

Nudibranchs of the Coral Triangle, by Andrey Ryanskiy and Yury Ivanov

Who isn't taken in by nudibranchs, these often psychedelically-coloured creatures with all their weirdly-shaped appendages sticking out like intricate antennae? In some hot spots, there always seem to be yet weirder and fancier, decorated specimens, moving slowly across the substrate, seemingly without a worry in the world. There are so many, and currently, about 3,000 species are known, from all parts of the world. It is therefore no mean feat that this new guidebook or identification guides has managed to cram in descriptions, with images, of more than a thousand species, which can be found in the Coral Triangle—the waters of Southeast Asia, which boasts the highest biodiversity in the world.

The book is intended to be a field guide for use by divers, such as underwater photographers, who would both want and need to identify their subjects. Even the printed version of the book, which is also offered as an ebook, is light enough to bring on a trip.

Each entry lists common name, Latin name, family, geographic distribution, size and the most distinctive features. A comprehensive photographic index at the beginning of the book will guide the reader through the taxonomy and to the right group of nudibranchs, providing a great aid in identifying the species—a task which otherwise can feel daunting. Being an identification guide, it is not the type of book you will sit down and read through in your armchair with a cup of tea. Rather, it is a specific reference tool with specific uses, but a very well-crafted one for its intended purposes. ■

Authors: Andrey Ryanskiy, Yury Ivanov
Series: Critter academy
Publisher: Andrey Ryanskiy
Publication Year: 2019
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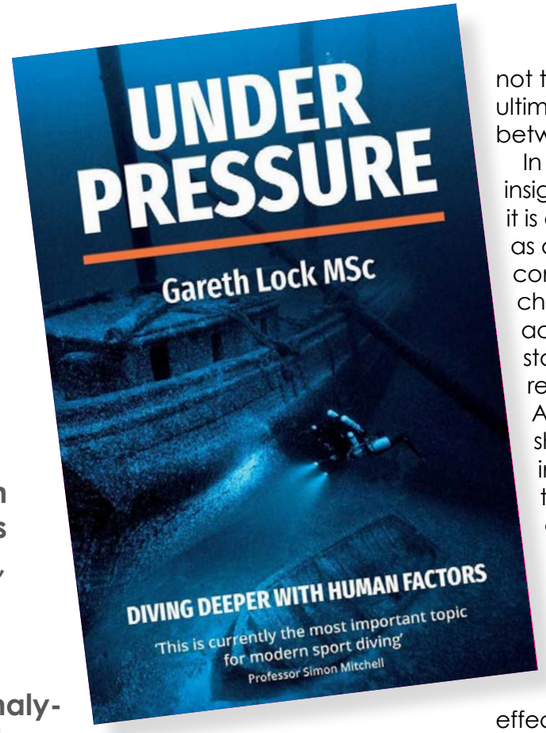
Text by Peter Symes

Under Pressure: Diving Deeper with Human Factors, by Gareth Lock

A must-read from regular *X-Ray Mag* contributor Gareth Lock.

This book contains more than 30 detailed stories from world-renown divers such as Jill Heinerth, Richard Lundgren, Steve Bogaerts and Roger Williams. The case studies and analysis show how experts can make mistakes and how they survived to tell the tale.



Convention states that reviewers should declare any conflicts of interest or relations with manufacturers, resort owners or authors with whom we have some sort of relationship. No problem. In fact, I am happy to declare I have never felt the slightest conflicted about Gareth Lock's work; I immediately recognised the significance of his findings and have happily published a series of his articles over the years. Now, his findings have been compiled into a new book, which should be made part of every diver's curriculum, because in this book is important stuff that will make you a safer and better diver. One could say, it is all about what we can learn from other people's mistakes in order to avoid making them ourselves.

Many of our long-term readers will be familiar with Lock, but for the benefit of latecomers, it should briefly be noted that he is a former RAF Squadron Leader, and he has applied the knowledge gained through a 25-year career in the Air Force to the significance of human errors in accidents and what can be done to prevent them.

Managing risk, while having fun

"Attributing 'human error' as the cause [of accidents and incidents] means we often focus on the outcomes rather than the failures in decision-making, situational awareness, communication, team work or the impact of stress and fatigue," said Lock. "In diving, errors which are not trapped or mitigated can ultimately mean the difference between life and death."

In the grander picture, Lock's insights made me realise how it is often the little things, such as a sudden distraction, which constitute the first link in a chain of events leading to an accident. We all know how stage magicians use misdirection to pull off their tricks. Attention is not where it should be. I like to think that in a similar manner, distraction, habits or presumptions can misdirect our attention when we go diving, or do other stuff for that matter. As a result, I have become far more mindful of how I go about various activities in life. Another positive side effect of these reflections is the enhanced appreciation of what I do as I have become more attentive to detail, focused on the task at hand and just being present in the experience.

New technology, smart gadgets and improved training curriculums only goes so far. We also have to improve our mindsets and how we interface with these new technologies. A sentence from the brief review on Amazon reads: "This book is a must for all divers who want to manage their risks more effectively and have fun in the process."

I could not agree more. ■

Paperback: 342 pages
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ISBN-13: 978-1999584979

An estimated 2,500 of the world's 10,000 blue whales spend time in the waters off the West Coast of the Americas and are known as the eastern North Pacific population.

Blue whales take note of where and when good food is most likely to show up

Blue whales locate prey by relying heavily on memory to return to stable, high-quality foraging sites, which historically have served them well, rather than matching the waves of krill availability in any given year.

The blue whale is the largest known creature to ever inhabit the earth, but up until very recently, almost nothing was known about its mating and migration routes.

By examining records of both whale migration and oceanic conditions in the California Current Ecosystem, researchers found that blue whales almost perfectly match the timing of their migration to the historical average timing of krill production.

Noting where and when

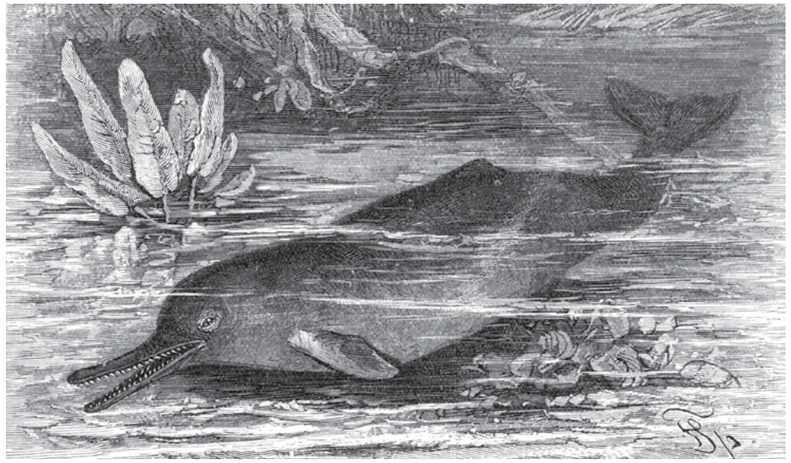
Many migrant species track waves of high-quality food sources across landscapes. Popular subjects on nature documentaries trekking caribou in the Arctic and wildebeests in the Serengeti, both enhance their survival by carefully adjusting the pace and timing of their migrations to find food as it becomes seasonally available along the way. Blue whales seem to embrace that same strategy. Tracking the timing of food availability along migration routes has been more difficult to identify in marine creatures and have not been extensively explored. By combining 10 years of satellite tracking data on blue whales with simultaneous remotely-sensed oceanographic measurements in the North Pacific, the timing of whale movements was compared to the timing of the spring phytoplankton bloom, which drives a coast-wide wave of krill, the whales' primary prey.

These comparisons went on to show that both long-term memory and resource tracking play key roles in the long-distance migrations of these mighty creatures.

Results also indicate that memory of long-term average conditions may have a previously underappreciated role in driving migratory movements of long-lived species in marine systems. ■

"We think that blue whales have evolved to use historical migration routes and timing that put them in proximity to the most predictably high production feeding areas and then make minor adjustments based on local conditions."

— Daniel Palacios, principal investigator with Oregon State's Marine Mammal Institute



Historical illustration of Indus river dolphin by Friedrich Specht, 1927

Endangered Indus River dolphin and Irrawaddy populations appear to be increasing

A survey of the Indus River dolphin has revealed a 55 percent increase in the population of the endangered species.

Indus river dolphins are one of only four river dolphin species and subspecies in the world that spend all of their lives in freshwater.

A survey carried out by the Sindh Wildlife Department has counted 500 more river dolphins—for a total of 1,419—compared to the last recorded census in 2011, which found 918 dolphins in the 200km-long Indus Dolphin Reserve between Sukkur and Guddu barrage. Most dolphins are confined to a 1,200km stretch of the river and divided into isolated populations by six barrages.

The first ever dolphin census in the country was carried out in 1974 by Swiss professor Giorgio Pilleri, which discovered only 150 dolphins. Numbers declined dramatically after the construction of an irrigation system. Following his survey, the first-ever protected area designated only for the conservation of endangered dolphins was created to save them from extinction.

In Cambodia, the Irrawaddy dolphins in the Mekong River have been on the brink of extinction for decades. Thanks to bans on using poison and dynamite in fishing, cracking down on illegal activities, and promotion of ecotourism, the dolphins slowly came back. The newest survey presents that there are 92 Irrawaddy dolphins swimming in the river again, and researchers were able to identify 12 new calves. ■ SOURCE: THE EXPRESS TRIBUNE PAKISTAN

J. P. SYLVESTRE / NOAA

Type D orcas are characterised by a very small white eye-patch and bulbous forehead. They prefer somewhat warmer waters of the sub-Antarctic over colder waters farther south.

New species of orca likely identified

A team of NOAA scientists have, for the first time, found and studied a possible new species of orca, called Type D, alive in the wild. Type D is characterised by a distinctly different colour pattern and body shape.

Killer whales are the largest extant members of the dolphin family. Genetic samples will help determine whether this animal, with its distinctly different colour pattern and body shape, is indeed new to science.

In 1955, a pod of unusual-looking killer whales stranded on a New Zealand beach and a skeleton was saved in a museum in Wellington. Initially, scientists speculated that the unique look might have been a genetic aberration only seen in those stranded whales.

Species or subspecies?

In 2013, a team from the University of Copenhagen used DNA from dried tissue and tooth fragments from the New Zealand skeleton, the only known specimen of type D killer whale. From that, the researchers estimated that type D separated from other killer whales approximately 390,000 years ago, making it the second oldest branch in the killer whale family tree and possibly a separate subspecies or species.

Type D orca shown on the left. Notice the much smaller white eye-patch and more rounded forehead.

"We are very excited about the genetic analyses to come. Type D killer whales could be the largest undescribed animal left on the planet and a clear indication of how little we know about life in our oceans."

— Bob Pitman, NOAA

In January 2019, an international team of scientists working off the tip of southern Chile aboard the research vessel *Australis* encountered a group of about 30 whales, which approached the vessel many times. In the next few months, NOAA scientists will analyse the DNA samples, which should finally reveal just how different the Type D is from other killer whales.

"These samples hold the key to determining whether this form of killer whale represents a distinct species," said Bob Pitman, a researcher from NOAA Fisheries' Southwest Fisheries Science Centre in La Jolla, California.

Living offshore

Because Type D killer whales seem to live in offshore waters in some of the most inhospitable latitudes on the planet—the Roaring 40s and the Furious 50s, known for their strong winds—it is no wonder it has been almost unknown to science. The sightings indicated a distribution around the entire continent of Antarctica, but within subantarctic waters and avoiding the coldest waters. ■ SOURCES: NOAA, POLAR BIOLOGY (JOURNAL)

CHRISTOPHER MICHEL - CC BY 2-0

(Filephoto) Orcas have been seen ramming white sharks, flipping them over and holding them belly up causing tonic immobility, a state of paralysis, after which the orca begin consuming the shark.

Orcas scare off great white sharks

Orcas and white sharks are prominent apex predators with highly-overlapping niches, yet their ecological interactions have remained obscure.

A group of scientists who were studying great white sharks at the Greater Farallones National Marine Sanctuary, off San Francisco, started to notice the sharks would disappear for an entire season once orcas turned up at the site. Great white sharks gather at the Farallones every year between September and December to hunt young elephant seals. They normally spend about a month at the Southeast Farallon Island—and this is the point where great whites and orcas overlap. The killer whales also prey on elephant seals, but their presence is transient.

In multiple instances, brief visits from orcas displaced white sharks from a shared foraging site around Southeast Farallon Island, disrupting shark-feeding behaviour for extended periods. "When confronted by orcas, white sharks will immediately vacate their preferred hunting ground and will not return for up to a year, even though the orcas are only passing through," Salvador Jorgensen, a senior research scientist at the Monterey Bay Aquarium and lead author of the study, said in a statement. It is not clear whether the orcas off San Francisco would have targeted and killed the great whites Instead, the killer whales might have bullied the sharks out of the area, so they could take advantage of the elephant seals there.

Tagged white sharks relocated to other aggregation sites, creating detectable increases in white shark density at Ano Nuevo Island. ■ SOURCE: SCIENTIFIC REPORTS

DAN Safety

Understanding the Future of Decompression Risk

Sponsored content by DAN

Decompression stress is a tricky topic to understand. From early in our diving careers, we are taught to think of decompression sickness (DCS) as binary—you either have symptoms or you do not. Being tired or achy after a long dive, unplanned exertion at depth or a change in decompression planning is often not considered very seriously; if you do not have symptoms, the prevailing thinking is to not worry about it. Despite the way divers have operated for decades, researchers at the forefront of decompression research are pushing hard for greater consideration of the factors that contribute to DCS risk—factors, which combined, create a total picture of our risk.

This holistic picture of DCS risk is called decompression stress—it is a combination of environmental, physiological and diver-specific factors. While excellent in theory, this conceptualization requires a more thorough understanding of bubble mechanics than we currently possess. Connecting decompression stress to real DCS numbers depends on a thorough understanding of how bubbles form in the body, what they do and when they cause symptoms, and that is something we just do not have yet.

Virginie Papadopoulou, Ph.D., a researcher at the University of North Carolina, is working on such an understanding of bubble mechanics. Her work deals with the clinical applications of bubbles in ultrasound-targeted drug delivery, bubble formation in divers and correlation of bubble counts with DCS risk.

Research from her lab has indicated that our inability to correlate a diver's postdive bubble count (the number of bubbles observed in their body) with DCS risk may hinge on the technology we use to view those bubbles. Papadopoulou specializes in ultrasound imaging techniques and has proposed that using more advanced ultrasound imaging to count not just the typical range of bubble sizes, but microbubbles and nanodroplets (bubbles on the order of 1-10 micrometers) may yield a more linear correlation between bubble count and actual DCS risk.

Microbubbles and bubble counts

These microbubbles have previously gone undetected, but recent projects using contrast ultrasound have shown that including microbubbles in postdive bubble counts results in a signal increase (indicative of bubble populations in this type of ultrasound imaging) in divers who were previously considered "bubblers" as well as those considered "nonbubblers" when subjected to tradition ultrasound imaging.

Some of these divers, imaged with traditional b-mode sonography, may bubble equally but in sizes that could not be imaged, leading researchers to conclude that they did not bubble at all. Similarly, divers that bubbled significantly and in sizes that could be traditionally imaged would appear to be "bubblers" while asymptomatic, which pushed research even away from an accurate relationship between bubble count and DCS risk.

Looking at the bigger picture

In addition to this revolution in imaging technology, many researchers, Papadopoulou included, are working toward understanding DCS in a linear model. Rather than noting just which divers had DCS and which did not, they are advocating a more complete understanding of each individual diver and their profiles and comparing this information to their dive outcomes.

The individual contributions to total DCS risk have yet to be determined, but understanding the effect of hydration, ascent rate, water temperature, exercise, body composition and more, and combining that with accurate bubble counts paints a clearer picture of decompression risk as a whole. Considering these risk factors in light of not only reported DCS symptoms but within a broader picture of fatigue, aches and other symptoms frequently dismissed as subclinical or as caused by other factors (such as exertion, sunburn, etc.) may help researchers find new ways to understand the risks we face while diving and how to better keep divers safe.

It is hard to know even now if we have a complete picture of bubble count or any other physiological change after a dive. Papadopoulou and others are actively working toward controlled studies to understand microbubbling and other factors that contribute to DCS risk, but their work is not yet ready for widespread application.

We can look forward to a field of young academics interested in both the clinical applications of bubble science and gaining a more thorough understanding of how bubble counts affect our risk as divers. The light at the end of the tunnel appears to be personalized decompression algorithms, tailored to our individual physiologies and dive profiles. Whether we will see these in the next year, five years or decade remains to be seen, but understanding the process as it progresses may provide divers with new best practices to minimize their risk, particularly as they push the limits of what recreational divers are capable. ■

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

Cave divers in Bjurälven cave system in Jämtland, Sweden

Bjurälven
— The Underground River

Text and photos Micke Tilja
Translated by Peter Symes

The waters of Bjurälven flows from Norway's mountains and into the Swedish province of Jämtland where the river meanders its way past the peaks and through the valley of Bjurälven where it is engulfed by the earth and disappears underground. In a thunderous roar, the great mass of water is swallowed by what is known as the Bjurälven Grotto, only to reappear more than one and a half kilometres away.

A decade of exploration

What course the water takes and what the passage is like nobody knows. What happens underground and how the water make its way from the entrance to the exit has been an enduring mystery. Until now.

The area surrounding the valley of Bjurälven is famous for its many caves and very popular with speleologists and cave enthusiasts. The calcareous limestone deposited some 450 million years ago is the reason why these caves exist. The water from the river finds its way into nooks and crannies and seeps into every crevice. Gradually, the calcium is dissolved and over the course of hundreds of thousands of years, the flow of water hollows out these magnificent underground chambers in an ongoing process, which continues to shape the landscape to this day.

As a result of this dynamic, it happens that some areas eventually cave in, leaving a funnel-shaped depression on the surface known as a *dolin*, or sinkhole. The valley of Bjurälv is dotted with these dolins, about 300 of them. The biggest one, Snödolinen (The Snow Sinkhole), is about 20m deep and 50m across. It is so named because it is so deep that snow remains in it all year round.

Diver making his way up "Alter Hill."

Basecamp was flooded due to rain.

Bjurälven

Discovery

In 1979, the Swedish federation of speleologists held a congregation in the valley of Bjurälven, and during this event, the attendees set out to visit the local caves. The longest cave in Sweden, Korallgrotten (The Coral Grotto) is located only a few kilometres from the valley of Bjurälven, and its passages reach more than 6km into the mountains.

One of the participants was Bo Leander, a dedicated speleologist and explorer with a vast experience in other caves. During a walk along the valley, Leander and his company happened to pause at a sandy beach by Dolinsjön (The Dolin Lake), a water-filled dolin. As he was enjoying a cup of coffee, gazing into the crystal-clear water, he caught a glimpse of what appeared to be an opening at the bottom and decided to take a closer look. It just so happened he still had his wetsuit, dive mask and Nikonos camera in his rucksack, after exploring some other cave earlier on. So, he jumped into the lake, holding a rock, and slowly descended to the bottom.

As it turned out, he was right. There, on the bottom, barely visible among the gravel, was an opening to a cave. The opening was quite small, about 10cm, and far too narrow to enter. But it was a significant find. Leander photographed the opening with his Nikonos camera. A map was drawn of the area, and the opening in the middle of the lake was marked. At that point in time, nobody had any inkling that this discovery would be of so much interest to a cave dive expedition more than 30 years later.

The challenge

In 2006, I had just arrived home from Florida with a freshly-minted cave diver certificate. An interest in exploring caves had started to manifest itself, and some of my dive buddies were up for taking a closer look inside Tuna Hästberg, an abandoned mine in the county of Dalarna. Diving in the mine was spectacular. We climbed down the shaft and camped overnight on the floor of quarry, falling asleep to the sound of water dripping from the ceiling. I loved every second of it.

This was when we began talking about the caves in Jämtland. My friends, who were far more knowledgeable on this topic, had tuned their inter-

Exploring a new cave entrance in Köldhålet

Air tanks were filled on site (below and right); Transportation to the location was by snowmobile (lower left)

est to the valley of Bjurälven, which had plenty of caves to explore. Evidently, a cave was discovered under a lake during the 1970s, and some diving was conducted during the 1990s. But due to the strong current, which is often prevalent during the summers, attempts to get inside the cave were unsuccessful. Another factor was that the area was about 5km from the nearest road accessible by car, and in the middle of a nature reserve.

Getting all the required equipment to the location, without impacting the protected area, posed quite a challenge. We either had to carry it all in ourselves, 5km over rough terrain, or we needed to use a helicopter. Neither option was feasible, so a completely different approach was required. The dives would have to be conducted during winter.

Thanks to the federation of speleologists, we succeeded in obtaining a permit to enter the otherwise strictly-guarded nature reserve for one week, using snowmobiles. Over the course of many evenings, a select group of divers met to plan what would become Expedition Bjurälven.

First expedition

In the beginning of March 2007, we were on our way to Jämtland. The car was packed with dive gear and clothes for a week, as I set a course for our destination, Stora Blåsjön, where we found accommodations in a former school. Halfway there, my phone rang. It was the driver of the first car in our group who had left the evening before, and after suffering a mechanical breakdown, had almost made it to our destination.

The Meteorological Institute had issued a "class three warning," which referred to extreme weather situations that can be very dangerous. The snow was coming down in droves. The other driver was now stuck, even in his four-wheel drive. So, if I carried on, I should be prepared for spending the night in the car.

I elected to turn about. Baffled, I later heard that dives had been conducted in the Bjurälv valley. Attempts to enter the dolin lake were unsuccessful, but a string of other interesting finds were made. Some 60m of a new cave had been mapped, and enthusiasm was running high. Another attempt had to be made.

Next attempt

The following year, a group of 13 keen divers gathered to make a new attempt, and once again, the dolin lake

A steel plattform helped divers gearing up in the water.

The hole in the ice froze shut every night.

was the focal point. Half of the team would explore Festins Grotta (Festins Grotto), a passage that was explored during the 1990s when divers Carl Douglas and Johan Candert (who were featured in *X-Ray Mag* #36), along with speleologists Johan Utas and Leif Sigvardsson, succeeded diving into one opening of the cave and reemerging from another some 70m away.

While the team I was in explored Festins Grotta and successfully followed the steps of the earlier group, the other team at Dolinsjön (the lake) had made significant progress. After cutting through metres of ice, creating an opening big enough for divers to enter and exit the lake, they began steadily digging away the gravel blocking the view into the opening Bo Leander had found so many years prior. After some digging, one of the divers, Nicklas Myrin, lay down on the gravel and slowly backed into the hole, legs first. The soft gravel packed around his body, as he slowly inched himself into the dark unknown behind him. The light from his torch disappeared from view, and the team anxiously, and with some trepidation, awaited to see what happened. After a while, the light reemerged, and back on the surface, Myrin announced that there was a big space inside.

Uncharted territory

A decision was made to get right back in, and this time, three divers prepared to enter. After some more digging and further effort, all three of them made it through the narrow entrance. The water was crystal clear, as the cave was illuminated for the first time ever. We were in uncharted territory. Nobody had been here before, and it was impossible to anticipate what lay around the next corner. Some 50m inside, the divers turned around in order to ascertain whether this was the right location for a continued exploration of the river. Plans for trying out other locations were abandoned, and going forward, the dolin lake became the hub and main starting point for further exploration.

Caves must be surveyed and mapped, and in the case of Bjurälven, it was decided that 3D mapping would be used on the whole system. In cave diving, lines are used as guides for navigating the labyrinth of passages, and emphasis is placed on positioning these lines in such a way that divers are led to the exit, even in low visibility. The guideline also serves as a reference for mapping the cave. Aided by compasses, dive computers and measuring tapes, directions, heights, depths, and right and left turns are recorded. As time-consuming and laborious a manual process as it might be, it forms the basis of creating a 3D model of the explored areas of the cave. After some successful dives in the dolin lake and compilation of the collected measurements, it became evident that this was the longest underwater cave in the country.

Despite our initial successes and all the progress made, we soon came to the realisation that

organisation and safety needed to be strengthened. Diving in caves in a remote mountainous region in the subarctic, beneath rocks and ice, in temperatures close to freezing, several kilometres from the nearest road and no cell phone coverage, poses some immense challenges. Even those few incidences we suffered initially, with overloaded snowmobiles keeling over and regulators that kept freezing and free-flowing, were exhausting. But in due course, we gradually found solutions and improvements were made, and the organisation was now properly set up for taking on the next challenges ahead.

Second expedition

Six years after our first expedition, we came to face a completely new scenario and new challenges. Stefan Barth and Markus Nord had swum for half an hour into the cave, making it to the farthest point so far. They were following the passage in an upward direction when they noticed something peculiar, a reflection on the water's surface. They cautiously approached and broke the surface. As their light beams illuminated the interior, they immediately realised where they were—in a huge chamber, located nearly half a kilometre inside the mountain.

This sensational discovery was shared during the meeting that evening, and the cave was further mapped the following day. What was discovered was a 100m-long, air-filled section of the cave, with fantastic colours, shapes and contours in the different layers of limestone, and even a 5m-high gallery. From the ceiling of this big chamber, a constant flow of water rained down, creating a little waterfall, which is why this space was named Regnsalen (The Rainy Hall).

Coming up with names

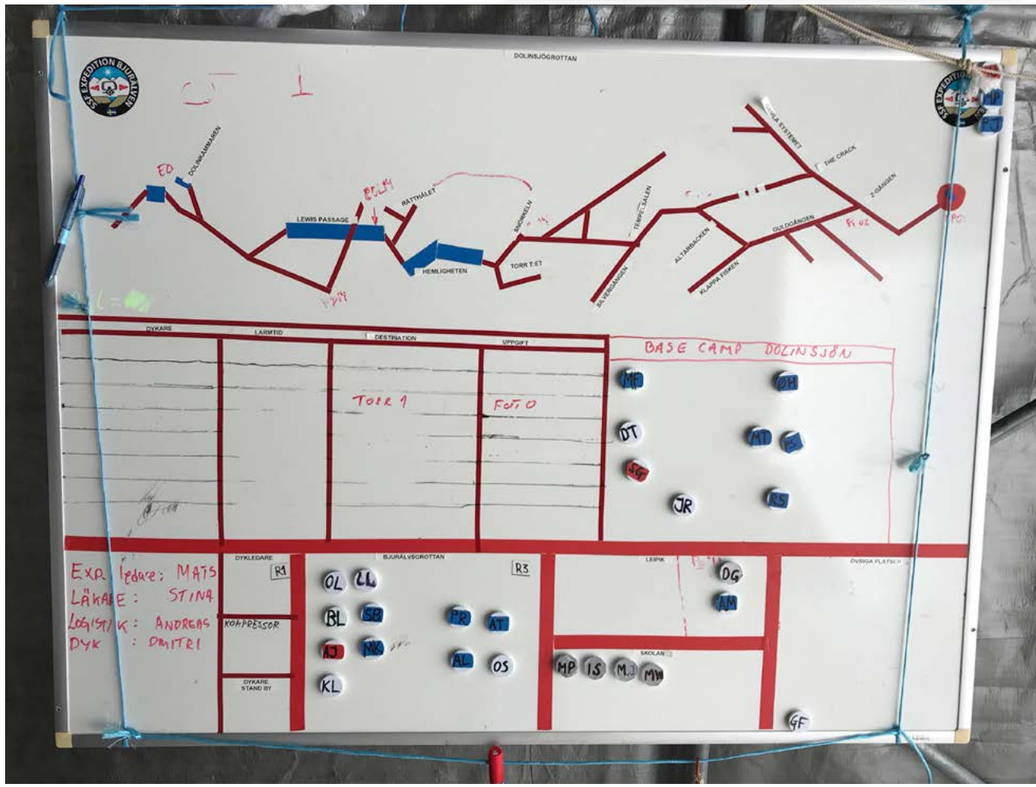
Naming the different sections of cave enabled us to better discuss the various areas, and they were often named on the basis of their appearance or after some event that took place at that location. Klappa Fisken (Pet the Fish), Tempelgången (The Temple Corridor), The Crack, Snorkeln (The Snorkel), or the recently explored tunnel Don't touch that rock! were all examples of names to which we could all relate.

The latter one, as the name indicates, described a spot where utmost caution was required. In order to proceed farther into the cave, divers had to make it through a narrow vertical shaft in the air-filled part of the cave, which was already quite a risky undertaking. But adding to the dangers was a nearly two-tonne boulder, balancing precariously just overhead. In other words, this was a rock you obviously did not want to touch.

A way forward

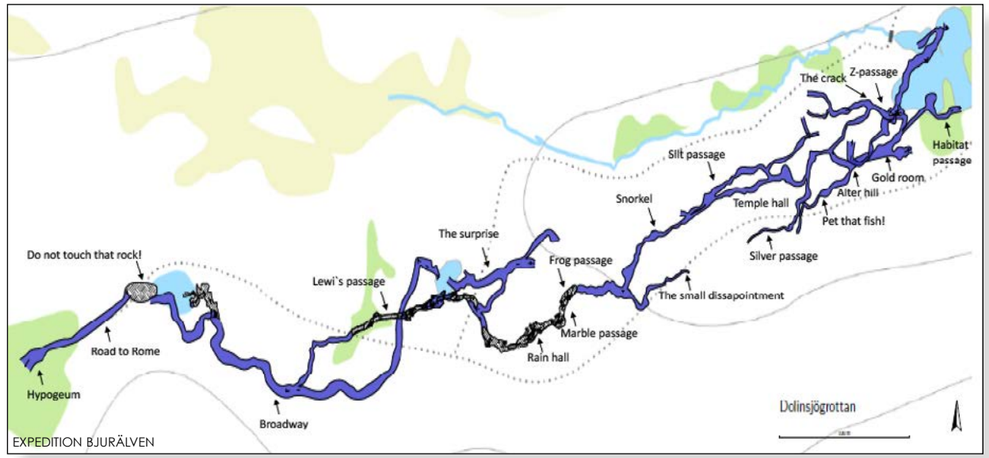
I had the pleasure, along with Pirre Sandberg, of naming a section myself, which we happened to stumble across.

Making our way up into the first air chamber



For safety reasons, team members needed to verify their locations.

PHOTO COURTESY OF MICKE TILJA



Bjurälven

Map of the Bjurälven cave system is being created from dive mapping and GPS tracking (left); Author Micke Tilja preparing for dive (far left)

It would turn out to be the way through which all further exploration would pass.

The expedition had arrived at an impasse. Two passages were explored, but they did not seem to lead anywhere. While frustration was starting to build, as the divers farthest in were trying to find a way forward, Sandberg and I decided to take a look at a side passage. I grabbed my reel, and we went to have a look through two narrow sections.

To venture into such spaces, not knowing what lay farther ahead, is not for those prone to claustrophobia. Would it be possible to turn around inside, or would we be forced to move out backwards through a passage, which was so low that our bellies and our backs would be scraping along the rock? Despite these concerns, our excursion paid dividends. Once we were past the two narrow sections, the space opened up to a 5m-wide tunnel, which stretched farther ahead than we could see in the light of our lamps.

We attached our line to a rock and swam back out. On the surface, we were jubilant and hugged each other before yelling to the dive leader that we had found the treasure room. This expression (Guldrummet) stuck and became the permanent name for this passage, which turned out to be the way farther into the cave.

Precise mapping

The mapping and documentation of the cave was taken to a higher level when Leander, who discovered the entrance to the cave in the 1970s, was invited to take part in the expedition. Leander is not just a cave enthusiast but also one of the country's leading authorities on radiocommunication and homing. In consultation with the dive team, he developed a transmitter and receiver that could pinpoint a location in the cave, relative to the surface, with great precision.

In order to produce precise charts of the cave, a number of points in space had to be localised with a high degree of precision. We called such points "fix points." Made up of small tags of stainless steel with unique ID-numbers, these fix points were attached with bolts to various strategic locations in the cave. These fix points were then traced from the surface and recorded, using a professional-grade GPS. This procedure was highly precise and enabled us to superimpose our survey of the cave onto a map and see exactly where the cave went under the landscape above.

Further discoveries and risk analysis

The discovery of Regnsalen and the air-filled sections turned out to be just a few of many more discoveries to come. A number of air-filled chambers have since been discovered, and each one poses its own challenges. Even as each of these sections had a lot to contribute to our adventure, they also posed many risks, because divers needed to make their way through the passages by climbing and crawling across rubble and slippery slopes while carrying heavy equipment.

In fact, the greatest risks we faced were not so much in the diving, but in the air-filled sections where a sprained ankle, or worse still, a broken leg would have serious consequences, since there was only one way out.

Hypothermia was another significant risk we had to factor into our risk analysis. The water temperature was barely above freezing, so a leaking suit or glove could soon become life-threatening.

A great deal of importance and focus has therefore been placed on risk analysis and safety. During the latest expedition, a whole day was dedicated to training and practising rescue

Water levels rose and the dive area flooded.

operations. Everyone practiced CPR and had basic training in handling trauma.

Hardware has also been continually upgraded, and emergency equipment, first aid kits and pain killers have been stowed in watertight containers, which have then been placed in the air-filled chambers in the cave. We also placed extra tanks at strategic locations in case of incidents, and we placed equipment topside for the immediate treatment of hypothermic or injured persons.

New challenges

Each new year presents new challenges, and weather plays a significant role. If there is too little snow, transport becomes more difficult, because we have to rely on snow ploughs to clear the road between our lodgings at Stora Blåsjön and Leipokvattnet, the last outpost before the road ends.

During our latest expedition, it rained heavily during the first two days. We had established a base at Dolinsjön, with tents and compressor. The ice had been cut, and we were about to commence diving when the water level started to rise. As the hours went by, we could only watch the ice disappear under the rising water. The snowmobile path to our base became impassable, and ultimately, we were forced to retrieve our two diesel-powered compressors or risk losing them under the rising waters.

In the course of two days, the water level rose more than a metre, and we were concerned that we had to evacuate the whole camp. But then the temperatures fell below freezing, and our base, which had been turned into a soupy slurry, became firm once more, and the water level slowly started to fall again.

A higher water level was not necessarily a disadvantage. It meant less schlepping of equipment in the air-filled sections of the cave, and by the end of the week, I managed to conduct my hitherto longest dive, which took me to the end of sump 4.

Sumps are the water-filled sections between the air-filled parts. So, the first submerged section from the entrance to the first air-filled space would be sump 1. The trip forth and back took about three hours, of which about 85 minutes were dive time.

We were not only exploring but also approaching the cave from other sides such as the Bjurälv Grotto where the river disappears underground. During summer, the river becomes a roaring waterfall, which is impossible to pass; however, during winter, it is possible, but still cumbersome, to find a way in. The entrance is frozen solid and needs to be shovelled free. Behind it, one encounters metre-thick, compact ice. Once past these obstacles, one has to rappel 10m down the vertical shaft, after which the cave can be entered.

There were several difficulties associated with approaching Bjurälven from this side. Aside from the challenge of getting inside, there was also the matter of the current, which was going to push us farther into the cave. The biggest challenge, however, was clearing a passage through all the rock and other debris, clogging up the entrance. The team that last explored the Bjurälv Grotto had to clear out several tons of rubble in order to battle their way forward, one metre at a time, to make it inside, through rapidly-flowing water. The objective was to make it possible to safely conduct diving from this entry.

Sweden's sixth longest cave

During this year's expedition, the cave under was explored a further 110m, which takes the total known length to 2,245m. This is the sixth longest cave in the country, and only 35m shy of being the fifth longest. The satellite images showed that we had made it about halfway to the Bjurälv Grotto. From the other end, some 275m has been explored so far. Every year, we get a bit closer to the ultimate goal of tracing the flow of the river and mapping the connection between the two openings. ■

Keeping regulators in the water between dives helped prevent freezing.

Bjurälven

Fibonacci Numbers

— in Underwater Photography

A feeling of beauty is often an indicator of the presence of a golden spiral.

Text and photos
by Rico Besserdich

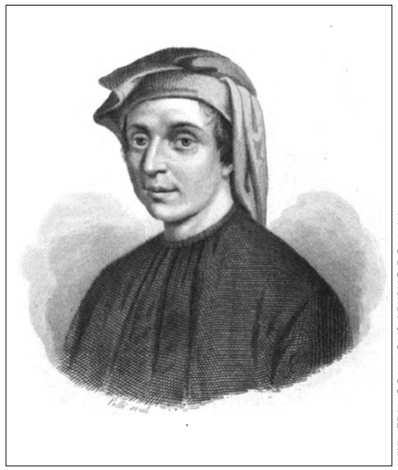
What makes an image a really good one is certainly a question that, at some point, troubles the mind of every image-maker. Is it the subject of the image, or is it the specific moment captured? Is it the colors in the photo, or the techniques used? Each of these aspects deserves consideration, and not every breathtaking image can be entirely explained by just following a checklist, marking the things that were done correctly with a green pen and using a red pen for the failures spotted. Yet, what most humans perceive as beautiful and aesthetically pleasing visually can surprisingly often be explained with math. Yes, math.

It is not a new thing. It all began in Pisa, 817 years ago, when a very clever mathematician was thinking profoundly about numbers… and also about rabbits. His name was Leonardo Pisano Bigollo, better known as Fibonacci.

Fibonacci lived around 1170-1250 B.C. and was known to be the most talented mathematician of the Western world in the Middle Ages. As a member of Pisan important trading family in Pisa, he traveled extensively throughout the Middle East as a youth and discovered the mathematical advantages of the Indian number system, which made its way to the West through the Arabic countries. In his time, the Roman numeric system was the one used in Europe, making advanced mathematics difficult, if not impossible.

In Fibonacci's own words (from his book *Liber Abaci*, published in 1202): "…when I had been introduced to the art of the Indians' nine symbols through remarkable teaching, knowledge of the art

Nineteenth century engraved portrait of Leonardo Pisano Bigollo, (aka. Fibonacci) from 1850 by an unknown artist (right); Leonardo da Vinci's *Vitruvian Man* (c. 1490) is considered to be a masterpiece, utilizing the golden ratio (far right)



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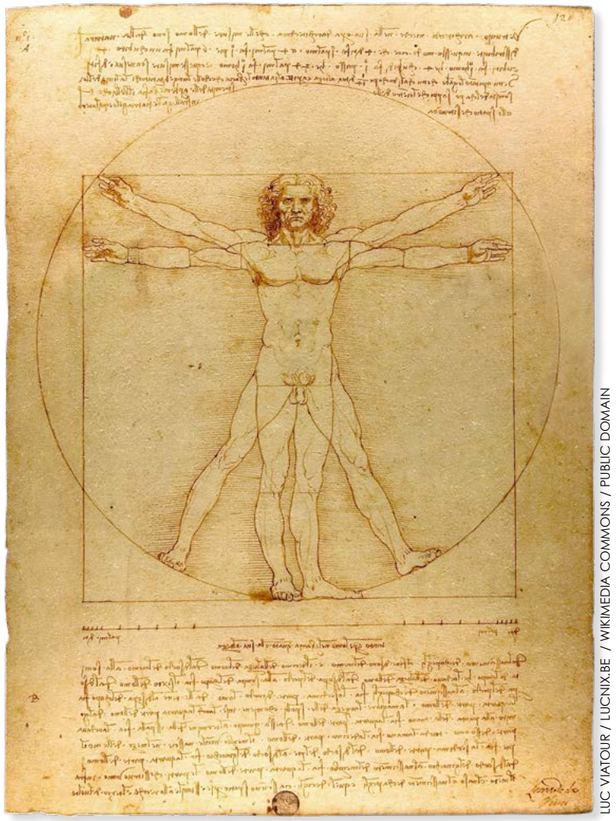

LUC VIATOUR / LUCNIX.BE / WIKIMEDIA COMMONS / PUBLIC DOMAIN

very soon pleased me above all else and I came to understand it, for whatever was studied by the art in Egypt, Syria, Greece, Sicily and Provence, in all its various forms."

Just imagine the year we are living in—2019—in Roman numerals. In Fibonacci's time, this number was written MMXIX. Tricky to do math with that.

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Statue of Fibonacci (1863) by Giovanni Paganucci, Camposanto di Pisa, Italy

A legendary formula

Around the year 1210, Fibonacci returned to Pisa, where he wrote several important texts and books. Copies of his works were extremely limited, as the great mathematician lived 200 years before print was even invented, so his texts and books were handwritten. One of his most well-known books survived the centuries: *Liber Abaci (The Book of Calculation)*. This book introduced the Hindu-Arabic decimal system and the use of Arabic numerals to Europe, an often forgotten but important fact. Forgotten perhaps because what is most often discussed is the problem about rabbits and the legendary mathematical formula resulting from it.

In his work, Fibonacci posed the following question: "A certain man puts a pair of rabbits in a place surrounded on all sides by a wall. How many pairs of rabbits can be produced from that pair in a year if it is supposed that every month each pair begets a new pair which from the second month on becomes productive?" (Fibonacci, *Liber Abaci*, third chapter)

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Find the golden ratio in human faces such as Grace Kelly's, the American actress who became Princess Grace of Monaco in 1956.

The resulting sequence, in which each number is the sum of the two preceding numbers, goes like this: 1, 1, 2, 3, 5, 8, 13, 21, 34, 55… and so on.

Behold, the world-renowned Fibonacci sequence, also known as the Fibonacci numbers. Please be patient, I will tell you in a short while what all this has to do with underwater photography.

An amazing proportion

Now Fibonacci himself actually had very practical matters and questions in mind when he studied and researched the deeper meanings of mathematics. Just take economy, accounting and population growth (rabbits!) as examples. Unbeknownst to Fibonacci at the time was that his sequence, or better to yet, the quotient of the adjacent terms, led to an amazing proportion—a proportion that can be found in tiny atoms, in DNA and in hurricanes, in small and large objects everywhere in nature, and even in distant galaxies.

This proportion is known by many names: the golden ratio, the golden mean, phi and the divine proportion, among others. Some even call it nature's secret code. It is a number that translates into a ratio, a ratio that defines beauty and aesthetics in nature and in the arts. The answer to the big question about (the meaning of) the universe, life and all the rest is not "42," it is 1.618. Nature's secret code—and yes, it is everywhere.

Do you like honey bees? If you divide the female bees by the male bees in any given hive, you will get 1.618. How about sunflowers? Sunflowers, which have opposing spirals of seeds, have a 1.618 ratio between the diameters of each rotation. Neither bees nor sunflowers in sight? Try measuring from your shoulder to your fingertips, and then divide this number by the length from your elbow to your fingertips. Your result will be 1.618. Too difficult? Take the length of your leg and compare it to the length of your arm. This proportion should be near 1.618 in almost all cases. The golden ratio cannot be avoided.

Everything beautiful in nature (including beautiful humans) is based on the golden ratio. Or, as the German philosopher Carl Friedrich von Weizsäcker nailed it down when he said, "Perhaps the omnipresent hidden mathematics of nature is the ground of all beauty."

With nature as the greatest teacher, many artists used the golden ratio to create artworks that will stay beautiful forever. Just take Raffael, Leonardo da Vinci, Dali, Rembrandt and Albrecht Dürer as a few examples. In the world of architecture, the Pyramid of Cheops (Giza) in Egypt, the Parthenon in Greece, St. Peter's Basilica in Italy or Cologne Cathedral in Germany are perfect examples, utilizing the golden ratio, the divine number, the sacred ratio 1.618.

In the underwater world

Once we open our eyes and minds to

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The Parthenon in Athens, Greece

The simplest way to divide an image frame into two sections, utilizing the Fibonacci number 1.618 (right); "Minimalistic" version of image composition, frame divided in the 1.618 ratio (far right)

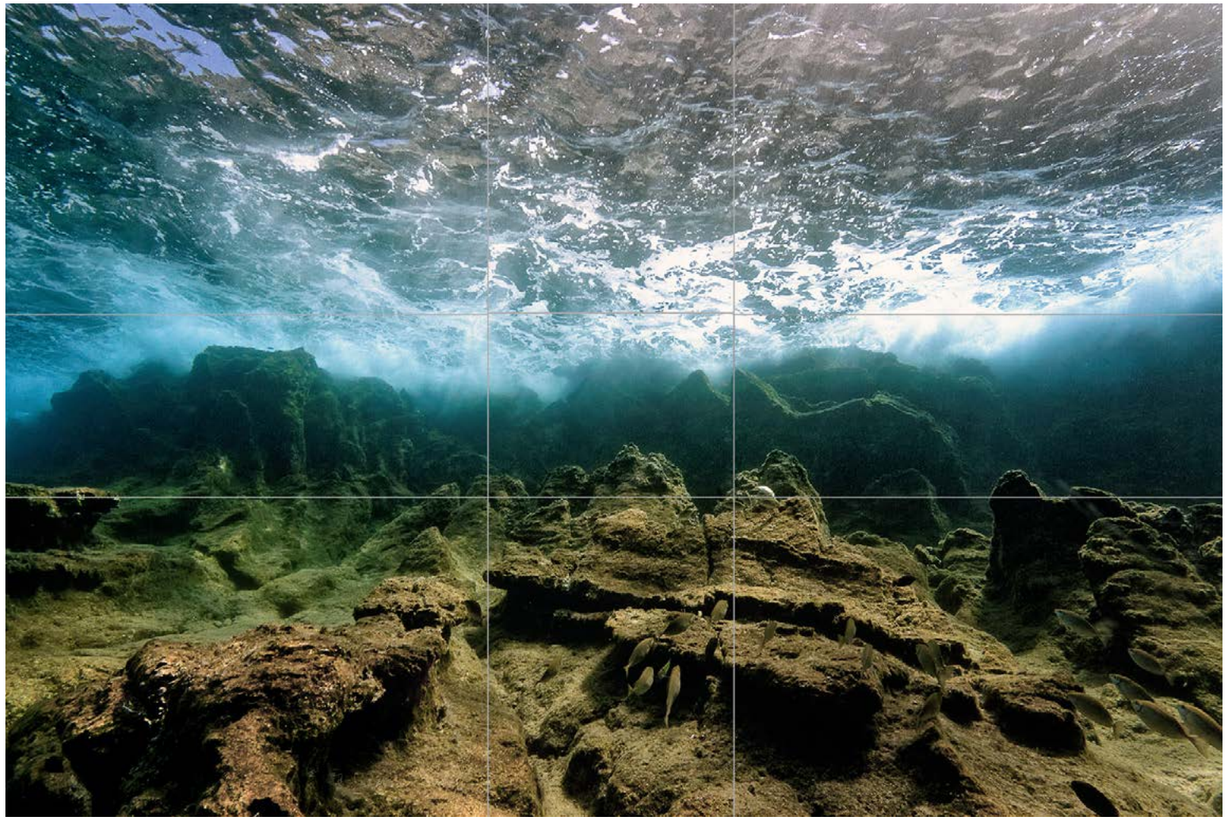
it, we can spot this divine ratio everywhere, even in the oceans. Seashells, nautilus, crinoids or even corals—everything we perceive as beautiful is based, in one way or another, on the Fibonacci sequence.

For photographers, this leads us to three options (assuming we want to create beautiful images with the divine number in mind): 1) We look out for marine life and subjects that fit into the golden ratio; 2) we compose our images according to the golden ratio; or 3) we combine the first two options above.

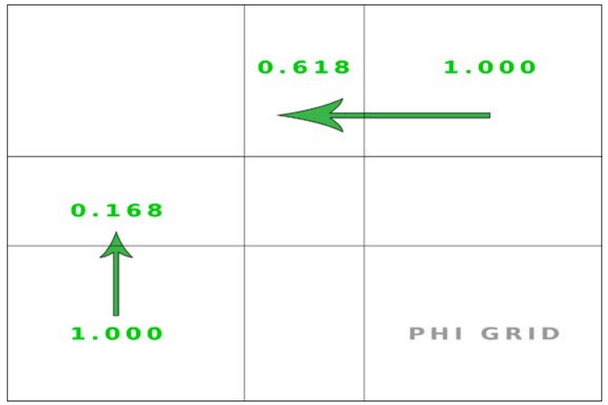
Well, not everyone likes math, and we are, at any rate, already overtasked with our diving, traveling, photo gear, and a million other things we need to keep in mind. So, let's start with something easy in terms of how to make use of the "magic number."

A very basic first step

Imagine your picture frame in your camera's viewfinder, LCD screen or on your computer screen in post-production. Divide this frame into two sections. Naturally, you might want to have two sections of the same size. But please don't... as it is not very Fibonacci!



The phi grid in an underwater landscape photograph—the "action" happens in the three center sections.



The phi grid (above) is based on the "divine number," or ratio, and as such, is very different from the well-known rule of thirds grid.

If you want to utilize the golden ratio, the two sections of your picture frame should not be of equal size. To do it "Fibonacci-style": Create one section that covers roughly 61.8 percent, and another one that covers roughly 38.2 percent of the frame.

To separate the frame into two sections of equal size would mean you subdivide your frame at "50," or directly down the middle. This could come with the risk of creating a boring image composition.

This works, by the way, with vertical and horizontal subdivisions alike. It also works with all kinds of different image aspect ratios (such as 4:3, 3:2, 1:1 and so on). What is important are the proportions of the sections (please see the image graphic top left).

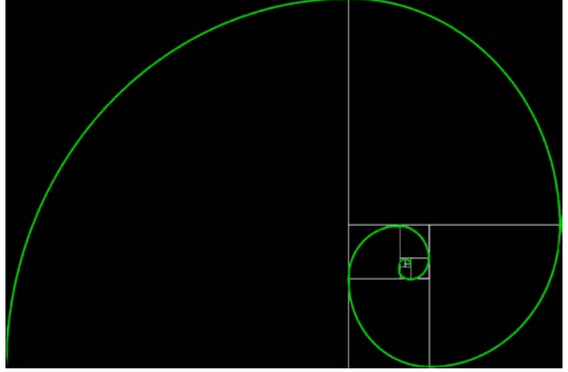
Please note that the Fibonacci sequence and its effects on image composition is not the "rule of thirds" and should not be mistaken for it. Image composition using the Fibonacci sequence is a far more advanced thing than the rule of thirds.

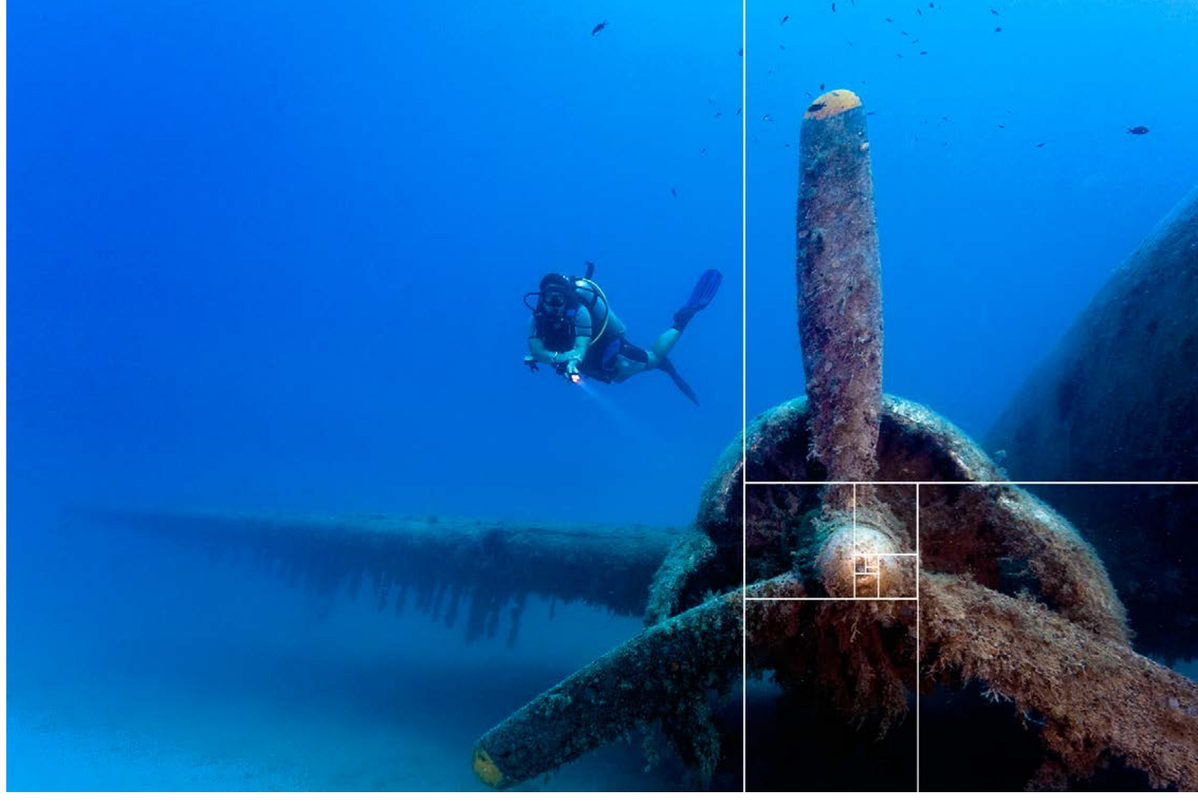
After that nice and smooth warm-up, let us proceed with the next step. It is called the phi grid, and again, it is a part of the Fibonacci numbers family.

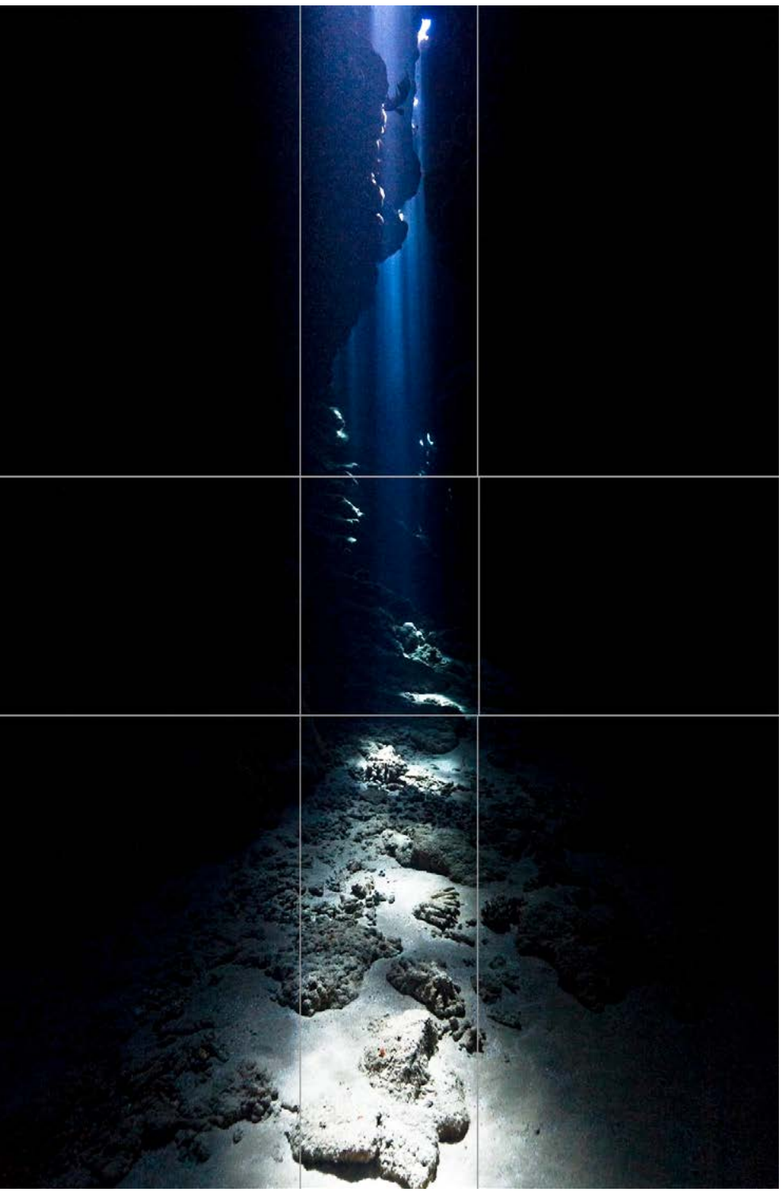
Phi grid

Now, everyone knows the rule of thirds. It divides a frame into three rows and three columns of equal size, resulting in a 1:1:1 ratio vertically and a 1:1:1 ratio horizontally—a well-known basis of image composition. The phi grid, however, works slightly differently. It divides the frame in a similar way as the rule of thirds does but makes the middle row and

The source of the magical golden spiral (right); The golden rectangle in an underwater image (far right); The golden rectangle and golden spiral, combined. Everything of interest in this underwater image fits in this configuration (lower right).







The phi grid and all other patterns of the golden ratio can be utilized in horizontal and vertical images alike.

middle column smaller according to the golden ratio. This results in a 1:1.618:1 ratio vertically and a 1:1.618:1 ratio horizontally. Simply put, the phi grid gives more weight to the top left and right sections, and to the bottom left and right sections of the frame (please see center image graphic on the previous page).

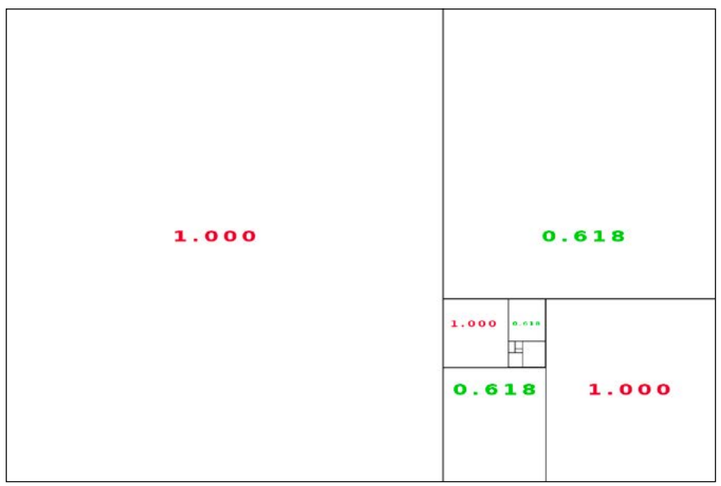
Golden rectangle

Whilst the first example was simple, because we divided a frame into only two sections; and the second example might have been easy to digest as well, since it reminded us somewhat of the rule of thirds; we will now go a little bit deeper into complexity with a third example.

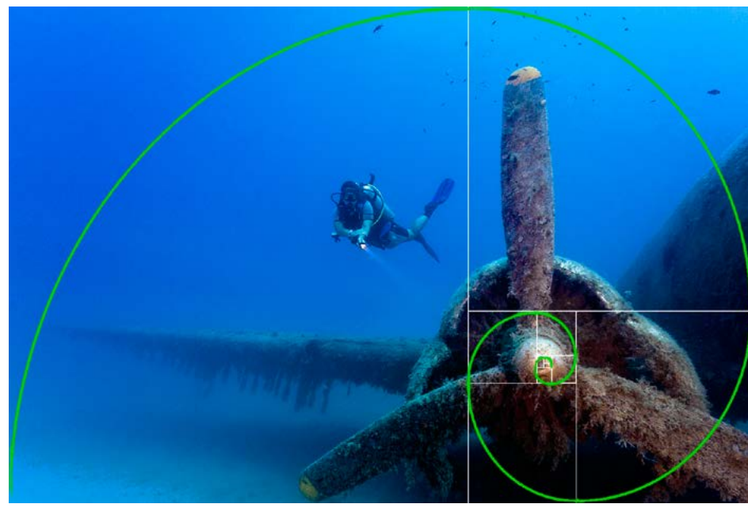
Following the Fibonacci sequence, an image frame can be subdivided into several sections of different dimensions, with each section and the sum of all of them fitting into the 1.618 ratio. Just remember the rabbits!

First, we divide the frame as in the first example, vertically dividing the frame into two sections, utilizing the 1.618 ratio. The larger section, we leave as it is; the smaller one, we divide into two sections horizontally, again in the 1.618 ratio.

The upper one stays as it is; the lower one we again divide horizontally into two sections. Again, we leave one of those new sections as it is and divide the next one. Logically, our sections are getting smaller and smaller. In the end, we have nine squares (outer frame border included) and a perfect Fibonacci sequence. Voila, the "golden rectangle." (See image left)



Dividing an image frame into several golden ratio sections. The proportion is always 1.618. This is the golden rectangle.



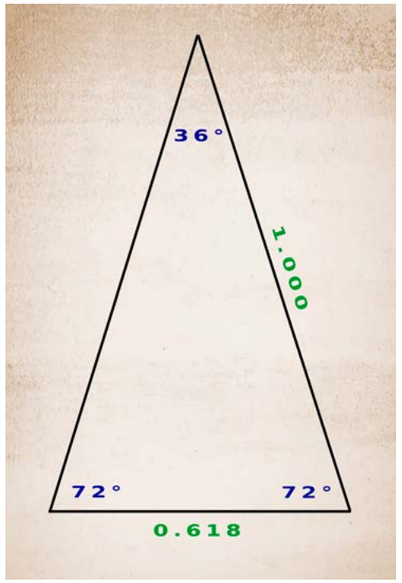
Golden spiral

This one is easy. Take the example above (our collection of different squares) and connect the vertices of these squares with a curved line. Result: The points of these vertices creates a (logarithmic) spiral. Voila, the "golden spiral"—Mother Nature's code of beauty. (See top left image)

The golden spiral is, one could say, a logical result of the Fibonacci sequence. And yes, it is everywhere.

Golden triangle

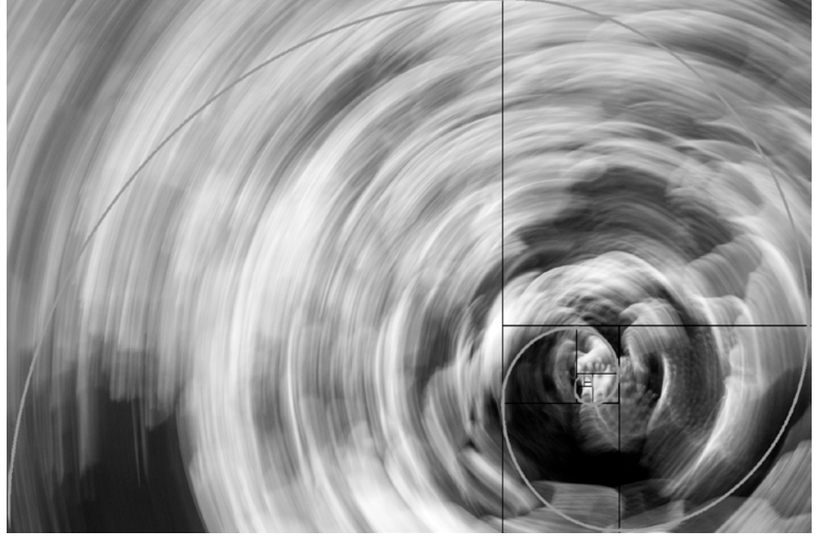
What works with squares works with triangles as well. The "golden triangle" is an isosceles triangle with a vertex angle of 36 degrees and base angles of 72 degrees. The legs are in a golden ratio (1.618 proportion) with the base. A penta-



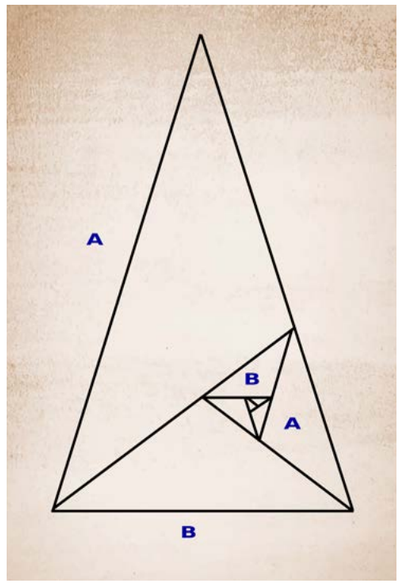
gram, for instance, is a perfect example of a combination of golden triangles.

Such a triangle can then be divided into smaller sections, with each section having a "golden number relation" to its neighbor. Connect the vertices of these squares in a curved line and you will have another golden spiral.

Any square-shaped image can be divided into golden triangles to help image composition. Just imagine (or draw) a horizontal line from one corner of the frame to the next. Consider this line to have the value of 1.618. Find a starting point (in your line) that is more or less equal to 1.000 (or at 68.2 percent of the line). From this point, draw another line that ends up in one of the two remaining empty frame corners. You do not have to, but you could draw a last line,



The golden rectangle and golden spiral image overlays are also useful to improve image composition (above); Beauty and the golden spiral, they are always together (right); The golden triangle, in its most basic version (left); The golden triangle, in a more advanced version—1.618 is the number! (below center); Wherever Fibonacci is, there is a golden spiral (lower right)

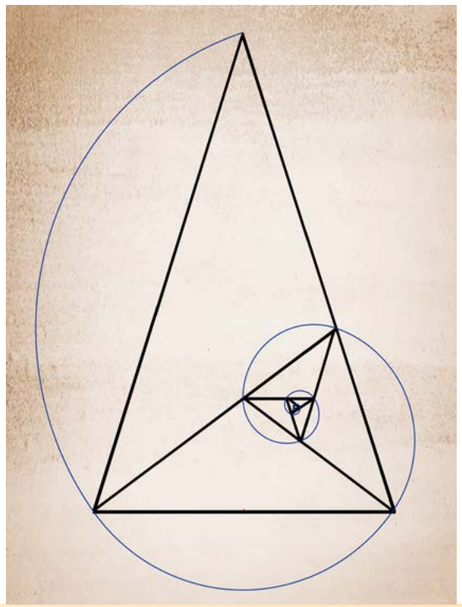


starting at 0.618 (or roughly 32.8 percent) of your "main" line, and reaching the last remaining corner of the image frame.

If the composition works according to the Fibonacci numbers, your main subjects will be oriented to the line(s) and/or fit nicely into the golden triangle sections, which your lines create in the image. (See lower images on next page).

Software

In case you find all this far too complicated to do, you can use Adobe Lightroom or Adobe Photoshop (version CC or later). Both provide the option to adjust or crop your image, utilizing the golden ratio. That does not mean you must crop, but it is a useful visual tool to find out if your image matches the golden ratio or not.



In Adobe Lightroom: When you are using the crop tool, you can cycle through the different options/grids by pressing O (for overlay). You cannot see or access this option unless you are actually using the crop tool. Which overlays (help grids) Adobe Lightroom makes available for you is something you can select by entering: Crop Guide Overlay > Choose Overlays to Cycle.

In Adobe Photoshop: First, the crop tool must be activated. To cycle through the different crop overlays/grids (including the golden ratio, of course), you can use the same keyboard shortcut (O).

Plan B: Just do a search online for "Fibonacci overlays," and you will find various websites of which some do offer free downloadable overlays with plenty of different golden ratio variations. For example: http://parksphotos.com/goldenoverlays/.

These tools are very useful when you want to check if your images are already proud members of the golden ratio, or golden number family, or perhaps could use a slight correction to improve their composition. After a little practice, you will easily memorize Mother Nature's special code as it has always been with you… even in your very own DNA.

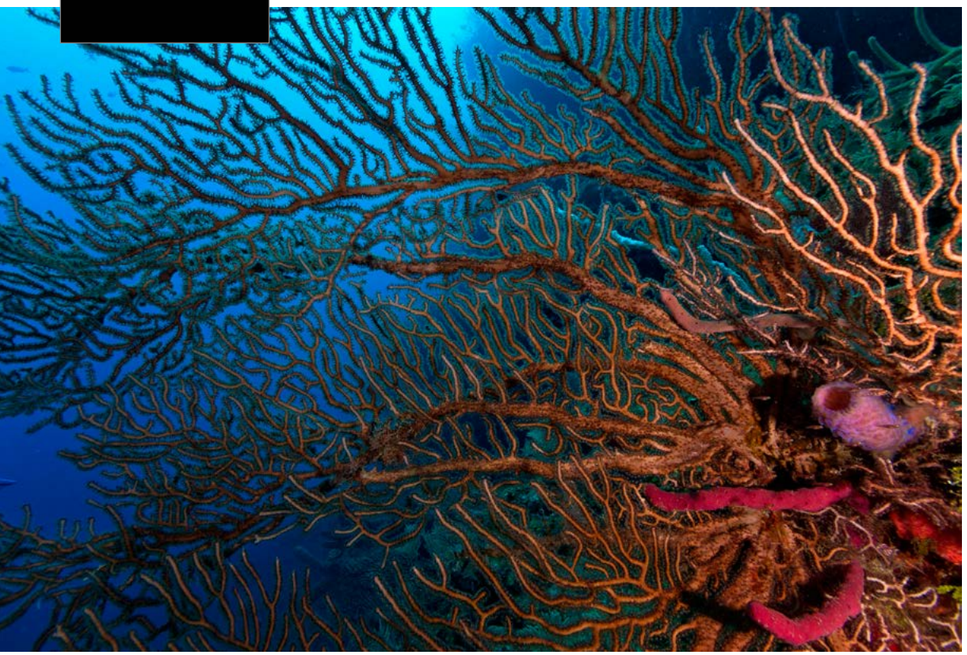
Composing & selecting

However, utilizing the Fibonacci numbers in underwater photography in terms of image composition might not always be easy if one thinks too much about ratios, numbers and math (especially while diving). But then again, many camera user manuals are actually more complicated than the Fibonacci sequence ever was, at least in terms of photography.

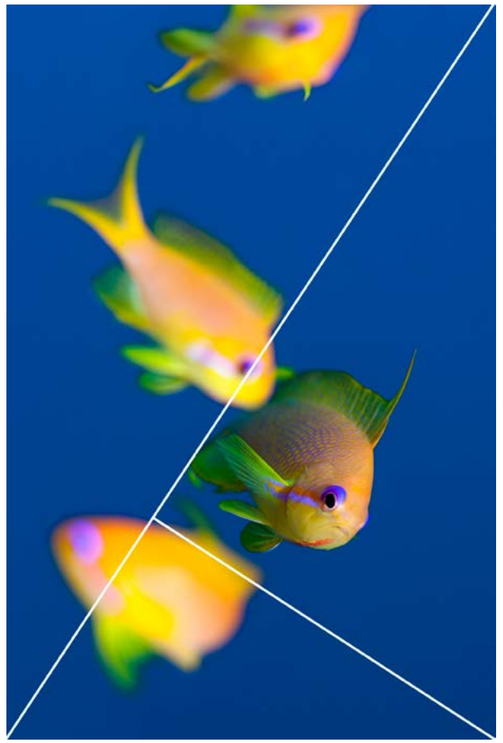
Going back to the question posed at the beginning of this article, which was: "What makes an image a really good one?" Perhaps, when selecting your images for a magazine, a contest, an exhibition or just for yourself, have a little dialogue with yourself: "This is so beautiful. I like it! But why is it beautiful? Is it the subject, the light, the colors or something else?"

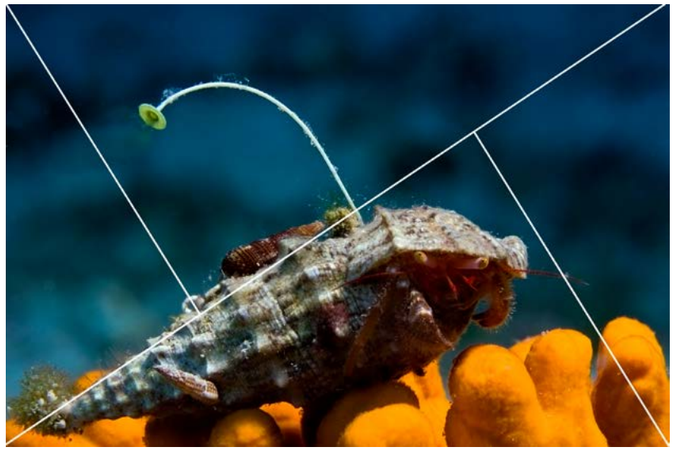
It could be that the answer to your questions is 1.618, nature's divine code of beauty, the Fibonacci code. This has nothing to do with the camera model used or specific photography techniques applied (not that they are useless, but they are not everything); it has a lot to do with

The Fibonacci code is present everywhere in nature, even in tube-worms (right); "Mother Nature's secret number" is present in corals as well. The 1.618 ratio can be found in many marine animals (below).



Utilizing the golden triangle (the most basic option) in an underwater image composition (right); When working with one (or more) golden triangles in image composition, it always helps if the main subjects of the image follow the line and/or nicely fill one or more of the triangle sections (lower left)





Beauty

Beauty is a universal language. Wise philosophers and scientists in Greece, Egypt and India pondered and studied the "key of beauty" long before Fibonacci was even born. But it was Fibonacci who, by using math as a universal language, paved a way for making some mysteries of life and nature understandable to humankind.

He did it at a time when the Fourth and Fifth Crusades took place, the Mongolian Gengis Khan ruled an empire and invaded China, truth (what is right and what is wrong) was dictated by religion, and everyone on the planet believed without a doubt that Earth was a disc and the center of the universe. ■

an understanding of what defines beauty. The knowledge of this will certainly help you on your way as a photographer, as it will give you the power to be able to explain why your images are good (beyond subject and technique) and beautiful.

Are you a Fibonacci fan? Learn more about the Fibonacci number sequence and related mathematical topics in The Fibonacci Quarterly *(fq.math.ca), a journal published four times a year since 1963, by the Fibonacci Association.*

Rico Besserdich is a widely published German photographer, journalist and artist based in Turkey. For more information, visit: ***Maviphoto.com****. See his latest book at:* ***Songofsilence.com****.*

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Tip of the Day

by Peter Symes

Read... the... manual!

Ideally, your camera rig should be an extension of yourself and second nature to operate. When you get a new piece of kit, say a camera, read the manual thoroughly with the camera in hand.

Then read it again while familiarising yourself with all the knobs and buttons and going through all the settings in the menus. It is unlikely you will ever use them all, or even most of them, as modern cameras have become very capable at the price of added complexity. But you should know which different functions are hiding in the menus as one day you may need them. Or you may later develop your technique and decide to go in a different direction—for example, from stills to video.

Practice makes perfect

But most importantly, practice and play until you can set and switch between your preferred modes of operation or settings, without taking your eyes off the viewfinder. It should be like driving a stick shift.

Technology is just a tool

Taking great pictures is not about having the latest and best equipment around but about knowing how to use what we have in an optimal way. Consider this: The classical masters of photography like Ansel Adams, Robert Capa, Henri Carter Bresson and Dorothea Lange had only rather rudimentary mechanical film cameras, with none of the many features and fancy technology that is now available in even basic consumer cameras and smartphones.

Technology makes many things a lot easier, but only if we know how to use it properly. It does not make us good photographers on its own. It is just a tool, and we have to understand how it works if we are to be in control of the creative process. ■

Contrary to popular belief, flash photography does not appear to damage seahorses' eyes. Flashes had no observable impact on foraging behaviour or feeding success rates. Still, touching the animals—perhaps to position them for the ideal snapshot—can trigger strong stress responses.

Impact of flash photography on fish

Text and photos by Peter Symes

With the advent of still more affordable and easier-to-use solutions for underwater photography such as waterproof action cameras and housings for cell phones and tablets, an estimated one in four divers is now also some sort of underwater photographer. On popular dive sites, flashes can be seen going off all the time. Yet, despite all these interactions, the impacts of photographer behaviour and photographic flashes on animals are quite poorly understood.

While taking pictures, divers spend more time close to marine life, causing damage to the substrate and often touching animals. It has been a long-standing contentious issue that some underwater photographers cause damage to reefs by either not being mindful, lacking sufficient buoyancy skills or simply just being unscrupulous in their pursuit of the desired image, never mind the damage caused to delicate corals.

Another prevailing concern is stressing or, worse still, molesting animals, say, by moving them to other locations in the misguided pursuit of a better composition. Divers will occasionally carry "muck sticks" to coax animals into a better position for taking photographs. For the same reason, most underwater competitions, exhibits and, indeed, magazines like ours will refuse images created under such circumstances.

What about flash?

Just taking photos is believed to cause harm in some cases. As a result, flash photography is banned in many aquariums. The bright photographic strobes used in underwater photography frequently raise questions about potential impacts on animals' behaviour and/or their visual systems, i.e. do they cause eye damage or even blindness?

Yet, thus far, no significant effect of flash photography has been detected on the behaviour of teleost fishes, according to a new study published in *Scientific Reports*, which investigated the matter.

To assess the impact of photographer behaviour and photographic flashes on animals, a study was conducted on 14 benthic fish species that are important for scuba diving tourism and aquarium displays.

Seahorses and frogfishes are highly popular with underwater photographers. Cryptic species such as these depend on camouflage to avoid predation. Many are slow swimmers, not capable of fleeing from scuba diving photographers. Species like seahorses are visual predators that rely on accurate resolving power to catch prey. Any reduction in visual acuity or sensitivity is likely to reduce survivorship, and the high intensity light of photographic strobe lights could theoretically result in retinal damage.

Flash is OK

The study found that photographic flashes had no significant effect on the time seahorses spent hunting. The number of strikes at prey was not different, neither was the catch success rate. Even in the treatments that caused movement reactions, feeding rates were unchanged, indicating that despite potential distress, visual acuity was not impacted.

There is no evidence that photographic strobes result in changes to gross eye anatomy (shape or size of the eye and/or lens) or basic retinal morphology, defined here as the thickness of the whole retina or the thickness of each retinal cell layer. Caution remains necessary, as different species may well have different susceptibility to damage to their retinas.

Don't touch!

On the other hand, the results showed very clearly that touching fishes in the wild has a very strong effect on seahorses, frogfishes and ghost pipefishes. The fish moved much more, either by turning away from the diver, or by swimming away in an attempt to escape. Moreover, manipulation of animals by underwater photographers elicited very strong flight and stress responses.

In the wild, seahorses need to hunt almost nonstop due to their primitive digestive systems, so frequent interruptions by divers could lead to chronic stress or malnutrition. The highly significant increase in movement for frogfishes, species which rarely move if undisturbed, implies a considerable energy expenditure, which could lead to decreased fitness. ■

SOURCE: NATURE

Waterproof SSDs from Sony

It happens to us all—we drop stuff, or spill something. Underwater photographers, who often will find themselves transferring or editing images in moist environments or close to water, will be reassured that a bout of butterfingers need not have catastrophic consequences. Sony's new high-speed external SSD drives are both dust and waterproof, and the USB-C port does not even require a cover to maintain protection. The drives can withstand being submerged in one meter of water up to 30 minutes, take a drop from three meters, and withstand 13,227 pounds of pressure. The drives come in 500 GB, 1 TB and 2 TB storage configurations. Pricing has not been released yet, and the drives are expected to ship in summer 2019.
pro.Sony

Tablet Housing

Divepad from Italian manufacturer Easydive is a universal underwater housing for both iOS and Android tablets in sizes up to 10 inches. The tablet communicates with the housing via a Bluetooth connection. All you need is the application, downloadable from the App Store or Google Play. With an iPad, all the camera features are accessible via an app. On Android tablets, the control unit enters into keyboard mode to enable access to different applications. The housing is depth-rated to 60m.
Easydive.it

Aquatica Monitor 5HD

Do you also struggle a bit looking through the viewfinder or seeing what is displayed on the rear panel of your camera? If so, rescue may be at hand in the shape of Aquatica's external monitors, which provide a Full HD 1920x1080 resolution. The monitor supports focus peaking and false colour to assist in focusing and proper exposure. The colour temperature is adjustable. The sunshade can easily be detached without the use of tools. The monitor is compatible with housings from other manufacturers using a 16mm bulkhead. The aluminum housing is depth-rated to 100m. **Aquatica.ca**

Masayo Fukuda

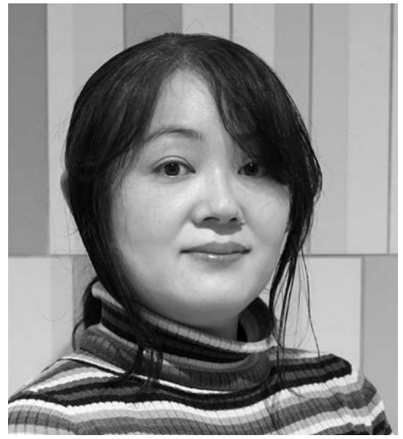
PORTFOLIO

PREVIOUS PAGE: *Humpback Whale*, by Masayo Fukuda. Paper cutting on black board, 420 x 297mm.

Octopus (above, right, top right), by Masayo Fukuda. Paper cutting on black board, 745 × 575mm.

Text edited by Gunild Symes
All artwork by and photos courtesy of Masayo Fukuda
Translated by Kentaro Kashimura

Artist Masayo Fukuda of Tokyo is a master of kirie, the Japanese art of paper cutting. Her beautiful, delicate creations and intricate designs of marine life, cut by hand from a single sheet of paper, have been exhibited in Tokyo, Osaka and Paris, and featured in print, television and social media. *X-Ray Mag* interviewed the artist to learn more about her artwork and her creative process.



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

MF: Ever since I was small, I liked to move my fingers, and I loved drawing and manga (Japanese comic books). I imitated manga characters and drew original characters by myself. I still like the work of the famous Japanese artist Katsuhiro Otomo even today.

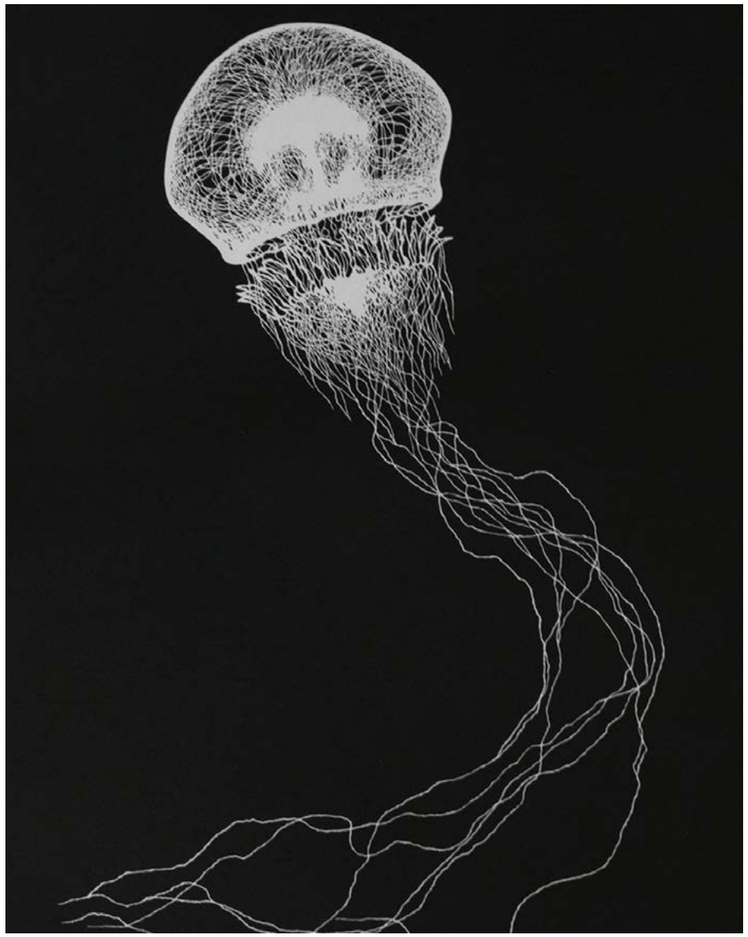
When I was a high school student, I had my first encounter with paper cutting. When giving a birthday card to my friend, I felt that it was unsatisfactory to send just a square card. So, I cut the paper into a heart shape.

After that, when giving greeting cards to family members and friends, I discovered that it was not so easy to cut their cards and present them with motifs such as flower bouquets and girls' profiles.

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

MF: I have liked creepy and mysterious creatures as well as marine life from an early age. Among them, I especially liked deep-sea fish and jellyfish, and made them motifs in my work. Through trial and error, I figured out how to portray a mysterious atmosphere with a sense of depth, and developed a delicate

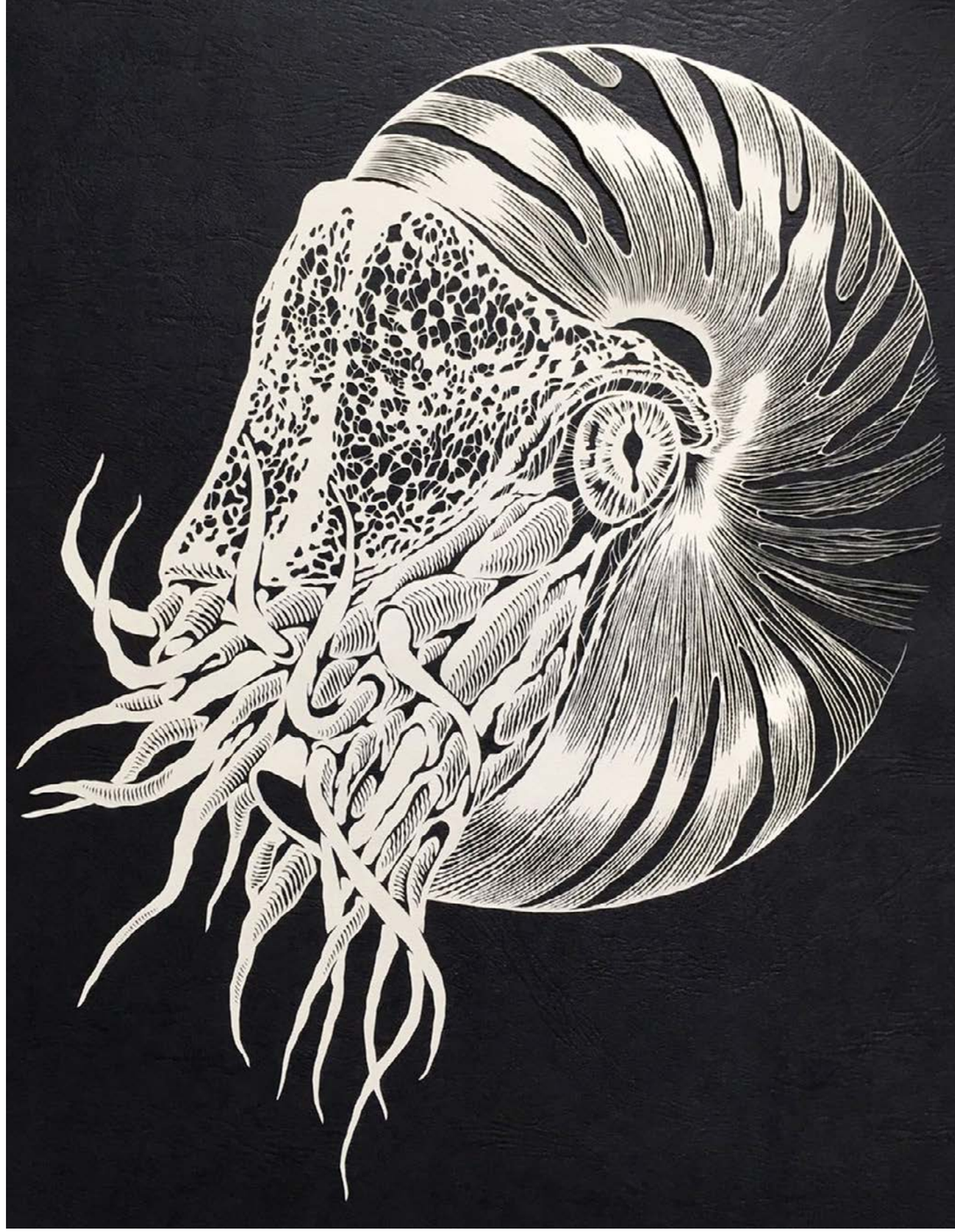
portfolio



The artist at work (above)

Jellyfish (left and below), by Masayo Fukuda. Paper cutting on black board, 420 x 297mm.

Nautilus (right and far right), by Masayo Fukuda. Paper cutting on black board, 420 x 297mm.



expression with a three-dimensional technique.

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

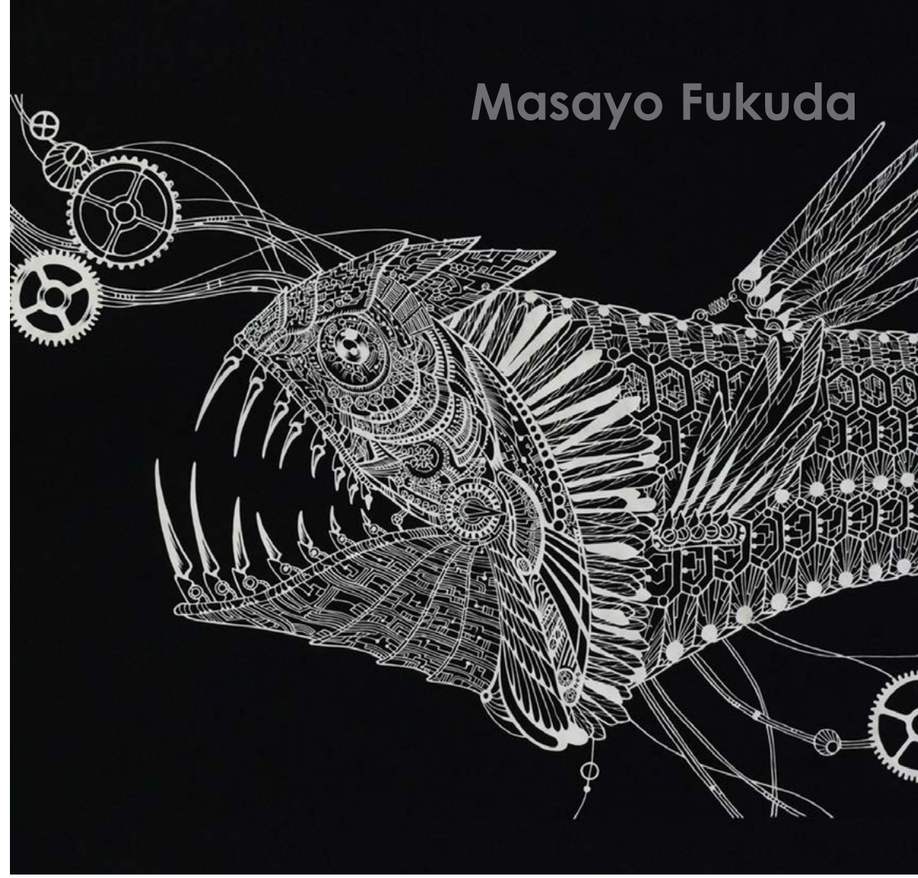
MF: The way to make a basic paper cutting is to first draw a sketch on thin paper, put it on top of a black sheet of paper, which will become the final work, and then cut the two pieces together. In the early days, I also did cutouts in the same way, but there was a limit to expressing thin lines with two cuttings. When the paper cutting was finished, it was more a two-dimensional work with no sense of depth. So, in order to better express a sense of depth, I draw a sketch directly onto white paper and cut only the one sheet. The work is done on white paper because the sketch is difficult to see if it is on black paper.

The most important thing is the "sketch." My work is either good or bad based on the sketch and its completeness. I think that it is a characteristic unique to my work, which other artists' paper cuttings do not have. In my case, the completed product will be reversed, left to right, because I have to draw the sketch on the back side of the paper. A very important part of the process in creating the sketch is calculating the overall balance while considering the reversal, left to right.

When we talk about traditional paper cutting art, the works are two-dimensional and depthless. However, I would like to express depth and a three-dimensional feeling with my paper cutting art. Therefore, I make large works, carefully using the contrast of the thickness and thinness of the line.

To make one artwork, I combine white paper, artistic skill, cutting techniques with a three-dimensional feeling on one piece of paper. There might be a painter who has exceptional painting skills, or a paper cutting artist with excel-

Deep Sea Fish (above and right), by Masayo Fukuda. Paper cutting on black board, 420 x 297mm.

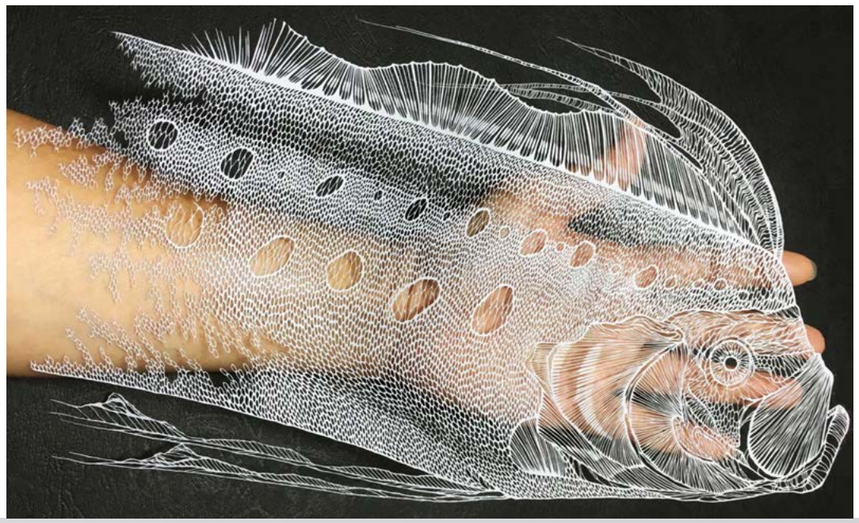


lent cutting skills, but I think that no one has the talents of both. An artist who can produce a three-dimensional feeling with one piece of paper is considered unusual.

X-RAY MAG: What is your relationship to the underwater world and coral reefs, and where have you had your favorite experiences?

MF: Actually, I have never done scuba diving or snorkeling. However, I was born along Kujukuri Beach in Chiba Prefecture, which is a famous surfing spot. So, when I was a young child, the beach was my playground. I loved picking up seashells when I was young. I remember squatting down on the beach for hours and finding seashells. However, beautiful seashells such as those of shellfish were not found so much in Kujukurihama. Therefore, I longed to see the unusual creatures that I saw in illustrations.

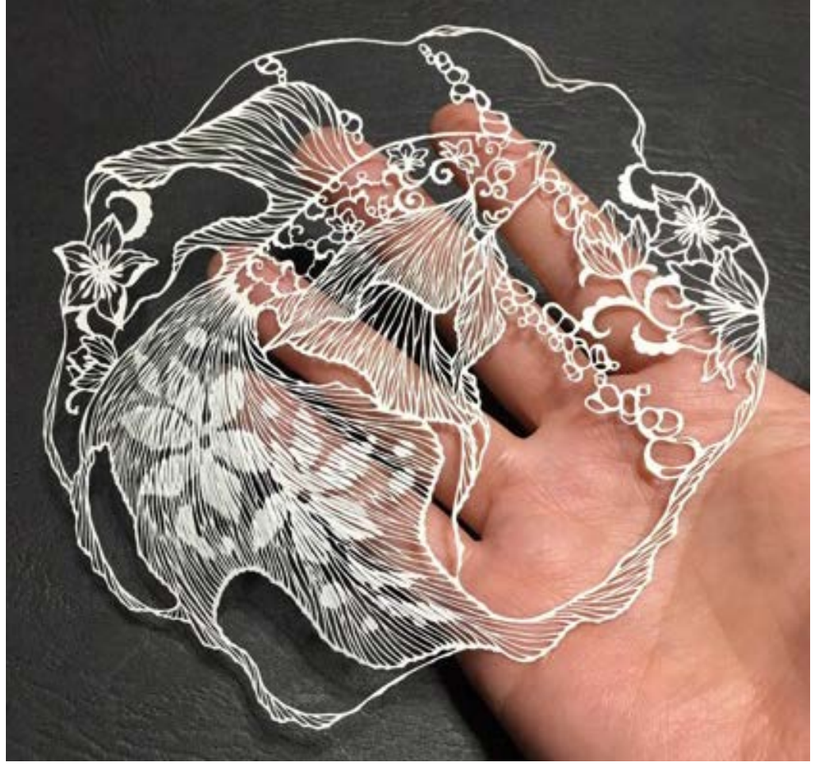
Being the kind of child as I was, I cannot forget the excitement I felt when I saw sea anemones on the rocks at Katsuura for the first time. From a diver's perspective, they might be common creatures, but up until then, I had only seen them in illustrations, and I was amazed by the fact that sea anemones were alive—really!



King of Herrings (above and right), by Masayo Fukuda. Paper cutting on black board, 420 x 297mm.

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

MF: When I went to Okinawa, which is a famous resort area in Japan, I saw a lot of bleached corals. It was a very sad experience. Also, I feel uneasy about the news of marine pollution I have seen on television and the Internet, and the news of



THIS PAGE: *Fish* series by Masayo Fukuda. Paper cutting on black board, 183 x 258mm (left and center), 420 x 297mm (right)

Masayo Fukuda

waves carrying lots of garbage.

My role may be to increase the number of people interested in marine life and the beauty of the sea through my artwork. In the future, I would like to make pieces with these ocean problems as their theme.

X-RAY MAG: What is the message or experience you want viewers of your art to have or understand?

MF: I stick to the eyes and the expressions of living things. In the constantly changing natural environment, wild creatures do not show anger or sadness against it. Nature accepts the way you are, and draws the line of evolving creatures that will continue to thrive. I am glad if anything is felt in the mind's eye when such creatures look at you.

X-RAY MAG: What are the challenges and/or benefits of being an artist in the world today? Any thoughts or advice for aspiring artists in ocean arts?

MF: Since social networking services (SNS) have been developed, many artists have announced various artworks on social media. Because there are lots of rivals posting, it is not easy to find and evaluate one's own originality within the crowd.

However, I say to all, please keep sharing posts, so that many people can see our work. Please do not become shy after getting better at your art or posting. Rather, please announce more and more with SNS that you like the artworks you like.

And actually go to the ocean and the aquarium. Please get inspiration—further your knowledge with various information from the Internet and books. Then, the sea creatures will mean something to you. Please visit your favorite sea a lot and take inspiration from nature.

I'm sure all will be on your side and people will cheer you up.

X-RAY MAG: How do people/children respond to your works?

MF: I am very happy when children who see my artwork say, "I want to do paper cutting art, too!" Some of them have actually made a paper cutting and showed it to me.

For about 30 years, I have continued to create paper cutting art. I was told by one viewer the most joyful and unforgettable words: "I cannot explain your paper cutting art. Only you can do it because you like it. You are sure to have some important role in this world."

I was very happy to hear this, and at the same time, I decided to prepare myself to do paper cutting art more seriously than before.

X-RAY MAG: What are your upcoming events?

MF: My artwork will be featured at the KIRIKEN Masayo solo exhibition in Tokyo, Japan, on 17-22 June 2019; and the Salon Art Shopping expo in Paris, France, on 18-20 October 2019.

X-RAY MAG: Any parting thoughts?

MF: From now on, I will devote myself everyday to producing paper cutting art. I am glad if my artwork inspires you and you feel something from it. If you like my artwork, please send me a message of support via SNS. It becomes vitality in art making. Thank you very much. ■

For more information, please visit the artist's website at: ***kiriken.thebecos.com/en/artist/***