Andrey Bizyukin, M.D.

Why vitamins protect divers

Reactive Oxygen Species and diving

Does diving produce free radicals? Can vitamins really protect divers from some the physiological effects of diving? X-Ray Mags own editor and medical doctor Andrey Bizyukin conducted a series of experiments to find out.

You probably heard about free radicals, and why you should eat antioxidants to stay healthy. But have you heard of Reactive Oxygen Species? Chances are that you haven't. But to cite a well-known on-line dictionary; Reactive oxygen species (ROS) include oxygen ions, free radicals and peroxides both inorganic and organic. They are generally very small molecules and are highly reactive due to the presence of unpaired valence shell electrons. ROSs form as a natural byproduct of the normal metabolism of oxygen and have important roles in cell signaling. However, during times of environmental stress ROS levels can increase dramatically, which can result in significant damage to cell structures.

With the help of our furry friends, an immune system response to hyperbaric pressures were investigated

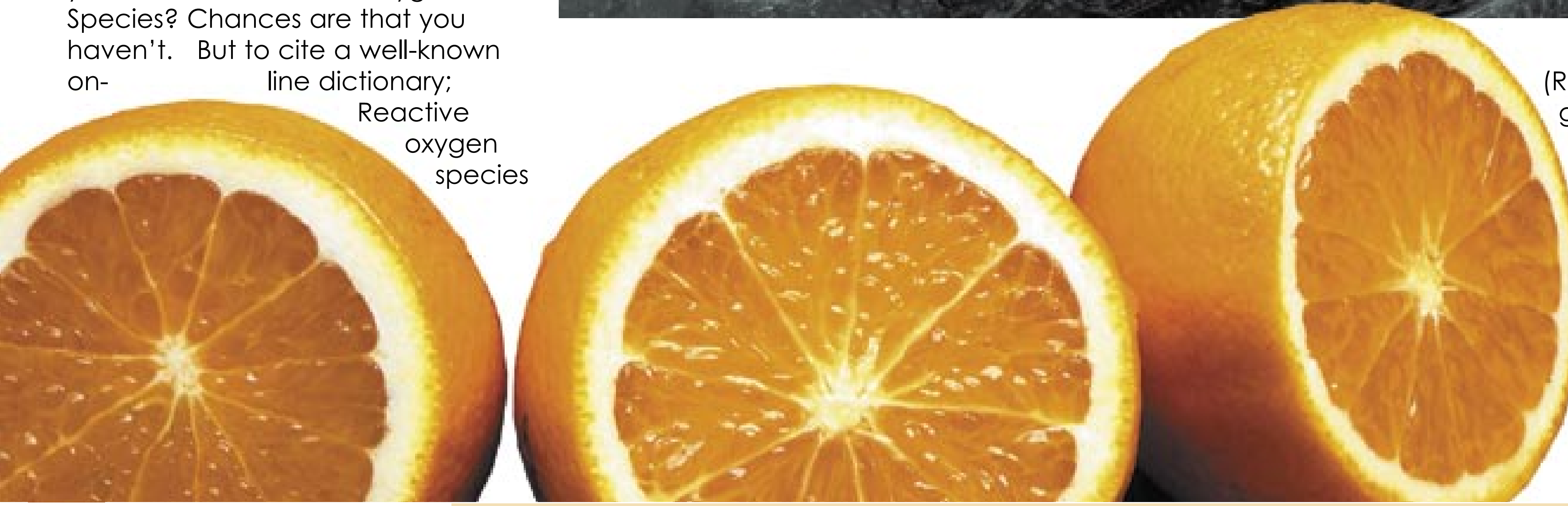
During times of environmental stress, huh? Does that include diving?

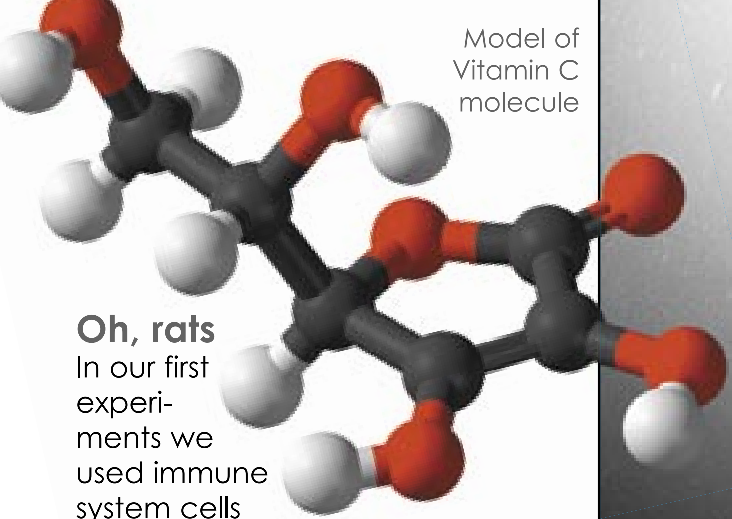
It is the cell enzymes that produces ROS during metabolism and it turns out that these molecules has several roles to play in the body. For one they are modulators of the immune system in other words molecules, which can intensify or weaken the immune response. And the very same molecules can, by virtue of their strong oxidizing powers, simply "kill" pathogenic microbes and viruses, destroy alien substances (antigens), or when the concentration gets too high also harm the cells themselves creating ulcers or abscesses inside of a living tissue or starting of allergic reactions.

Even for an experienced diving physician it is not so simple to understand all the subtleties.

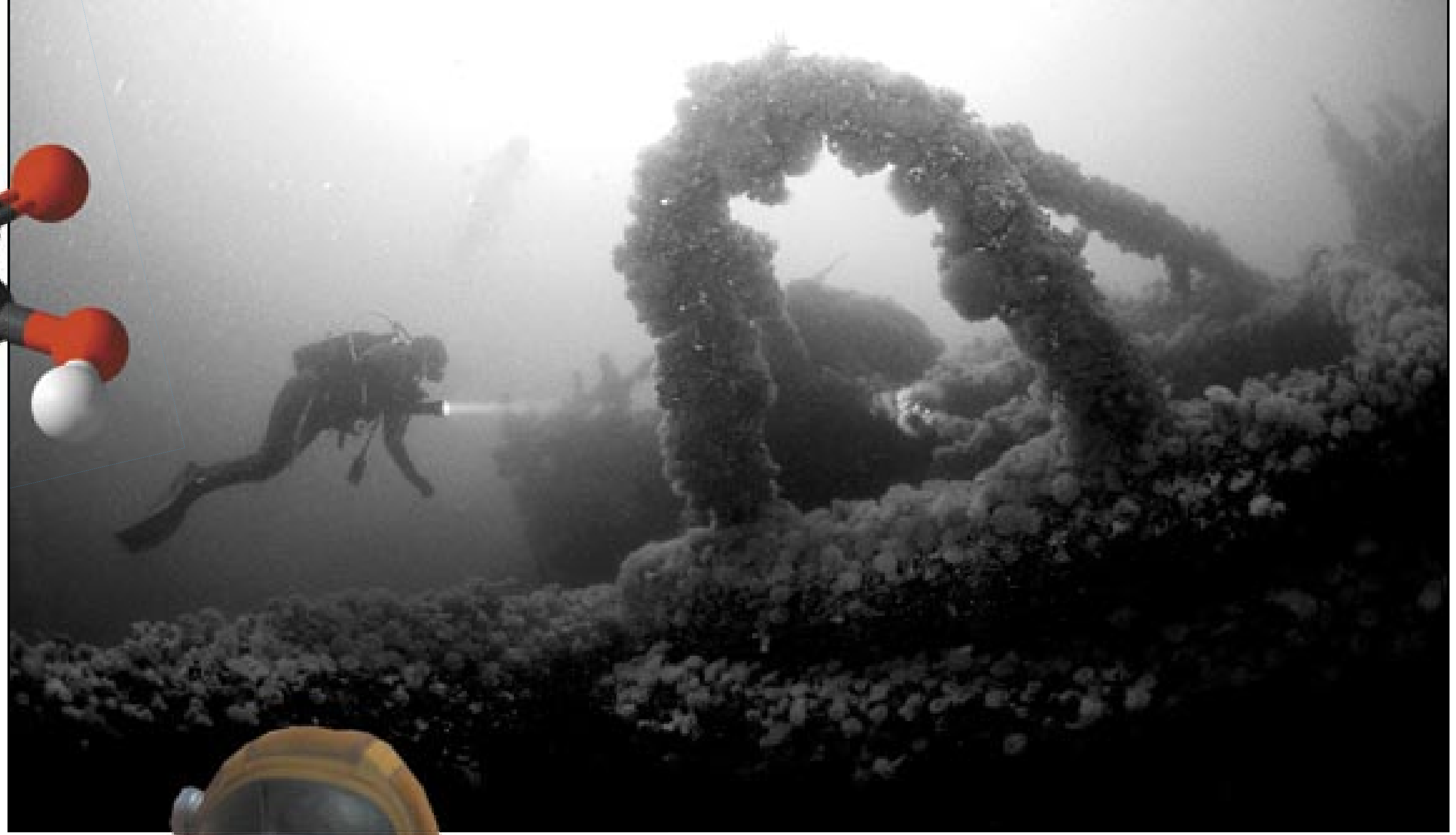
There is a normal quantity or production of ROS. If too little ROS is produced, the normal immune reaction does not develop, and the organism falls ill from even the most insignificant trifle. If too much ROS is produced, it first enhances the immune response, but then (if high production levels persist) it will start destroying the organism. Speak about a golden median.

Any technical diver breathes gas mixes be it oxygen enriched (nitrox) or impoverished (hypoxic trimix). Either of these will surely influence ROS production and levels somehow. But how? And in which direction, is it going to be for the better or worse? And if it is for the worse, what can a diver do to protect him or herself from the negative effects of these molecules and go on to live a long life and dive happily?





Model of Vitamin C molecule



Oh, rats

In our first experiments we used immune system cells from white rats. They were placed in test-tubes with a nutritious solution to keep them alive. These test-tubes were then pressurized equivalent to a depth of three hundred fifty meters. One group of test-tubes was staying under this pressure for no more than one minute. Another group was kept under pressure for a considerable time. Both groups were brought "back to the surface" in an uniform manner. All the cells remained alive. But ROS production in them was considerably different.

In the cells that were under pressure for a short period ROS production was found to be elevated. By contrast the other group which has been under pressure for a long time practically lost their ability to produce ROS. In other words these cells have essentially lost their immune protection.

Problems staying upright? . Evidence suggest that deep dives affects the immune system

Hypothesis

This made us hypothesize, that short dives are beneficial for cells - they keep up their tone and strengthen immunity whereas long dives destroys parts of the enzyme system involved in immune system response. And that the cause may be an excessively prolonged elevation of ROS production. Thus, it seems, to be a good idea if one could get ROS production under control during a dive.

Vitamin pills

This can be achieved in several manners. We opted for the easiest. Antioxidants are readily available in the form of commonplace and over-the-counter vitamin supplements: Vitamin PP (rutin), vitamin C (ascorbic acid), vitamin E (alpha-tocopherol) and lipoic acids.

These substances bind to the reactive oxygen forms, preventing the damaging peroxidation in the organism. A regular intake of these anti-oxidants interferes with surplus ROS production and protects the organism. It doesn't harm either that vitamin E is said to enhance sexual performance in divers (at least according to what IANTD president Tom Mount states in his "Technical diver encyclopedia").

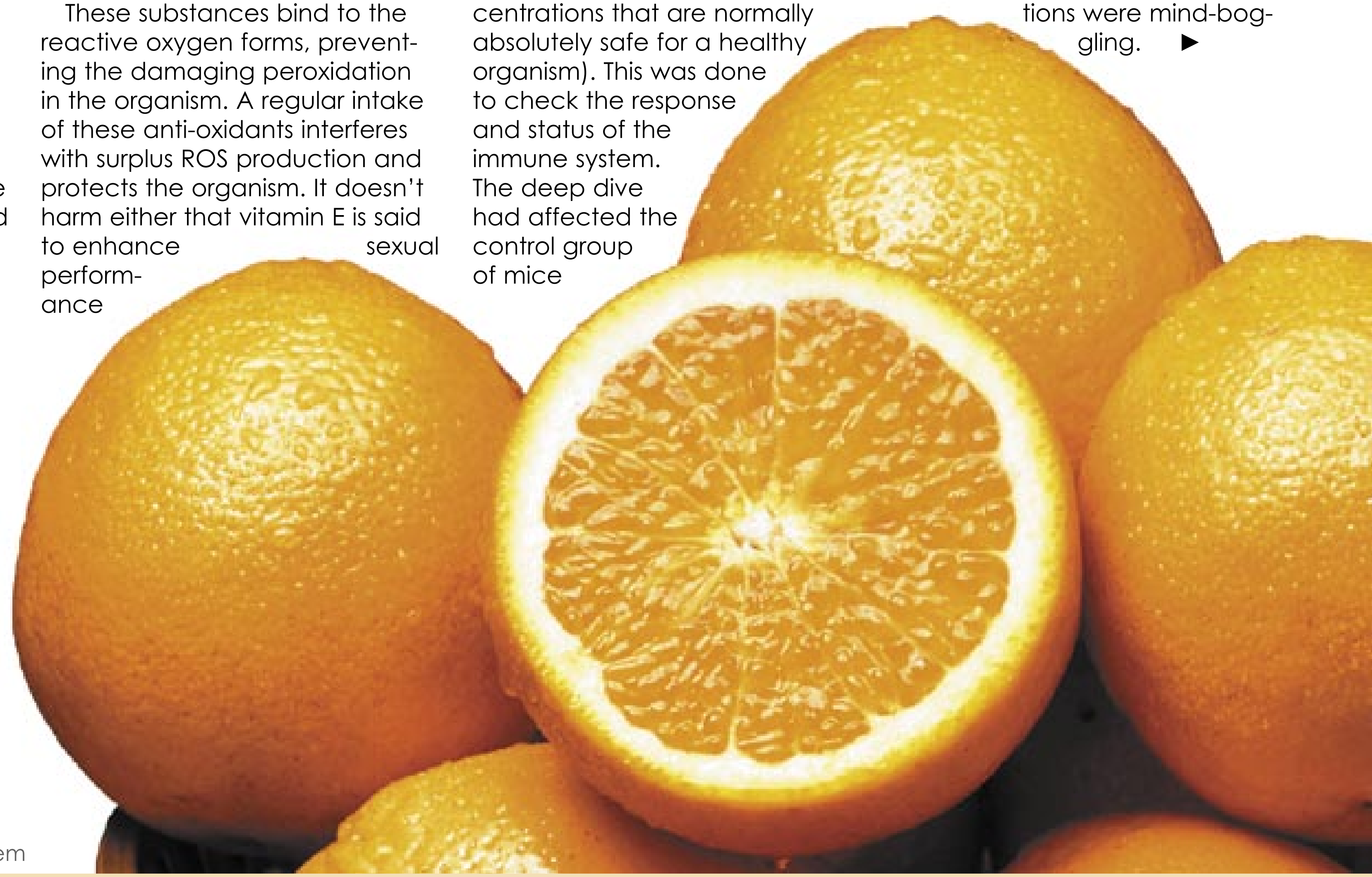
Verification

We then put our hypothesis to the test by conducting another experiment, this time with mice. In this we compared two groups of animals: The first group were given plenty of ascorutin (vitamin PP + vitamin C) in their drinking water for two weeks. The other group did not receive these large doses of vitamins.

Both groups of animals were then put in a decompression chamber and sent to a depth of five hundred meters and returned to the surface following identical decompression profiles. Following this experimental dive all the animals received a very small dosis of blue pus bacillus toxin (in concentrations that are normally absolutely safe for a healthy organism). This was done to check the response and status of the immune system. The deep dive had affected the control group of mice (those who were not given vitamins) so profoundly, that the blue pus bacillus toxin killed all of them. By contrast, the mice from the experimental group who were given the vitamins all survived, but for one who got sick and died.

The conclusion seemed clear: The increased doses of vitamins protected the mice during and after the deep dives.

But does that imply that pharmacological substances that can reduce the risk of decompression illnesses may exist? How many people could possibly be saved or protected following these scientific findings? And could this knowledge possibly extend the time span a human can spend safely under water? The implications were mind-boggling. ►



The cooberating evidence:

Can antioxidants protect scuba divers?

A recent study, published in The Journal of Physiology, shows that acute oral intake of antioxidants Vitamin C and E prior to a scuba dive can reduce alterations in cardiovascular function, that are caused by a single air dive.

A group of professional divers were studied before and after a moderate scuba dive to a depth of 30 meters for 30 minutes, similar to those enjoyed by countless recreational divers. A single scuba air dive induced mild changes in cardiac function and a significant decrease in endothelial function (endothelia is the inside lining of bloodvessels and other tissue). The authors thought that these changes could be influenced by oral ingestion of antioxidant vitamins C and E prior to diving, and that endothelial function, in particular, might be preserved.

This intervention showed a positive effect on vascular endothelial function, whereas other cardiac functional changes were unaffected. Although generally very safe, diving may be associated with serious consequences, such as decompression sickness. These new data raise the possibility that pre-dive intake of antioxidant vitamins may prevent some of the negative effects of diving on vascular function. The results of this study are of interest for those involved in all types of recreational and professional diving.

► Now there was no turning back, we just had to investigate the effects in humans. During a run of 21 days we then monitored three professional commercial divers as they went down as far as 250 meters. One these was our diving doctor who took blood samples at regular intervals which were sent up through a special sluse for analysis in a lab.

Conclusions

The results were stunning. Neither during the descent nor during the extended stay at maximum depth could we detect any significant deviations from normal ROS production. However, during ascent the picture changed dramatically. From the beginning of ascent the production of reactive oxygen forms spiked and stayed high at alarming levels during much of the decompression procedure until surface was reached. And for an extended period after the experiment the divers had immune responses well below normal. These otherwise healthy fellows had become quite susceptible to even banal infections. This period of suppressed immune system lasted at least 10 days.

"Take those vitamins and keep on diving with pleasure, have a long life and live happily ever after."

Our friends, who had to listen to all our technical babble and enthusiastic tales about "wandering under water", made fun of us and thought we were engaged in something too etherical for normal people, but they couldn't help finding the jargon a bit sexy and envy our enthusiasm and dedication.

A scientific investigation like this is indeed somewhat akin to detective work and here is our conclusions:

1. Short dives can be beneficial to an organism.
2. Longer dives can have a profound negative effect on the immune system and make deep water divers very susceptible to infections that is normally harmless for healthy people
3. It has been demonstrated that diving starts long-term immune infringements calling for a scrutiny of decompression procedures. Also the various free-of-charge decompression programs and algorithms in the cheaper computers should be reevaluted in the light of these findings..
4. Regarding the average diver,if he has made it this far without falling asleep over the text above, we recommend: "Take those vitamins and keep on diving with pleasure, have a long life and live happily ever after.

Andrey Bizyukin, PhD of Medicine, senior researcher of Pulmonology institute, ■

Researchers found that humans and sea urchins share a lot of the same biology.

Sea Urchin Could Help Cure Diseases

A purple sea urchin has 70 percent of its genes in common with humans, including genes associated with such diseases as Huntington's, Parkinson's, Alzheimer's and muscular dystrophy. There are roughly 100 human disease genes in the sea urchin genome.

Researchers said they believe similarities in the genes of sea urchins could one day help them better understand how the human immune system works.

Sea urchins have no eyes or brain and could live for up to 100 years. Because sea urchins live longer than most humans, they might also provide clues in developing new antibiotic and antiviral compounds to fight various infectious diseases.

DAN Releases 2006 Report on Dive Accident Data

The 2006 Report on Decompression Illness, Diving Fatalities and Project Dive Exploration is ready for the scuba diving community to review. Compiled and published annually by DAN research, the report presents information on Project Dive Exploration (PDE), scuba diving injuries and dive fatalities, as well as breath-hold diving incidents based on data collected during 2004. DAN has added new material this year that describes breath-hold incidents and annual injury and fatality rates for this activity.

Rates of DCS and Death

According to the PDE data collected between 1998 and 2004, the decompression sickness (DCS) incidence rate among warm-water dives fluctuated from 0 to 5 cases per 10,000 dives. The annual fatality rate for DAN Members between 1997 and 2004 varied between 11 and 18 deaths per 100,000 members per year.

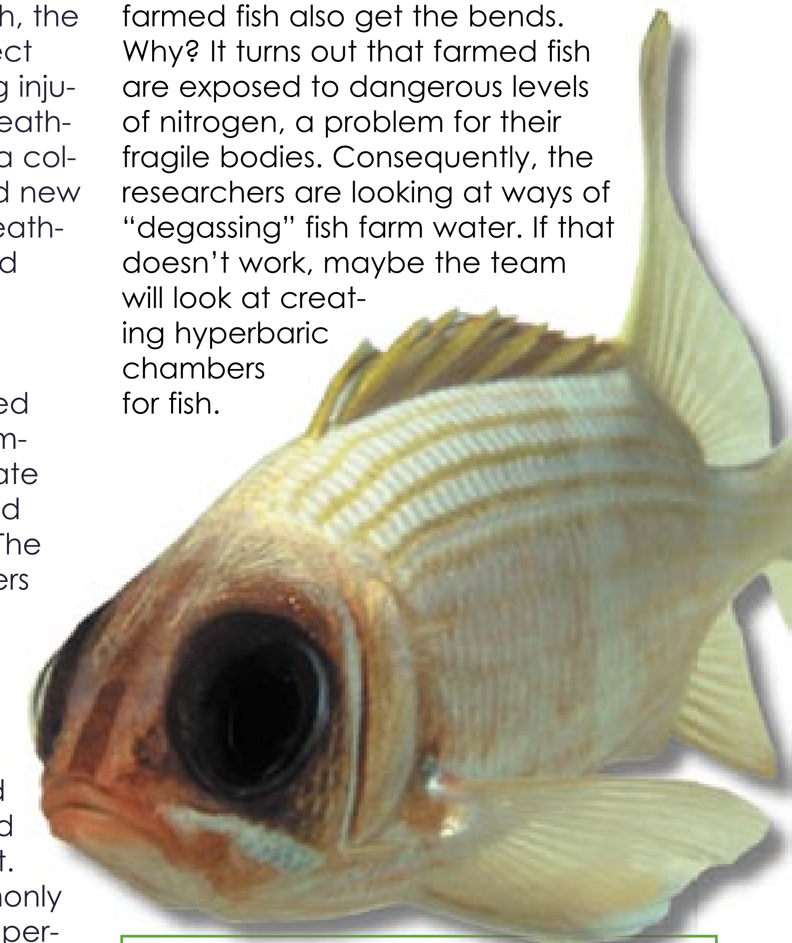
The most common procedural problem was equalization, reported in 2.7 percent of PDE dives, followed by buoyancy trouble at 0.9 percent. The face mask was the most commonly reported equipment problem (0.69 percent); the dive computer followed at 0.4 percent.

Twelve PDE divers reported post-dive headaches, and three reported fatigue. Out of 591 reported instances of equalization problems, six divers reported post-dive symptoms that were severe enough to concern them or make them skip at least one dive. One diver reported short-lasting vertigo, and there was one case of severe sinus barotrauma.

In the PDE population, there were five DCS cases reported; this totaled an annual incidence of two DCS cases per 10,000 dives. SOURCE: DAN

Fish gets bends too

Researchers in the UK have concluded that fish can get the bends.
After reviewing anecdotal evidence from fishermen that fish hauled up quickly from depth suffer from decompression sickness, the researchers decided to look at fish raised in commercial fish farms, as well. Sure enough, they concluded that farmed fish also get the bends.
Why? It turns out that farmed fish are exposed to dangerous levels of nitrogen, a problem for their fragile bodies. Consequently, the researchers are looking at ways of "degassing" fish farm water. If that doesn't work, maybe the team will look at creating hyperbaric chambers for fish.

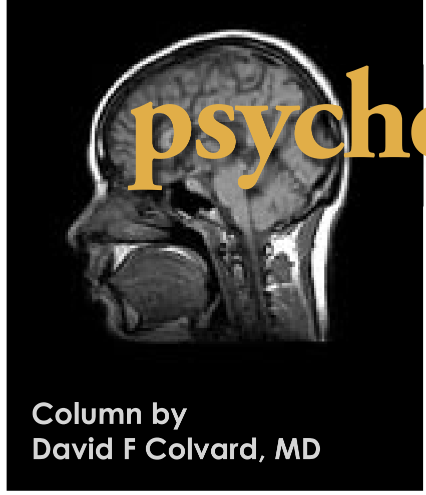


Cancer Cure?

Scientists at Southwestern Medical Centre in the US believe they have developed a new cancer treatment using the toxin from a sea squirt

Diazona Angulata resembles a translucent ring donut, emits the liquid to repel potential predators. It is found off the coast of the Philippines and lives in colonies anchored to rocks.

Studies using mice were successful in reducing tumour growth without some of the side effects associated with other cancer drugs.



Column by
David F Colvard, MD

Panic Study

In 2000, when my wife Lynn and I conducted the "world's largest diver survey," our main goal was to determine exactly what factor or combination of factors led to diver panic aside from just "stress." The unquestioned gospel in all the dive literature for decades has been that diver panic is the number one cause of diver deaths, so it is a worthy research subject.

PADI vice president of international training, Drew Richardson, challenged me over even the feasibility of studying the problem, but as a private psychiatrist I told him that even severe panic disorder patients can remember the details of their first panic attack. I also had several panic disorder patients who were divers and not only had they never had a panic attack while diving, but they claimed they felt the most relaxed when they were diving. DAN founder and then president Dr. Peter Bennett gave me a big break when he allowed me to administer a beta test of the survey to the 100+ attendees of a Dive Medicine continuing education course that summer, which helped me convince Drew that the study could be done.

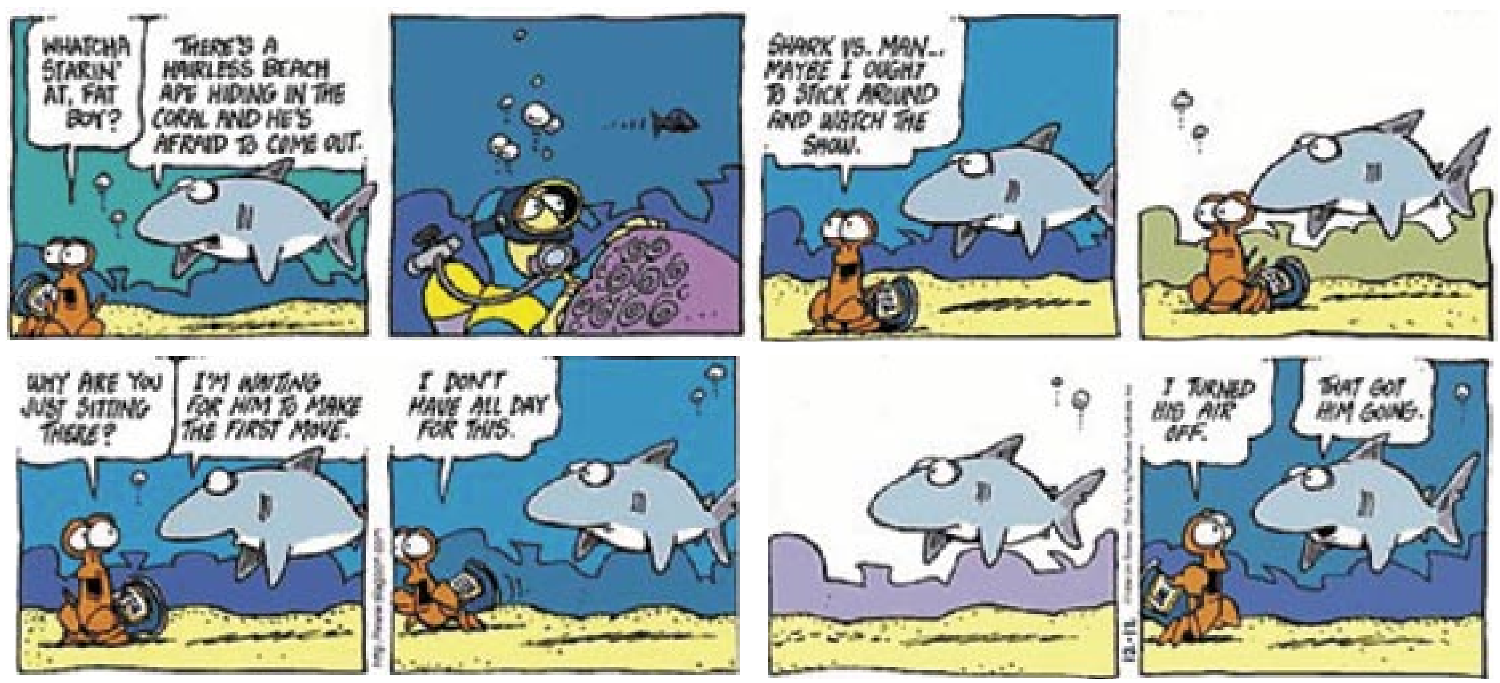
Over 13,000 scuba divers from around the world participated in the online survey sponsored and hosted by Rodale's Scuba Diving magazine and actively supported by then PADI vice president of international training, Dr. Drew Richardson. Many dive clubs and other organizations around the globe helped publicize it. Paper surveys were also made available for magazine readers without access to the web. We designed the 28 questions with the invaluable input of experts like Dr. Peter Bennett, Dr. Drew Richardson, Dr. Art Bachrach, Dr. William Morgan, Dr. Thomas Griffiths, and many of my dive buddies on Bonaire and in Raleigh. Due to incomplete surveys the final number of useable surveys was just over 12,200. In May 2002 I presented a poster and gave a brief talk to the annual international scientific meeting of the UHMS in La Jolla, California. At the request of Drew Richardson we prepared a six-page feature article for The Undersea Journal first quarter 2003 issue. Both can be found at **www.DivePsych.com**.

But Lynn and I failed to achieve our main goal of determining exactly what factor or combination of factors leads to diver panic. We used the useable responses to questions 6 and 26 to calculate the relative risk of panic under each of the 44 "circumstances that you have ever experienced while scuba diving" (Question 6) and "conditions that were present during your first panicked dive" (Question 26). We also asked in question 26 if they were experiencing the condition for the FIRST TIME during their first panicked dive, but apparently too many respondents got confused by the question's wording, so we had to just analyze the conditions that were present during the first panicked dive whether it was the first time they had ever experienced them or not.

When I showed Dr. Bennett Table 1 and he saw that three of the top four factors were "Other," "Other," and "Other," his response was that we had proven nothing after several years of hard work. Researchers do not tend to publish negative findings, so the table has resided in my laptop until now.

For three years I conducted follow up surveys of those divers and am slowly analyzing the data and releasing the results, such as the prior articles on diver obesity. In September I will be speaking at a workshop on diver panic and stress at the South Africa UHMS annual dive medicine refresher course in Johannesburg, South Africa.

David F. Colvard, M.D., is a private psychiatrist and clinical investigator in Raleigh NC and a divemaster, He hosts the website www.DivePsych.com which provides evidence-based information for divers on psychological and stress factors in scuba divers. ■



"Sherman's Lagoon" by Jim Toomey © 1999 Jim Toomey

TABLE. Relative Risk of Panic During Dive in Presence of the Following:

Males N=9292		
Females N = 2939		
Hyperventilation	4.6	3.1
Other physical/psychological factor(s) not listed	3.4	2.4
Other equipment problem(s) not listed	3.4	2.0
Other dive condition(s) not listed	3.4	2.6
Chest tightness	2.6	2.0
Fear of the unknown	2.5	2.1
Cold water	2.1	1.1
Poor visibility	1.9	1.1
Inhaled water instead of air	1.8	1.5
Task overload	1.8	1.4
Fear of scrutiny or embarrassment	1.6	1.2
Loss of orientation	1.6	1.3
Fatigue or overexertion	1.6	1.1
Low on air or out of air	1.6	0.6
Deep dive	1.3	0.5
Separation from buddy or instructor	1.2	0.8
Strong current or surge	1.2	0.7
Uncontrolled ascent	1.1	0.7
Difficulty operating buoyancy compensator	1.1	1.2
Entrapment or entanglement	1.1	0.6
Poorly fitting equipment	1.0	0.6
Loss of mask	1.0	1.2
Dry suit dive	1.0	0.6
Rough sea or surf	0.9	0.7
Overhead environment (cave, wreck, ice)	0.7	0.3
Nighttime or darkness	0.6	0.4
Over-weighted or under-weighted	0.6	0.4
Long surface swim	0.5	0.3
Loss of weight belt	0.5	0.3
Mask leak	0.4	0.4
Solo dive	0.4	0.1
Medication, other than decongestant	0.4	0.3
Difficulty equalizing ears	0.4	0.4
Regulator leak or free flow	0.4	0.2
Muscle cramps	0.3	0.2
Motion sickness	0.3	0.3
Decongestant medication	0.3	0.2
Dive light failure	0.2	0.1
Loss of computer or gauge functions	0.2	0.1
Shark	0.2	0.1
Other dangerous marine life	0.2	0.1
Broken or loose fin strap	0.2	0.1
Sharing air	0.1	0.4
Tank slippage	0.1	0.1