A talk with Richard Pyle

Biologist, rebreather diver, inventor of Pyle Stops or... database manager

X-RAY MAG catches up with the ever-inventive and contemplative pioneer, Richard Pyle, to find out what makes him tick, insights into his theories, and the stories behind his accomplishments.

Who is Richard Pyle really? A biologist or a rebreather diver?

Excellent question, many people have asked me that. I am definitely a biologist. My whole life I have been interested in fishes, and I don't know why but it always has been that way. I've had an aquarium since I was a little kid, so fishes have always come first. Scuba diving was a tool to get access to fishes. The most exciting part for me is finding new things that nobody ever found before, and I quickly learned that the only way I could go where my Ph.D advisor P.H.Randall hadn't already found a fish was—and he has been all over the world other than down—so I got into deep diving to try to get into a new place and find new kinds of new fishes nobody found before. There is a lot of history there, but I started off with regular scuba, going deeper and deeper and deeper. And I found out the hard way what the problems were. I got a bad case of the bends—you can read all about it on my website—and then decided not to give up on deep diving but to learn to do it properly. That led me to Bill Stone. I read his article about trimix diving—this was before technical diving became a common term—in 1987. (See Interview with Bill Stone in X-RAY MAG #15). So, I wrote him a little letter and I asked,"How do you do this?" And he then wrote me back and told me, "We do it this way…" So, I learned how to do trimix diving from Bill Stone, and through him, I also learned about rebreathers, as he was already building rebreathers at that time. So, I got into rebreathers through fishes, and if I had to give one of them up, I would give up rebreathers before fishes.

I am definitely a biologist first and a rebreather diver second. But I will say that I get almost as much enjoyment out of thinking about the technical aspects of the diving. I enjoy thinking about rebreathers and technical diving almost as much as thinking about fishes, so every day I change hats. I have my fish hat and my rebreather hat. They are two very different things to think about, as the topics are very different. I enjoy being able to think about them both.

The reason I ask is that you seem to have not just one, but two claims to fame.

It is actually more, as I have four worlds that I move in—and my family is my fifth world. The four worlds that I travel in are: The saltwater aquarium world—I am actually more known to people in the saltwater aquarium world than any of the other worlds—and I always get invited to give keynote presentations at aquarium meetings, but generally, I have been too busy to do that. The second world is the fish world where I know a lot of people and then, of course, the rebreather and tech world. But there is a completely different world from which I get my pay check, and that is for programming databases. Most of my travelling goes to

profile

What is the "Twilight Zone"?

In this context, the coral-reef Twilight Zone is roughly defined as coral-reef habitat at depths between about 200 feet (60 meters) and 500 feet (150 meters).

The upper limit represents the approximate maximum depth to which stony corals tend to dominate the reef structure, and the lower limit represents the maximum depth at which significant photosynthesis occurs (the maximum depth to which the living coral reef extends).

The reason the coral-reef Twilight Zone is shallower than the open-ocean Twilight Zone stems mostly from the difference in water clarity between the two habitats.

In the open ocean, the crystal-clear water allows sunlight to penetrate considerably deeper than around coral reefs, where the water is often teeming with plankton.

Therefore, the biologically important transition zone between light and dark exists at somewhat shallower depths around coral reefs. ■

Richard Pyle

meetings to discuss standards for computer databases, so we can exchange data about biological diversity from different computers around the world. I am changing between all these hats all the time and between all these different groups of people. A lot of times, I joke about…you know what a nerd or geek is, someone who is too much into something … I have found that in those worlds there are geeks in every one of them. Some are science nerds about the fish, and some are dive nerds.

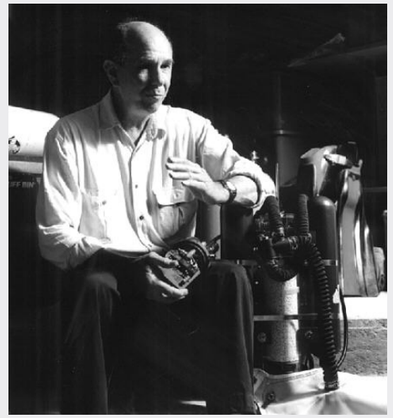
There are different sorts of geniuses?

The funny thing is that across the topics, they all have the same characteristics, and I am one of the nerds. In fact, I am a nerd in all four categories. I can have the same sort of excited conversations over dinners regardless of whether it is about databases, fishes or rebreathers. I am surprised how similar it is.

In fact, I am a nerd in all four categories

But you are the one that is widely credited with coining the term—or in some way being synonymous with—"The Twilight Zone"

It actually started out with Walter Starck who I think got credit for recognising that this depth zone, however we want to define it, say from 50 to 150 meters, is awaiting to be explored. (Scubadivers can rarely go beyond 40m and submersibles rarely operate shallower than 150m – ed.). Walter Starck, aside from his fame as a photographer, his most significant contribution was to build the very first electronically controlled rebreather, the Electrolung. He invented this rebreather to do what I do, to find new fishes on the deeper coral reefs but this was back in the 1960's. Of all the known technical divers, I am the least pioneer because rebreather diving. in the sense of what I use it for, was already invented by Walter Starck when I came along. In that



Dr. Walter Starck is one of the pioneers in the scientific investigation of coral reefs. He grew up in the Florida Keys and received a PhD in marine science from the University of Miami in 1964. He has over 40 years worldwide experience in reef studies, and his work has encompassed the discovery of much of the basic nature of reef biology. In this process, over 100 species of fishes, which were new to science, were found as well as numerous, corals, shells, crustaceans and other new discoveries.

In the early 1960s, he began the first extensive exploration of coral reefs at night.

In conjunction with this work, he was among the first to adapt and use SLR cameras and electronic flash underwater. This, in turn, enabled the first underwater macro photography. In 1964, he developed the optical dome port now used universally for wide-angle underwater photography.

In 1968, he developed the Electrolung—the first electronically regulated, closed circuit, mixed gas scuba. With the Electrolung, Dr Starck began exploring the deep reefs beyond the frontiers of compressed air diving, and many exciting new discoveries resulted. ■

SOURCE: WWW.GOLDENDOLPHIN.COM

Bio

Dr. Richard Pyle was born and raised in Hawaii, where he caught an interest for fish from a very early age. He set up his first aquarium when he was five years old, and started scuba diving when he was 13. By the age of 19, he lived in Palau where his passion for discovering new fishes lured him into deep water, resulting in a crippling case of decompression sickness while diving with world-renown ichthyologist John "Jack" Randall. Jack then offered him a job in the fish collection of the Bernice P. Bishop Museum in Honolulu, where Richard continues to work.

Determined to continue exploring the coral reef "Twilight Zone" in a safe and responsible way, Pyle was among the pioneers of modern Technical Diving in the late 1980s. In 1994, he was a test-diver for the prototype Cis-Lunar MK-4 closed-circuit rebreather, and travelled the Pacific in search of new species of fishes on deep coral reefs—which he and his colleagues are discovering at a rate of 11 new species per hour of bottom time. Recently, he has acted as consultant for Poseidon in developing the new Cis-Lunar Mk VI, which will be marketed in 2008.

Richard has authored over a hundred scientific, technical and popular articles and has been featured in dozens of documentary films (including the IMAX film, *Coral-Reef Adventure*). He was a founding member of the Board of Directors for the Association for Marine Exploration—a non-profit organization dedicated to conducting innovative scientific exploration using advanced diving equipment and techniques. In 2004, he was selected by Esquire magazine for the "Best and Brightest" issue, and was also recipient of the "Genius Award" from General Electric which helped support his research. In 2005, he was awarded the NOGI award—coincidentally, simultaneously with another X-RAY MAG interviewee, Bob Evans.

■ SOURCES: BISHOP MUSEUM

respect, I am just a late comer. There was also another guy, Pat Colin, who was a bit later than Walter Starck and was also inspired by him. He also built his own rebreather to go down to the deep reef zones, so I am not the first, by a long shot.

But I seem to be the lucky one who was around when technology was finally ready to do this. Walter invented his own technology, but at that time, they even had to make their own oxygen sensors. They built them themselves from scratch, whereas, I can just go order them from Teledyne or whoever. I was lucky in being 20 or 30 years later, because now I have access to technology that they didn't. I don't think that I was the first person to use the term "Twilight Zone" either. Walter Starck wrote an article, I think it was in 1972, in National Geographic where he used the phrase about all the discoveries awaiting to be done in the twilight zone. He was probably the first, and then I started applying that term, and then I started talking about it. But then biologists got angry with me, because that term already applies to something in the middle of the ocean, about a 1000 meters deep, and in the cave world, it means something else. So, it is a little overused. I then started calling it deep coral reefs, but then they discovered these coral reefs a 1000m deep. So, now I don't know what to call that zone that I am working in. It is the "coral twilight zone" or what? I don't know, but that is the area that I am interested in.

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But what is so special about this zone in a biological sense?

Two things are special about it. One, is that we know so little about it, about the species and about the interactions that go on there. The other thing is that it is a transition zone. One environment where the coral reef meets another environment, the open ocean, and this zone is the bridge between the two, and very interesting things happen. The coral reef is clear, obviously a sunlight driven ecosystem where the energy comes from the sun and is passed on through the algae, into herbivores, etc. But once you get below the light zone, you only find scavengers and carnivores that rely on energy from elsewhere.

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But my zone represents that area where one system transforms into the other. And one of the things that is most surprising that we have found is that while you may think that it is a mix of species from above and from below, it is actually a completely new set of species. This zone is unique at the species level, and there are lots of new species there. But every species we find is somehow related to the shallow reefs rather than the deep ocean. The big question we had in the beginning is whether the zone was mostly like the shallow ecosystems or the deeper ones, and it is definitely mostly like the shallower systems, except that we almost

Deep Stops = Pyle Stops

Deep stops seems to be the latest buzz-word when it comes to promoting the latest models of dive computers. Deep stops allow you to complete your safety stops at depth. The amount of stops needed, as well as the depth at which they are required, depends on the maximum depth reached during the dive.

But Deep Stops are not all that new and were in fact discovered by Richard Pyle by coincidence—hence the alias *Pyle Stops*—as he started noticing that he was much less fatigued after deep dives if he had taken some breaks in the decent.

A "Pyle stop" is an additional short deep-water stop, which is increasingly used in deep diving. Typically, a Pyle stop is two minutes long, and at the depth where the pressure change halves on an ascent from the bottom to a shallow water decompression stop. For example, on an ascent from a maximum depth of 60 metres 7 bar to a decompression stop at 20 metres 3 bar, the Pyle stop would take place at the halfway pressure, which is 5 bar at 40 metres.

This is an excerpt from an article Richard Pyle wrote 10 years ago:

Back before the concept of "technical diving" existed, I used to do more dives to depths of 180-220 feet than I care to remember. Because of the tremendous sample size of dives, I eventually began to notice a few patterns. Quite frequently after these dives, I would feel some level of fatigue or malaise. It was clear that these post-dive symptoms had more to do with inert-gas loading than with physical exertion or thermal exposure, because the symptoms would generally be much more severe after spending less than an hour in the water for a 200-foot dive than they would after spending four to six hours at much shallower depths.

The interesting thing was that these symptoms were not terribly consistent. Sometimes I hardly felt any symptoms at all.

At other times, I would be so sleepy after a dive that I would find it difficult to stay awake on the drive home. I tried to correlate the severity of the symptoms with a wide variety of factors, such ►

Modern dive computers now incorporate Deep Stops in their decompression models. Suunto (D6 is shown) is one of the most prominent proponents

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only found new species. Not all was new, but many. What is interesting from an ecological perspective is the transition from one habitat to another and, from a species viewpoint, the fact that everything within the zone is unique.

Is it just the species' composition?

It is a bit of both. In fact, you find hardly any herbivores down there, which makes sense as there are not many algae down there. You find a lot of omnivores, wrasses for example, fishes that will eat almost everything, and there are a lot of those. You'll find planktivores, fish that eat plankton, like damselfishes and anthias, for example. The fishes you find there are the ones most adapted to just surviving. So, it is a little of both.

Do you have any pet theories?

I have one that we stumbled upon. It is possibly a little complicated to communicate, but I give it a try. I don't know if you know that in the tropical Pacific, the most diversity you'll find is in the western parts, around Indonesia. And as you move away from there, there are less and less species. And this holds true for fishes, crabs and corals and what not. Whatever you look at, the pattern is the same. So, for example, in the Indonesia-Philippines region, you have about 2500 species of coral reef fishes. In Palau, you have about 1500. In Fiji, you have around 1000, and Hawaii about 500. In Easter Island, they have about 100... so, fewer and species as you go. And this pattern is so consistent among all these organisms. There is a lot of scientific discussion going on about what causes that pattern, and there are two main ideas. One, is that species evolved along the periphery of the Pacific and accumulated in this area as they, over time, migrated and that is why you, in this area, have this mixing of species from all over the place. That is why there are so many here.

as the magnitude of the exposure, the amount of extra time I spent on the ten-foot decompression stop, the strength of the current, the clarity of the water, the water temperature, how much sleep I had the night before, the level of dehydration...you name it...but none of these obvious factors seemed to have anything to do with it. Finally, I figured out what it was—fish! Yup, that's right... On dives when I collected fish, I had hardly any post-dive fatigue. On dives when I did not catch anything, the symptoms would tend to be quite strong. I was actually quite amazed by how consistent this correlation was.

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Yup, that's right... On dives when I collected fish, I had hardly any post-dive fatigue.

The problem, though, was that it didn't make any sense. Why would these symptoms have anything to do with catching fish? In fact, I would expect more severe symptoms after fish-collecting dives because my level of exertion while on the bottom during those dives tended to be greater (chasing fish isn't always easy).

There was one other difference, though. You see, most fishes have a gas-filled internal organ called a "swimbladder"—basically a fish buoyancy compensator. If a fish is brought straight to the surface from 200 feet, its swimbladder would expand to about seven times its original size and crush the other organs. Because I generally wanted to keep the fishes I collected alive, I would need to stop at some point during the ascent and temporarily insert a hypodermic needle into their swimbladders, venting off the excess gas.

Typically, the depth at which I needed to do this was much deeper than my first required decompression stop. For example, on an average 200-foot dive, my first decompression stop would usually be somewhere in the neighborhood of 50 feet, but the depth I needed to stop for the fish would be around 125 feet.►

Not being a person who enjoyed confrontation, I kept quiet about my practice of including these "deep decompression stops".

The other theory is that species evolve in a hotspot—in the middle and radiate outward. And the farther you get from that hotspot, the fewer species you find because of the distance. Both of these mechanisms, which the scientific community are arguing about all the time, are operating at evolutionary timescales—in other words, at least hundreds of thousands or millions of years. So, they are thinking of it in terms of biology.

But we found cue patterns that we didn't expect on deep coral reefs as compared to shallow reefs. The first pattern we found is that there is a higher rate of endemism here. So, if you go to a particular island and go down deep, you'll find that 70 percent of the species are only found at that island. On the other hand, if you go shallow, perhaps only ten percent of the species are endemic. The deeper you go, the more unique the species are to that one island, which is strange, and we did not know why this would be. The second pattern is, if you go to say Fiji and dive in 15m and then looked at Cook island also at 15m, the difference is huge. Fiji has thousands of species, Cook island a few hundred. It is a completely different diversity. But if you go down to 100m instead, then the islands look comparable. There is no more diversity in one place than in the other. So, this pattern of high diversity versus low diversity seems to only apply in the shallow areas.

Endemism is the ecological state of being unique to a place. Endemic species are not naturally found elsewhere. The place must be a discrete geographical unit, such as an island, habitat type, or other defined area or zone.

NASA Astronaut image of Astove Island (Aldabra Group, Seychelles) in the Indian Ocean

So, it is almost like the ocean is layered?

Yes, so it appears. And that makes you think, what is it about the deep reef fishes that 1) makes them unique to each island and 2) makes them no more diverse in the Western Pacific than in the Eastern Pacific? We started the deep reef stuff in the Cook islands—which is low diversity—and we found all these new species and thought, "Wow! If we go over to the Western Pacific where the diversity is higher, we are going to find five times as many new species down deep because it is more diverse." But once we got there, we did find new species but in no greater numbers than we found on Cook. We thought that this was strange, and it was perhaps because we were just not in the right place. But as we went on to visit more and more locations, we found that the emerging pattern was the same—new species, but not a greater number of new species over there than here.

So, here is my pet theory about this: It occurred to me that the sea level goes up and down every hundred thousand years with the cycles of ice ages and glaciation. How much does it go up and down? About a hundred meters. Where is the break between shallow and deep reef fishes? About a hundred meters.

What I think happens is that every hundred thousand years, the sea level drops, and the species of the shallow reefs die out because all the shallow habitats, the lagoons, the fringing reefs, all of that disappears. Because when you look at an atoll, they come up straight to the surface and are flat on the top. And if you dropped the sea level a hundred meters the island just sticks out of the water it just doesn't erode away. So, when the sea level is high like it is now, you have a lagoon and all of these habitats up shallow. When the sea level then drops again, these habitats dry out, and all the species on the oceanic island's shallow reefs may die out. But if you go to the Western Pacific, which lies on the continental shelf, a shallow

So, whenever I collected fish, my ascent profile would include an extra 2-3 minute stop much deeper than my first "required" decompression stop. Unfortunately, this didn't make any sense either. When you think only in terms of dissolved gas tensions in blood and tissues (as virtually all decompression algorithms in use today do), you would expect more decompression problems with the included deep stops because more time is spent at a greater depth.

As someone who tends to have more faith in what actually happens in the real world than what should happen according to the theoretical world, I decided to start including the deep stops on all of my decompression dives, whether or not I collected fish. Guess what? My symptoms of fatigue virtually disappeared altogether! It was nothing short of amazing! I mean I actually started getting some work done during the afternoons and evenings of days when I did a morning deep dive.

I started telling people about my amazing discovery, but was invariably met with skepticism, and sometimes stern lectures from "experts" about how this must be wrong. "Obviously," they would tell me, "you should get out of deep water as quickly as possible to minimize additional gas loading." Not being a person who enjoyed confrontation, I kept quiet about my practice of including these "deep decompression stops".

As the years passed, I became more and more convinced of the value of these deep stops for reducing the probability of decompression sickness (DCS). In all cases where I had some sort of post-dive symptoms, ranging from fatigue to shoulder pain to quadriplegia in one case, it was on a dive where I omitted the deep decompression stops.

GRAPHIC BASED ON PHOTO BY AARON P - VIA FLICKR

Technical Diver doing a deep decompression stop

Here is my method for incorporating deep safety stops:

1) Calculate a decompression profile for the dive you wish to do, using whatever software you normally use.

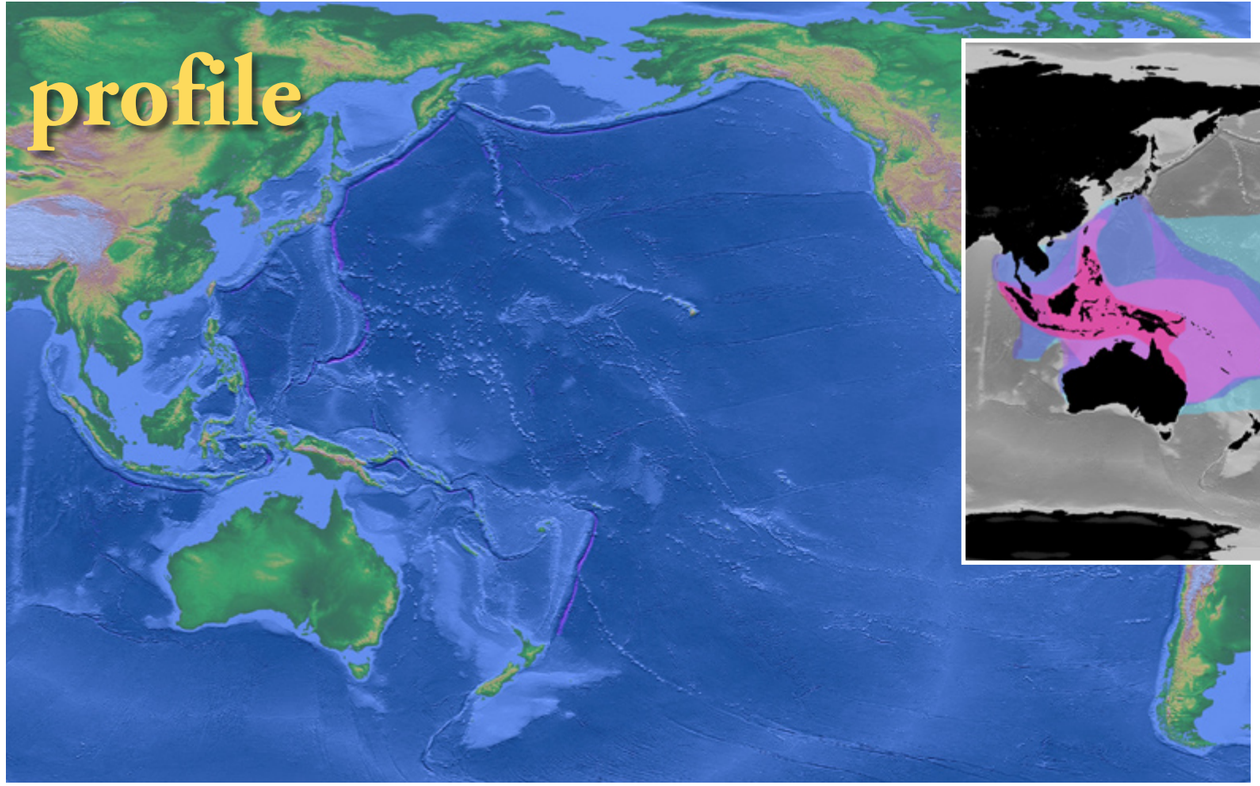
2) Take the distance between the bottom portion of the dive (at the time you begin your ascent) and the first "required" decompression stop, and find the midpoint. You can use the ambient pressure midpoint if you want, but for most dives in the "technical" diving range, the linear distance midpoint will be close enough and is easier to calculate. This depth will be your first deep safety stop, and the stop should be about 2-3 minutes in duration.

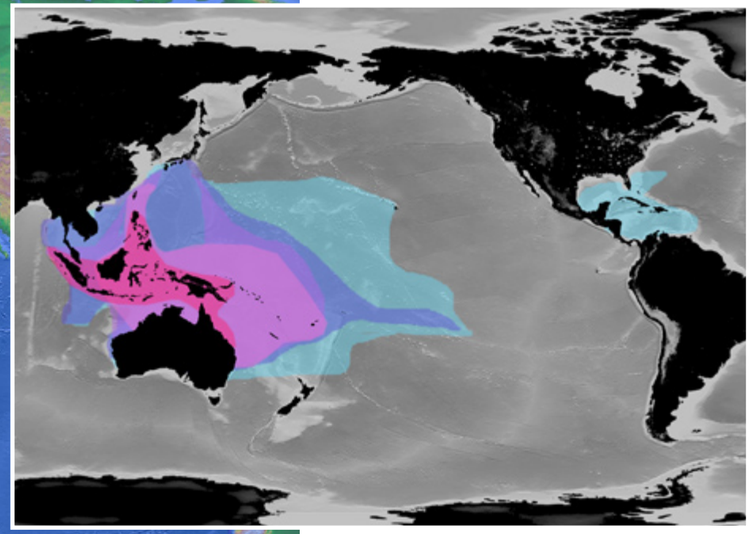
3) Re-calculate the decompression profile by including the deep safety stop in the profile (most software will allow for multi-level profile calculations).

4) If the distance between your first deep safety stop and your first "required" stop is greater than 30 feet, then add a second deep safety stop at the midpoint between the first deep safety stop and the first required stop.

5) Repeat as necessary until there are less than 30 feet between your last deep safety stop and the first required safety stop.

— Richard Pyle ■





Depth profiles (left) over the Pacific show that the archipelogoes of Indonesia, Malaysia and Philippines sit on the shallower continental shelf. If compared to a chart of biodiversity (above) the high biodiversity on the shallow reefs correlates with these areas

plateau, you don't have all these islands just sticking up from the deep bottom. When the sea level drops here, all what happens is that you move the habitats down a slope, so you don't destroy them. Whereas, in the Eastern Pacific, they die. However, if you go down deep, the fishes are already living along a vertical habitat, the wall, so if the sea level changes the fishes just move up and down with it, nothing really changes. That means that the deep fishes don't get wiped out every hundred thousand years or so. If this model is true, the shallow reefs gets wiped clean every time the sea level goes through a cycle, except in the Western Pacific—where the deep fishes don't get wiped out. They survive for many hundreds of thousands of years or millions of years, and therefore, have the time to become unique new species, because they are isolated there.

The species in the shallows, on the other hand, are never there long enough to become new species. Instead, what happens when the water comes back, the shallow reefs are repopulated from the Western Pacific. So, the idea is, that it is not evolutionary time scales that creates this pattern, but ecological. You wipe it out, you fill it out, you re-populate it—over and over again. Down deep, it just goes up and down, up and down.

This hypothesis would be predict two things: One, that there are more endemic species on these islands because they would have more time to become endemic; and two, you wouldn't expect the same pattern in the east and the west. And what do we find? Exactly that pattern. So, it is a very complicated equation. I presented this idea at a meeting in Taiwan a couple of years ago, which was full of these people arguing about the two theories, and amidst all their bickering, they all became quiet.

Can't this be settled somehow?

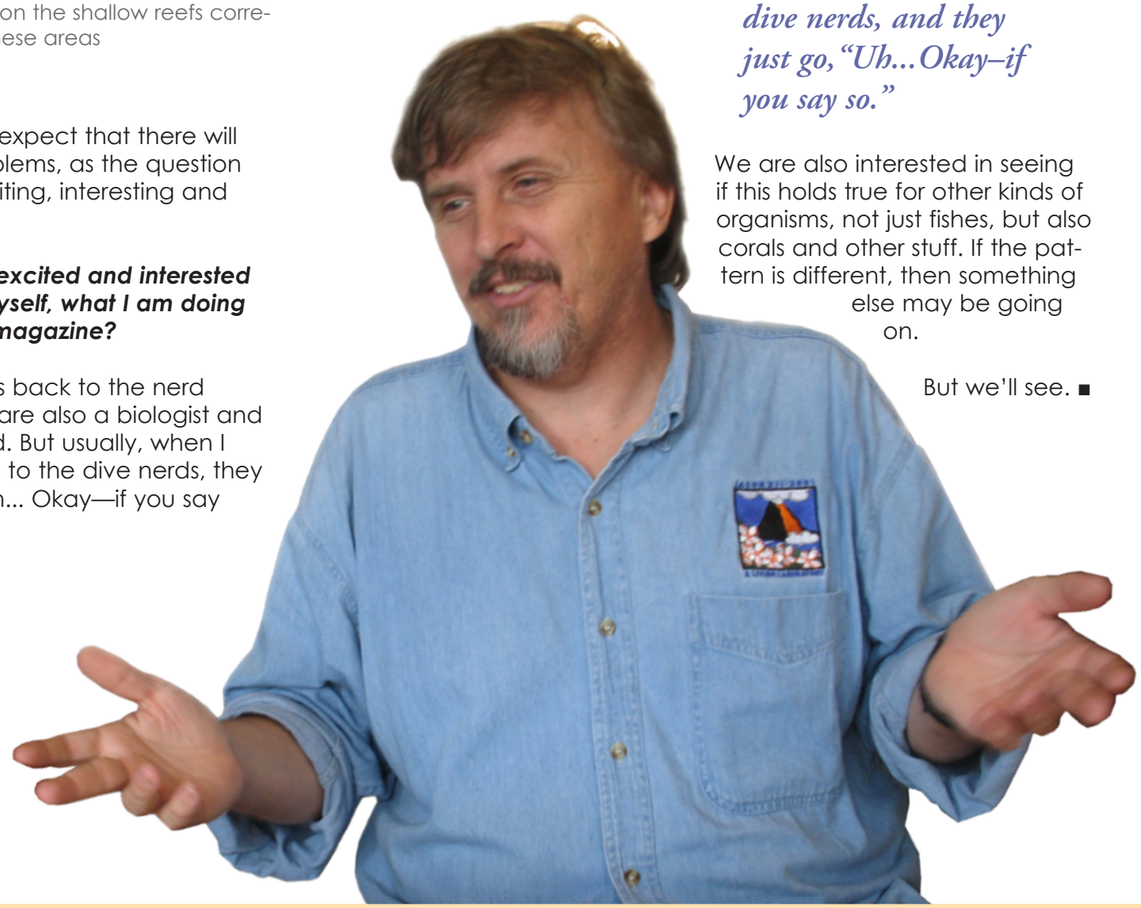
Yes, and it is going to be. The only way you settle it is to contrast the shallow reef fishes to the deep fishes. If there were no deep reef fishes, you couldn't settle it —even with DNA techniques. But since the deep fishes are higher endemics, and the shallower species are more connected to the Western Pacific, that means that they came from there—while the deeper ones have been there all the time. The shallow ones have been recolonising, whereas the deep ones were unique there. That is what we have a grant proposal submitted to do—to investigate this phenomenon. We just have to have more preliminary data to support to the application. and I expect that there will be no problems, as the question is both exciting, interesting and important.

Well, I get excited and interested and ask myself, what I am doing on a dive magazine?

It all comes back to the nerd thing. You are also a biologist and understand. But usually, when I explain this to the dive nerds, they just go, "Uh... Okay—if you say so."

Richard Pyle

Richard Pyle was instrumental in developing the original Cis-Lunar CCR rebreathers into an useful tool for researchers in the 1980s. Two decades later, his experiences were put to use by Poseidon, who had acquired the Cis-Lunar brand, in developing the new CCR for sports-divers that is being launched on the worldwide market in 2008



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We are also interested in seeing if this holds true for other kinds of organisms, not just fishes, but also corals and other stuff. If the pattern is different, then something else may be going on.

But we'll see. ■