

P. NG (LEFT); TAN HEOK HUI (CENTRE)

A tragedy with many players

Peter Ng is a man with a mission: to catalogue the huge diversity of life dwelling in habitats long dismissed as uninteresting. It's a race against time, he tells Carina Dennis and Peter Aldhous.

A tropical peat swamp is not a welcoming place. Its acidic waters sting every tiny scratch on your body. Hold your hands just beneath the surface and you can't see them through the tannin-laden water. The only bonus is that leeches don't fancy the murk. But Peter Ng, a taxonomist and conservation biologist at the National University of Singapore, loves getting up to his armpits in the mire.

Ng has discovered that the peat swamps of southeast Asia are teeming with rare species of fish and crustaceans, many of which are new to science. "Peat swamps have been badly neglected," says Ng, who pulls out novel specimens on nearly every dip into these hostile waters. His team has found a treasure trove of biodiversity in other unlikely places too, including the broken rubble of dead coral found off tropical beaches.

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Swamp king: Peter Ng has discovered dozens of species new to science.

Now Ng is engaged in a race to catalogue these neglected faunas before many of them are wiped out by Asia's relentless economic development. The peat swamps, in particular, are being drained as fast as he can sample them, sometimes for urban or agricultural development, at other times — in a bitter irony — under the guise of 'environmental improvement'.

The rich faunas found in such neglected habitats underline a growing realization that conservation biologists really know very little about our planet's biodiversity (see 'Hyperdiversity, or hype?', overleaf). But Ng's quest is driven by more than academic interest. "Scientists and environmental managers need to know these habitats exist and that they deserve to be conserved," he says. "If they are lost through ignorance or misinformation, then it will be a terrible tragedy."

Ng's excitement about peat swamps was first fired in the early 1990s, when his surveys of the North Selangor swamp in Malaysia turned up some unexpected finds. Wading through the muck, his team stumbled on several species of an elusive genus of catfish called *Encheloclarias*[1]. The last time anyone reported finding such a fish was in the 1930s.

The pH of such swamp waters can be as low as 3 — about the same as vinegar. "Until recently, peat swamps were assumed to be hostile, acidic places where the biodiversity was low," says Ng. "But that's because no one had actually jumped in." After taking the plunge into numerous swamps on the Malay Peninsula and the islands of Borneo and Sumatra, Ng's team has found some 80 fish new to science, bringing the estimate of the total number of species in the swamps to 200–300. "My students say they have too much to study," he says. A high proportion of the species are exclusive to the peat-swamp environment[2].

Hide and seek

It isn't easy pulling these creatures from the mire. Many of the fish and crustaceans hide in crevices in the peat, rather than swimming in the watery channels that run through it. Ng has to wade into the murky water holding a net, while his larger colleague, Maurice Kottelat, jumps up and down on the banks. "Maurice does his rain dance," says Ng — and that's enough to startle the creatures out of the peat. If Ng wants to sample all of the species present, including amphibians, he has to collect at night as well. Wading in a swamp in pitch darkness isn't for the easily spooked, he says.

"I'm interested in fish in places where people haven't been," says Kottelat, who is president of the European Ichthyological Society and is based in Cornol, Switzerland. Some of the fish they have found in the swamps — including colourful species of *Betta* fighting fish, popular with the aquarium trade[3] — have thrown up some intriguing mysteries. "Why they should be so colourful in such black water is the million-dollar question," Ng says.

Ng doesn't spend all his time in the field wading chest-deep in fetid swamps. Sometimes his trips take him to much more pleasant destinations, including the idyllic sandy beaches of the US-controlled island of Guam, some 2,000 kilometres east of the Philippines. There he studies another overlooked habitat: the piles of broken coral rubble that lie just a few tens of metres from the shore.

If you swim from a tropical beach to its fringing reef, you first pass over expanses of this rubble, created by storms and the ravages of time. Many naturalists make this journey time and again, lured by the stunning array of fish and other animals in the reef itself. But few pause to give the rubble a second thought. "It looks like a desert, almost," says Ng.

The rubble piles might still be dismissed

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What lies beneath? Acidic, fetid and unfriendly, southeast Asia's peat swamps (above) are home to a rich diversity of life, including unique and surprisingly colourful species of *Betta* fish (opposite).

as a desert, were it not for the obsessive curiosity of Harry Conley, who began diving off the beaches of Guam in the early 1980s after retiring from the US Air Force. Conley's initial interest was in collecting seashells. Realizing that they were present in large quantities in the rubble, he started to excavate the piles by hand. "The holes he dug looked like bomb craters," says Ng.

Rubble rousers

By the 1990s, Conley's interests had expanded to the crabs and other creatures that his digs disturbed. He teamed up with researchers at the University of Guam led by Gustav Paulay, who was conducting a survey of the island's marine biodiversity[4]. Ng joined the team in 2000, when he was asked to help identify crabs pulled from the rubble.

Sadly, Conley's work came to an abrupt end in 2002 when he was killed by a gunshot to the head — probably self-inflicted — after an argument in which another man was shot and wounded. Friends describe Conley as a generous yet troubled individual. "Harry was always a loner," recalls Bruce Henke, who accompanied him on many collecting trips. "He was very competitive. If you found something, he had to find something better."

Henke, who works in Guam as an air-traffic controller, continues to collect samples from the rubble piles. Now 50, he has dived recreationally since his teens and is an accomplished underwater photographer. In shallow waters, each dive might last for two hours, consuming several tanks of air. Larger pieces of rubble have to be prised away with a crowbar. "It can be dangerous," says Henke. "It's not something that I would recommend to just anybody."

> "These places don't have big, sexy animals. But in almost all cases, when they say a place is species-poor, they're wrong." — Peter Ng

Like the peat swamps, the rubble piles fascinate Ng because many of the species present have been found in no other environment. The crabs alone include about half-a-dozen genera and dozens of species that were previously unknown to science[5]. Those that live deep within the rubble look similar to crabs that are found in caves, with no pigments and shrunken eyes[6]. "It's a whole new world," says Ng.

Paulay, who is now at the University of Florida in Gainesville, believes that the rubble piles support a similar range of creatures to those that live in crevices deep within the coral reef itself. "This 'cryptofauna' represents the bulk of the reef's biodiversity," argues Paulay, who views the rubble as a window through which to study creatures that otherwise could be reached only by destroying the reef.

Hidden depths

There could be even more life inside the rubble than has been found so far — including faster-moving creatures that dart away from the dig sites before they can be caught. "I would expect to find prawns, gobies and worms of all sorts," says Ng. Sampling the sites more thoroughly is a huge challenge, though. One way would be to deploy a heavier-duty version of the vacuum pumps that marine archaeologists use to suck up silt to sift through for fragments of artefacts. But such devices don't yet exist.

Other parts of the marine ecosystem, such as the steep walls that fall away from the reef into deeper waters, are even harder to reach. Scuba divers can't descend below 100 metres and the walls are too steep to be dredged. Without access to a submersible, the only means of sampling the area is to throw a net blindly into the depths and cross your fingers.

Guam's rubble fauna isn't under immediate threat, so there is opportunity to think about how to improve sampling. But time is running out for many of Ng's field sites, which include extensive systems of limestone hills and caves found across southeast Asia. Water seeping down from the dense forest there creates moist grooves and crevices in the rock that host a wide assortment of plants and animals.

These 'karst' systems haven't been entirely overlooked — they include the Gunung Mulu National Park in Malaysian Borneo, granted World Heritage status for its biodiversity and geological features. But

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Pincer movement: these crabs are among the many species that make their home in piles of smashed dead coral.

their faunas are poorly studied[7]. "Limestone hills are hotspots of richness, but this has only really been appreciated recently," says Tony Whitten, a biodiversity specialist with the World Bank, based in Washington DC.

The forests that grow above the limestone are rapidly being cleared, which dries out the rock, destroying its subterranean ecosystem. Ecologists studying the caves often find themselves side-by-side — literally — with developers or cement companies mining the hills for raw material. "We'll be carefully collecting our samples, trying not to damage the habitat, and a few hundred metres further on, there's a guy busy with a chainsaw," says Jaap Vermeulen, a collaborator of Ng's at the Singapore Botanic Gardens, who specializes in the taxonomy of snails.

Vanishing world

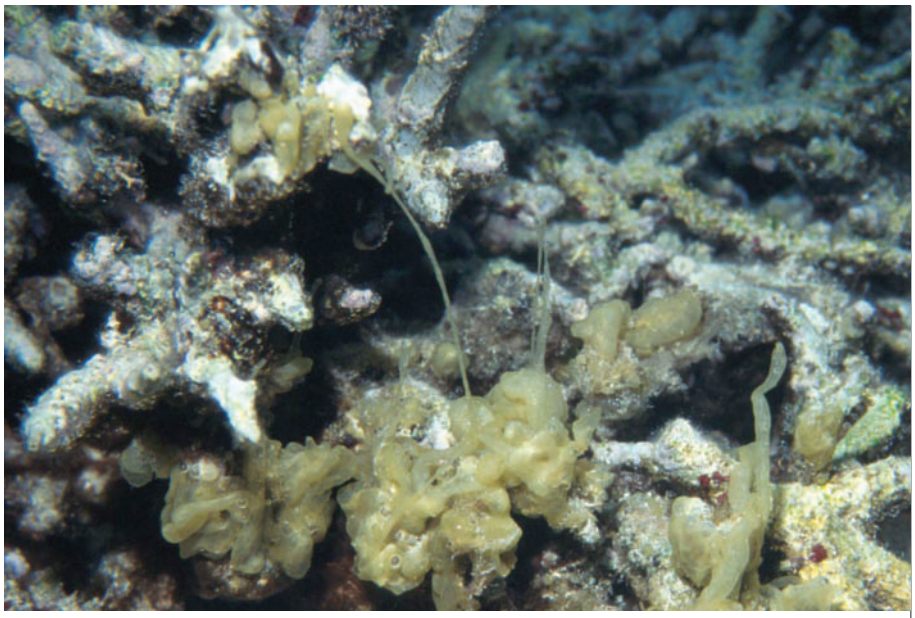
Living in the concrete jungle of Singapore, Ng knows all too well the consequences of unfettered development. Last year, he published a paper in *Nature*[8] that used the detailed records made by British colonial naturalists to document the extinctions that have occurred since most of Singapore's forests were cut down. Extrapolating from these data, Ng and his colleagues concluded that up to 42% of the species currently in southeast Asia's forests will disappear over the next century if habitat destruction continues at its present rate. About half of these will be global extinctions, as the species are not found elsewhere.

The race to catalogue biodiversity before it disappears is particularly intense in the peat swamps, which are disappearing at a frightening rate. The drainage is even affecting neighbouring bits of forest; dried peat bogs have fuelled huge fires that have razed some areas.

When he talks about the threats to the peat ecosystems, Ng's natural enthusiasm can't hide a deep melancholy. He has become a reluctant ambulance chaser, rushing in to sample sites earmarked for development. The collecting methods that Ng's team uses in such cases are severe and destructive. "We call them salvage operations," he says. "We catch whatever is scientifically valuable, knowing full well that there is no tomorrow. It is a very rotten feeling."

Ng hopes his work will counter the ignorance that underlies the blasé destruction of these habitats. Officials and developers argue that there is no point conserving the swamps because there is 'nothing' there. "These places don't have big, sexy animals," Ng concedes. "But in almost all cases, when they say a place is species-poor, they're wrong."

He remains gloomy about the chances of protecting the remaining swamps from the tide of development. But at the very least, Ng is determined to reveal for future generations the true magnitude of the devastation that is now being wrought. "The story is much more tragic once you know the characters," he says. ■



K. EVANS

Coral rubble used to be ignored, but it offers researchers access to creatures that live deep within a reef.

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Hyperdiversity, or hype?

Back in the mid-1990s, John Lambshead was a cheerleader for a radical idea: that the mud of the ocean's depths is every bit as rich, in terms of biodiversity, as a typical rainforest. Today, he has a different message.

Lambshead, an expert on the taxonomy of nematodes at the Natural History Museum in London, has found that the conclusions you draw about biodiversity can vary dramatically, depending on the area over which you measure it.

In 1995, he and Guy Boucher of the Paris Natural History Museum described the diversity of nematodes — worm-like creatures that account for about 80% of the abundance of animals in seafloor mud — recorded in nearly 200 sediment cores from around the world. They counted up the number of species found in each batch and extrapolated from these samples to estimate that the deep sea is a 'hyperdiverse' environment, containing more than a million species[9].

But this extrapolation was controversial. The cores had been analysed by different people, so it was unclear how much overlap there was between the species found in different cores. To tackle this problem, Lambshead's PhD student Caroline Brown analysed cores taken along a 3,000-kilometre stretch in the central Pacific[10]. Her results showed that, although every core was very diverse, a similar pattern of species repeated itself from sample to sample. In retrospect, says Lambshead, this shouldn't be that surprising: explorations by research submersibles have revealed that the deep-sea environment varies little from place to place.

Based on Brown's evidence, Lambshead and Boucher officially downgraded their estimate of the diversity of the deep ocean in a guest editorial in the *Journal of Biogeography*[11] last year. Lambshead is now doing further work with John Gray of the University of Oslo in Norway, who had independently questioned the idea of deep-sea hyperdiversity[12]. Their unpublished data confirm that the same picture applies to polychaete worms — the next most abundant creatures in the mud.

Lambshead's repudiation of deep-sea hyperdiversity has met with some resistance from marine ecologists, who had eagerly embraced the concept. Environmentalists had also used the theory to argue that it is crucially important to conserve every segment of the deep ocean. Conservation is still important, says Lambshead, and the deep ocean still diverse — just not hyperdiverse. **P.A.**