Economist.com SCIENCE & TECHNOLOGY

Biodiversity

Fathoming out evolution

May 19th 2007
From The Economist print edition
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A survey of the Weddell Sea uncovers extraordinary biological diversity

THREE hundred years after the birth of Linnaeus, the Swedish naturalist who established the concept of a biological species, no one has much of a clue how many species there are on Earth. Taxonomists—bipedal apes who tend to inhabit temperate zones in the northern hemisphere—have characterised what is under their noses reasonably well. A fair amount is known about the life in tropical forests, too. And a back-of-the-envelope calculation based on the 1.8m sorts of organism recognised so far as species under the Linnaean system, on the rate at which new species are being discovered and on such ecological matters as the average number of parasites (themselves new species) that each free-living species harbours, suggests the final total may be around 30m.

But that 1.8m starting point is mainly from the land and the upper reaches of the sea. What is going on in the deep ocean is so badly understood that estimates of biodiversity there range from 100,000 species to 100m. The reason for this is that sampling the ocean depths is tricky and expensive—and doubly so in the seas around Antarctica. That is why the results of three German expeditions by the vessel *Polarstern* to the Weddell Sea, published in the current issue of *Nature*, are a big step forward. Angelika Brandt, of the Zoological Museum in Hamburg, and her colleagues have found an extraordinarily long list of new species in the frozen depths.

Dr Brandt's team discovered this novelty by sampling deeper than the 500 to 1,000 metres frequented by their scientific predecessors. They also used nets capable of capturing the smallest animals. They picked up critters from as deep as 6km, and they did so using both typical trawling nets and a special box that was designed to scoop up a slab of ocean floor along with a slice of undisturbed water from immediately above it. Many patient taxonomists from several European countries and America then sieved through litres of muddy gravel with microscopes and pairs of tweezers to see what treasures had been captured. Each litre was found to contain up to 40,000 animals, many of them species new to science.

The isopod pictured above, for example, is but one of some 600 new species of these woodlouse-like creepy crawlies. That triples the number of Antarctic isopods known. More to the point, though, is that as *Polarstern* pursued its mission during the summers of 2002 and 2005, the rate at which new isopod species were discovered did not decline. That suggests biology has only scratched the surface of isopod diversity—and in the grand scheme of things, isopods are a pretty obscure group. This implies that the total biodiversity of the Weddell Sea is enormous.

The questions are, where did that diversity come from? And does the answer point to a more general mechanism for generating diversity? Dr Brandt thinks she knows the answer to the first question and that it bears on the second.

Pump up the volume

At the moment, many biologists suspect terrestrial biodiversity is something that is generated in the tropics and exported to the rest of the world. Why the tropics are so diverse is something of a mystery, but one explanation is called a species pump. This hypothesises that climate change associated with ice ages regularly shrinks and fragments the forest into isolated "refugia", which go their own merry evolutionary way. When the climate improves and the forest expands, all the new species that have evolved in the refugia mix. Then the process happens all over again.

A similar thing could happen in the Weddell Sea. Growing ice shelves would make the shallows uninhabitable. The ocean depths would act as the refugia. Then, when the ice melted, the shallows would act as a mixing bowl for the newly evolved species.

Dr Brandt and her colleagues built family trees of their new species to see whether a species pump of this type might explain their findings. It did. Many of the novel isopods, for instance, could be grouped as closely related pairs of species, with one of the pair found in shallower waters and the other down in the depths. That is exactly the pattern that would be expected if deep-dwelling creatures had spread into the shallows and evolved into shallow-dwellers. The tropical rainforests and the Weddell Sea may, as it were, be polar opposites as habitats. But it looks as though their species richness is caused by the same underlying mechanism.