almost two kilometres down trawling the black depths and landing FISH WE'VE NEVER SEEN

PHOTOGRAPHS John de la Roche

TEXT Steve Bunk

THE HORIZON IS STILL FAINTLY VISIBLE after dark, 60 kilometres offshore, as if the Southern Ocean had hoarded light from the slipped sun. It must be similar under the surface, deep down where only the narrow blue spectrum penetrates, where fish bigger than fingerlings are relatively few and very strange. Even at those black depths the medium of communication, aggression, camouflage and courtship is light.

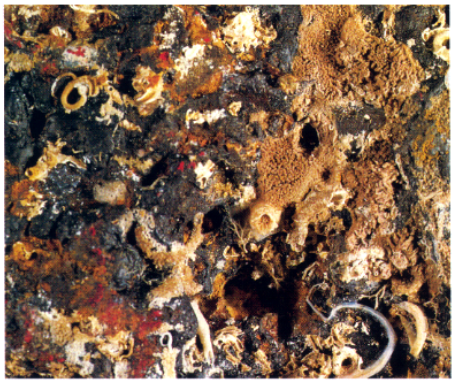
If we could survive the pressure to swim that far down, it might look rather as it does on shipboard at sea, gazing skyward on a moonless night. In place of starlight, we would see the photophores, or light organs, of fishes and squid. If we had the sensory capabilities of fish or of modern acoustic equipment, we could detect the "deep scattering layer" of zooplankton, pyrosomas, crustaceans, all the biodiversity which extends

Awesome-looking creatures

FEARSOME ASPECTS predominate among deep-sea creatures, none more so than the black dragonfish (above) and the hyperiid amphipod (opposite). Astonishingly the latter can survive massive pressure changes during its ascent to the surface in the trawler's net.

down to about 900 metres throughout our seas, making them as rich with life as any on Earth.

Very little of the detritus rain of nutrients from the surface gets down that far. With a few exceptions, such as sperm whales and giant squid, it is a Lilliputian world because of this food scarcity, albeit one inhabited by creatures that would have horrified Gulliver far more than the first sight of his own tiny tormenters. Many of the denizens in these depths are razor-fanged incarnations of that zoological descriptor, "opportunistic feeder": if they can fit you in, they will eat you.



Generally, they have little or no commercial value, which is why scientific study of them has been negligible. "Depths beyond mid-slope, deeper than 1,200 metres, have never been sampled," says CSIRO's Dr Alan Williams, marine biologist on this expedition of research vessel *Southern Surveyor*. A main objective of the trip is to study one of the deepest-dwelling commercial species, the orange roughy or deep sea perch, whose habitat ranges from 700 to 1,200 metres. Catches of non-commercial fish are a scientific bonus.

Most fisheries are on the continental shelf, which extends down to about 200 metres. Around much of Australia, the ocean's floor then slopes to between 1,500 metres and 2,500 metres before plateauing. It descends again to between 4,500 metres and 5,500 metres, where the sea's virtually unexplored abyssal plain begins. "Thus far, because the research on commercial species drives a lot of what we do and there is no identified commercial resource below the orange roughy depths, there has been no exploration by us as scientists," Dr Williams says. "There's no doubt that a large number of species that have not been discovered are living at those depths. That applies to both the sea floor and the open ocean."

According to CSIRO's Marine Laboratories in Hobart, 800 new species have been discovered in Australia's waters over the past decade, plus 700 "new records", or previously identified species which had never been found in our seas before. A month-long CSIRO survey off Western Australia in 1991 was the first time that coast's mid-slope waters (700-1,200 metres) had ever been sampled. "We turned up 390 species of fish, of which 10 to 20 per cent were new to science," Dr Williams says. "There was in the order of 100 new records for Australia in that single survey."

No similar search was ever again mounted off WA, nor indeed in most of Australia's surrounding seas at depths beyond those of commercial fishing. Before this voyage of the *Southern Surveyor* ends, Dr Williams' plan is to trawl a net at about 1,800 metres, easily a new deep-sea sampling record for the nation.

Prior to this "deep shot", two shallower dips are made, one of which produces the likely inspiration for the thing that popped from an astronaut's chest

High-tech research vessel

THE SOUTHERN SURVEYOR (top), equipped with the latest marine technology, often takes CSIRO scientists over a range of sea mounts (above) that rise up to 500 metres from the Southern Ocean's floor. Dense communities of marine life congregate around them.

THE METALLIC LOOK

WHILE MANY DEEP-WATER fish species typically appear to be sculpted from metal, not all of them possess a threatening exterior like the viperfish (centre) and the bristlemouth (top). An example is the spiny fin (left), a relation of the orange roughy which, in fact, preys on the bristlemouth.

Amazing sounds

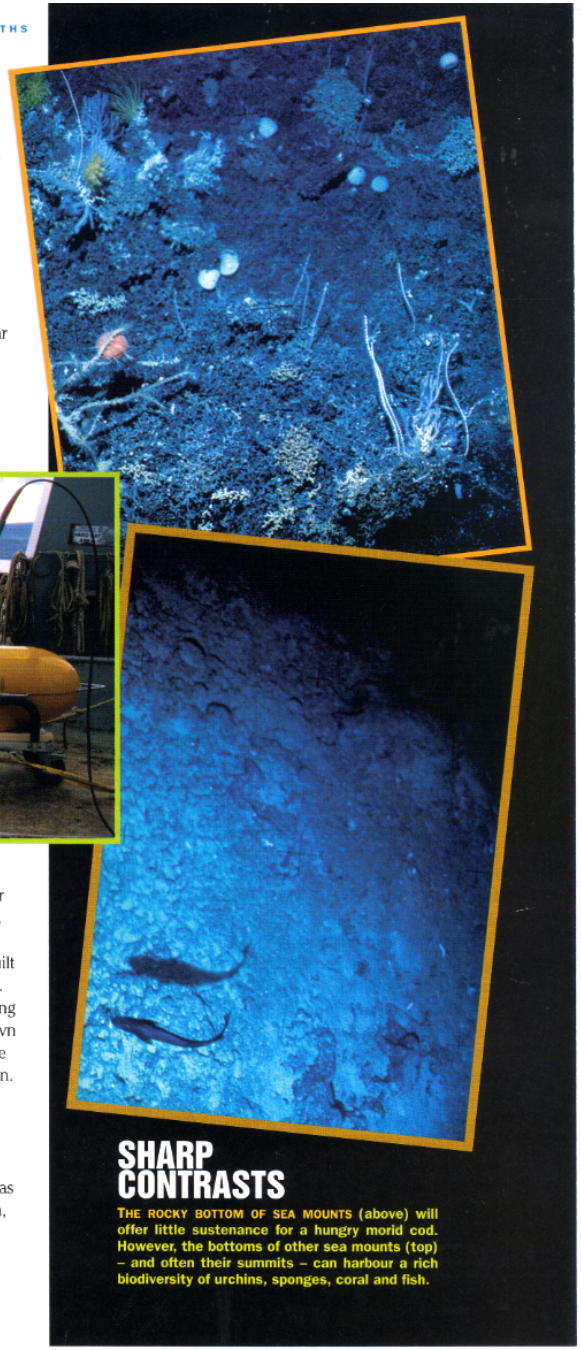
THE TORPEDO-LIKE MUFTI (multi-frequency towed instrument, below), a CSIRO invention, is dragged behind the *Southern Surveyor* down to 1,000 metres. The reflections of its acoustic signals off marine life are recorded by computer enabling scientists to differentiate individual species and count populations.

in the movie *Alien*. The black dragonfish, about as long as your hand, is streamlined with a thin appendage dangling from its chin, capped by a bauble that emits light underwater to draw prey near its mouth. It has other photophores on its viciously sharp teeth, which are hinged at the base. You can push them backwards to see how they let prey in. Then they lock shut.

The black dragonfish is similar to the anglerfish family in its use of a rod and lure. Anglerfish are prominent among the little fish with big teeth which are found deep down. Their illicium (Latin for "decoy") usually extends from the snout and ends in an esca ("food" or "bait"), a fleshy blob or tuft of filaments containing light-emitting bacteria. Sometimes, the esca resembles a preferred meal. Anglerfish, like most deep-sea animals, are not built for speed. They tend to drift, then lunge for a feed.

Dr Williams has dissected anglerfish, determining that they can consume up to 90 per cent of their own weight. "I know of a well-documented case where one was found floating on the surface of the ocean. It was scooped up, sent to a museum and they worked out that this fish had eaten something so large, it had choked on it. Both the anglerfish and its prey turned out to be undescribed species."

Another species on the ship's laboratory table was first aptly described in 1801 as a viperfish. Its teeth, curved like bent needles or thin tusks, are so long



SHARP CONTRASTS

THE ROCKY BOTTOM OF SEA MOUNTS (above) will offer little sustenance for a hungry morid cod. However, the bottoms of other sea mounts (top) – and often their summits – can harbour a rich biodiversity of urchins, sponges, coral and fish.

that the bottom molars fit into grooves on top of its head. The jaw is capable of an enormous gape. Although its fins are much farther toward its tail than those of the anglerfish, the fish still can extend an elongated rod over its head and dangle a bauble.

It's rather a relief that, like the other specimens brought up from the deep ocean, this one is dead from the rapid change in pressure by the time it reaches the surface. The thought of a viperfish writhing and snapping on the laboratory table is not a pretty one.

A more approachable strangeness is that of the pyrosomas, simple filter-feeding organisms shaped either like spongy tubes or mats. A notice on the wall asks crew to note the depth distribution of pyrosomas. The big ones, the note says, are thought to rise near the surface at night; they have been estimated at 2.4 metres wide and 14.3 metres long. Pyrosomas are composed of individual salps, interim creatures between invertebrates and vertebrates which are mostly made of water.

Salps also are thought to be the stuff of a translucent, open-ended little barrel made by the hyperiid amphipod for protection and to lay its eggs. This thumbnail-sized crustacean resembles a transparent grasshopper with claws, and is the only moving thing from the net. We shake a few out of their barrels and put them into a bucket of water. They quickly relocate the sacs, climb back in and continue paddling.

One of the flashiest-looking animals in the catch is the giant hatchet fish. About as giant as your palm but shaped like a hatchet's head, it is covered with a gelatinous slime that Dr Williams suspects is a buffer to prevent other species from sensing its movements. Rows of light organs adorn its side like tiny windows. The fish dwells in open

Looking for the unknown

SORTING THE CATCH ON BOARD the *Southern Surveyor* (above) can be an exciting time for CSIRO scientist Dr Alan Williams (left of picture) and crew. Amidst the relatively common species there's always a good chance of finding something as yet undescribed by science.

water without the protection of geological structures. It avoids predators with the help of semi-telescopic eyes that can look directly upwards and that have a separate structure to gauge the amount of light filtering down from the surface. Only the blue spectrum can penetrate these depths, in an almost single plane at an even wavelength.

Somehow, the hatchet fish can match exactly this amount of light with the amount it generates from its photophores, which beam downward. To a predator coming from below, the prey's silhouette is invisible. From above, the hatchet fish's dark back blends with the blackness of the sea floor. In shallow water, this camouflage effect is called counter-shading and most deepwater fish follow the principle by being either black with photophores on their undersides, transparent or red, which does not reflect light at depth.

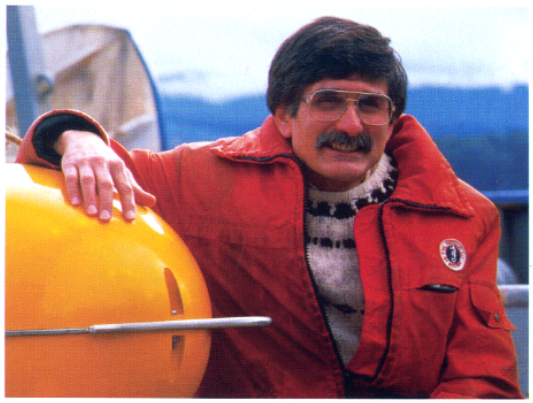
The blue spectrum photophores are not the only ones on hatchet fish. Some have light organs in the roofs of their mouths, which lure prey for a closer look. Other species have glands that light up like flash bulbs, probably to startle predators long enough for the flasher to make an escape. Yet others have photophores on the sides of their heads which alert their own kind to their presence. This could be for spatial organisation such as the marking of hunting territory or for locating potential mates. Still other species have special yellow filters over their eyes, enabling them to see light reflected from red prey.

Fish associated with the bottom of the sea along the mid-slope often make sounds to communicate. The most numerous of these creatures, the whiptails, have muscles that drum a kind of ocean-jungle beat on their gas-filled swim bladders. The bladder, also a good structure to receive sounds, has a close physiological connection to ear bones in the skull.

Those fishes at mid-slope which do not have contact with the bottom, such as the hatchet fish, are without swim bladders. They have other adaptations to the open ocean, including greatly reduced ossification in their

JUST A HANDFUL

WITH SOME EXCEPTIONS, such as the sperm whale and the giant squid, most marine creatures in the deep ocean are constrained in size by a scarcity of food. The deepwater squid (right), the giant hatchet fish (top) and the lighthouse fish, fit with ease in a person's hand.



bones and a high water content in their muscles to make them lighter. Placing a metre-long, deep-water shark on the laboratory table, Dr Williams says such animals typically have an enlarged liver filled with high volumes of squalene, an oil which gives them buoyancy. A sluggish fish, the deep-water shark is spongy to the touch and would make terrible eating.

The only three commercial fish found at mid-slope – two species of deep sea dory and the orange roughy – are all rather bland tasting, although that probably makes them palatable to some people who don't like fishy flavours. A glance at an orange roughy explains why it usually is filleted for retail sale. Although not as ugly as many of its deepwater neighbours, its cavernous head and membranes filled with oil to detect vibration are hardly mouth watering. A seam-like lateral ridge gives the fish multi-layered sonar and its orange hue is unreflective of light at depth. Maturing at about 32 years and living to 100 or older, it is one of the world's longest-lived fishes.

Southern Surveyor cruise leader Dr Tony Koslow, a key figure in orange roughy research over the past decade, says the conventional wisdom when he was in graduate school held that the numbers and kinds of sea life decrease with depth. But the roughy research has revealed a world of diversity in the deep which defies that theory.

Orange roughy congregate around the tops of sea mounts which rise to heights of 200-500 metres from the ocean floor, at depths of 700-2,500 metres. These sea mounts have proven to be startlingly rich in life, from top to bottom. Most deep water has virtually no current but Dr Koslow's research showed that currents brush past the sea mounts, bringing with them a smorgasbord of nutrients, which helps to explain why roughy are bigger, more muscular and well fed than most other deep-dwelling fish. They hide around the mounts, swimming to keep their position and hunting like trout, never needing to rise to the surface to feed.

As the time approaches for the *Southern Surveyor*'s deep shot, the seas rise and pitch. Twice as much cable is needed on each of two reels than the depth to which the net will be lowered, and this ship is the only one in Australian waters equipped to trawl so deeply. It will take about two hours to get the net down to 1,800 metres, four hours of fishing and three hours to haul up the catch. Dr Williams and crew are visibly excited by the prospect.

Reasoning that they want just one deep-water shot, they remove a timed device at the end of the net which opens and closes sections of it to permit catches at various depths. This is a mistake. When the net is raised in the early hours of morning, they see that the absence of the timing device has allowed the catch to flow back and forth and become tangled in the entire net, as if it were in a giant washing machine. Most of the specimens have been destroyed.

Dr Williams consoles himself that there was nothing too outstanding in the catch, although there were a few goodies, such as two badly damaged red headlight fish. They not only have special cells which can detect the red spectrum but they can emit a red light to illuminate unsuspecting prey. But he has caught red headlight fish before this and tries to dismiss his disappointment in the deep shot, which he has been attempting to accomplish for years. The worry, of course, is that there is no commercial incentive for another chance.

Back at Hobart, CSIRO Fisheries chief Peter Young puts the problem in harsh perspective. "Australians' attitude toward the sea stops at the beach's edge, with the exceptions of whales, turtles and crocodiles. There isn't a shared curiosity for what's out there," he says. "The general public must go beyond the Flipper mentality. They have, to a degree, with the Great Barrier Reef, but it's still, 'Gee whiz', without really understanding." ■

Expert on the roughy

DR TONY KOSLOW, expedition leader on the *Southern Surveyor*, is an expert on the orange roughy. He has made many important discoveries about this commercial fish and its habitat, including the distribution and circulation of water columns in the deep ocean.

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