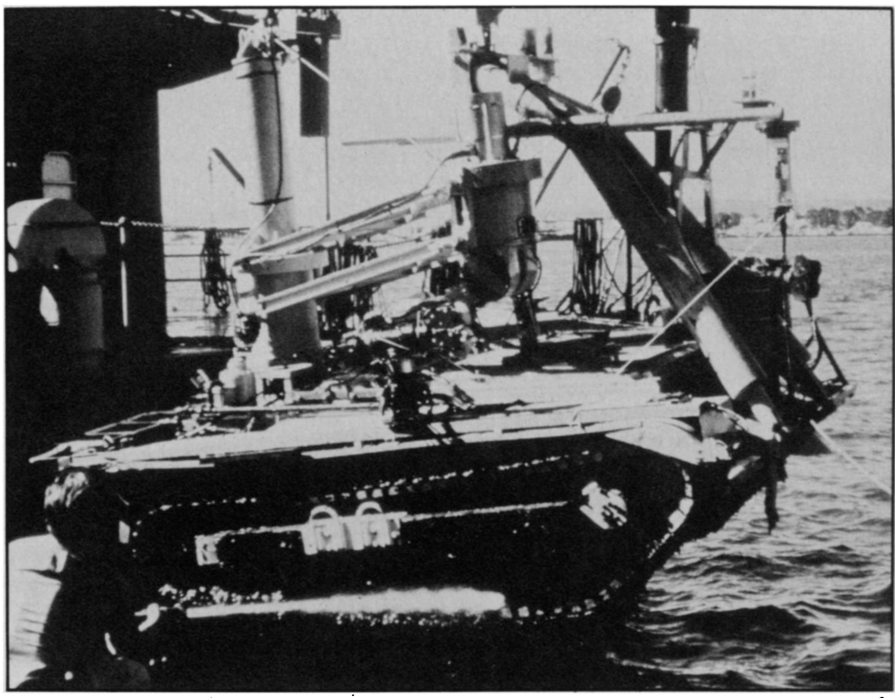
Life in the Ocean Depths

An innovative effort to study deep-ocean life has been undertaken by a Scripps team

BY JOAN AREHART-TREICHEL



Hessler et al.

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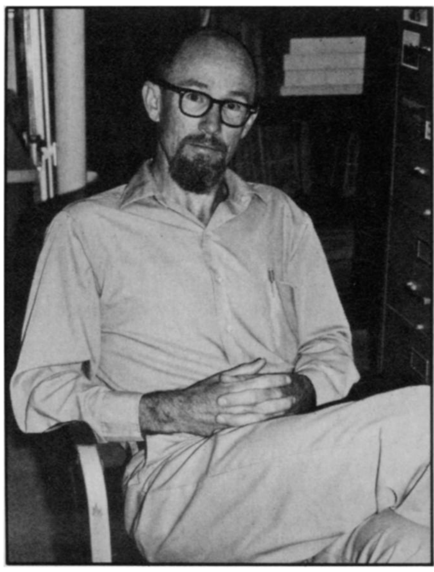
Although scientists have measured and even used bathyscaphes to visit the ocean's greatest depths (10,500 meters or 35,000 feet), they still know relatively little about deep-ocean organisms. One problem is that the water that covers 70 percent of the globe masks chasms as deep as the Rockies are high. The water in these abysses is dark, cold and exerts incredible pressures, conditions that make research at such depths not only difficult but terribly expensive.

Nonetheless, during the past several years a team of biological oceanographers headed by Robert R. Hessler of the Scripps Institution of Oceanography in California has undertaken one of the most aggressive, innovative efforts yet to learn about life at various ocean depths. The team has a wide background of knowledge and skills at their disposal, not to mention the technical and financial resources of Scripps, one of the largest ocean research centers in the world.

Analysis of their data is far from complete and mostly still to be published. But they've already learned some fascinating things about deep-ocean life. For example, life in the deep ocean is much slower than it is toward the surface, and some deep-sea organisms reproduce seasonally although it's unlikely that the seasons or even weather stressors such as storms penetrate the ocean's depths to any degree. Such basic research also bears on timely, practical questions, such as whether nuclear wastes can be disposed of in the ocean without hurting life there or whether manganese nodules can be mined from the ocean without upsetting the ocean's ecology.



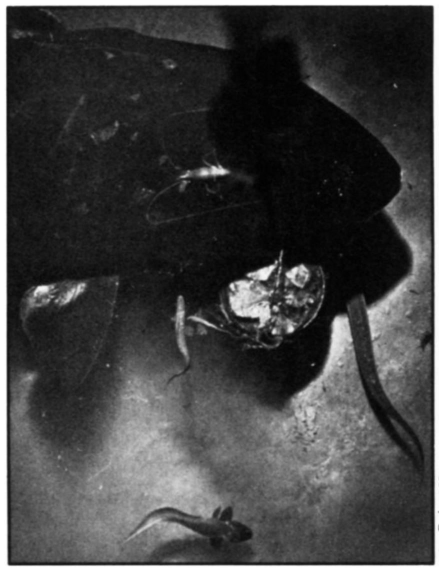
Arehart-Treichel

"Alas, no sea monsters," Hessler says.

Like a number of oceanographers, Hessler is colorful. He sports khakis, long woolly socks and tennis shoes, and his blue-green eyes dance humorously above a Confucian beard as he recounts his team's exploits: "Many scientists have a hypothesis about the deep sea, then they test it. But what we have done is inductive. And when you look at the ocean with a clear view, my God, are there some differences down there."

The techniques the Scripps group used to explore with a clear view included trawling for samples of specimens; box coring to obtain quantitative samples; dropping bait and taking time-lapse photos as fish and other animals come up to eat it; trapping fish in a fish-trap respirometer to measure their breathing; and finally, in Hessler's words, "a beast lovingly known as RUM" that stands for Remote Underwater Manipulator.

"Actually, it is a large tractor from war surplus," Hessler confesses. "A Scripps team attached sensors and two television cameras to it, as well as a mechanical arm that could do just about anything, including control the fish-trap respirometer and take box core samples. Once RUM was fixed up, we then lowered it into the ocean, meanwhile keeping it attached to a barge above the water by an electrical cable." The barge, the investigators' home while operating RUM by remote



John D. Isaacs

Twenty-foot shark goes for team's bait.

Dead fish bait dropped to bottom of Philippine Trench; six hours later amphipods gobble bait; three hours later bait is gone.

control, was dubbed ORB for Oceanic Research Buoy. From there they watched sea-floor operations continually from the barge's television screens.

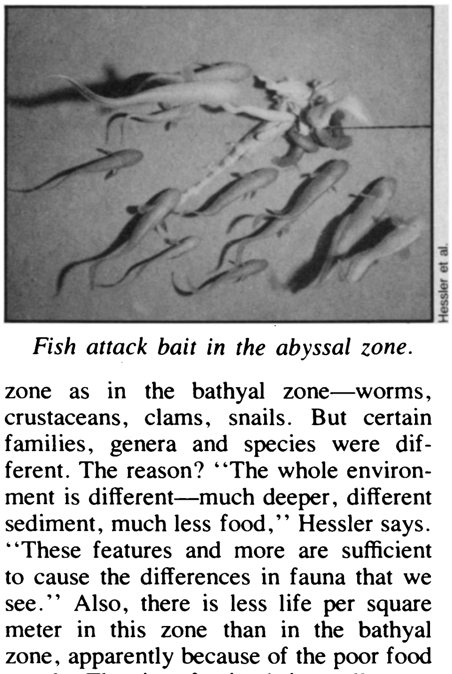
The scientists selectively used these techniques to explore life at three ocean depths: the bathyal zone, which includes the slopes beyond the continental shelf, to depths of about 1,200 meters or 5,000 feet; the abyssal zone, which consists of plains down to 6,000 meters or 19,000 feet, and the hadal zone, the deep ocean trenches, around 9,600 meters or 32,000 feet. Many scientists have studied life in the bathyal zone, but few have tackled it in the deeper abyssal and hadal zones.

The fish-trap respirometer, RUM and ORB, for example, were used to study life in the bathyal zone, specifically the San Diego Trough. "We worked like hell day and night," Hessler recalls. (He likes to spin a good ocean yarn, especially when it's true, and while the Pacific Ocean pounds outside his lab door.) Their navigation was refined enough that they could study the spatial distribution of various organisms. The distribution had not been measured before, due to limitations of the sampling gear that operates from a normal ship. Such gear cannot be positioned accurately enough to obtain a sample repeatedly at the same spot.

The team also measured the breathing of the hagfish and rattail, two fishes that are common in the deep oceans of the world, especially along continental slopes. They found that the fish breathe about a third as fast as shallow-water fish. This was the first time that the metabolic activity of individual deep-sea animals had ever been successfully measured in their natural environment. The metabolic activity of communities of deep-sea bacteria has been measured before, and it too was found to be slower than that of shallow communities. So it looks as if the pace of life is much slower in the bathyal zone, where the temperature of the water is near freezing and ocean pressures are ample.

Another interesting finding to emerge from this zone, courtesy of Scripps team member Frank Rokop, was that dominant animals, such as clams, worms and brittle stars, reproduce continually throughout the year. But some others, such as tooth shells and lamp shells, reproduce seasonally. This is curious, since it is unlikely that the seasons or even night and day influence this ocean depth. Still another provocative finding in this zone, by Joe Siebenaller, is that bathyal animals show high genetic variability within a species. One hagfish, for example, may reproduce slightly later than another hagfish. Genetic individuality is considered important for organisms that must adapt to heterogeneous or fluctuating environments. But why, Hessler asks, would genetic individuality be necessary in the bathyal zone, since it is a cool constant environment?

The abyssal zone, on the other hand, was too deep for the team to use RUM and ORB, so they relied on dropping bait and camera and trawling for samples. They studied an area of the abyssal zone in the food-poor central North Pacific and found the same general kinds of animals in this



Fish attack bait in the abyssal zone.

zone as in the bathyal zone—worms, crustaceans, clams, snails. But certain families, genera and species were different. The reason? "The whole environment is different—much deeper, different sediment, much less food," Hessler says. "These features and more are sufficient to cause the differences in fauna that we see." Also, there is less life per square meter in this zone than in the bathyal zone, apparently because of the poor food supply. The size of animals is smaller too, probably for the same reason.

To study the hadal zone the scientists visited the Aleutian and Philippine Trenches. Although the Philippine Trench is the second deepest area of ocean in the world, the scientists were still able to study it by trawling for samples of specimens and by dropping bait and taking photographs. Although they are still analyzing their finds, they have already noted some interesting phenomena.

For one, even though the trench is stupendously deep, it is steep and close to land. Hence, it receives more food than do the shallower waters of the abyssal plains. As a result, there is a much higher density of life in these trenches than on the plains. However, there are fewer varieties of life in the trenches, because the community is being constantly disturbed by sediment sliding off the trench walls.

No fish were seen at all in the Philippine Trench. In fact, no one has ever seen a fish at depths greater than 8,300 meters. Ordinarily, it is fish that dominate bait, but in the Philippine Trench, all the team saw were tiny crustaceans called amphipods. Why should amphipods survive at those depths and not fish? Perhaps the amphipods out-compete the fish, but if so, the researchers still don't know how. Alternately, perhaps fish can't withstand the hydrostatic pressure of the trench.

In any event, Hessler laments with a grin, "We didn't find any monsters of the deep."

Hessler swivels in his lab chair. "There used to be no earthly good for this kind of science other than the pure love of learning. But during the past decade or so, several important projects have evolved that absolutely depend on this kind of research." One is the National Oceanic and Atmospheric Administration's manganese nodule mining program. Scientists are asking what the effects of manganese nodule mining would be on life in the deep oceans. Still another is a multi-institutional study being administered by the Sandia Laboratory for the Earth Resources Development Administration, to determine whether nuclear power wastes can be stored in the oceans without hurting life there. Hessler is participating in this study.

The Scripps research also holds implications for offshore outfalls and garbage dump proposals. Because metabolic rates may be generally lower in the deep sea, the rates of breakdown and recycling of materials placed there may be proportionally reduced. □