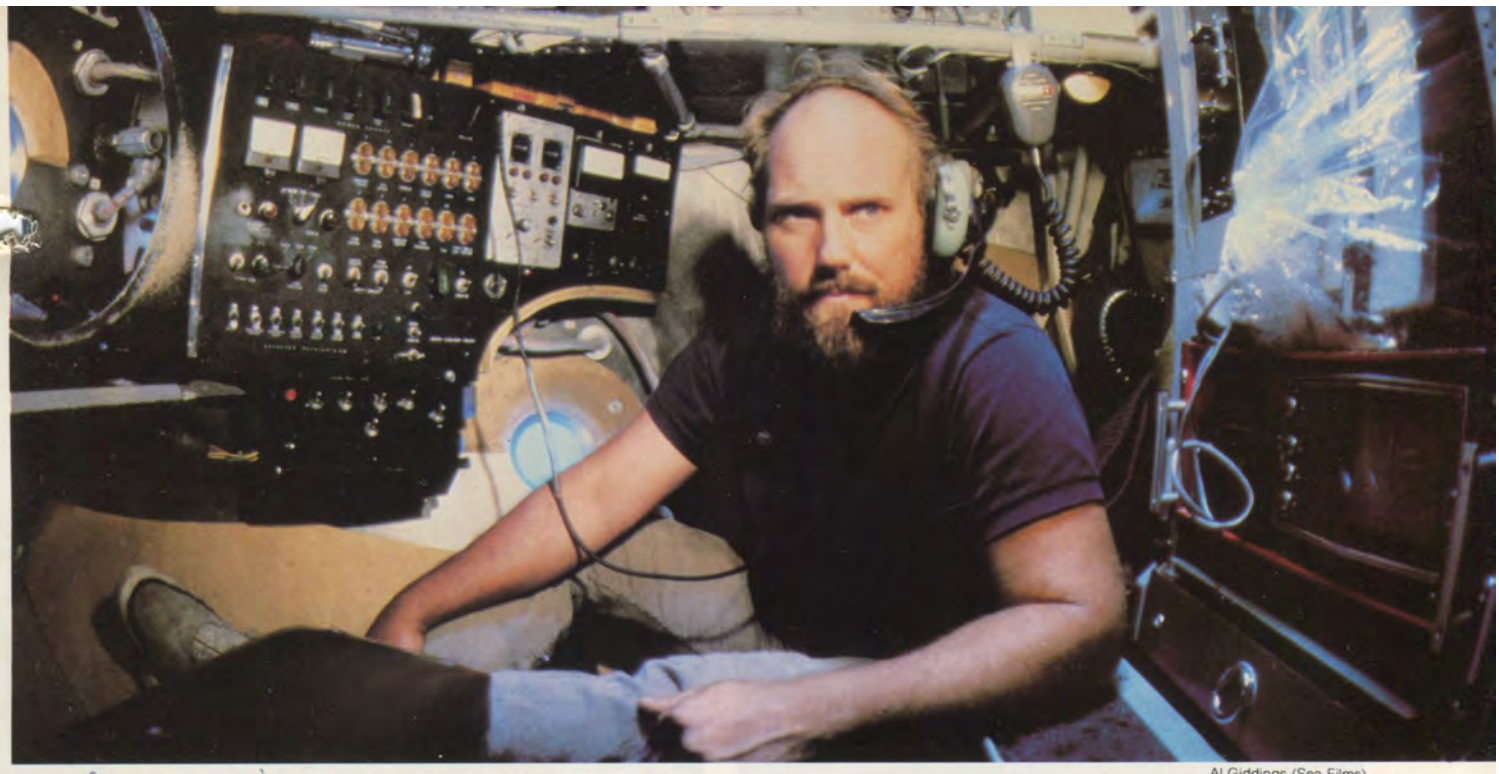


Al Giddings (Sea Films)

International Wildlife
Nov-Dec
1980

Fred Grassle dives to a strange new world

In the supposedly barren depths of the Pacific Ocean, a marine biologist explores a "new" community of bizarre creatures

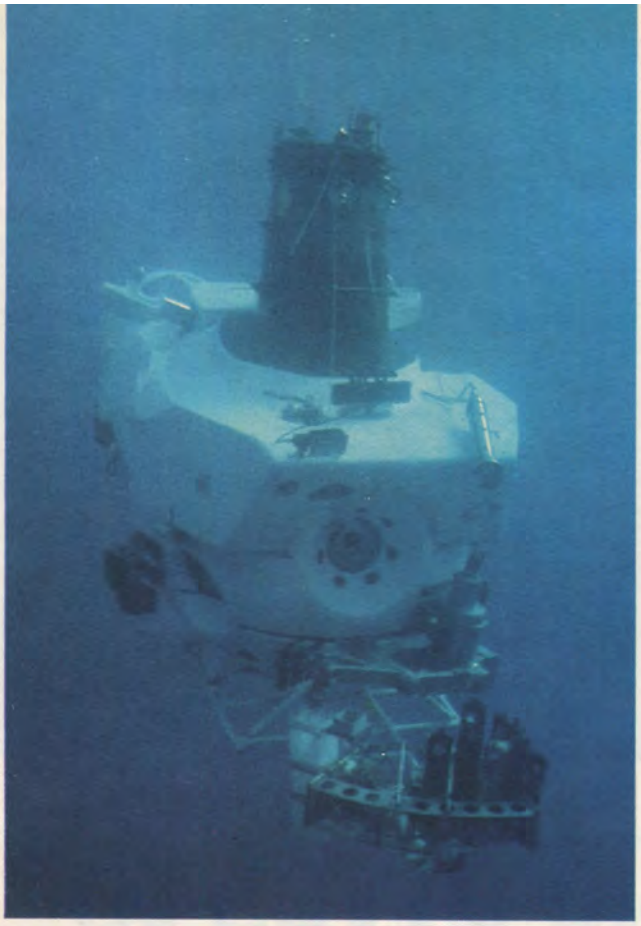
BY JOHN SEDGWICK

ON a February morning last year, a team of swimmers guided the little submarine *Alvin* from its bobbing mother ship, *Lulu*. With a gentle splash, the sub began its slow descent to the bottom of the Pacific Ocean over 1½ miles below. Crammed inside the *Alvin's* tiny, instrument-laden compartment along with pilot Dudley Foster and filmmaker Al Giddings was biologist Fred Grassle of the Woods Hole Oceanographic Institution in Massachusetts. A man of Bunyanesque proportions with a bushy beard to match, Grassle was a tight fit in the little sub, but he didn't mind. After all, this wasn't a pleasure cruise; it was an historic scientific expedition.

Four hundred miles off the Galapagos Islands, where Charles Darwin researched his epochal *Origin of the Species*, Grassle would be the first biologist to view a deep-sea phenomenon of almost Darwinian importance. In the pitch-black waters where virtually no life was thought to exist, a team of geologists had earlier discovered a biological oasis around vents in the ocean floor. Spewing hot water loaded with chemicals from the earth's core, this volcanic landscape was absolutely teeming with strange creatures: ten-foot tube worms tipped with bright red plumes, sightless crabs, clams the size of dinner plates, huge mussels, flowerlike animals. "It was like something out of Jules Verne," marvelled one oceanographer. Now, Grassle had come to see the spectacle with a contingent of other biologists from Harvard, Yale, Scripps Institute of Oceanography, the University of California, the University of Texas, the University of Hawaii and the Marine Biological Laboratory.

A genial, blue-eyed man in work boots, Grassle was selected to lead the group because his quiet-spoken nature and his reputation for even-handedness were ideally suited to the task of shepherding a dozen aggressive scientists. Each of them was anxious to have his experiments made highest priority, and all of them were living shoulder-to-shoulder in one of *Lulu's* slender pontoons for two weeks.

That combination might have spelled trouble under a rougher hand, but not under Grassle's, with his soft voice and friendly chuckle. "Fred never gets ruffled," says one veteran of several Grassle trips. Grassle's serenity



John Porteous (WHOI)

may derive from the fact that he is so devoted to science. In one recent interview, it took him several moments to calculate how old he is (41), and he never did figure out how long he has been married to his wife, Judy, a fellow marine biologist at Woods Hole.

Grassle decided on a career in deep-sea ecology one summer when, as a Yale undergraduate, he did research at Woods Hole. He has been totally immersed in oceanography ever since — almost destined, it seems, to play an important role in the Galapagos exploration. The biological significance of that project can hardly be overstated. "Normally you see very few animals on the rocky surfaces in the deep sea," says Grassle. "But at the vents, there seemed to be a spectacular concentration of large animals of extremely unusual nature. And each community seemed to be an island amid a vast expanse. Scientists have been interested in islands ever since Darwin. What were these animals, we wanted to know? How does each community maintain itself? Why is one more diverse than another? Why are the growth rates high at one place and low at another?"

To find the answers, the scientists rigged *Alvin* with an arsenal of devices supplementing its mechanical arms, lights, cameras, thermometers and tape recorders to collect information about the deep sea creatures: a stereo camera for judging depths and dimensions, which Grassle himself would operate by means of switches to bend the camera's mechanical arm at the shoulder, elbow or wrist; an array of plastic containers; a vacuum device to suck specimens into captivity; scrapers and corers for taking bacteria samples; netted traps of all sorts; a pump for collecting water samples; and a meter for measuring the organisms' oxygen intake.

Shades of Jules Verne! The deep-diving sub *Alvin* (above) takes Grassle and other scientists 8,000 feet down to explore a spectacular oasis of weird worms, corpulent clams and mysterious mussels.

On the day *Alvin* slowly descended like a pearl through honey, the only thing Grassle could see out the portholes was the bright luminescence given off by the various undersea animals — specks of red, blue, green and yellow drifting up past the sub like an inverted, multicolored snowstorm. Finally after a 1½-hour descent, the submersible touched bottom. Grassle looked out. His bearded face curled into a broad smile. There, in tangled webs on the rocks, were some of the creatures

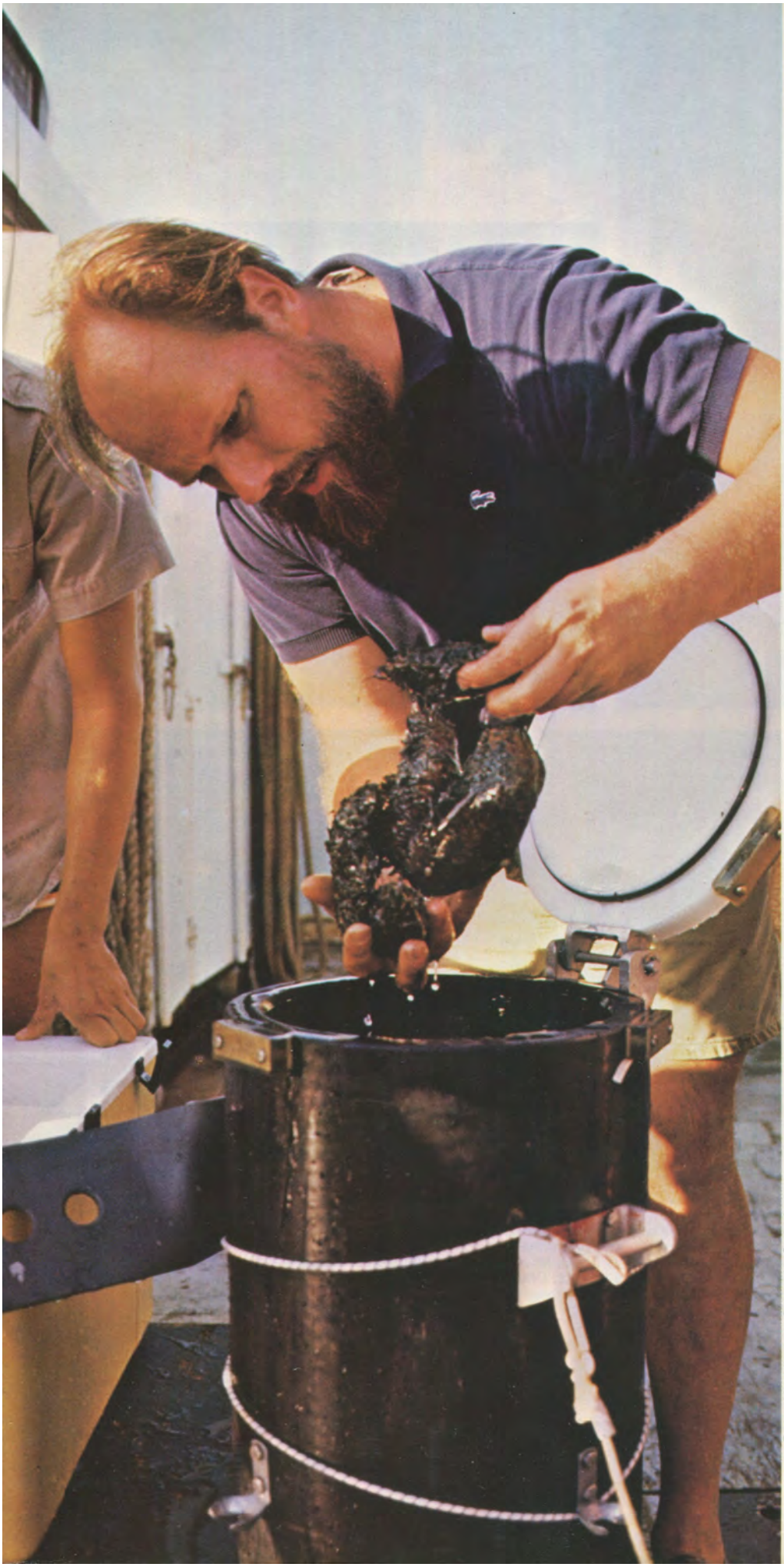
James Childress (UC-SB)

Al Giddings (National Geographic Society)

Al Giddings (Sea Films)

ALVIN External Camera

Here's what Grassle saw — a cornucopia of creatures thriving in waters warmed and enriched by vents in the ocean floor not far from the Galapagos Islands. Draped on the rocks, the spaghettilike organisms (top left) are actually worms. Tube worms (left) are up to 12 feet long and graze on the bacteria-rich water with 300,000 tiny tentacles. The "dandelion" (top) is related to the Portuguese man-of-war. The foot-long clams (above) and the galatheid crabs lay just beyond one of *Alvin's* baskets.



Topside, the work begins. Grassle unknots a squirming mass of mussels for further study. The specimens were scooped from the hot muck in *Alvin's* mechanical claw and brought up in this insulated bucket.

Emory Kristof (National Geographic Society)

the geologists had seen earlier. Directing the pilot, making observations into his tape recorder, aiming the stereo camera and desperately taking his own still photos, Grassle had no time to muse about the wonders of the deep. "I was tremendously excited actually to see what was down there," he says quietly. "But at the time I wasn't thinking how wonderful it was, or how excited I was, because I was so busy."

It was thrilling, says Harvard scientist Ruth Turner, who was the next to dive after Grassle. "Even though we knew what to expect, it was amazing to see all those animals out the window. With the submarine resting on the sea bottom and the porthole window facing down, I had to squat and crane my neck to see the tube worms. They were so tall and so luxuriant they went up over the top of the sub and up and up *and up* into the darkness. It was an unbelievable thing to see."

The first animals to appear were stringy, spaghetti-like organisms w[illegible] their yellowish strands waving gen[illegible] in the water. Then, as the pilot fired the propellers to steer closer to the vent, thousands of little galatheid crabs came into view, scuttling everywhere across the black lumps of lava. "Ballerina" worms never seen before swam past twirling their diaphanous tentacles like pigtails. Yellow "dandelions" hung from long threads attached to the rocks quivering in the water currents like a spider web. Then, closer still to the vents, Grassle found vast beds of clams nearly a foot across. (When he opened up a shell later, he found the animal to be a slab of stinking, sulphurous red meat.) The clams were so densely packed, Grassle could see why the geologists had dubbed the spot "the clam bake." He also saw that most of the clams were dead, their meat eaten by the crabs, and empty clam shells littered the cracks between the black rocks. There were clumps of enormous black mussels among them. Eyeless brachyuran crabs lumbered all about.

The *Alvin's* outside thermometer was rising steadily toward 60 degree[s] Fahrenheit, indicating the presence o[f] the nearby vents. And then the crew spotted the "Garden of Eden" — a

dense forest of birchlike tube worms, thick and tangled. Their feathery red tips slithered in and out. Examining a specimen later that pilot Foster had been able to snare with *Alvin's* mechanical claw, Grassle found that the tube was like tough, slippery plastic, and the worm itself was "like a sausage filled with blood. Cut it and you get blood all over the place." Grassle noticed that the tube worms covered every inch of the vents, their stalks entwined as they grew, and they oriented themselves to the flow of water gushing forth from the vents. He also could see a milky-blue cast to the water — a clear indication of sulphur.

Grassle spent seven hours nosing around the bottom on that first dive. His next two dives were marred by technical difficulties, but the other scientists in his party managed six more descents before time ran out. Since then, Grassle has returned to the Galapagos site for another look around, distributed many specimens to experts in various fields and examined them himself at the Woods Hole labs. He and his colleagues have also analyzed water samples from the vents and studied the bacteria found in that water.

What to make of it all? How does this remarkable submarine kingdom thrive so exuberantly without the benefit of sunlight?

Grassle is confident that he and his fellow investigators know the answer. Unlike practically every other biological form, the clams, crabs and tube worms at the Galapagos vents don't depend on nutrients developed by photosynthesis from the sun. They live off bacteria that, by chemosynthesis, metabolize the hydrogen sulphide in the water. This chemical is contained in the materials jetted out through the vents from the molten bowels of the earth. Thanks to the abundant supply of hydrogen sulphide, 200 different types of bacteria are up to 500 times more plentiful at the Galapagos site than they are elsewhere in the deep sea. And because this food is plentiful, the bizarre animals are plentiful.

Just what *are* these strange animals? Most of them have relations in more accessible locations through which they can be identified. The dandelions are now known much less charmingly as benthic siphonophores, distant cousins of the Portuguese man-of-war jellyfish. Each of the petals is now understood to have a separate function, some to gather food, others to digest it, still others to spawn. The mussels are more closely related to their shallow-water counterparts, occasionally even producing lustrous pearls. Despite the clams' unusual size and blood-red meat, they, too, are fairly familiar. The "spaghetti" is now thought of as an enteropneust, also known as the acorn worm. Only the tube worm is still a mystery. Lacking mouth, eyes, gut and anus, it appears to ingest its food through 300,000 tentacles covering its retractable red plume. Meredith Jones, Curator of Worms at the Smithsonian, can't decide what phylum to put it in.

All of these animals seem to be equipped to make the most of the vent's bacteriological bounty. Hence the tube worm has 300,000 food-grabbing tentacles. The various strands of spaghetti, or enteropneusts, painstakingly extend themselves outward from the rock to expose every bit of skin to the food-rich water. The sightless crabs have scrapers to pry the bacteria off the rocks. And a tiny crustacean, the shrimp-like leptostracan, has combs extending out of the eyestalks for scooping up the food.

But although life around the vents seems bountiful enough, it is relatively brief. Each vent burns out in about 100 years or less, which means death for the creatures around it. To ensure the survival of their species, the vent organisms have evolved in special ways. The enormous clams, for example, grow 500 times faster than other deep sea clams in order to reach their reproductive age early — but they live only a tenth the time of their longest-lived relatives. Other denizens of the Galapagos vents spawn long-lived larvae that ride the deep-sea currents in search of similar and perhaps longer-lived sites elsewhere. Even as he discusses such matters, however, Grassle cautions against being too certain. "We are always making generalizations," he says, "but there are probably thousands of these centers and so far we have seen only a few of them." ■

Free lancer John Sedgwick, a Harvard graduate, contributes to Boston Magazine *and other publications.*

Emory Kristof (National Geographic Society)

Now, what to make of it all? Expedition members huddle intensely over a partially dissected tube worm, which doesn't fit into any known biological category. The biggest puzzler, though, was how the recently discovered animal community could flourish without sunlight.