Close Encounters of the Deep-Sea Kind

CHERYL LYN DYBAS

Single, tentacled male seeks mate; long arms empty too long. Loves dark, cold depths, raw clam dinners, and time spent curled between rocks. Must want children—immediately. Reply to Box 1547 (meters), Gorda Escarpment, Pacific Ocean.

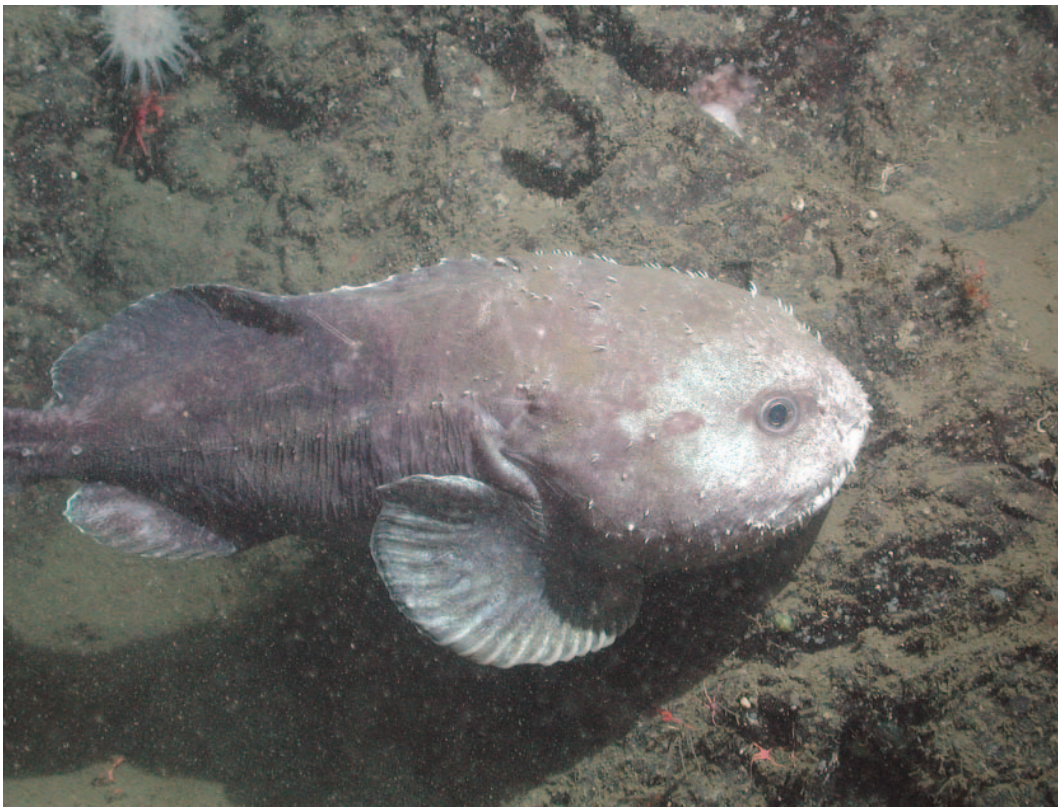
Cruising the deep sea is like cruising the personal ads in search of that special someone—the finding isn't easy. But whether you're a topside human or a below-deck deep-sea octopus, knowing where the hotspots are greatly increases your chance of success.

Jeff Drazen, a biologist recently at the Monterey Bay Aquarium Research Institute (MBARI) in Moss Landing, California, and now at the University of Hawaii, discovered the first evidence of the importance of such hotspots to reproducing animals in the deep sea. Along the Gorda Escarpment, a submarine plateau off northern California, Drazen found a love nest of deep-sea octopuses and fish—a congregation of animals in numbers never before glimpsed in the deep. The observation is the first evidence of a multispecies reproductive aggregation in the abyss.

Aboard the MBARI research vessel *Western Flyer,* Drazen and a team of scientists and engineers peered into the depths through robotic eyes, carefully lowering a remotely operated vehicle (ROV) named *Tiburon* to 3000 meters beneath the ocean surface. "Suddenly, at about 1500 meters, we caught sight of a deep-sea octopus," remembers Drazen. "As we approached it with the ROV's manipulator arm, it just wouldn't let go of that arm. Soon we found out why: It was a female protecting a huge brood of eggs."

Keeping her company were many other deep-sea octopuses (*Graneledone* sp.) and dozens of ocean-bottom fish called blob sculpins (*Psychrolutes phrictus*). "You almost never see this fish," says Drazen. "Since 1989, only 13 blob sculpins have been sighted on more than 200 ROV dives. So we knew something big was going on." "Something big" turned out to be blob sculpin nests with as many as 108,125 eggs per nest.

At two sites in this rugged area, 84 blob sculpins with 64 nests were observed, and 232 octopuses in the genus *Graneledone* were found. "The biomass of blob sculpins alone was equivalent to the average total biomass of fish on the continental slope," says Drazen. "And



*This blob sculpin (*Psychrolutes phrictus*) was photographed at a depth of about 1600 meters by the remotely operated vehicle* Tiburon *on a dive to the Gorda Escarpment. This species, first described in 1978, has been captured infrequently despite its large size (up to 56 centimeters long and 11 kilograms in weight). Dozens of these fish were observed on the dive at the top of the steep, rocky escarpment, often guarding large nests of pink eggs. Photograph: © 2002 Monterey Bay Aquarium Research Institute.*

the density of octopuses was considerably greater than previously published estimates."

A sea change in sea views

At one time, the deep sea was thought to be a sparsely populated and homogeneous environment, says deep-sea biologist Craig Smith of the University of Hawaii. But scientists now know that dense, localized animal communities are found in ocean depths: chemosynthetic communities on hydrothermal vents and methane cold seeps, suspension-feeding communities on seamounts, and the complex succession of communities that subsist on decaying whale carcasses at final rest in the deep.

In another recent discovery, MBARI scientist Rob Sherlock found giant larvaceans (*Bathochordaeus* sp.), which usually live at midwater depths of up to 400 meters, in waters three times that deep. Larvaceans—so named for their resemblance to the larval stage of members of the Tunicata, to which they belong—build gossamer, butterfly-shaped "houses" around their finger-shaped bodies. They float through the water column, trapping food particles in these webs.

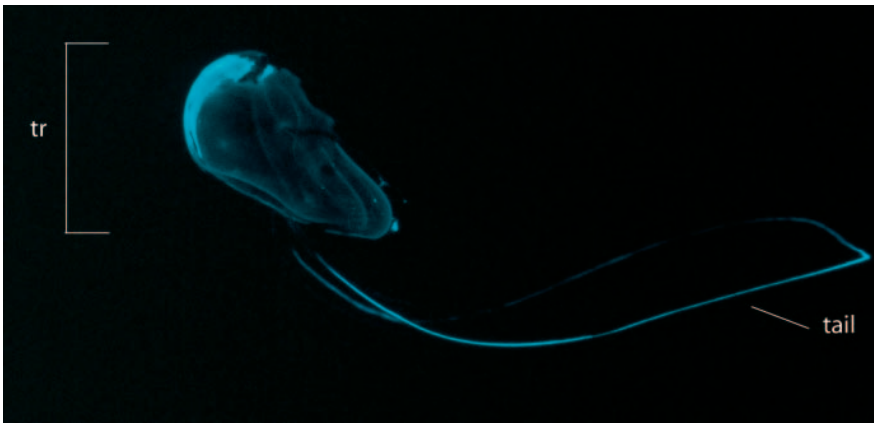
Sherlock and MBARI colleague Bruce Robison happened upon free-swimming *Bathochordaeus* (without their houses) at depths up to 1214 meters. What, the researchers wondered, were giant larvaceans doing down this deep? "Clearly not feeding," says Sherlock, "or they'd have been inside their houses. We were astounded to learn that they apparently head to these depths to allow their eggs to develop. The why is a real mystery. They may be escaping shallower water predators, like fish called hake, but we really don't know."

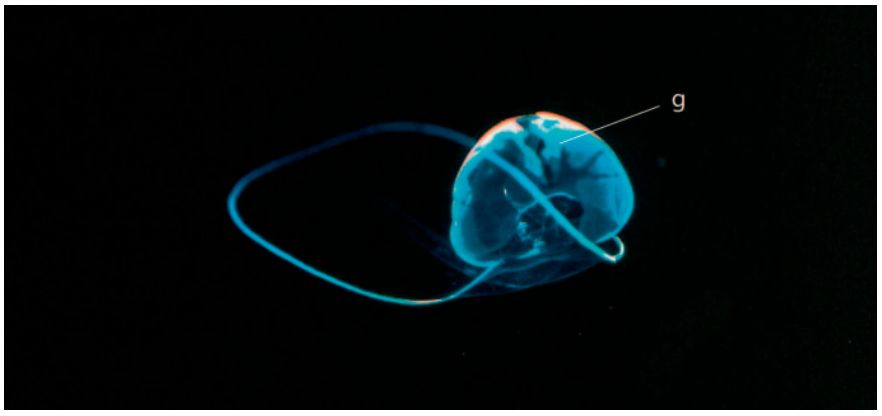
Aggregations of reproducing deep-sea animals once were believed to be rare. Another octopus species of the genus *Graneledone,* a fish known as orange roughy, and small groups of echinoderms were the only examples known.

From here to maternity

Finding a mate occurs in the unlikeliest of places, as blob sculpins and deep-sea octopuses attest. They've chosen a meeting ground that Drazen believes is the Gorda Escarpment's roughest terrain: steep topography, with rocky outcrops, talus fields, and sediment slumps.

Drazen and MBARI scientists Shana Goffredi, Brian Schlining, and Debra Stakes discovered the Gorda Escarpment hotspot at two sites. Site 1, at a depth of 1547 to 1603 meters, is an undersea land





*These giant larvaceans (*Bathochordaeus *sp.), which are 5 to 7 centimeters in length, were collected in May 1999 at a depth of 130 meters in Monterey Bay by the remotely operated vehicle* Ventana. *The side view (top) of one larvacean shows its trunk (tr) and tail. The animals use their tails to draw water through gossamer "houses," the large food-concentrating filters in which they are usually found. This larvacean was observed swimming free and was not associated with a house at the time of collection. The front view (bottom) of another larvacean shows an opaque gonad (g) just beginning to form on either side of the trunk. When fully ripe, the gonad is a denser, white layer. Giant larvaceans are hermaphroditic; male and female gametes are released when the trunk ruptures. Photograph: Rob Sherlock, © 1999 Monterey Bay Aquarium Research Institute.*

of rocky cliffs that shoal to a slope in which gravel and boulders are interspersed with sediment. Site 2, a short distance away as the fish swims and some 1534 to 1583 meters down, lies along a sloping mud bottom pockmarked by boulders and small rock outcrops.

In the case of blob sculpins and *Graneledone,* a rocky substrate gives the animals something to which they can attach their eggs. But the rocky substrate alone isn't the answer to why these species chose the Gorda Escarpment as a place to mate. Cobbled bottom is found throughout the area, but reproductive aggregations were discovered at only these two locations.

"The bases of bouldered slopes there were lined with many small patches of vestimentiferan tube worms and vesicomyid clams, indicative of nearby cold seeps," says Drazen. "The fact that huge numbers of fish and octopuses were also found there suggests that they, too, may benefit from the food source cold seeps provide."

Cold seeps are found where methane-rich fluids flow upward from sub–sea floor depths. First discovered in 1984 in Monterey Bay, cold seeps have now been found in other parts of the world's oceans, including the Gulf of Mexico, the Sea of Japan, and waters off Alaska. The deepest cold-seep animal community known is in the Sea of Japan, living at a depth of 5000 to 6500 meters. Discharges from cold seeps, while not the hot boilings of hydrothermal vents, generate slight increases in nearby water temperature. These warmer waters, MBARI scientists believe, could shorten egg development times, an advantage to species that brood their young.

The dark nightspot called Baby Bare may provide more answers. A 2600-meter-deep basalt outcrop in the North Pacific Ocean, Baby Bare is a nursery for deep-sea octopuses in the genera *Graneledone* and *Benthoctopus.* Biologists Janet Voight, of the Field Museum of Natural History in Chicago, and Anthony Grehan, of the Martin Ryan Marine Science Institute in Galway, Ireland, have found that as female octopuses in these genera mature, they increasingly associate with hard substrates.

Baby Bare is an isolated outcrop on a deep-sea sediment plain. "On the vast sediment-covered ocean floor, the availability of hard substrate may strongly affect the distribution of brooding octopuses," says Voight.

She and Grehan reviewed videotapes taken on dives of the submersible *Alvin.* Like the Gorda Escarpment, "Baby Bare's fauna differs strikingly from that of the surrounding abyssal plain," says Voight. "Its abundant sponges and echinoderms are more typical of the filter feeder–dominated fauna of seamounts."

Sediments sampled at Baby Bare contained shells of chemosynthetic clams—leftovers from octopus meals, Voight believes. At a nearby hydrothermal vent field named Middle Valley, these chemosynthetic clams were widespread. "The high density of octopuses at Baby Bare and Middle Valley," suggests Voight, "is linked to the availability of chemosynthetic clams as prey." The proximity of potential prey for newborn octopuses probably attracts brooding females to such sites.

Once female octopuses have located a breeding hotspot, they may remain there for years, "which is just astounding," says

Voight. The 25-millimeter-long eggs of one species of *Graneledone,* for example, are thought to need almost four years to develop.

Finding love where you least expect it

If hard substrate suitable for egg attachment and a smorgasbord of chemosynthetic clams are what make a rock outcrop the hottest spot around for mating, at least to a deep-sea octopus, high densities of brooding octopuses should be found at sites other than Baby Bare, Middle Valley, and the Gorda Escarpment, Voight says.

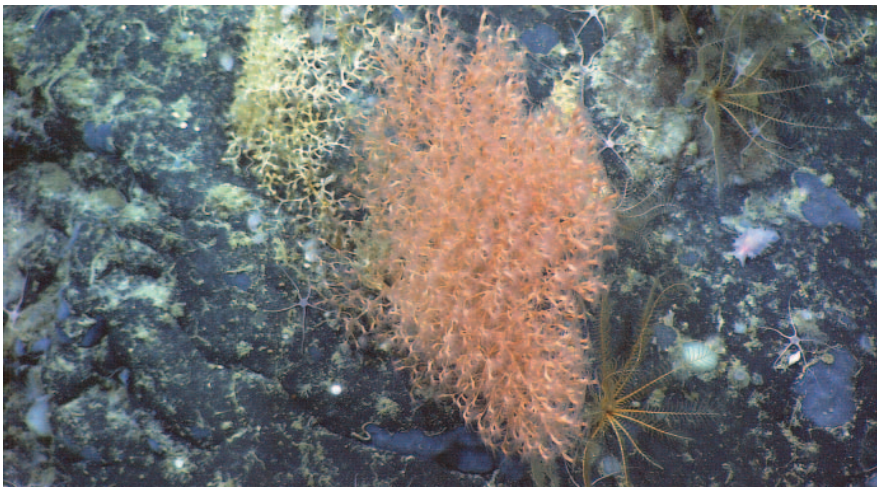
"These places are among the few [isolated] exposures of hard substrate that have been explored by submersible. The bases of seamounts surrounded by heavily sedimented sea floor should be better observed, to determine whether sites like Baby Bare are unique or whether reproductive aggregations of deep-sea species are found at such locations throughout the oceans."

During past expeditions to seamounts, scientists have tended to focus on the tops of these underwater mountains. Says biologist Les Watling of the University of Maine, who conducts research on the reproduction of deep-sea corals, "If we start looking in the other direction, we may find some amazing things going on."

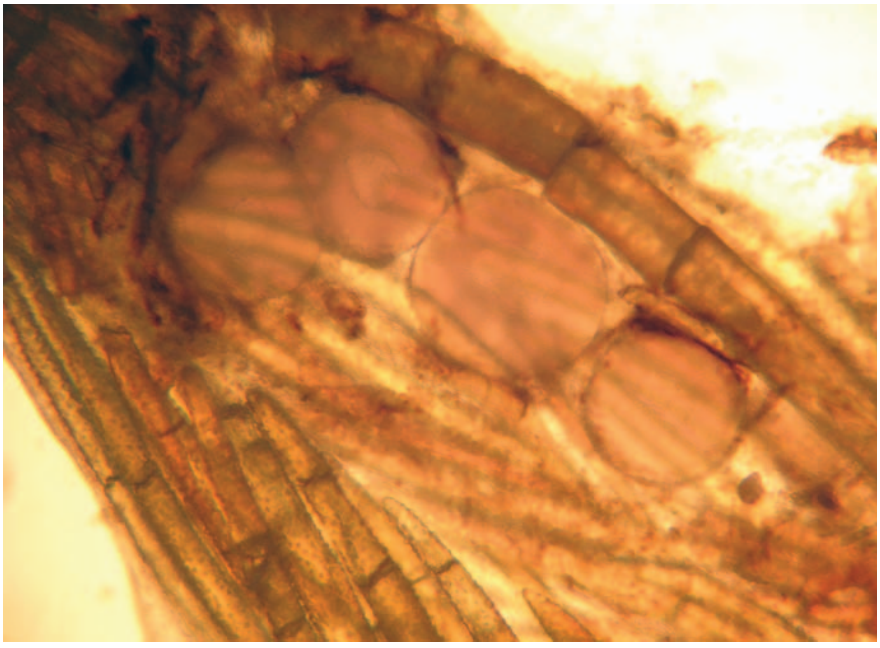
But will these deep-sea romance hotspots last? Discovery of sea-floor nurseries has important implications for the future of species like blob sculpins, deep-sea octopuses, and corals, scientists say. "The protection of habitats associated with vulnerable life stages, especially spawning aggregations, is critical," cautions Drazen. "The sites we've discovered could be threatened by commercial fishing operations."

As the shallows become "fished out," fishers are exploring deeper and deeper waters in pursuit of their catches. In the last two decades, deep-sea fisheries have reached depths of 2000 meters. Fishers regularly operate in 1000 meters of water off the West Coast of the United States. In the Indian Ocean, unregulated catches of orange roughy threaten to wipe out spawning aggregations around seamounts there. Near New Zealand, such orange roughy hotspots have already disappeared.

"Finding the hotspots was complete serendipity," says Drazen. "They're an accidental meeting of local topography, food sources at cold seeps or hydrothermal vents, and animals that are very elusive. I hope we don't destroy this fragile connection before we even know what it's all about."



This octocoral is an unidentified species of the deep-sea bamboo coral (genus Acanella*) from a depth of 2035 meters. Retriever Seamount, where the coral was found, is one of a chain of seamounts off the New England coast that includes Manning, Kelvin, and Bear Seamounts. Photograph: Les Watling, Mountains in the Sea Research Group.*



Eggs of the deep-sea bamboo coral (genus Acanella*) can be seen through the translucent wall of the polyp in this live specimen, photographed at sea. The production of a few large, yolky eggs in each polyp is common in deep-sea octocorals. Photograph: Les Watling, Mountains in the Sea Research Group.*

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