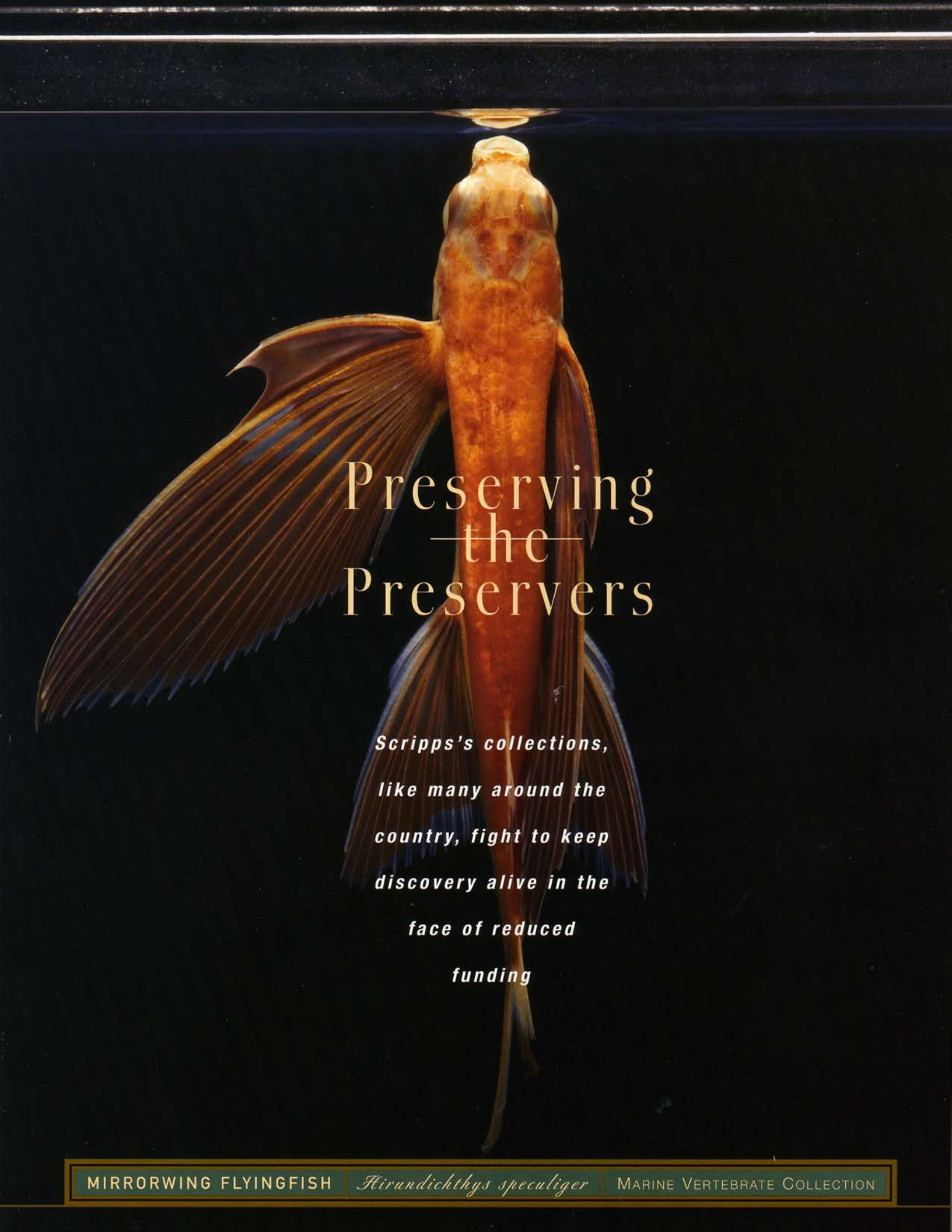
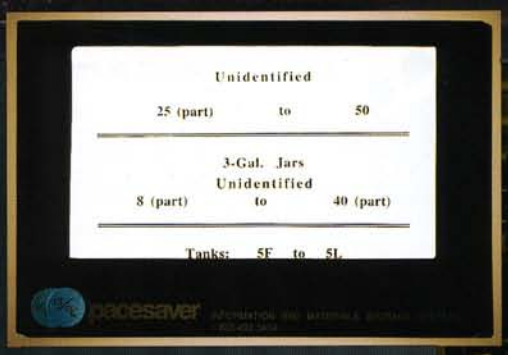


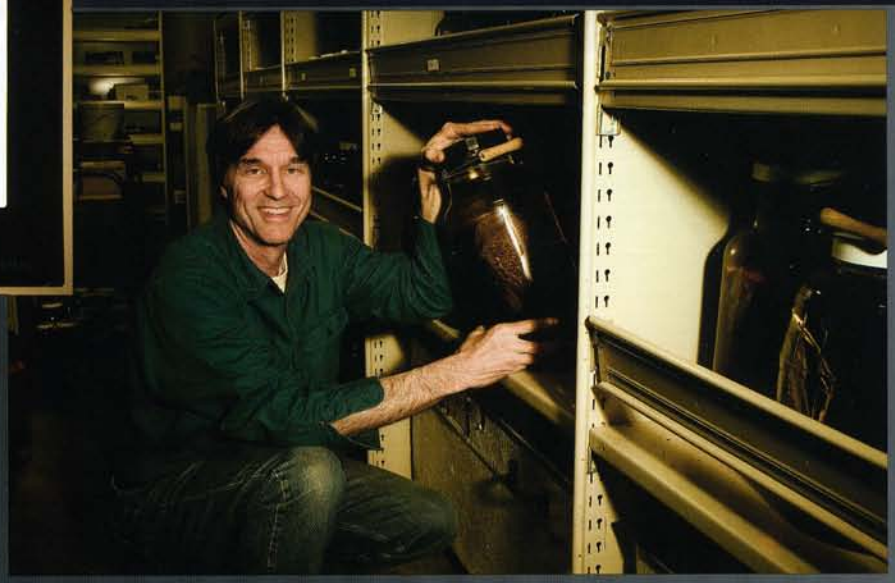
Preserving the Preservers

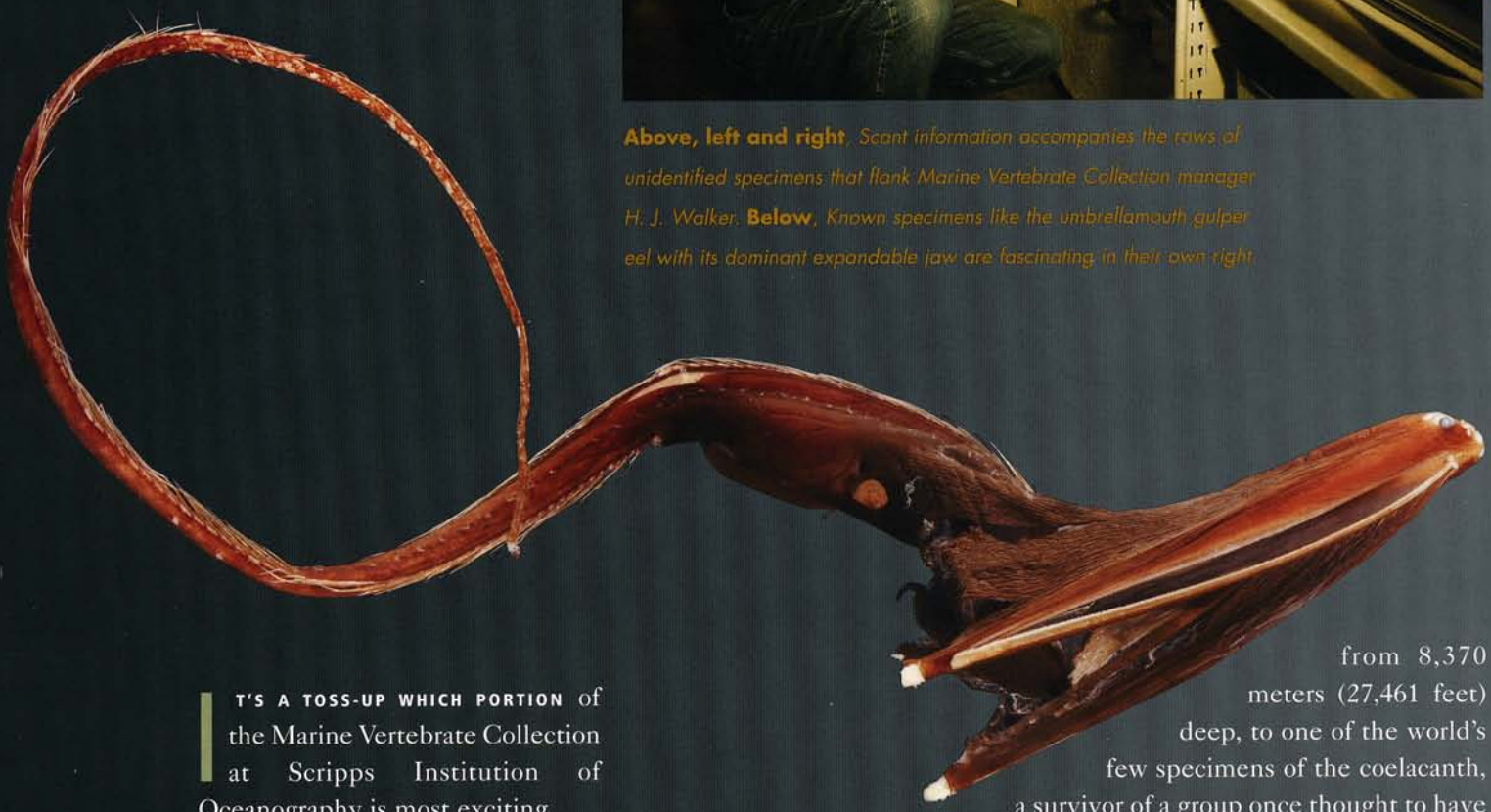
Scripps's collections, like many around the country, fight to keep discovery alive in the face of reduced funding

MIRRORWING FLYINGFISH | *Hirundichthys speculiger* | MARINE VERTEBRATE COLLECTION

BY ROBERT MONROE







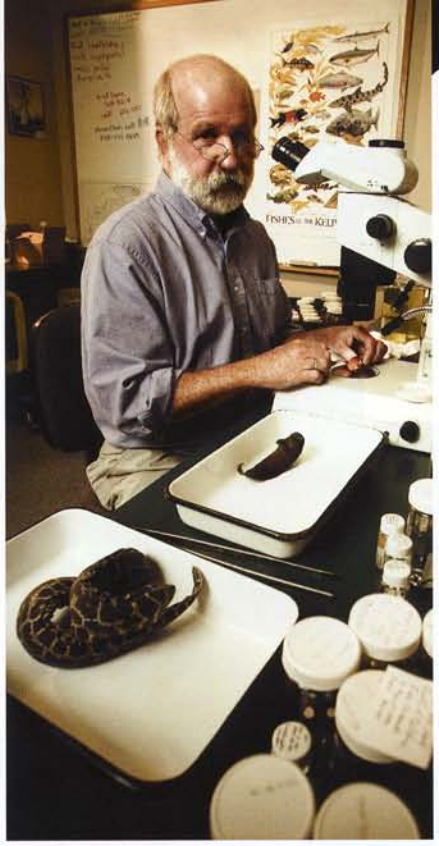
Above, left and right, *Scant information accompanies the rows of unidentified specimens that flank Marine Vertebrate Collection manager H. J. Walker.* **Below**, *Known specimens like the umbrellamouth gulper eel with its dominant expandable jaw are fascinating in their own right.*

IT'S A TOSS-UP WHICH PORTION of the Marine Vertebrate Collection at Scripps Institution of Oceanography is most exciting.

The lion's share of the 2,200-square-foot library of preserved specimens is devoted to some 2 million identified and categorized specimens captured from the sea over a long history of field collecting that predates the institution itself. The holdings range from the world's largest fish (the whale shark), to the deepest-dwelling fish (a cuskeel called *Abyssobrotula galatheae*), painstakingly retrieved from 8,370 meters (27,461 feet) deep, to one of the world's few specimens of the coelacanth, a survivor of a group once thought to have been extinct for 65 million years.

But a few dark rows bear jars characterized only by mystery. Inside, unknown species float suspended in alcohol and anonymity, identified by little more than the information about when and where they were collected.

From these shadowy rows the stout infantfish, *Schindleria brevipinguis*, recently emerged to set a world record. In 2004, collections manager H. J. Walker and fisheries biologist Bill Watson of the National Marine Fisheries Service identified the Great Barrier Reef denizen as the world's smallest backboned animal. The collection's male specimen weighs approximately 0.7 milligrams (0.00002 ounces) and is 6.5 millimeters (0.26 inches) long. A female specimen kept at the Australian Museum is slightly longer, measuring 8.4 millimeters (0.33 inch).



Right and below, *Curator Phil Hastings and Scripps students Hsiu-Chin Lin and Brad Erisman conduct research in the Marine Vertebrate Collection lab as do dozens of visiting scholars every year.*

Australian researcher Jeff Leis had collected the infantfish a full 25 years before the tiny vertebrate took its star turn. The story of what took so long to describe it reveals as much about the state of collections and museums as it does about deliberative morphology studies. It's a cinch that Walker and his counterparts in Scripps's other four collections—Benthic Invertebrate, Pelagic Invertebrate, Dredged Rock and Core, and Microfossil—have enough unidentified samples and specimens to keep them busy for the rest of their careers. Due to a downturn in financial fortunes, what's less certain is whether they will be able to continue the endeavor at all.

FABLED PAST, TENUOUS FUTURE

In 2002, Scripps administrators, faced with a shortfall of $1.3 million from the institution's operating budget, decided something had to give. The cut was part of a trend that has seen state funding dwindle from a historical average of around 20 percent of Scripps's operating budget to about 10 percent today. Even more cuts are anticipated in the future.

The costs of the salaries of collections managers like Walker, supplies such as alcohol and formalin, and shipping for loaner specimens to researchers around the world are all paid by Scripps, as at most university collections worldwide, from the same pot of funds that pay the electricity bill. That was the pot that shrank in 2002. Curators and collections managers braced themselves for a percentage cut in the collections budget. Instead, Scripps administrators, forced to decide among essential functions, opted to phase out the $300,000 collections budget entirely. It was, as Scripps Deputy Director Tom Collins told a newspaper, the "least worst of what we could have done." To others, the news was simply a bombshell.

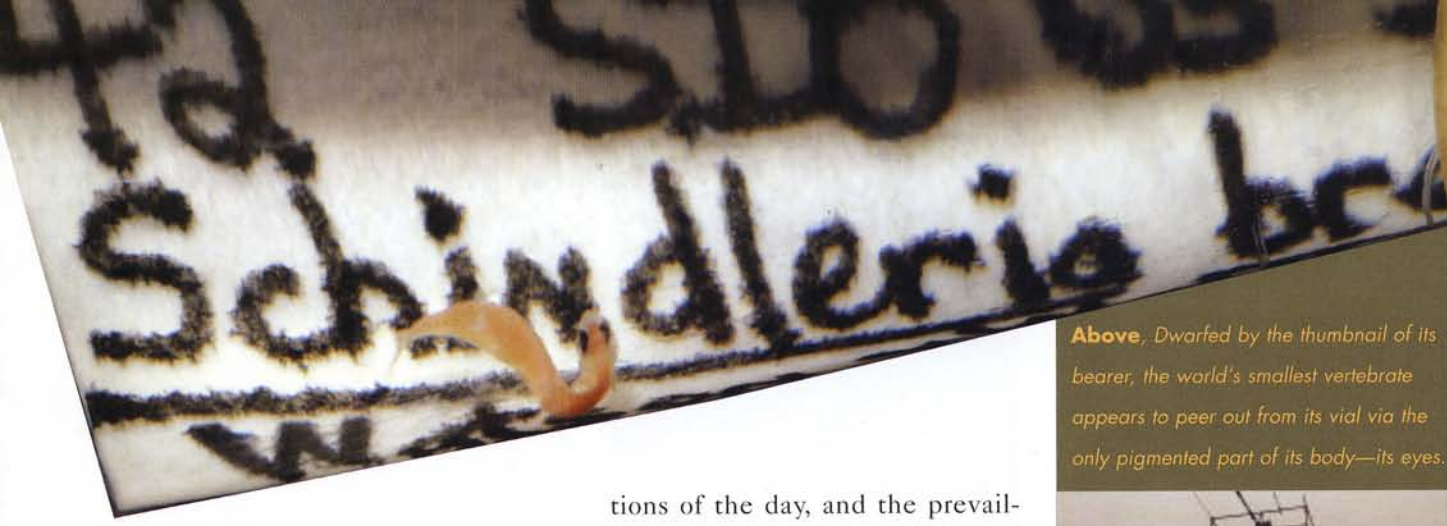
"For me, being really intimately involved in a collection, it was almost disbelief," said Warren Smith, manager of the Sediment Core and Microfossil Collection. "It was like saying 'Let's close all our libraries.'"

On hearing the news, Giuseppe Notarbartolo di Sciara, a Scripps Oceanography alumnus and president of Italy's Instituo Centrale per la Ricerca scientifica e tecnologica Applicata al Mare, said in a letter to Scripps Director Charles Kennel that the collections are "the jewels in the SIO crown . . . constituting the backbone of [the] research institution." A German researcher called the collections the marine biology equivalent of the ancient Library of Alexandria. More than 100 scientists from around the world wrote letters expressing similar sentiments.

The preservation of fishes and invertebrates took place even before Scripps's founding in 1903. Among the collections' holdings are bottles of specimens collected by members of the San Diego Marine Biological Association in the 1880s and manganese nodules collected from the bottom of the Pacific during the 1875 HMS *Challenger* expedition—the first systematic scientific study of the deep sea.

Fish collections took shape under their first curator, Percy Barnhart, who arrived at Scripps in 1914 from an aquarium run by the University of Southern California (USC). In the decades that followed, the fish collection grew steadily under the care of famed Scripps biologist Carl Hubbs. Shortly after Hubbs arrived at Scripps in 1945, William Riedel began to formally organize the institution's various geological samples.

When Richard Rosenblatt arrived to take over the marine vertebrates curatorship in 1958, the collections were just entering their golden age of growth. Scuba gear was an invention less than a decade old, as was the Isaacs–Kidd Midwater Trawl, a



Above, *Dwarfed by the thumbnail of its bearer, the world's smallest vertebrate appears to peer out from its vial via the only pigmented part of its body—its eyes.*

ship-towed instrument still in use today. Both tools enabled unprecedented access to marine life in the oceans while rock dredges—giant bags made of chain link—were giving scientists material for studying the composition of rocks at the bottom of the ocean. The number of specimens and samples grew exponentially as did scientific understanding of the biodiversity contained in the oceans and the volcanic history of the deep sea.

The trawl, developed at Scripps by John Isaacs and Lewis Kidd, enabled efficient specimen collection from ocean swaths as deep as 7,000 meters (22,965 feet). The instrument and the roamings of Scripps biologists left a mark on the collections that is evident to this day: Scripps is considered the leading repository of deep-sea fishes as well as fishes from the coastal eastern Pacific Ocean.

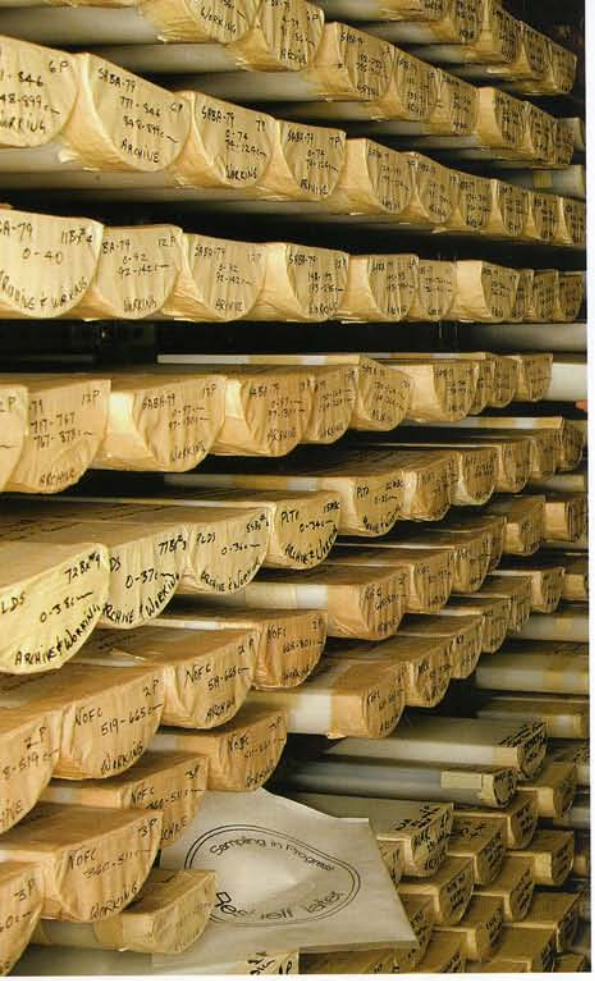
Rosenblatt credits those technological advances, the more relaxed field collection regulations of the day, and the prevailing spirit of then Scripps Director William Nierenberg for the explosive growth of the collections in the 1960s and '70s. Field researchers followed Nierenberg's unwritten mandate that they would devote at least some cruise time to the collection of biological specimens, "kind of like tithing," Rosenblatt said.

Likewise, bringing home geological specimens was something of a vocation. Scripps's collection of cores, what Smith calls his "library of mud," dates back to the 1920s. Those collected before World War II have special value because they are free of the isotopic signatures of uranium and other radioactive elements that mark most cores collected after atomic testing began. After Scripps became the West Coast home of the Deep Sea Drilling Project, sediment cores here were used to confirm basic tenets of plate tectonics in the 1960s.

But over time, research ship operating costs became too expensive and use agreements among universities too formalized to allow for impromptu hunts for specimens and samples. The flow of fish, invertebrates, and rocks to museums and collections slowed.

Now fish and invertebrate curators rely on occasional expedi-

Above, top to bottom, *The Isaacs–Kidd Midwater Trawl facilitated collection of fish from the deep ocean including this whalefish caught in 1976. A chunk of seafloor basalt gathered in a rock dredge off southern California in 1964.*



Far left, *A few dozen of the 6,500 sediment cores in the Dredged Rock and Core Collection.* **Left**, *Collection manager Warren Smith (left) helps geophysicist Neal Driscoll examine a core's interior.*

tions, as well as students, biologists, fisheries officials, and fishermen to bring in odd specimens or keep an eye out for sought-after species. Despite the more sporadic nature of field collecting, the pace of discovery of the world's marine life continues at a staggering rate. In the mid-1990s, the world knew of 23,000 species of fish. Now only 10 years later there are 28,000 identified fish species.

"We've added 5,000 new species in the last 10 years with a very low level of collecting," said Ted Pietsch, curator of fishes at the Burke Museum of Natural History and Culture at the University of Washington. "That gives you an idea of how much we don't know."

How much more is out there? How fast we find out depends on how fast collections managers can work through their extensive backlogs and how quickly scientists can come up with new questions to ask of collections. The world's largest fish collection, at the Smithsonian's National Museum of Natural History, reports that it has a 50-person-year backlog just to finish computer cataloging its 4 million specimens.

Sometimes the task is a race against time. Pietsch, who has been visiting the collections at Scripps since he was a graduate student at USC 40 years ago, was recently on one side of a debate about the world's shortest fish. (By mass, the stout infantfish is the smallest, hands-down.) While Pietsch advanced *Photocorynus spiniceps*, a deep-sea anglerfish, as the shortest, another research group believed a kind of carp called *Paedocypris progenetica* was even stubbier. The carp lives in Indonesian swamps diminishing so rapidly that at the time of its identification, it was running the risk of going extinct before it was discovered. Its discovery could help influence efforts to save its native habitat.

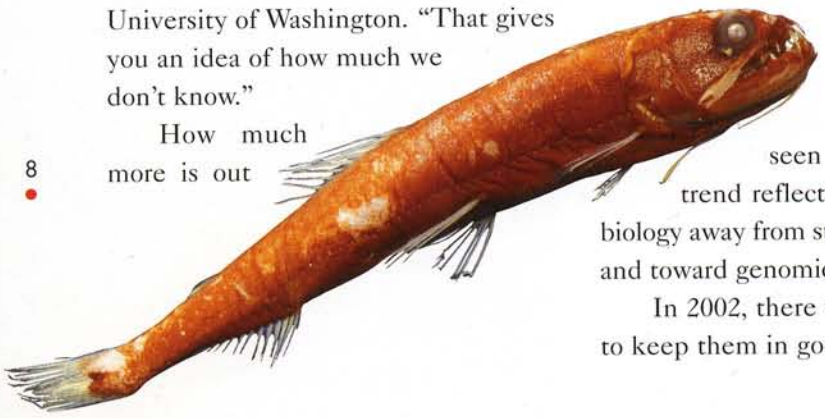
"It could have happened that if it weren't in a collection somewhere, the world may never have known it existed," said stout infantfish co-discoverer Watson.

In addition to demonstrating the vastness of biodiversity in the oceans, collections have the ability to create snapshots of marine life frozen in time.

"We're already losing much of the biodiversity in the world and the only record of that is in collections," said Larry Page, curator of fishes at the Florida Museum of Natural History. "I don't understand why nobody cares about that."

VANISHING BREEDS

The problem of supporting collections financially is common enough that the National Science Foundation has a budget to facilitate the acquisition of small "orphaned" collections by larger ones. But these days even the big ones are in trouble.



The University of Michigan, with some of the most impressive holdings in the country, has slashed its collections staff. The University of Miami and Florida State University donated their collections to that overseen by Page at the Florida Museum of Natural History. The trend reflects not only shrinking financial support but also a shift in biology away from studying organisms through traditional methods of anatomy and toward genomics and cellular-level studies.

In 2002, there was talk of donating Scripps's holdings to a willing taker to keep them in good hands, said Marine Vertebrate Collection curator Phil

Hastings. The talks were short-lived. Not even the Smithsonian felt it could absorb a collection of such size unless a sizeable amount of funding could accompany it.

"It's like taking in a whole orphanage instead of adopting just a couple of kids," Hastings said.

With nowhere else to go, along with the acknowledgement of their critical value in understanding Earth and its oceans, the goal has been to keep the Scripps collections intact at home while a permanent endowment can be created. Various short-term solutions have been implemented while the $10.4-million endowment needed to sustain a $400,000 operating budget is raised. To date, a $320,000 planned gift and numerous other donations have helped the collections raise nearly $1 million.

Philanthropic groups like Friends of the Collections, led by Ellen Lehman, wife of Scripps Director Charles Kennel, have been formed to bring in funds. The five divisions have cut back on staff. Smith, for instance, used to have four colleagues working with him. Now he works alone.

Above, *Jaws and other body parts get their own space in the Marine Vertebrate Collection.*

Collection managers have also taken on duties associated with grant-funded projects outside their normal scope of functions. Around 40 percent of Walker's salary for the next five years will come from a federal grant supporting an innovative partnership with the UCSD School of Medicine. Walker will help create a "digital library" of magnetic resonance images (MRIs) of fish specimens in the Marine Vertebrate Collection. The electronically cataloged images will be made available online to anyone studying anatomy, taxonomy, or related disciplines.

Similarly, over the past two years Walker has devoted significant time to a California Sea Grant-funded project to archive tissues and DNA-sequence data for the state's marine fishes. Were Walker's funding not in jeopardy, funds from these grants might instead be used to support student projects.

THE NEXT BIG (OR LITTLE) THING

Jeff Leis snatched six stout infantfish using a very fine plankton net during his 1979 survey off the Australian coast. He intended to sort through the catch after gathering some more specimens to distribute among colleagues, but never got around to collecting more. In 1983, he lent all six specimens to Watson, who was writing a chapter of a book about larval fish. Watson identified them as being of the genus *Schindleria* but set aside the question of whether they represented an undescribed species. Five specimens—including a well-preserved female that would become the holotype or physical

KRILL *Thysanopoda spinicaudata* PELAGIC INVERTEBRATE COLLECTION

Though most species of krill are no more than 20 millimeters (0.78 inches) long, the biggest known specimen of this species reached 150 millimeters (6 inches), making it the world's largest. Found at depths below 2,000 meters (6,562 feet), T. spinicaudata *is a brilliant shade of red in the wild.*

COELACANTH *Latimeria chalumnae* MARINE VERTEBRATE COLLECTION

Perhaps the most famous "living fossil," the coelacanth is a member of a group with a fossil record stretching back 400 million years. Scientists assumed that coelacanths had gone the way of the dinosaurs when that record abruptly ended 65 million years ago but a chance find off the South African coast in 1938 brought the lineage back from the dead. Though the coelacanth lives to this day with a morphology scarcely changed over millions of years (including the fins that relate them to the fish that would evolve into the first four-legged creatures), it does so in small numbers. This specimen, captured on Nov. 22, 1973, was a gift from former Scripps student John McCosker, then director of the Steinhart Aquarium, to his mentor, Marine Vertebrate Collection curator emeritus Richard Rosenblatt.

exemplar of the species—went back to Australia. One was placed on the shelves of the unidentified in the Scripps collections. There it sat for more than a decade, until Watson and Walker, two men among many jars, reopened the question and took the time to describe the species that turned out to be the world's smallest vertebrate.

"I just knew it was a new species," Walker said. "That's exciting enough for people like me. It's like meeting a new person for the first time."

Walker's involvement with the fish MRI project and the reduction from full-time to part-time of fellow manager Cynthia Klepadlo means that the next amazing find, might have to wait even longer before being introduced to the world.

On the other hand, if the collections can secure permanent funding, Hastings hopes he can realize his goal of expanding fieldwork, offering stipends to visiting researchers, and maintaining the collections as the vital teaching tool they've been in the past. He remains optimistic.

"As humans continue to alter the environments of the earth, these historical archives assume ever-increasing importance," he said. "While we continue the unfinished descriptive research that motivated the building of these collections, we are also working to use the collections in novel ways to address new and exciting questions."

COPEPODS *Calanus pacificus*

PELAGIC INVERTEBRATE COLLECTION

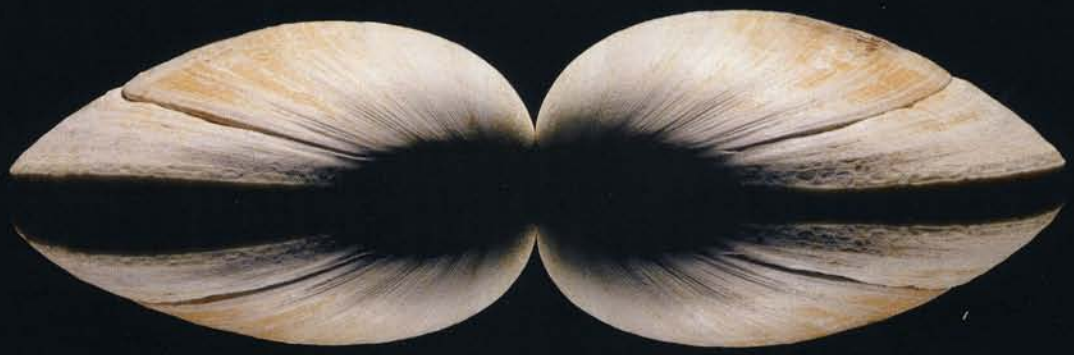
Several specimens and samples at Scripps predate the institution itself. Calvin Esterly, a student of Scripps's first director William Ritter, collected this lot of copepods in 1903, the year of the institution's founding. Other holdings include manganese nodules collected in 1875 during the famed voyage of H.M.S. Challenger.

BLUE CORAL | *Heliopora caerulea* | BENTHIC INVERTEBRATE COLLECTION

Also known as fire coral, it is not actually a true coral but more closely related to organisms that deliver painful stings to whomever brushes against them. The species is termed a relic, meaning it is the last surviving member of its genus. Five million years ago, there were between 26 and 30 species of Heliopora *worldwide. This survivor's range is now restricted to the western Pacific and Indian oceans.*

RED ABALONE | *Haliotis rufescens* | BENTHIC INVERTEBRATE COLLECTION

This abalone and the pismo clam below represent animals once commonplace but now seen in reduced numbers or in limited areas along our coast. This decades-old 190-millimeter (7.5-inch) shell is large by today's standards though abalone with shells up to 300 millimeters (12 inches) were once common in southern California.



PISMO CLAM | *Tivela stultorum* | BENTHIC INVERTEBRATE COLLECTION

This clam, measuring 14 centimeters (5.5 inches) across would have been considered on the small side when it was found in the 1950s. Today clamdiggers find fewer clams this size as the bivalves and other organisms cope with overfishing, ecosystem change, and other pressures.

SANDDAB | *Citharichthys sordidus* | MARINE VERTEBRATE COLLECTION

Cleaned and stained specimens are valuable research tools that allow intact fish skeletons to be studied. The enzyme trypsin digests muscle tissue, leaving only cartilage, bone, and connective tissue. Collections managers stained this specimen with a red dye specific to bone and a blue dye specific to cartilage, then infiltrated it with glycerin, which renders the connective tissue transparent.

SEA SPIDER | *Colossendeis* sp. | BENTHIC INVERTEBRATE COLLECTION

Thanks in part to a number of Scripps expeditions to the deep ocean, the institution is considered the world's foremost repository of deep-sea fishes and invertebrates. Holdings include this sea spider collected on Dec. 11, 1966, at a depth of 3,230 meters (10,600 feet).

VENT BARNACLE | *Neoverruca* sp. | BENTHIC INVERTEBRATE COLLECTION

This currently unnamed species, collected in 2005 from a Pacific Ocean volcanic seamount, is a missing link between two barnacle suborders. The existence of such an organism was predicted by Charles Darwin, who studied barnacles for nearly a decade.

HUMBOLDT (JUMBO) SQUID | *Dosidicas gigas* | PELAGIC INVERTEBRATE COLLECTION

The range of this two-meter (6-foot)-long specimen was thought to extend from southern Chile to Baja California (this particular squid coming from Zihuatenejo, Mexico) but recently there have been mass strandings reported off California and sightings of Dosidicus *as far north as Alaska. Specimens such as this can provide a biological profile of a species in transition.*

PRICKLEBACK | *Lumpenopsis clitella* | MARINE VERTEBRATE COLLECTION | HOLOTYPE

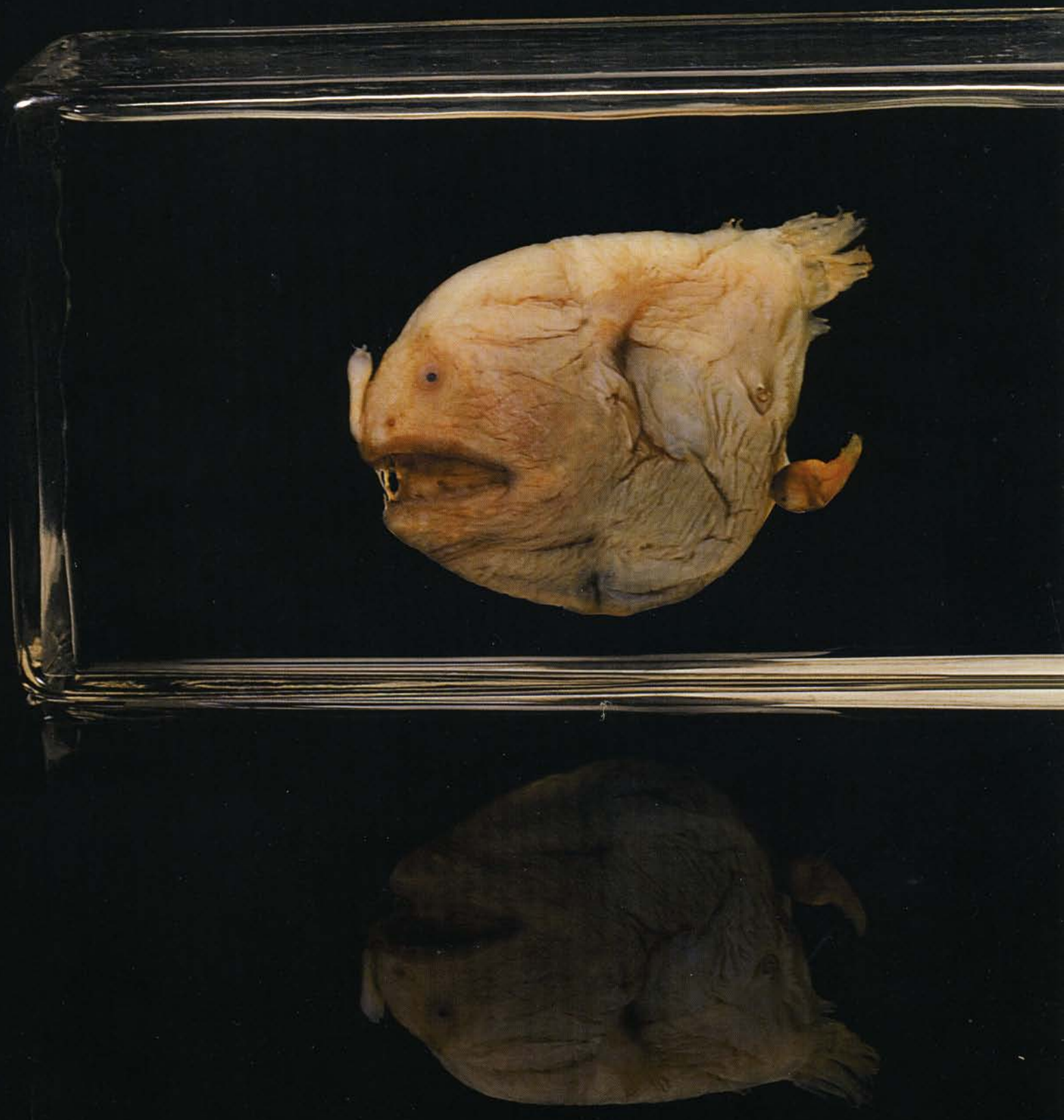
On July 10, 2000, a zoologist monitoring the fauna near a sewage outfall in well-studied waters near Point Loma brought this mystery find to Scripps. The fish pictured is a holotype, a specimen designated as the reference representative of a species.

VENT CUSKEEL | *Thermichthys hollisi* | MARINE VERTEBRATE COLLECTION | HOLOTYPE

This species had been photographed since the first discoveries of hydrothermal vents in the 1970s but this first specimen was not captured until 1988. Native to hot caustic waters near a seafloor vent, it remains the only specimen in a collection.

VENT EELPOUT | *Thermaces cerberus* | MARINE VERTEBRATE COLLECTION | HOLOTYPE

Considering its inhospitable habitat, Rosenblatt named this deep-sea fish after the mythical dog that guards the gates of hell. Like the cuskeel, it lives in a hydrothermal vent ecosystem reliant upon the chemosynthetic activity of bacteria for primary production.



ANGLERFISH (netdevil) | *Borophryne apogon* | MARINE VERTEBRATE COLLECTION

Although this female specimen was caught in a tow that reached 1,829 meters (6,000 feet), an intact male (the finlike protrusion at rear) remained attached when the net was retrieved. In an environment where males and females can have trouble finding each other, a male attaches to the female's body and their circulatory systems fuse. The male becomes a parasite, with all systems but the gonads reduced.