

In the summers of 1995 and 1996 and in October, 1998, I participated in three research cruises led by Dr Eric Vetter (Hawaii Pacific University) studying submarine canyon ecology in Southern California submarine canyons. Here I am posing in the Delta submersible, just after a dive; over the three trips, I did seventeen dives in this submersible. I'm the Director of Scripps Institution of Oceanography Library, so these cruises were a great change from my desk job.

These research cruises were undertaken by Dr Vetter to extend deeper and more broadly the work he began in his Scripps doctoral dissertation on the benthic ecology of Scripps Canyon particularly the invertebrate population ecology in the debris mats. All cruises used the Delta two-man submersible to suction up bottom samples, take photos, and run video transects to determine relative abundance of macro-organisms.

Deep diving in submarine canyons !!



Here is Delta on the deck of the tender ship *Cavalier*. Delta is 15 1/2 feet long with a beam of 3 1/2 feet and a height of 6 feet. Delta has a maximum operating depth of 1,200 feet, cruises at 1.5 knots with a maximum speed of 3.5 knots, and can stay down 144 man hours supporting two

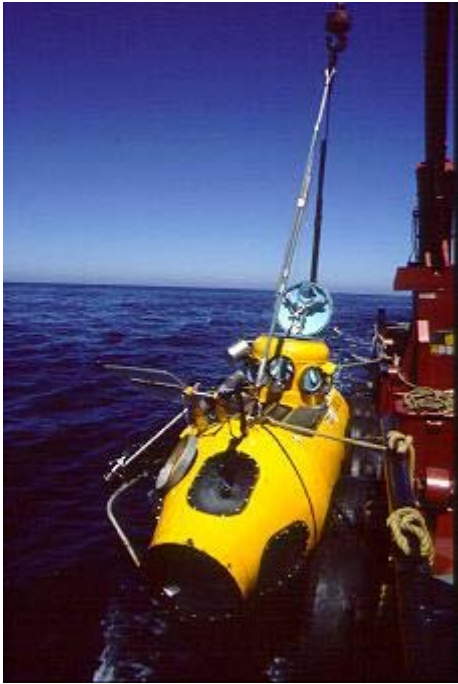
occupants (captain and scientist/observer). Here you can see Delta's accordion-pleated suction tube and external video and still cameras.

Getting Delta in the Water



Bright and early, everyone gets up to put Delta into the water.

With a rolling sea, you have to be careful to hold Delta steady with guidelines so it doesn't crash around into the ship or people.



Delta gets tied up alongside the ship so you can load up gear and then people



After loading up Delta, it gets lowered into the water by all of us.

Here Delta is heading out from the tender ship a short distance away and then it will submerge and begin the dive.

Inside Delta



sitting in the captain's seat inside Delta.

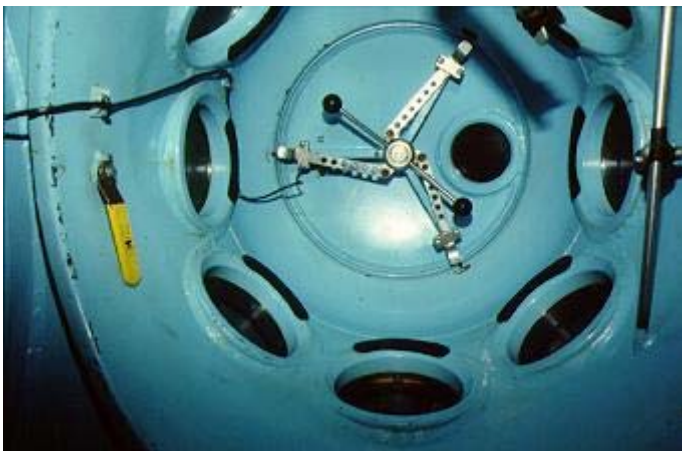
What's it like inside Delta ?

Tight for two grownups and just the right size for children!

The forward observer lays stretched out towards the front and the captain sits on a seat looking out through the cupola's portholes. Here I am in front looking back at my son Leo

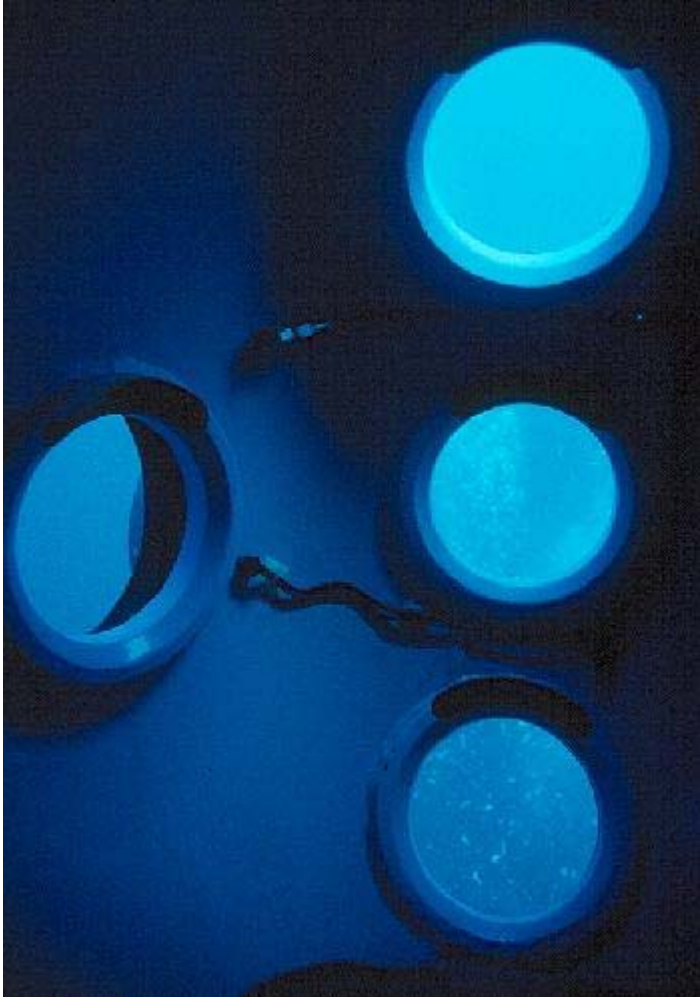


Here I am in the captain's seat looking towards the front of Delta at my son Leo and Alyssa Vetter. You can see the front portholes that the forward observer uses to look out. Leo and Alyssa were so excited being inside Delta that I had to watch them closely to ensure they didn't start enthusiastically flipping switches and pressing buttons.



Here's a view looking straight up from the captain's seat at the hatch you use to enter Delta.

You can see the cupola portholes that the captain uses to see while driving Delta.



Here's the forward observer's view of the portholes on the right side of Delta. You can look around in almost any direction.



You cannot be claustrophobic if you dive in Delta since space is tight and you only get a portholed look outside.

Here's a view out through a front porthole at the tender ship *Cavalier*.

Getting Delta Onboard Ship



Here Delta is heading back towards the tender ship after a dive.

Delta approaches alongside the tender ship and two crew hook up a cable yoke with two hooks to front and back eyehooks on Delta. The ship's crane then yanks Delta out of the water into a hanging position alongside a mattress of old car tires on the side of the ship. Tie up the sub to ship cleats, open the hatch, and clamber out.



Here Delta is moving alongside to be landed onto the tender ship.



Reach down and quickly snap on the cable clips in order to pull up Delta and land it alongside the tender ship!



At the end of the day, Delta is brought back onto deck of the tender ship.

Following are my trip logs from three dive trips to various Southern California submarine canyons in 1995, 1996, and 1998, as well as an oceanographic research ship cruise to collect sediment core samples from various canyons in 1996.

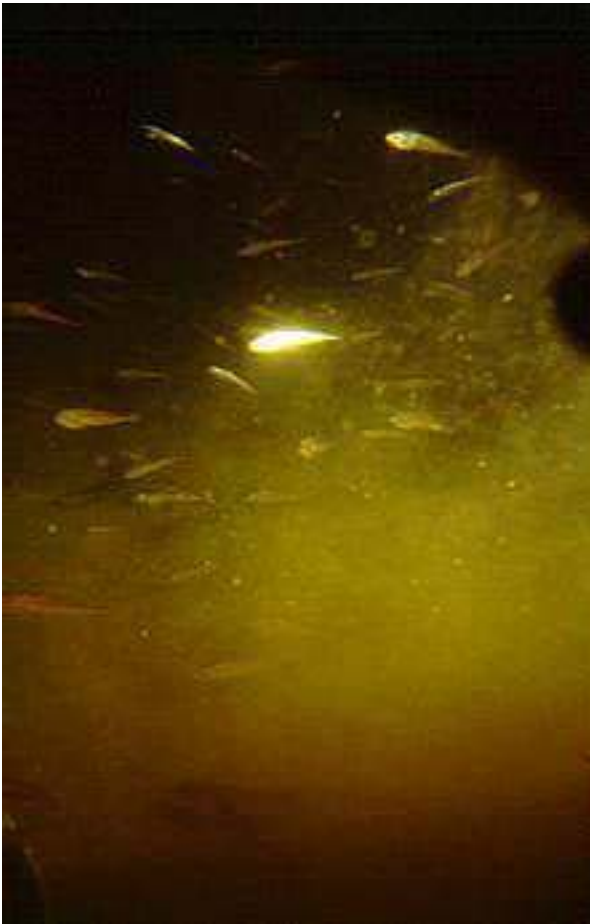


Scripps Canyon 1995

At the end of August 1995 I made two deep dives in Scripps Canyon to 538ft and 499ft in the two-man submersible Delta.

Delta is pictured here heading towards its tender ship in the waters above Scripps Canyon.

I also did a control site dive to the flat **Del Mar seafloor to 690 ft**. On this cruise, Delta made a total of 27 dives over four days with the Del Mar dives collecting control samples.

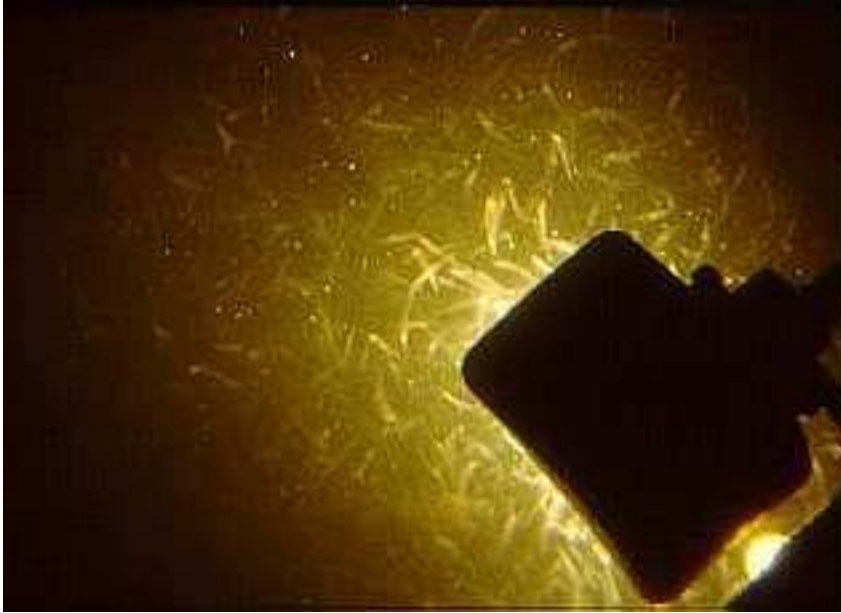


Scripps Canyon 1: 538

feet/164 meters: On my first dive down in **Scripps Canyon to a maximum depth of 538 feet**, we dropped down over the lip of the Canyon at 200 feet. There was a squid swarm at 328 feet. On the vertical wall of the Canyon down deep approaching the target depth, I saw orange cup corals, red galatheid crabs in profusion, white sponges with finger-like protrusions, and small quarter-coin-sized white anemones or hydroids. The wall was not a continuous carpet of marine life one sees when scuba diving at shallower depths. The wall down deep in this 500 foot range is much the same morphologically as seen shallower: overhangs, vertical cracks, ledges, etc

even some long-lost/left-behind cables. The red galatheid crabs live down

there in deeper water and were hanging about clinging to the walls. At the bottom of the canyon as we cruised along, the walls were 15 or so feet across and there was an immense congregation of juvenile hake (seen here), so many that they were stirring up the silty, muddy bottom as they flitted about. The objective on these dives is to suck up bottom sediment into two sample bags so I saw more of the bottom than the walls. Some fish get inadvertently sucked up with sediment since there are so many fish.



There wasn't much debris intermingled into the mud; what debris there was mostly surfgrass which lasts longer than kelp in debris. Swarms of swimming invertebrates (mysids) were attracted to the submersible's floodlights as seen here. This area of the canyon was obviously a rich area since it was supporting so

many juvenile fish. The submersible stirred up the bottom mud and a mud cloud would follow the sub down the canyon. In the canyon, I also saw a

chimaera ratfish, a blenny and a cusk eel.



At one point, we came up on a torpedo ray *Torpedo californica* which, obviously irritated, turned toward the submersible, and draped itself on a front viewport as seen here -- it was obviously shocking the Delta submersible. Rocks on the bottom of the canyon were

covered with white hydroids. There were lots of small flatfish around.

Photography is difficult due to the darkness and the uneven lighting from Delta's floodlights.

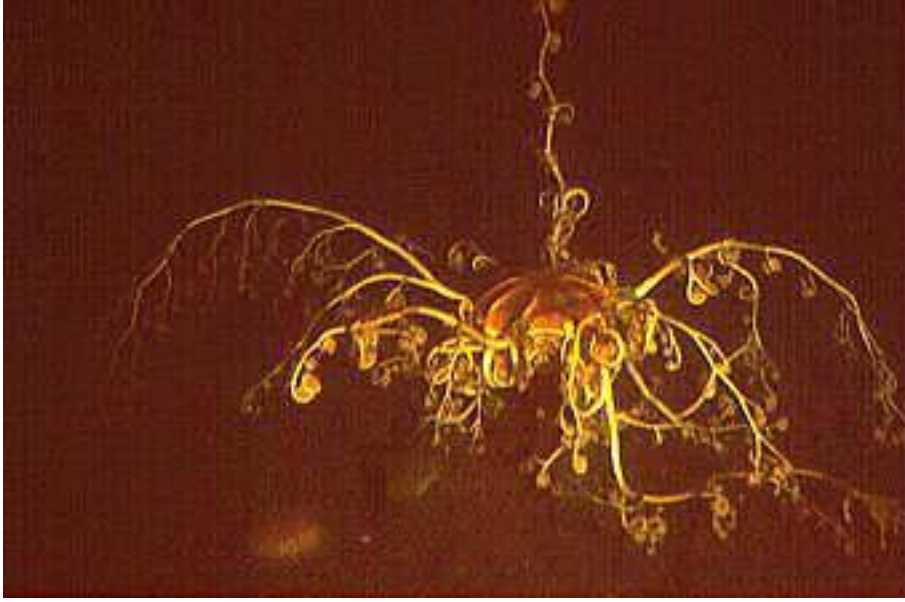
Scripps Canyon 2: 499 feet/152 meters: My second dive into **Scripps Canyon reached a maximum depth of 499 feet.** I saw rocks with white hydroids on them, vertical wall overhangs with white sponges and galatheid crabs, lots of hake and flatfish, even a horizontal cable in the Canyon which the sub had to carefully maneuver around.

Southern California Submarine

Canyons 1996: In mid-July 1996, I went out on another research cruise lasting eight days with Dr Eric Vetter using the Delta two-man submersible to study submarine canyon ecology in more Southern California canyons.

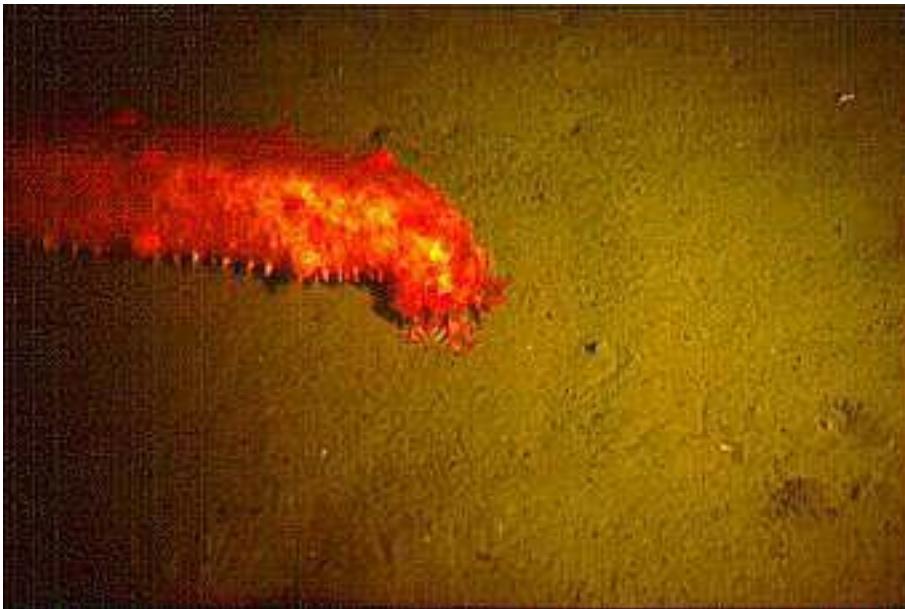
All the canyon sites I saw had muddy/silty bottoms with very infrequent rocks; I only saw canyon walls at Dume Canyon. Several canyon bottoms accumulate trash which the fish and invertebrates shelter in and there are also kelp holdfasts and stipes that the urchins congregate on and eat. None of these canyon bottoms were loaded with detritus like Scripps Canyon.

Dr Vetter also did single scouting dives at Hueneme and Mugu Canyons which were not easily divable due to currents and visibility. Walls were not seen and one canyon was swept by currents making it uninteresting. A single scouting dive was done at Santa Cruz Canyon off Santa Cruz Island which was notable for a fishing boat wreck but no walls and generally an uninteresting canyon from a benthic ecology viewpoint.



Malibu seafloor
(Control Site):
670 feet/204
meters: I did a
control site dive to the
seafloor off Pepperdine
University off **Malibu**
to a maximum depth
of 670 feet. I saw many
large white *Metridium*
anemones but mostly

sea urchins. Most spectacular were two *Gorgonocephalus* basket stars (one shown here).



On this seafloor dive
off Malibu to 670 feet,
I saw bright red sea
cucumbers feeding on
the seafloor (shown
here).

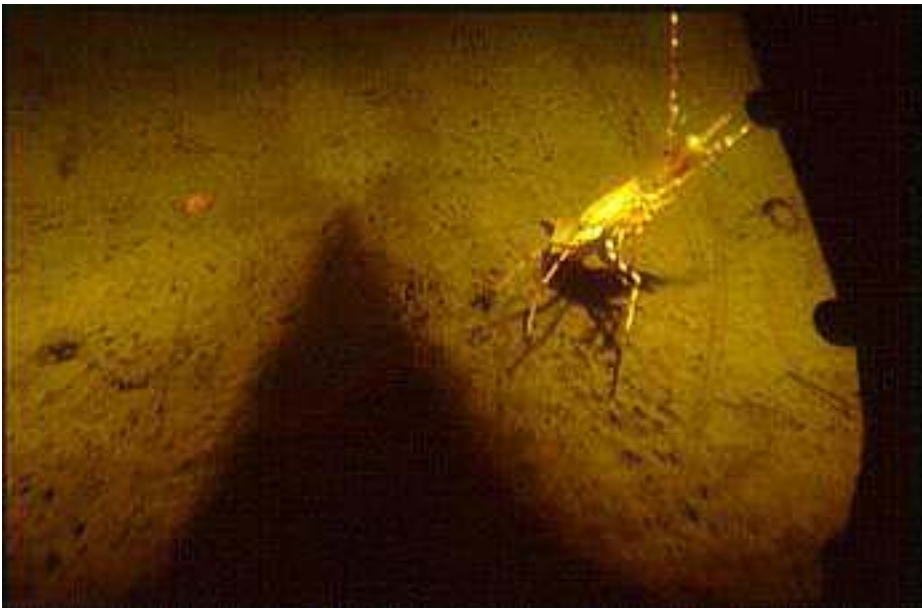
You can see its mouth
parts sweeping the
bottom to pick up loose
material for
consumption. I saw
flatfish, octopus,

rockfish, cusk eels, two large *Pleurobranchus* opisthobranch, big fluffy sea
pen, and shrimp.



Dume Canyon Dive #1: 680 feet/207 meters: I did a dive into **Dume Canyon to a maximum depth of 680 feet.**

This was my favorite dive on this research cruise. I saw lots of big white shrimp that were sized like small lobsters and looked pretty yummy to me.



Here is a shrimp rearing up in defense with its claws attacking at the approach of Delta.

It was a tough little fellow and held its ground until it was forced to retreat at the last second.



I saw flatfish which can be very well camouflaged on the bottom.

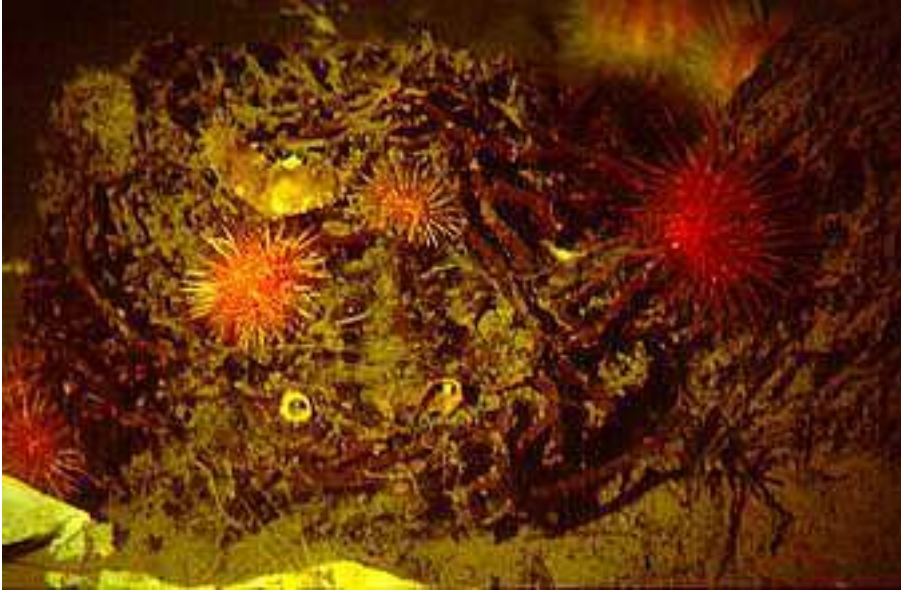
Find the flatfish's two side-by-side eyes to find the flatfish.



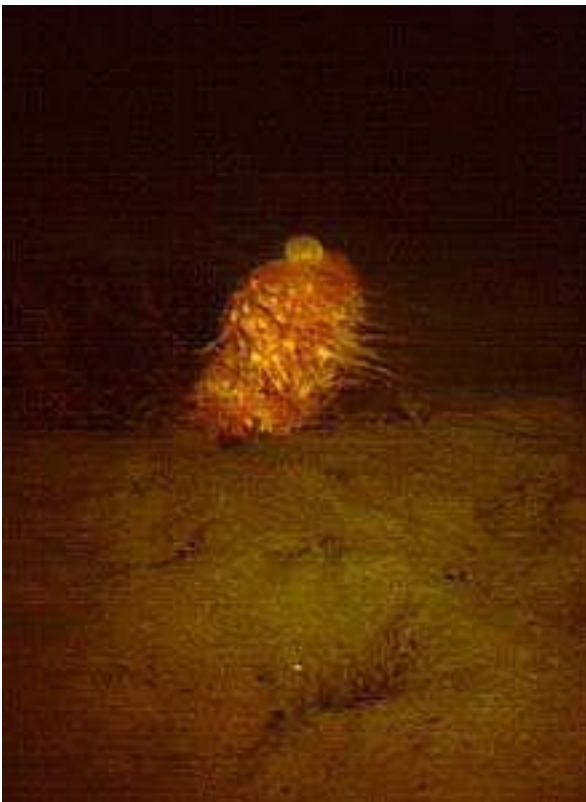
There were lots of drift kelp holdfasts scattered around the bottom of Dume Canyon.

The holdfasts are tougher and heavier than the kelp blades and so find their way deeper into submarine canyons before being consumed. Shrimp sheltered under these

drift kelp holdfasts.

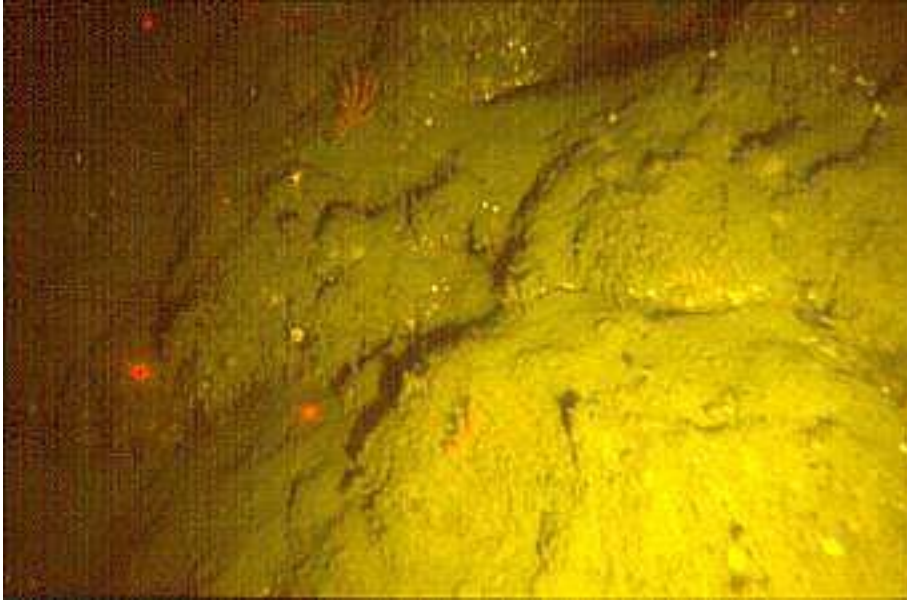


I saw sea urchins piled up and consuming these drift kelp holdfasts and stipes.



I saw many other things on this Dume Canyon dive to 680 feet. The most alien sight to me is shown here and I saw two of them: a tethered, floating egg-shaped large orange siphonophore *Dromalia alexandri*.

I also saw *Pleurobranchus* opisthobranchs, cusk eels, rockfish, red anemones, and long rope-like siphonophores.



**Dume Canyon
Dive #2: 360
feet/109 meters:** I did a dive into **Dume Canyon** to a **maximum depth of 360 feet**. I saw octopus, two hagfish (not slimey), flatfish, and no sea urchins. The Delta sub dropped down a short vertical stretch of

the west wall and hit the canyon bottom at 110ish meters; here is the Dume Canyon wall at approx 310 feet. Delta left Dume Canyon by ascending its east wall from 95 up to 60 meters. The Dume Canyon wall is a shelly aggregate, deeply eroded with big overhangs and infolds and has lots of caverns and columns. The wall is covered with rockfish.



**Santa Cruz
Island seafloor
(Control Site):
480 feet/146
meters:** I did a control site dive to the **seafloor off Santa Cruz Island** to a **maximum depth of 480 feet**. It was a featureless mud plain

and I saw two *Metridium* anemones, several species of sea pen (one shown

here and they were exquisitely beautiful), sea whips, cancer crabs, small flatfish, and small seastars.



My Santa Cruz Island seafloor dive was marked by octopus!

I saw many octopus trying to look inconspicuous in shallow seafloor holes as the Delta sub passed by.

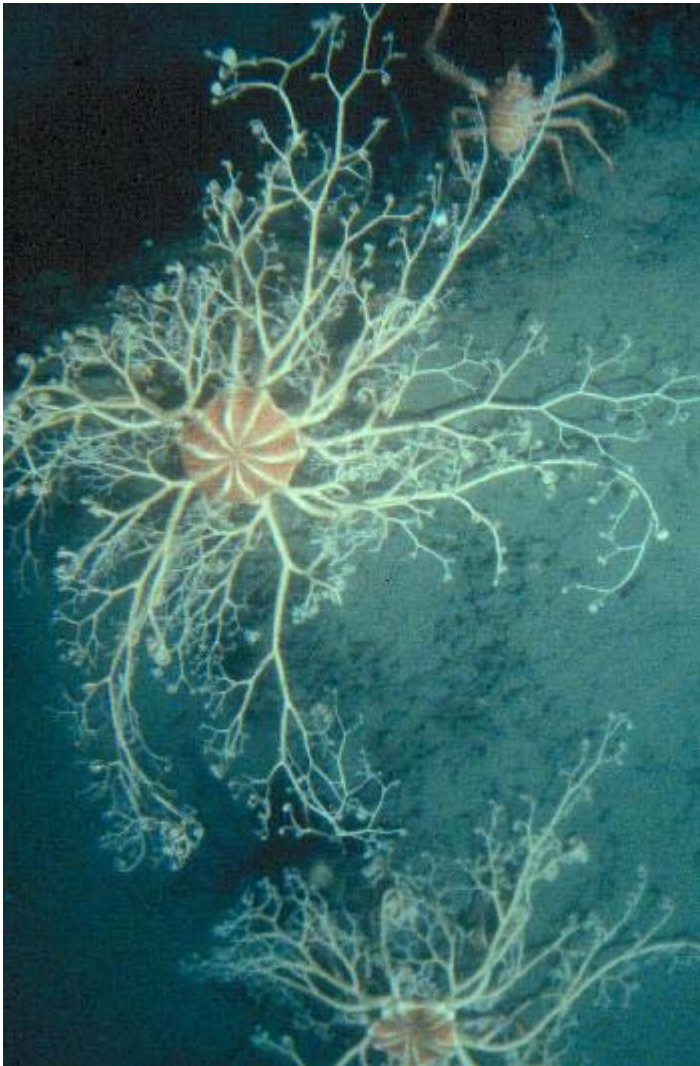
Carlsbad Canyon 410 feet/125 meters: I did a dive into Carlsbad Canyon to a maximum depth of 410 feet. I saw two squid, two octopus, small white urchins, lots of worm tubes, lots of white shrimp, sea cucumbers, seastars, cusk eels, and lots of juvenile hake. Clouds of invertebrates were attracted to the Delta flood lights.

Redondo Canyon 300 feet/91 meters: I did a dive into Redondo Canyon to a maximum depth of 300 feet. There was lots of trash and visibility was reduced. I saw rockfish, cusk eels, octopus, small flatfish, sea pens, a big wolf eel (!), prawns, a ray, and a chimaera ratfish.

Southern California Submarine

Canyons 1998: The October 5-12, 1998 Delta cruise was tendered by the 106 foot workboat McGaw. We spent most of our time diving in Scripps Canyon, La Jolla Canyon, and Dume Canyon off Point Dume / Zuma Beach in Malibu. We also did some non-canyon control site dives as

well as a few forays into Carlsbad Canyon offshore from the powerplant. Down deep the water temperatures were 9-10 deg C (48-50 deg F).



Scripps Canyon Dive #1:
682 feet/208 meters: On the way down to the target depth in the canyon bottom, I saw a *Gorgonocephalus* basket star perched on the canyon wall (shown here). At 208 meters depth, the precipitous walls of Scripps Canyon were too narrow to take Delta down another fifteen feet to the bottom. Delta is 3.5 feet across in beam so this was indeed a narrow-walled section of Scripps Canyon. We moved up shallower to 204 meters where the canyon walls were twelve feet apart in order to get a bottom sample.

On the bottom there were schools of hake flitting about; the hake were 5-6 inches long. Many of the hake would be settled on the bottom and when flitting off in a startle reaction to the sub, each hake would stir up a small cloud of bottom sediment. With a big school of hake flitting about and stirring things up, the final one foot of water column can get pretty cloudy with sediment so you can't see the hake there. You see them above the cloud but see them intermittently in the brown mud cloud on the bottom. The hake flash silver in Delta's floodlights so you are looking out on a flashing school of fish above a low-lying brown mud cloud with some silver fish showing here and there in the mud cloud.



Hake that are very close up in the floodlight show violet color flashes. Hake everywhere!

Intermingled here and there with the hake were several long silver ribbon-like fish with one long undulating fin running down their body. These ribbon-like fish were hard to see in their narrow top-to-bottom cross-section but were broad and shiny silver from side

view. These are cutlassfish, ribbonfish or scabbardfish -- can't tell without looking at some slides. These ribbon-like fish were positioned vertically heads-up which is a typical hunting position to spot the dark shadow of prey outlined against the dim light coming down from the surface. Of course my human eye couldn't see any light looking up but the fish can; it becomes totally dark to my eye at about 400-500 feet depth. Some of these ribbon-like fish moved in close to Delta's front portholes in a slow, deliberate movement and I swear they were curious and looking inside at me (the sub has low-lighting inside).



Cancer crabs were here and there (shown here). One cancer crab waved its clawed arms at hake while in the midst of a thick hake school. That crab was either being defensive about being crowded by hake or was trying to grab one that bumped in close. The canyon bottom was a fine silty mud with hydrogen sulfide blackened

sediment underneath with seagrass debris mixed in. There were eel-like fish

similar to cusk eels, shrimp, flatfish, chimaera ratfish, lizardfish, and some deepwater urchins.

The vertical or steeply dropping canyon walls were rocky and sprinkled with red galatheid crabs with occasional orange anemones, sea cucumbers, and orange cup coral. There were big bouldering sections of the canyon walls with cracking; there was a fine dusting of silt on the canyon walls. Occasionally there was an orange-red small gorgonia on the wall. Delta dives by others at 100m spotted a sunken inflatable boat that was grey with orange markings; the engine was uncovered and had some encrusting growth. Observers deemed the boat itself in good condition and covered with a dusting of mud.

Dume Canyon Dive #1: 692 feet/211 meters: At this depth, Dume Canyon had sloping soft mud walls. The bottom was soft mud and there were fat worm tubes in the canyon bottom sediment below the surface. Typical for some submarine canyons, there were aged broken-down kelp holdfasts with sea urchins on them. Sightings included: chimaera ratfish; small and large shrimp; lots of cusk-eel-like fish and other small fish; an octopus near a 50 gallon drum with a bat star inside; small flatfish; hermit crabs; fiberglass skin of a surfboard.



Dume Canyon Dive #2: 1073 feet/327 meters: At this depth, Dume Canyon has a steep mud slope on its bottom. Saw lots of pink *Allocentrotus* urchins which are a deepwater species usually found below 100 meters. The water column near the bottom had lots of small jellies and ctenophores (like *Beroe*). Other dives at this depth in Dume Canyon sighted the orange Dumbo octopus

Grimpoteuthis but I never saw them.



Sightings included: large orange octopus (shown here); small flatfish; red galatheid crabs; sea cucumbers; and, head-down ribbon-like fish just above the canyon bottom.

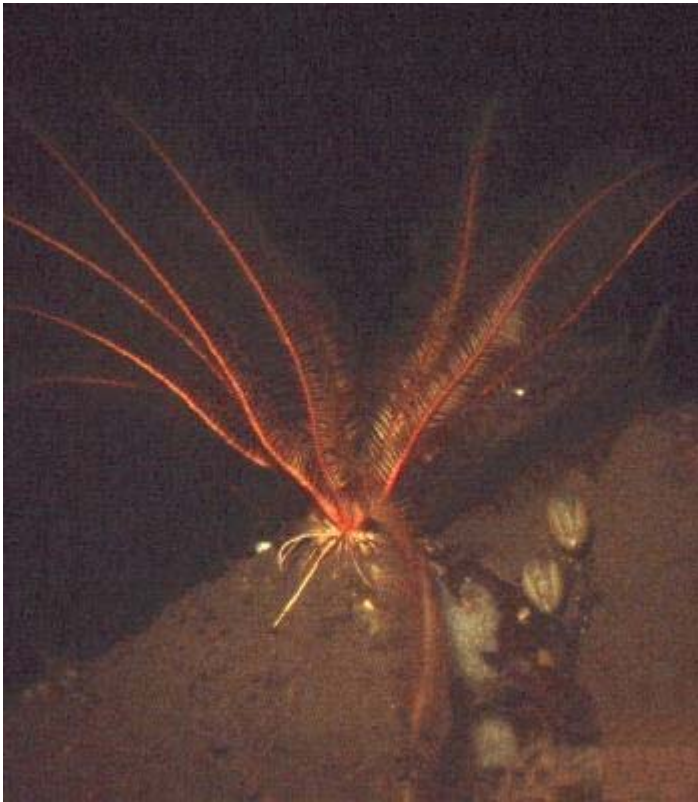


Other sightings included: large *Pleurobranchus opisthobranchs* (shown here).



Around 656 feet (200 meters) in Dume Canyon, there were lots of *Dromalia alexandri* siphonophores. *Dromalia alexandri* is a colonial orange-colored floating filter-feeding siphonophore that is roughly sphere-shaped. It floats just off the bottom tethered by many thin white threads. When disturbed, it pulls in its threads and lowers itself closer to the bottom. The mud canyon bottom is marked by crab tracks running along it.

Sightings at this depth range included: hagfish; *Gorgonocephalus* basket stars; crinoids; California king crab; rockfish.



At 525 feet (160 meters), a wall of Dume Canyon with big stretches of rock outcrops was a crinoid garden (shown here). Individuals and clusters of crinoids were feeding with outstretched arms and were attached to rock with their specialized curved structures called cirri. *Gorgonocephalus* basket stars with their outstretched arms were sprinkled here and there amongst the crinoids. Red galatheid crabs were tucked in rock cracks (shown above). Sightings at this depth range included: lizard fish; white sponges; *Metridium* anemones; orange anemones; shrimp; bright

red scorpionfish *Sebastolobus*.

Scripps Canyon Dive #2: 627 feet/191 meters: At the max depth, the canyon walls were vertical towering up over fifty feet high with a slope above that. The opposing canyon walls were like slabs with a canyon span of 8-15 feet. One really feels closed in dropping down into such a relatively narrow canyon bottom and seeing walls close by through sub portholes on either side. The bottom six feet of these slab-like walls were slick and above that the walls had little growth except for some white spots (sponges?).

Sightings included: large and small shrimp; hake; big sheep crab; sea cucumbers; galatheid crabs. The big sheep crab I saw set a documented depth record of 191 meters for that species (according to two Scripps graduate students who visited onboard and were studying sheep crabs). Male sheep

crabs are known to move into deeper water foraging; we saw some really big ones in Scripps and La Jolla Canyon. The usual reaction is "Oh my God" on seeing one of these monsters; they are easily twice as large as ones I have seen scuba diving in Sumner Canyon.

The canyon bottom is sandy mud with blackened surfgrass. Spotted a seastar on the canyon wall; one doesn't see that many seastars in the canyon at depth. There were a few jellies in the water column above the bottom and euphausiids or some crustaceans swimming about and drawn to Delta's floodlights.

Oceanside seafloor (Control Site) Dive #1: 702 feet/214 meters: A small school of big mackerel were attracted to Delta's floodlights while we were cruising along the seafloor. Out of the dark they rushed and smacked into the sub, flipping about on it. Inside the sub, one could easily hear their thuds and flipping so it sounded like an attack on the sub was in progress. Sightings included: two octopus; flatfish; several species of large and small shrimp; big tall *Metridium* anemones where there was something to attach; purple anemones in the sandy bottom; many different types of fish; three types of sea pens; urchins; seastar; large hake; a lingcod.

This was a non-canyon control site and it is very evident that at the same depth the canyon bottom and its rich ecosystem support a greater variety and abundance of life. We switched off Delta's floodlights at the bottom to plunge ourselves into darkness to observe the bioluminescence triggered by a fleet of crustaceans flitting about. On the way up in the water column at 500 feet, there were two long white rope-like siphonophores; one was coiled up and the other was stretched out about twelve feet in length.

Oceanside seafloor (Control Site) Dive #2: 341 feet/104 meters & 325 feet/99 meters: These were two non-canyon control site dives to suction up benthic samples. Sightings included: flatfish; purple anemones in the sand; fish; sea pens; seafloor was hummocky; good-sized halibut; small white urchins; seastars; dogfish in the distance.



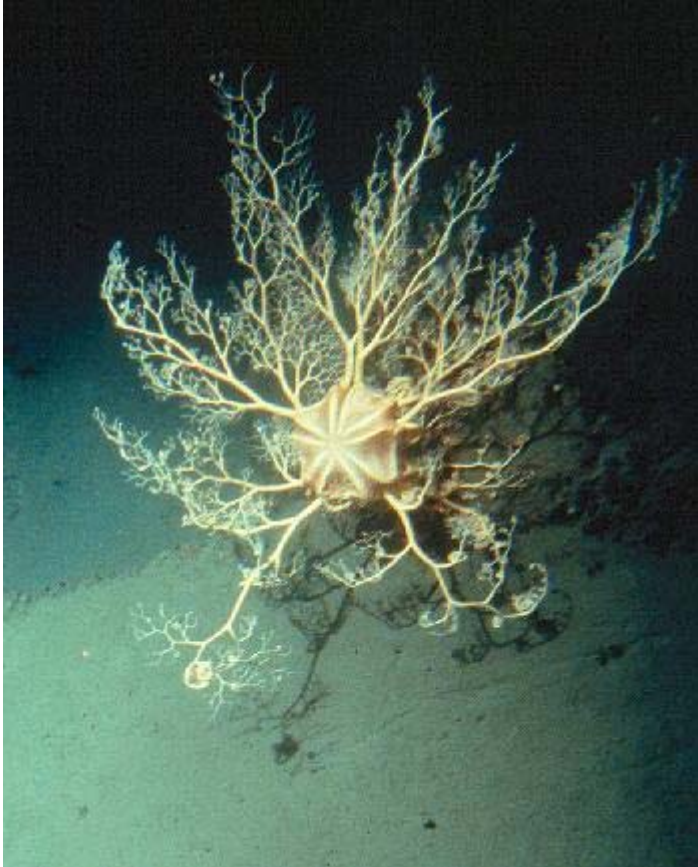
Oceanside seafloor
(Control Site) Dive #3:
1.5 hour transect from
948 feet/289 meters to
328 feet/100 meters: Down
deep, there were orange floating
Dromalia alexandri siphonophores.
Sightings included: large greenish-
white urchins with spines askew;
pink medium-size urchins with
erect spines; flatfish and various
fish; California king crab (shown

here); big, tall *Metridium* anemones where there was something to attach;
octopus; small shrimp of various species; buried purple anemones; reddish sea
cucumbers; a small *Metridium* attached to a Miller Lite beer can; various
whip-like and quill-like sea pens; very large pink sunstar. Shallower, there
was much less life and sightings included: very small white urchins; flatfish;
whip-like sea pens; cancer crabs.

Carlsbad Canyon: 630 feet/192 meters: Down deep, there were
orange floating *Dromalia alexandri* siphonophores. *Metridium* anemones
were clustered on a rock. The canyon bottom was spotted with debris. Pink
Allocentrotus urchins climbed on old kelp holdfasts. A school of approx
twenty flashing silver-blue mackerel over one foot long shot right into the sub
with many hitting the sub and making a flippery beating sound as they
skittered along the sub. Sightings included: large and small shrimp of various
species; large pink sunstar.

Canyon walls were usually sloping sediment but passed one long section of
towering vertical rock walls approx 50-100 feet high on the south wall of
Carlsbad Canyon. This rock section had crinoids attached here and there along
with red galatheid crabs with their outstretched clawed arms raised in alarm at
us. Sightings included: octopus, various fish including flatfish and one of

those heads-up long slender silver ribbon-like fish (cutlassfish, ribbonfish or scabbardfish) which approached the front of Delta with some curiosity.



La Jolla Canyon: 1.5 hour transect from 919 feet/280 meters to 285 feet/87 meters: Down deep, La Jolla Canyon had a steep rocky wall on the south side with escarpments and bouldering. A *Gorgonocephalus* basket star was perched on the top of one part of the wall.



On the canyon bottom, sightings included: fish of various species (chimaera ratfish shown here); occasional long silver heads-down eel-like fish; small silver fish holding themselves in a U-shape a meter or two off the bottom (eelpout ?).



Other bottom sightings included: galatheid crabs (shown here); shrimp of several species; California king crab; orange floating *Dromalia alexandri* siphonophores; large *Pleurobranchus* opisthobranchs; a few urchins but not many; big cancer crabs. Down deep, there were lots of little jellies and clear shrimp in the water column above the canyon bottom.



Up shallower, there was a talus slide down the north canyon wall which narrowed the canyon to a vertical channel about twelve feet across. A big electric torpedo ray *Torpedo californica* was seen at 220 meters depth (shown here). A school of hake was passed through at 210 meters.



There was a huge sheep crab at 100 meters. In some areas of the canyon, shrimp dominated the bottom by far and were situated about every square foot. There were many small juvenile fish of various species in the canyon bottom. Saw three squid - one alone, two together. Up shallower, the canyon walls were the typical mudstone familiar to La Jolla Canyon scuba divers. Saw a small pink sunstar and a few other seastars. Some

Metridium anemones and orange anemones. There was a rope line across the La Jolla Canyon bottom at 90 meters or so.

R/V Roger Revelle Canyon Cruise 1996

I participated in two round-the-clock days of sediment collecting in several Southern California submarine canyons during a five-day cruise of the R/V Roger Revelle at the end of September 1996.

Using a multicorer (shown here), Dr. Eric Vetter (back to camera, in middle, wearing blue tee shirt, blue shorts, orange life jacket) orchestrated a gang of us into six-hour round-the-clock shifts, bringing up a lot of samples both within



canyons and on non-canyon control sites. Here the multicorer is being brought onboard after a trip to the bottom to gather sediment samples. After landing it on deck, the core sample tubes are removed and taken to a lab room for unloading of the sediment samples.



Here's Dr. Eric Vetter on the left during the process to unload the sediment in a corer tube into sample jars.

Sunrise off Malibu was particularly memorable, while working on deck winching the multicorer up and down, unloading and reloading corer tubes, etc.



Jana Davis suctions out some sediment surface water from the top of the corer tube, while Ruth Gustafson steadies the contraption.

A particularly memorable incident for me was assisting Gene from SIO Shipboard Technical Support with the unbolting of a stern railing so that we could winch gear up and down from the deck. We were having a conversation about our fathers teaching us about tools, their proper usage, and things mechanical. I loosened a tight nut by kicking the ratcheting spanner as I had seen other do; however the direction of my kick was towards the sea and I perfectly kicked the spanner

overboard as it slipped off the tight nut. I sheepishly watched it drop down into the briny deep and Gene said with amusement "I wonder what your father would say about that."

Thank You !



**Thank you to Dr Eric Vetter (shown here)
for allowing me to participate in his
research cruises. I am forever indebted for
these unique opportunities**

**The Delta pilots, David Slater and Chris
Ijames, make Delta diving a fun experience -
- thanks !**

Peter

Read more about Delta

and its owning company Delta Oceanographics

at

www.deltaoceanographics.com

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