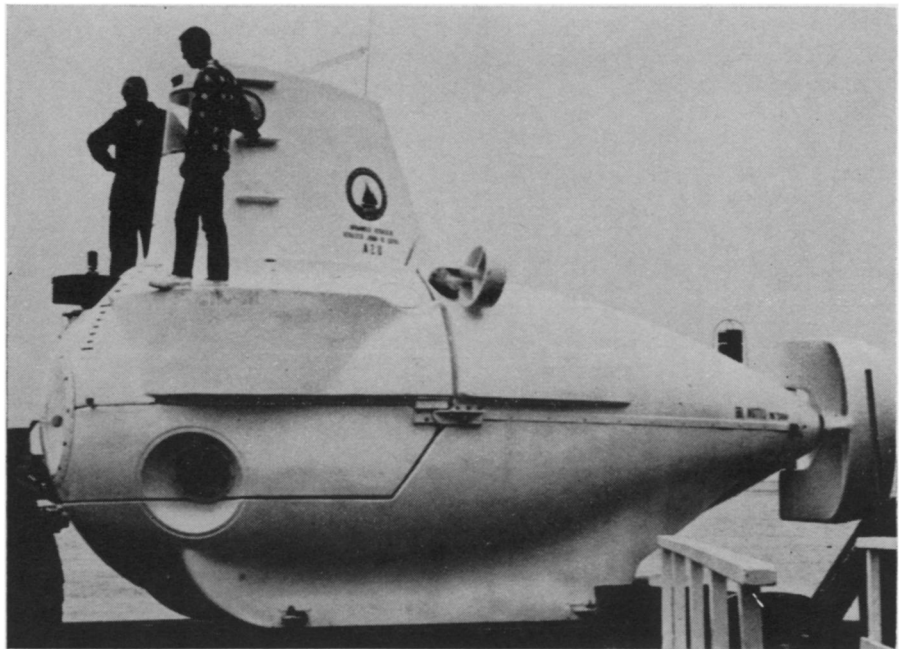


ALVIN

## Search for the mini-sub

4,700 feet down lies  
an empty research submarine;  
storms impede the search



Geological Survey

*Alvin on the cradle that dumped it into the Atlantic when a cable broke.*

The furor is considerably smaller than that over the loss of the Scorpion—but so is the submarine. The 819-foot Scorpion disappeared at an unknown location with 99 crewmen aboard, resulting in a search that involved some 5,000 men, 40 ships and 5 months of intensive hunting (SN: 6/15, p. 565). The Alvin, a 23-foot research sub operated by the Woods Hole Oceanographic Institution, went down with no one aboard almost directly beneath its own surface support vessel. An oceanographic ship, a Coast Guard cutter and another mini-sub were called in to help.

The scale of the operation was smaller, but scientists would still like to have the vessel back. Alvin is one of the more capable members of the U.S. mini-sub fleet. It can reach depths of 6,000 feet and more, and recently it scored a coup by being the first research submersible to drill rock core samples from the ocean bottom. Built in 1964 by Litton Industries, Alvin was commissioned by the Office of Naval Research, which pays Woods Hole to run it, and two years later made its reputation by finding a lost H-bomb off the coast of Palomares, Spain.

On Oct. 16, Alvin was engaged in exploring an area of the Atlantic floor known as Hydrographer's Canyon, about 120 miles south of Cape Cod. The site is on the continental slope well beyond the continental shelf. With its catamaran mother ship Lulu and another research vessel, the Gosnold, in attendance, the submarine was prepar-

ing to inspect buoy moorings on the bottom prior to making detailed exploratory dives.

As support crewmen readied it for its descent, Alvin was resting on a cradle-like structure, slung between the two hulls of the Lulu on four ¾-inch-thick steel cables. The deck crew held six more hand lines to stabilize the sub as it was lowered on its cradle into the water. Standing atop the conning tower of the sub was pilot Edward Bland. Oceanographer Paul Stimson and pilot-trainee Roger Weaver were working inside the pressure hull, with the hatch open.

Suddenly, one of the forward cables supporting the cradle snapped. An instant later, yanked by the sudden increase in load, the other forward cable broke and dropped the end of the cradle into the water letting Alvin slide off. Some of the hand-held auxiliary lines parted, others simply tore themselves from the deckhands' grip.

Bland leaped off, and Stimson and Weaver just managed to scramble out to safety as water poured in through the open hatch and through a plexiglas window in the tower, broken in the impact with the water. In 60 seconds, Alvin had disappeared completely, headed for the bottom some 4,700 feet below.

It is unlikely, Woods Hole officials feel, that Alvin drifted horizontally for a greater distance than it covered downward. With this reasoning, they concluded that the mini-sub should be some-

where in a circle with a radius of a bit less than a mile.

The approach of winter brings rough weather to the northern Atlantic, and it soon became too violent for the Gosnold, so a larger ship, the Chain, was sent from Woods Hole to take charge of the search. Meanwhile, the Coast Guard buoy tender Sassafraz was sent in to help, and the General Motors-built Deep Ocean Work Boat was flown in from California.

One of the first parties on the scene was not part of the rescue team at all, but a Russian trawler. Within hours it put a marker buoy on the spot. Three days later, however, it gathered up its buoy and departed.

It took about two hours for the DOWB to run into troubles of its own. Scanning difficulties in its sonar (a sharp-eared Woods Hole design capable of spotting a half-gallon tin can hundreds of yards away), and a malfunction in an emergency weight release, sent that sub back to land for repairs. The Chain stayed at the site, towing an undersea camera back and forth to photograph the bottom. The search area covered more than three square miles, while the camera could see only about 30 feet.

The Lulu, carrying the DOWB, set out for the site on Nov. 9; she got to about an hour from the location when a storm forced her back to port where she remained, waiting for clear weather. If, when it goes out again, the DOWB does locate the downed craft, it will

try to attach a cable that could be used with a surface winch to pull Alvin up. Though it weighs only 10,000 pounds on the bottom, Alvin, full of water, would weigh almost five times as much in the air. Winches on the Chain, officials said, would be able to lift it, if they get the chance.

**Even with** a prompt recovery, engineers face a time-consuming job of refitting Alvin. "It may take several months, at least, to repair the equipment damaged by water," says Dr. John Schlee, a U.S. Geological Survey marine geologist who has been working with the vessel. Because Alvin's hatch was open, he says, "it did not implode from

sea pressures, but a lot of electrical equipment may be ruined."

**In any event,** more Alvins are on the way. At its Groton, Conn., yards, home of most of the U.S. nuclear sub armada, General Dynamics Corp.'s Electric Boat division is building a pair for the Navy. One will reportedly go to Woods Hole via the Office of Naval Research, while the other is destined for the Navy's Advanced Underwater Test and Evaluation Center. The new craft, expected to be completed next month, will have two maneuverable claws instead of the downed Alvin's one, will be two feet longer and capable of 500 feet of additional depth.

## PLUTO

### Reconciling the mass

There are two ways to calculate the mass of a planet. One is from the effects it has on the motion of nearby planets. The other combines its size with the density of the matter that is known or assumed to make it up.

In the past, when the two methods were applied to the planet Pluto, they led to widely disparate results. Now a new analysis of the motions of Neptune by a team from the U.S. Naval Observatory brings the two figures reasonably close to each other.

Motion effects, observed on a known planet, have sometimes begun the search for an unknown one. The identification of Neptune in 1846 resulted from studies of the motion of nearby Uranus.

In Pluto's case, motion data were not sufficient to predict its position, though they did lead astronomers to suspect its existence. The actual observation came from an intense search of the sky rather than preknowledge of its position.

Earlier analyses, one based on the motion of Neptune and the other on Uranus and Neptune, had given Pluto masses of 0.91 and 0.82 earth masses respectively. (One earth mass is  $5.98 \times 10^{21}$ —nearly 6,000 billion billion—metric tons.)

Such a mass would give to Pluto a density of at least 40 grams per cubic centimeter.

The problem with this figure has been to decide just what Pluto could be made of to be so dense. Earth's density is only 5.5 grams per cubic centimeter. Iron, which makes up a large part of the earth, has a density of 7.8. A solid lead Pluto would have a density of 11.3; solid uranium, the heaviest stable element, would give only 18.95.

**On the other** hand, if one took the size of Pluto—best recent measurements give an upper limit of 6,400 kilometers for its diameter—and assumed that the composition of Pluto, like that of other

terrestrial-sized planets, was similar to the earth's, the mass of Pluto would be only 0.13 times that of the earth.

But, Drs. R. L. Duncombe, W. J. Klepczynski and P. K. Seidelmann point out in *SCIENCE*, for Nov. 15, the orbits of Neptune that have been used in the older calculations did not really predict the motion of the planet very well. Each of these had been carefully fitted to observed positions of Neptune up to the time of calculation, but when it was compared to positions of Neptune observed since then, discrepancies—up to 1/720 of a degree—in Neptune's position in orbit appeared.

The Naval Observatory group therefore decided to make trial calculations of the motion of the five outermost planets using supposed values of Pluto's mass that ranged from 0.18 to 0.91 earth masses, to see whether one of them would give a better fit to Neptune's motion for all positions observed since 1795. One of the difficulties in making such a calculation is that all these observations represent only about 70 percent of a single Neptunian orbit.

**The best fit** was found with Pluto's mass equal to 0.18 earth masses. If Pluto has the same density as earth, this figure would require it to have a diameter of 7,200 kilometers. If the observed figure of 6,400 kilometers is taken as accurate, then Pluto's density must be at least 1.4 times that of the earth, or 7.7 grams per cubic centimeter, a much more plausible figure than 40.

Though the figures have been brought a good deal closer together, the end is not yet. "Further refinement," the three astronomers conclude, "of the value of the mass of Pluto and the elements of the orbit of Neptune must await completion of a systematic discussion of the observations of Neptune now being made at the Naval Observatory." ◇

## THE NEW FEMINISTS

### Equality, not protection



*Mrs. Friedan: not laughed off.*

After several years of limping along behind minority groups, women are making a strong bid for job equality.

Fed up with years of watching men win promotions they think should be theirs, factory women are fighting both unions and employers in the courts of half a dozen states. The outcome will determine whether old state laws limiting the hours and conditions of female employment are still valid. Industry has used these laws as reason for not promoting women. Ironically, the laws were enacted in the first place to protect women workers.

**The drive by** factory women reflects stirrings of a larger feminist movement given new life by the Civil Rights Act of 1964. The act prohibits job discrimination on the basis of race, national origin or sex. But while the Government acted immediately to implement the racial provisions, those dealing with sex were treated with something less than seriousness.

"The minute sex got into the act, it was treated as a joke," says Betty Friedan, author of "The Feminine Mystique" and president of the National Organization for Women. "No one intended doing anything about it. Sexual discrimination was the only kind of discrimination still considered moral, or at least fashionable."

Nevertheless, the legislation provided a focus for female discontent and complaints began pouring into local offices of the Equal Employment Opportunities Commission. They equal and some-