per minute, though scientists speculated that isolation in the capsule could account for this. In addition, the astromonk lost 20 percent of his body weight. Men in space have lost from 3 to 8 percent—a loss too significant to be ignored.

Then, on the eighth day, Bonnie deteriorated rapidly. His heart rate dropped to 70 beats per minute; immediately before recovery of the capsule it was down to 39 beats. Bonnie refused food and water. Brain temperature, which had been more than 100 degrees F. at launch, declined to 95 degrees. Body temperature followed brain temperature in its downward course.

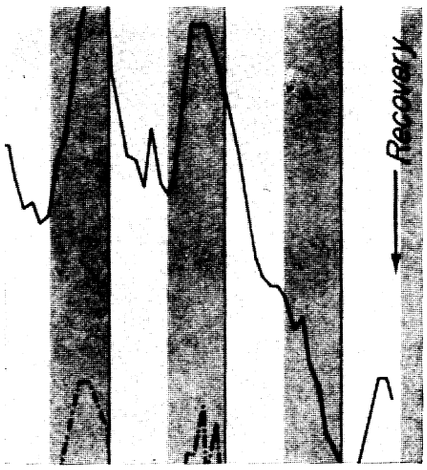
Most seriously, scientists observed a distinct rise in central venous pressure: the pressure in the veins going to the heart. Further, Bonnie lost an excessive amount of fluid, a factor that can be attributed, at least hypothetically, to the alteration in venous pressure, which, in turn, resulted from the weightless condition.

Weightlessness leads to a pooling of blood in the thorax and abdomen with consequent filling of receptors in blood vessel walls. A reflex reaction takes over. Blood volume sensors are activated, followed by rapid fluid loss through the kidneys and sweating. Resulting dehydration of tissues reduces the body's capacity to respond to stress. Additionally, X-ray studies of bone made before and after the flight showed a greater loss of calcium than was seen in the control animals. At autopsy, little tissue damage was seen except for small bruises in the liver and heart, probably from reentry shock.

Now, scientists must interpret these data in light of future plans and past evidence from manned flight. They inevitably suggest a hazard to man at work in zero gravity.

In addition to the problems noted from Frank Borman's Gemini ride, experience from Richard Gordon's walk in space during a Gemini mission is relevant. His job was to put a tether on the Agena craft. In simulated tests on earth, he managed the tethering in 25 seconds. In space, he could not perform the task in 25 minutes. And there have been a number of reports by astronauts of sweating, associated with subjective feelings of heat and cold, Dr. Adey recalls. Rapid heart rates and respiratory difficulty have also been reported from manned flights.

From available data, which are clearly preliminary and will be expanded as evaluation of Biosatellite 3 continues, weightlessness is the primary cause of Bonnie's death. However, space scientists admit that certain conditions peculiar to the experiment must be weighed before the final verdict is in.



NASA

Bonnie's heart rate fell sharply.

For one thing, the cabin temperature of the capsule remained at about 69 degrees F. throughout the flight, though 75 degrees was the desired level. The significance of this factor, coupled with the associated patterns of movement of air over the immobilized animal, will have to be tested further.

Total immobilization could have been another detrimental factor, though the scientists tend to put little emphasis on it.

A third factor, the monkey's diet, must also be weighed in evidence. Bonnie ate only a single form of protein—casein. Says Dr. Abraham Cockett, a Biosatellite investigator from the University of Rochester, "Had he had other sources of protein, he would have precipitated calcium phosphate in urine and might have developed urinary problems." This is a known tendency peculiar to monkeys, and the restricted diet was designed to avoid it. But the casein diet might have had other effects.

The open question at this point is what happens next. There are no plans for additional Biosatellite experiments and little evidence that they will be initiated. One suggestion is flights of man and monkey in concert.

Dr. Orr Reynolds, director of NASA's Bioscience Programs, reports that many investigators would like to see man-monkey flights with larger animals. Bonnie, a macaque, weighed about 14 pounds. Animals weighing from 25 to 50 pounds, such as the rhesus monkey, baboon and chimpanzee, are candidates.

The possibility of introducing artificial gravitational fields in spacecraft planned for long journeys has also been raised again as a result of Biosatellite 3, but whether that will be necessary is still unknown.

In short, Dr. Reynolds says, NASA simply does not know right now what it will do with the information from Biosatellite 3. But some changes are inevitable. □

DEEP DRILLING

Challenger extended

The cruise of the oceanographic vessel Glomar Challenger has been called one of the most successful scientific missions of all times.

The 40,000 miles of Atlantic and Pacific Oceans it has crossed in the last 14 months have yielded secrets to Challenger's scientists at an unprecedented rate.

Oil-bearing salt domes were discovered beneath the Gulf of Mexico (SN: 10/12/68, p. 361). Continental drift, through the mechanism of sea-floor spreading, was given strong support (SN: 5/10, p. 449). The northwestern Pacific was shown to be the remnant of an old basin in existence long before the birth of the Atlantic (SN: 9/13, p. 197). Every leg brought back new surprises (see p. 405).

"The Deep Sea Drilling Project," says Dr. William D. McElroy, director of the National Science Foundation, "has proven to be an outstanding scientific and technical success. It has excited not only the more than 300 scientists of this country who have been involved in the project's planning and execution, but many others throughout the United States and abroad who are following its progress."

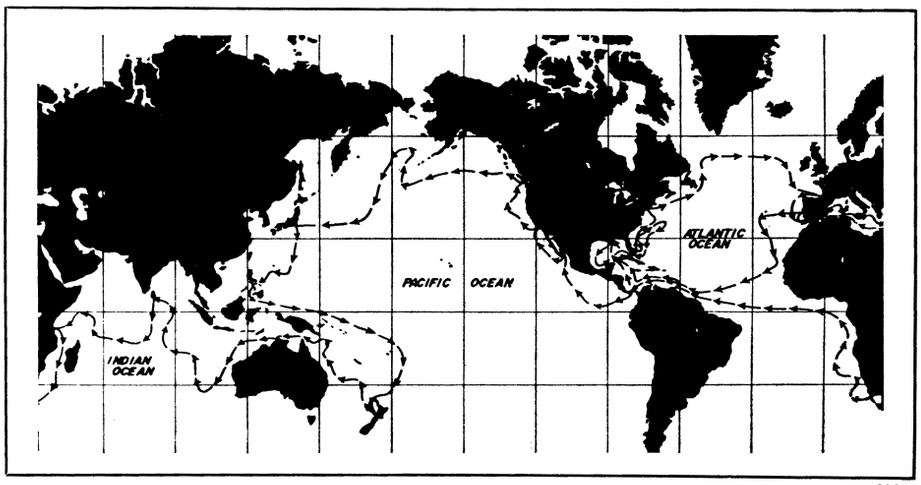
This week the NSF insured that the historic mission will continue. The agency announced a three-year, $22.2 million extension of the original $12.6 million project. It will allow the Challenger to roam the rims of the Atlantic and Pacific Oceans in search of new discoveries and, for the first time, enter the Indian Ocean and the Mediterranean Sea. The contract extension will allow 30 months of additional drilling in 15 two-month cruises lasting from 1970 to 1973. The drilling will be followed by six months of further analysis. The extension almost triples the scope of the project as it was originally funded.

The initial 18-month scientific program, which will end in late January with the conclusion in Panama of the Challenger's ninth leg, was directed primarily toward reconnaissance of the deep ocean basins.

The major thrust of the next 30 months of drilling will be to take advantage of the next generation of ideas that come out of continental drift and sea-floor spreading—the interaction of the ocean floors with the continents.

"We are interested," says project chief scientist Dr. Melvin N. A. Peterson, "in what is known as tectonic relationships—the motions of the hard parts of the earth."

Not all the interactions occur on a global scale. The first leg of the extend-



NSF

Challenger goes global: Around three ocean basins, into the Mediterranean.

ed project will explore the edges of the Gulf of Mexico next February and March in search of evidence to help decide between the two major theories about the origin of the gulf basin. One holds that the gulf was once a shallow sea that sank; the other, that the gulf has been a deep ocean basin dating back to geologically ancient times.

It should also provide more information about the oil deposits found in association with salt domes on the gulf floor on the Challenger's first leg last year—the first demonstration that hydrocarbons can be formed and accumulated in deep sea conditions. Geologists hope that Challenger will be able to provide explanations for major breaks in the topography of the basin west of Florida and off the Yucatan peninsula and for the origin of the Straits of Florida. They intend also to probe into the great cone of sediments built out into the gulf by the waters of the Mississippi.

"There are enough scientific questions that we could put the whole campaign in the Gulf of Mexico," says Dr. Maurice Ewing, director of the Lamont-Doherty Geological Observatory. But the Challenger will move on.

From the gulf, it will head north into the Atlantic, drilling east of the United States. Here, northeast of San Salvador in the Bahamas, the Challenger will return to the site where sediments 140 million years old were found earlier. This time the scientists hope to be able to drill into even older sediments and reach the igneous rock floor beneath.

Here and at many other sites, project scientists hope to be able to penetrate the layer of hard chert, or flint, which the Challenger discovered within sediments in many places (SN: 10/12/68, p. 362), to the great surprise of marine geologists. The chert layers, harder even than granite, are formed primarily from the skeletons of microorganisms such as Radiolaria, which have been welded together by some unexplained process to form layers that often stopped the Challenger's bits. The existence of the chert in the same time-sequence of sediments from many locations seems to indicate a dramatic change in ocean conditions during the mid-Eocene, about 45 million years ago, that caused the organisms to flourish.

After a drilling leg across the far north Atlantic, the Challenger will investigate the Mediterranean, an area which is strongly suspected to be a product of recent sea-floor spreading. "I have been on two expeditions in there, and I saw several interesting signs of spreading," says Dr. Ewing. The geology of the land areas of southern Europe has been thoroughly documented, he says, making it possible by drilling to turn up valuable comparisons between land features near the coast and those beneath the sea surface.

European scientists are expected to make up more than half the scientific team on the ship during this phase.

Plans for later segments are not as firm. The Challenger will return across the Atlantic, enter and cruise around the edge of the north Pacific, at one point drilling north of the Aleutian Islands, swing north of Micronesia, and then cut between Australia and New Guinea before heading into the Indian Ocean and around the tip of Africa.

One of the biggest hopes of the next three years, says Dr. Peterson, is to develop the capability to reenter a hole once the drilling has been stopped to change a worn bit or make a repair. Several techniques will be tried, making use of acoustical guidance at the ocean bottom.

As for the future, ambitions are not being limited to the 30-month extension. One day, says Dr. Peterson, the drilling group would like to take the Glomar Challenger into the Black Sea to study its heavily sedimented floor, which is underlain with oceanic-type crust. No official contacts with the Soviets have been made, but many Russian colleagues have made informal invitations in conversation.

NO PANACEA

Social scientists offer themselves

Social and behavioral scientists have been trying for several years to come to terms with society's erupting problems, and with the demands for guidance being made on them by equally frustrated public officials.

They would like to take their place in the councils of government, and this week a Report on the Behavioral and Social Sciences prepared over a three-year period under the auspices of the National Academy of Sciences (SN: 9/13, p. 201), attempted to lay out some of the areas where the scientists might make a contribution.

The report was initiated by the academy's own Behavioral and Social Sciences Survey Committee, composed of more than 60 scientists under the chairmanship of Prof. Ernest R. Hilgard of Stanford University. It is the first large-scale attempt to present a complete view of the current state of the social and behavioral sciences.

Much of the report is devoted to recommendations for involving the behavioral and social sciences in the formation of public policy. For instance, the survey committee recommends that a system of social indicators be developed to measure the social health of the nation in the way that the gross national product measures the country's economic health.

Inasmuch as the quality of life is more difficult to quantify than economic activity, it is unlikely that a single number such as the GNP will emerge, but the committee hopes that enough meaningful social indicators can be drawn from statistics on such factors as education, health, crime, housing and cultural activities, so that the President can make an annual social report to the nation similar to his annual economic report.

The Office of Statistical Policy in the Bureau of the Budget has already been given the task of creating a system of social indicators; meanwhile, the survey committee suggests that behavioral and social scientists outside the government publish their own annual social report.