Dr. Claude E. ZoBell, principal investigator in studies re-effects of hydrostatic pressure on life processes in the sea

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Why do some organisms thrive under tremendous deep-sea pressures while others are adversely affected?

What effect do deep-sea pressures have on the complex chemical compound, DNA, often called the "coil of life?"

What mysteries are being probed that will tell man something of the effect of deep-sea pressures on the cells and physiological reactions of higher organisms, including man?

These are but a few of an increasing number of questions of fundamental and practical significance that scientists the world over are being asked about the effects of hydrostatic pressure on life processes in the sea.

Some of the answers may derive from a three-year investigation on the effects of high pressure on the life processes of microorganisms just getting under way at the University of California, San Diego's Scripps Institution of Oceanography through a $46,800 National Science Foundation grant.

Principal investigator in the new research program is Dr. Claude E. ZoBell, professor of microbiology at Scripps and internationally known for his work in the field of oceanic microorganisms.

"Most of the scientific observations on the effects of hydrostatic pressure on the environment and physiology of organisms have been made on organisms that normally live at one atmosphere pressure," said Dr. ZoBell.

"Deep-sea organisms, living at 700 to 1,000 atmospheres, have received scant attention in this regard."

(One atmosphere is equal to about 15 pounds of air per square inch at sea level. For each 30 feet of descent below sea level, the pressure of water increases by approximately one atmosphere.)

"As with man beneath the sea surface, bacteria are injured by increased partial pressures of free oxygen, although diving man, as well as bacteria, can tolerate hydrostatic pressures which occur at water depths of a few hundred feet, provided the proper gas mixture is made available to him," Dr. ZoBell explained.

"Further observations on the effects on bacteria of various gas mixtures at increased pressures may tell us something about what may be best for man beneath the sea. Obviously, it is far easier to make such observations on bacteria than on man.

Scientists have found that certain types of bacteria which normally live on the earth's surface, as in soil, sewage, or fresh water, are injured by pressures characteristic of water at depths of about 5,000 feet. This leads them to believe that the cells making up the human body will not be able to withstand such pressures.

Dr. ZoBell said that experiments with bacteria at increased pressures have provided some "interesting" information about the synthesis, or formation, of DNA (deoxyribonucleic acid) and RNA (ribonucleic acid).

"Surprisingly," he said, "at increased pressures, certain bacteria continue to produce RNA at a normal rate but produce proportionately less and less DNA.

"DNA is a complex chemical compound occurring in the nuclear material of all normal cells. It has been described as the 'Coil of life,' because DNA is a genetic material which determines the function, size, and other properties of the cell."

Funds from the NSF grant will give Dr. ZoBell and his associates opportunity to investigate the cultural requirements and comparative physiology of barophilic bacteria, that is, those bacteria that grow at deep-sea pressures.

"We will compare these bacteria with those of barophobic varieties, those that are adversely affected by increased pressures," he continued.

"Although we will attempt to obtain species of these 'pressure-loving' bacteria, as we call them, from the deep sea - where pressures exceeding 1,000 atmospheres prevail - we will also examine soil, shallow-water sediments, and other materials for their presence."

Dr. ZoBell and Dr. Frank H. Johnson, of Princeton University, coined the term barophilia in 1949 to describe bacteria which grow at high pressures.

"We will consider nutrient requirements, osmotic pressure tolerances, temperature range of growth, and other cultural conditions as we compare the 'pressureloving' with the pressure-resisting bacteria," Dr. ZoBell said.

"We also expect to emphasize in our research the biochemistry and physiology of bacteria cultivated in the laboratory at increased, controlled pressures, with special stress on protein synthesis, nucleic acids, and various enzyme systems."

Deep-sea sediment samples are believed to be the most likely source of barophilic bacteria, he pointed out.

"Recently, on Scripps' Dodo Expedition, we collected four well-stratified bottom sediment cores from the Philippine and Marianas Trenches at depths of approximately 10,000 meters (32,748 feet).

"Preliminary observations have shown in all four cores the occurrence of appreciable numbers of bacteria, a few of which are now growing in an enriched medium at 1,000 atmospheres.

"This core material, some in its raw state and some enriched with various nutrients, is being held in experimental apparatus at pressures and temperatures experienced in the deep-sea trenches from which they were taken, awaiting further examination."

Although the occurrence of pressure-loving"bacteria was demonstrated by Dr. ZoBell and Dr. Richard Y. Morita, now of Oregon State University, in the Galathea Expedition of 1951-52, they isolated in the laboratory a pure culture that grew in a nutrient medium of sea water, peptone, and yeast extract, at 600 to 800 atmospheres but not at one atmosphere.

It is believed that similar results will result from investigations carried out under the new NSF grant as bacteria are brought back to Scripps Institution from research expeditions to be scheduled during the next three years.