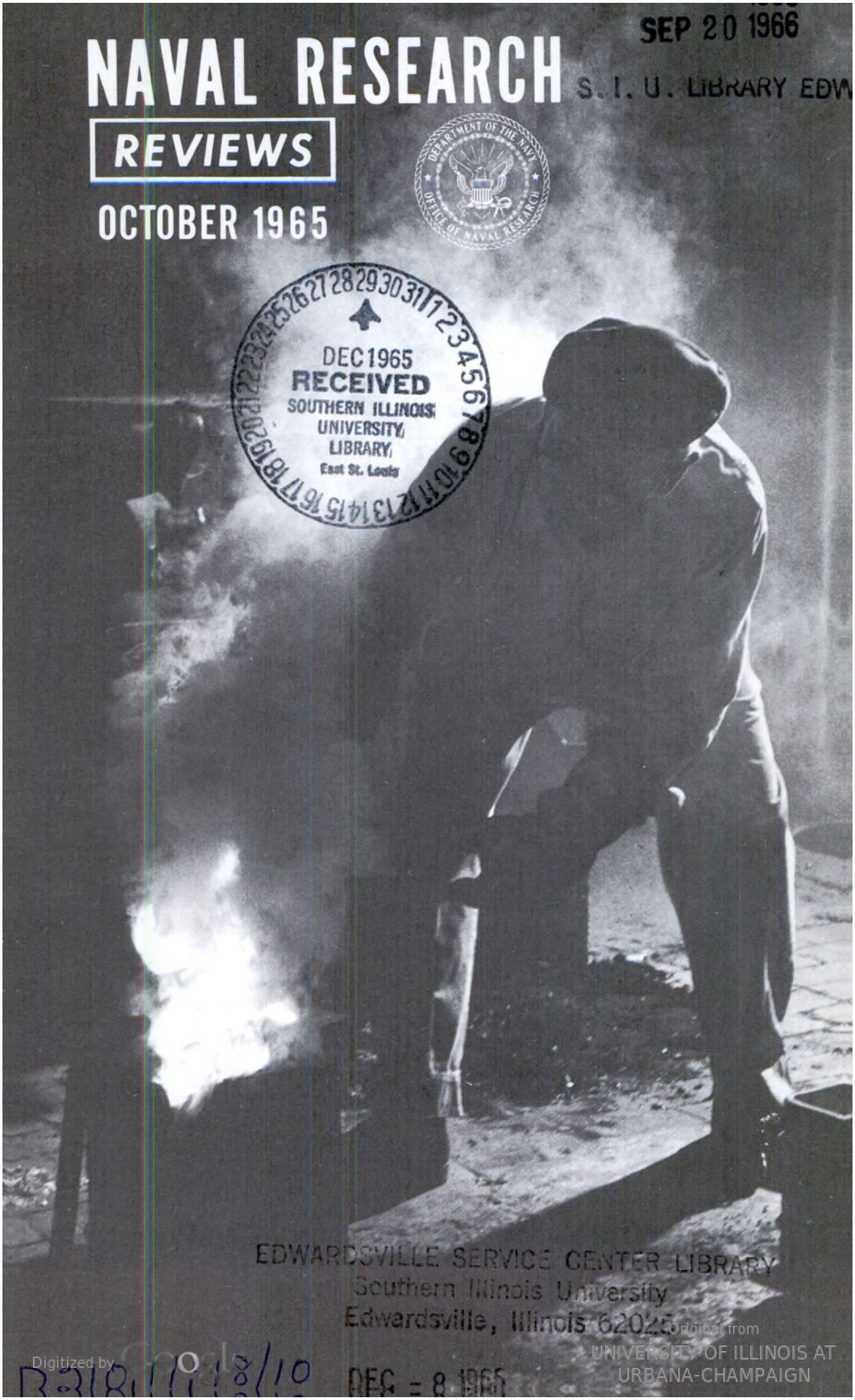
NAVAL RESEARCH REVIEWS

OCTOBER 1965



IN MEMORIAM
Dr. John Flynn

The passing of Dr. John Flynn, Chief Scientist at the New York Branch of the Office of Naval Research, will be deeply regretted in many organizations and in many scientific disciplines. Twenty-four years spent in editorial capacities with Biological Abstracts prior to his association with the Office of Naval Research, which began in 1953, brought Dr. Flynn into personal contact with biologists from all over the world. No doubt the conscientious care he gave to his responsibilities as an editor contributed to the enormous background of knowledge in widely diversified fields of research upon which a large part of the scientific community came to rely. His kindliness and wise handling of people and problems have made a lasting contribution to the public image of the Office of Naval Research, exerting a quiet but powerful influence on the character of the contract research program in the life sciences and so on the whole course of biological research in this country. A mere accounting of recorded honors and achievements cannot begin to do justice to the service which Dr. Flynn has rendered to a generation of research workers in a most important era in the growth of science.

The New Oceanographer

On September 7, RADM Odale D. Waters, USN, became the new Oceanographer of the Navy, relieving RADM Denys W. Knoll, who has been appointed Deputy Commander, Military Sea Transportation Service. RADM Waters served last as Commander Mine Force, Pacific Fleet, with additional duty as Commander Naval Base, Los Angeles.

The new Oceanographer graduated from the Naval Academy in 1932. When World War II started in Europe, he was sent to London as Assistant Naval Attache with additional duty as technical observer in mine recovery operations. Before Pearl Harbor, he was called back to the United States to establish and run the Navy's first Mine Disposal School. In the latter days of the War, he served as Fleet Gunnery Officer and Assistant Chief of Staff to Commander Fourth Fleet and as War Plans Officer on the staff of the Commander-in-Chief, Atlantic Fleet.

After the War, he participated in the atom bomb tests at Bikini as Commanding Officer of the destroyer USS LAFFEY.

RADM Waters' Washington assignments have included Senior Technical Officer and Mine Development Project Officer at the Naval Ordnance Laboratory and Inspector General and Assistant Chief of the Bureau of Naval Weapons for Administration. While at the Naval Ordnance Laboratory, he participated in the designing of atomic weapons.

The Marriage of Science and the Navy*

RADM John K. Leydon, USN
Chief of Naval Research

The Navy of today is more than anything else a product of science, and it can be truly termed a scientific Navy. However, I don't want to give the impression that the Navy is now using science for the first time. For example, the American Navy was the first in the world to build a steam warship. This was the DEMOLOGOS, which was launched in 1814. In fact, our early leaders closely associated the Navy with science. President John Quincy Adams, in delivering his first annual message to Congress in 1825, spoke of establishing a naval academy "for the formation of scientific and accomplished officers." He also requested authorization for a national observatory and a voyage of discovery to the northwest coast of America.

Although no immediate action resulted from these proposals, the Navy's role in science and scientific exploration was set. In 1836 the Navy was authorized to conduct the first national expedition, known later as the Wilkes expedition, which was the first of many naval explorations that have garnered much scientific information. This one—a four-year voyage that ranged from the Central Pacific to the Antarctic—benefitted a number of fields of science. Incidentally, some of the charts it produced were still useful to the Navy at Tarawa in 1943. By 1841, a naval observatory had been established by Act of Congress, and in 1845 the Naval Academy was born.

A National Scientific Body

The Navy's participation in science in those early days is brought out by its role in the establishment of the National Academy of Sciences in the middle of the Civil War. It was the action of Commodore Charles Henry Davis, the Chief of the Navy's Bureau of Navigation, which led at an appropriate moment in history to the creation of a long sought and often discussed national scientific body.

Commodore Davis first proposed a "Permanent Commission" designed to obtain for the Navy information on "questions of science and

*A lecture given at the Franklin Institute, Philadelphia, on February 3, 1965. The paragraphs concerning oceanographic programs have been modified slightly on the basis of recent developments in those fields.

art" and won the enthusiastic support of leading men of science for his idea in 1863. The Permanent Commission was established by the Secretary of the Navy on February 11, 1863. The ready acceptance of this organization as an aid to wartime technology persuaded Commodore Davis to urge civilian scientists to ask Congress outright for the incorporation of a National Academy of Sciences. His instinct was right, and legislation by Congress and its signature by President Lincoln followed within a month.

Actually, as early as 1815, Alexander Dallas Bache, Superintendent of the Coast Survey, declared that an institution of science "is much needed in our country to guide public action in reference to scientific matters." However, it took a war, as has happened so often since then, to bring out the role of science in advancing the nation's security.

The situation virtually repeated itself during World War I. When war broke out in Europe, this country had no central military research organization. The Navy again realized the need for one. In 1915, Secretary of the Navy Josephus Daniels appointed a Naval Consulting Board with Thomas Alva Edison as chairman. In outlining its mission, Secretary Daniels wrote to Edison that "one of the imperative needs of the Navy is machinery and facilities for utilizing the natural inventive genius of Americans to meet the new conditions of warfare."

Aware that the Navy had almost no facilities that could be used for research, the Naval Consulting Board proposed the establishment of a naval laboratory that would be under the command of an officer and that would have a staff of "civilian experimenters, chemists, physicists, *etc.*" In 1916, Congress authorized the laboratory and approved an initial appropriation. Ironically, immediate construction was delayed because members of the board could not agree on a location for the laboratory. America's entry into the war caused a further delay, so it was not until 1923 that the Naval Research Laboratory came into existence.

A Military Laboratory Staffed by Civilians

From the outset, the concept of a military laboratory staffed by civilians has been successful. As one historian has written, "although under the command of a regular officer, the Naval Research Laboratory developed a certain spirit among its civilian scientists and a taste for fundamental work." As a result, in the 20's and 30's NRL was the one bright spot in the dark picture of the general lack of research in this country.

The story of the development of radar at NRL is well known. This work began in the early years of NRL under A. Hoyt Taylor and L. C. Young. Finally, on April 28, 1936, a team of NRL scientists headed by

Robert M. Page, now Director of Research at NRL, put together equipment which gave satisfactory echoes from airplanes at ranges up to 25 miles.

In 1939, an NRL scientist, Dr. Ross Gunn, participated in the historic meeting at which Navy officials were informed by Dr. Enrico Fermi that the successful splitting of the uranium atom had released tremendous energy. The practical problem of harnessing this energy had yet to be solved. However, Rear Admiral Harold Bowen, Chief of the Bureau of Engineering, which then had cognizance over NRL, immediately approved a request for funds from NRL to initiate a research program aimed at utilizing this new source of power for ship propulsion, with the submarine particularly in mind.

NRL did not get very far with its research on atomic power during World War II. However, as a result of its research, the laboratory was able to develop a process for the separation of the uranium isotope U-235. This process, known as the liquid thermal diffusion method, made a significant contribution to the production of fissionable material for the first atomic bomb. This early experience gave the Navy further impetus to consider the possibilities of developing nuclear propulsion after the war.

The "Bird Dogs"

It was also during World War II that the events occurred which led finally to the establishment of the Office of Naval Research. Again it was a matter of the Navy recognizing the need for scientific research to advance technology. The creation of the Office of Scientific Research and Development by President Roosevelt in June 1941 prompted Secretary of the Navy Frank Knox to study what steps might be taken to increase the Navy's effectiveness in the prosecution and utilization of research and development. The answer was to establish, in July 1941, the Office of the Coordinator of Research and Development, which was given the responsibility for advising the Secretary of the Navy broadly on matters of naval research.

The small staff of the Coordinator included four young Naval Reserve officers with technical backgrounds who received the nickname "bird dogs." One of them, Dr. James H. Wakelin, recently finished an extended term as Assistant Secretary of the Navy for Research and Development, and another is now senior vice president of Arthur D. Little, Inc. Gradually, as the group became immersed in the immediate problems of wartime R & D, these men began to be concerned about the postwar situation. Realizing that the OSRD-NDRC civilian research groups were only temporary wartime bodies, they began to worry about how the Navy could better organize and administer its own research on a permanent basis after the war.

The "bird dogs" began to meet informally at home in the evenings with people who could help them with this problem. Out of these sessions, the initial pattern of ONR was almost completely conceived as early as November 1, 1943. The essential element was the establishment, under the Secretary of the Navy, of a central research office, which would receive funds from Congress for research projects and which would have a powerful research advisory committee made up of top scientists. Naturally, much ground work involving numerous persons both inside and outside of the Navy remained to be accomplished before any such plan could become a reality.

On September 6, 1944, a revised organization plan for an Office of Naval Research was set down. It included the naming of an Assistant Secretary of the Navy for Research with broad powers, a program emphasizing basic research work, and the transfer of NRL to the new Office. The "bird dogs" had an ingenious alternative if their proposal failed to get through channels. They would present it as a beneficial suggestion to the Secretary of the Navy.

New Policies for Supporting Research

At first, it appeared that they were stymied. In October 1944, Secretary of the Navy Forrestal created the Office of Research and Inventions, which was to be concerned with coordinating the Navy's patent practices as much as with Naval research. However, Vice Admiral Bowen, who was named to head ORI, proved to be an ardent supporter of the move to create an Office of Naval Research. By September 1945, the "bird dogs" had a Congressional bill drafted for the establishment of an Office of Naval Research, including the establishment of a Naval Research Advisory Committee composed of eminent scientists.

Final Congressional approval was not the most serious hurdle that remained. It was recognized that ONR would be a hollow shell unless the universities, where the majority of basic research is performed, were willing to accept Navy contracts. The prospect of persuading the universities, now that the war had ended, to tie themselves to military contracts appeared formidable. Nevertheless, they did become convinced, mainly because they liked ONR's new policies for supporting research. These included a pioneering research contract system which permitted basic research to be supported on a long-term basis. Other key policies were encouraging unclassified work as much as possible and encouraging the investigator to publish his results in scientific journals, which was accepted in lieu of a final report. When Public Law 588 established the Office of Naval Research on August 1, 1946, a new era in the Federal support of scientific research was inaugurated.

Just recently, Dr. R. L. Sproull, Director of the Advanced Research Projects Agency of the Department of Defense, in a speech to industry, commented on the innovations established by ONR. To quote his words: "They developed the pattern of unclassified contracts negotiated by technical people talking with technical people, monitored with official restraint and a minimum of reporting, and defended in Washington in terms of long-term advances of relevant science and technology rather than immediate application to military problems. As other agencies entered the field, the basic principles of the ONR tradition were maintained. Even the National Science Foundation, the first agency that had the statutory responsibility of supporting science as opposed to a military or atomic energy mission, could not improve much on this pattern." In fact, the first chief scientist of ONR, Dr. Alan Waterman, became the first Director of NSF.

Recognizing the Interests of the American Scientist

Dr. Sproull also pointed out that "one of the most rewarding features of the ONR tradition has been the support of individual technical people or small groups." In this way, research support has enjoyed a quasi-independence from the institutional structure of departments and colleges. It means that the promising individual research worker can be supported even in a poor department, and a group of professors from different departments can receive support for a common program.

Over the years ONR's major contribution to the scientific community has been its role in extending significantly our national basic research effort. If this effort continues to be nourished and supported properly, we need never worry about becoming a second-rate nation scientifically. In such a climate, major scientific progress is certain to be made.

ONR has succeeded because it recognized from the start that the talents of scientists cannot be commandeered. Our national effort in science is not a monolithic structure rigidly controlled and directed from the top. Science is composed of many elements and many fields of interest. The American scientist is intent in exploring every one of them. He is encouraged to probe into any obscure corner of this mysterious universe that intrigues him. There is no one in Washington who dictates to the American scientist on which areas he must concentrate his thinking. He sets his own pace and works on whatever problem that provides him with the greatest personal challenge.

Eventually, out of such work, a radically new military system may evolve. However, it is almost always the unplanned by-products of several men, each of whom individually contributes a new theory about a physical or chemical process, which make a new system possible. The important point is that unless such new theories and other basic discoveries are constantly added to our storehouse of scientific knowledge, our engineers cannot continue to advance our technology.

The Sea: The Navy's Major Laboratory

Basic research has one advantage, as far as Federal support is concerned, and that is the fact that it is comparatively inexpensive. A great deal can be accomplished with relatively small amounts, especially compared to development costs. On the other hand, there is an increasingly heavy expense in the cost of the new, unique, and complicated research tools and instruments on which universities and research institutions have become more and more dependent for their research programs. Without government support, few of these tools and instruments would be available.

Oceanography is one example. Ever since its inception, ONR has provided much of the support for the country's leading oceanographic research institutions. This support was necessarily limited, and oceanographers had to utilize old sailing yachts and converted Navy auxiliary ships for their floating oceanographic laboratories. In recent years, however, the new national oceanography program has made it possible to build a whole fleet of new ships specially designed for oceanographic research.

ALVIN. Even more of a challenge has been the need for deep-diving research vehicles. ONR pioneered by bringing the bathyscaph TRIESTE to this country several years ago. Shortly afterward, but long before the tragedy of the THRESHER sinking, ONR planned and arranged for the construction of ALVIN, which is now being operated successfully at its design depth of 6000 feet. The little submarine is being used by the Woods Hole Oceanographic Institution to explore the ocean at depths that have been closed to us previously, except for the brief up-and-down trips of the bathyscaph. It is the first of a whole family of deep-diving undersea vehicles that will open up to man a large area of the earth that is more mysterious to us than the surface of the moon.

SEALAB. Parallel to this effort but aimed more directly at such practical problems as deep-sea salvage and rescue are the SeaLab experiments, which are conducted as part of the Man-in-the-Sea program. Working with CAPT George Bond, who has been investigating the medical aspects of deep diving for several years, ONR conducted SeaLab I in the summer of 1964, during which four Navy divers lived and worked for 10 days at a depth of 192 feet off Bermuda. At this writing, SeaLab II is being conducted by ONR at a depth of 205 feet off the coast of Southern California. This project called for 27 divers, divided into three teams, to remain below for at least 30 days and perhaps 45 days to continue the series of experiments designed to make it possible for men to work on the ocean bottom for extended periods at depths of 1000 feet or even beyond.

ARLIS II. Another unique research tool that has been provided by ONR is a laboratory on a floating ice island in the Arctic. Known as ARLIS II, it was operated by the Arctic Research Laboratory, Point Barrow, Alaska, which is supported wholly by ONR through a contract with the University of Alaska. After meandering across the Arctic Basin, it entered the Greenland Sea, through which it was carried southward to its destruction by a warmer climate. By the time it was abandoned last spring, Navy-supported scientists had worked for four years on the platform, gathering a great deal of scientific data about an area which has never been penetrated by surface ships in winter and rarely in summer. In addition, we have gained valuable information relating to the passage of our nuclear submarines through arctic waters.

In these research programs it can be said that we are following the precept put forth by Isaac Newton 250 years ago: "If, instead of sending the observations of seamen to able mathematicians on land, the land would send able mathematicians to sea, it would signify much more to the improvement of navigation and to the safety of men's lives and estates on that element." In the last analysis, the sea itself must serve as the Navy's major laboratory.

The Long Range Influence

Our study of the sea is only one example of the many Naval research programs which have no counterpart anywhere else and which have a long-range influence on man's future status. Other areas of research supported by ONR also have broad impact. In every case, we are gaining knowledge of vital concern both to the Navy and the future of man.

The Navy and the other military services are constantly thinking decades ahead, relying on science to show them their future course. It is clear that our national security always will be based largely on technological skills developed through science. The greater the capability of our scientific instruments to detect an attack in advance and the greater our means of responding instantly with terrible and accurate destruction, the safer we can feel that no one will plan violent aggression against us.

However, this should never be the principal goal of science. The major contribution of scientific research conducted by and for the military services is that it establishes peace. We require peace over a period of many decades to give us time to exploit the new knowledge gained through basic research that will help us build a new kind of world for man.

Rearing Barnacles in the Laboratory

A New Approach to the Old Problem of Marine Fouling

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Christopher P. Cologer

Material Sciences Division
Naval Applied Science Laboratory

Fouling is caused by the growth of animals and plants on the surfaces of submerged objects. It results in the corrosion of ships' hulls; increased fuel consumption, because of the greater frictional resistance it imposes to the movement of the hulls through the water; losses in time and money in applying the necessary remedial measures; and reduction in the efficiency of underwater sound devices and other equipment.

In recent years new high-potency toxics, antimitotic chemicals, and other biological excitatory or inhibitory substances have become available which may provide new approaches to fouling control. To facilitate the development of antifouling formulations suggested by these materials, the precise mode of antifouling action must be determined—a requirement that calls for far more control over the fouling agents than has been effected in the past. Heretofore, antifouling studies have been carried out with relatively hit-and-miss, nonreproducible, protracted methods, which involve, for the most part, the examination of adult barnacle (or other fouling) populations on test panels exposed on harbor test rafts.

The Naval Applied Science Laboratory's efforts in the field of marine fouling have been directed to the development of laboratory methods for studying and evaluating antifouling coatings with respect to biological responses—the ultimate goal being the development of improved materials and processes for preventing or reducing fouling. One of the approaches taken toward this goal has been the design of a technique for the mass-rearing of barnacles in the laboratory. Studies leading to the successful development of this technique received the generous assistance and cooperation of the New York Zoological Society, particularly of the Society's Director of Research, Dr. Ross F. Negrelli.

Barnacle larvae, following hatching from fertilized ova, undergo a series of metamorphoses and pass through several stages of development. The first six stages of the species being reared currently are referred to as naupliar stages, because the larvae are called "nauplii" (singular, "nauplius"). The nauplius is a free-swimming microorganism that ranges in size from about 200 to 800 microns. At the end of the sixth stage, the nauplius metamorphoses into a swimming-and-crawling larva called a "cyprid." It is the barnacle cyprid that ultimately attaches itself to a submerged surface, builds a calcareous shell, and becomes "fouling."

Through the collection and rearing of large quantities of barnacle cyprids, an investigator can maintain close surveillance over the fouling organisms at all stages of their development from embryo to adult and thus can study the mechanisms which lead to attachment.

Briefly, the technique consists of the following steps:

- Collection, from natural sources, of adult barnacles.
- Removal of embryos from the adult.
- Rearing of the juvenile barnacles through the successive naupliar and planktonic cyprid stages.
- Exposure of antifouling test panels to a fixed number of planktonic cyprids under controlled conditions.
- Determination of the number of cyprid attachments or of the vigor of the shell-building capability of the young attached barnacles.
- Interpretation of the "attachment data" in terms of antifouling effectiveness.

Four species of barnacles are being mass-reared in the laboratory. They are *Balanus amphitrite, B. eburneus, B. Improvisus,* and *B. trigonus.* The adult barnacles, most of which are between 10 and 20 mm in diameter, are identified readily by the color, shape, and markings of their calcareous shell plates.

The collection of barnacles begins by placing aluminum panels in ocean localities known to be inhabited by the species selected for study. Within three to five months, after thousands of the organisms have settled on the aluminum, the panels are retrieved and shipped by air freight to the laboratory, where the adult members of the population are removed. The embryos are collected in the form of two compacted masses, called lamellae, that are enclosed within the body sac. Between 800 and 2000 embryos are contained in each lamella. They are removed by means of a dissecting needle or a pipette and reared separately according to species and degree of maturity.

After hatching, which occurs in from one to seven days, the vigorous, healthy larvae are separated from the sluggish ones by placing a small spotlight at the side of the vessel. The healthy nauplii, which are phototactic, concentrate at the side of the vessel nearest the light, where they are drawn off in great numbers with a pipette and placed in a collecting vessel. The nauplii then are transferred, in groups of 200, to 1500-ml rearing vessels in which they will grow to the cyprid stage. Each vessel contains 750 ml of filtered seawater, a Pyrex Petri dish on

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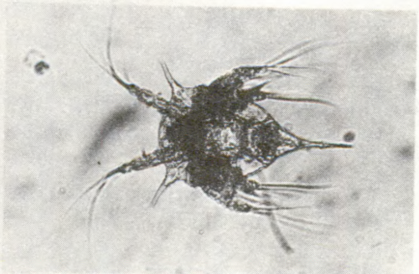
BALANUS EBURNEUS
LARVAL STAGES

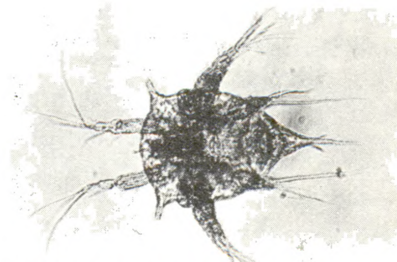
0 100 200 300
SCALE: MICRONS

FERTILIZED OVA

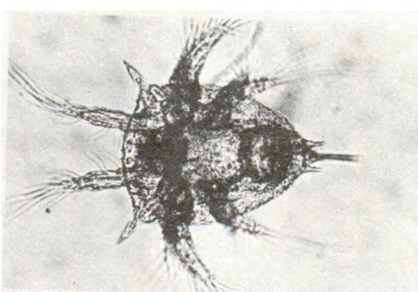
FIRST STAGE NAUPLIUS



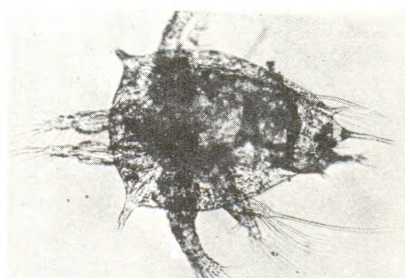
SECOND STAGE NAUPLIUS



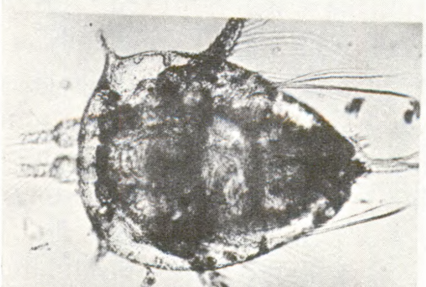
THIRD STAGE NAUPLIUS



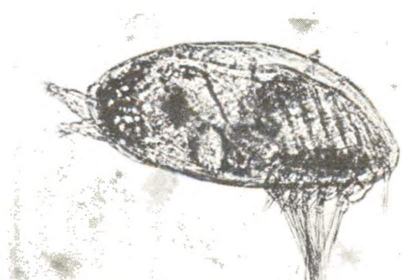
FOURTH STAGE NAUPLIUS



FIFTH STAGE NAUPLIUS



SIXTH STAGE NAUPLIUS



PLANKTONIC CYPRID STAGE

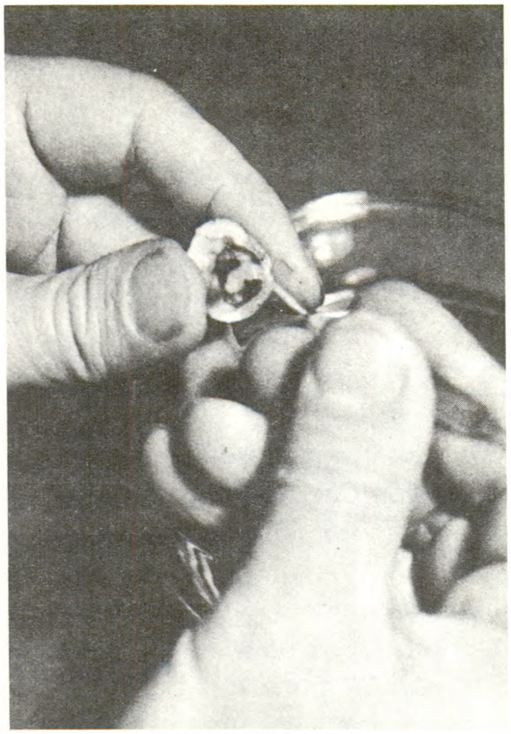
which a one-half inch grid has been inscribed to facilitate counting, and an algae culture, *Cyclotella nana*, upon which the larvae feed. A film of bacterial slime, on which most of the cyprids will settle and metamorphose into young adult barnacles, forms on the Petri dish. The vessel is covered loosely with a polyethylene bag and the interior maintained at a temperature of 70 degrees.

Every day the seawater in the rearing vessel is changed, fresh algae added, and the progress of larval development observed under a microscope *in vivo*. The stage or stages present are noted and a qualitative observation made. The general health and vigor, evidence of feeding, and the number of living and dead forms are reported.

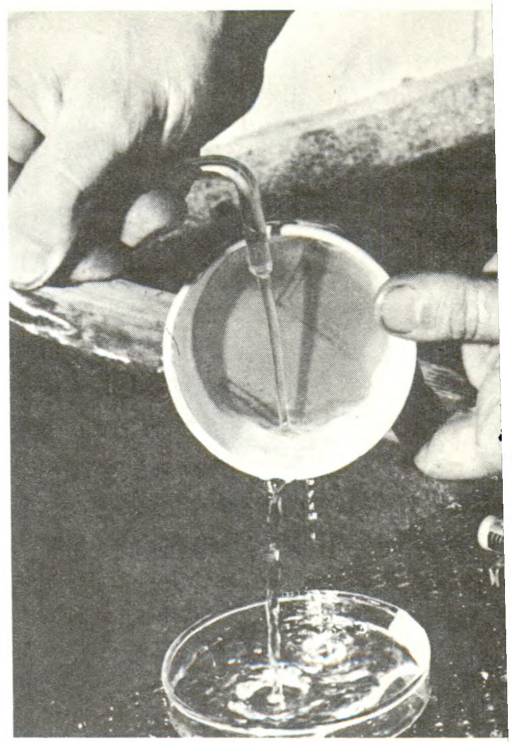
When the larval population begins to metamorphose from the sixth naupliar stage to the cyprid stage—between one and two weeks after hatching, depending on species—the Petri dish is removed and the rearing vessel scrubbed thoroughly with seawater. The Petri dish is drained, but not scrubbed, before it is replaced in the rearing vessel along with the cyprids. Algae culture and fresh seawater are added, the vessel covered, and the temperature maintained as before. The rearing vessel then contains a 3/4-liter seawater environment, a known number of healthy cyprids, and the glass grid upon which most of them settle. In from 9 to 20 days after hatching, again depending on species, cyprids make up 80 percent of the larval population.

In the course of developing this procedure, well over 1000 cultures of larvae were prepared and studied with progressively increasing success. Early attempts at rearing resulted in high rates of mortality, particularly at the lower naupliar stages, and no survival to the cyprid stage. But as the technique was refined (especially with the introduction of non-metallic sieves to facilitate water changes in the rearing vessels), and as a better understanding of feeding and algae culture was acquired, survival rates increased, populations consisting of higher naupliar stages were attained, and eventually complete larval metamorphosis to the cyprid stage was achieved. To date, several hundred individual cultures have yielded cyprids.

Careful searches of the technical literature of the biological sciences and of antifouling-coating technology indicate that this accomplishment represents (1) the first successful mass-rearing to the cyprid stage of larvae of barnacles *Balanus amphitrite, B. eburneus, B. improvisus,* and *B. trigonus*; (2) the first mass-rearing of barnacle larvae at a laboratory located at a considerable distance from the barnacle's natural growing site—which demonstrates the universality of application of the technique; and (3) the first rearing technique to provide for the ultimate use of barnacle larvae in investigations involving controlled settlement and attachment of cyprids upon test panels treated with antifouling substances.

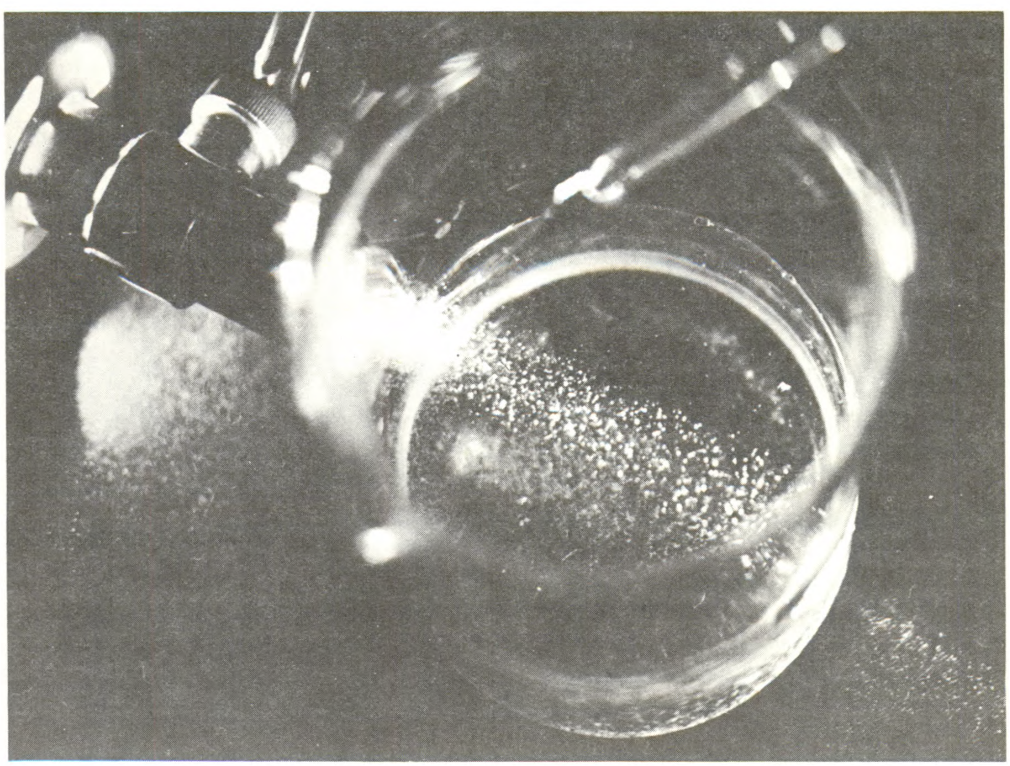


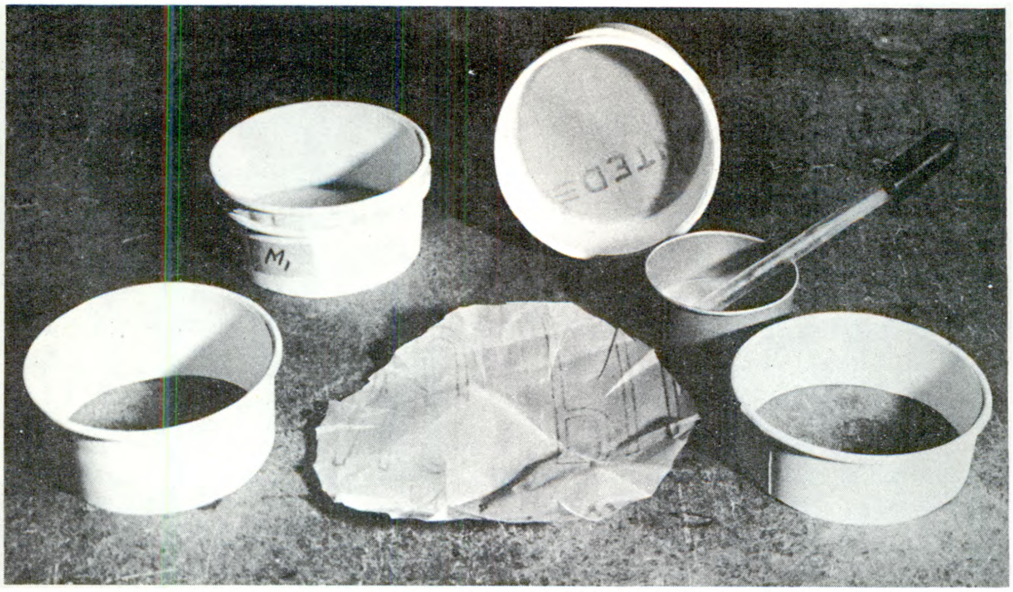
Lamella, consisting of hundreds of embryos, is removed from body of parent barnacle.



A population of larvae is flushed from sieve into a shallow examining dish.

The beam from a spotlight placed at the side of a collecting vessel causes phototropic nauplii to concentrate near the light source.

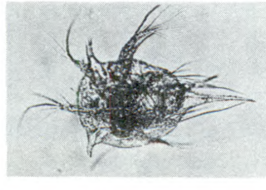




Non-metallic bolting-cloth sieves. In front, sieve components (paper hoops, bolting cloth, and wax). In rear, finished sieves.

The problems involved in rearing and maintaining large quantities of cyprids have, up until now, precluded the possibility of exploring fully the crucial area of the actual attachment of juvenile barnacles upon test surfaces. With the establishment of the NASL technique for the culture of barnacle cyprids, the following benefits will accrue: (1) investigations of antifouling toxics and antifouling toxic-containing coatings can be pursued with increased technical control, reproducibility, and speed; (2) studies which heretofore were carried out on a small scale, such as of cyprid settlement and attachment and of the shell-building of young adult barnacles, can be expanded to yield information of great value to antifouling-control efforts; and (3) bio-physical approaches to fouling control, such as studies of the effect upon juvenile barnacles of acoustical energy, magnetic and electrical fields, light, and other stimuli or repellants will be facilitated.

Current laboratory work is involved mainly with studies of the behavior and survival of newly settled young barnacles which are being subjected to a variety of toxic environments. Curves of growth-rate versus time are being used to evaluate the effect of the presence of low concentrations of toxic materials and to provide a statistical basis for determining the value of antifouling coating formulations.



Promoting Naval Interests through Science in Latin America

The first Inter-American Naval Research Conference—a six-day exchange of ideas on naval scientific interests in Latin American nations—was held in San Juan, Peurto Rico, during the last week of July 1965. Officials of seven Latin American countries as well as of the United States and Puerto Rico, attended the conference, which served as a showcase for the many contributions now being made or capable of being made to the navies of the hemisphere in the marine biological sciences, which were selected as the principal theme of the exchange. Judging by the enthusiasm generated during the discussions, the conference succeeded in large measure in meeting the major objective set for it by its principal sponsor, the Office of Naval Research—to lay the foundation for a closer working relationship between Latin American navies and their scientific communities.

For many years, the U.S. Navy, through the direction of the Office of Pan-American Affairs and Naval Missions of the Chief of Naval Operations, has been developing collaborative programs with the navies of Latin America designed to improve the defense of the Western Hemisphere. The U.S. Navy has wanted particularly to encourage the development and utilization of standardized naval material as well as standardized strategic and tactical concepts and activities for joint naval defense. Although, since World War II, great progress has been made toward this goal, the concepts of standardization still await full exploitation. One obstacle has been the lack of a cadre of scientists in the southern part of the hemisphere needed to maintain a source of new ideas and techniques for advancing naval capabilities. Another has been the shortage of technologists, who are needed to translate these ideas and techniques into effective materials, components, equipments, and systems.

Because of these handicaps, most of the navies of Latin America remain almost entirely dependent on the United States as the primary source of equipment, ships, and of repair and maintenance "know how." In the event of a prolonged emergency involving the entire hemisphere, this dependency would impose a tremendous burden on the logistic resources of the United States.

By mens of the July conference and perhaps a series of similar conferences that might be held in the future, it is hoped that a mechanism can be provided whereby the processes of developing a better rounded, less dependent group of navies can be accelerated.

The biological theme was chosen for the first conference for several reasons. One is that many of the operational problems that confront the navies of the Americas are basically marine biological in character. Another is that Latin American countries possess some of the world's leading scientists in the field of marine biology. A third is that a sizeable percentage of the world's leading marine biological scientists conduct investigations in the waters adjacent to Latin American shores; with the proper stimulus, Latin American scientists might collaborate more extensively in this research and thereby provide much information that would be useful to the navies of their countries.

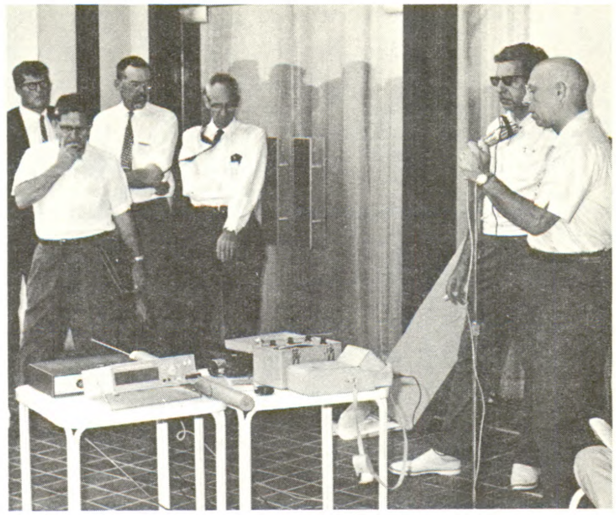
The conference was opened on July 26 with addresses by CAPT R. J. Toner, USN, Commander of the U.S. Naval Station, San Juan; The Honorable Angel Quintero Alfaro, Secretary of Education for the Commonwelath; RADM H. P. Weatherwax, USN, co-host of the conference and Director, Pan American Affairs, Naval Missions, and Advisory Groups Division of the Office of the Chief of Naval Operations; Rear Admiral D. W. Knoll, USN, then Commander, U.S. Navy Oceanographic Office; Rear Admiral John K. Leydon, USN, co-host of the conference and Chief of Naval Research; Dr. Sidney R. Galler, Head of the Biology Branch of ONR and the person whose early vision of such a conference was finally being rewarded; Rear Admiral George Cals de Oliveira, Director, Brazilian Naval Research Institute; and Dr. Jaime Benitez, Chancellor of the University of Puerto Rico.

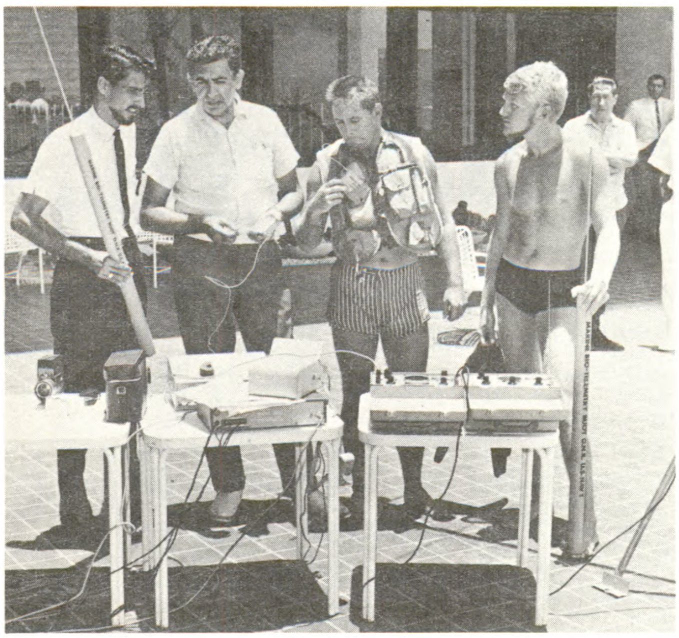
During the six days of sessions, 23 technical papers or discussions were presented, all of them by noted experts in their fields. The speakers included marine biologists from a number of universities in North America, scientists and naval personnel from U.S. Naval agencies, the University of Puerto Rico, and the Naval Research Institute of Brazil. As a whole, they indicated the range of biological components of the marine environment that may influence the effectiveness of naval operations. The principal areas under consideration were:

- Development of protection against obnoxious marine animals.
- Biological aspects of propagation of acoustic energies under water.
- Marine biological aspects of prevention of deterioration and fouling.
- Biological aspects of propulsion and hydrodynamics, underwater communications, human performance under water, target detection and identification, and long-range navigation and migration.
- Survival under emergency conditions.

Each presentation was designed to demonstrate the practicability of applying basic research to the achievement of naval objectives. For example, the papers delivered on the subject "Survival under emergency conditions" were supported by a "live" demonstration of electronic

Dr. Sidney R. Galler discusses a life-jacket radio transmitter survival device. Left to right: Dr. Arthur A. Myrberg, Jr., University of Miami; Dr. George Llano, NSF; Dr. William Schevill, WHOI; Dr. Archie Carr, University of Florida; Mr. Bernard Spector, American Electronics Laboratory; and Dr. Galler.





Mr. Bernard Spector, second fro left, instructs scuba divers before te of radio-transmitter survival devic

RADM George Cals de Oliveira, Director of the Brazilian Naval Research Institute, addresses the conference banquet. At the table, left to right, are Dr. Sidney R. Galler and RADM John K. Leydon, USN. (Right.)

RADM John K. Leydon, Chief of Naval Research, addresses the conference banquet. At the table, left to right, are Mrs. R. J. Toner; CAPT R. J. Toner, USN; RADM D. W. Knoll, USN; and Dr. Jaime Benitez. (Far right.)

Exchanging views during a conference recess are (left to right) Dr. Findlay Russell, Loma Linda University; CAPT Bradley F. Bennett, USN (Ret.), formerly Director, Naval Research Laboratory; and CAPT John R. Seal, MC, USN, Director, Naval Medical Research Institute. Behind them is CDR Earl Ninow of NMRI.

Dr. Jaime Benitez, Chan
cellor of the University o
Puerto Rico, addresses th
conference banquet. A
the table, left to right, ar
RADM D. W. Knoll, USN
Dr. Sidney R. Galle
RADM John K. Leydon
USN; and Mrs. Richard B
Black.

Group picture of some of the conference participants.

equipment designed to be installed in life-jackets for transmission of a wide-band emergency signal that can be picked up on shore, aboard ship, or in the air. The equipment, which was developed for the Office of Naval Research by the American Electronics Laboratory of Pennsylvania, proved its feasibility and provided a graphic illustration of one of the major problems of survival at sea—namely, finding the individuals in distress.

One session was concerned principally with the ways and means of strengthening working relationships between civilian scientists and the navies of the Western Hemisphere. It was conducted as an open forum in which the delegates from the eight attending nations spoke freely on the present navy-civilian scientist relationship in their countries; the availability of research facilities and the level of their basic research; and the improvements that are needed in current research capabilities to enable scientists and technologists to make the desired inputs to naval operations.

As a final demonstration of the effect of biological activity on naval operations, the delegates visited the University of Puerto Rico's Marine Biological Laboratory at La Parguera, where they viewed a spectacular display of bioluminescence in the "Bahia Fosforescente." The bay is well known to tourists because the passage of a boat through the water at night produces a wake sufficiently bright to allow one to read newsprint by its light.

Although the San Juan conference revealed clearly the benefits to be derived from the establishment of working relationships between navies and scientific communities, it served also to chart the course toward such an achievement in Latin America. It did so by identifying the conditions there which block progress along this line.

First, the number of trained civilian scientists is relatively low compared with that of the USA, the USSR, and the Common Market countries.

Second, much of the Latin American scientific community is engaged in the application of research conducted by other nations rather than in basic research. Clearly, applied research is more attractive to the less developed countries than expensive basic research, which in the short run may yield fewer returns.

Third, the navies of Latin America often experience difficulty in recognizing areas of basic research which might be of value to them and in locating members of the scientific communities who might be of service to them.

If the desired working relationships can be developed, the navies involved not only will be less dependent upon the U.S. Navy as the innovator and leader in the field of naval technology—they will then be able to make positive contributions to the reservoir of scientific knowledge in the hemisphere.

Inventions

High-Current High-Energy Battery for Submarines

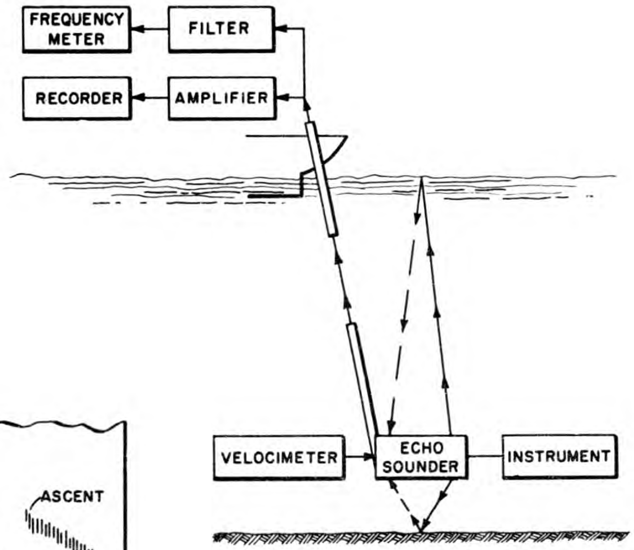
Navy contractor employees Ernest B. Yeager, Harry J. Dietrick, and Romeo R. Witherspoon were recently issued Patent No. 3,161,546 for a "Continuous Feed Primary Battery" (fuel cell) developed under a Navy contract with Western Reserve University, Cleveland, Ohio. This battery is particularly useful for meeting the high-current and high-energy demands of submarine propulsion systems. It consists of a primary cell composed of a liquid alkali metal amalgam, an alkali hydroxide electrolyte, and a cathodic gas that react in the presence of carbon.

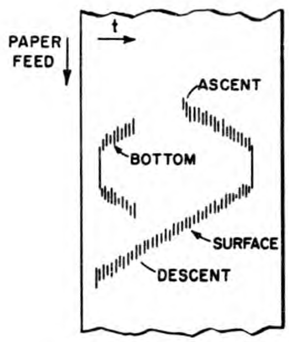
Each cell involves a liquid amalgam anode and an oxygen cathode in an alkaline electrolyte. One novel feature of the cell construction is the use of a vertical electrode assembly for the anode. The liquid amalgam is directed through a set of nozzles onto a vertical metal plate. The cathode involves a partially waterproofed active carbon electrode similar to the type used in air-polarized batteries. The cell generates its own electrolyte and can use sea water to dilute the electrolyte.

The sodium amalgam-oxygen primary cell of this invention has many inherent advantages which are particularly desirable in special propulsion applications. The anodic polarization is virtually zero, and the cathodic polarization is relatively low, even at high-current densities. The cell voltage is high compared with conventional primary cells. The self discharge of the liquid sodium amalgams is very small in alkaline solution. The electrolyte is produced directly by the electrode reactions, and sea water can be used to dilute the electrolyte. When atmospheric oxygen is available, the cell can be operated on air, although the current density will not be as high as when pure oxygen is used. Furthermore, the electrochemical "fuels" need not be carried in the cell but can be stored elsewhere.

Combined Depth Monitoring and Seismic Surveying Apparatus

A new "Combined Depth Monitoring and Seismic Surveying Apparatus" has been developed for the Navy by the Woods Hole Oceanographic Institution. Patent No. 3,174,128, covering the inventive aspects of this apparatus, was issued recently to Woods Hole employees Willard Dow and Stephen L. Stillman. The invention takes advantage of the fact that most sounders have not only a major lobe but a minor





Above, schematic diagram of combined depth monitoring and seismic surveying apparatus. Left, section of recording paper from the recorder, showing a typical lowering operation.

lobe oriented in an opposite direction to the major lobe. Consequently, each time the echo sounder is activated, a weaker sound signal is radiated towards the ocean bottom. In the invention of Messrs. Dow and Stillman, this principle is utilizes in one modification to provide an indication of the height of the gear above the bottom. All that is necessary to carry out bottom surveys is to lower the equipment to a level near the bottom and tow it across the region of interest. Since the sound source is close to the bottom, a minimum amount of beam spreading occurs; therefore, fine details of the bottom can be observed. By means of a device of this type, a detailed profile of the ocean bottom was obtained during the search for the THRESHER.

Basically, this invention utilizes an inverted echo-ranging unit as the depth-determining apparatus. This sonar unit is orientated so that its main lobe always points towards the water surface. Thus, when triggered, it radiates a short pulse of sonic energy towards the surface. The pulses reflected from the surface are thereafter detected by the sonar set operating in its receiving mode. Both the trigger pulses and the detected reflected pulses are transmitted over an electrical conductor, which is incorporated into the cable suspending the sonar set from the surface, and applied to a conventional graphic recorder. Since the round-trip travel time of each pulse is available at the recorder, the depth of the apparatus at any one time can be determined directly.

Antifouling Resin

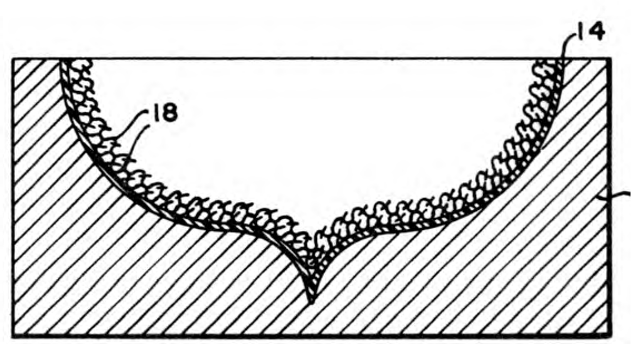
Each year, thousands of gallons of antifouling type paints are applied to the bottoms of Naval vessels to prevent or minimize fouling by marine organisms which attach themselves to the hull. Because of the cost of drydocking a ship, plus the work involved in scraping and repainting, it is desirable that time between overhauls be extended as much as possible. Therefore the Navy is seeking constantly to improve antifouling coatings.

On October 27, 1964, Patent No. 3,154,460, for "Anti-Fouling Coating," was issued to two Bureau of Ships engineers, William R. Graner and Maxwell Stander. The coatings covered by this patent are anti-fouling compounds of proven effectiveness, such as copper, arsenic, or mercural base chemicals, which have been ground to a fine particle size and dispersed in a resin. The resin is formulated to have controlled permeability in sea water. The new coatings have the following advantages over those presently in use:

- The formulations are substantially 100-percent reactive and contain higher toxic contents than conventional paints. Solvents are not necessary, so cost is based on 100-percent solids content.
- Thick buildups of 10 to 30 mils and over may be applied in one coat, thus reducing application costs.
- The coating may be applied as an overlay or gel coat for glass-reinforced plastic boats, marine structures, and undersea weapons.
- The coating may be applied with a reinforcing medium, such as glass cloth, and can be molded into a structure.

Investigations to test, develop, and improve these antifouling coatings indicate that they may provide corrosion protection for a long period of time without use of the numerous base coats required for conventional antifouling paints.

anner in which the antifouling coating is lapted for use as a gel coat, or overlay, in reinforced molded plastic boat. A layer of e air-tight antifouling material (14) is pplied to the interior surface of the mold 6). In subsequent steps, layers of reinrcing fibers (18) are placed on the interior the mold in contact with the layer of antiuling material, and the entire assembly is nded together, with or without heat or essure. The result is a boat hull with the ntifouling surface layer integrally bonded the exterior.



On the Naval Research Reserve

Roster of Research Reserve Companies

There are 93 Research Reserve companies located throughout the United States. These companies are listed below by Naval Districts. For each company the time of meeting, meeting place, and the commanding officer and his address are given.

FIRST NAVAL DISTRICT

NRRC 1-1
1930, 1st & 3rd Mondays; Rm. 4-270, Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, Mass. (CDR Merrill Callum, USNR, 26 Dehart Ave., Sharon, Mass.

NRRC 1-2
1930, 1st & 3rd Wednesdays; U.S. Naval& Marine Corps Reserve Training Center, Fields Point, Providence, R.I. (LCDR Earle N. Trickey, USNR, Sachuset Way, Middletown, R.I.)

NRRC 1-3
1930, 1st & 3rd Tuesdays; no meetings during July & August; Rm. 10-11, Dickinson Hall, University of Massachusetts, Amherst, Mass. (LCDR Joseph S. Marcus, USNR, 44 McClure St., Amherst, Mass.)

NRRC 1-5
1930, 1st & 3rd Mondays; no meetings during July & August; Conference Room, Higgins Laboratories, Worcester Polytechnic Institute, Worcester, Mass. (LCDR Robert W. Young, USNR, P. O. Box 104, Woodstock, Conn.)

NRRC 1-7
2000, 1st & 3rd Tuesdays; Room 524, Dartmouth Medical School; Hanover, N.H. (CDR Eugene C. Winslow, USNR, Windham College, Putney, Vt.)

THIRD NAVAL DISTRICT

NRRC 3-1
1830, 1st & 3rd Thursdays; Rm. 1609, 16th Floor, 745 Fifth Ave., New York, N.Y. (LCDR John J. O'Connor, USNR, 10 Woodland Dr., Noroton, Conn. 06822.)

NRRC 3-2
1930, 2nd & 4th Mondays; Engineering Bldg., U.S. Naval Training Device Center, Port Washington, L.I., N.Y. (CDR Andrew J. Hangarter, USNR, 4 Sea Wall La., Bayville, N.Y. 11709.)

NRRC 3-3
2000, alternate Mondays; Rm. G14A, School of Medicine, University of Buffalo, Buffalo, N.Y. (LCDR Leonard M. Seale, USNR, 52 Columbia Dr., Williamsville, N.Y. 14221.)

NRRC 3-4
2000, alternate Mondays; Bausch & Lomb Hall, Rm. 106, University of Rochester, Rochester, N.Y. (CDR Thomas S. Ely, USNR, 464 Smith Rd., Pittsford, N.Y. 14534.)

NRRC 3-5
2000, alternate Thursdays; Hartford Electric Bldg., 176 Cumberland Ave., Wethersfield, Conn. (LCDR James E. Halle, USNR, 30 High Ct., Apt. 2, East Hartford, Conn.)

NRRC 3-7
2000, 2nd & 4th Thursdays; U.S. Naval Reserve Training Center, Scotia, N.Y. (LT Lawrence C. Pedersen, USNR, 129 6th St., Scotia, N.Y.)

NRRC 3-8
1900, 2nd & 4th Tuesdays; 16th Floor, 285 Madison Ave. (Young & Rubicam, Inc.,

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40th St.), New York, N.Y. (CDR John F. Place, USNR, 290 Grace Church St., Rye, N.Y. 10580.)

NRRC 3-9
1930, 2nd & 3rd Wednesdays; Brookhaven National Laboratory, Upton, L.I., N.Y. (CDR Leonard A. Baker, Jr., USNR, Bldg. 535, Brookhaven National Laboratory, Upton, L.I., New York 11973.)

NRRC 3-14
1800, 1st & 3rd Tuesdays; U.S. Naval Reserve Training Center, 75 Oakley St., Poughkeepsie, N.Y. (CDR William C. Lang, USNR, Hornbeck Ridge, Poughkeepsie, N.Y. 12603.)

FOURTH NAVAL DISTRICT

NRRC 4-1
2000, alternate Wednesdays; 10 Guyot Hall, Princeton University, Princeton, N.J. (CDR Edmund C. Reichard, USNR, Box 353, Main St., Holmdel, N.J. 07733.)

NRRC 4-3
2000, alternate Thursdays; U.S. Naval & Marine Corps Reserve Training Center, 4902 Forbes St., Pittsburgh, Pa. 15213. (LCDR James J. Walsh, USNR, 1287 Arrowood Dr., Pittsburgh, Pa. 15216.)

NRRC 4-4
1900, alternate Mondays; 303 Wagner Hall, Military Science Bldg., Pennsylvania State University, State College, Pa. (LCDR James C. Dean, USNR, RD #1, Box 425-D, State College, Pa. 16801.)

NRRC 4-5
2000, alternate Mondays, U.S. Naval & Marine Corps Reserve Training Center, 3920 Kirkwood Highway, Wilmington, Del. (CDR Clayton E. Ranck, USNR, Brook Hill Farms, Hockessin, Del. 19707.)

NRRC 4-7
1930, alternate Thursdays; No meetings during August; Battelle Memorial Institute, South Conference Rm., 505 King Ave., Columbus, Ohio. (CDR Clarence H. Myton, USNR, 2596 Elliott Ave., Columbus, Ohio 43204.)

NRRC 4-8
1800, alternate Mondays; U.S. Naval & Marine Corps Reserve Training Center, 1089 East 9th St., Cleveland 14, Ohio. (LCDR Edward H. Bollinger, USNR, 442 Mowbray Rd., Akron 13, Ohio.)

NRRC 4-9
1930, 2nd & 4th Mondays; U.S. Armed Forces Training Center, 410 Gettysburg Ave., Dayton, Ohio 45417. (LT John K. Coles, USNR, 7200 McEwen Rd., Dayton, Ohio 45459.)

NRRC 4-11
1900, alternate tuesdays; Rm. 202, Albers Hall, Xavier University, Cincinnati, Ohio 45229. (CAPT Edward F. White, USNR, 1000 Richwood Ave., Cincinnati, Ohio 45226.)

NRRC 4-12
1930, alternate Tuesdays; no meetings during July & August; Technical Training Bldg., U.S. Naval Air Station, Willow Grove, Pa. (CDR John P. Burich, USNR, 123 Waverly Rd., Wyncote, Pa. 19095.)

NRRC 4-13
1930, 1st & 3rd Mondays; Franklin Institute, 20th St. and Parkway, Philadelphia, Pa. 19112. (LCDR Robert J. Merklin, USNR, 5548 Whitman Ter., Pennsauken, N.J. 08109.)

FIFTH NAVAL DISTRICT

NRRC 5-2
2000, Mondays; Rm. 310, Hutcheson Hall, Virginia Polytechnic Institute, Blacksburg, Va. (LT Frank West, USNR, 207 Fairview Ave., Blacksburg, Va.)

NRRC 5-3
1930, 1st & 3rd Tuesdays, Bldg. 426, Fort Detrick, Frederick, Md. (LCDR L. Lee Kupferberg, USNR, 606 Rosemont Ave., Frederick, Md. 21701.)

NRRC 5-4
2000, 1st & 3rd Thursdays, Board of Education Bldg., 3 East 25th St., Baltimore, Md. (LT Alan S. Markham, USNR, 9409 Flagstone Dr., Baltimore, Md.)

NRRC 5-8
2000, 1st & 3rd Thursdays, National Academy of Sciences, 2102 Constitution Ave., N.W., Washington, D.C. (CAPT Ernest J. Zellmer, USNR, 8102 Thoreau Dr., Bethesda, Md.)

NRRC 5-9
1630, 1st & 3rd Fridays; during first quarter, meetings are alternate Wednesdays; U.S. Naval Research Laboratory, 4555 Overlook Ave., Washington, D.C. (LCDR George Abraham, USNR, 3107 Westover Dr., S.E., Washington, D.C.)

NRRC 5-10
2000, 2nd & 4th Tuesdays; Naval Medical Research Institute, National Naval Medical Center, Bethesda, Md. (CDR Kenneth R. Scudder, USNR, 8827 McGregor Dr., Chevy Chase, Md.)

NRRC 5-11
2000, 2nd & 4th Tuesdays; Conference Rm., U.S. Naval Engineering Experimental Station, Annapolis, Md. (CDR William E. McConnaughey, USNR, 2908 Barrister La., Bowie, Md.)

NRRC 5-12
1900, Mondays; Dahlgren University Center, U.S. Naval Weapons Laboratory, Dahlgren, Va. (CDR Robert M. Fenn, USNR, Rt. 4, Box 61A, Fredericksburg, Va.)

SIXTH NAVAL DISTRICT

NRRC 6-1
1930, 1st, 2nd, & 3rd Thursdays; no meetings during first quarter; U.S. Naval & Marine Corps Reserve Training Center, 274 Fifth St., N.W., Atlanta, Ga. (LCDR Raphael B. Levine, USNR, 6455 Bridgewood Valley Rd., Atlanta, Ga.)

NRRC 6-3
1930, 2nd & 4th Wednesdays; ORINS Training Bldg., Oak Ridge, Tenn. (CDR David S. Zachry, USNR, 874 West Outer Dr., Oak Ridge, Tenn.)

NRRC 6-4
1915, 1st & 3rd Tuesdays; U.S. Naval Reserve Training Center, 1300 N.E. 8th Ave., Gainesville, Fla. (CDR Richard A. Rhodes, USNR, 321A SW 12th St., Gainesville, Fla. 32601.)

NRRC 6-5
1930, 1st, 3rd, & 5th Mondays; U.S. Naval & Marine Corps Reserve Training Center, P. O. Box 48, Broad Ave., Gulfport, Miss. (LT John R. Boardman, USNR, 1552 Wilson Dr., Pascagoula, Miss.)

NRRC 6-6
1800, 1st, 2nd, & 3rd Mondays; NROTC Bldg., University of North Carolina, Chapel Hill, N.C.; no meetings during first quarter; 3rd quarter: 1st 4 meetings at USN&MCRTC, Raleigh; 4th quarter: 1st 4 meetings at USN&MCRTC, Durham. (LT Kenneth L. Penegar, USNR, Cedar St., Mount Bolus, Chapel Hill, N.C.)

NRRC 6-8
1930, 1st & 3rd Tuesdays; U.S. Naval Reserve Training Center, Livingston & Parramore Sts., Orlando, Fla. (LCDR William G. Chace, Jr., USNR, 1134 Western Way, Orlando, Fla.)

NRRC 6-9
1900, 1st, 3rd, & 4th Mondays; Smith Hall, U.S. Navy Supply Corps School, Athens, Ga. (LCDR Acton R. Brown, USNR, 104 St. James Dr., Athens, Ga.)

NRRC 6-10
2030, 1st & 3rd Thursdays; Processings & Research Bldg., Miami 33, Fla. (CDR Ethelbert D. Scrogin, USNR, 6450 S.W. 147th St., Miami, Fla. 33158.)

NRRC 6-13
1900, 2nd & 4th Thursdays; American Red Cross Bldg., Laurens St., Aiken, S.C.

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(LCDR Dennie E. Ray, Jr., USNR, 451 Powder House Rd., S.E., Aiken, S.C.)

NRRC 6-16
1630, 1st & 3rd Tuesdays; PAFB Chapel Annex, B St., Patrick Air Force Base, Fla. (LCDR Furman J. Clark, USNR, 298 Glenwood Ave., Satellite Beach, Fla.)

NRRC 6-17
1900, 2nd & 4th Tuesdays; U.S. Naval Reserve Training Center, 203 Leeman Ferry Rd., S.W., Huntsville, Ala. (LCDR James H. Hoyle, USNR, 3111 Johanna Circle, N.W., Huntsville, Ala. 35810.)

NRRC 6-18
2000, 1st & 3rd Mondays; Rm. 311, S-R Bldg., Peabody College, Nashville, Tenn. (CDR Ned L. Warren, USNR, 2500 Hemingway Dr., Nashville, Tenn.)

EIGHTH NAVAL DISTRICT

NRRC 8-1
1930, alternate Tuesdays; Conference Rm., 3rd Floor, Southern R&D Division Offices, 1100 Robert E. Lee Blvd., New Orleans, La. (CDR E. P. Johnson, Jr., USNR, 6570 Louis IV St., New Orleans 24, La.)

NRRC 8-3
1930, Mondays; Biological Science Bldg., Texas A&M College, College Station, Tex. (CAPT Walter H. Thames, Jr., USNR, Box 285 Faculty Exchange, Texas A&M College, College Station, Tex.)

NRRC 8-4
1930, 1st & 3rd Wednesdays; U.S. Naval Reserve Training Center, Houston, Tex. (LCDR Thomas N. Whitaker, USNR, 4606 Rockwood, Houston, Tex. 77004.)

NRRC 8-5
1900, Mondays; 115 Experimental Science Bldg., University of Texas, Austin, Tex. (LTJG George F. Sears, USNR, 3311-C Speedway, Austin, Tex.)

NRRC 8-7
1930, 1st & 3rd Wednesdays; U.S. Naval & Marine Corps Reserve Training Center, 1805 Yale Ave., S.E., Albuquerque, N.M. (LT Charles J. Mauck, USNR, 6004 Arvilla, N.E., Albuquerque, N.M.)

NRRC 8-8
1930, 1st & 3rd Tuesdays; American Legion Bldg., Bartlesville, Okla. (LT Donald E. Griffin, USNR, 211 S.E. Rockwood, Bartlesville, Okla.)

NRRC 8-9
1700, 1st, 2nd, & 3rd Tuesdays; Lecture Rm., Administration Bldg., Los Alamos Scientific Laboratory, Los Alamos, N.M. (LCDR Robert H. Dinegar, USNR, 2317 46th St., Los Alamos, N.M. 87544)

NRRC 8-12
2000, 1st & 3rd Tuesdays; U.S. Naval & Marine Corps Reserve Training Center, 9638 Bachman Blvd., Dallas, Tex. (LCDR F. D. Colegrove, Jr., USNR, 3420 Morningstar La., Dallas 34, Tex.)

NRRC 8-13
2000, 2nd, 3rd, & 4th Thursdays; Rm. 352, Union Bldg., Oklahoma State University, Stillwater, Okla. (LCDR Franklin R. Crow, USNR, 2011 W. Tenth Ave., Stillwater, Okla.)

NINTH NAVAL DISTRICT

NRRC 9-1
1900, 2nd & 4th Tuesdays; Naval Armory, Randolph at The Lake, Chicago, Ill. (LT Thomas McAvoy, USNR, 209 S. Rush St., Roselle, Ill.)

NRRC 9-2
1930, 2nd & 4th Tuesdays; Law Bldg., University of Illinois, Urbana, Ill. (LCDR R. L. Langenheim, Jr., USNR, 506 Gregory, Apt. 3, Urbana, Ill.)

NRRC 9-3
1930, 1st & 3rd Mondays; varied dates July, August, & September; 62 N. Hall,

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University of Michigan, Ann Arbor, Mich. (LT Lawrence D. Phillips, USNR, 1706 Dunmore Rd., Ann Arbor, Mich. 48103)

NRRC 9-4
2000, 2nd & 4th Tuesdays; U.S. Naval & Marine Corps Reserve Training Center, Milwaukee, Wis. (LCDR Thomas G. Barnum, USNR, 4730 N. Ardmore Ave., Milwaukee, Wis.)

NRRC 9-5
1900, 1st, 2nd, & 3rd Wednesdays; U.S. Naval Reserve Officers Training Center, Iowa State College, Ames, Iowa. (LTJG Laurence P. Watko, USNR, 3803 Ontario Rd., Ames, Iowa.)

NRRC 9-6
1930, 2nd & 4th Mondays; Rm. 208, Mechanical Engineering Bldg., University of Minnesota, Minneapolis 14, Minn. (LT John W. Barber, USNR, 1233 Bellows St., W. St. Paul 18, Minn.)

NRRC 9-7
1900, 2nd & 4th Tuesdays; Rm. 1, New Heavilon Hall, Purdue University, Lafayette, Ind. (CDR Ralph L. Davis, USNR, 906 Essex, W. Lafayette, Ind.)

NRRC 9-8
1900, 2nd & 4th Wednesdays; Webster Groves Public Library, Webster Groves, Mo. (CDR Charles W. Hawken, USNR, 446 Hampshire Ct., Webster Groves, Mo. 63119.)

NRRC 9-10
1800, alternate Tuesdays; Elder Hall, Northwestern University, Evanston, Ill. (LCDR James P. Martin, USNR, 741 Judson Ave., Evanston, Ill.)

NRRC 9-12
1930, 2nd & 4th Thursdays; Rm. 220, Chemistry Bldg., Colorado A&M College, Fort Collins, Colo. (LCDR William W. Ferguson, USNR, 120 W. Magnolia St., Fort Collins, Colo.)

NRRC 9-14
1930, alternate Mondays; 119 Babcock Hall, University of Wisconsin, Madison, Wis. (LCDR Matthias Stelly, USNR, 677 S. Segoe Rd., Madison 11, Wis.)

NRRC 9-15
1900, 2nd & 4th Tuesdays; Dow Abbott Rd. Bldg., Midland, Mich. (LCDR Willis J. Beach, USNR, 4900 Ironwood St., Saginaw, Mich.)

NRRC 9-16
1930, 1st & 3rd Mondays; 221 Computing Center, Michigan State University, E. Lansing, Mich. (CAPT Maynard M. Miller, USNR, 363 University Dr., E. Lansing, Mich.)

NRRC 9-19
1930, every Monday; Psychopathic Hospital, State University of Iowa, Iowa City, Iowa. (LTJG James H. Cavanaugh, USNR, 315 Ellis Ave., Iowa City, Iowa.)

NRRC 9-20
1930, alternate Thursdays; 104 Military Science Bldg., University of Kansas, Lawrence, Kans. (LT Bernard J. Judge, USNR, 2444 Jasu Dr., Lawrence, Kans.)

NRRC 9-21
2000, 1st & 3rd Thursdays; John Greene Hall, Denver Research Institute, Denver, Colo. (CAPT Abraham F. Myers, USNR, 838 S. Vine St., Denver, Colo. 80209.)

NRRC 9-22
1930, Tuesdays; Rm. 308, Dairy Industry, University of Nebraska, Lincoln, Nebr. (LT Warren E. Englehard, USNR, 839 Eastridge Dr., Lincoln, Nebr.)

NRRC 9-23
1930, 2nd & 4th Wednesdays; Naval Ordnance Plant, 7500 W. Roosevelt Rd., Forest Park, Ill. (LCDR Henry C. Krass, USNR, 4729 Prince St., Downers Grove, Ill.)

NRRC 9-25
1930, 1st & 3rd Wednesdays; U.S. Naval Reserve Training Center, Indianapolis, Ind. (CAPT Wendell Calkins, USNR, 507 W. Main St., Crawfordsville, Ind.)

NRRC 9-26
1930, Tuesdays; U.S. Naval Reserve Training Center, Colorado Spring, Colo. (CDR John C. Burt, USNR, 802 S. Tejon, Colorado Springs, Colo.)

ELEVENTH NAVAL DISTRICT

NRRC 11-2
2000, 1st & 3rd Thursdays; U.S. Naval and Marine Corps Reserve Training Center, 2727 Paloma St., Pasadena, Calif. 91107. (LCDR Robert L. Owen, USNR, 3063 Brookhill, LaCrescenta, Calif. 91014.)

NRRC 11-3
2000, 1st & 3rd Mondays; 1st Floor, Conference Room (1-3-105) U.C.L.A. Center for the Health Sciences, Los Angeles, Calif. (CDR Frank D. Mason, USNR, 3900 Kingswood Rd., Sherman Oaks, Calif. 91403.)

NRRC 11-5
1930, 2nd, 3rd, & 4th Tuesdays; U.S. Naval Reserve Training Center, Camp Decatur, San Diego, Calif. 92133. (LCDR Robert D. Bradshaw, USNR, 2894 Mobley St., San Diego, Calif. 92123.)

NRRC 11-7
2000, 1st & 3rd Thursdays; no meetings during July & August; U.S. Naval & Marine Corps Reserve Training Center, 1100 S. Avernon Way, Tucson, Ariz. 85711. (LCDR Phillip H. Krutzsch, USNR, c/o School of Medicine, University of Arizona, Tucson, Ariz.)

NRRC 11-8
1645, 1st & 3rd Wednesdays; Bldg. 761, NMC, Pacific Missile Range, Point Mugu, Calif. 93041. (CAPT M. Hudson Fields, USNR, 430 Roderick Ave., Oxnard, Calif. 93032.)

NRRC 11-9
2000, 2nd & 4th Wednesdays; Pitzer College Conference Room, Administration Bldg. 8, Mills Road, Claremont, Calif. (LCDR Howard M. Sears, Jr., USNR, 1819 Seventh Pl., Arcadia, Calif. 91106.)

NRRC 11-11
2000, 1st & 3rd Mondays; U.S. Naval & Marine Corps Reserve Training Center, 3400 Airport Ave., Santa Monica, Calif. 90405. (LCDR Harry L. Smith, USNR, 235 Truckey St., Playa del Rey, Calif. 90291.)

TWELFTH NAVAL DISTRICT

NRRC 12-1
1930, 2nd & 4th Mondays; Rm. 214S University of California Medical Center, Parnassus Ave., San Francisco, Calif. (LCDR Louis H. Davy, USNR, c/o Louis Graham & Associates, 2928 Adeline St., Berkely, Calif. 94703.)

NRRC 12-2
1700, 1st, 2nd, & 3rd Mondays; Conference Rm. A, Bldg. 111, Lawrence Radiation Laboratory, Livermore, Calif. (CDR Richard C. Epps, USNR, 335 Estates St., Livermore, Calif. 94550.)

NRRC 12-3
1930, 1st & 3rd Wednesdays; Rm. 101, Physics Lecture Hall, Stanford University, Stanford, Calif. (LCDR James T. Nawrocki, USNR, 1449 Ranchita Dr., Los Altos, Calif. 94022.)

NRRC 12-4
2000, Wednesdays as scheduled; Rm. 119, Agriculture Bldg., Fresno State College, Fresno, Calif. (LT Wayne E. Biehler, USNR, 3314 Griffith Way, Fresno, Calif. 93726.)

NRRC 12-5
1930, 2nd & 4th Wednesdays; Rm. 247, Cory Hall, University of California, Berkeley, Calif. (CAPT Richard W. Smith, USNR, 2768 Darnby Dr., Oakland, Calif. 94611.)

NRRC 12-6
1930, 1st, 2nd, & 4th Thursdays; 192 Physical Sciences Bldg., University of California, Davis, Calif. (LT Emerson L. Besch, USNR, 1909 Drexel Dr., Davis, Calif. 95616.)

NRRC 12-8
2000, Wednesdays as scheduled; Rm. S-136, U.S. Naval Postgraduate School, Monterey, Calif. (CAPT Carl A. Hering, USNR, 1211 Sylvan Rd., Monterey, Calif. 93940.)

NRRC 12-9
1700, Tuesdays as scheduled; Main Conference Rm., Bldg. 2001, Aerojet-General Corp., Nimbus (Sacramento), Calif. (LCDR Martin Gross, USNR, Rt. 2, Box 2872, Loomis, Calif.)

THIRTEENTH NAVAL DISTRICT

NRRC 13-1
1930, 1st, 2nd, & 3rd Mondays; U.S. Naval Reserve Training Center, 860 Terry Ave. N., Seattle, Wash. (CAPT John H. Avery, USNR, 9414 N.E. First, Bellevue, Wash. 98004.)

NRRC 13-3
1930, 2nd & 4th Mondays; Rm. 410, Holland Library, Washington State University, Pullman, Wash. (LCDR Robert O. Johnson, USNR, 2009 Clifford St., Pullman, Wash. 99163.)

NRRC 13-4
2000, 2nd & 4th Tuesdays; U.S. Naval & Marine Corps Reserve Training Center, Swan Island, Portland, Ore. (LCDR Donald J. Marihart, USNR, 5231 S.E. 48th Ave., Portland, Ore.)

NRRC 13-5
1930, 1st & 3rd Mondays; U.S. Naval Reserve Officers Training Center Armory, Oregon State University, Corvallis, Ore. (LCDR Lafayette C. Harter, Jr., USNR, 3755 Van Buren St., Corvallis, Ore. 97330.)

NRRC 13-6
1930, 2nd & 4th Thursdays; U.S. Army-Navy Reserve Center, Skyline Dr., Idaho Falls, Idaho. (LCDR Chad K. Anderson, USNR, 2346 Croft St., Idaho Falls, Idaho 83401.)

Studying Eye-to-Brain Information Transfer by Computer

Scientists at the Navy Electronics Laboratory have adapted computer techniques to the study of information transfer from the eye to the brain. The speed of the computer permits tracing the message from its receipt on the retina of the eye to its transfer to cognizant areas of the brain.

The technique uses a flash stimulus the size of a pinhole in a large black background. The subject observes the milli-second flash, and the computer records this observation. Sensitive electrodes taped to the subject's skull record the arrival of the message in the brain. The computer measures the extremely short time delay between the two points and between points at different locations in the brain. The computer also records the way the eye measures the growth of the amount of light from its first detection until it reaches maximum intensity. Furthermore, it is able to distinguish the difference in response between right and left eye and the strength of the input to the right or left lobe of the brain. A correlation between right and left eye strength and right and left handedness seems to be present.

The technique has expanded the ability of NEL psychologists to study the way the brain functions, particularly the way the eye receives visual information, the way that information is transferred, and the way the brain handles this incoming information.

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Alaskan Gulf and Bering Sea Expedition

For ten weeks this past summer, a scientific party aboard the USNS CHARLES H. DAVIS cruised the waters of the Alaskan Gulf and Bering Sea measuring the sub-bottom structure, photographing and sampling the bottom itself, and recording water temperatures between the surface and a depth of about 900 feet. The expedition, which began May 27 at Seattle and ended August 3 at San Francisco, was conducted by the Navy Electronics Laboratory, San Diego, California.

The structure of the material beneath the sea floor was studied by means of a sub-bottom acoustic profiling system, the sound energy for which is produced by firing an array of electrodes that is towed by the ship. Each electrical "spark" forms a high-energy low-frequency sound pulse. When all systems are operative, 38,000 joules of energy are produced by each pulse. A string of hydrophones, which also is towed by the ship, picks up the pulses that are reflected by the bottom and sub-bottom layers. The signals are amplified, filtered, and displayed in chart form.

The ocean floor was probed with the NELDSOS (Navy Electronics Laboratory Deep Sea Oceanographic System), which has a number of functions. Its primary function is taking 70 mm stereographic photographs for photogrammetric application. In addition, each time it is lowered, it takes a bottom grab sample, two short cores, and a sample of bottom water; records the temperature of the bottom water; and measures the bottom current. The lowering of the NELDSOS to within about six feet of the bottom at depths as great as 20,000 feet is controlled by sonar. On this expedition, the greatest depth to which the system was lowered was about 12,000 feet. In the Aleutian area, the temperature of the water sampled was very near to freezing. The sea floors that were probed were found to have very little micro-relief and to consist of smooth clay. Star fish ("brittle stars") are the common form of life seen; in some areas, they literally cover the floor. The water velocity near the bottom ranged from a quarter-knot in abyssal areas to one-and-one-half knots in shallower, flat areas. The data obtained by NELDSOS is to be used in a study of the acoustics of roughness caused by biological, organic, and physical forces.

Measurements of the ocean temperature structure were obtained by means of NEL's Thermistor Chain, a 900-foot-long string of thermistors that is towed in a near vertical position by the ship. Every 27 feet along the length of the chain, a thermistor bead sensor determines the water temperature. This information is then transmitted to the ship, converted into constant temperature isotherms, and recorded on a depth-time chart. Dome-like thermocline structures were found very near the surface in the Gulf of Alaska; the Alaskan Gyral, a huge counter-clockwise circulation in the Gulf was investigated; detailed records of the cold water layers below the surface of the Bering Sea were taken; and two of the boundaries of the Eastern North Pacific water mass were studied.

The Alaskan Gulf and Bering Sea region was of interest because it had not been as well explored as many other ocean regions; the water temperatures are transitional between those of the Arctic and lower latitudes; and it is unstable, as indicated by its frequent volcanic activity and earthquakes.

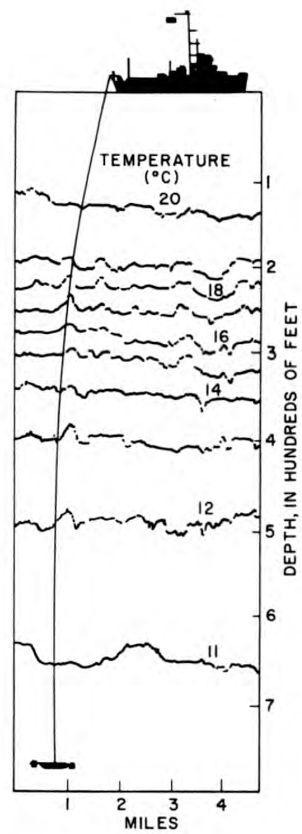

Diagram showing thermistor chain in operation and resultant temperature record.

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EDITOR: Richard D. Olson

A worker in the experimental foundry at the Naval Research Laboratory handles one-half of a melt during the production of 1000 white cast-iron spectrographic reference materials for the National Bureau of Standards. This type of work is done only once in a while. The technique had not been tried before; had it not been successful, it probably would not have been tried again. Twenty elements were added to each half of an original melt and controlled to a precision as high as ±0.001 percent—an impressive example of modern foundry practice. The cast-iron standards are used for calibrating emission and x-ray spectrometers in other research laboratories and in industrial foundries.

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