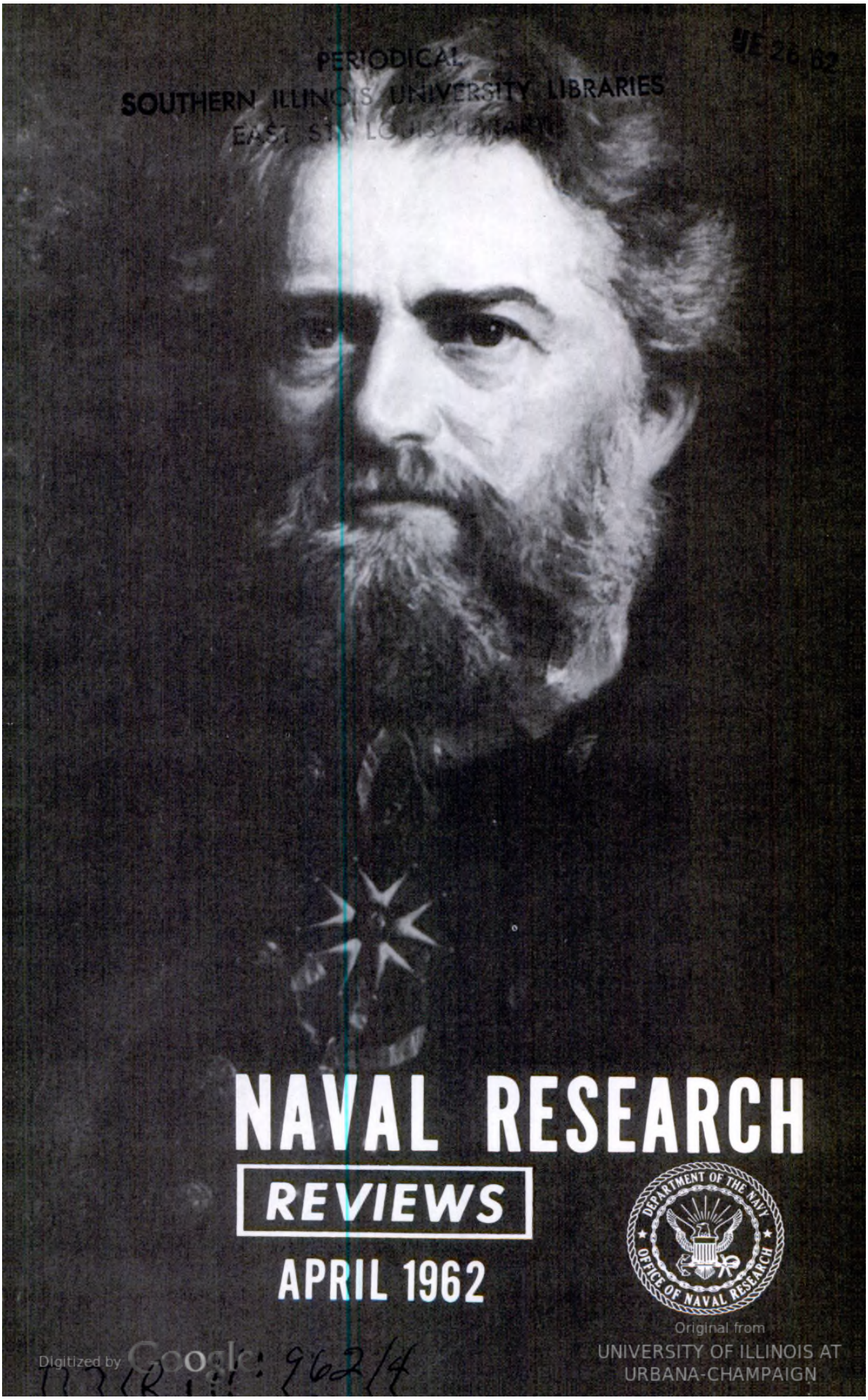


Biological research is not parochial and knows no national boundaries. There are literally thousands of people throughout the world following different leads to reach a wide variety of objectives. Many of the specific benefits that will result from this work are not known today. How research results will be used by the Navy is not always clear, but to meet the challenge of tomorrow we must prepare today. Therefore, the Navy is wisely carrying out a broad program of biological research, especially fundamental research, which in the best Navy tradition looks toward the future.

A patient undergoes ultrasonic irradiation to modify brain structures to relieve symptoms of a neurological disorder. ONR-sponsored research led to the development of this technique.

ONR Research in the Biological Sciences

Roger D. Reid
Director, Biological Sciences Division
Office of Naval Research

The Office of Naval Research program in the Biological Sciences is primarily concerned with extending knowledge of fundamental life processes and the utilization of this knowledge to solve problems with which the Navy is now — or may some day — be confronted. Research sponsored by the Biological Sciences Division of ONR has the following four major objectives.

- Naval personnel must be protected from the stresses imposed by new weaponry, vehicles and unusual environments. The combat effectiveness of the Navy can only be assured if its men can function efficiently while undergoing such stresses.

- The design of advanced ship types, aircraft, and weapons requires in part a basic understanding of biological phenomena. New means of propulsion may derive from studies of the hydrodynamic characteristics and methods of propulsion of marine animals. Longer range underwater detection and navigational devices could result from studies of the communication and acoustic signals emitted by marine life.

- The Navy's ships, docks, cables, mines, and electronic equipment must be protected from the ravages of marine fouling organisms. This requires research on the organisms responsible for fouling and deterioration, including basic research on the reproduction, physiology, genetics and even taxonomy of the organisms involved.

- Basic research is supported in order to fill gaps in our knowledge of biological systems with a potential for affecting naval situations. This research is not necessarily related to specific problems but may be applied at a later date to solve presently unrecognized problems. The more fundamental knowledge that is available, the better are our chances of quickly developing solutions to unexpected problems.

It should be emphasized that although they are often complementary, the programs of research supported by the Biological Sciences Division of ONR and those carried out by other Federal agencies are not competitive. While the National Institutes of Health may be involved with similar research on agents which cause specific diseases, their sole objective is the prevention, control, and treatment of the disease. The National Science Foundation is interested in basic problems for their own sake. In ONR we have a unique blend of both these approaches, but ONR research is oriented in terms of Navy interests.

Much of the Navy's research in biology, which includes medicine, is in collaboration with other bureaus and offices and carefully coordinated. For example, the Bureau of Medicine and Surgery has the responsibility for the health and selection of naval personnel. To meet this objective a program of both basic and clinical research as well as evaluation and development must be supported. The Bureau expends much of its research effort on "in house" clinical research directed toward specific application. ONR's basic biological research complements the clinically oriented objectives of the Bureau by contributing to a better understanding of the host, exotic parasites, man-machine relationships, and the environmental factors to which Navy personnel are exposed.

The Biological Sciences Division is one of six research divisions in ONR and is composed of five branches: Physiology, Biochemistry, Microbiology, Medicine and Dentistry, and Biology. The research supported by the division can be placed in five functional groups:

- Response to and repair of injury
- Physiological reactions to stress
- Host-parasite relationships
- Environmental biology
- Chemical and physical biology (biophysical chemistry)

In fulfillment of its responsibility to conduct basic and applied research of importance to the Navy, ONR has no greater requirement than to investigate those aspects of biology which may contribute to the prevention and repair of injury resulting from Naval operations and activities of Naval personnel. Some of the approaches to the solution of these problems are: (a) studies on the acquisition, preservation, and transplantation of various tissues, e.g., blood, skin, bone, and tissue substitutes for the surgical repair of injured parts of the body; (b) investigations into immunochemical reactions of homografts or heterografts; (c) studies of the biological, physical, and chemical problems involved in long-term preservation of whole blood, blood derivatives, and other tissues; (d) expansion of our knowledge of electrolyte balance and replacement fluids; and (e) investigations into the etiology, prevention, and treatment of oral diseases.

Progress in the field of cryobiology (study of biological systems at low temperatures) has made it possible to define the major parameters affecting the freezing and thawing of whole blood. This has provided a firm foundation for technologic development. Two promising techniques for preservation of blood are now under intensive study. One is based on ultrarapid freezing, and storage, at minus 196°C, and ultrarapid thawing to reconstitute the blood in fluid state. The other, a BuMed project, involves separation of cells and plasma before freezing and storage, and reconstitution with additives, if desired, before use.

Tissues other than blood may be preserved and stored for long periods of time at the temperature of liquid nitrogen.

One promising result of research on tissue substitutes is the development of a plastic artificial cornea for implantation in opaque

corneas caused by infection or injury. This resulted from the serendipitous observation that certain plastics are not irritating when implanted in the eye. Basic biophysical-chemical research was undertaken, and a technique which makes the substitute cornea acceptable was developed.

The ONR program dealing with burns is designed to collect and collate information concerning the transfer of proteins and electrolytes, and changes in amino acid levels in body tissues which may induce shock in burned patients. In the belief that proteolytic enzymes are involved in the necrotizing process following thermal injury, a characterization of these enzymes in skin has been undertaken. Another study has to do with biochemical and endocrine disturbances following burns. We are evaluating the experimental evidence to determine whether substances liberated from burned skin are toxic and antigenic. Current studies are designed to determine the identity of these substances and their biological action.

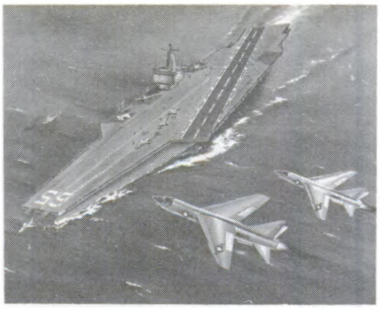
A study initially supported to yield information on the effects of ultrasonic energy on biological systems has led to the development of a technique reported to be promising in certain types of neurosurgery.

In the field of human physiology the Navy requires information on response to the stresses of cold, anoxia, acceleration, pressure, exertion and exposure. We must evaluate the effect of noise, vibration, and noxious vapors on personnel in closed spaces such as those of submarines. This requires research on regulatory mechanisms of the body as they influence physical-chemical reactions in the body. Such investigation leads in turn into the in vivo study of enzymes, hormones, transmission of nerve impulses and muscle contraction and relaxation.

Research on pressure effects includes studies on the human subject at high pressures in Navy divers' recompression chambers and physiological requirements for free dives to depths in excess of 600 feet. At the other extreme, ONR-sponsored investigators have studied the comparative physiology of temperature regulation in wild animals and the mechanism of their adaptation to high altitudes. A wide variety of investigations are being supported at the White Mountain Laboratories in California at elevations of 10,150 feet, 12,470 feet and 14,250 feet.

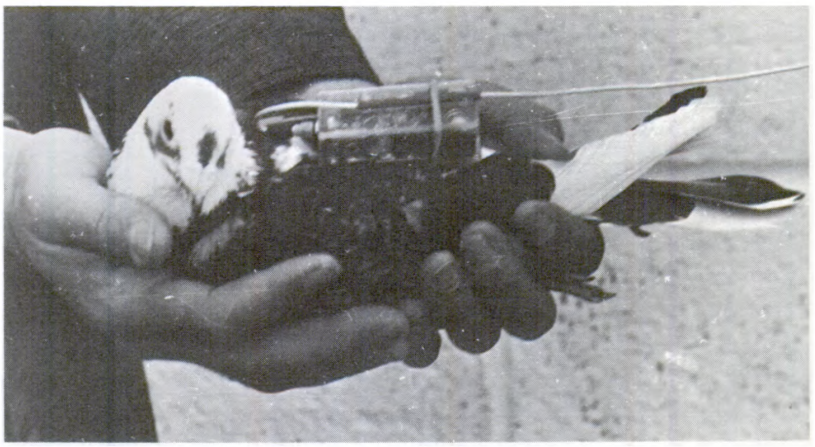
To determine physiological responses to alterations in gravitational fields, experimental animals are maintained in a centrifuge for periods of two months at G forces of 1.6 to 2.5. Basic information obtained in these studies complements the BuMed research on the human centrifuge at Johnsville, Pa.

ONR contributes to the support of a Toxicology Information Center which serves not as a research organization but as a clearing house for toxicological information. This work is done under the direction of the National Academy of Sciences (NRC) for the benefit of the military services and the Atomic Energy Commission. From information gathered there, the Navy may obtain data concerning the potential toxicity of small amounts of vapors that may accumulate in closed spaces, as in submarines; the toxic hazards of jet fuels on carriers; and about similar problems that are unique to the Navy.

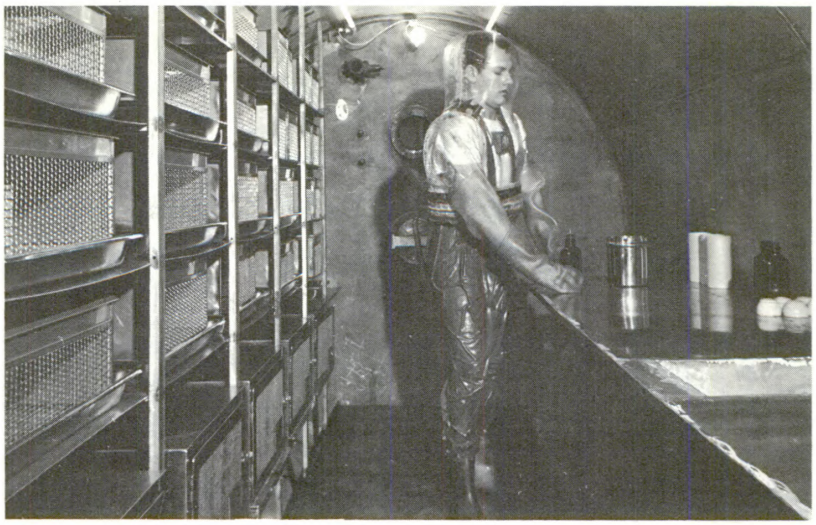


The Biological Sciences ...

A radio-equipped pigeon is readied for a "test flight" in a study aimed at learning the bird's navigation secrets.

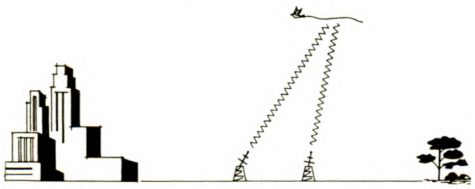


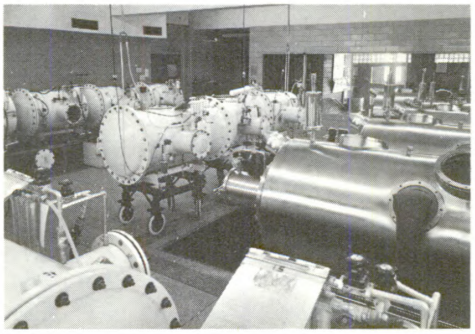
This porpoise's unique capabilities--among them speed, maneuverability (demonstrated here), and underwater sound transmission and reception over great distances--are of much interest to the Navy.



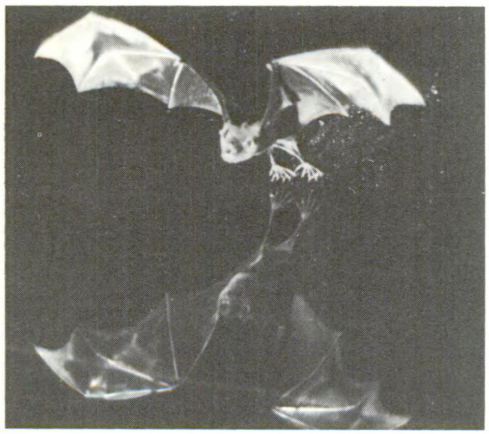
An operator tends animals in a germ-free tank.

The germ-free environment is under study as an aid to research conducted on many diseases.



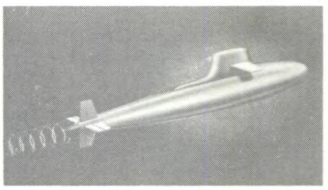


A view of steam-sterilized isolators.

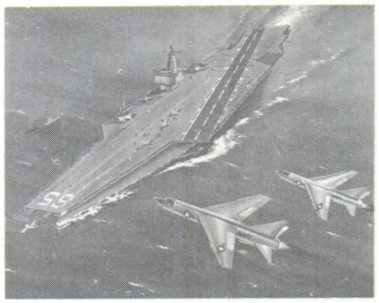


A fishing bat skims the water. The Navy is interested in the bat's sonar system.

.... behind Naval Operations

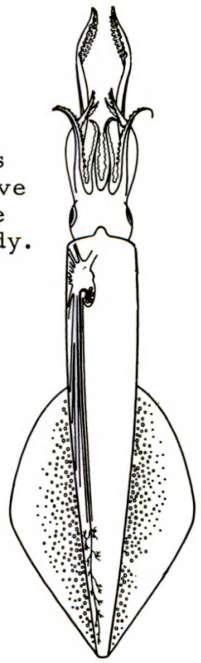


Scientists prepare telemetering equipment and penguin egg for recording incubating egg temperatures remotely.

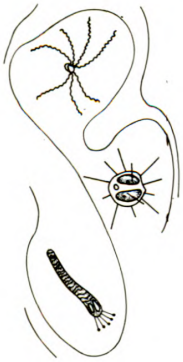


Biological Sciences...

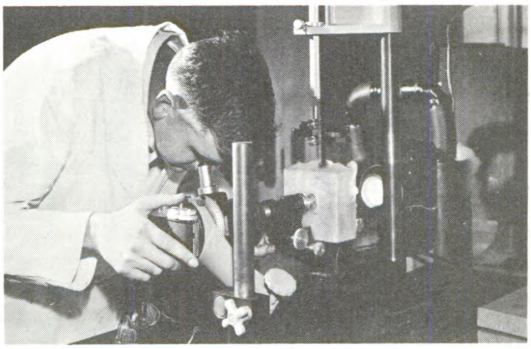
Navy diver enters decompression chamber in study of pressure effects.



A giant squid. Its large nerve fibers are under study.

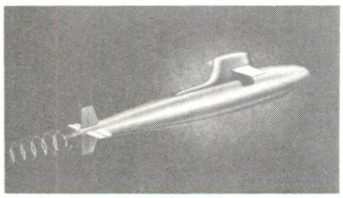


The need for research on microorganisms is illustrated by these devastated pilings.



Using a special microscope, an investigator studies a sample of blood preserved by rapid freezing.

... Naval Operations



ONR biologists examine jawbone and teeth of a shark in research aimed at controlling shark attacks.

ONR has taken a lead in the study of the torpid states, particularly true hibernation. In addition to some contracts to provide for research on physiology of animals in the hibernating state, we have sponsored the first International Symposium on Mammalian Hibernation. Furthermore, our Chicago office maintains a Hibernation Information Exchange.

Particular emphasis has been placed on research into basic factors underlying infections caused by microorganisms introduced into the host by the respiratory route. It includes investigations of factors that influence the ability of microorganisms to survive and retain their virulence under different environmental conditions. Other studies are designed to find methods for rapid detection and identification of airborne microorganisms. In cooperation with the Bureau of Medicine and Surgery, ONR supports research dealing with host susceptibility and resistance, methods for prevention and treatment, and parasites involved in certain exotic diseases of importance to the Navy.

The Office of Naval Research has encouraged the development of the germ-free animals concept and is supporting research on basic host-parasite relationships, such as mechanisms of infectivity and antibody production. With the accumulating evidence that the host may harbor latent viruses for long periods of time, it is important to understand the mechanisms involved and the possibility that a host may harbor latent bacterial pathogens, thus explaining sudden epidemics of bacterial diseases such as cholera.

Other aspects of basic microbiology which will contribute to a better understanding of host-parasite relationships, and incidentally to improved means for defending against biological warfare are microbial genetics, physiology, metabilism, and virulence factors.

Not only are we concerned with the relationships between parasites and living hosts, but also with the organisms responsible for deterioration of materials. Studies in this category include the physiology of the organisms and the mechanism of action of chemical inhibitors and antibiotics.

The Office of Naval Research pioneered in the support of a basic research program in marine microbiology. There is a pressing need to have a better understanding of the microorganisms of the sea and their potential for helping or harming man and his machines. Preliminary evidence leads us to believe that marine microorganisms offer great promise as a source of food for man (they are known to be used as food for higher marine forms) and as a source of antibiotics and rare elements. Very little is known about infectious diseases of marine animals or the part played by microorganisms in causing such diseases.

The hydrobiology program is designed as a comprehensive approach to an understanding of aquatic biology. It is concerned with the influences of biological systems and their products on the physical, chemical, and geological aspects of natural waters, as well as the converse. We are investigating the effect of various densities and configurations of particulate populations on the transmission of acoustical or optical energies. We are also attempting to determine the limiting environmental factors on individual organisms in communities.

Specific adaptations of biological organisms to special aquatic environments are also under study. Problems of biological fouling, bioluminescence, locomotor adaptations for rapid swimming or for burrowing or boring, and of the character and significance of underwater sounds are all being intensively investigated as areas of knowledge expected to be of value in naval operations.

The program in biological adaption and control is concerned with protection and survival of personnel through recognition of those elements of stress environments which may be potentially either beneficial or harmful. Shark attack and the control and repelling of sharks is being approached through studies of this fish under natural conditions. Toxins produced by fishes and other marine organisms are being analyzed to determine their utility as drugs or antibiotics. Natural adaptations of some biological organisms which are necessary for their survival under environmental stress are under investigation. For example, birds which drink sea water exclusively have adapted by developing glands to eliminate excess salt. These glands are not found in other animals.

The program in biological orientation is based on the realization that living organisms have capabilities for direction finding, interval recognition, and communication. We are searching for environmental clues which may serve to trigger responses in homing birds and migrating fishes leading them to their destination. Sensory perception of such clues as well as perception of special identifying characteristics enable the recognition of special targets such as food, enemies, mates, and obstacles. Major areas in this program include examination of the possible mechanisms accounting for the biological clock, communication methods such as the "sonar" of bats and porpoises, the dance of bees and other social insects, and the unknown communication accounting for schooling of fishes.

Biochemistry and biophysics are closely allied to nearly all biological questions of interest to the Navy. Thus, the ONR program in biochemistry is designed to provide a deeper understanding of the role of energy in living systems, frequently by studies of reactions at the molecular level. Primarily, we need to know how a biological system obtains, converts, stores, and utilizes energy to carry on essential life processes. As these phenomena become clear it is hoped that the information can be used to solve problems of importance to the naval mission. The mechanisms of synthesis of proteins, of deoxynucleic acid (DNA) and ribonucleic acid (RNA), and of biological building blocks is fundamental to learning more about the behavior of man (and finding ways to cope with various stresses) and other biological systems that may be useful to man or detrimental to reaching the Navy's objectives. ONR-sponsored research on photosynthesis includes studies of electronic energy-transfer mechanisms using chlorophyll in vitro as well as in intact chloroplasts, the formation and decay of free radicals during the photosynthetic process, and the photoconductive properties of DNA and RNA.

Other research in biochemistry and biophysics is included in those programs previously mentioned. Information and techniques developed in these fields are required to solve problems in physiology, microbiology, hydrobiology, and other areas of Navy interest.

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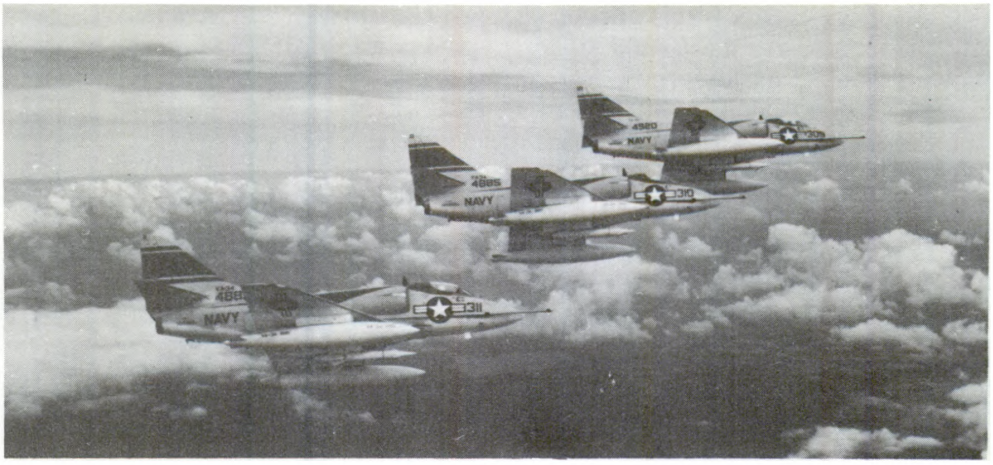
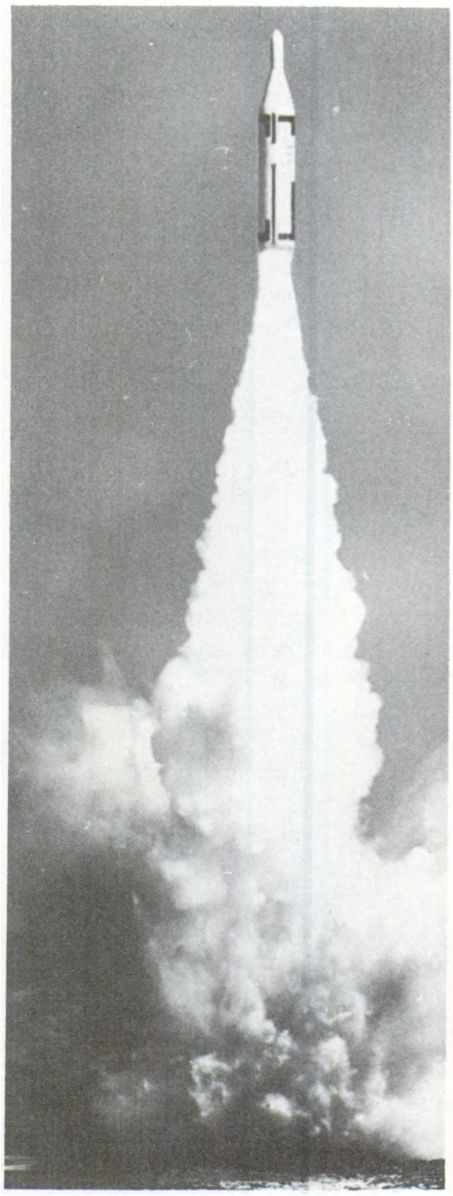


Three U. S. Navy A4D Skyhawk carrier-based jet aircraft in flight carrying the BULLPUP air-to-surface missile.



Short Refresher Course on Navy Missiles

[Adaptation of a speech given by RADM J. A. Jaap, USN, Director, Development Programs Division, Office of the Chief of Naval Operations, January 23, 1962.]

A POLARIS missile breaks the surface of the ocean and ignites to begin its rapid journey along a pre-selected flight path.

The Navy long ago recognized the need for long range, sophisticated weapons systems which actually seek out the target, much like the falcon of old. As a result, a revolution in naval armament has taken place. It has lasted more than ten years, and it is still underway. Out of it have come nine guided-missile systems and one ballistic missile in use in the Fleet—each with a capability far exceeding that thought possible before the Korean War.

Here is a brief introduction to the members of this impressive family:

• REGULUS was the first operational attack missile to join the Fleet. In essence, REGULUS is a bomb-carrying, swept-wing, jet fighter airplane piloted by electronics instead of a human being. We have this missile in five submarines and two of our cruisers. With a range of over 500 miles, it can reach many targets within hostile territory. REGULUS launching equipment, by the way, can be installed in a short time, at relatively low cost, and with only slight modification to the ship itself.

• ASROC, another shipboard weapon, is a surface-to-underwater rocket torpedo fired by surface ships. It is projected through the air to the target area and, upon water entry, becomes an acoustic homing torpedo which seaks out and attacks its submarine target. This is a missile whose lethality is so respected by submariners they have adopted the concept and have adapted it to use aboard submarines.

• They call it SUBROC—a guided missile which is fired from the torpedo tube of a submerged submarine, leaves the water, flies through the air to the vicinity of the target, re-enters the water, and finds and kills the hostile submarine. The SUBROC system can detect a submarine at long range, compute its course and speed, and automatically fire the missile in such fashion as to give a high probability of a hit.

• To provide close air support for our Marines we have BULLPUP. This is a relatively inexpensive, highly accurate, reliably designed air-to-surface missile to be used against comparatively small well-defended targets, such as pillboxes, tanks, truck convoys, and bridges. In addition to increased accuracy it has the advantage of rather long range, permitting the delivering aircraft to remain outside the effective range of enemy ground fire.

Next we come to our air combat missiles. The maxim that a good offense is the best defense is almost the credo of the Navy. And to maintain the offensive we must be able to take command—and maintain command—of any selected air space which may be in dispute. To do this our fighter airplanes must have the best air-to-air weapons available—and, until something better comes along, we have them.

• First is the SIDEWINDER, specifically designed to destroy high-performance enemy fighters and bombers. This missile seeks the target by homing on the heat emitted by the aircraft. Indeed, in our tests, SIDEWINDER many times has flown right up the tail pipe of the

jet-powered target aircraft. As you know, the Chinese Nationalists successfully employed SIDEWINDER during the Quemoy crisis in 1958—to the fatal discomfort of some Red Chinese.

This deadly weapon is also the Navy's smallest and cheapest. It is about nine feet long, five inches in diameter, and weighs about 150 pounds. It costs a little more than a Volkswagen. Now this may not sound cheap, but when you realize that it destroys a target costing the enemy a figure in the millions of dollars—it is cheap! And when one is fired, it destroys its target. This is what I call a favorable balance of trade. Why, an enemy could go broke just keeping us in targets!

• Then there is SPARROW III. This weapon provides the fleet with two additional features not yet available in other weapons. These are the ability to attack the enemy high-performance aircraft from all aspects, including head-on, and in all kinds of weather. So that you can better understand the implications of this capability, let me give an illustration. Assume an enemy aircraft is making an attack at twice the speed of sound. Our interceptor goes out to meet him, also flying at twice the speed of sound. This means they are approaching each other at four times the speed of sound—or, about 3,000 miles per hour. Doesn't give the missile much time to do its work, does it? But, in that time the SPARROW III system can locate its target, make up its mind whether it must go up or down—as much as a couple of miles—or stay at the same altitude, get underway, and keep the rendezvous before the bandit knows he is in any danger.

Now, remembering that the Fleet will take the offensive whenever combat is required, its ships must be prepared to fight regardless of any air attack. And to meet the air threat, the Navy has a special group within its family of missiles—this is the trio of the terrible T's. I am referring, of course, to the missile systems we know as TARTAR, TERRIER, and TALOS.

• The TARTAR is the smallest of this group, since it was designed primarily to fit on destroyer-type ships, but it is highly effective against both low and high altitude targets.

• TERRIER was the first shipboard missile developed, and it initiated the current revolution of which I spoke earlier. This missile is even being used ashore by the U. S. Marine Corps and represents a great stride forward in the U. S. Navy's program of power for peace.

• The last of this group, TALOS, although primarily a surface-to-air missile, can also be used effectively against ships and against targets on the shore. TALOS also is our largest and the most expensive of our guided missiles. It has a length of about thirty feet; a diameter of about thirty inches; and a weight at launch of about 7,000 pounds. Each TALOS costs a little more than a dozen Cadillacs. That's a lot of money! But it carries a lot of power designed to destroy million dollar targets which are on the way to do multi-million dollar damage to our ships—and irreparable damage to the integrity of our way of life.

• No discussion of our Navy today could be complete without some mention of POLARIS. A little over a year ago, the Navy added a gigantic punch to our offensive power by putting into operation the most useful mobile deterrent weapon system the world has ever known. On July 20, 1960, the Navy accomplished a historic "first" by firing two operational POLARIS missiles from the USS GEORGE WASHINGTON, submerged at sea in the Atlantic Ocean. This was the culmination of five years of intense Navy effort. About four months later GEORGE WASHINGTON took up the watch at sea. We now have five POLARIS submarines capable of standing this watch, and some of them are in position and ready now. Others are following in their wake.

Headed by the nuclear-tipped, 1200-mile range, sold fuel POLARIS, the Navy missile line-up, reviewed here, must give serious pause to those who would consider starting another world war.

Surveying Ship to be Built from Keel Up

A new Navy surveying ship is to be built soon by the Marietta Manufacturing Company, Point Pleasant, West Virginia. A fixed-price contract in the amount of $2,714,198 for construction of the new vessel, to be built from the keel up for research purposes, was awarded to the West Virginia shipbuilding company by the Bureau of Ships.

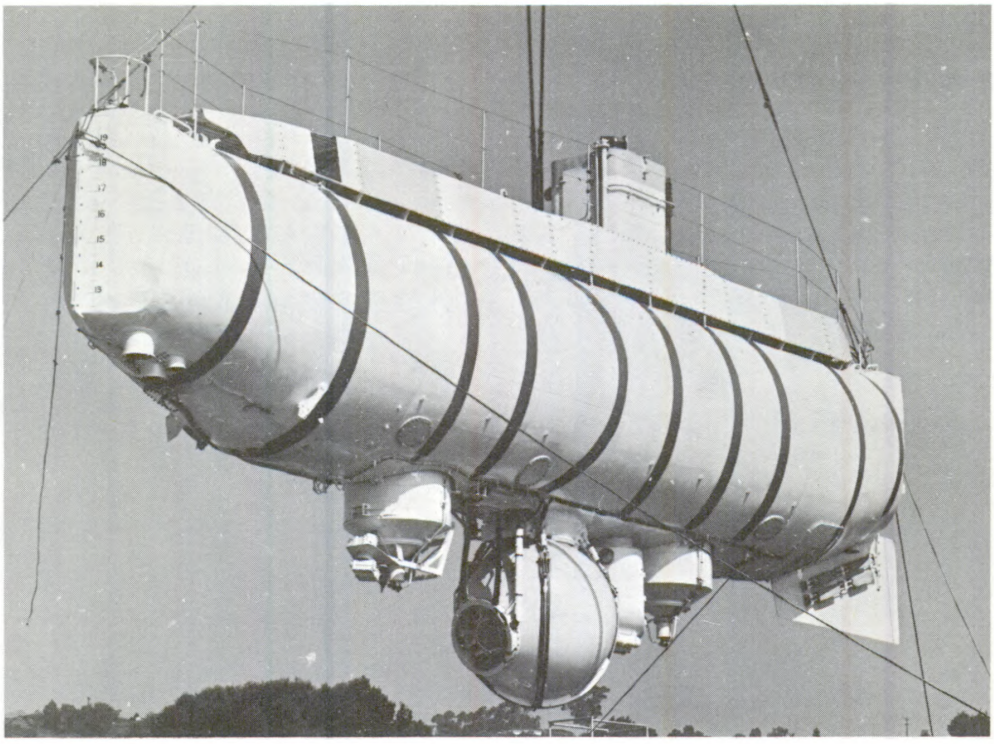
The new ship will be designed and equipped to conduct hydrographic surveys and to collect special oceanographic, acoustic, and meteorological data. It will be capable of performing these operations independently for extended periods. The overall length of the ship will be about 210 feet and the full-load displacement about 1,370 tons.

Conference on Self-Organizing Systems

A conference intended to bring together research workers concerned with the evolution of self-organizing information systems will be held May 22-24 at the Museum of Science and Industry, Chicago. The conference will be sponsored jointly by the Information Systems Branch of the Office of Naval Research and the Armour Research Foundation.

During the three years that have passed since the previous ONR-ARF conference on this topic was held, greatly increased emphasis has been placed on self-organizing systems. The purpose of the forthcoming conference will be to evaluate the recent progress and to consider the future directions of research.

The conference will be open to all interested technical personnel. Further information and a preliminary conference program can be obtained by contacting Mr. George T. Jacobi, COSOS Conference Secretary, Armour Research Foundation, 10 West 35th Street, Chicago 16, Illinois.



The U. S. Navy's bathyscaph TRIESTE.

The Bathyscaph as an Acoustic Vehicle

LT Don Walsh, USN
Officer-in-Charge, Bathyscaph TRIESTE
U. S. Navy Electronics Laboratory
San Diego, California

The bathyscaph TRIESTE has now been in operation with the U. S. Navy for more than 3-1/2 years. During that time this unique BuShips-ONR sponsored craft has proved the value of the manned deep submersible in oceanographic exploration. It is the purpose of this short discussion to outline past, present, and future acoustic programs for the craft and also to suggest some lines of interest that could be pursued.

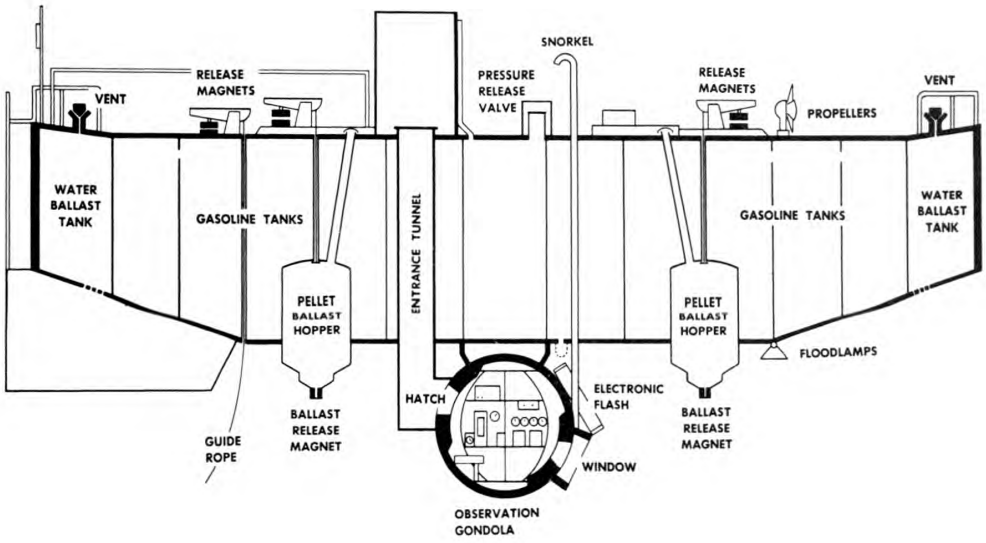
The past acoustic program has dealt mostly with the in situ techniques and measurements of the sound velocity profile of the water column. Mr. Kenneth Mackenzie of the Navy Electronics Laboratory (USNEL), San Diego, California, made one dive to 4200 feet in the spring of 1959 to test the feasibility of this method of measurement. On the basis of this sample dive, it was decided that a diving program should be initiated to make extensive sound velocity measurements in a deep water column. This program, Project NEKTON II, took place at Guam from May until July 1960. Its objective was to obtain the in situ relationship between temperature, salinity, depth, and sound speed. The deep waters offered an ideal opportunity to obtain the depth dependence of the

sound speed. Five dives were made in support of this project, the deepest being to 19,250 feet. It was intended to make a second 35,800-foot dive into the Challenger Deep; however, mechanical difficulties prevented this. A gravity measurement was made with a La Coste Romberg Gravity Meter, Model G, on the bottom at 7000 feet. The actual results of these dives were published by Mackenzie in the Journal of the Acoustical Society of America in August 1961.

The final dive of this program offered an opportunity to try out the bathyscaph as a deep target against a moderately well-equipped ASW vessel. The ship used in this test was the USS HAVERFIELD (DER-393) which is equipped with the SQS-4 and the AN/SQR-8 sonars. The results of this dive showed that the equipment performance far exceeded that expected or anticipated. This experiment was not made under controlled conditions and cannot be considered formal; but it did show that a great deal can be learned of deep targets and extended sonar performance through the use of a manned vehicle, such as the TRIESTE.

A piece of acoustic equipment that gave excellent service during both Project NEKTON and Project NEKTON II was the underwater telephone, designed and built by USNEL. This small unit, which operated on the same frequency as the AN/UQC, was completely transistorized and operated from a small 24-v battery pack. We had two such units at Guam, one (with two transducers) was installed on the TRIESTE while the other portable unit was carried either on the towing vessel or the Project workboat, a converted LCM. The performance of this equipment was clearly outstanding, and it is significant to note that the TRIESTE's crew was able to talk to the surface ship from the sea floor at a depth of 35,800 feet.

Some ambient-noise sample recordings were made using the underwater telephone and a small portable (Mohawk) tape recorder which is



Principal features of the TRIESTE. Note diagram is reverse of photograph on facing page.

normally used for recording verbal data; however, the results, while interesting, were inconclusive, due to low system fidelity. It was noted that the passage of the bathyscaph through the water did cause some increase in background noise which could be attributed to causes other than self noise. An accurate measurement of the modified TRIESTE's self noise will be made in the near future.

In July 1961 the bathyscaph completed an extensive rebuilding and overhaul at USNEL. The 10-month modification period was the first opportunity for the revision and installation of new equipments and instrumentation in the craft since it "first joined the Navy" in 1958. The product of over 2 years of operational experience with the Navy went into this work and the result is a more effective and productive deep-submergence research platform.

A complete conversion to standardized wiring, connections, and equipment racks will permit rapid re-instrumentation after each dive series. In addition, many new fixed-instrumentation equipments have been installed which will record data during each dive without interfering with the specific employment of the vehicle for that dive. This "fixed-instrumentation suit" will enable the project team to gather the maximum amount of data on each dive in a more or less automatic fashion. Included with this equipment is an ambient-noise transducer which is omnidirectional and can measure from 10 cycles to 30 kc. For routine measurements, the input from the transducer will be fed to an automatic tape recorder (300 to 10,000 cps) which will operate during the complete time that the bathyscaph is submerged. In this way, unusual acoustic noise can be correlated with a wide range of factors at any point in the water column. A directional hydrophone is planned for future work.

The underwater telephone has been modified. Its power was boosted from 200 watts to 1000 watts and the circuitry has been "cleaned up" to reduce internal noise. In addition, its size was reduced even further to fit into the new instrument panels inside the sphere.

To avoid collisions with outcroppings and ledges, the craft will have a small NEL-built sonar on board which will give a high resolution picture out to a distance of 150 feet. In addition, it will provide data on the gross contours of the bottom in the immediate vicinity of the area of investigation. Advanced plans call for the eventual installation of a CTFM-type high-resolution sonar unit for increased performance. Other major new features are:

1. A closed-circuit TV system which will have a scanning feature for visual observation of larger areas of the sea floor.
2. A mechanical remotely operated arm which can gather selected samples from the sea floor in front of the observation window. The capacity of the arm is 50 pounds.
3. Five propulsion motors which will allow movement in the vertical, horizontal, and lateral directions. This will permit the bathyscaph to hover at a given depth.
4. External batteries which give two and one-half times more electrical power and greatly increased ac supply.

5. Three times more instrumentation and equipment space inside the sphere.

6. Rapid ballast, gasoline, and battery handling systems which will minimize "turnaround" time.

7. Increased photographic capabilities through additional cameras and lighting.

At present the TRIESTE is beginning the fourth quarter of its fiscal year 1962 program. The early part of this fiscal year was devoted primarily to post-reconstruction shakedown diving and the correction of mechanical difficulties. The scientific program is covering three broad areas:

1. Acoustic research
2. Physical oceanography
3. Sea floor studies

It is anticipated that a total of 15 scientific dives will be made by the end of fiscal year 1962. Additional dives will be made for test and training purposes, principally to train two new pilots this year.

The fiscal year 1963 program should be a continuation of this year's program. The increased efficiency of operations and the reduction of lay-up time because of mechanical problems should permit many more dives than in the past. Thus the TRIESTE is rapidly becoming "operational," but the frequency of dives will probably never exceed an average of one per week.

Through continued operation of the TRIESTE, the Navy hopes to discover a variety of approaches to the problems of oceanography. Some of the acoustic work that can be done by the bathyscaph is suggested in the following listing:

1. Investigation of sound velocity in bottom sediments.

2. Improvements in techniques for taking sound velocity profiles of the water column.

3. The study of sound field levels in the sea from near-surface sources at various frequencies.

4. Investigation of ambient noise types, levels, vertical, and geographical distribution.

5. Operations as a deep target against all types of sonar equipments and vessels including submarines.

6. Deep-scattering layer investigations correlating acoustic measurements, visual observations, and photography.

7. The study of sound convergence zones with sound sources located at various depths.

8. The measurement of sound reflection and scattering from the sea floor.

It would perhaps be well here to cite some of the "pros" and "cons" for the use of a manned vehicle, not only for acoustic work but as a valuable adjunct to current oceanographic techniques. Some of the advantages are:

1. It eliminates the groping method of deep sea research.

2. The trained mind and the eyes can be taken to the information source to explore a poorly known frontier. This is especially appropriate for the field sciences, such as geology and biology.

3. Profile measurements of various parameters can be made simultaneously and continuously throughout a large column.

4. Direct visual observations of dynamic events and the interaction of animal life and the environment are superior to those made using only television and cameras.

5. Color and low light levels can be observed.

6. Immediate mental integration of a variety of events is possible because the craft is capable of carrying a large instrumentation load.

7. It affords close proximity of man and machine. Delicate adjustments and revised programming in the instrumentation system can be executed to meet the immediate requirements of the observer.

8. Qualitative evaluation of many biological and physical factors can be made that are now below the threshold of sensitivity for existing instrumentation.

9. Exploratory observations of the deep sea environment are useful in planning the design and construction of instrumentation devices.

10. Precise control of selective instrumentation near the source of information can be accomplished. Selective sampling of specimens can be executed.

11. The bathyscaph can carry a relatively large payload when compared to cable-lowered equipment loads. Cumbersome cables are eliminated and instrument load capacity can be thought of in terms of tons.

12. With improved propulsion systems, these vehicles will be able to obtain continuous profile measurements of the water column and horizontal surveys at any depth.

13. Surface effects are ruled out as the bathyscaph has no connection with the surface.

On the other side of the ledger, but by no means overwhelming, are the disadvantages of the manned vehicle such as the TRIESTE:

1. The operation of the bathyscaph requires a great deal of logistic support and is by no means low priced.

2. There is only one such craft available.

3. The bathyscaph cannot investigate large areas of interest but rather the microdetail of the water column from the surface to the sea floor at the base of the column.

4. The cost "per pound" of oceanographic information is not competitive with shipborne methods. The uniqueness of the craft must be used as a way of obtaining information that cannot be obtained by the "classic" methods.

In the not too distant future the scientist will be able to become truly "three dimensional" through the use of facilities of deep-ocean submersible vehicles. Just as one aircraft cannot perform all flying jobs, we cannot expect to rely upon an "omniscaph" idea. The studies of shelf, slope, and the great ocean basins each will require special approaches and, in many cases, specialized vehicles. The TRIESTE is a "Model T" vehicle, but we have learned this through usage and evaluation. It still has a profitable future ahead of it in demonstrating the uniqueness of its approach to studying the oceans.

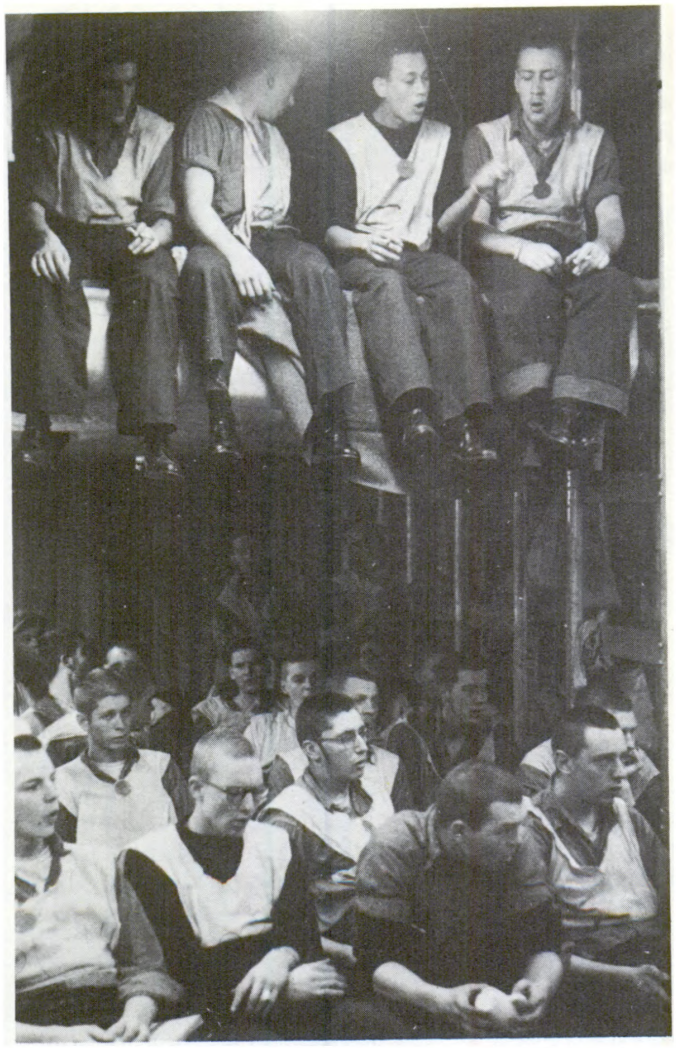
Shelter Design and Habitability Study

Entrance to the underground shelter.

The Bureau of Yards and Docks, the Naval Research Laboratory, and the Naval Medical Research Institute (NMRI) completed a winter test early last month of the safety and habitability of a prototype underground shelter in which sailors of the U. S. Navy "survived" until the outside environment was free of "hazardous radiation." The trial, which was held at the National Naval Medical Center, Bethesda, Maryland, was part of the Navy's effort to standardize the design of shelters for construction at shore installations. Technical aspects of the shelter-living trial were directed by submarine habitability specialists from the Naval Research Laboratory, Dr. Eugene A. Ramskill and Mr. Harold F. Bogardus. (In December 1959, the Naval Radiological Defense Laboratory conducted a shelter survival study in which 92 of the 100 shelterees were inmates of a nearby rehabilitation center; see Nav. Res. Rev., July 1960.)

The shelterees for the test were Navy enlisted men, representing 24 states and the District of Columbia, who were just out of "boot camp." Including stand-ins, 107 volunteer sailors were screened at the Great Lakes Naval Training Center and selected for shelter occupants at NMRI. Ninety-six of the volunteers occupied the shelter in company with two hospital corpsmen and two commissioned officers—the shelter commander, LTJG John T. White, CEC, USNR, of the Bureau of Yards and Docks, and a doctor, CAPT David Minard, MC, USN, of the Naval Medical Research Institute. All occupants single-filed into the shelter on February 17, 1962, the volunteers without any knowledge of how long they would have to stay. Their confinement depended, theoretically, on the duration of the radiation hazard outside the shelter. At certain intervals, designated teams left the living area to measure the decay of a portable external radioactive source and determined from plots when it was safe to evacuate the shelter. The radioactive source was controlled from outside so that the men would be able to evacuate the shelter at the end of a two-week period. The sailors kept diaries of their experiences and were given thorough medical and psychological examinations prior to, during, and following the trial.

The shelter itself is a 25 by 48 foot reinforced quonset-type structure, designed by the Bureau of Yards and Docks, with a 4-inch thick floor of bare concrete over a 4-inch layer of crushed stone. Anchored to



Shelterees in two crowded tiers engage in group activity.

"Surviving" sailors line up for mess. The choice of food is simple: wheat wafers, soup, peanut butter, jelly and coffee.

concrete footings, which are not attached to the concrete floor, is an arching, unpainted, corrugated steel roof under 6 feet of earth. A blast door at the corrugated steel entrance tube is specified to withstand 100 psi. Neither artificial heating nor cooling was provided, because the Navy wanted to learn how well the men's body heat could warm the shelter in the winter and how Washington's summer weather might affect another group which will be confined in a later trial (to be held sometime this summer). The ventilation system is capable of removing atomic, biological, and chemical contaminants from air pumped into the shelter at 300 to 600 cubic feet per minute. This is adequate to maintain an outward leakage of filtered air rather than an inward seepage of contaminated air from outside the shelter. A 4,000-gallon ration of cold water, which had to last for two weeks, was metered at every outlet so that records could be kept of the amount consumed, primarily for drinking and cooking. There was one cold shower, but it was to be used only by the men who checked the hazards outside the living area. These men were required to wash away any radioactive contamination picked up in the monitoring process before they could rejoin their colleagues. A 10-kilowatt generator supplied electric power for lighting, for the filtration system, the coffee urn, and an electric deep-fat fryer, used as a soup kettle. Experimental equipment, such as the TV camera and the NRL rack of instruments that continuously measured carbon dioxide, carbon monoxide, oxygen, and smoke, were powered by a separate electrical source.

Living space in the shelter was about 100 cubic feet per man, which is about one tenth of the roominess of a nuclear-powered submarine. The men slept, stood, and sat in shifts. There were 50 stretcher-type bunks (10 in a row and 5 rows high), several wooden benches, camp chairs, card tables, and six chemical toilets (three were found to be adequate and only that number were used). The shelter was stocked with books, games, magazines, and a 2,000-calorie per day ration of food consisting of small wheat wafers, soup, peanut butter, jelly, and coffee.

As this article goes to press, the analysis of the data from the winter trial is still underway. However, some preliminary information about the effects of shelter life and the nature of the shelter atmosphere during the test can be given. The figures reported here are approximations and thus subject to revision.

The shelter was sealed as tightly as possible for the first 3-1/2 hours of occupancy to simulate the blast and fire periods. No electricity was available in the shelter from the time of entry until the motor-generator was turned on 1-3/4 hours later. Ventilation was started 3-1/2 hours after entry, upon determining that no fires existed topside. This determination was made by an analysis of the carbon monoxide content of the outside air through a sampling tube.

During the initial 3-1/2 hour period when the shelter was not ventilated, the carbon dioxide concentration rose to 2.7 percent and the oxygen concentration fell to 18 percent. Throughout this period the air temperature in the shelter was about 52° F. Smoking was permitted, for experimental purposes, during the last hour of this interval. As a result of the smoking, primarily, the carbon monoxide content rose to

40 ppm and the aerosol content to 9 micrograms per liter. When compared to the allowable limits for continuous 90-day exposure aboard a nuclear submarine, these figures are found to be quite acceptable for the time involved in the shelter. The threshold limit values for nuclear submarines are as follows: carbon monoxide—50 ppm (max.); carbon dioxide—1 percent (max.); and oxygen—19 percent (min.).

After ventilation was started, the "normal" condition was soon reached and maintained for the duration of the trial. Only small variations were observed, these due to the amount of activity of the men and to changes in the ventilation rate. The "normal" ranges for concentrations of air components were as follows:

- Carbon dioxide — 0.1 to 0.5 percent.
- Oxygen — 20 to 20.8 percent.
- Carbon monoxide — 6 to 15 ppm.
- Smoke — 1 to 4 micrograms per liter.

During the first 6 days of the trial, the air temperature in the shelter rose steadily to a maximum of 83° F. At that time the ventilation rate was increased, causing the temperature to go down to a comfortable 74° F., where it remained until the trial ended. In contrast, outside temperatures ranged from 16° F. to 55° F. during the two-week period. Relative humidity in the shelter varied from 40 to 65 percent.

In general, the two-week winter trial was considered a success. The 100 occupants of the shelter "survived" without serious problems arising, either with regard to the mechanical functioning of the shelter or to the medical and psychological aspects of such living. The diet, although austere, was acceptable. The high noise level, due principally to the ventilation blower, was annoying but not cause for concern. The most common complaint was the lack of wash water for sanitary purposes; the total water used per man per day for all purposes was 1.7 quarts. Little objection was made to the crowding and "hot-bunking."

Detailed plans for the summer trial are now being made. Before they are firm, a multitude of data must be analyzed. It appears, however, that the primary problem to be dealt with in preparing for this trial is deciding on a satisfactory way of effecting the dissipation of heat in the shelter.

When the information on the two trials has been analyzed, the Navy hopes to have a sound basis for determining the number of people that may occupy a given shelter for a specified length of time, the probable effects of overloading a shelter, the types and quantities of all supplies needed for the shelter, and the optimum method of operating the shelter and all associated equipment. If the shelter utilized in the trial described here proves to be adequate, it could serve as the prototype for shelters that may be constructed at Navy shore installations.

Internal Burning of Rocket Motors Photographed

X-ray technologists at the Naval Ordnance Laboratory, White Oak, Maryland have developed what they call a "cinefluorographic" system for photographically recording the internal burning of rocket motors during static tests. It will aid the Navy in determining to what extent manufacturing variables such as separations, cracks and voids in solid missile propellants affect motor performance.

In addition to an X-ray source, the system utilizes a modified 35-millimeter camera coupled to a nine-inch light-intensification tube. During a test, the rocket motor is situated between the X-ray source and the light intensifying system so that X-rays penetrating the rocket form a picture of it on the fluoroscopic tube. As the rocket motor burns, its changing internal dynamics are recorded by the movie camera.

Cracks and voids purposely introduced into the solid propellant of the rocket motors under test provide the required variables. Tests conducted so far with such controlled variables have disclosed that small uniform voids located in the center of the solid propellant merely result in a slight increase in the burning area with no observable effect on pressure. On the other hand, multiple voids located along a crack nearer to the side of the rocket motor may cause a blowout.

So far, rocket motors examined with the cinefluorographic system have not been larger than five inches in diameter. These have required a 250-kilovolt radiation source. NOL X-ray technologists say that large rocket motors such as those of the Polaris Fleet Ballistic Missile will require megavolt radiation.

Beach Study Disrupted by Atlantic Storm

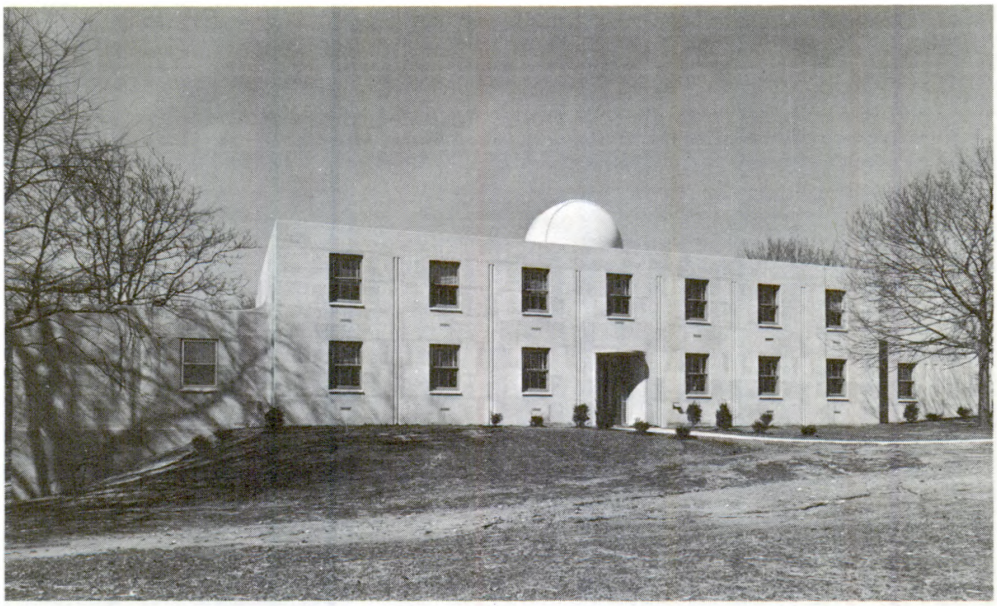
Last January the Coastal Studies Institute of Louisiana State University, supported by ONR and others, began a detailed, carefully instrumented study of beach changes at Nags Head, N.C. Then, in early March, came the most devastating storm the Atlantic Coast has seen in many decades.

The LSU investigators had installed synchronized time-lapse and normal speed cameras on a pier jutting into the ocean. There was a pressure cell, wave recorder, and tide gauge in the surf zone, and a layout of carefully surveyed stake markers to measure small shifts in the beach sand. The various recording and surveying instruments, and power supplies, were housed in a small building on the pier. The unique pilot study was thus designed to obtain photographic and survey data on the major factors involved in beach processes.

On the first day of the storm, the investigators stayed at the study site until darkness, recording data and photographing the beach. That night, both ends of the pier and the beach study area were washed away.

When the investigators returned after the storm, they found that the beach had receded 125 feet. Also, a new inlet to the sound had formed. Only the central portion of the pier—the part supporting the pier house—remained. Many of the instruments were lost entirely or ruined by sand and salt water. The tide gauge and survey stakes were all carried away. One instrument—the pressure cell—was found 5 miles down the beach.

When present records have been analyzed, the project will be re-established, either at Nags Head or a similar location.



The new Simon Newcomb Laboratory

New Laboratory...Famous Old Astronomer

A member of the staff of the U. S. Naval Observatory more than 100 years ago....a distinguished mathematician....a U. S. Navy Rear Admiral....and the Nation's foremost astronomer of the 19th Century.... These are only a few of the "credentials" of Simon Newcomb (see photo, front cover), the man for whom a new $230,000 laboratory at the Naval Observatory has been named. The two-story building with its 8,000 square feet of working space for the Time Service Division and Astrometry and Astrophysics Division was dedicated on February 2 by VADM J. T. Hayward, Deputy Chief of Naval Operations (Development).

THE FACILITY

The first floor of the building houses the Time Service Division's administrative offices, equipment rooms, laboratory, and Horological Museum, in which are displayed examples of both antique and modern timekeepers. The equipment rooms contain the atomic and quartz-crystal clocks, used to keep the Nation's time, and the electronic equipment used to monitor and control the Navy's precise time and constant frequency broadcasts. These transmissions are coordinated with the Naval Research Laboratory and the National Bureau of Standards. In cooperation with the U. S. Coast Guard, the Time Service Division also controls the time of emission of LORAN-C navigational pulses, accurate to the microsecond. Equipment planned for future installation on this floor will electronically monitor and control time signals from Transit navigational satellites.

On the second floor are the administrative offices and equipment rooms of the Astrometry and Astrophysics Division. The equipment

rooms will contain special plate-measuring engines used to make astrometric measurements from photographic plates taken with large telescopes. Projects of this division include photographic and photoelectric measurements of the colors and magnitudes of stars, measurement of the polarization of light from stars in clusters and the determination of the positions of asteroids, comets, and satellites. In addition, photographs of the sun are taken daily to obtain positions, areas, and counts of sunspots. These data are used by the Radio Warning Service of the National Bureau of Standards in making immediate predictions concerning radio communications.

An astrodome on the roof will contain a satellite tracking camera, which will be used to determine the positions of artificial satellites.

The move of instruments and equipment from old quarters at the Observatory to the new laboratory involved a 100-yard transfer of the highly delicate quartz crystal oscillator that provides the key energy for synchronizing the Observatory clocks. Two master clocks were kept in motion while the 73-pound oscillator unit was carried gingerly to its new quarters by two Observatory employees. During the move, the oscillator was kept in operation by a battery unit which limited variation of the temperature surrounding the crystal to 1/1,000 of a degree. This was necessary as a pronounced temperature change would have altered the aging characteristics of the unit.

THE SCIENTIST

Simon Newcomb, whose name henceforth will be associated with the laboratory and its work, was one of the most notable men of science that America has produced. Born in 1835 at Wallace on the north coast of Nova Scotia, Newcomb became interested as a young man in astronomy and seemed to be irresistibly attracted to the field of theoretical mathematics called celestial mechanics, which to him embodied the highest intellectual power that man had ever obtained.

Newcomb's father was a country school teacher, and as a youth, Newcomb's life was spent in various parts of Nova Scotia and Prince Edward Island. He received very little formal education as a child, and while attending his father's school, he came and went with complete freedom. He knew the alphabet at the age of 4, began arithmetic at 5, and geography at 6. He avidly read a work on astronomy before he was 10 years old, and was greatly attracted by the subject. Without the guidance of an instructor, he eagerly studied algebra, natural philosophy, and navigation, mainly from old books that had belonged to his grandfather.

In 1854, after the death of his mother, Newcomb and his father moved to eastern Maryland, and Newcomb, at the age of 19, became a country school teacher. While teaching, he devoted his spare time to the study of mathematics and astronomy. During this time, he frequently visited the city of Washington. Here he went as far as the gate of the Naval Observatory but feared to enter.

In 1855, when 20 years old, Newcomb published his first paper, written to point out the fallacies of the arguments in a letter, published by a newspaper, that repudiated the Copernican Theory.

In January of 1857 Newcomb was appointed to the staff of the Office of the American Ephemeris and Nautical Almanac at Cambridge, Massachusetts. Unsatisfied with the prospect of doing nothing more than making routine calculations with formulae prepared for him by others, Newcomb continued his studies at Harvard and was awarded a B.S. degree in 1858. Except for this one year of formal study at Harvard, he was largely self-taught.

From this beginning he rose rapidly to a position of eminence in mathematical astronomy. In October of 1861 Newcomb was appointed Professor of Mathematics in the U. S. Navy for service at the U. S. Naval Observatory in Washington, D. C. In 1877 he was appointed Director of the Nautical Almanac and held that position until his retirement in 1897 with the rank of Rear Admiral.

The complete bibliography of his writings contains 541 titles, including 318 pertaining to astronomy, 35 to mathematics, 42 to economics and 146 on miscellaneous subjects that comprised even fiction. His greatest project and most important achievement was the construction of new theories and tables for the motions of all the principal bodies of the solar system, an endeavor to which he devoted more than 20 years of his life. The mathematical results of his research are still used in astronomy today.

Four Men in a Spin

Four men recently spent two weeks in a revolving compartment as part of a Navy test conducted to see how well man can adjust to prolonged rotation and close quarters. The experiment, carried out in the Slow Rotation Room at the School of Aviation Medicine, Pensacola, Florida, will help investigators determine a feasible rotation rate for future manned space stations.

Only at the beginning and end of their 336-hour and 20 minute spin did the men experience dizziness. The initial spell of dizziness lasted just a few hours, then the men became accustomed to the unusual environment. Upon completion of the test, the men's sense of balance was affected by the change-over to a motionless state; however, this ill effect disappeared the following day.

During the period of rotation a close watch was kept for any ill effects that might have developed. This was done through performance and medical tests, lasting about 8 hours each day, which checked balance, reflexes, memory, alertness, coordination, and the overall physical condition of the men. They indicate that the men's mental and physical capabilities were not lessened during their "travel." In fact, results of some of the performance tests indicate a gradual improvement in capability over the two week period.

Further experiments--to be made at different speeds and for longer intervals--have been planned for the Slow Rotation Room.

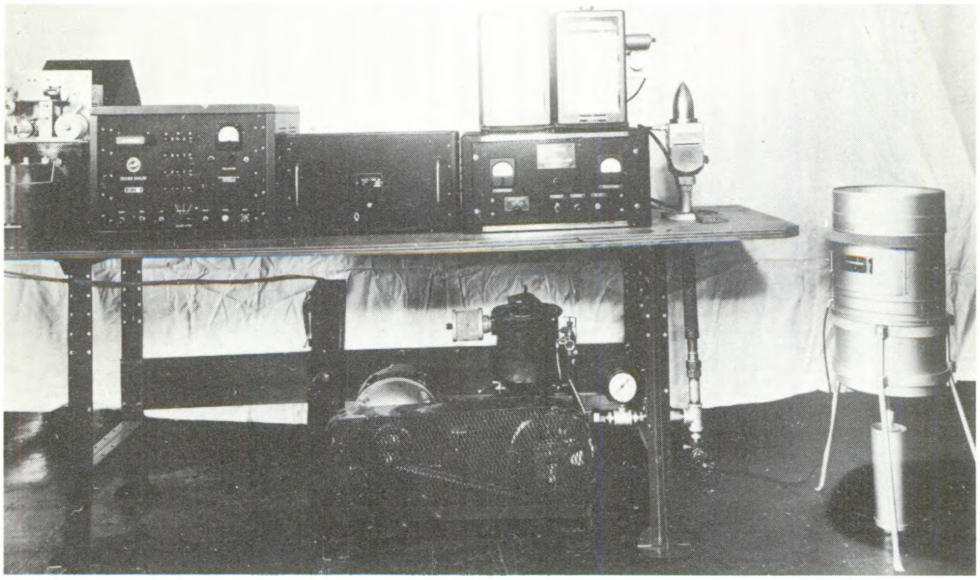
Measurements of Fission Debris from Recent Soviet Explosions

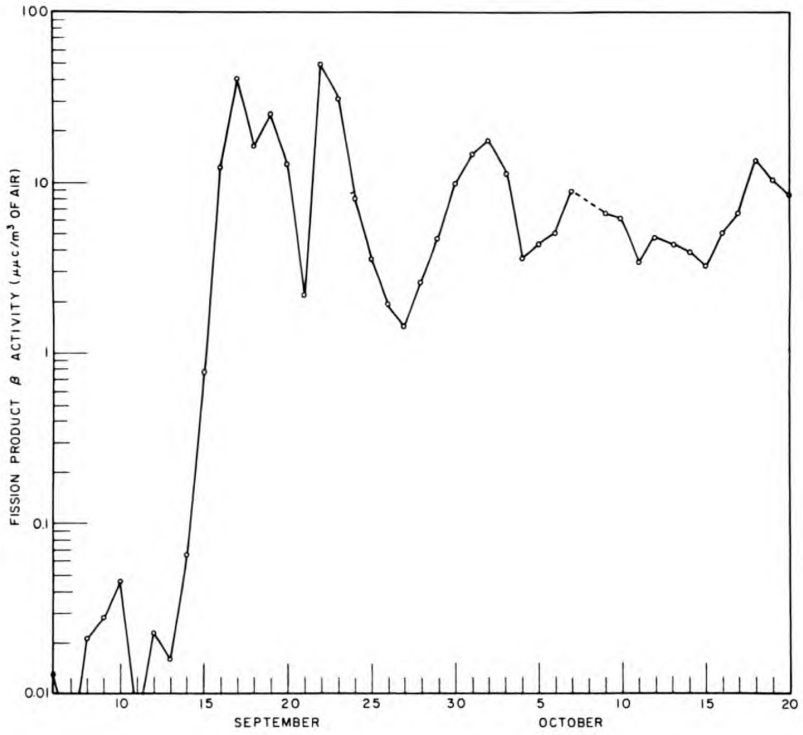
L. B. Lockhart, Jr.
Physical Chemistry Branch
Naval Research Laboratory

Initial interest at the U. S. Naval Research Laboratory in the subject of atmospheric radioactivity was directed towards methods of detecting nuclear explosions at great distances by taking advantage of the radioactive fission products introduced into the air at the site of the explosion. Also of interest were the natural radioactive products of the radon and thoron decay series existing in the air, which were in sufficient quantity generally to mask completely the presence of fission products. A method was developed, however, whereby the fission products and the major natural contributors to the radioactivity of the air could be readily determined from radioactive decay measurements of particulate matter collected from the air by filtration. Equipment used for this purpose is shown below.

Routine radioactivity measurements with this NRL air monitoring equipment have been carried out in Washington, D. C., and elsewhere since 1949. Measurements with this equipment at NRL were discontinued in September 1960 when the fission product level decreased to a low value (however, this atmospheric contaminant continued to be monitored by other NRL equipment in the area). The program was reactivated in September 1961, on receipt of information that renewed

Equipment used to collect nuclear fission debris.





Fission product concentration in the ground-level air at Washington, D. C., following initiation of the 1961 Soviet nuclear tests.

Comparison of the β Activity of Fission Products in the Atmosphere with that of its Normal Major Radioactive Constituents

Month	Fission Products ($\mu\mu c/m^3$)		Natural Radioactivity ($\mu\mu c/m^3$)*	
	Daily Maximum	Monthly Average	Radon Series	Thoron Series
September 1961	48.4 (22) ‡	7.4	315	5.1
October 1961	17.4 (2) ‡	6.6	299	4.2
November 1961	16.6 (14) ‡	6.1†	338	2.9
December 1961	7.2 (27) ‡	3.5†	400	2.7
January 1962	8.8 (5) ‡	5.1†	330	2.0

*Monthly averages during period 1950-1961.
†Measurements made on 16 days in November, 17 in December, 15 in January.
‡Numbers in parentheses refer to dates on which the maximum occurred.

nuclear testing in the atmosphere had been undertaken in the Soviet Union.

Results of the daily gross fission product measurements covering the period of early September, prior to arrival of fresh debris from the USSR, through mid-October, 1961, are presented in the graph above. A thousandfold increase in fission product activity took place in a three-day period as the fresh radioactivity from the Soviet tests swamped the background of old debris remaining from past series. The two highest peaks of radioactivity during the entire series occurred in September even though the yields of the earlier shots were not as great as some later in the series. These peaks, 48 micro-micro curies per cubic meter ($\mu\mu c/m^3$) of air on September 22, and 41 $\mu\mu c/m^3$ on September 17, were exceeded by only two others during the entire period of operation of this equipment at NRL. These higher values were 55 $\mu\mu c/m^3$ on May 27, 1953, and 51 $\mu\mu c/m^3$ on May 24, 1955, following tests in Nevada. However, the combination of two large peaks in a single month caused September 1961 to have the highest monthly activity ever recorded in this area, even though very low activity was present during the first half of that month.

The monthly average fission product β-activity existing in the Washington area since these tests began is shown in the table on the preceding page. For comparison, the average β-activity is shown that resulted from members of the radon and thoron decay series present normally in the atmosphere; these results were obtained from an analysis of the data collected over the period of operation of this equipment here, and represent the averages of these activities near the time of their daily minima. It may be noted that the average fission product β-activity in the air has been only a small fraction of the activity which might be expected in the normal, uncontaminated atmosphere. At these concentrations, fission products constitute no external hazard; they become a problem only if a sufficient quantity is accumulated internally through radioisotopes incorporated into man's food supply.

The U. S. Public Health Service also makes measurements of the fission product activity in the air at Washington, D. C., using entirely different air sampling and counting techniques. Their laboratory results generally run 30 to 40 percent higher than those reported here due, in part, to the greater sensitivity of their equipment toward β-particles of low energy. The District of Columbia Health Department exposes these filters and makes preliminary field evaluations of them with a survey-type instrument one hour following the end of the collection, before forwarding them to the PHS. This soon after collection, considerable activity from the natural radioactive products remains and contributes a background so large and variable that no reasonable estimates of fission products can be made, except when the fission product levels are unusually high. These preliminary measurements, which were designed primarily to serve as "an alert" system for indicating the presence of unusually high levels of radioactivity in the air, also form the basis of the newspaper accounts of "radioactivity in the atmosphere above Washington."

"Lost" Ocean Current is Found

Scientists at the Scripps Institution of Oceanography have found an ocean current they thought they had "lost"--the eastern end of the Cromwell Current. This large, shallow stream of ocean water, discovered in 1951, courses eastward beneath the equator from the western Pacific to the Galapagos Islands, which sit astride the equator. But there the great stream--which moves millions of tons of water, more than flows in a thousand Mississippi Rivers--simply vanished from the map.

John A. Knauss, Scripps oceanographer who made extensive measurements of the Cromwell Current three years ago, recently returned aboard the research vessel ARGO from an expedition which spent several weeks in the vicinity of the Galapagos Islands. Knauss says that this year's work has proved that the current does not disappear, but veers to the north of the Galapagos Islands and returns to the equator on the east. However, it does change in nature--weakening in force, shrinking in size, and flowing several hundred feet deeper than it does on the west side of the Islands. Actually, Knauss says, this change probably begins well to the west of the Galapagos Islands, the effect of the islands being to hasten the decay of the current.

The recent findings have emphasized the fact that the Cromwell Current differs from any other known in the ocean, Knauss says. Unlike such major surface currents as the Gulf Stream and the California Current, the Cromwell Current carries waters that differ in no great degree from those on either side. The Gulf Stream, for example, carries warm water to the north, whereas the waters of the Cromwell Current are not notably warmer or colder than those on either side of the stream. The waters of the California Current can sometimes be distinguished by the nature of the creatures that live within it and are not found on either side. But the waters of the Cromwell Current do not differ biologically from those bordering it. "Although the current travels across the entire Pacific Ocean along the equator, it seems possible," Knauss says, "that any given water particle travels only a relatively short distance within the current."

Knauss' studies of the current received support from the National Science Foundation and the Office of Naval Research.

German Commander's Cross Awarded CAPT Wiesner

CAPT Frederick C. Wiesner, USNR, former Head of ONR's Power Branch, was decorated by the Federal Republic of Germany on February 21 at ceremonies at the German Embassy. CAPT Wiesner was awarded the Commander's Cross for his liaison duties with the German Navy concerning research and development and for his efforts in establishing first contacts between the U. S. Navy and German Navy upon reactivation of the latter after World War II. Honored at the same time were ADM Arleigh Burke, USN, former Chief of Naval Operations, and VADM Howard E. Orem, USN (Ret.), who received the Knight Commander's Cross.

On the Naval Research Reserve

Wildlife Biologist Visits Tanganyika

CDR Buss

Early in 1961, CDR Irven O. Buss, USNR, Commanding Officer of Naval Research Reserve Company 13-3, Pullman, Washington, received an invitation from the International Union for Conservation of Natural Resources (IUCN) to participate in an international conference to be held at Arusha, Tanganyika, East Africa, last September. CDR Buss, who as a civilian is a professor and the head of wildlife biology at Washington State University, was asked to prepare a paper based on his research of the African elephant. This investigation was conducted between June 1958 and June 1959 in Uganda while CDR Buss was a Senior Fulbright Scholar.

The study included the collection of 127 elephants, each of which was measured, dissected, and the separate organ structures weighed. In addition, nearly three tons of material was collected from the elephants, preserved, and shipped to the laboratories at Washington State University for scientific study. On the basis of this work, CDR Buss wrote five scientific papers which were published in technical journals. One of these—"Observations on Number, Mortality, and Reproduction of Elephants in Uganda"—was presented at the IUCN conference in Tanganyika on September 6, 1961.

As the conference neared its end, CDR Buss joined Major Bruce G. Kinloch, the director of Tanganyika's game department, for a three-day safari to the world famous Ngorongoro Crater on the Serengeti Plains. The crater floor, about 10 miles in diameter, is the home of about 15,000 big game animals including approximately 5,000 zebra and 7,000 to 8,000 wildebeest. During the night, while descending the crater's steep slope to a camping site on the crater floor, five elephants and a leopard crossed the road close ahead of the Land Rover. A quick trip across the crater floor before dawn the following day gave the travelers a "ring-side" view of 31 lions (24 feasting on a freshly killed zebra), 3 rhinos, about 6,300 wildebeest, more than 3,500 zebra, and a large number of smaller animals. The Ngorongoro Crater is one of Africa's truly magnificent and unspoiled wild animal ranges, but it is disappearing rapidly as man proceeds with the modernization of this part of Africa.

CDR Buss' globe-circling trip to and from Tanganyika was supported by Washington State University and the American Conservation Association, Inc. It was made entirely by air, beginning on August 16 and ending on September 12.

Reserve Officers Selected for Promotion

Eight hundred and forty Naval Reserve line officers have been selected for promotion to Commander by the FY 1962 Reserve Selection Board, which was approved on February 28, 1962. Of this number 12 are Research Reservists, three of whom are Commanding Officers of their companies. Congratulations are extended to these officers.

	NRRC		NRRC
R. Atherton	4-3	E.C. Reichard	4-1
W.R. Hitchman	6-13	K.R. Scudder	5-10
F.B. Knight	9-3	E.P. Strong (C.O.)	4-4
R.R. Lance	5-4	J.R. Thomen (C.O.)	9-20
E.R. Nelson	11-3	D.B. Todd	12-5
A.O. Parks	5-9	C.F. White (C.O.)	5-9

Statistics based on the records of the Research Reservists selected for promotion are as follows:

Date of Rank	Designator	Year of Birth
Earliest 7-15-51	1105 - 8	Earliest 1910
Latest 11-1-57	1405 - 1	Latest 1926
Median 7-1-55	1455 - 3	Median 1919

It is to the advantage of the officers selected to qualify for promotion within one year from the date on which the President approved the report of the selection board (February 28, 1963). By qualifying within this year these officers will be entitled to the pay and allowances of the new grade for that year. However, if more than a year is taken to qualify, the entitlement for pay and allowances dates from appointment in that grade.

Another change this year permits the physical examination for promotion to be taken as soon as the official letter of notification of selection has been received, even though the officer may not have completed the professional requirements at that time.

Reservists Visit Naval Postgraduate School

A weekend tour of the U. S. Naval Postgraduate School at Monterey, California, provided group training for two Research Reserve companies. Naval Reserve Research Company 11-8, Point Mugu, and NRRC 11-10, Ventura, took part in the training from January 26 to 28. Air transportation was provided by the Naval Air Station, Point Mugu.

The session started with a briefing by directors of the Engineering School, General Line and Naval Science School, and Naval Management School on research activities of the institution. These talks were followed by a tour through the Engineering School.

The reservists were impressed by the excellent facilities and the high-quality educational program now being conducted at the school. They agreed also that this group active duty for training had proved to be a highly profitable experience.

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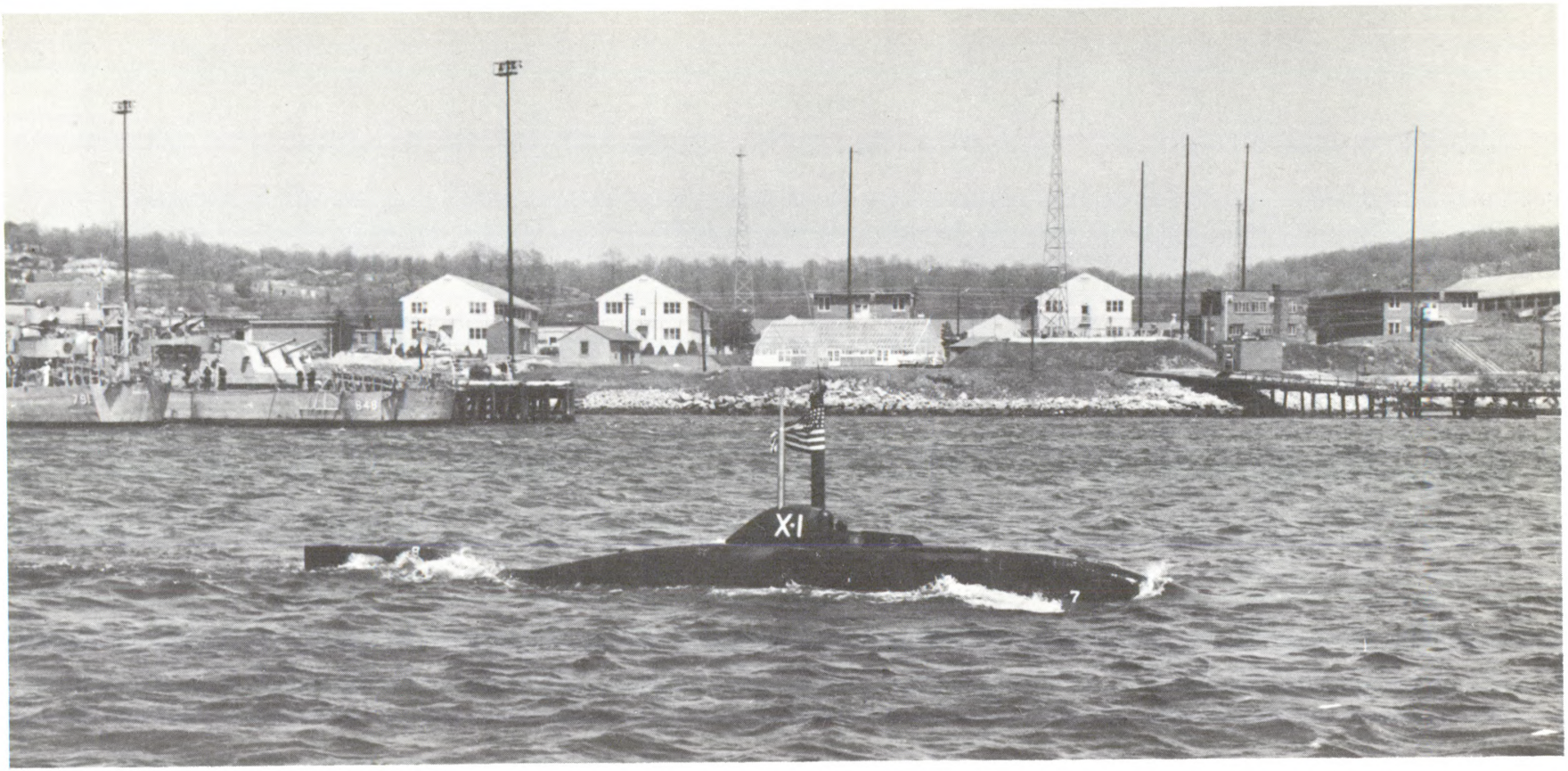

This experimental midget submarine, SS X-1, is solely a research vessel. Like the TRIESTE, described elsewhere in this issue, the X-1 is one of the specialized vehicles being used in the Navy's broad program of oceanographic research. The boat is presently operating in the Chesapeake Bay.

IN THIS ISSUE

NAVAL RESEARCH reports highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. The magazine is listed for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. Subscription price: $1.50 per year in U. S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. Changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C. The issuance of this publication approved by the Secretary of the Navy on 1 March 1961.

Portrait of astronomer Simon Newcomb, painted by C. H. L. MacDonald, now on display at the Simon Newcomb Laboratory, U. S. Naval Observatory. See pages 24-26.