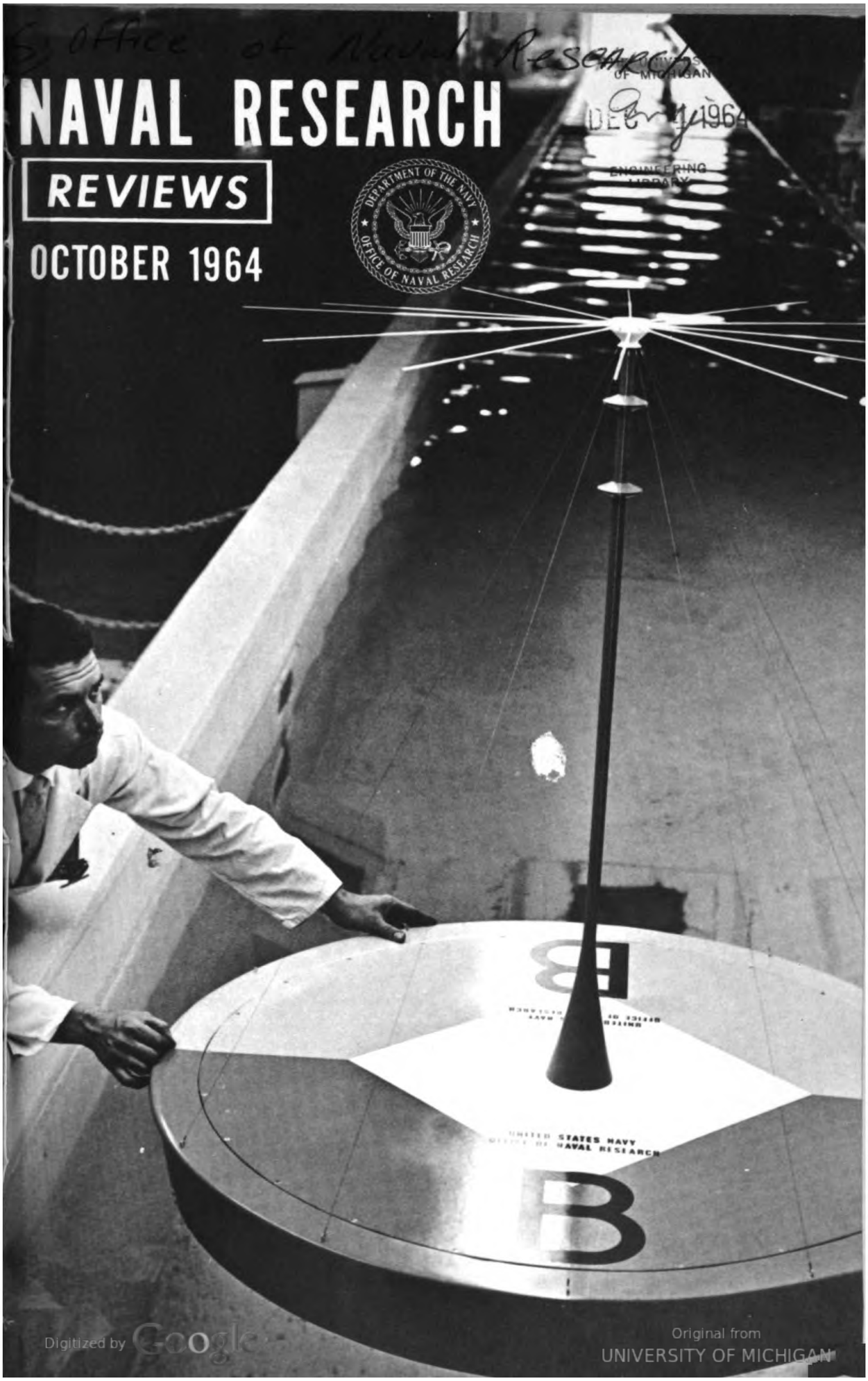
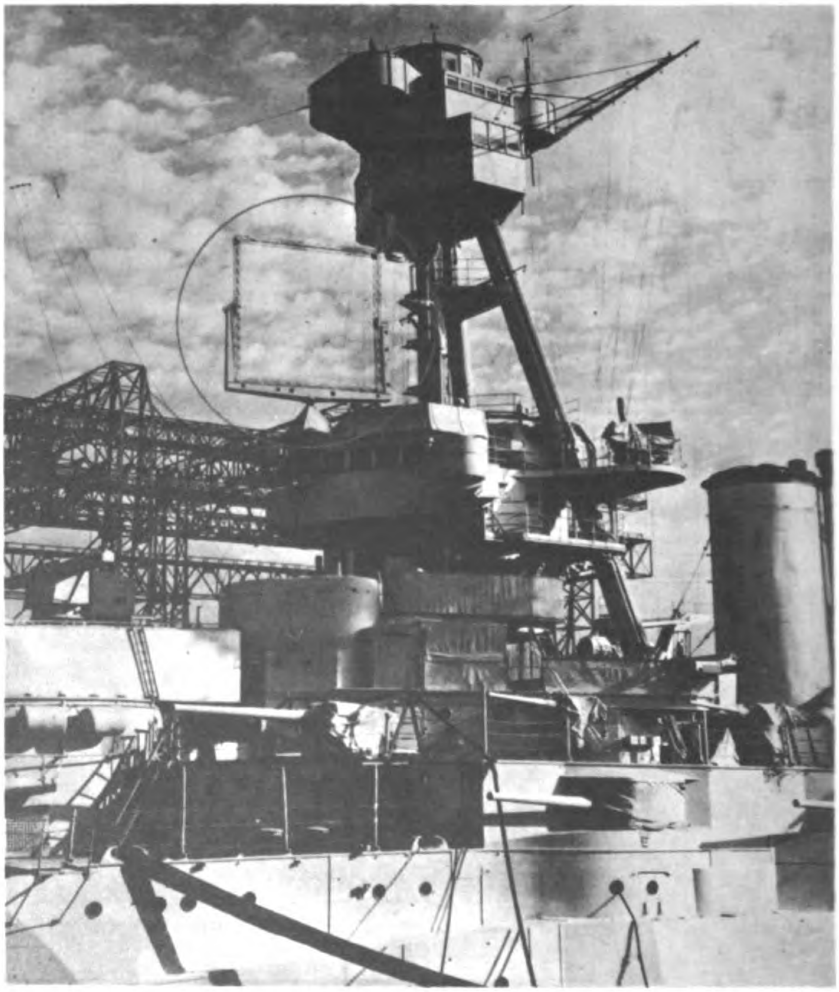


Famous Antenna Given Place in Museum

The XAF radio detecting and ranging device that first convinced the Navy and the world of the great potential of radar has been moved from the Naval Research Laboratory, where it was designed and developed, to a permanent "home" at the new Naval Historical Display Center. The Center houses models and souveniers of historical importance to the Navy.

On February 21, 1939, while mounted aboard the battleship USS NEW YORK, the oversized "bedspring" antenna and its associated electronic gear were tested against a squadron of fast destroyers making a mock torpedo attack under cover of darkness. The XAF quickly picked out the raiders, permitting them to be "sunk" by the battleship's searchlights, which served as guns. After the attack on Pearl Harbor, radar experimentation and development mushroomed. Thousands of sets were built and given vital roles to play in the Fleet and in the other services. Radar thus became one of the most important developments of the century.



The first operational radar as it looked aboard the USS NEW YORK in 1938.

The First Ocean Data Station

Air-Sea Data Collection on World-Wide Basis Foreseen in Network of Large Sophisticated Buoys

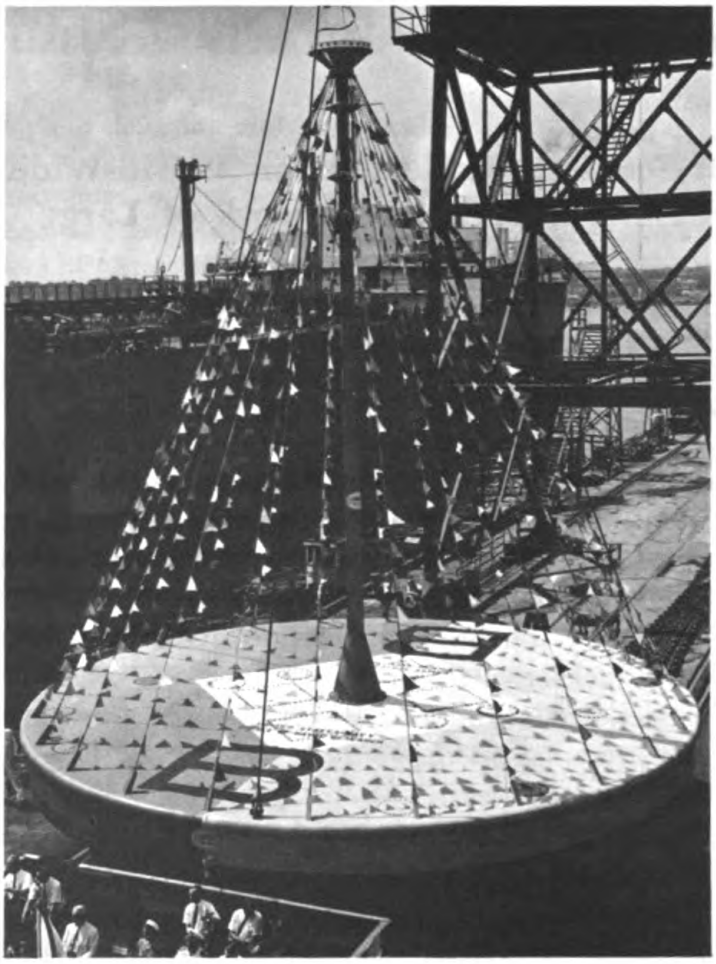
A prototype scientific oceanographic buoy, the first to be capable of telemetering on command a great amount of oceanographic and meteorological data to shore stations as far as 3,000 miles away while operating unattended for a year at a time, was launched by the Navy at Jacksonville, Florida, on August 20. The discus-shaped buoy, called Ocean Data Station, is 40 feet in diameter, 7 feet thick, and is topped by a 40-foot-high steel antenna mast. It was designed for the Office of Naval Research by the Convair Division of General Dynamics and fabricated by the Jacksonville Shipyard.

An initial series of tests of the 50,000-pound red-and-yellow buoy was begun in September in the Gulf Stream about five miles off the coast of Miami, where it was moored in 300 feet of water. The tests were planned for this time of year on the chance that the buoy would be exposed to a full-scale hurricane, which would serve to verify its seaworthiness. Scientists and engineers want particularly to determine the extent of strains on critical structural areas of the buoy and the temperatures and voltages of the electronic systems inside. Monitoring is being done from a mobile station, actually a converted passenger bus, that contains all the equipment required to command and receive data on structural strains from the telemetry package in the buoy.

The Ocean Data Station is the product of a four-year development program involving the investigation and testing of dozens of buoy configurations. The design finally selected had to be such as to enable the buoy to weather 60-foot waves, 10-knot currents, and 150-knot winds, and to permit anchoring in depths exceeding 20,000 feet.

A few buoys put in operation before the Ocean Data Station was conceived were designed to operate at comparable distances from receiving stations, but their mission was limited to the acquisition of meteorological data, the transmission of that data on only five or six channels, and unattended operation for no longer than six months.* In comparison, the Ocean Data Station will have 100 channels for gathering, storing, and sending oceanographic information; and its instruments will measure phenomena ranging from wind velocities and

*Recently, a buoy of this type, called NOMAD (Navy Oceanographic Meteorological Automatic Device), was adapted for collection of oceanographic data by the attachment of sensors to the mooring line.



Two views of the Ocean Data Station taken at time of launching.

air temperatures at the surface to currents and water temperatures many thousands of feet deep, to be obtained by sensors attached along the length of the mooring line.

When the buoy becomes operational, in about one year, the data it acquires will be stored in two memories. One has a 24-hour capacity, and the other is capable of retaining data for the entire one-year period the buoy will function. The buoy will be queried every six hours to collect all "perishable" information accumulated during that period of time.

Power for the electronics equipment will come from nickel cadmium batteries charged by piston-engine generators that burn propane fuel. The choice of this system was dictated in part by the requirement for off-the-shelf hardware. Thus, energy-conversion systems involving nuclear power and fuel cells could not be considered. Chemical batteries were also ruled out as the primary source of power because of the excessive number required to furnish the necessary 18,000 amp hours for one year's operation. And the possibility of using a diesel engine was discarded because such an engine would have to be designed to fit in the relatively small space of a buoy compartment and, therefore, would have to have a small bore, which would present starting difficulties. However, a thermoelectric generator system is being developed for the Navy by Westinghouse as a possible replacement for the piston engine.

The buoy's 7 foot-thick steel hull, which is shaped like a filled-in pie tin, is divided into eight compartments. The four smaller compartments, each of which is about 112 cubic feet in volume, house the electronics and energy-conversion equipment. The other four compartments are filled with plastic foam to provide buoyancy. The buoy carries a high-intensity xenon flash-tube beacon, located high on the mast, and an automatic fog signal.

Following the Gulf Stream experiment, the Ocean Data Station will be given a further series of tests in very deep water near the Bahama Islands. This study will be made to evaluate the buoy's behavior in deep water and the mooring line's effectiveness in supporting the many instrument packages strung along its length. The final trials of the Ocean Data Station will concern the actual transmission of oceanographic and atmospheric data from the buoy to the mobile shore station by short-wave radio over distances up to 3,000 miles.

A second Ocean Data Station, identical to the first one, is being constructed in California by Convair under contract to ONR. The first tests of this buoy will be made off the coast of San Diego in December.

One of the major problems yet to be resolved in the telemetering of a large amount of information on a world-wide basis is the availability of high-frequency channels (in the 3-30 mc/sec region), which

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Adaptation and Acclimatization of Mammals to High Altitude*

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Comparative physiological studies of animals made in recent years have yielded a rich harvest in examples of biological engineering. Perhaps the best known of these studies have concerned the remarkable orientation and sensory-perception abilities of birds, fishes, bats, and other animals. Less publicized, but also receiving considerable attention in this field, are investigations of the capacity of animals to withstand environmental extremes, such as temperature and pressure. Often information on this subject is sought for the purpose of improving man's ability to bear up under stresses imposed by these conditions. Although such studies are not substitutes for direct experimentation on man, they do contribute substantially by helping to define the broad background of biological adaptation† against which man must be viewed as an individual case.

That animals can survive at very high altitudes is well known from observations made of mammals living as high as 20,000 feet in the Himalayas. Surprisingly, the means whereby such species not merely visit, but live and even prosper, at heights to which man seldom ventures seem not to have excited much interest among mountaineers. Similarly, hypoxia (reduced oxygen intake) in man has been a topic of continuing interest to physiologists and aeromedical specialists since the classic studies of Paul Bert, but until recently little attention has been paid to the adjustment to hypoxia by natives who live their entire lives at high altitudes.

Peruvian Indians have been studied in recent years in order to identify and characterize those physiological features which make them so capable in their native highland. Miners living near the high-altitude

*The study described in this article received logistic support from the Office of Naval Research and financial support from the National Institutes of Health and the National Science Foundation.

†The word "adaptation" often is used loosely in both common and scientific parlance. The best current usage restricts the meaning of the word to the Darwinian sense: Changes in individuals entering a new environment are referred to as "acclimatization." The term "acclimation" describes experimental exposures representing a change (usually) in only a single factor.

station in Morococha, Peru, have a much greater metabolic capacity, both during physiological work tests and while playing soccer, than do visitors from sea level. Unfortunately, man is a poor subject for this kind of evaluation because of his great individual variability in characteristics and background, because adequate controls (comparable lowland races) do not exist, and because the numbers of human subjects and the types of experimental procedures that can be applied to them are by necessity limited. By studying wild animals we can hope to resolve some of these difficulties by comparing closely related highland and lowland species or subspecies.

The results described here were obtained from a preliminary survey made in 1959-60 of adaptations of some wild Andean mammals to high altitude. About a dozen species and subspecies of rodents, which, in contrast to larger animals, form altitudinally stable populations, were the principal subject material. Highland forms were taken from central and southern Peru and from northern Chile, and lowland forms from near Lima and Santiago.

As one moves upward in altitude, oxygen partial pressure (abbreviated "pO_2") is progressively reduced from the sea level value of 155 mm. Oxygen transport from the lungs to the tissues becomes more difficult until eventually the demands of the tissues exceed the supply. This "critical" altitude represents an index of altitudinal fitness, but it must, of course, be related to a specified metabolic level. Choosing a metabolic rate of twice the basal level to allow modest activity, some lowland mice showed a critical pO_2 of 115 mm, a reduction of only one quarter from the value at sea level, indicating an unacclimatized tolerance limit of three-quarters of an atmosphere (or an altitude of about 10,000 feet). Others were more effective, and the average for the nine lowland species tested was 93 mm. By contrast, the average for 14 highland species was 68 mm; and one race showed a critical pO_2 of between 50 and 60 mm, or only a third of the value at sea level. Highland men and highland mice exhibit a similar advantage in physiological performance over their less capable lowland relatives.

One might expect this superior performance in mice living at high altitudes to be associated with the phenomenon of higher erythrocyte (red blood corpuscle) content, which is observed in men following successful high-altitude acclimatization. On the contrary, our highland species and subspecies of mice averaged about the same in hematocrit (a measure of the relative erythrocyte volume) as their lowland relatives (47 percent as compared with 46 percent). A greater difference was noted between the vigorous species and the relatively sedentary types, the former having a distinct advantage in hematocrit at *both* high and low altitudes (52 percent as compared with 42 percent). The amount of hemoglobin, therefore, has not been an adaptive feature

in these native species. However, oxygen affinity of the hemoglobin of highland species was greater, a phenomenon already noted in prewar studies on several larger Andean mammals. Electrophoretic evidence indicated that this increased oxygen affinity may be related to a change in the net charge on the molecules.

Mountain men are reputed to have the advantage of large hearts and chests. Although the highland rodents had somewhat larger hearts, lungs, and diaphragms than the lowland rodents, the differences were very modest compared with those reported in laboratory rats and mice acclimated to high altitudes (12-25 percent as compared with 90 percent). Recent immigrants (housemice) at Morococha, however, showed a 50 percent increase in heart weight. Hemoglobin in diaphragm and leg muscle was about twice as concentrated in the highland rodents, but the acclimatized mice showed no such change.

When man travels to high altitude, the breathing rate always quickens in response to the hypoxia, a response that is reversed on return to sea level. Highland rodents, in a like manner, showed a much higher respiration rate than their lowland relatives. Even when respiration is stimulated in lowland mice by transfer to high altitude, it still is not as rapid as that of the highland forms. Furthermore, when the highland mice were lowered to sea level, *no* reduction in respiration rate resulted. Thus, their higher respiration rate did not depend on an hypoxic stimulus.

Many of the differences observed between resident rodents at high altitude and equivalent lowland forms are not the same as those produced by experimental or short-term hypoxia. This apparent conflict may be explained in terms of two different processes, acclimatization and adaptation. Both will act to meet the requirements of life at high altitude, but the former represents a quantitative distortion of an existing pattern, whereas the latter acts to fix more favorable functional and structural patterns through natural selection. Acclimatization is a phenomenon of the individual, while adaptation involves the history of the species or population. Although acclimatization can appear to be just as effective as adaptation—mice acclimatized to high altitude at Morococha exceeded some native highland mice in the performance test—it is achieved at some cost. Thus, the adrenals of mice at Morococha weighed three times as much as those of their fellows at sea level, whereas the adrenals of the native highland forms had the same weight as those of their species at sea level. Hypertrophy of the adrenal, a key endocrine gland, is taken as a general measure of the impact of a stressful situation on an animal. Adaptation in native mice, it would seem, has so successfully met the environmental requirements that the ambient hypoxia no longer presents a stress, and hence a metabolic stimulus. A thorough understanding of

these principles may modify our views on acclimatization and could lead to more effective selective procedures for the manning of environmentally stressful stations.

The First Ocean Data Station—Continued from page 3

are required for data transmission over long distances (3,000 miles). Unfortunately, the high-frequency region is already one of the most congested, both nationally and internationally. A number of organizations in the United States have been at work on this problem for the past several years, attempting to obtain exclusive frequency assignments for oceanographic services. They have also been trying to work out a comprehensive, highly efficient communications system—one making the utmost use of every kilocycle and minute of time. This effort is continuing.

Another problem remaining to be solved is the type of mooring line best suited to hold the Ocean Data Station in place in 20,000 feet of water for at least one year. The most available material—steel cable—is not practical because of its great weight when strung out over such a distance. Under consideration, therefore, are other materials, such as nylon and glass fiber. Nylon is readily available and has a good strength-to-weight ratio, but it has the disadvantage of stretching excessively. Glass fiber also is very strong in relation to its weight, but it has not as yet been developed fully and is not easily obtainable. These materials will be tested thoroughly before a selection is made.

Foreseen for the future is a network of hundreds of Ocean Data Stations covering the major ice-free waters of the world, available to all nations of the world. Four times a day, on a synoptic basis, these buoys will report on air-sea interactions, ocean currents, deep-ocean tides, animal migrations, the onset of tsunamis and hurricanes, and on many other phenomena. This information will be of immense value to science, weather forecasting, the fishing industry, and the Navy—particularly to the Antisubmarine Warfare Environmental Prediction System (ASWEPS).

The buoys of a few decades ago could be moored only in shallow water, or, if they were set adrift, could be recovered only with a lot of luck, and they were capable of collecting only a limited amount of data and transmitting it over short distances. Striking indeed is the contrast between them and the 40-foot-diameter, 100-channel, 3,000-mile-range buoy of today. With the launching of this new platform, both the accumulation of oceanographic data and the utilization of these data for the benefit of man will be greatly accelerated.

Seagoing Platform for Acoustic Research

In the August 1962 issue of NAVAL RESEARCH REVIEWS *appeared an article entitled "Giant Manned Buoy Brings Stability to Deep-Ocean Research." The subject of the article, a 355-foot-long cylindrical structure called FLIP (Floating Instrument Platform), was put in operation in the Pacific Ocean to facilitate studies of acoustic phenomena. A few months ago, a similar platform was launched in the Atlantic Ocean for the same purpose. The new structure is called SPAR (Seagoing Platform for Acoustic Research).*

On these pages, FLIP and SPAR are compared and some of the important characteristics of the latter are discussed. The introductory paragraphs, which apply equally to both platforms, were extracted from NAVAL RESEARCH REVIEWS, *August 1962.*

An enemy surface ship or submarine coming within range of a Navy ship's sonar system could slip by undetected—or appear to be where it is not—if the sound waves from it are distorted enough by the ocean medium through which they travel. Thus far, scientists have been unable to learn much about the details of this phenomenon in the open ocean.

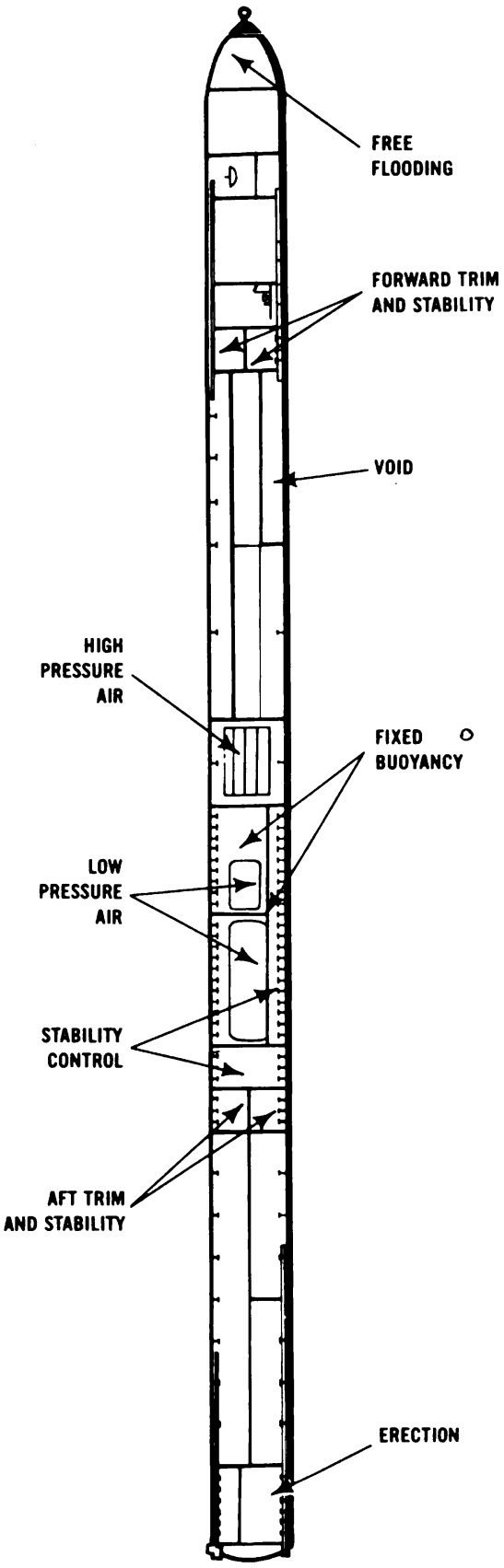
In general, the bending of sound waves is caused by inhomogeneities of the medium, just as the twinkling of stars occurs as the result of differences of the atmosphere through which the light waves pass. "Acoustic twinkling" in sea water presents a difficult problem because the ocean is an ever changing medium and because so many factors are involved, such as variations in temperature, salinity, and currents. Also, very exact measurements are needed. Ships are ordinarily used to obtain data of this type, but because of the accuracy required for sound-wave studies, they are not sufficiently stable. The station obtaining these measurements must be virtually immovable.

For a platform to remain nearly motionless relative to the water in the constantly moving sea, even during storms, a large amount of its weight must be situated at considerable depth. Ideas for creating a structure having this characteristic originated about 17 years ago. One suggestion made was to upend a submarine, placing sufficient weight in the stern so only a small portion of the bow would protrude from the ocean surface. But steps were not actually taken to build a stable platform until March 1960. That was when FLIP (Floating Instrument Platform) was conceived at the Scripps Institution of Oceanography's Marine Physical Laboratory in San Diego, California. This huge cylindrical structure was to be so designed that it could be towed

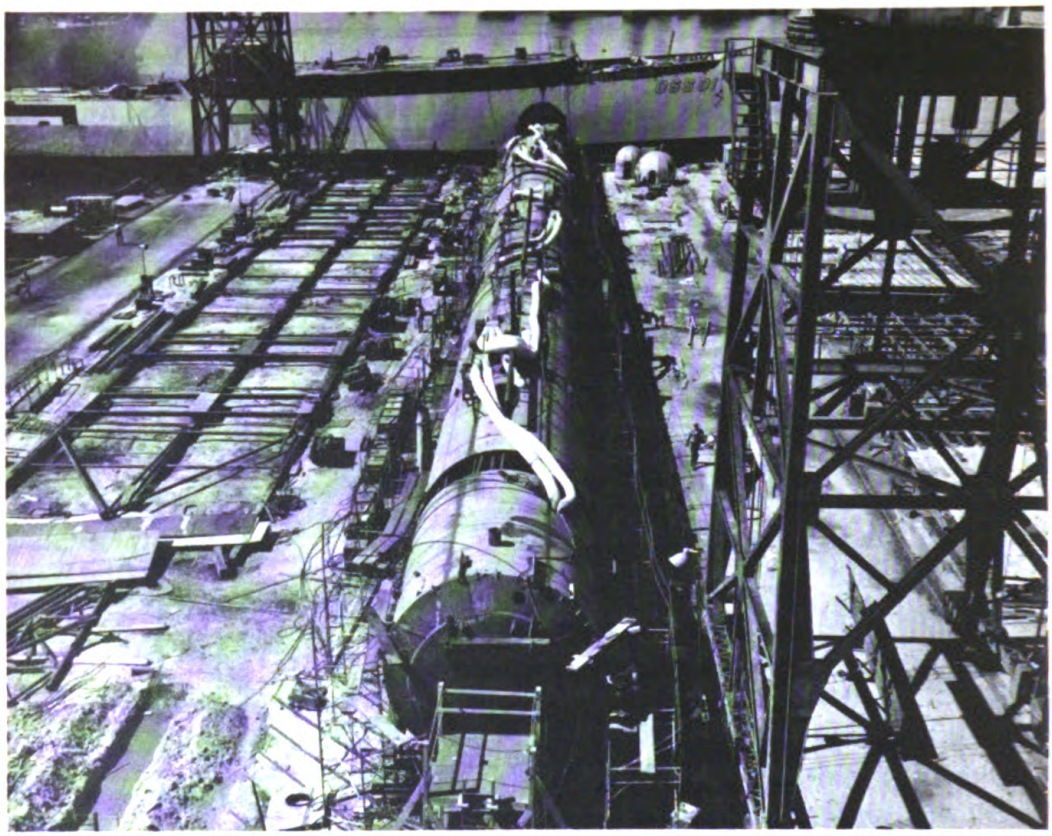
on the ocean surface in a horizontal position, then upended by flooding special ballast tanks in the stern. Most of the buoy's weight and bulk would then be situated well beneath the ocean surface, giving the platform maximum stability. FLIP was designed and built under the direction of the Office of Naval Research. She was launched in 1962 and is now being operated in the Pacific Ocean by the Marine Physical Laboratory.

Last July, another giant buoy was launched at Jacksonville, Florida. Designed and developed by the Naval Ordnance Laboratory, the new vessel, called SPAR (Seagoing Platform for Acoustic Research) was planned for operations in the Atlantic Ocean. Although SPAR and FLIP are similar in many respects (they are 354 and 355 feet in length, respectively, and about 16 feet in diameter), they were designed for different methods of operation, and therefore are dissimilar in important ways. For example, SPAR was intended for unmanned operations, whereas FLIP requires the services of a crew of several men. Thus SPAR will be controlled and receive its power by means of a floating cable connected to a "mother" ship situated nearby; FLIP, on the other hand, carries its own power source and thus can operate independently of a tender once it has been set up on station.

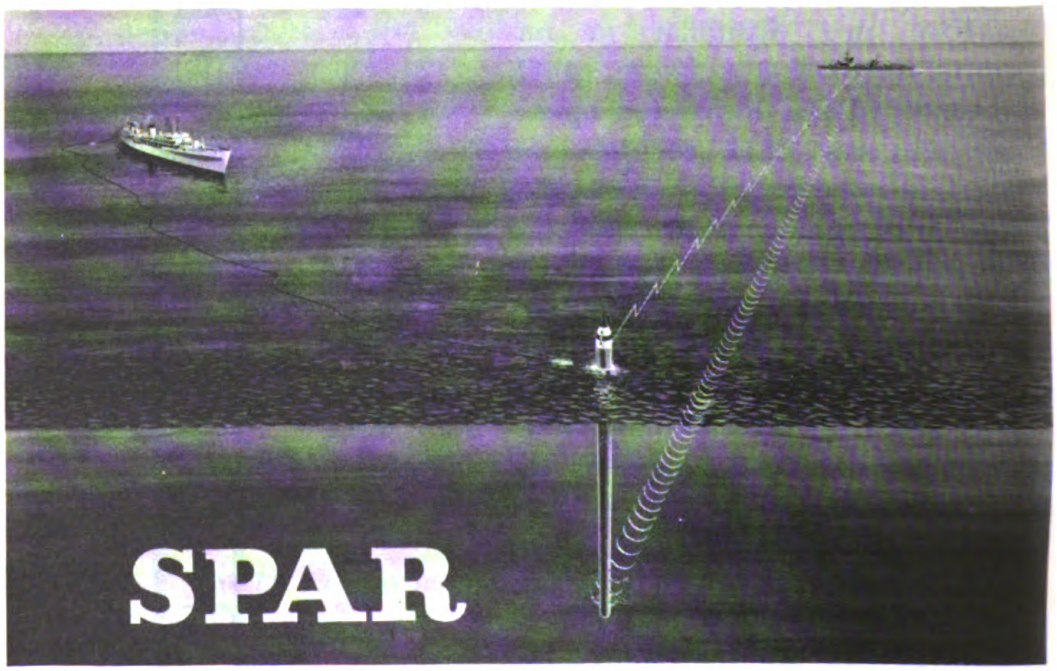
SPAR will be towed to its ocean stations in the horizontal position, then upended by the flooding of certain of its compartments—the same procedure followed in turning FLIP to the vertical position. With



Compartmentation of SPAR.



SPAR under construction in June 1964.



Artist's concept of SPAR on station. Power is supplied by electrical control cables extending from tender at left. Electromagnetic and acoustic signals are received by the platform from auxiliary ship at right.

304 feet of the vessel underwater and the remainder projecting above the surface, SPAR will be highly stable—its heave velocity being less than one foot per second in sea state 4, which is characterized by waves ranging from 5 to 8 feet in height. In a sea state 5, with waves 10 feet high, SPAR will have an average heave amplitude of less than 1 foot and a probability of exceeding a heave velocity of 1 foot per second of 2.7×10^{-5}. In normal seas, she will heave only a matter of inches, and her lateral movement will be negligible. Movement in the vertical plane, which is related to wave height and periodicity, is the most difficult of these motions to control. Lateral movement is due primarily to the horizontal component of ocean action against the structure, and also to the effects of wind force and direction. In both SPAR and FLIP, the length, shape, weight, and distribution of weight were all determining factors in the design to minimize both vertical and horizontal movement.

After SPAR has been put through her initial sea trials, she will be towed to the NOL test facility at Solomons, Maryland, and then to the Navy Yard Annex, Washington, D.C., to be outfitted with direction-finder antennas, gyrocompass, accelerometers, a string of thermistors, wave-measuring equipment, hydrophones, and recording instrumentation. Equipment external to the shell of SPAR has been kept to a minimum to decrease the tendency for the vessel to weathercock in the wind when the buoy is in the vertical attitude. Hydrophone bents extending 25 feet out from the centerline in each direction are located at the stern and 50 feet forward from the stern. In addition, hydrophone mounting rails are attached a few feet from and parallel to the cylinder walls for a distance of 200 feet forward from the stern.

When put in operation early next year, SPAR will require the services of two ships. One ship will tow the buoy to its station and serve as a tending vessel, supplying power by means of a 3000-foot floating electrical cable. The other vessel will stand off at distances of from 5 to 100 miles, transmitting electromagnetic and acoustic signals which will be picked up by the buoy's instruments. The combination of hydrophones and precision UHF direction-finder antennas, mounted on the cylinder, will enable SPAR to make very exact acoustic measurements at depths as great as 300 feet. A high-capacity data-logging system will be installed on the tender for recording data received from SPAR. Preliminary analyses of the data will be made on the tender, and detailed analyses will be made at NOL, using analog equipment and an IBM 7090 computer.

SPAR is constructed of rolled shell plating stiffened with T-beam longitudinals and transversals. It is subdivided by watertight bulkheads into ballast, buoyancy, trim and stability, free-flooding, and

— *Continued on page 28*

Transoceanic Migrations of the Green Turtle

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Professor of Zoology
University of Florida

In the interest of developing a valuable natural food source and of conducting an important biological study, the Office of Naval Research, the Caribbean Conservation Corporation, and the University of Florida joined forces several years ago to find ways of replenishing the green turtle population in Caribbean waters.

At the time the project was initiated, the green turtle population had dwindled alarmingly, the breeding grounds then being confined to the coast of Costa Rica. Biologists "transplanted" baby turtles from this homeland to many similar sites along other mainland and island coasts of the Caribbean. The result was the establishment of many new breeding grounds and a rapid upswing in the population of the protein-laden green turtle, "la pieza bella resistencia" to many Latin Americans.

The Navy participated in the conservation effort primarily because of its interest in the green turtle's remarkable orientation abilities, which may well lead to exciting improvements in long-range navigation.

In the following article, the chief investigator of the ONR-supported study of green turtles discusses some of his findings. The article is reprinted from Bioscience, August 1964, published by the American Institute of Biological Sciences.

One aspect of the program of studies of marine turtles being carried out at the University of Florida* has been a small tagging project at Ascension Island, in the South Atlantic between Brazil and Africa. The aim was to test the assumption that the green sea turtle, *Chelonia mydas,* is capable of long-range open-water navigation. Our much more extensive tagging data from Tortuguero, Costa Rica (3,000 green turtles tagged; 120 international returns) have shown clearly that *Chelonia* is a periodic long-distance migrant. The mainland location of that nesting ground, however, makes it difficult to prove that the turtles do not locate the place by following shorelines.

At Ascension Island 206 turtles were tagged by Harold Hirth in 1960 (Carr and Hirth, 1962). Eight of these have been recovered

*Supported by a NSF grant and an ONR contract with the University of Florida and the Caribbean Conservation Corporation.

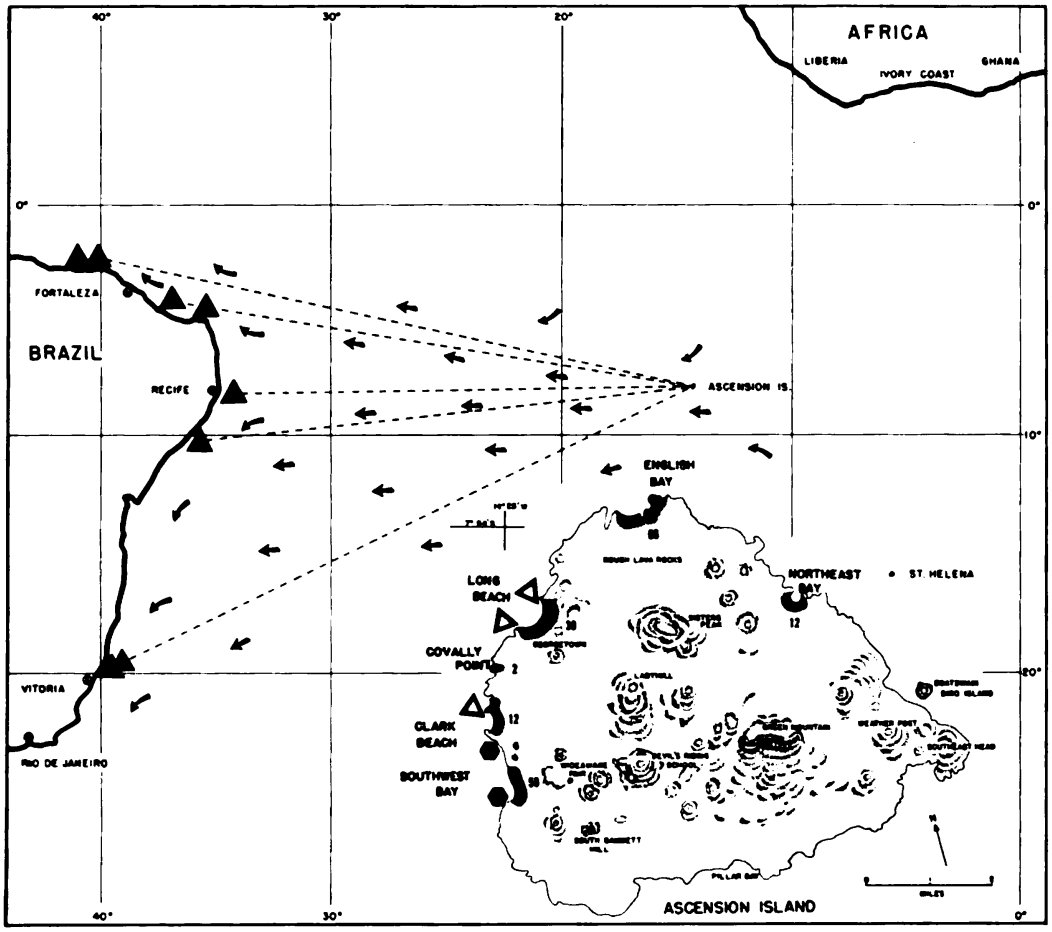


Figure 1 — History of a tagging project at Ascension Island. Two hundred and six turtles were tagged on the six nesting beaches (shaded areas) in 1960. The figure next to each nesting beach is the number of turtles tagged there. Solid triangles indicate locations on mainland where turtles were recovered. Hollow triangles indicate points to which turtles returned to nest in 1963 after a 3-year interval. Solid hexagons represent areas to which turtles returned in 1964, presumably for a second time, after two round trips to Brazil. All but one of the recovered turtles had gone back to the original tagging site. The one that failed to home precisely came out on an adjacent beach formed by recent wave action. Arrows represent ocean-current trends.

from the coast of Brazil. The recoveries were made both north and south of the bulge, at sites located downstream in both the Equatorial Current and the Brazil Current. There has been no return from the African coast, the nearest mainland shore to the island. Returns are shown in Figure 1.

Although the tag returns strengthen our original belief that Brazilian turtles go to Ascension to nest, they still do not prove it. To test the idea further, a tag-check patrol was made at three of the Ascension beaches during the 1963 season, three years after the original tagging year. At that time, the major three-year reproductive rhythm characteristic of the genus should have sent some 70 percent of the surviving 1960-nesters back to the island to nest again. Three of the 1960

tags were found, each on the same short strip of beach on which the turtle had been tagged. During the current season (1964), four years after the original date of tagging, the smaller component of the population that nests on a two-year cycle should be making its second round trip to the island. So far this season (as of May 1, 1964), two more tags were recovered, one at the place where both had been tagged, the other at a newly formed beach, a short way to the north.

Chelonia apparently never nests in two successive seasons. Its returns to the beach are every two, or more often every three, years. Because each year, after June, the disappearance of green turtles from Ascension waters is complete and because the mature female turtles that occur along the Brazilian coast do not nest there, it is logical to conclude that the three tagged animals retaken at Ascension in 1963 had returned for the first time since 1960 and had spent the interim in Brazil. The two 1964 recoveries almost surely represent the smaller contingent that nests each two years.

The growing solidity of the case for such regular long-range migration enhances the importance of Ascension Island as a site for experimental study of navigation problems. There seems to be no wholly satisfactory explanation for oriented open-sea travel by animals over distances so great that compass-sense alone would be insufficient to keep them on a successful course. The finding of Ascension Island, for instance, obviously requires more than compass-sense, and it also seems impossible to explain the turtles' arrival there by any process of piloting. The feat thus appears to be practically *prima facie* evidence of some sort of bicoordinate navigation. The problem here is to account for the necessary position-finding in the open sea, where there is no fixed reference by which to measure sun azimuth. All current explanations of island finding—by birds, green turtles, or any other animal—appear to rest upon somewhat tenuous theoretical grounds. The several theories can only be tested finally when migrating animals can be followed or tracked precisely and the guidance processes in operation at successive stages of the travel courses can be determined. It is a fundamental weakness in the outlook for research in animal navigation that in the case of the most spectacular of all guidance adaptations—navigation through and over the open sea—the travel courses have not even been plotted.

The periodic reproductive travel of animals to small mid-ocean islands seems a bizarre complication of the life cycle. The Ascension-Brazil system, however, may offer slight extenuations of the orientation problem. For one thing the island, though tiny now, is a peak of the Atlantic Ridge and may have been much larger at the time the travel patterns of ancestral green turtles were evolved by the species, by the genus, or some other ancestral stock. A slow shrinking of the old island would have allowed the gradual selective refinement of the

orientation capacity to find it. Today the Ascension-bound migrants are compelled to find a five-mile rock after a swim of over a thousand miles; but the early, less refined stages of the adaptation did not have to evolve under the current physiographic conditions.

Another conceivably significant advantage in the commuting between Ascension and Brazil — one that might reduce the minimum requirements in hereditary travel information — is the possibility of passive transportation of the naive hatchlings from the nesting ground to Brazil by the Equatorial Current. If they behave as mere plankton on the westward trip, the three-knot Equatorial Current and its branches could carry them within short distances of any of the localities from which our mainland tag-returns have come. The Ascension-Brazil relationships may even simplify the navigation problem on the eastward trip to the island. Perhaps the outbound migrants move northward or southward along the shore, turn eastward at some imprinted coastal landmark in the latitude of Ascension; from there on out to the point at which the island landfall is made, they would have only latitude to determine. Between Ascension and the nearest part of the bulge of Brazil, the Equatorial Current would complicate navigation with much less, and less variable, displacement than would plague migrants making a direct approach to the island from north or south of the bulge and crossing the current at a changing slant that would make constant position-finding and course-correction necessary. Until the migrating turtles have been tracked, it will of course remain impossible to say whether these natural geographic advantages are actually exploited.

Besides the indications from tag returns, much can be deduced about migration patterns of *Chelonia* from the known ecological geography of the populations. This geography clearly shows that specialized guidance processes are used. In an effort to fill gaps in one of these patterns and to locate a possible new site for tagging and tracking experiments, I visited the coast of the western Indian Ocean during September and October, 1963. A specific aim of the trip was to gather data bearing upon the possibility that the main green turtle populations of East African shores migrate to the island of Aldabra to nest. On the coasts of Kenya, Tanganyika, and Madagascar, I visited feeding grounds, collected information on age-groups, and investigated reports of local nesting beaches. All the latter proved to involve species other than the green turtle. Results of the survey suggest that the young and subadult green turtles that now occur on the East African coast are derived from rookeries located elsewhere. The situation resembles that on the Gulf Coast of peninsular Florida where, each summer, similarly immature schools of green turtles turn up in April from unknown origins and then disappear completely in November. In Malagasy waters, both two-year-old and mature green turtles

were found, but there, also, all evidence indicated that there has been no nesting in recent decades.

Along the African coast north of Mombassa, I made contact with the Bajun Island turtle fishermen, the traditional hunters of green turtles for the East African export trade. These people still use leashed sucking-fish in their turtling. The remoras are kept in tubs, cared for solicitously, and on calm days taken out in the dhows and dugouts to the turtling grounds. A line is fastened to the tail of the fish. When the head of a turtle is sighted, the remora is taken from its tub and dropped into the water. Special words of encouragement are said to it, and line is paid out. The remora, following its natural urge to fix itself to some larger animal, moves away in widening arcs, evidently guided by scent. It eventually intercepts the turtle and fastens to its shell. Then, either a diver goes down the line and takes hold of the turtle or other remoras are paid out to furnish more secure attachment. When three or four fish have taken hold, the pull that can be exerted on the several lines is strong enough to immobilize a good-sized green turtle.

The Bajuni people claimed that there is still some nesting by green turtles on a small island near the Somaliland frontier. Like other inhabitants of the coast, however, they said that most of the Kenya turtles "come from somewhere far off." All evidence pointed to Aldabra as the only important rookery remaining in the western part of the Indian Ocean, with the possible exception of one rumored to exist on the coast far to the south in Zululand.*

The recent delimitation of the breeding range of the Mexican ridley, *Lepidochelys kempi* (Hildebrand, 1963; Carr, 1963), reveals an extraordinary example of trenchant isolation between sea-turtle populations within a single ocean system. In this case the isolation is reflected by a fairly well-marked morphologic difference between the separated populations. Taxonomic divergence among separate nesting colonies of green turtles is mostly trivial, however, and on many feeding grounds it is not possible to distinguish between turtles from different breeding areas except perhaps on weakly statistical grounds. In some of the predominantly dark, high-shelled Pacific populations, however, an occasional light-colored, often yellowish, flat-shelled individual can be noted. I have seen such variants in the mid-Pacific – at French Frigate Shoal and on the islands of Pearl and Hermes Reef where *Chelonia* still emerges to bask on the sand among monk seals and albatrosses, at Espiritu Santo Island near the mouth of the Gulf of California, and in the Bay of Fonseca off Honduras and El Salvador – and other observers have told me of seeing them elsewhere. The single light-colored, flat yearling seen at French Frigate Shoal was

*Since this article went to press, the turtles of the Zululand Colony have been found to be the leatherback, *Dermochelys*.

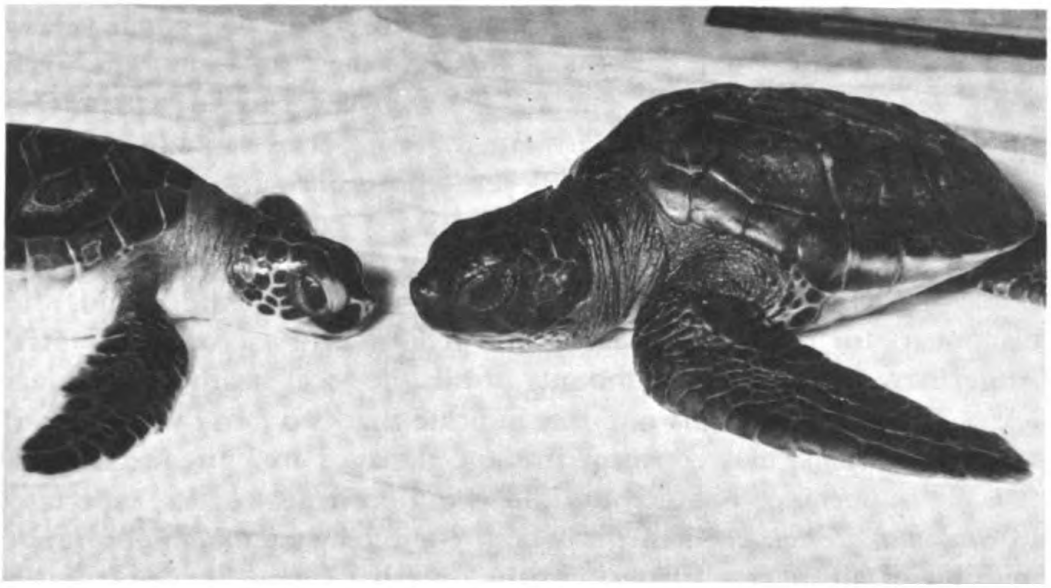


Figure 2—First-year *Chelonia* from Atlantic (left; Tortuguero, Costa Rica) and Pacific (right; French Frigate Shoal), showing deeper body and heavier black pigment characteristics of most East Pacific stocks.

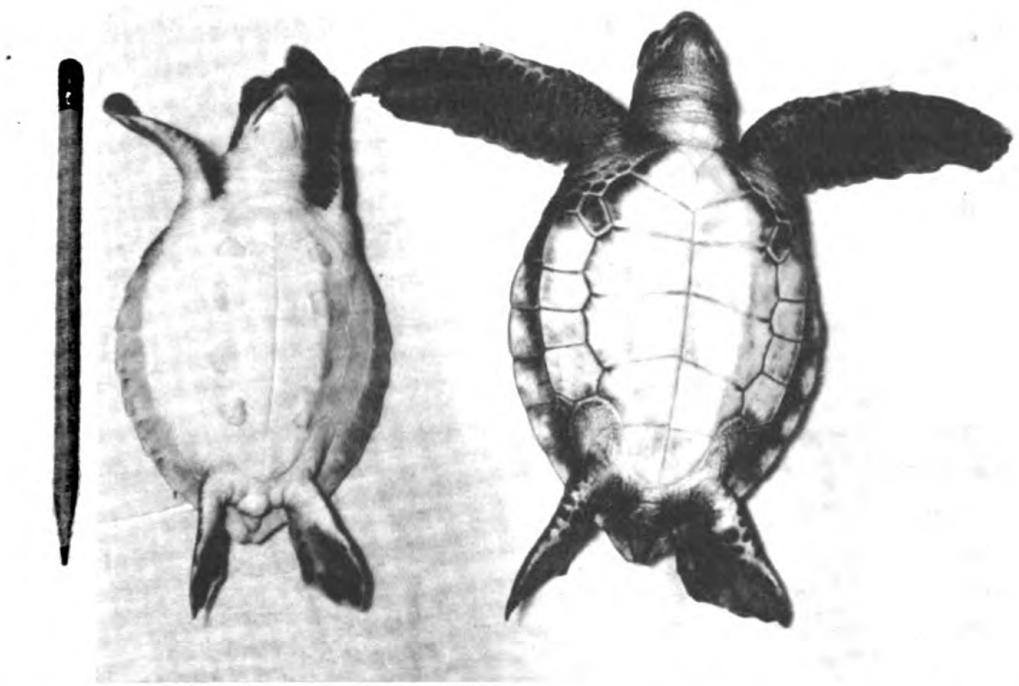


Figure 3—Ventral view of the Atlantic (left) and Pacific *Chelonia* shown in Figure 2.

especially striking because one of the few known nesting grounds of the dark form is located there. A six-month-old specimen from that colony is compared with a Caribbean green turtle in Figures 2 and 3.

I have nowhere been able to decide whether the occasional yellow East Pacific turtles were variants of the local dark stock or waifs from some genetically different population. Two years ago I had an extraordinary letter from Mrs. Carmen Angermeyer of Santa Cruz in the Galápagos Islands. Mrs. Angermeyer, whose husband deals in turtle oil, wrote me that to her eye the Galápagos "green" turtles were of two kinds: a black, high-shelled one that nests locally, and a light-colored, yellowish, flatter kind that nests nowhere in the Islands but disappears for part of the year. The yellow turtle, according to Mrs. Angermeyer, yields large amounts of oil; the local strain yields much less. These observations not only indicate that two fairly well-marked stocks of *Chelonia* may converge in the Galápagos area but also emphasize the importance of studying fat-deposition in sea turtles, especially in *Chelonia*. The green turtle is both the most systematic long-range migrant of all marine turtles and the one that carries the most fat in the body cavity. If the fat is, as seems likely, a ration for migratory travel, then fat assays might furnish criteria helpful in the determination of migratory schedules and destinations, as they have in birds (Caldwell, Marshall and Odum, 1963).

The Galápagos Islands seem a promising place for such studies. Another is the coast of Brazil, where the main green turtle stock moves out to Ascension to nest while a small contingent goes no farther than the nearby island of Trinidad. Still another is the Gulf Coast of Florida, where the immature summer population clearly comes from some distant locality and probably goes back there when it leaves in October.

Acknowledgments

For their collaboration as research associates in the Ascension Island tagging work, I am indebted to Dr. Harold Hirth, to Mr. K. E. L. Simmons, and to Mr. C. A. Jones. The British Cable and Wireless Ltd. at Ascension Island, and the Down Range Affairs Office of Patrick Air Force Base, Cocoa Beach, Florida, and Ascension Island, have furnished important cooperation. For his sustained interest in the problem and his aid in documenting tag recoveries, I am grateful to Dr. Melquíades Pinto Paiva, Director, Estacão de Biologia Marinha, Universidade do Ceará, Fortaleza, Brazil.

At the Governor's palace in San Juan, Puerto Rico, CAPT Bennett, acting in behalf of the Chief of Naval Research, recognizes the contributions and accomplishments made by key participants in the green turtle project. CAPT Bennett is shown here making the presentation to Mrs. Munoz, wife of the Governor, who is standing to her left. To the left of the Governor are CAPT Bridgers and Dr. Galler. On the far left of the picture is Puerto Rico's Secretary of Agriculture, Luis Rivera Santos. RADM Caldwell was not present.

Literature Cited

Caldwell, Larry D., Eugene P. Odum, and Shirley G. Marshall. 1963. Comparison of fat levels in migrating birds killed at a Central Michigan and a Florida Gulf Coast television tower.

Carr, Archie. 1963. Panspecific reproductive convergence in *Lepidochelys kempi*. *Ergebn. Biol.*, **26**:298-303

Carr, Archie, and Harold Hirth. 1962. *The ecology and migrations of sea turtles, 5. Comparative features of isolated green turtle colonies.* Amer. Mus. Novitates No. 2091, 42 pp., 20 figs.

Hildebrand, Henry H. 1963. Hallazgo del área de anidación de la tortuga marina "lora," *Lepidochelys kempi* (Garman), en la costa occidental del Golfo de Mexico. *Ciencia,* **22**(4): pp. 105-112, 3 figs.

On August 6, 1964, contributions to the success of the green turtle project were recognized at a ceremony held in the Governor's Palace in San Juan, Puerto Rico. CAPT B. F. Bennett, Director of the Naval Research Laboratory, acting in behalf of the Chief of Naval Research, RADM J. K. Leydon, presented certificates of commendation and appreciation to individuals who played key roles in the green turtle undertaking. Those cited were the Hon. Inez M. de Munoz Marin, wife of the Governor of Puerto Rico, for the encouragement she gave to conservationists and scientists engaged in the project; Dr. Sidney R. Galler, Head of ONR's Biology Branch, for the technical leadership he provided; and RADM H. H. Caldwell, USN, Commander, Caribbean Sea Frontier, U. S. Naval Station, Roosevelt Roads, Puerto Rico, and CAPT H. C. Bridgers, Jr., USN, Commanding Officer, U. S. Naval Station, Roosevelt Roads, Puerto Rico, for the material assistance they gave to project personnel.

Research Notes

Oldest Scientist Given Highest Award

Dr. Edwin Bidwell Wilson, science consultant for the Office of Naval Research Branch Office, Boston, has been given the Navy Distinguished Civilian Service Award—the highest award granted by the Navy to civilian employees—in recognition of his more than 15 years of valuable service to the Department.

The 85-year-old Dr. Wilson, the oldest scientist serving the Federal Government, began his active career with the Navy at nearly 70 years of age, a time of life when most men retire. In the words of Dr. Frederick Seitz, President of the National Academy of Sciences, "Dr. Wilson has played a leading role in determining the spirit of much of the evolution which has occurred in science and technology in our country in the last 50 years."

Dr. Wilson graduated from Harvard in 1899 and received his Ph.D. from Yale in 1901 when only 22 years of age. His work in science during the next 45 years was on a grand scale. While at Yale, 1900-1907, he was a distinguished protegé of Professor Josiah Willard Gibbs, the mathematical physicist who developed the basic theory of the science of physical chemistry. Later, at M. I. T., 1911-1922, he became a pioneer in the formulation of aeronautical theory. During this period he helped to found M. I. T.'s Department of Aeronautics. In 1920, he was appointed secretary of a committee of three which managed M. I. T. during a two-year period after the death of President MacLaurin. And then, characteristically, he launched a new career as Professor of Vital Statistics at the Harvard School of Public Health, a post he held until his retirement from teaching in 1945. While in this position he applied his unique aptitude for statistics to the development of a novel approach to analysis and systematization of public health information.

The citation, in part, reads, "Dr. Edwin Bidwell Wilson, brilliant contributor to the development of aeronautical theory and the founding of Naval aviation and for more than 15 years a valued advisor and consultant to the Office of Naval Research in many fields of scientific research and research administration, has had a vital influence on the development of an effective and successful policy for administration of government research programs by the Navy."

Important New Application Found for Malaria Drug

At a special roundtable discussion held in conjunction with the annual meeting of the American Society for Microbiology, Dr. M. G. Sevag of the School of Medicine, University of Pennsylvania, reported on the results of his investigations on microbial resistance to antibiotics (*Naval Research Reviews*, July 1963). For many years, Dr. Sevag has conducted research on this problem at the University of Pennsylvania under a contract with the Office of Naval Research.

Dr. Sevag has learned that a combination of penicillin or streptomycin and a second drug belonging to the group of chemicals known as "polyamines" prevents the emergence of antibiotic-resistant bacteria. Quite recently, Dr. Sevag found that atabrine, the drug commonly used in World War II to prevent malaria, functions as well as a polyamine when combined with streptomycin. Atabrine has been widely used and accepted as a chemotherapeutic agent in human medicine, whereas the polyamines have not (their effects on the human system have not yet been investigated thoroughly). Therefore, atabrine shows exciting promise for widespread clinical use in combination with such antibiotics as streptomycin, penicillin, sulfathiazole, chloromycetin, novobiocin, and tetracylin.

Dr. Sevag hopes that this combined chemotherapy will be the ultimate answer to the serious problem of microbial resistance to antibiotics encountered daily in our military, veteran, and civilian hospitals.

TRANSDEC Begins Operations

The Navy Electronics Laboratory has formally opened a huge sonar transducer test and evaluation center, known as TRANSDEC, on Point Loma near San Diego, California. Research, development, and test functions performed at the center—a concrete anechoic tank 300 feet long, 200 feet wide, and 38 feet deep—are directed primarily toward the improvement of weapons systems for submarine warfare, mine hunting, and ASW and mine countermeasures. TRANSDEC is one of the largest artificial transducer testing tanks in the world, and it is the only one of its kind.

A transducer takes energy or power from one source and applies it to another system, just as, in the case of a telephone, the electromagnetic energy generated by distant talkers is transformed into acoustic vibrations at the listener's ear. For perfecting these instruments, the concrete pool has many advantages over a natural body of water. Elimination of fish and other marine interference and complete control of surface and subsurface conditions are two of the more important of these.

The new pool's echo-free sound field is obtained by the unique design of the bottom. Basis for the design is an ellipsoid of revolution forming the central bowl, which is 160 feet in diameter. The ellipsoid forms a bottom slope which reflects all unwanted sound into the absorbent trap which surrounds the central bowl. By locating the test transducer at one focus of the ellipsoid, only the direct sound is recorded by the listening transducer. All reflected, or echo, sound dies in the absorbent trap.

A circulating system is installed to keep the water moving so as to prevent stagnation. In addition, the water is treated with copper sulphate to prevent growth of algae. The main calibration building is suspended from a truss bridge across the pool, isolating it from the water and preventing structure-noises from entering the liquid and influencing the measurements. An adjacent building houses filtration and pumping plant, work areas, storage room, and power installations.

Antarctic Peninsula to be Studied

Early in 1965, the United States will establish a new research station in the antaractic. It will be located about 1700 miles from the South Pole on mountainous Anvers Island, about 25 miles off the coast of the Antarctic Peninsula. The new station, to be called Palmer Station, in honor of Nathaniel Palmer, an American seal hunter who explored the region in 1820-21, will be established to give American scientists the opportunity to investigate the glaciers, geology, plant and animal life, and other features, of the peninsula region.

Like other U. S. research ventures in the antarctic, projects undertaken at Palmer Station will be administered by the National Science Foundation. Also, as in the past, the Navy's Operation Deep Freeze will provide logistic support. During the antarctic summer, when the base will be constructed, 7 scientists and 16 Navy men will live there. During the long winter night, 5 scientists and 4 sailors will occupy the station.

Three glaciologists and two biologists will conduct the first year's scientific investigations.

The biologists plan to study antarctic insects—the only permanent land-dwelling animals in antarctica. Small numbers of primitive flies, ticks, mites, midges, and springtails are found in the peninsula region, and a few are found elsewhere on the continent. The biologists will identify species and investigate their distribution, living conditions, life cycles, and physiology.

They will also survey the plant life of the area, which is primitive and sparse relative to that of the rest of the world, but considered lush for the "last continent." There are algae, fungi, lichens, mosses, liverworts, and three flowering plants struggling for existence—two grasses and an herb; Anvers Island marks the southerly limit of flowering plants.

Studies of the ways that primitive flora and fauna maintain their tenacious grip on life at the limits of tolerance—freezing cold, desert dryness, and a dearth of nutrients—will perhaps reveal principles applicable to more complex forms of life.

One of the major advantages Palmer Station offers in the field of glaciology is the simplicity of the experimental conditions. Because glacial movement and sources of ice accumulation and wastage on Anvers Island are confined to the island, many of the variables that complicate the study of such glacial systems as the great continental icecap are eliminated. Principles discovered in a small, isolated system may prove applicable to more complex systems. The glaciologists will also study sea ice conditions to facilitate future oceanographic projects.

Other scientists who are expected to conduct research at Palmer Station in future years include geologists, meteorologists, upper atmosphere physicists, and geomagnetic observers.

The New Assistant Secretary (R&D)

The former Dean of the College of Brown University has succeeded Dr. James H. Wakelin as Assistant Secretary of the Navy (Research and Development). The new leader of the Navy's research and development activities, Dr. Robert W. Morse, was appointed to the office by President Johnson on July 10.

Dr. Morse has been associated with the Navy since he was commissioned ensign in the Naval Reserve in 1942. After his graduation from Bowdoin College in 1943, he went on active duty for the Navy, serving as a compass adjuster, an instructor in small-boat handling, and as an instructor in navigation.

As a civilian physicist, Dr. Morse performed research in the fields of ultrasonics and low-temperature physics, and he served many times as a Navy consultant in underwater acoustics and antisubmarine warfare. He has also been a member of the Undersea Warfare Committee of the National Academy of Sciences since 1947 and chairman of the committee since 1962. Recently, he was appointed chairman of the Division of Solid State Physics of the American Physical Society. He is also the president-elect of the Acoustical Society of America.

Dr. Wakelin was appointed Assistant Secretary of the Navy (Research and Development) on June 5, 1959. However, his involvement in Naval Research began many years earlier. During World War II, he was Ordnance Staff Officer to the Coordinator of Research and Development, Navy Department, and shortly afterward he served as head of the Chemistry, Mathematics, and Mechanics Section and of the Materials Section of the Planning Division, Office of Research and Inventions. In the latter capacity, he was active in planning and organizing the Navy's program to sponsor basic scientific research, now under the direction of the Office of Naval Research.

Dr. Wakelin also directed research for the Navy through his association with several private firms. For example, he directed the Field Survey Group of ONR's Project SQUID, under contract to Princeton University; and he directed investigations in the field of underwater sound and acoustic devices and on the structure and physical properties of high polymers.

Dr. Henry A. Imus

Dr. Henry A. Imus, Deputy and Assistant Director of Research and head of the Psychological Sciences Division, Naval School of Aviation Medicine, Pensacola, Florida, died on May 18.

Dr. Imus was well known to the Office of Naval Research because of his nine years of service to that organization (1946-54) in the Psychological Sciences Division in Washington and as scientific liaison officer (psychology) in ONR's London Branch Office. He was also a familiar and active figure in the Naval Research Reserve program, for which he planned, organized, and conducted seminars in aviation medicine and aerospace medicine.

During World War II, Dr. Imus received outstanding recognition for research conducted on vision under the National Defense Research Committee of the Office of Scientific Research and Development. After the war years he was involved in psychological research for the Government with the Bureau of Medicine and Surgery in Washington, D.C., the Office of Naval Research, National Institutes of Health, and the Naval School of Aviation Medicine (Bureau of Medicine and Surgery).

In May 1963, Dr. Imus was presented the Raymond F. Longacre Award at the Aerospace Medicine Association's 34th annual scientific meeting. The

award is given annually to one of the association's 4000 members for outstanding accomplishment in psychological and psychiatric aspects of aviation medicine.

The Thermistor Chain

A valuable device for measuring ocean water temperatures both rapidly and at many depths simultaneously is the thermistor chain, a 37,500-pound string of sensors that can be lowered from the stern of a ship to a depth of 800 feet and operated while the ship is underway. Since the sensors, called thermistors, report their readings constantly, the thermal structure of the ocean can be measured in two dimensions – depth and distance. The readings are then fed to a computer on board ship that translates them into isotherms (lines of equal temperature).

The thermal measuring device, a product of the Navy Electronics Laboratory, is large and rugged. The chain, which is wound on a drum, consists of flat links about 10 inches long, 8 inches wide, and 1 inch thick. At the end of the chain is a 2300-pound streamlined "fish" which serves as a weight. Through grooves inside the flat links are strung about 80 pairs of insulated wires that connect with the sensors every 27 feet along the upper end of the chain and every 9 feet along the lower length. The shorter spacing at the lower end of the chain permits greater thermal detail to be obtained when only this section of the chain is in the water.

An important feature of the water structure is the depth of the seasonal thermocline – the level at which an abrupt change in temperature occurs. A knowledge of the exact thermocline depth, changes in depth, and the characteristics of associated water masses and their boundaries is important to the evaluation of sound transmission in the oceans. Thermocline depths may be easily scaled off of the continuous record provided by the thermistor chain and contoured if desired.

Another important property of a thermocline is its sharpness, or the number of degrees change in temperature which occurs per unit of depth. This sharpness varies from place to place as well as in time. The number of degrees change in temperature over a given vertical distance can be scaled from the recorded isotherms, thus making it possible to construct a geographical "map" of thermocline sharpness.

Probably the most useful parameter which the chain reveals is the roughness of the thermocline. In some regions the isotherms are nearly level, in others they form large vertical sinusoidal oscillations, and in still others they occur as rough, peaked waves. Isotherm oscillations of the latter two types, which are called internal waves, may travel long distances, much as do surface waves. They are believed to be caused by a number of factors, such as converging currents, tide currents, and storms.

A knowledge of the roughness of the thermocline is extremely important to the Navy, because such a condition affects the direction in which sound travels through the thermocline. When the thermocline is rough, the sound rays bend and even cross each other, concentrating and rarefying different patches of the sound field and thus making acoustic detection in the sea more difficult.

Through further study of the thermal structure of the sea by means of the thermistor chain and other equipment we will understand better the causes of thermocline roughness and will be able to predict its character in distant areas from a knowledge of weather, currents, bottom topography, and other related features.

SQUID Director Honored

Dr. John B. Fenn, professor in the Department of Aerospace and Mechanical Sciences at Princeton University, was honored by RADM L. D. Coates, former Chief of Naval Research, at a ceremony held at the University shortly before the admiral retired from Naval service in July. The honor, which was in the form of a letter of appreciation, was given for his service as director of the ONR-supported Project SQUID.

Under Dr. Fenn's leadership, Project SQUID fostered many fundamental and applied research investigations at leading universities in the field of jet propulsion. Combustion, fluid dynamics, heat transfer, and kinetics, as well as applied work on engine cycles, were studied.

Last year, Project SQUID was transferred to the University of Virginia. The new director is Dr. John E. Scott, Jr., professor in the Department of Aerospace Engineering.

Dr. Ralph Roberts, left, Head of the Power Branch, ONR, and his deputy, Mr. J. R. Patton, Jr., center, present letter of appreciation to Dr. John B. Fenn, right, for his services as director of Project SQUID.

National Academy of Engineering Planned

Plans for the formation of a National Academy of Engineering were announced at the last annual meeting of the National Academy of Sciences in Washington, D.C. The plans were drawn up by a committee composed of 25 of the Nation's leading engineers, appointed by Dr. Frederick Seitz, president of the NAS.

The committee, which will seek a Congressional charter for the proposed academy, elected the following three officers at its meeting: Dr. Augustus B. Kinzel, Vice President for Research, Union Carbide Corporation, chairman; Dr. Eric A. Walker, President, The Pennsylvania State University (and Chairman, Naval Research Advisory Committee), vice-chairman; and Dr. Harold K. Work, Director of the Research Division and Associate Dean, School of Engineering and Science, New York University, Executive Secretary.

Scripps Scientist Honored by French Oceanographers

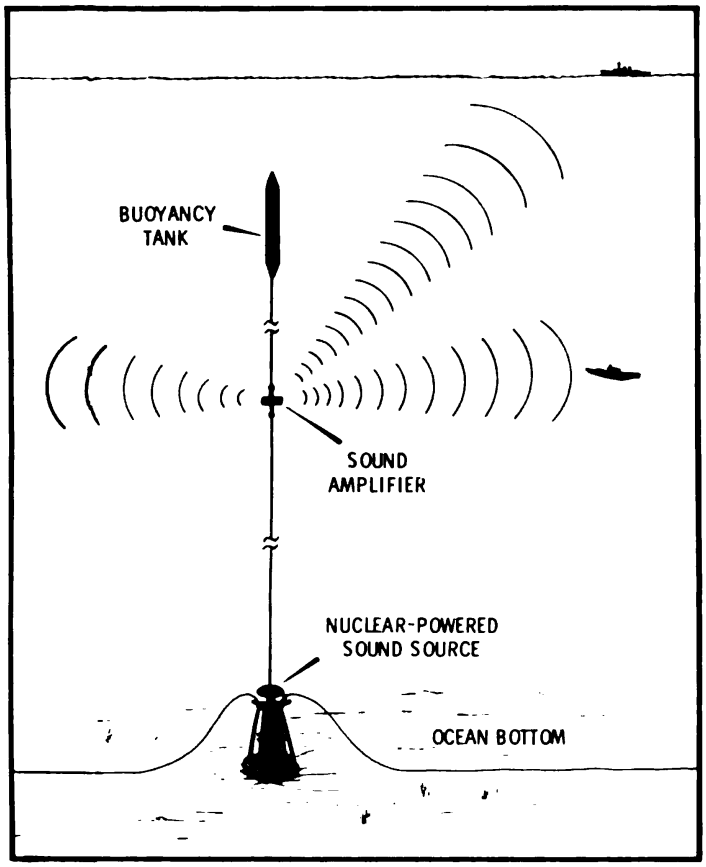
Dr. Gifford C. Ewing, research oceanographer and former chairman of the Oceanic Research Division of Scripps Institution of Oceanography at the University of California, San Diego, has been awarded the Albert 1st, Prince of Monaco, Medal, the highest distinction which can be given by the Institut Oceanographique of Paris, France. Dr. Ewing was selected for the prize for. "your wonderful oceanographical researches and for your fine spirit of international cooperation."

Since joining the faculity at Scripps, Dr. Ewing has worked extensively with the Applied Oceanography Group in infrared temperature mapping of the ocean from aircraft. He has also conducted aerial reconnaissance of the ocean and coastal estuaries, and he has studied internal wave action, physics of the sea surface, oceanic diffusion, and thermal gradients. Much of this work has been conducted in Mexican waters.

Next spring, Dr. Ewing is planning a trip to Europe, at which time he will accept his oceanographic award.

Deep-Sea Nuclear Generator Aids Navigation

Late last July, the SNAP-7E isotopic generator, which was designed for use by the Navy as an undersea navigational aid, was placed on the floor of the Atlantic Ocean at a depth of 15,000 feet about 750 miles off the coast of Jacksonville, Florida. The device will provide about 7 watts of electrical power continuously for at least two years.



Artist's concept of SNAP-7E in operation. The sound amplifier is situated about 3,000 feet above the generator. It is supported by a buoyancy tank located 50 feet higher. The lines to the right and left of the generator represent 4-mile-long grappling cables which can be used to recover the unit.

The letters SNAP stand for Systems for Nuclear Auxiliary Power, a series of power devices developed for sea, space, and land use by the Atomic Energy Commission. SNAP-7E was built for the AEC by the Martin Company, Baltimore, Maryland.

Four cylinders in the center of SNAP-7E contain fuel pellets of strontium 90 (31,000 curies weighing about 3 pounds) alloyed with titanate in a relatively insoluble compound. Heat produced by the spontaneous decay of the fuel is converted directly into electricity by 60 sets of thermocouples grouped around the fuel. The long life of the fuel and the absence of moving parts in the energy-conversion system insure long-term, maintenance-free operation.

The nuclear generator is carried in a 6-inch-thick, cast-iron cylinder covered by a plate of depleted uranium that serves as a biological shield. This container, in turn, is placed within a 2-inch-thick forged-steel vessel capable of withstanding extremely high pressures. Also carried in the pressure vessel are the energy storage system and electronic equipment. The pressure vessel is 31-1/2 inches in diameter, 64 inches high, and weighs about 6,000 pounds. The

heavy shielding cuts external radiation to a minimum and contributes to the overall ruggedness of the device.

The entire unit is encased in a six-sided steel superstructure designed to absorb pressure while being placed on the ocean floor. The superstructure also supports the buoyancy tank. The total height of the unit, including superstructure, is about 10 feet.

Seagoing Platform for Acoustics Research—
Continued from page 11

equipment compartments. The attitude of SPAR is controlled by flooding or blowing a tank at the stern. During the change of attitude, stability is maintained principally by shifting salt water ballast between two tanks. When the buoy is in the vertical position, its trim is adjusted by means of eight small ballast tanks, and its orientation about the longitudinal axis is accomplished by operation of a small, reversible propeller mounted on the skin of the ship.

Four machinery rooms have been built into the forward end of the vessel. They will house a diesel generator (for use when external power is not available), air compressors, and storage batteries; two radio direction-finder antennas and the analyzer for an optical-twist measuring device; the gyro compass and electronic instruments; and the pump and valve stations. A ventilation system will provide automatic heating of the electronics compartment, pump room, and machinery compartment and automatic cooling of the electronics compartment.

Early in 1965, SPAR will begin making a series of one-month cruises in the Atlantic. The first year's studies will concern the properties of the ocean that affect underwater sound transmission. They will be undertaken in areas about which information is available on the ocean structure and profile of the bottom. The following year, a research program will be conducted to determine the extent that long-range underwater sound transmission is affected by the various parameters of the ocean. This program will be carried out in ocean areas that are representative of as many conditions of sound transmission as possible.

Sounds produced in the oceans can serve both to conceal and reveal the objects which emit them. Through the work to be done by SPAR it is hoped that many of the potential acoustic "hiding places" of enemy submarines will be uncovered and that methods of detecting these craft in all ocean environments will be improved.

Inventions

Disposable Bomb-Arming Device

When a bomb is launched from an aircraft, it is generally not armed until it starts its travel away from the aircraft. Since most present-day bombs are electrically armed, it is necessary to have an electrical connection between the aircraft and the fuse during part of the downward travel of the bomb. After the bomb has gone a short distance, a switch is closed, sending an electrical impulse to the bomb fuse. The electrical cable then separates and either travels with the bomb or is retracted into the aircraft.

Although such devices arm bombs satisfactorily, they can be hazardous, because before the bomb is launched, the arming cable is formed into numerous bends, so as to occupy as small a space as possible, and thus acts as an antenna, which is vulnerable to electromagnetic radiation. To avoid this danger, the Engineering Department of the Naval Avionics Facility, Indianapolis, Indiana, developed an inexpensive disposable bomb-arming device that is not affected by radiant energy.

When this arming device is installed in a bomb aboard an aircraft, a quick-disconnect-type connector on the device is mated to the electrical connector on the bomb rack. The two outer shells of the connector are mated together before the connector pins come into contact. In this manner, arcing through the connector pins is prevented when the arming device is plugged in, and the outer skin of the bomb is kept electrically isolated from the fuse assembly.

The arming device, which is firmly attached to the bomb, contains a circular groove in its top face for receiving the arming cable. As the cable is withdrawn from the groove after the bomb is launched, a pin held in place by the cable is released. Movement of the pin actuates a single-pole switch within the arming-device casing, thus energizing the arming circuit of the bomb. The duration of the energization phase is controlled by a second pin, which limits the length of arming cable that can be withdrawn from the groove. When the unwinding cable reaches this pin, the sudden increase in cable tension caused by the falling bomb releases the quick-disconnect coupling, and the bomb separates entirely from the aircraft.

A patent covering the "Disposable Bomb Arming Device"—No. 3,101,055—was issued to Messrs. William Kuntz and George Souviner of NAFI on August 20, 1963.

Improved Dosimeter

Over the past several years a number of patents have been issued on the inventions of Navy employees relating to radiation-dose measuring devices. One of these is Patent No. 3,115,578, which covers an improvement in thermoluminescent radiation dosimeters made by Dr. James H. Schulman of the Naval

—Continued on back cover (inside)

On the Naval Research Reserve

First Applied Research Seminar

The first Research Reserve Seminar in Applied Research was held in Albuquerque, New Mexico, in August. The seminar was sponsored by the Office of Naval Research in conjunction with two New Mexico Research Reserve companies: NRRC 8-7, Albuquerque, and NRRC 8-9, Los Alamos. CDR Nelson E. Spurling, USNR, of NRRC 8-7, served as seminar chairman. For two weeks, from the 10th through the 22nd, 35 Naval Reserve and three Army Reserve officers were briefed on research activities in the State.

The first week was devoted to "in-service" research. The highlight of the opening day was a most informative presentation by RADM John K. Leydon, USN, Chief of Naval Research, guest speaker at the luncheon. The day's program also included a thought-provoking talk by CAPT D. J. Mooney, Jr., Special Assistant to the Chief of Naval Research for the Research Reserve, on the status and future plans for this program.

After engaging in general orientation sessions, the participants were brought up to date on the activities of the Defense Atomic Support Agency, the Air Force Special Weapons Center, and the Air Force Weapons Laboratory in Albuquerque. One day was devoted to a review of research and testing at the Air Force Missile Development Center at Holloman Air Force Base near Alamogordo.

Research contractors told their story the second week. These included Sandia Corporation, the University of California's Los Alamos Scientific Laboratory, the Lovelace Foundation for Medical Research, and three of New Mexico's universities doing contract research.

The final day was devoted to the Coast and Geodetic Survey's Seismological Laboratory, located on the Isleta Indian Reservation south of Albuquerque.

RADM J. K. Leydon, USN, guest speaker at the Albuquerque seminar luncheon, discusses the program with CDR A. Thomas, USN (left), Executive Officer of the Naval Weapons Evaluation Facility at Kirtland Air Force Base, and LCDR C. B Rogers, USNR, NRRC 8-7.

An innovation at this seminar was the proclamation issued by the Hon. Jack M. Campbell, Governor, State of New Mexico, designating the first week of the seminar as "Naval Research Reserve Week in New Mexico." The proclamation stated in part that the Naval Research Reserve is dedicated to the security of our country and to the growth of scientific knowledge; that it stimulates the professional growth, both military and civilian, of its members; and that New Mexico's volunteer members of the Naval Reserve are contributing to the progress and general welfare of the State through their efforts in the laboratories and universities.

Of special assistance in the presentation of the seminar were the following activities: Field Command, Defense Atomic Support Agency; Sandia Corporation; Air Force Special Weapons Center; and Los Alamos Scientific Laboratory.

Numerous extra-curricular activities were enjoyed by the Reservists. Of particular interest was the Intertribal Indian Ceremonial held at Gallup during the weekend of August 15-16. A tour of the cliff dwellings at Bandelier National Monument near Los Alamos, following the day spent at the Los Alamos Scientific Laboratory, was climaxed by a western barbecue supper. A movie-and-slide report of the Hillery Expedition and a search for the Abominable Snow Man was presented by Dr. T. O. Nevison, of the Lovelace Foundation, following the banquet held on the 20th.

USN Science Cruiser Awards National Science Fair—International

Nineteen Research Reserve officers from three Companies—NRRC 5-3, Frederick, Maryland; NRRC 5-4, Baltimore, Maryland; and NRRC 5-11, Annapolis, Maryland—served as judges for the USN Science Cruiser Awards, which were presented at the National Science Fair—International, held in Baltimore, Maryland, on May 6, 1964. The general chairman for the judging was CAPT Raymond A. Kempf, NRRC 5-4. He was assisted by R.R. Roberts and E. H. Brown from the Bureau of Naval Personnel.

The judges selected ten exhibits from over 400 for the Navy awards. Judging was based on creative ability, scientific thought, thoroughness, skill, clarity, and dramatic value. Exhibits had been preassigned to one of the following categories: botany, medicine and health, zoology, chemistry and biochemistry, earth and space sciences, physics, and mathematics and computers.

Research Reserve officers make final selections for Navy Science Cruiser Awards. From left to right: LCDR H. D. Raynes, NRRC 5-4; CDR J. M. Vallillo, NRRC 5-11; LT R. E. Boyle, NRRC 5-3; CAPT R. A. Kempf, NRRC 5-4; LCDR L. L. Kupperberg, NRRC 5-3; and CDR H. T. Eigelsbach, NRRC 5-3.

The awards were presented by RADM H. P. Weatherwax, USN, Assistant Chief of Naval Operations (Development), at a banquet held on May 8. They consisted of a pair of Navy binoculars, with carrying case suitably engraved, and a one-week cruise consisting of a flight to and from a port on the East or West coast, a trip aboard a Navy vessel, and tours of various Naval science and engineering facilities—for each of the ten winners. An additional surprise award was given to the student displaying the exhibit considered the best of the ten by the Navy judges. This award consisted of an all-expense-paid week in Tokyo, Japan, as an attendee at the Japanese National Science Fair for the purpose of displaying the winning exhibit as a representative of the Secretary of the Navy.

Second Reserve Research Seminar on Aerophysics

For the second successive year the Reserve Research Seminar on Aerophysics was held on the campus of the University of Denver at Denver, Colorado. The two-week session was co-sponsored by the

Office of Naval Research and the University of Denver. It convened on August 2 for a program of lectures, discussions, and tours. Thirty-five Naval Reserve officers and one Marine, one Air Force, and two Army reservists took this opportunity to learn of the latest developments in man's understanding of atmospheric and space sciences. LCDR H. E. Bluebaugh, USNR, NRRC 9-21, Denver, served as seminar chairman, and CAPT J. K. Sterrett, USNR, NRRC 9-26, Colorado Springs, was program coordinator. Two other Research Reserve companies in Colorado that assisted in the presentation of the seminar were NRRC 9-12, Fort Collins, and NRRC 9-17, Boulder.

The opening session was chaired by CDR Orval D. Hughes, USNR, of the Office of Naval Research Branch Office, Chicago. Dr. Chester M. Alter, Chancellor or the University of Denver, and Mr. Shirley A. Johnson, Jr., the Director of Denver Research Institute, welcomed the attendees and discussed the scope and highlights of the education and research programs of the University and associated Institute. CAPT E. J. Alt, USN, Assistant Chief of Staff for Naval Reserve and Training in the Ninth Naval District, and CAPT E. J. Hoffman, USN, Deputy and Assistant Chief of Naval Research, set the stage for the seminar by portraying vividly the role of scientific research and development in the introduction of modern weapon systems into the Fleet and air arm of the Navy.

The ten days of the Aerophysics Seminar were divided between lectures and field trips. The lectures were presented by eminent authorities on specialized fields of research pertinent to the employment of communication, transportation and weapon systems in space; field trips were made to university centers, industrial laboratories and military establishments in the region. Recent discoveries and new theories about the earth's atmosphere at all levels were thoroughly presented. Problems of interplanetary communication and space travel were discussed in considerable detail by many of the speakers. From Washington, D.C. with the latest word on the Research Reserve Program was CAPT D. J. Mooney, Jr., USNR, Special Assistant to the Chief of Naval Research for Research Reserve.

After listening to a variety of excellent lectures by members of the staffs of the region's universities and laboratories, visits were made to the University of Colorado and Colorado State University where reserve officers were able to see some of the research in progress and to discuss the progress with the speakers. While in Boulder, the National Bureau of Standards and Ball Brothers Research Corporation were visited. Of particular interest was the observation of the production of the Orbiting Solar Observatory at the latter.

It was particularly fortunate that the Seminar was able to take advantage of the intercontinental ballistic missile production and deployment in the Denver locale. Half-day visits to the Martin-Marietta plant

that produces the Titan series of missiles and to a Titan I silo of the 451st Strategic Missile Wing at Lowry Air Force Base enhanced the knowledge of the attendees.

A visit to the North American Air Defense (NORAD) headquarters, Ent Air Force Base, in Colorado Springs, gave the Reserve scientists a far-reaching view of the relation of aerophysical problems to present and future aerospace defense capabilities. Brig. Gen. John K. McCormick, USA, impressed upon the visitors the defense requirement for high-quality research in aerophysics. Group Captain Sweetman, Canadian Air Force, demonstrated the procedures employed in the Combat Operations Center of NORAD in maintaining an alert defense posture.

While they were in the Colorado Springs area, the reservists also visited the U.S. Air Force Academy.

A formal banquet was held at Lowry Air Force Base Officers Club near the end of the tour. Dr. Edward U. Condon, Professor of Physics at the University of Colorado and former Director of the National Bureau of Standards, presented a sparkling lecture of great interest to the officers, their wives, and other guests.

Admiral Hardy Retires

On September 1, 1964, RADM James D. Hardy, USNR, was transferred to the Retired Reserve after completing 23 years of service. Admiral Hardy is well known to the Research Reserve. He organized and served as the first commanding officer of NRRC 3-1, New York, in 1949; later he established a panel of NRRC 4-2 at Willow Grove, Pennsylvania, which is now a full-fledged company. Although he was required by present directives to terminate his association in a drilling unit upon his promotion to flag rank, Admiral Hardy continued his close association with the Office of Naval Research through his mobilization billet at the U.S. Naval Training Device Center.

RADM James D. Hardy, USNR (left), reminisces with CAPT H. B. Stevens, USNR (Ret.), at the admiral's retirement ceremony, held at the Officers Club of the Brooklyn Navy Yard. RADM Hardy and CAPT Stevens served as first and third commanding officers of NRRC 3-1, respectively.

Active Naval service for Admiral Hardy began in 1941 when he reported to the Bureau of Ships' Electrical Mine-Sweeping desk. Eight months later he was sent to England as a Naval observer, where he remained until 1942. His next assignment took him to the Boston Navy Yard where he served as Officer-in-Charge of the Experimental Mine-Sweeping Section. He continued in this capacity until 1943, when he returned to the European theatre. Here he served as Staff Mine-Sweeping Officer and Officer-in-Charge, Mine-Sweeping Group, in which he took part in the invasions of North Africa, Sicily, and Italy. Subsequently, he was designated Fleet Mine Officer for the invasions of Normandy and southern France. His last tour of active duty was in the Mine-Sweeping Section of CNO; while there, he took part in the preparation of the current U.S. Navy Mine Sweeping Manual.

Dr. Hardy is a native of Georgetown, Texas. He received his B.A. and M.A. degrees from the University of Mississippi and a Ph.D. in physics in 1930 from The Johns Hopkins University. He then moved on to increasingly challenging positions at the University of Michigan, Cornell University, University of Pennsylvania, and at the Aviation Medical Acceleration Laboratory, Johnsville, Pennsylvania. He is presently associated with Yale University and the John B. Pierce Foundation Laboratory.

First Woman Commanding Officer Ends Tour

Naval Reserve Research Company 9-5, Ames, Iowa, had a unique commanding officer during the 1963-64 year—LCDR M. E. Hansen (the "M" stands for Margaretha). LCDR Hansen, a Navy nurse who served during both World War II and the Korean situation, is the first woman to become a Commanding Officer of a Naval Reserve Research unit. She is also the only woman officer in the company of 14 officers.

LCDR Margaretha E. Hansen turns the company log over to LT Burt Gleason during change of command ceremonies for NRRC 9-5. The plaques hanging on the wall behind them are awards for excellence won by NRRC 9-5 in recent years.

A ruling was required before this "first" appointment could be made. It was determined that while women officers do not succeed to command, the law is silent on their appointment to command. Thus the appointment was allowed.

LCDR Hansen has been a member of the NRRC 9-5 for eleven years. She turned over the command of the company to LT Burt Gleason, USNR, on June 30, 1964.

Nuclear Sciences Seminar

Once again Naval Reserve Research Company 13-6, Idaho Falls, Idaho; the U.S. Atomic Energy Commission, Idaho Operations Office; and the city of Idaho Falls played hosts for the Tenth Research Reserve Nuclear Sciences Seminar, which convened on August 3, 1964. Addressing the seminar at the opening session were CAPT Julius W. Jockusch, Jr., USNR, Commanding Officer of ONR's San Francisco Branch Office; and CAPT R. E. Harmer, USN, Commandant, Thirteenth Naval District (Acting). In his address, CAPT Harmer said, "This seminar will contribute significantly to each attendee's knowledge in the field of nuclear technology and reflect the ever increasing importance of atomic energy."

LCDR Chad K. Anderson, USNR, opened with a prayer. A joint Army, Navy, Air Force, and Marine Corps color guard presented Old Glory. Then the Chairman of the Day, CDR Mark Baum, USNR, a member of NRRC 13-6 and National Surgeon of the Navy Reserve Officer Association, introduced the dignitaries who were present. Among those welcoming some 30 Armed Forces Reserve officers were the Hon. S. Eddie Pederson, Mayor of Idaho Falls; Mr. Walter B.

Participants at the Tenth Research Reserve Nuclear Sciences Seminar

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Carlson, Deputy Manager, U.S. Atomic Energy Commission, Idaho Operations Office; and CAPT Thomas J. Wadsworth, USNR, seminar chairman and Representative of the Commandant, Thirteenth Naval District.

Attendees came from many parts of the Nation, including Gainesville, Florida; San Francisco, California; Braham, Minnesota; and Baton Rouge, Louisiana.

Besides five days of classroom presentations and discussions by outstanding nuclear scientists, the group made five tours of the world's largest collection of experimental reactors, located at the National Reactor Testing Station in the Lost River desert west of Idaho Falls.

CAPT D. J. Mooney, Jr., USNR, Special Assistant to the Chief of Naval Research for the Research Reserve, briefed the conferees on the last day of the seminar. He discussed the pros and cons of the program as it is today and offered constructive action to be taken to help it fulfill its mission in the event of mobilization. Final briefings were given by LCDR W. S. Lindberg, Jr., USNR, Reserve Assistant, ONR Branch Office, San Francisco, and CAPT Wadsworth, the seminar chairman.

The citizens of Idaho Falls, spearheaded by the local Navy League Council and the Idaho Falls Chapter, Naval Reserve Association, left no stone unturned in making the participants welcome. Thus the reservists not only enhanced their mobilization potential by participating in a most informative seminar but also enjoyed it in the process. Officers were detached from the twelve days training duty on August 14.

Inventions — Continued from page 29

Research Laboratory. A dosimeter of this type is based on the property that thermoluminescent materials or phosphors have of storing energy in the form of trapped electrons when exposed to ionizing radiation, the amount of energy stored being proportional to the amount of the radiation. The material so exposed, when subsequently heated, produces a luminescent glow emitting an amount of light which is a measure of the ionizing radiation.

Prior to Dr. Schulman's invention, the practical problems encountered in heating the thermoluminescent material — for example, in a controlled oven — made this type of dosimeter unsuitable for personnel monitoring.

Basically, Dr. Schulman's invention involves mounting the thermoluminescent material in an inert environment inside a hermetically sealed envelope resembling a light bulb. An electrical heater, which can be energized from a source outside the envelope, is also mounted in the envelope. By making a part of the envelope transparent, the luminescent glow that occurs when the material is heated can be observed and measured.

A substantial effort is now being made to develop this device for military applications.

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A one-tenth scale model of a long-range oceanographic telemetering buoy designed for the Office of Naval Research is tested prior to the building of the first full-scale buoy. diameter and