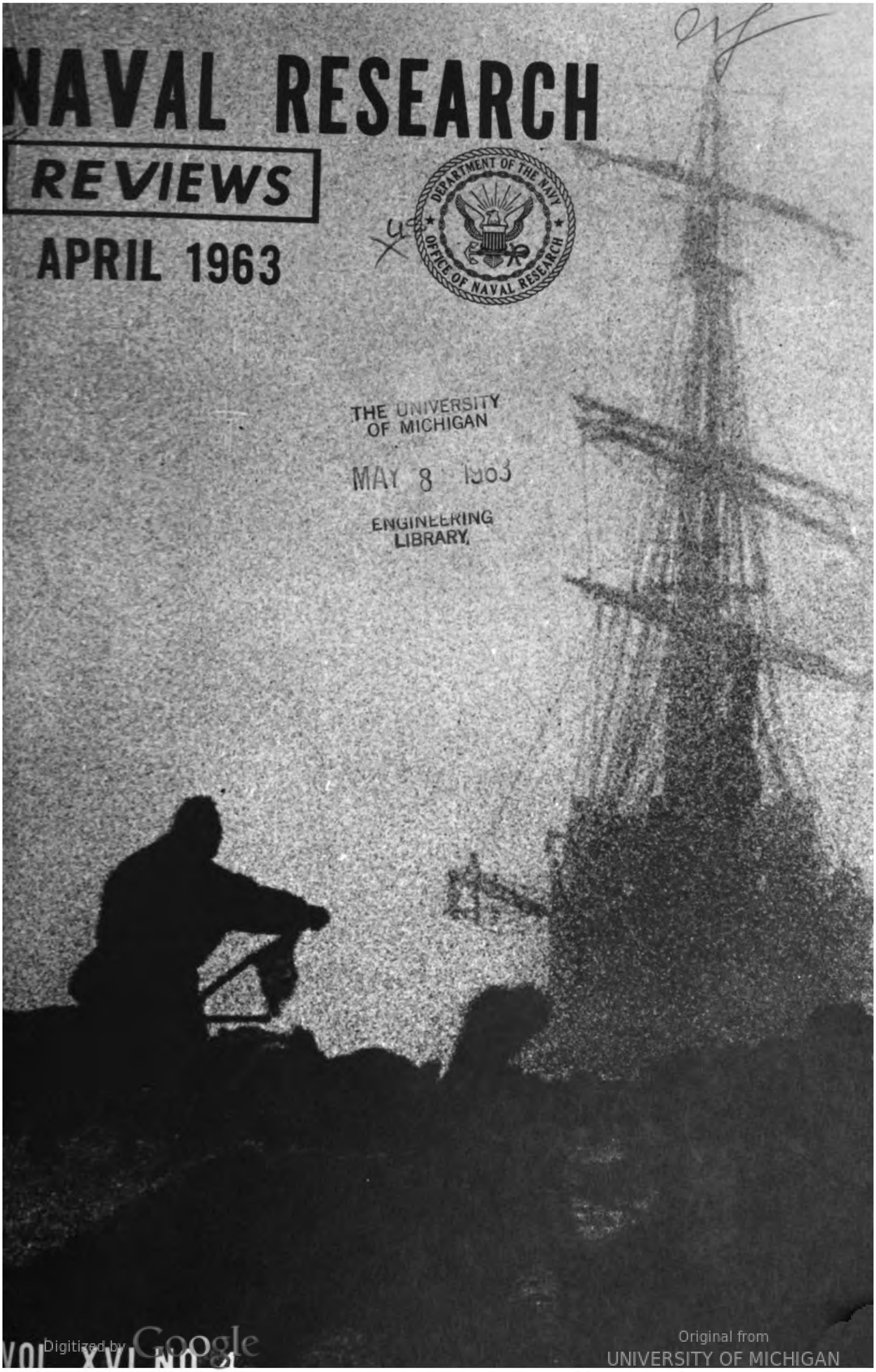
NAVAL RESEARCH REVIEWS

APRIL 1963

DEPARTMENT OF THE NAVY · OFFICE OF NAVAL RESEARCH



VOL XVI NO

ATLANTIS II Now Operational

ATLANTIS II, America's first large vessel built from the keel up for oceanography, was turned over to Woods Hole Oceanographic Institution late in January. From its quiet but powerful propulsion equipment to its four remote-control maneuvering stations and its underwater observation chamber, the 2300-ton ship was designed to provide oceanographic scientists with the most sophisticated and versatile laboratory ever to ply the seas.

The new vessel is 210 feet long (195 feet at the waterline), 44 feet wide, and has a draft of 17 feet. She has a cruising speed of 12 knots, a range of 8,000 miles and accommodations for a scientific party of 25 and a crew of 28.

She has a steel hull and twin propellers driven by two uniflow reciprocating steam engines. Operating noise and vibration have been reduced to a minimum by special design features throughout the ship. For extra maneuverability, the ATLANTIS II is equipped with a bow propeller mounted in an underwater tunnel athwartships which will move the bow to port or starboard. In addition to the standard controls on the bridge, the new vessel has four remote control stations automatically connected to the rudders and engines, and located so that the operator can coordinate the movements of the ship while observing the scientific work on deck.

There are four major laboratories on the ship, located so as to provide easy traffic back and forth. All laboratories are fitted with outlets for needed scientific supplies such as fresh water, sea water, electricity, oxygen and other gases. Major equipment on deck includes a large hydraulic crane on the starboard side aft and a hydraulic A-frame on the afterdeck for handling heavy apparatus, a steam powered trawl winch with enough wire to lower scientific instruments to a depth of seven miles, and two hydrographic winches for handling other equipment. For comfort and scientific accuracy, the ship is air-conditioned throughout.

Other unusual features, which make ATLANTIS II especially suitable for oceanographic research, are: a bulbous underwater observation chamber at the bow equipped with six viewing ports, precision echo-sounding equipment and racks for other gear--underwater lights near

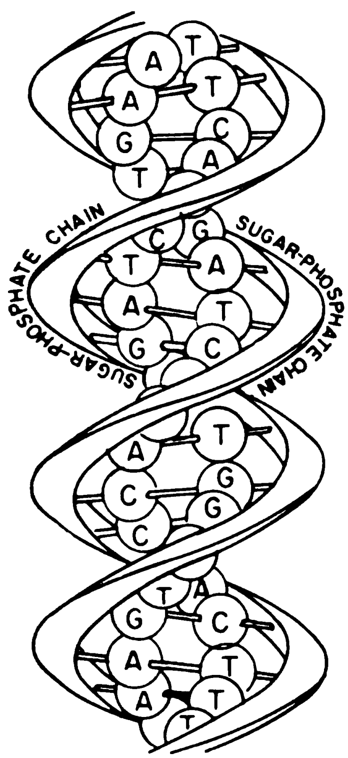
--CONTINUED ON INSIDE BACK COVER

"Chance" Encounter

Robert K. Jennings
Scientific Liaison Officer
ONR Branch Office, San Francisco

Biology today stands in the position occupied by physics just prior to World War II. Its most advanced protagonists have embarked on a new sea of knowledge, with a promise of exciting new capabilities just over the horizon. The ability to investigate and to begin to understand the chemical code in which instructions for heredity are written on the self-reproducing genes has led experts to make a remarkable prediction: that Man may soon be able to issue instructions himself and to create living beings evolution never intended. Howard H. Pattee, a biophysicist at Stanford University who has been doing research for the Office of Naval Research on the response of individual parts of cells to radiation, believes that man will be able to give such instructions. And he believes that man may also be able to answer some questions as to the nature of living things long since gone from the earth.

Life on earth began many millions of years ago when majestic geological events culminated in the formation of the seas. The theologist and the scientist are not at odds concerning this version of genesis. In many laboratories today, shrewd guesses as to the nature of the earth's atmosphere on that "first day" and about the forces at work in the earth, the sea, and the sky, are being translated into working models on a



A strand of deoxyribose nucleic acid, better known as DNA, is diagrammed here to show how its molecules are strung together to carry instructions for heredity. Backbone of the strand is a chain of alternating sugar (deoxyribose) and phosphate molecules. Attached to each sugar molecule is one of four other molecules: Adenine (A), Guanine (G), Thymine (T), or Cytosine (C). The message carried by the DNA is determined by the order of these attached molecules. Thus the sequence A-T-T-C-G would have a meaning different from another sequence, such as T-A-T-C-G.

test-tube scale. From the test tubes, amino acids and other organic compounds, now only generated in Nature by living protoplasm, are being recovered to show that the building blocks of flesh could indeed have been made in the ancient, cosmic laboratory.

In the absence of creatures which dine on such food, an early pool of water might well have contained a mixture of amino acids, purines, pyrimidines, and other simple organic molecules. Chance encounter between molecules could have resulted in the assembling of the first nucleic acid. This substance contained the instructions for the arrangement of amino acids into the particular chain structure of protein that determined the nature of the first living material, and it possessed the inherent capability of self-reproduction. Since the properties of protein are largely responsible for the form and activities of living things, the chance order of the chemical "letters" of the code of instructions of the first molecule of nucleic acid would have determined the characteristics of the first organism.

Organisms feed, grow, reproduce, age, and die. The process is a dynamic one involving the continual replacement of molecules, but always in the same order. The order is passed on from parent to offspring. The flesh perishes, but the order, in a very real sense, is immortal. It is immortal, but not immutable. A cosmic ray, for example, or some other physical agency, may alter a nucleic acid molecule and change the instructions for heredity in some particular. A new set of instructions replaces the old, and a new type of protein is made in accordance with the new description.

According to Darwinian theory, mutations of this nature which may be helpful in continuing the chain of reproduction in a competitive world will result in the persistence and accumulation of the organisms affected, while those which make survival of the organism more difficult will result in the disappearance of that form of life. Given geological time in which to operate, random mutation might modify the aboriginal, chance-determined instructions for the manufacture of protein into the highly meaningful order which is expressed in the form and function of creatures living on the earth today. The earliest instructions would therefore be lost forever to man.

The hypothesis is a convincing one, perhaps, but it is only a hypothesis. As such, it will be useful to the biologist if he can apply it as a guide in predicting accurately what the outcome of actual experiments will be. Therefore, if it is true that statistical probability played an important role in the creation of man, then analyses made in the laboratory of probable alternative arrangements of chemicals should be useful as a basis for determining how the first living material formed and evolved. We should expect that the amino acids of a protein, or parts of a protein, produced artificially in the laboratory—that is, without genetic control—would be arranged in a random fashion. We should also expect, on the other hand, that protein formed by highly evolved living protoplasm would display a high degree of order in its structure. Randomness, in effect, becomes a kind of orderliness in its own right—a shipshape chaos appropriate to the beginning of life.

Several investigators, including Dr. Pattee himself, have observed instances in which the amino acids of biologically fabricated proteins seemed to be assembled by chance. Conversely, these men have observed synthetic polypeptides and nucleic acids whose order is not random. Pattee suggests that what is actually found in the laboratory may indicate that ordering factors other than sheer probability might have been at work during the birth of the first living thing.

He points out that evidence is not now available on which to make a guess as to what amino-acid sequences existed in the earliest protein. As a matter of fact, he says, investigators do not even have a notion as to how such information might be acquired. Therefore, certain exploratory steps need to be taken. For example, modern computer methods can be used to determine the theoretical effects of random mutation and selection on hypothetical sequences chosen. Some of these sequences could be the same as an original chance distribution; others might have a simple form of orderliness. It may be possible to compare the results of such mathematical investigations with the kind of order observed in the components of present-day flesh, and thereby to arrive at some understanding of the kind of molecules which existed when life first began.

Dr. Pattee, once an instructor at the USN Electronics School on Treasure Island, has an impressive record of inventions and discoveries made in connection with ONR contracts, for which he has been the principal investigator since 1958, and with related studies in which he has been engaged under the support of NIH and the American Cancer Society. His work on the development of capabilities for selective X-irradiation of individual structures within single cells is a highly interesting story in itself. Problems in the microchemical analysis of component parts of cells were met and mastered, providing the background of technical knowledge which makes the present undertaking of tracing the evolution of simple ordered sequences in protein a reasonable one. The progress of Dr. Pattee's research demonstrates the success with which the modern biologist is assimilating technological advances, and the very nature of his new field of interest illustrates the contemporary metamorphosis of biology into a highly sophisticated science appropriate to the Atomic Age.

Antenna Installed for Space Communications

A 60-foot dish antenna to be used by the first space communications station designed to inject information into the Navy's navigational satellites has been completed atop 1,400-foot Laguna Peak near the Pacific Missile Range headquarters at Point Mugu, California. The antenna is mounted on a hydraulically driven complex of gears which move, aim, and direct the dish. The reflector and its gear assembly, which weigh 126 tons, are mounted on a tower 34 feet high. Within the tower is a hydraulic motor which drives the reflector assembly. To move the dish one foot in any direction requires 1,300 pounds of hydraulic pressure.

The antenna is designed to transmit orbital positions and time data into a satellite "memory" unit for subsequent rebroadcast to ships using the Navy navigational satellite system.

Whale Music

W. E. Schevill
Woods Hole Oceanographic Institution

The sounds of the wild life of the sea are many and varied. In this article, reprinted from WHOI's Oceanus, Dec. 1962, a marine biologist describes an ONR-supported effort to track down some of the more important sound makers.

Why study the vocal sounds made by whales? For a curiosity-powered, or "pure," scientist this is not too difficult a question to answer: "Because they are neither well-known nor understood, and happen to have caught my attention." (As so often happens, some aspects of this study impinge on the practical sphere of applied or dollar-driven science, but here we are talking only of the fun of it; this is not a touch.)

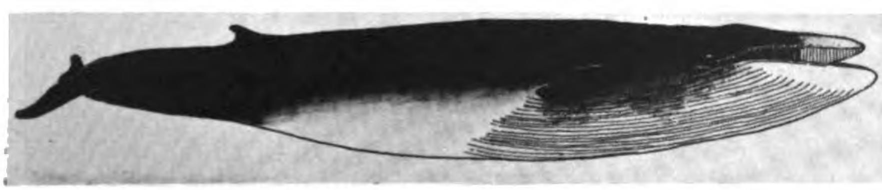
During World War II many people on both sides listened to underwater sounds for military reasons. Not only the wanted sounds (those made by enemy ships), but a bewildering variety of others were heard. Most of these were ascribed to animals living in the sea, usually as "fish noises," and at first only a few were more closely attributed. Some were ascribed to whales, in part correctly, but without identification of the kind of whale; most military listeners were not biologists, and anyway the traditional naval sonar room is woefully deficient in windows.

Included in my post-war plans was a project to try and find out just who was talking, and in 1948 we succeeded in identifying certain very characteristic sounds as the calls of a particular species, Delphinapterus leucas (beluga or white whale). Since then, with the support of both the Navy and the National Science Foundation, we have listened and recorded as opportunity offered, accumulating many reels of magnetic tape. From this tape we have selected 18 whale and porpoise sounds and reproduced them on a phonograph record, recently released by the Institution, entitled "Whale and Porpoise Voices."

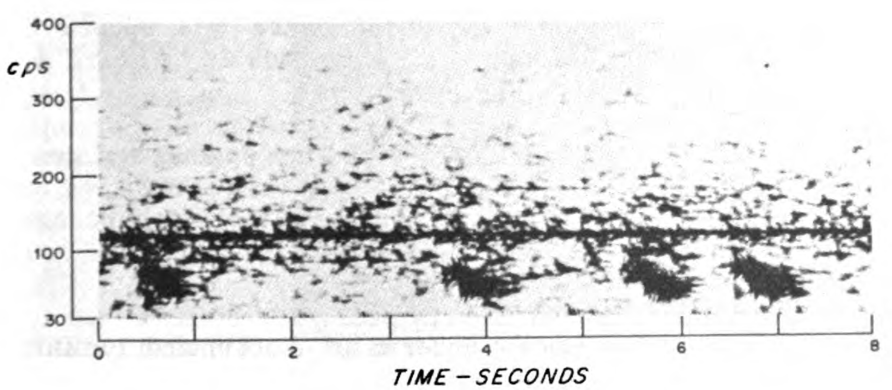
The military introduction to the subject was important because it provided expensive listening equipment without which biologists would not have heard much. Sound is very poorly transmitted between water and air, so that only the loudest underwater sounds are audible in air. Putting one's head in the water is uncomfortable in the first place, and doesn't help much, since immersion obliges one to hear by bone conduction, by which means man's hearing is very dull indeed. The pre-instrumental accounts of underwater sounds reflect fortunate combinations of loud sounds and quiet places, with perhaps mechanical coupling as through a resonant boat hull.

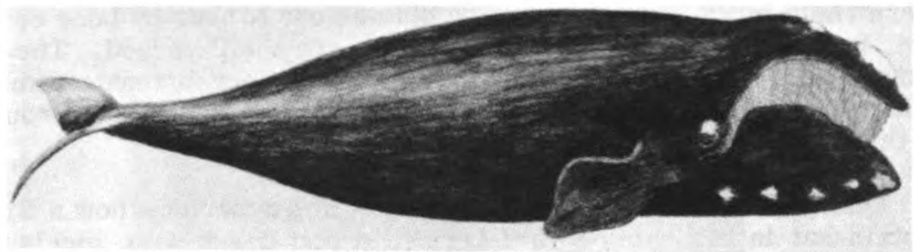
One of the nineteenth century Arctic tales describes how a British captain sat in his cabin in his becalmed and beset ship, and heard a riotous racket from below. "Some of the crew have broken into the spirit room," he supposed, and called the Master-at-Arms. But all was intact below, and it turned out that the captain had been hearing white whales shouting under his quiet ship. There is another famous tale, of what in New Bedford was known as Kelley's Band. Several Yankee whale-ships were anchored under Indian Point (Mys Chaplina) at the southern entrance to Bering Strait, waiting for favorable whaling conditions. Some of the captains were visiting in the cabin of one ship, when Capt. Kelley, who had been leaning his head against the side, announced that he heard bowheads singing, and went on deck amid jeers and ridicule, called away his boat, and returned to his ship. After he had sailed around the point, the other captains followed, and found him with two bowheads alongside, ready for cutting in. So far as I know, no phonograph records have been made of this whale (Balaena mysticetus), although we have the moans of its near relative Eubalaena glacialis (right whale, Nordkaper) on our disk.

Herbert L. Aldrich (in his book, "Arctic Alaska and Siberia," 1889) wrote: "With bowhead whales the cry is something like the hoo-oo-oo of the hoot-owl, although longer drawn out, and more of a humming sound



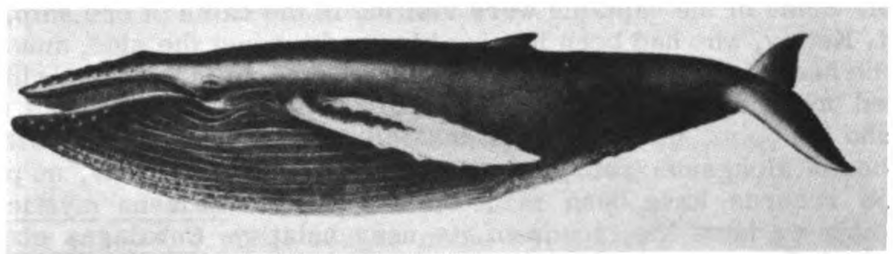
The finback whale, Balaenoptera physalus (reduction, 1:213), and its moans as revealed on a spectrogram. Low tones are at the bottom, and high tones at the top. Intensity of the sound is indicated by the darkness of the trace--the fainter the sound, the fainter the mark.

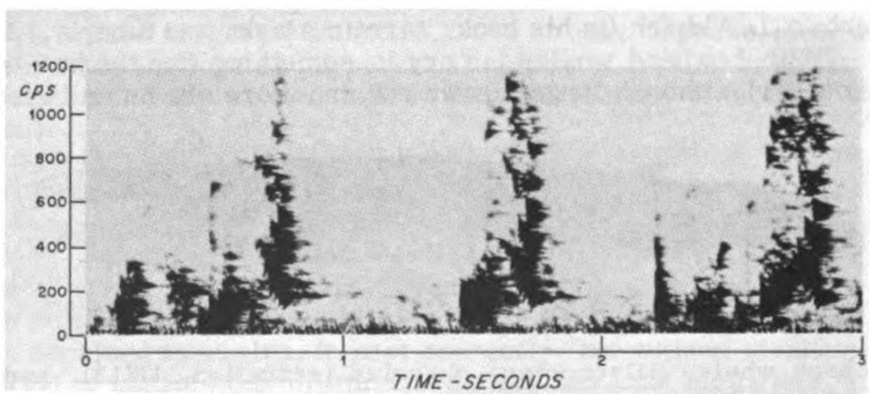




Eubalaena glacialis, known also as Right Whale or Noordkaper. He has a double blowhole, which causes him to produce a characteristic double spout. Reduction, 1:157.

Megaptera, the humpbacked whale, and three of his calls. Reduction, 1:145.



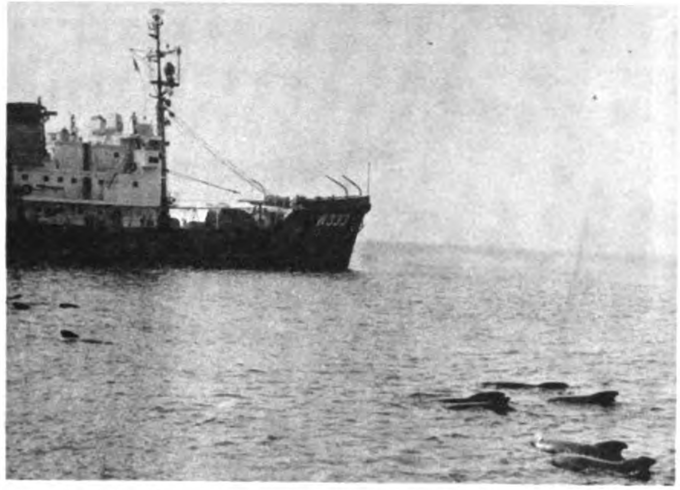


than a hoot. Beginning on F, the tone may rise to G, A, B, and sometimes to C, before slanting back to F again. With the humpbacked whale the tone is much finer, often sounding like the E string of a violin." The late Henry Mandley, Jr., who for some years was second mate of 'Atlantis,' has sung me the song of the humpback as he heard it when a boy in the forecastle of an anchored whaler.

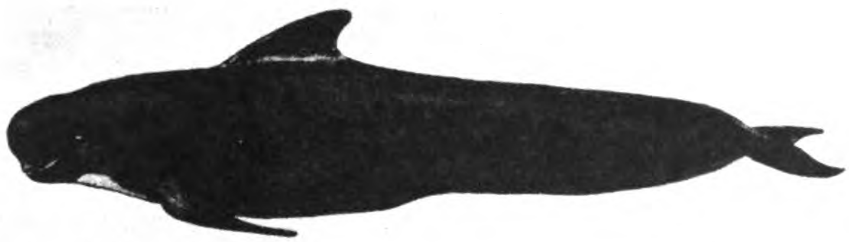
But all this was in the good old days, before engines and generators made even idle ships noisy. Now, without special equipment, we can hear only the very loudest of underwater sounds, and these only occasionally.

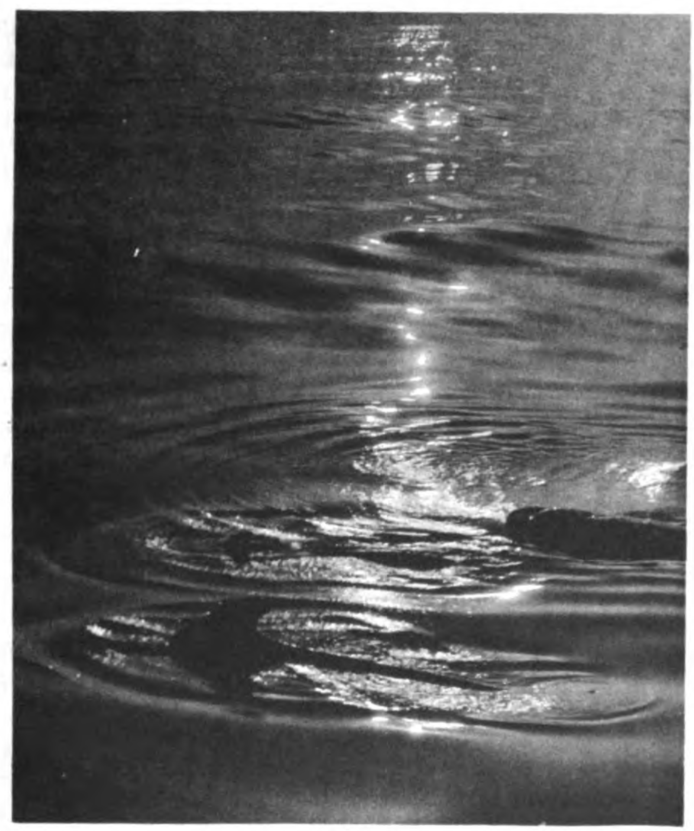
FIND THEM

Merely going to sea with listening gear is not enough for this work. First you have to find the animals, which requires a better lookout than



The U.S.C.G. cutter YAMACRAW and the ATLANTIS (not shown) rendevous with a school of blackfish, or pilot whales, in the Mediterranean.





"Pod of whales on the port bow!" At sunrise on a beautiful morning in the Mediterranean, the ATLANTIS was cruising around slowly waiting for the arrival of the YAMACRAW when a school of blackfish at right, was spotted (reduction, 1:65). A life raft was set overboard for a close look. The photograph (center) shows the characteristic fin and blunt head of the blackfish.

most ships keep. Besides, it is important, even necessary, to have some sort of operational control of the vessel, so that you can change course and speed to close the sighting, and so that you can devote time to staying with the whales or porpoises, which can be extremely difficult if they are shy. The need to be able to take over the ship when animals are found makes this an expensive sport, for it is awkward to combine other oceanographic projects in one cruise if unscheduled interruptions are likely to upset methodical work. Even after you have found animals, you will ordinarily hear many unwanted sounds. Steps have to be taken to eliminate the noises made by one's own ship, usually by stopping all shipboard machinery and putting the hydrophone so far away that it will not pick up the noise of waves against the ship.

And then there remains the problem of identifying the sound maker. A great deal of study and experience, supported by occasional capture of specimens (which in turn may be followed by long study in a museum), is required before one is able to form a reliable opinion of the talker's identity. Of course a few kinds are difficult to mistake, such as sperm whales, right whales, and humpbacks, but the several species of Balaenoptera, the fin whales, are distinguishable only after much experience; this applies even more strongly to the many species of the smaller delphinids which we call porpoises.

The larger whales are usually detected by the spout, which may be seen as far away as five miles when the light is favorable. Smaller whales and porpoises, with inconspicuous spouts, are usually spotted by white water made as they splash. It requires a good deal of familiarity to recognize and identify the species from the small amount of animal that one usually sees. We have learned to know some of the larger whales apart by the shape of the spout (exhalation) and the amount of back or tail shown above the surface at the brief breathing exposure before the whale rolls under again. This sort of hint is not so useful for the smaller kinds, which must generally be well seen, or actually caught, to be identified.

MANY SPECIES

Perhaps a dozen or so kinds of whales and porpoises have widely understood common names, since they are seen by relatively few people, and not particularly often by those few, who consequently do not always make sharp distinctions ("You mean there's more than one kind of porpoise?"). We use the technical names, which are understood by biologists of all nations, regardless of language, and give only such common names as we have found in use by seamen.

There are less than one hundred ten kinds of whales and porpoises. As far as we are aware, the sounds of well under twenty-five have been identifiably recorded. Eighteen of these are represented on our record. Three of these are mysticetes (baleen whales), and the rest are odontocetes (toothed whales). This is not too unreasonable a proportion, since there are only about a dozen mysticete species against some ninety-five odontocetes.

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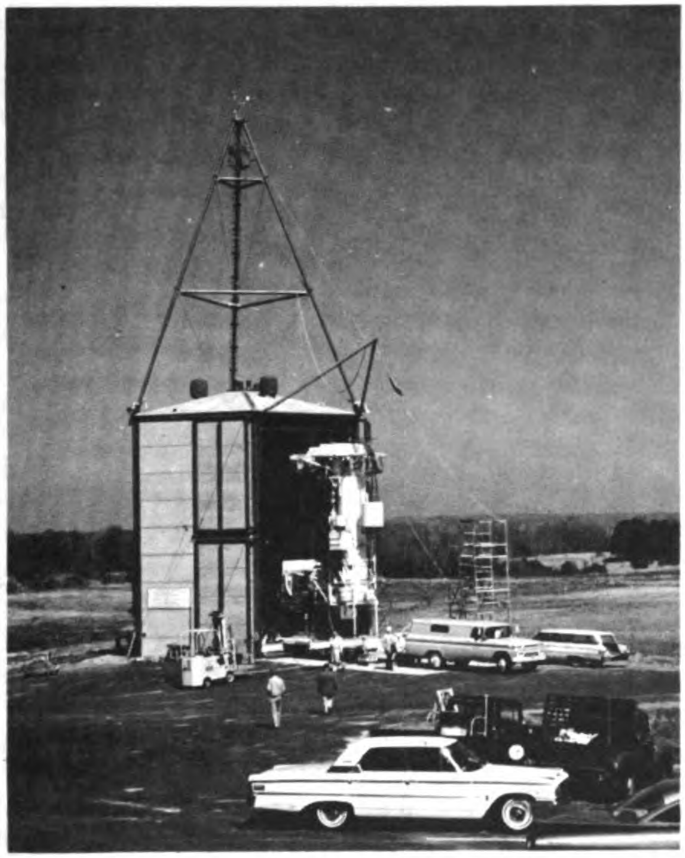

The First Flight of Stratoscope II

At 5:40 p. m. on March 1, 1963, the 36-inch, 6,300-pound Stratoscope II telescope was lifted by balloon from the National Scientific Balloon Flight Station near Palestine, Texas, to begin a night-long journey to an altitude of about 80,000 feet and back again to measure the infrared spectra of light received from Mars, then about 60 million miles away. The telescope returned to earth undamaged near Memphis, Tennessee, early the next morning. Since then the scientists involved in the experiment have been analysing the spectra to determine as nearly as possible the amounts of water vapor and carbon dioxide occurring in the Martian atmosphere. As Naval Research Reviews goes to press, an announcement of their detailed analysis was scheduled to be made on April 19 in Tucson, Arizona.

The story of the development of the Stratoscope system, which led to this fine achievement, goes back a number of years and involves several government organizations, including the Office of Naval Research, which initiated the program, the National Science Foundation, and the National Aeronautics and Space Administration. It is told in Naval Research Reviews, October 1962. The following set of pictures brings the story up to date. The pictures, taken on March 1 at Palestine, show some of the preparations for the flight and the launching of the big telescope.

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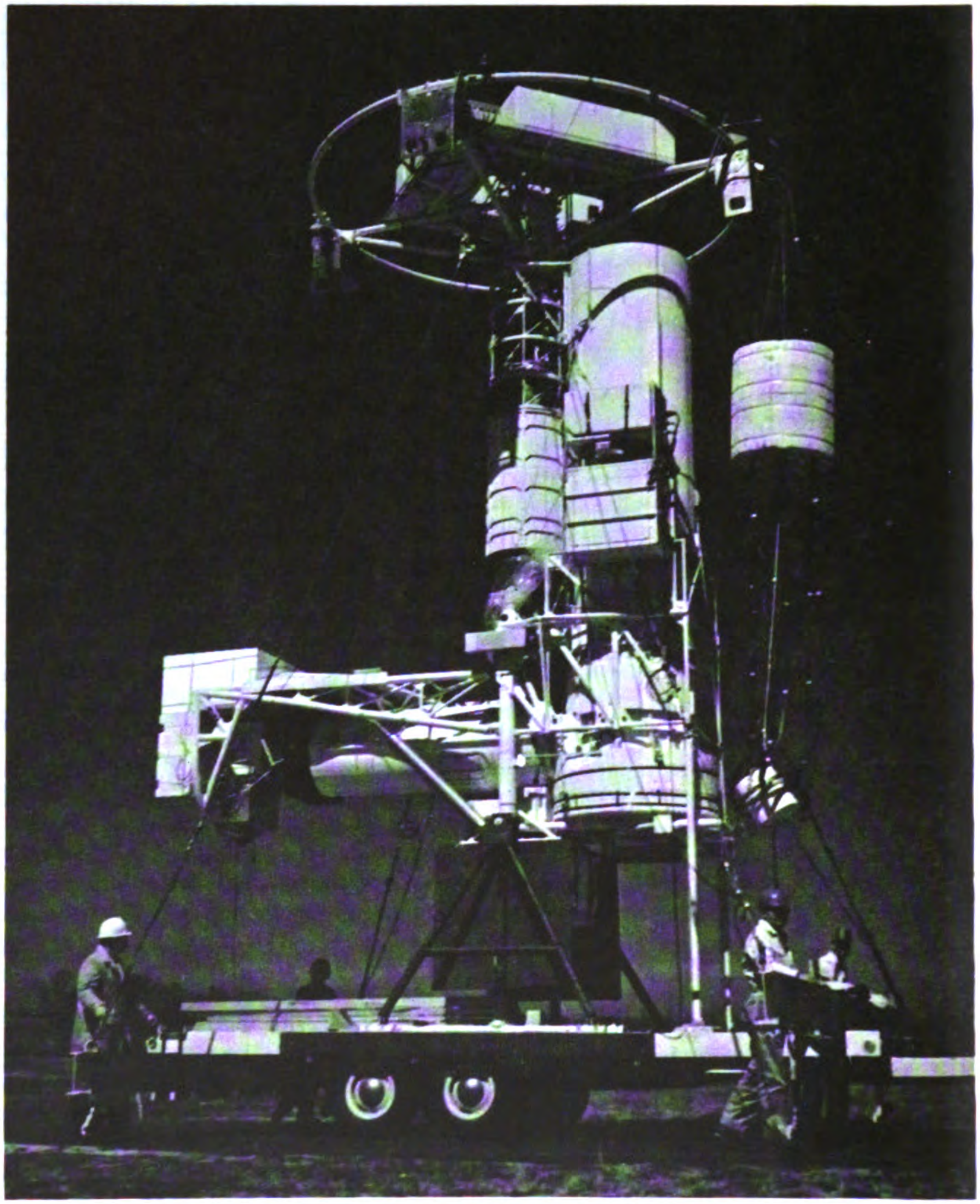
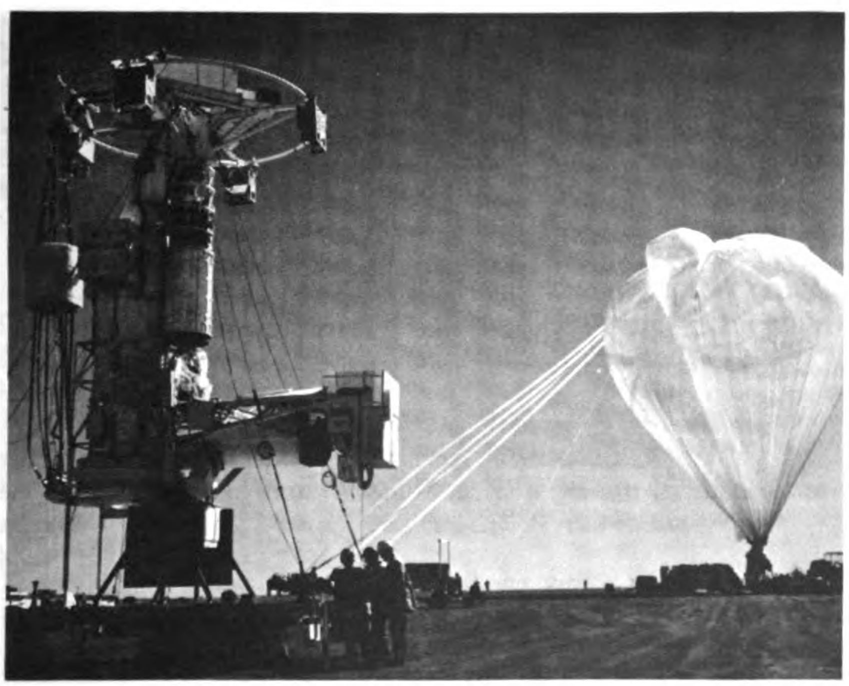


The big telescope is moved to the flight line. It will be attached to 600 foot long balloon system by straps hanging from right side of ring at top of telescope. The cylinder through which the straps pass contains antennas.

A LOOK INTO THE FUTURE: The second flight of Stratoscope II has been planned for next October. Its objective, like that of the first flight, will be to obtain infrared spectra of light received from celestial sources. The subjects of observation will be Jupiter and Saturn and one or more of the giant red stars. The first photographic flight is not expected to be made until the fall of 1964.

The principal investigators for the program are now Dr. Martin Schwarzschild and Dr. Robert Danielson, both of Princeton University.

Above, balloon personnel inspect top fitting of launch balloon just before they begin inflation. Below, Stratoscope II waits nearby as 232,000 cubic feet of helium (14,500 pounds of lift) are pumped through four inflation tubes into the launch balloon. Right, moments after launch, balloon system rises into sky at rate of about 1,400 feet per minute. Average rate of rise during ascent was nearly 800 feet per minute. In this view of the complete flight train, the telescope (at bottom) appears tiny.



B

By

Richard Blackburn Black
Rear Admiral, USNR (Ret.)
Advanced Planning Division
Office of Naval Research

The BEAR on

f wooden ships have hearts of oak,
And I believe they do,
know of one whose stout heart broke!
I'll tell the tale to you:

The BEAR, an ancient barkentine
Whose years topped eighty-nine
Was limping southward, old and green,
Upon a tow-tug's line.

Her destination? "Shame!", she cried,
I'm going to be a pub,
A rest'rant!-(Chicken? Stewed or fried?)
A gin-mill! There's the rub!"

She lay back on the cable then
And dreamed of all her past-
Of gales and ice and shouting men,
Taut canvas in the blast,

The shriek of wind, the sting of sleet,
The green seas sweeping back,
The clinging seamen with their feet
Braced on the foot-rope track,

With bellies pressed against the yard,
Chilled fingers clutching sail,
And elbow movement slowed and hard
By wind on raincoat's tail.

She thought of evenings still and bright,
Locked in Antarctic pack, -
Ice-blink ahead, and blue-black night
Behind her in her track,

When Byrd and English paced her deck
With anxious eyes ahead,
While Ben Johansen said, "By heck,
Ve'll push trou or ve're dead!"

Then Cruzen - (
Fought thro
To free the men
One hundred

Of ice-locked se
So in a patc
The East Base m
All reached

Her thoughts the
To Bering S
Her fights with p
And heavy w

Her years of aid
And starving
And murderers a
A-hanging in

*

On March 19 at 2010 GCT, a beloved old veteran of polar exploration, research, and rescue sank to the bottom of the sea off Nova Scotia. On these pages, a man who knew her well describes her eventful past and final voyage.

kan patrol in 1890.

it's forty-one) -
to Biscoe Isles
Stonington.
ty miles

EAR could not break,
up plane
- a chance to take -
ship again.

ew back sixty years
Patrol,
hers, British jeers,
e-ship toll,

Barrow town
éuts,
er yard-arm
eir boots.

* *

Now, back to present, and the gale
Off Nova Scotia's shore:
The seas run high, the tug men pale,
"Old BEAR can't take much more!

Old ships have souls, some sailors say,
And some have died of shame, -
I'll not contend this, either way,
And I will place no blame

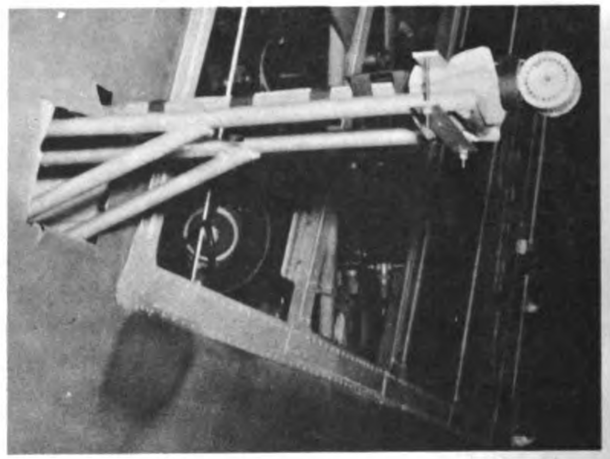
But tell you just what seamen saw
Aboard that towing ship;
The BEAR heaved back, began to yaw, -
Her bow commenced to dip.

Then with a muffled, mighty sigh
Her seams all opened wide,
And with her colors gaff-tip high
She plunged beneath the tide!

"West Over Sea," the Vikings said,
When funeral was planned,
With chieftain lying midships, dead,
Full armored, sword in hand.

I'll always feel, as some will voice
Who worked that ship with me,
That she went down by her own choice -
The BEAR - West Over Sea!

The Sky is the Limit
For Radar Tracking Accuracy



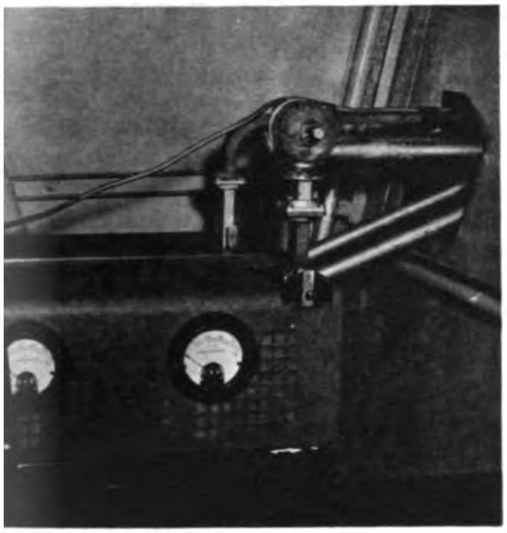
A. W. Straiton
Electrical Engineering
Research Laboratory
The University of Texas

As astronaut Scott Carpenter was seated in the Mercury Atlas 7 capsule prior to his historic orbital flight on May 24, 1962, an aircraft from the Air Force Cambridge Research Laboratories was making soundings of the refractive index of the atmosphere in the region of the sky through which the space vehicle would be launched. The data taken by this plane indicated the possibility that atmospheric refraction might cause some trouble in the tracking and guidance of the vehicle, and a brief delay in the launching was ordered while the exact nature of the refractive-index data was checked out. A few minutes later the clearance was given, and the launching took place.

The instrument which was used by the Meteorological Research Laboratory of the Air Force Cambridge Research Laboratories at this launching to measure with precision the refractive-index structure of the atmosphere was the Crain refractometer. The history of the development of this device is an excellent illustration of the valuable practical applications that are sometimes made as by-products of basic research projects.

In 1945 when the Office of Research and Inventions (which later became the Office of Naval Research) was first established, a contract was given to The University of Texas to study the angle of arrival of radio waves transmitted through the lower atmosphere. It was known that deviations of the angle of arrival were caused by the inhomogeneity of the atmosphere—particularly variations in temperature and moisture. The purpose of the contract was to examine the magnitude of this radio-wave bending in a variety of meteorological situations, in order to establish the relationship between the meteorological parameters and the angular error. Measurements were made of the humidity and temperature in the atmosphere as a function of height, and from these data the refractive-index structure was calculated. This method was extremely cumbersome, however, and as was later determined, many of the variations in the atmosphere occurred far too rapidly to measure with ordinary hygrometers and thermometers.

In order to verify directly the constants in common use for finding the refractive index from known water-vapor pressure, temperature, and total pressure, Dr. Cullen M. Crain of the University of Texas developed an instrument for laboratory use which would measure directly the refractive index of gases.



The Crain refractometer mounted in a U.S. Navy blimp for the first airborne refractometer measurements, taken in April 1951. Left, outside view; right, inside view.

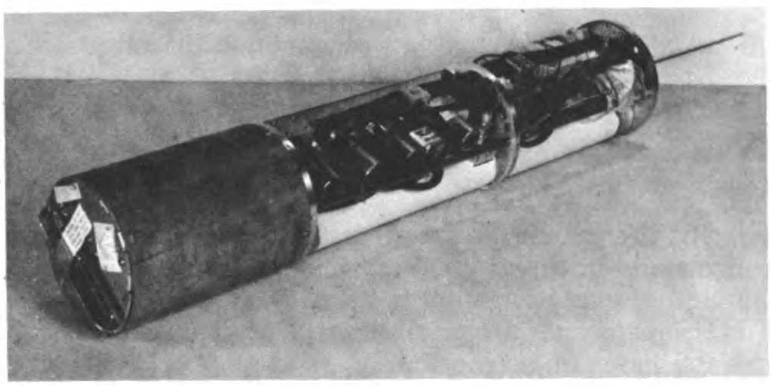
This instrument is based on the principle that the resonant frequency of a microwave cavity is inversely proportional to the index of refraction, or the square root of the dielectric constant of the air in the cavity. By measuring the change in frequency, as air was admitted to the cavity, it was possible to measure the index of refraction.

Upon successfully completing this study, Dr. Crain took the refractometer out of doors as an incidental experiment. He found to his surprise that the swings of the needle recording the refractive index of the atmosphere were very large and rapid, and he was afraid that something was wrong with the instrument. After checking out its performance, he again found that the variations in the atmosphere were far greater than anyone had predicted. Thus began a long series of measurements of the refractive index of the atmosphere which have come to be a standard part of many test programs.

In April 1951 the Office of Naval Research sponsored the first airborne flight with a refractometer. This was made by Mr. A. P. Deam of the Electrical Engineering Research Laboratory of the University of Texas in a Navy blimp at Lakehurst, New Jersey. The installation of the Crain refractometer was accomplished by simply cutting a hole in the skin of the gondola and sticking the refractometer cavity through the hole. This initial flight showed that the refractive-index layers were much sharper than could possibly be measured by radiosondes and that fluctuations in horizontal flight could be quite large, particularly in passing from sea to land and in the vicinity of strong atmospheric turbulence.

Since that time many thousands of refractometer soundings have been made in numerous parts of the world. A large percentage of these were made with refractometers developed at The University of Texas and subsequently constructed for many groups including the Wright Air Development Center, the Naval Air Missile Test Center at Point Mugu, the Air Force Missile Test Center at Cape Canaveral, Lincoln Laboratory of MIT, University of Southern California, and Air Force Cambridge Research Laboratories. These units served as prototypes for the refractometer later built by the U.S. Navy Avionic Facility. Refractometers have been used for many research programs in which the transmission of radio waves through the atmosphere was compared with the electrical structure of the atmosphere determined by the refractometer.

A new importance of the electrical structure of the atmosphere has arisen with the advent of satellite and space vehicles. With present radar capabilities, it appears that the limiting feature in the control of these vehicles is the atmosphere itself. Refractive-index anomalies may cause loss of the signal from a target or lead to false direction angles—the angles remaining constant or varying rapidly. The overall



Deam expendable refractometer--used for making balloon or airdrop soundings. The receiver used with this instrument is set up in an airplane or on the ground.

refraction of the radio waves as they travel through a stratified atmosphere causes a constant bending which may be partially corrected if the refractive-index structure is known approximately. The scintillation of the signal, which is similar to the "dancing" of stars on a clear night, presents a difficulty which cannot now be corrected, but which may be in the future as advances are made in instrumentation and techniques.

Refractometers have also served as very powerful tools for other types of work. The effects of smokes and other aerosols on radio propagation characteristics were measured by passing these materials through the refractometer cavity. The properties of polar molecules have also been examined in the laboratory with the refractometer by putting the gas to be studied in a sealed cavity and observing its change in properties as a function of temperature or pressure. Ionized gases and recombination effects have also been investigated using refractometer techniques.

More recently, Mr. Deam developed an expendable refractometer which has been dropped from aircraft and sent aloft on small balloons. Use of this instrument eliminates the necessity for the airplane to make flights through the entire height interval to be sampled. Such measurements are more nearly in a vertical line than when taken aboard an airplane, and they can be taken more rapidly.

The story of the development of refractometers indicates the importance of allowing contract-research investigators the freedom to go after new aspects of science even though they may not be exactly in the original charter. Such sideline explorations may lead to important developments which can be of more significance than the original contract objectives.

Research Notes

Boy's Life Saved by Hair Gun

A little boy, expected to die within months, will now live a fairly normal life. His withered legs, inert since birth, can now hold him erect. Soon he will walk and run like other children. This remarkable change has come about as the result of an adaptation of a surgical technique originally developed under an ONR contract to treat brain aneurysms. (NavResRev, Aug. 1962.)

Aneurysms are bubble-like deformities that appear in the walls of arteries at weakened points. In time, these bubbles or sacs begin to leak and eventually to rupture—with fatal results. In the past, brain aneurysms were treated by applying a tiny V-shaped silver clip around the neck of the sac. However, in many cases, manipulation of the sac caused the weakened wall to break; sometimes the clot that stopped up the tiny opening was dislodged. The problem, then, was to find a way to destroy the aneurysm without handling it.

Dr. John P. Gallagher of Georgetown and Providence Hospitals, Washington, D. C., postulated that the introduction of a hair into the deformity would cause the blood around the hair to clot immediately. Within a few days, scar tissue should invade the clot and anchor it into place permanently. In order to deliver the hair without complications, Mr. H. P. Hagemeyer, of the Naval Research Laboratory, devised an airgun barely larger than a pencil that could shoot a hair under controlled conditions. Since June 1962, several operations have been performed using this technique—all of which proved successful.

The little boy did not have a brain aneurysm. Instead, the deformity was in his lower back, pressing directly on his spine, thus accounting for the lack of movement in his legs. Its location negated the possibility of removing the aneurysm surgically. It kept growing in size, and the boy's doctor predicted it would burst within a short time. The airgun technique seemed to be his only chance for survival.

The operation was performed recently at Georgetown University Hospital. More than a dozen hairs were shot into the dark bulbous mass. Within minutes the aneurysm began to shrink; the spinal pressure was relieved; the boy's legs began to relax. Three weeks later the boy began to make attempts to stand. Now he is well on his way to recovery.

ONR Contractor Honored by Danish Society

The principal investigator under an ONR Biology Branch contract concerned with the nutrition of the wood borer (Limnoria) has been elected a Corresponding Member of the Royal Danish Society for Natural History. She is Dr. Dixy Lee Ray, Associate Professor of Zoology at the University of Washington. For the past two years Dr. Ray has been on leave of absence from the University, working for the National Science Foundation as a special consultant on biological oceanography and as a special assistant to the associate director of NSF. She is returning this month to the University of Washington, where her ONR contract work is continuing.

Dr. Ray was honored, in the words of the Danish Society, ". . . .not only in appreciation of (her) recent great part in the dedication of the ANTON BRUN (formerly the Presidential yacht WILLIAMSBURG—NavResRev, June 1962), but also in order to acknowledge (her) contributions to marine biology." The ANTON BRUN is now taking part in the Indian Ocean Expedition (NavResRev, Aug. 1962) as a biological research vessel.

Early this month, on invitation from the Danish Society, Dr. Ray lectured in Copenhagen and Lund on present and future American activities in biological oceanography.

Magnetic Survey Made of North Polar Region

During the past two months, a group of investigators from the University of Wisconsin has been flying back and forth over the Arctic Basin in a Navy P-2E Neptune patrol plane measuring and mapping magnetic intensities. Their chief objective is to determine the structure and other geologic characteristics of the earth's crust in the Polar region. The principal investigators are Dr. G. P. Woollard, Director of the University's Geophysical and Polar Research Center, and Dr. Ned A. Ostenso of the Geology Department. Also participating is LTJG J. W. Boosman, USNR, of ONR's Geography Branch, which is sponsoring the program.

Carrying a Varian proton precession magnetometer in a plastic cone in its tail, the plane flies at altitudes between 1,500 and 2,000 feet along carefully preplotted flight paths calculated to supplement similar flights made during the first phase of the program—completed in May 1961. The flight paths have been plotted to span most of the Arctic Ocean in an attempt to close the gaps between previous tracks and to cover geographic areas of special scientific interest.

Flights of the present series are being made between Point Barrow, Alaska, and airfields in northern Greenland. ONR's Arctic Research Laboratory at Barrow, is providing logistic support for the operation.

Also on board the aircraft, but carrying out an assignment not directly concerning the magnetic study, is a veteran ice observer—Aerographer's Mate First Class Michael J. Bardon, USN, of the Naval Oceanographic Office. His observations of the ice will be valuable in forecasting ice breakup and drift, and will make possible more effective planning of ship movements.

The 1961 magnetic survey, which consisted of 12 flights covering about 30,000 miles, produced a great deal of valuable scientific information, including data which revealed that the Arctic Basin can be divided into two large sub-basins with distinctively different magnetic characteristics. The ocean floor of the sub basin between western North

America and Siberia is characterized by generally high magnetic activity, while that between eastern North America, Greenland, and Europe is generally quiet magnetically.

Ore is Mined at Two-Mile Depth in Pacific

What is probably the first ton of ore mined from the high seas has been sent to the U. S. Metallurgy Research Center in Reno, Nevada, for study. The shipment consists of manganese nodules—roundish mineral lumps that resemble fire-blackened potatoes—dredged from a depth of 12,000 feet about 200 miles west-southwest of Cape San Lucas at the tip of Baja California, Mexico. The mining operation was carried out from the SPENCER F. BAIRD, a research vessel of the Scripps Institution of Oceanography, which is supported by the Office of Naval Research.

Manganese nodules were first discovered on the sea floor in 1876. Since that time they have been found in all the world's oceans. The long cruises made by SIO's ships in the Pacific during the 1950's showed by means of deep-sea photographs, cores, and dredging that thousands of square miles of the floor of that ocean were covered with the nodules. This fact aroused the interest of H. W. Menard, Jr., Professor of Geology, and Charles D. Wheelock, then Director of the Institute of Marine Resources, as to their commercial possibilities.

Analysis of the nodules showed that in addition to manganese, which is used in several industrial processes such as the hardening of steel, the nodules contained nickel, cobalt, and copper in percentage amounts exceeding those found in ores mined on land. However, no attempt was made to dredge the nodules in quantity until the recent trip of the SPENCER F. BAIRD.

Studies were begun by the Institute to determine exactly what metals the nodules contained, where they were present in large quantities, and whether they could be economically mined. These studies were made by Dr. John L. Mero of the Department of Mineral Technology, University of California at Berkeley. Mero found that the nodules could be mined profitably if their concentration exceeded two pounds per square foot of sea floor. He also found that in many areas of the Pacific the concentrations were that large or much larger.

Scientists Exchange Knowledge

The Seventh Navy Science Symposium, entitled "The Solution to Navy Problems through Advanced Technology" will be held May 14-16 at the U. S. Naval Aviation Medical Center, Pensacola, Florida, with that activity acting as host. The symposium will be held for military and civilian employees of the Federal Government and for scientific and technical non-government personnel working on Navy contracts—all by invitation. Sponsor of the meeting will be the Office of Naval Research.

Sessions to be held during the symposium will concern bio-medicine, materials, nuclear and infrared radiation, sonar and sound propagation, advanced electronics, and propulsion and structures. Introductory remarks will be made by Dr. F. J. Weyl, Deputy Chief and Chief Scientist, ONR; RADM L. C. Newman, MC, USN, Commanding Officer, U. S. Naval Aviation Medical Center; RADM L. D. Coates, USN, Chief of Naval Research; and VADM W. A. Schoech, USN, Deputy Chief of Naval Operations (Air).

The exchange of ideas and techniques which will occur during this gathering together of the outstanding scientists and engineers in the Navy Establishment is expected to have a significant effect on the future directions taken in solving Navy problems through advanced technology.

Time Delay of Transionospheric Signals

Back in the early 1920's, radio engineers of the Naval Research Laboratory conducted some of the first experiments that measured the behavior of radio waves transmitted from the ground and reflected downward from the underside of the ionosphere. Last winter, the availability of a satellite, the S-27 or "Alouette," made it possible for a new generation of NRL scientists to study the behavior of radio waves transmitted through the ionosphere from above. The satellite is a "topside sounder" developed by the Defence Research Telecommunications Establishment of Canada.

The experiments have achieved the first quantitative measurements of delays experienced by high-frequency (hf) signals passing through the ionosphere. From previous earthbound experiments it has been understood that the ionsophere is substantially transparent to radio waves above a critical frequency and relatively opaque to waves of a lower frequency. Moreover, the ionsophere sometimes splits hf waves into two components, each having a separate critical frequency. It was expected, but previously unmeasured, that the decreasing transparency at a critical frequency should be accompanied by an abrupt slowing of a radio wave's forward propagation.

Alouette's radio transmits short, hf (1.5 Mc to 12 Mc) pulses that rebound from the upper side of the ionosphere and are received as echoes by the satellite. Some of the signals penetrate the ionosphere and reach the earth. With each hf pulse the satellite simultaneously emits a uhf pulse which penetrates the ionosphere without impediment. The arrival at the earth of the uhf pulse is used as a reference for measuring the delay of hf pulses. These transionospheric signals have been measured and analyzed by NRL scientists in Washington and by the Canadians in arctic areas. On winter nights, and when the satellite is at 40 to 60 degrees elevation, pulses that are just above two critical frequencies of the ionosphere have arrived at the ground stations showing two separate frequency-dependent time delays.

As the radio frequency is decreased toward the critical region, one pulse shows a delay corresponding to free space propagation which is substantially independent of frequency. The second response splits from the first, with delay increasing rapidly toward an indefinitely high value. At a somewhat lower frequency, delay of the first response may be seen to increase similarly. No quantitative predictions of this multiple transionospheric delay have been found in the literature, but preliminary analysis indicates a behavior similar to a multiple-ray phenomenon observed in oblique reflections from the lower ionosphere.

The new measurements of ionospheric delay are to be tested in a computer program against standard propagation equations and model ionospheres postulated by other experimenters. The resulting confirmations or inconsistencies are expected to aid in the accretion of understanding of the ionosphere's complexities.

The Deep-Ocean Sound Track

Navy scientists are again studying the transmission of sound across the Atlantic Ocean via a natural sound track which exists in deep water because of certain temperature and density combinations. Once sound waves begin to move along this pathway—which is situated at the level of minimum velocity for sound—they are confined to it and will travel great distances with relatively little decrease in intensity. Sound rays departing at angles both above and below the horizontal are refracted back toward the level of minimum velocity, and thus remain in the track.

Interest in this type of transmission dates back at least to the 1930's. In 1943, a practical application was made of it when the SOFAR (SOund Fixing And Ranging) air-sea rescue system was developed to locate flyers down at sea (Naval Research Reviews, March 1953). When a pilot was in trouble, he dropped into the water a SOFAR bomb set for detonation at a depth of 2,000 feet in the Pacific and 4,000 feet in the Atlantic. Upon receipt of its signals at three separate land listening stations, the approximate position of the downed plane could be determined—on the basis of the time differences of reception by the three stations.

The primary objective of the current study, which is being conducted by the Naval Ordnance Laboratory, White Oak, Maryland, is to collect data on the levels, frequencies, and other characteristics of sound waves made to travel along the pathway. Such information is expected to help improve submarine detection and communications systems which utilize the track.

Another purpose of the project is to determine the attenuating effects of the Mid-Atlantic Ridge on the transmission of sound across the Atlantic Ocean via the sound track. This submerged mountain chain runs north and south along the ocean floor, dividing the Atlantic into two huge basins. At its highest point, the chain breaks the ocean surface to form the Azores, located about 1,000 miles west of Portugal.

In making the study, the investigators air-dropped a pair of four-pound explosive charges every 100 miles across the Atlantic along a path stretching from Bermuda to Great Britain by way of the Azores. The resulting sounds were then picked up by hydrophones located along the sound track's axis near Bermuda. At each drop point, the separate charges were pressure-detonated at depths of 1,500 and 3,500 feet. A zigzag pattern was followed over part of the course to avoid possible shadowing of the signals by plateaus rising from the ocean floor.

On the Naval Research Reserve

A. Hoyt Taylor Award

Presented to NRRC 11-4

Naval Reserve Research Company 11-4, Compton, California, was honored Wednesday evening, March 6, 1963, when the Hon. James H. Wakelin, Jr., Assistant Secretary of the Navy (Research & Development) presented the company with the A. Hoyt Taylor Award. The award is named in honor of the late doctor and Naval Reserve officer whose original research in 1922 led to the development of radar. It is presented to that Naval Reserve Company out of the 116 companies throughout the nation which submits the best scientific or technical study during each year. NRRC 11-4 was selected winner of the award in the second national competition (NavResRev, Jan. 1963).

Presentation ceremonies took place at a banquet at the U.S. Naval Station, Long Beach, California. After dinner, Secretary Wakelin presented a plaque emblematic of the award to the members of the winning company, and CDR Victor H. Hunsaker, USNR, Commanding Officer,

The Hon. James H. Wakelin, Jr., presents the A. Hoyt Taylor Award to CDR V. A. Hunsaker, USNR. Looking on are CAPT Julius W. Jockusch, Jr., USNR (left) and CAPT R. J. Trauger, USN (right).

accepted the plaque in their behalf. In presenting the award, Secretary Wakelin paid tribute to NRRC 11-4 for their winning scientific study entitled, "Control of Salt Water Piping Marine Fouling." He praised the initiative and perseverance of the Company in carrying on the study, which he adjudged deserving of further Navy Laboratory development.

In addition to members of NRRC 11-4, the ceremony was attended by many senior naval officers from commands throughout the area. Among those present were RADM K. L. Veth, USN, Commander, Naval Base, Los Angeles; RADM J. J. Fee, USN, Commanding Officer, Long Beach Naval Shipyard; CAPT F. W. Silk, USN, Commanding Officer, Naval Station, Long Beach; CAPT J. W. Jockusch, Jr., USNR, Special Assistant for Research Reserve, Office of Naval Research, Washington, D.C.; CAPT R. J. Trauger, USN, Commanding Officer, Office of Naval Research Branch Office, Pasadena; CAPT E. H. Maher, USN, Deputy Chief of Staff for Naval Reserve, 11th Naval District; CAPT C. A. P. McAree, USNR, Assistant Chief of Staff for Naval Reserve and Training, 11th Naval District; CDR G. W. Spurlin, USN, Commanding Officer, Naval Reserve Training Center, Compton; LCDR N. L. Fish, USN, Research Reserve Program Officer, 11th Naval District.

Also in attendance were six commanding officers of research companies of the Los Angeles area. Many ladies were present, including Mrs. Wakelin, wife of the Secretary.

For Outstanding Cooperation

Plaque is presented to Research Reserve Liaison Officer.

Appreciation was expressed recently to CDR R. N. Jennings, USNR, for the outstanding cooperation and support given by him during his service as the Fifth and Sixth Naval District Research Reserve Liaison Officer. The "thanks" were expressed by the commanding officer of Naval Reserve Research Company 5-12 on a plaque given to the commander at a buffet reception held at the Naval Weapons Laboratory, Dahlgren, Virginia.

CDR Jennings now assumes command of the U.S. Naval Reserve Training Center, Tacoma, Washington.

Reserve Assistant Reports to ONR New York

CDR McKinlay

CDR Donald McKinlay, Jr., USNR, reported to the Office of Naval Research Branch Office, New York, on February 25, 1963, for duty as Assistant for Naval Reserve. Prior to reporting to New York, CDR McKinlay completed a tour of duty at sea. He served as Executive Officer of the USS HAMUL (AD20) for two years, and upon its decommissioning on June 9, 1962, he was appointed Executive Officer of the USS ISLE ROYALE (AD29) which was commissioned on the same date.

In 1933, CDR McKinlay graduated from New York State Merchant Marine Academy, and in 1941 received an A.B. degree from Columbia College, Columbia University. He received a direct commission as Ensign in the Naval Reserve in March 1941. During World War II he commanded the destroyer escort USS ROBERT E. PEARY, and was twice commended for his seamanship.

He returned to civilian life in 1946, but remained active in the Reserve, commanding a Naval Reserve Surface Division in Yonkers, New York.

In 1950 he was recalled to active duty. For the following two years he served as Executive Officer of the E.A.GREENE (DD711), then spent three years as Executive Officer of the Naval Examining Center, Great Lakes. His next assignment, 1955-57, took him to Korea, as Naval Advisor to the National Defense College. Returning to the States in 1957, he served as Commanding Officer of the Armed Forces Reserve Center in Dayton, Ohio. He continued in this capacity until 1960.

Seminars Scheduled for Remainder of Fiscal Year

Those officers who have not yet performed active duty for training this fiscal year are reminded that the Research Reserve has five seminars left on its schedule:

Life Sciences Seminar, Bethesda, Maryland	May 12,
Marine Science Seminar, Quonset Point, Rhode Island	June 9,
Research Reserve Seminar, ONR, Washington, D. C.	June 9,
Research Methods Seminar, Columbus, Ohio	June 17,
Training Device Seminar, Port Washington, New York	June 17,

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--CONTINUED FROM INSIDE FRONT COVER

the winches for better observation of equipment being raised and lowered near the surface. . .extra-large twin rudders for faster turning, better maneuverability. . .a ramp in the stern for ease in lowering and retrieving heavier equipment. . .a special antenna array fitted to fore and main mast. . .an enclosed crow's nest equipped with large windows and wipers. . .an unusually large and uncluttered afterdeck with flush, watertight hatches to facilitate movement and on-deck scientific work. . .unobstructed passage along starboard rail for easier handling of coring equipment and other gear. . .gyrocompass repeaters in many locations for use of scientists. . .winch line pull indicators on the bridge and elsewhere to give instant notice of possible snagging of submerged equipment. . .large electric patch panels in all major laboratory spaces for rapid and flexible communication of scientific information.

ATLANTIS II was designed for the Institution by the Bethlehem Steel Company's Central Technical Department, Shipbuilding Division, Quincy, Mass., with M. Rosenblatt & Son of New York as design associate. She was built by the Maryland Shipbuilding & Drydock Co. of Baltimore, Md. Her cost of nearly $4,000,000 was financed by a grant from the National Science Foundation.

* * *

The first ATLANTIS, meanwhile, is neither retired nor idle. The 32-year-old schooner, veteran of 1-1/2 million miles of scientific cruising on the seven seas, will be used this coming summer as a school ship. She will be the base for three courses offered by WHOI, under NSF sponsorship, for advanced students in science and engineering: "Introduction to Physical Oceanography," "Advanced Physical Oceanography," and "Marine Geology and Geophysics." Each class, consisting of about a dozen men, will spend three weeks aboard the ATLANTIS in active data collection and observation. The balance of the 12-week course will be devoted to classroom work ashore.

New Technical Director Appointed for Model Basin

The Technical Director of the Structural Mechanics Laboratory at the David Taylor Model Basin near Washington, D. C., has been moved up to the top scientific position at that important BuShips establishment. He is Dr. Alfred A. H. Keil, a world renowned physicist. As Technical Director of the Model Basin, Dr. Keil will be responsible for the coordination and executive direction of the entire technical program at the research establishment, including studies in hydromechanics, aerodynamics, structural mechanics, mathematics, and operations research.

Dr. Keil was born in Germany and attended the Friedrich Wilhelm University in Breslau, where he received the degree of Doctor of Natural Sciences in 1939. In February 1947 he came to the United States and began working for the Bureau of Ships on phenomena related to underwater explosions. In that same year he was transferred to the Norfolk Naval Shipyard as Chief Scientist of the Underwater Explosions Research Division, where he engaged in research on ship protection.

The Navy has given him two Meritorious Civilian Service Awards--one in 1954 and the other in 1957. The latter was given for his valuable contribution in connection with the specific application of scientific theory in the field of scale model testing.

IN THIS ISSUE

NAVAL RESEARCH REVIEWS publishes highlights of research conducted by Navy laboratories and contractors and describes important Naval experimental facilities. Manuscripts submitted for publication, correspondence concerning prospective articles, and changes of address, should be directed to Code 740, Office of Naval Research, Washington 25, D. C. The magazine is listed for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Subscription price: $1.50 per year in the U. S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. The issuance of this periodical approved in accordance with Dept. of the Navy publications and printing regulations.

EDITORS. A. T. Drury and Richard D. Olson

NAVEXOS P- 510

The barkentine BEAR in sea-smoke. The BEAR backs out of ice at the Bay of Whales, Feb. 26, 1934, during Byrd's Second Antarctic Expedition, 1933-35. The famous old ship sank last month. See page 12 for an account of her last voyage and a review of her illustrious past.