VOL. IX. NO. 4 JUNE 1963

OCEANUS

EDITOR: JAN HAHN

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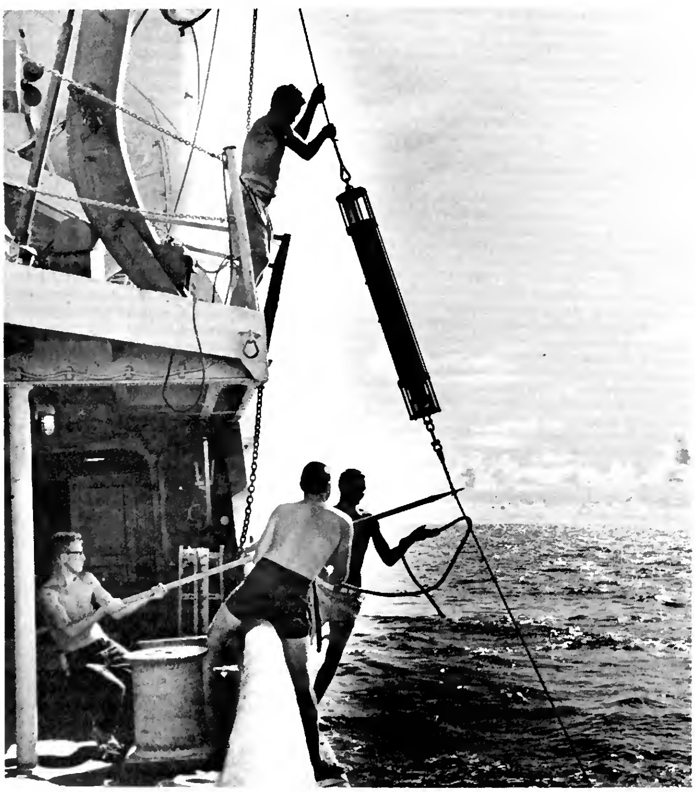
Library of Congress Catalogue Card Number: 59-34518

The Woods Hole Oceanographic Institution • Woods Hole, Massachusetts

VOL. IX, No. 4, June 1963



Buoy Retrieved

EVEN in a calm sea quiet a bit of stretching and muscle exercise are involved in retrieving the current meters which are suspended below the buoys of our anchored stations.

A successful program of moored buoys was carried out as part of our work for "Operation Equalant I".

Editorial

VOL. IX, No. 4, June 1963

FREQUENTLY, one reads questions about international co-operation in science, particularly in the case of space research. The answers given usually are vague and tied closely to politics. It is not sufficiently well known that in oceanography there is thriving agreement among many nations, including the USSR.

In the International Indian Ocean Expedition some 40 ships of 25 nations are taking part. The example of the IGY only is a few years behind us. This spring, two of our ships, the R/V 'Chain' and the R/V 'Crawford' took part in "Operation Equalant I", an intensive investigation of the Atlantic Equatorial region. Thirteen ships from seven nations were involved in this study. Four came from the U.S., three from the USSR, two from Brazil, one from Argentina and one each from Nigeria, the Republic of the Ivory Coast, and the Republic of Congo-Brazaville. In addition people from various nations mingled on other ships. Texans, Floridians and Californians were on the South American ships, while the 'Chain' also had scientists on board from Great Britain, Venezuela, Brazil, West Germany and visitors from four other U.S. laboratories.

Not the least interesting part of the work done by the 'Chain' was a landing on St. Peter and St. Paul Rocks (see page 2). These desolate bits of rock pinnacle just above the sea surface in the middle of the deep ocean and must have struck terror in the hearts of those sailing ships who may have suddenly come upon this boiling cauldron in the middle of the night. The rocks are so uninviting that a second landing a month later was not possible although the weather was only moderately rough. The landing was made partly as a reconnaissance survey to determine if the U.S. MOHOLE project could land supplies to drill through the outer crust of the earth, an attempt which previously has been tried from a drilling barge in the Pacific.

The articles in this issue provide only a glimpse of the work done on board our ships: we cannot duplicate the heat in our quarters, the fragrant and not so fragrant smells of some of the ports visited, nor the admiration we felt for the two Brazilian divers who, for five days, worked in unbelievably murky water at 86°F., to repair the damaged propeller blades of the 'Chain' with a small hacksaw. (No docking facilities were available.)

We also wish to thank our (unpaid) contributors who were hounded by the editor to sit down in the 110° temperatures on board ship to write their articles before they scattered home. A rather large number of paper towels were used under their wrists to prevent the writing paper from disintegrating. Thanks also are due to the officers and crews, and particularly to the stewards and cooks who provided excellent and frequent meals.

A Visit

to

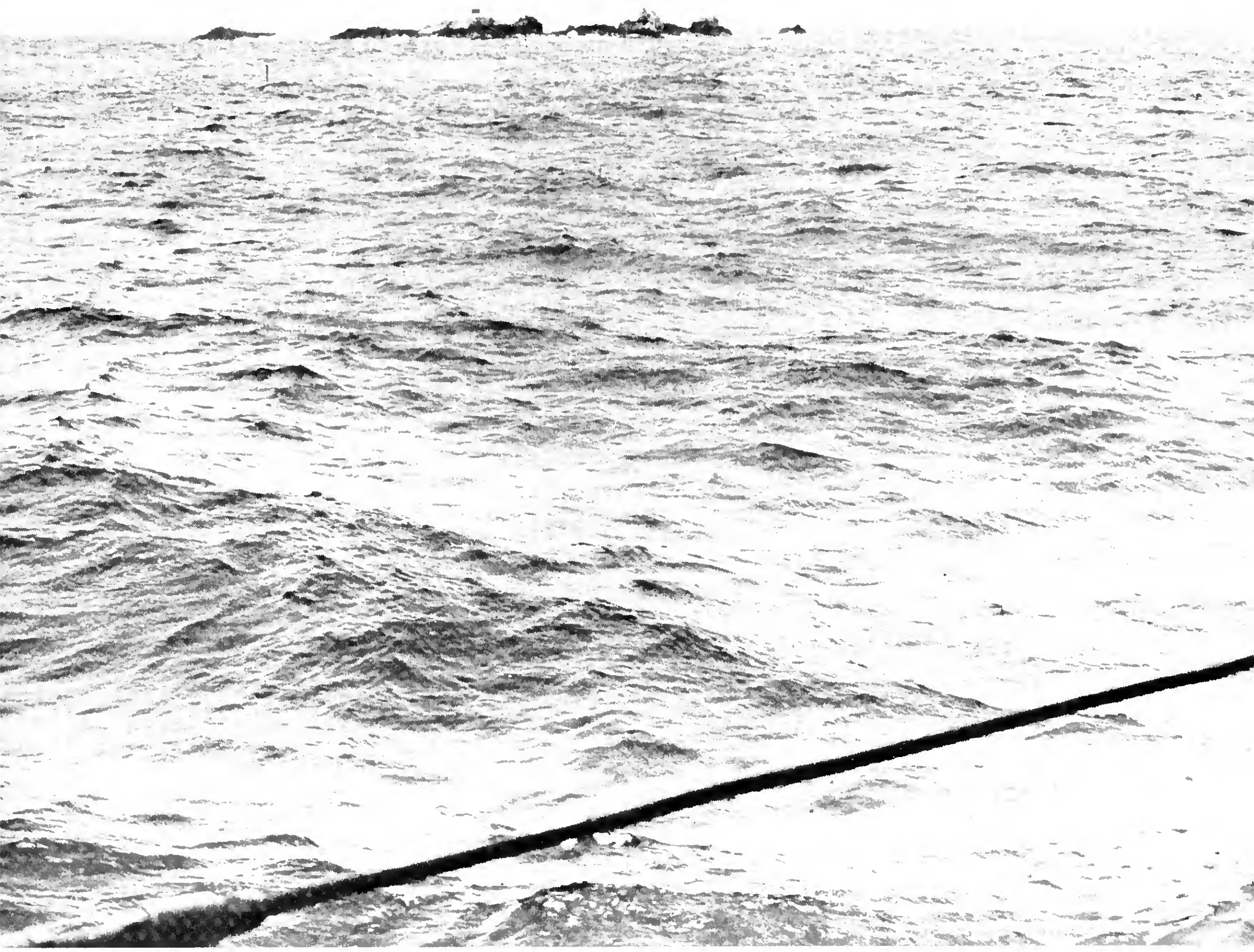
St. Peter and St. Paul Rocks

by P. L. SACHS

Would these desolate rocks in the middle of the ocean provide a stable platform for Mohole drilling?

ON March 18, 1963, a party of four geologists from the research vessel 'Chain' landed on the largest islet of St. Peter and St. Paul Rocks. The desolate appearance of this jagged group of pinnacles belies their popularity with inquisitive minds, and the four were following in the footsteps of distinguished visitors, including Darwin, who had arrived here in such famous ships as the Beagle, the Challenger, the Meteor and the Albatross.

The rocks were discovered sometime in the first half of the sixteenth century and first appear on Mercator's Chart of 1538. They are located nearly on the equator at 00° 56′ N, 20°22′ W, about 500 miles from the South American coast and roughly twice that distance from the African coast. The group consists of five islets, the largest measuring less than 400 by 200 feet, four small rocks and a few pinnacles barely above the surface. Two of the islets reach a height of



The Rochedos São Pedro e São Paulo, commonly known as St. Paul Rocks, belong to Brazil. They are a part of the Mid-Atlantic Ridge sticking above the sea surface. Boiling surf obscures the shore line configuration of these desolate islets in the middle of the ocean.

about 40 feet. A swell nearly always surges around the rocks and rips indicate the westerly flow of the Equatorial Current. An untended lighthouse was erected on the largest of the islets by the Brazilian government in 1930-31. It was operative for only a few months however, and now only a skeletal ruin remains. Nearly tame sea birds, a great number of land crabs and numerous species of fish and porpoises constitute the dominant fauna of the group, but sharks which figured more or less prominently in most of the earlier reports were observed only well offshore.

To the geologist, St. Peter and St. Paul Rocks are a fascinating and exciting feature, of considerable scientific interest for a number of reasons. Not only are they one of the few places where the great mid-Atlantic Ridge rises above the surface, but they are nearly unique among oceanic island in composition. Practically all other islands consist of extrusive volcanic material often covered by calcareous sedimentary rock. St. Paul Rocks, on the other hand, are composed largely of peridotite, an ultra-basic igneous rock, rich in olivine, generally formed only at considerable depths below the earth's surface. This material is believed by many to constitute the mantle below the Mohorovicic discontinuity, and its appearance at the surface in relatively fresh, unaltered condition, leads to some interesting speculation. The rocks may have been carried up from great depths through the crust by rising convection currents in the mantle. This mechanism has been postulated by some for the formation of the Mid-Atlantic Ridge. The very considerable seismic activity of the area, the topographic expression of the Ridge in this region and the nature of the alteration and deformation of some of the rocks, all suggest faulting on a grand scale, which may have squeezed abyssal material to the surface. These hypotheses for the origin of St. Paul Rocks are not mutually exclusive, and it seems plausible that both processes may have been operative.

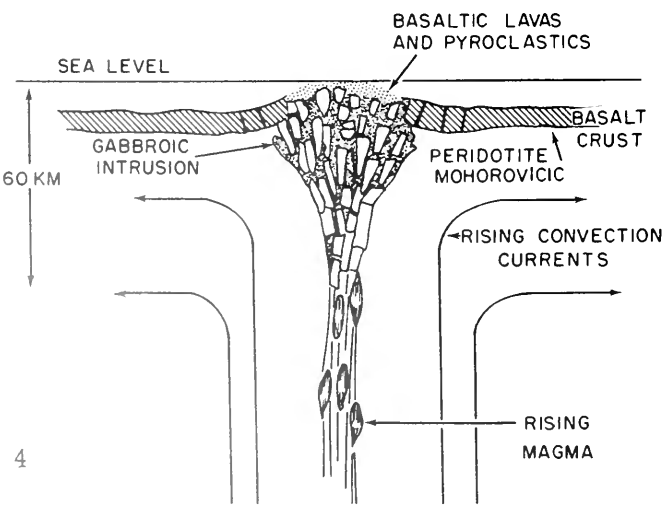
Extensive analyses of rock samples from this location should yield much new information concerning the islets, but previous landing parties had never collected sufficient material for some of this work. It was primarily for this reason that a landing here, as part of the 'Chain's' Equalant Program was considered most desirable.

Mr. SACHS is a geologist in our Department of Chemistry and Geology, with Dr. V. T. Bowen.

Objectives

More specifically the landing party had four objectives: 1. A large amount of as many igneous rock varieties as could be found was to be collected for various chemical and petrological analyses, and subsequent correlation and comparison with offshore samples. 2. Sedimentary deposits formed by the reaction of guano with weathered igneous material and carbonates present, were to be sampled preferably in all stages of the process. 3. Oriented rock specimens for petrofabric analyses which might yield clues about the directions of forces which have deformed the rocks were to be obtained. 4. A reconnaissance survey was to be made to determine the feasibility of putting a drill rig ashore later this year.

As 'Chain' approached the area, the group of jagged stark pinnacles appeared out of the morning mist low on the horizon to fire the imagination of those who stood lining the rail. The ship approached to within 1000 yards and launched a boat and a raft containing the landing party with their gear. The launch took the raft in tow and circled the rocks so that a landing site might be chosen.



St. Paul Rocks may have been carried up through the crust of the earth by rising convection currents in the earth's mantle.

(After Hess, 1954. Courtesy: U.S. Naval Oceanographic Office)

The famed 'Challenger' tied to the St. Paul Rocks on August 27, 1873, not an easy task for a square rigged ship. The 'Chain', on March 18, 1963 stayed 1,000 yards offshore. In both cases the actual landings were made by small boats.

This composite view of the ships was made at the suggestion of our Port Captain J. Pike. The original engraving is from: Sir C. Wyville Thompson: "Voyage of the Challenger", Harper Bros., 1878.

H.M.S. Challenger, 1873 *R.V. Chain, 1963*

Difficult landing

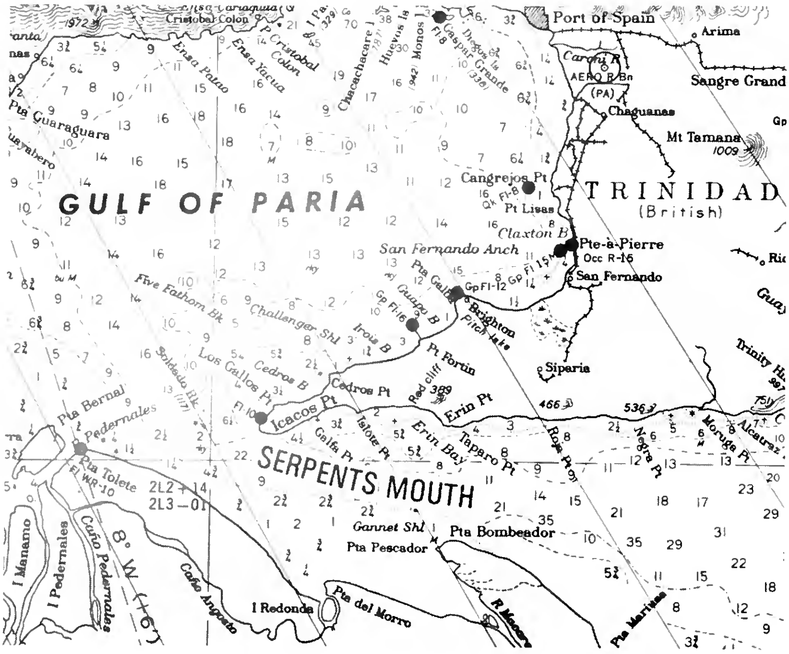
The charts state: "difficult landing", and indeed on this occasion there was no question of actually landing any craft. The swell surging through a cove which had been the site of most previous landings made any attempt at entering appear hazardous. There seemed to be only two small areas where boiling surf did not continuously surround the rocks. A small ledge above one of these, on the western side of the Southwest Islet looked most promising and the raft was maneuvered close to this spot. One by one, the members of the landing party chose what seemed the propitious instant, and each in turn leaped for the ledge when the raft was carried upward and close to the rocks by the surging swell. Gear and food were thrown ashore by those remaining in the raft and launch, after which they returned to the 'Chain' to proceed with her assignments of bathymetry and rock dredging while the landing party went to work on the islet.

Once ashore there was little to modify the original impression of desolation. The sun was by then directly overhead and no place on the Rocks afforded any shelter. There was a pervading odor of guano and the birds, some with young or brooding, screamed at the intruders. Not a trace of vegetation graced the rocks, and the only refreshing aspects were the clarity of the surrounding waters, and some small salt water pools which sheltered a number of colorful reef fish and were frequently replenished by spray and surge.

Rocks collected

After a brief reconnaissance which included the derelict lighthouse and divulged some letters and photos left in a sealed jug by previous visitors,* the party began to chip, sledge and blast off rock samples, until the launch returned for them in the afternoon. The collection of hundreds of pounds of samples from the Southwest Islet, as well as rewarding dredge hauls from surrounding waters, successfully concluded the field work for the investigations, and should, when analyses are completed, substantially increase present knowledge about the geology of St. Peter and St. Paul Rocks.

*The 'Chain' left a canvas flag on which had been painted the date of the visit and the names of all those on board ship.



Subsurface Echosounding

by Tj. H. van ANDEL

EARLY in 1951, in the Gulf of Paria, the author was introduced simultaneously to the beauties of marine geology and the frustrations and difficulties of work at sea. The excitement of this double experience was such that an interesting phenomenon remained undiscovered until the cruise was almost finished. This was the occurrence of reflections on the echo-sounding records below the bottom of the Gulf. Such subsurface reflections had been reported and speculated upon earlier by a few American and German investigators, but had never yet been used systematically, although they were known to be due to the existence of buried layers of varying hardness. Although our equipment was embryonic and the measure of our naiveté great, we succeeded in piecing together many disrupted occurrences of these subsurface reflections, and surmised, from a variety of circumstantial evidence, that they belonged to a single surface forming the base of the soft modern muds and sands of the Gulf. This resulted in the publication of a chart of the topography of this pre-Recent surface and of the thickness of the modern sediments. Some knowledge of the geology of the surrounding land, and of the stages of slow rise of sea level while it recovered from a low stand during the last period of glaciation (at approximately 65 fathoms, some 17,000 to 19,000 years ago), indicated that the buried reflectors might represent the weathered and hard surface of the Pleistocene land prior to its flooding by the sea. The topography of the old surface was much more complex than that of the present Gulf floor; modern sedimentation apparently having smoothed out many of the irregularities. It clearly gave evidence for the existence of a drainage system in the west connected with some minor streams that still exist today, and for a similar one in the east related to rivers on Trinidad. However, there was no trace of any valleys that might represent the Pleistocene equivalent of the two large Orinoco river tributaries that nowadays enter the Gulf, and we were forced to conclude that the entire northwestern portion of the Orinoco delta is a very young feature.

Elegant hypothesis

Although all this was published with the appropriate amount of courage and decisiveness, the memory of the poor and fragmentary records and of the exceedingly circumstantial nature of the evidence remained vivid, and was by no means alleviated by the beautiful work done on subsurface echosounding in recent years with more advanced equipment. When, therefore, in 1960 Dr. V. T. Bowen offered me the opportunity to return to the Gulf and do some work of my choosing on the return of 'Chain's' Equalant I cruise, I accepted with this problem primarily in mind. It might have been wise to leave well enough alone and not run the risk of having to retract fully an early and elegant hypothesis, but scientists are forever optimistic and the temptation of modern equipment and facilities was great.

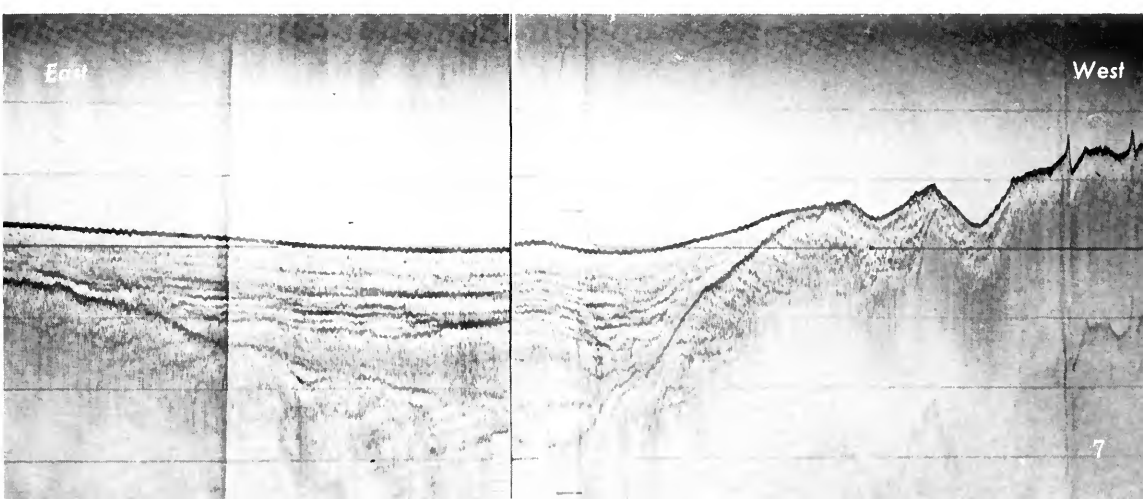
Many reflectors

It is too early at the moment to assess fully the results of this study, which at the moment of writing is still continuing, but the presence of subsurface echos was beautifully confirmed. In fact, we found so many subsurface reflectors that it will be difficult to ascertain with confidence which one it was, if it was a single one, that we charted in 1951. The general picture that has emerged so far appears to confirm in general the earlier conclusions, including that of the absence, until very recently, of Orinoco drainage into the Gulf proper.

Dr. van ANDEL is Associate Research Geologist at Scripps Institution of Oceanography. He will be at Woods Hole this summer as a Post Doctoral Fellow.

Moreover, as is so often the case, the more sophisticated capabilities of the Precision Graphic Recorder have introduced considerable complexity in places where the situation originally appeared simple. A good example is shown in the accompanying photograph of a record obtained in the Serpent's Mouth, the southeastern entrance to the Gulf between Trinidad and the Orinoco delta. The record, clearly shows a protruding, relatively steep-sided mass of hard bottom, covered on both flanks with well-bedded modern sediment. This ridge, probably Tertiary in age, appears to connect the Peninsula of southwestern Trinidad with the Orinoco delta, where its presence in the subsurface is known in an oil field at the edge of the large estuary opening into the Gulf. On the Trinidad side several oil fields both on land and in the shallow Gulf have been developed in the ridge. The position of the top of the ridge is such that it may well have barred the Serpent's Mouth until some seven or eight thousand years ago.

Echosounder record of partially buried, pinnacled Tertiary ridge (right) adjacent to well-bedded modern sediments in a trough of complex structure (left). The total height of the record represents the interval of 0-40 fathoms, the width a distance of approximately 2 nautical miles.

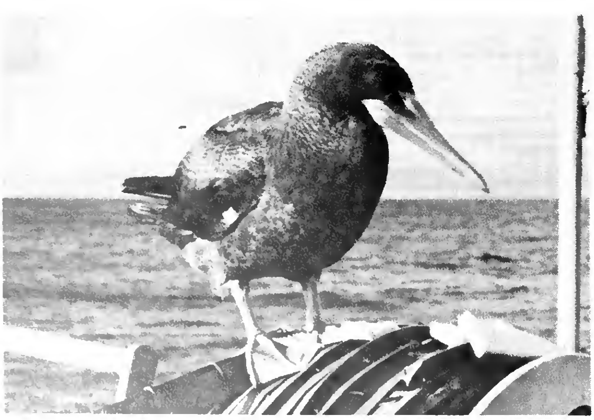


CRAWFORD'S WORK

by W. G. METCALF

As an aftermath of the 1961 Equatorial Cruise of the 'Chain' to the Romanche Trench during which measurements were made of the Atlantic Undercurrent,* a somewhat more elaborate plan was devised for further equatorial current studies using both 'Crawford' and 'Chain' in 1963.** This plan mushroomed into an extensive international effort known as Equalant I. (Note: Equalant II, a continuation of the international effort will take place during July and August 1963, but our Institution is not participating.) The U.S. Bureau of Commercial Fisheries has taken on the task of coordinating the efforts of the various co-operating agencies.

The present article concerns 'Crawford's' work in Equalant I between mid-January and the end of April, 1963. With a scientific party of eight we left Woods Hole on 18 January and headed for the Cape Verde Islands via Bermuda. Except for a bathythermograph profile on the Bermuda-Cape Verde Islands passage and a few plankton tows, the scientific program did not start until after the ship left Sao Vicente and headed south along the 25th W. meridian.



METCALF

The 'Crawford' also had a foreign visitor on board.

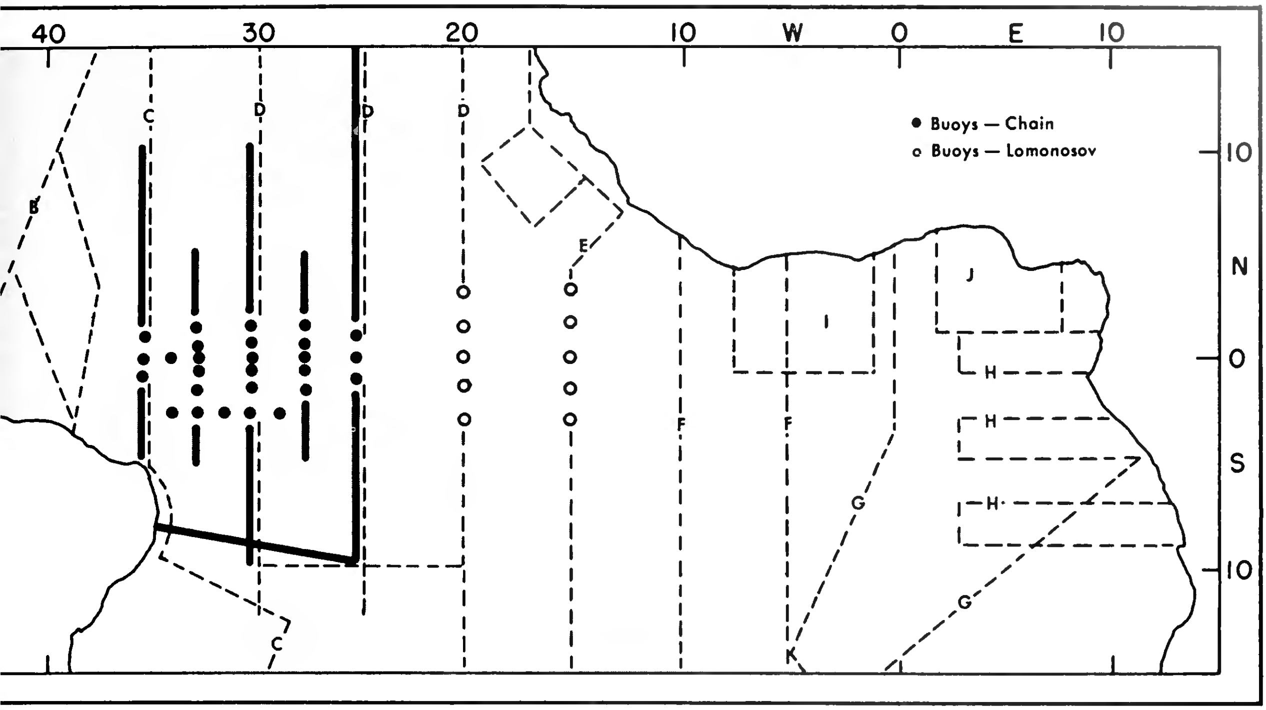
Hydrographic stations, augmented in most cases in the upper 375 meters by **in situ** salinometer lowerings, were occupied every full degree of latitude (60 miles) from 15° N. to 10° S. Between 5° North and South, the interval was reduced to 30 miles. This general pattern was followed on all the sections. North-south section were run at 25°, 27½°, 30°, 32½°, 35°, and 40° West, and additional sections were run connecting the southern ends of the 25° and 32½° sections with the Brazilian shelf. A total of 174 stations were occupied.

On three Equator crossings, parachute drogues were placed in the Undercurrent at about 55 meters, and in all cases the subsurface drift was at a speed of about 1½ knots to the East. In general, the surface current flowed to the West if the Trade winds were blowing. On some occasions when the air was calm the surface current was either lacking or was running to the East.

Unfortunately the **in situ** salinometer only functioned on two of the crossings but the information it gave

*See "Chain Cruise #17", Oceanus, VIII, 1, Sept. 61

**See: "Equatorial Studies", Oceanus, IX, 2, Dec. 1962



Tentative cruise plan for the Equatorial region shows where our ships and those of other nations operated. The dots indicate where our R.V. 'Chain' and the Russian 'Lomonosov' set out Richardson current meters on buoy stations.

was of immense value in delineating the salinity maximum which is such an important feature of the Undercurrent.

Electronitis

A current meter designed to be lowered from the ship refused to work properly. After years of experiences of this sort, I have reached the inescapable conclusion that electronic devices are very apt to malfunction on any ship I am aboard. I used to think that vacuum tubes found my presence incompatible, but have recently come to realise to my sorrow that transistors feel the same way. The new transistorized PGR put up with me for a total of 18 hours before quitting for the rest of the trip.

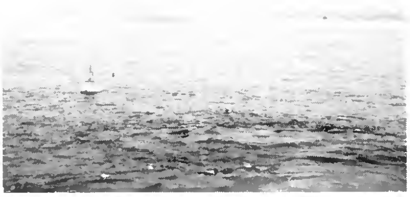
Fortunately, Nansen bottles and reversing thermometers are less temperamental in my presence, and the hydrographic data appear to be very good. In conjunction with the current records from the 'Chain' part of the cruise, these results should give us new and interesting information about the Undercurrent which must play a major role in the distribution of biological and chemical products in the equatorial region.

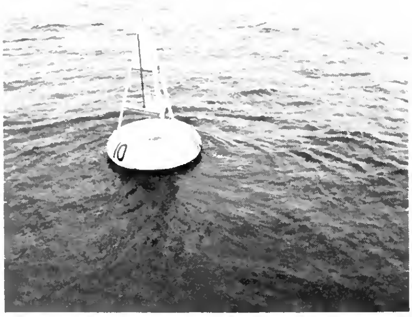
On all the Equator crossings, the core of the Undercurrent showed a salinity of about 36.5 o/oo. Along the coast of Brazil, a narrow but well defined subsurface core of water with a salinity of greater than 37.0 o/oo was found between 50 and 100 meters in depth, which appears to be the source of the saline core of the Equatorial Undercurrent.

In general, the temperature picture gave little evidence of either a northwesterly current along the coast nor of the Equatorial Undercurrent. A slight spreading of the isotherms in the main thermocline could be seen at the Equator but it was not very pronounced in most of the crossings.

Navigation

Although much interesting work remains to be done on the current system close to the Equator, much of it must wait until some of the newer navigational techniques become available to us. In an area such as this, where variable and unknown surface currents are at work and cloudy skies are often present for prolonged periods of time, celestial navigation is uncertain enough to be a seriously limiting factor in the accuracy of current observations. It is hoped that good Loran coverage or the use of an inertial navigation system will solve some of these problems.

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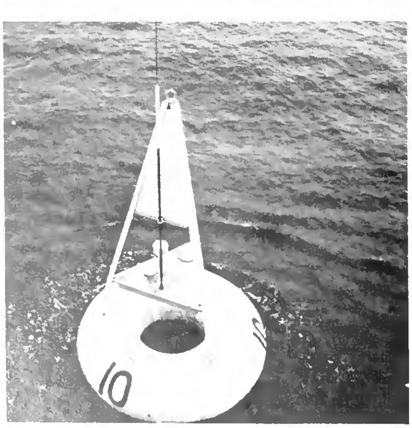
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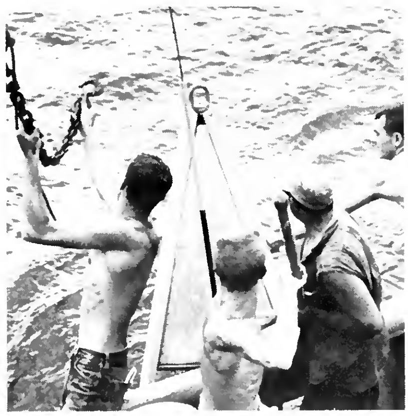

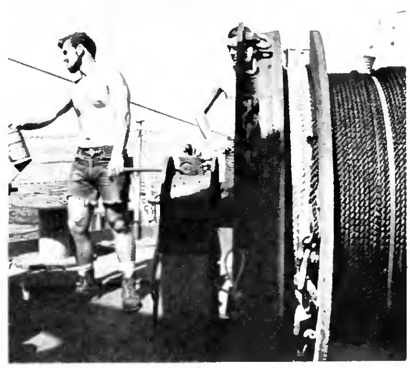


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Equalant Buoy Program

A most successful moored buoy program was carried out during the 'Chain-35' participation in the Equalant Program.

by PAUL B. STIMSON

BUOY work along the Woods Hole-Bermuda line* was discontinued in the autumn of 1962, in order that the equipment would be ready for the Equalant I Program. Twelve buoys crowded the afterdeck of the 'Chain', while the associated instruments and anchoring equipment took up considerable space in other parts of the ship.

Seven of the stations were established on a long term basis of approximately two months on and near the Equator. The buoys were programmed to record current speeds and directions three times per hour. Of these seven, three were recovered on station, two were picked up adrift, and two were lost.

The remaining five buoys were used for short term measurements, of approximately one week each, with the instruments set to record continuously. Each buoy was set out four times and was recovered each time without loss of instruments. We were most pleased with the results of this successful experiment.

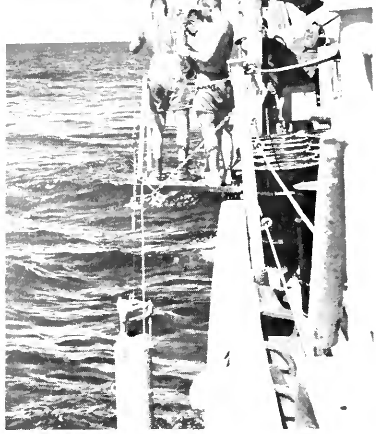
The current meters suspended at various depths, constituted the bulk of the instrumentation but some thermographs were also installed. In addition, several recordings were made of mooring tension, in line with our continuing efforts to improve the design of the mooring.

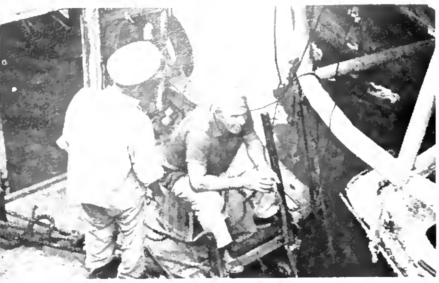
Modern electronic aids to navigation do not extend to the Equatorial Atlantic so that the positioning problem proved to be a crucial element in the buoy program. Celestial fixes were obtained whenever possible but there were extended periods of dense cloud cover which left us dependent upon dead reckoning.** Fortunately, each buoy was fitted with a small beacon transmitter fitted with a newly designed keyer which caused it to emit an identification signal once every few seconds, instead of once an hour as was formerly the case. The 'Chain' carries a good radio direction finder. Invariably the detection of a radio signal led to the speedy recovery of the buoy.

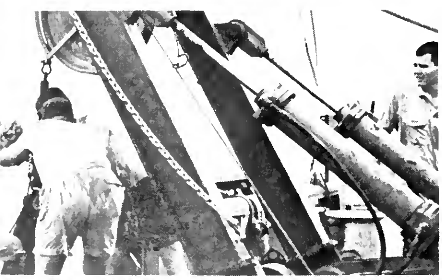
Mr. STIMSON is in our Department of Applied Oceanography with Dr. W. S. Richardson.

*See: "Current measurements from moored buoys", Vol. VIII, No. 2, Dec. '61.

**Deduced from courses sailed, ship's speed and known or estimated drift.





Major Purpose: Two of our research vessels took part in "Operation Equalant I", from January through May, 1963, to study the Atlantic Equatorial region.

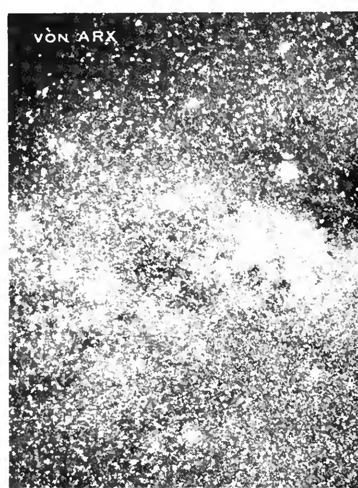
Total miles sailed: 'Chain' (Captain C. A. Davis) 15,878 miles. 'Crawford' (Captain D. F. Casiles) 15,054 miles.

Ports of call: 'Chain': Bermuda, St. Thomas, V. I., Recife, Paramaribo, Port of Spain, St. Thomas, V. I.
'Crawford': Bermuda, St. Vincent, Cape Verde Islands, Recife, St. Thomas, V. I.

Personnel: 'Chain': 43 scientists (not at any given time). Chief scientists: Dr. W. S. Richardson (legs 1 and 2), Dr. V. T. Bowen (legs 3 and 4).
'Crawford': 12 scientists under Mr. W. G. Metcalf.

Data: 'Chain': 6 Hydrographic stations, 94 plankton tows, 12 piston cores, 22 gravity cores, 57 dredges (rock, pipe, shell and quantitative), 6 large volume stations, 33 mid-water trawls, 27 moored buoys set out (25 recovered) utilizing some 25 miles of braided nylon and polypropylene mooring lines, 2 scattering layer stations, 9 shallow salinity and pH stations (upriver in Venezuela by small boat), 61 chlorophyll stations. Continuous or repeated observations: bottom profiles with PGR, CO_2 measure-

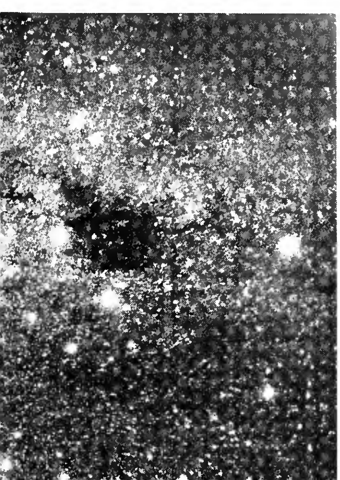




ments, bioluminescence counts, Bathythermographs, vertical profiles of salinity and oxygen, visible counts of marine life and birds, nightfishing.

'Crawford': 174 Hydrographic stations, 5,067 temperature observations, and 5,067 salinity determinations, oxygen titrations, total phosphate, in situ inorganic phosphate, 64 in situ salinity lowerings, 6 large volume stations providing 46 water samples, 1226 Bathythermograph observations, 14 plankton tows, 12 sea surface radiation measurements, 5 parachute drogues, 4 surface drogues, 3 anchored buoy stations, 2 Swallow floats, 2000 drift cards set out, continuous sea surface temperature records, 75 cloud photographs.

Working visitors on board the 'Chain': Leg 1; Dr. N. B. Marshall, British Museum; Dr. P. Koske, Kiel Univ. (W. Germany); Mr. R. W. Mosher, U. S. Weather Bureau. **Leg 2:** Dr. G. D. Nicholls and Mr. G. Thompson of the University of Manchester (Gr. Britain); Dr. Maurice Rinkel, Miami Univ.; Mr. E. Eckstein, Univ. of Sao Paulo (Brazil); Dr. I. Macgregor, Princeton Univ. **Leg 3:** Dr. Tj. van Andel, Mr. R. Gibbs, both of Scripps Inst. of Oceanography; Dr. R. Cifelli and Dr. D. Squires, U. S. National Museum; Dr. N. Sachs, U. S. Geological Survey; and Lt. R. Salas, observer for the Venezuelan Navy. (See also page: 20). Naval Evaluatoin Group for the GEON: Warren A. Stickney, Naval Applied Science Laboratory; Ralph H. Thrasher, Bureau of Ships; Louis Larsen, Naval Applied Science Laboratory; Bruce Sammitt, I.T.T.—Federal Laboratories.



A Varied Experience

By R. GIBBS

By various methods of travel, from floating in dug-out canoes and eating monkey meat, to sailing in the 'Chain' and dining on filet-mignon, the suspended materials in and from the Amazon river were sampled.

EVERYONE who has seen tropical or subtropical waters has been intrigued by the brilliantly blue hues and the clarity of the sea. Yet, clear as this water appears it contains a lot of suspended materials as well as dissolved salts. The vast majority of these materials are supplied by rivers to the ocean, yet very few studies have been made of this incoming flow.

There are many intriguing questions that need to be answered. What are the types of material arriving from different rock areas? What changes occur in the material en-route to the ocean? Where does the material go in the sea? To try to answer these questions we selected the Amazon river system, since it is one of the few rivers left in the world which are not seriously disturbed by man through dams, sewage, agricultural activities, etc. Also, the Amazon system has the widest range of climatic conditions, from the Arctic type of region in the Peruvian Andes to the tropical rain forests.

The plan for the river work was to sample periodically the tributary rivers which bring materials from various climatic and geological areas and to visit each region in the dry and rainy seasons to make other measurements such as temperature, pH, eH, etc. The inaccessibility of the areas and the very difficult travel conditions obviously make it impossible to visit the areas regularly. In two months of difficult field work we managed to establish ten sampling stations where doctors, missionaries and scientists living along the rivers will sample the water every two to four weeks. This also permits a survey of the conditions during the wet season which lasts from December to May and during which time travelling becomes even more difficult.

Monkey meat

The river work entailed travelling from the mouth of the Amazon up into the foothills of the Andes, a distance of approximately 3500 miles, using every possible means of transportation, from airplanes (when available) to small dug-out canoes. The conditions of "lodging" were far from desirable. Many a night was spent in my U.S. Marine surplus jungle hammock hanging from a couple of trees along the river bank. Usually, however, I managed to be in some village at night, for they were my chief source of food. Needless to say there were no Duncan Hines recommendations, the food included such delicacies as monkey, boa constrictor (anaconda) and a multitude of exotic fruits and vegetables. Arranging for a canoe was a matter of finding some Indian who had one and bargain for a price. The usual rental for a good dug-out and a strong man to paddle from dawn to dusk was from 50 cents to one dollar.

Later on, in the estuary of the Amazon a brief survey was made of the conditions of the materials and what happens when they first come into contact with salt water. This entailed the use of an in-situ transparency and salinometer, current meters and sampling devices. The work was easier since I.C.O.M.I., a division of Bethlehem Steel at Santana, Amapa, kindly made one of their barges and tugs available.

The outflow of the turbid Amazon waters are carried northward along the Atlantic coast by the North Equatorial current. This discharge can be seen from the air as a zone of brownish turbid water extending ten to twenty kilometers out to sea. It can be traced easily for more than 1600 kilometers as far as the Gulf of Paria. To obtain information on this outflow, I joined the R.V. 'Chain' and worked also from the M/V 'Oregon' of the U.S. Bureau of Commercial Fisheries and the destroyer 'Bertioga' of the Brazilian Navy. All these ships took part in 'Operation Equalant'. I received the kindest co-operation from the officers and scientists on board these vessels.

Shark supper

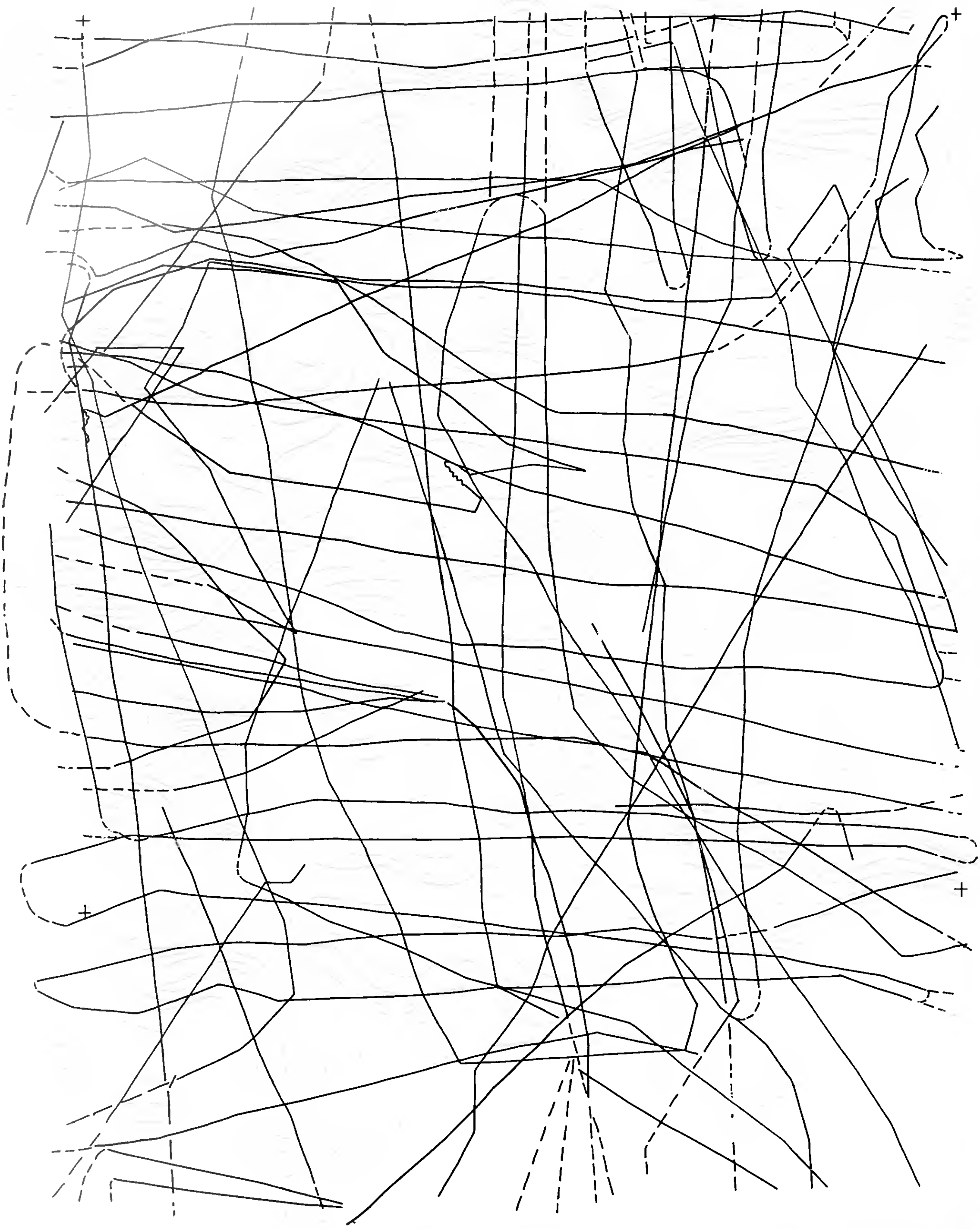
The cruise on board the 'Bertioga' was made possible through the kind efforts of the Oceanographic Institute at Sao Paulo. About halfway through the cruise the "Langosta guerria" with the French lobsterman started. Being a naval vessel we merrily went along the waves carrying on gunnery practice after the French boats. Another sidelight was the fondness of the crew for catching sharks while we were hove-to on hydrographic stations. And guess what we had for supper on those nights?

To obtain sufficient material for analysis each water sample from the rivers had to be from 20 to 40 liters and in the ocean from 40 to 100 liters. Each sample was then filtered using special pressure apparatus and microfilters. A pressure head was obtained by hoisting plastic bags high up on the mast of the 'Chain'. Extracting suspended materials from such large volumes of water proved to be a difficult problem. So, for laboratory analysis onshore, all the suspended material from each sample and between one and two liters of the filtered water was stored. We are now anxiously awaiting the results of our chemical and mineralogic analyses for only then can we distinguish between the various suspended materials which, like cats in the dark, all look about the same on the filters.

Ed. note: Unfortunately no photographs were available to illustrate Dr. Gibbs' fascinating cruise up the Amazon River.

MORE and more articles which have appeared in Oceanus are reprinted by permission in various other periodicals and newspapers.

The article: "Whale music" by Wm. E. Schevill in the December 1962 issue was reprinted in Vol. XVI, No. 4 of **Naval Research Reviews**. The article: "Education" by G. E. Stokes, published in the March 1963 issue, will be reprinted in **Science and Mathematics**, a High School publication published by the Weslyan Press.



The intensity of the search made for the Thresher by the 'Atlantis II' is shown on this chart superimposed on the bottom contour chart resulting from the extensive search.

Depths in fathoms

Thresher Search

HIGH

S. T. Knott anxiously scanning the PGR on board the 'Atlantis II'.

THE search for the lost submarine 'Thresher' has been so widely reported in the newspapers and other periodicals that we cannot hope to compete in the reporting of this dramatic undertaking. Instead we shall give a brief account here, especially brief since everyone at Woods Hole has been busy. We hope to be able to provide an adequate background story in the near future.

By chance, the 'Atlantis II' was within 100 miles of the area where the 'Thresher' disappeared on April 10th. Our ship was on her second scientific cruise, making biological and chemical observation in the Gulf of Maine. Upon hearing of the disaster, our Director, Dr. Fye, offered the services of the 'Atlantis II' and the facilities of the Institution to the U.S. Navy. Consequently, our new ship arrived in the search area in the morning of April 11th. From that date, until May 28th when the 'Atlantis II' was released by the Navy to resume her interrupted scientific schedule, she played an important part in the search operations, principally because of our ability to distinguish small protuberances on the ocean bottom with our Precision Graphic Recorder, and due to the "know-how" of our ship's officers, crew and scientists in the study of the ocean bottom. A large number of our people took part under the leadership of Dr. J. B. Hersey, Chairman of our Geophysics Department.

The Woods Hole work at sea on 'Atlantis II' consisted of four separate cruises led in turn by N. Corwin, S. T. Knott, J. B. Hersey, E. E. Hays, W. Dow, and S. T. Knott again. The effort, in the search area, roughly 220 miles east of Cape Cod, consisted mainly of locating bottom irregularities which might be the 'Thresher's' hull, using echo-sounding techniques* and then to examine these protuberances more closely with other instruments, chiefly underwater cameras.

Debris shown

The difficulty of positioning a camera at the end of 1½ miles of cable over a precise spot only a few hundred feet in size hardly can be overstated. When we went to press no photographs identifying the 'Thresher's' hull had been taken. Quite a few photographs, however, showed debris which might or might not have come from the submarine.** These photos, together with other information were deemed sufficient to concentrate the search in one particular area.

Meanwhile, Navy and civilian scientist analyzed the evidence obtained and tried to narrow the search area.

*See: Oceanus, Vol. V, nos. 1 and 2, 1957
**See: Life, June 7, 1963

Commendation

The following message was received from Vice Admiral A. Grenfell, Commander Submarine Fleet Atlantic. "1. Through all phases of 'Thresher' search and survey to date, performance, by the 'Atlantis II' has been marked by the highest standards of seamanship and scientific performance.

2. Please express my appreciation to your dedicated team of scientists and seamen for their assistance in a difficult task. Their efforts have contributed significantly to oceanographic knowledge and to our capabilities at deep ocean depths."

THROUGH this night the ship moves as on a sea of watered silk; softly lighted by the past-full moon which keeps easy pace at the end of a slowly writhing path of light. The ship is unnaturally still as she pushes a circle of awareness through the vacant tropical sea. Beyond the hard line underscoring the moon's place in the night, there is no end of sea; no beginning of sky. The ship is without support; balanced precariously on the very tip of a finger of light. The soft wash of the bow wave hints that the ocean may still be real and may still be sliding past her sides.

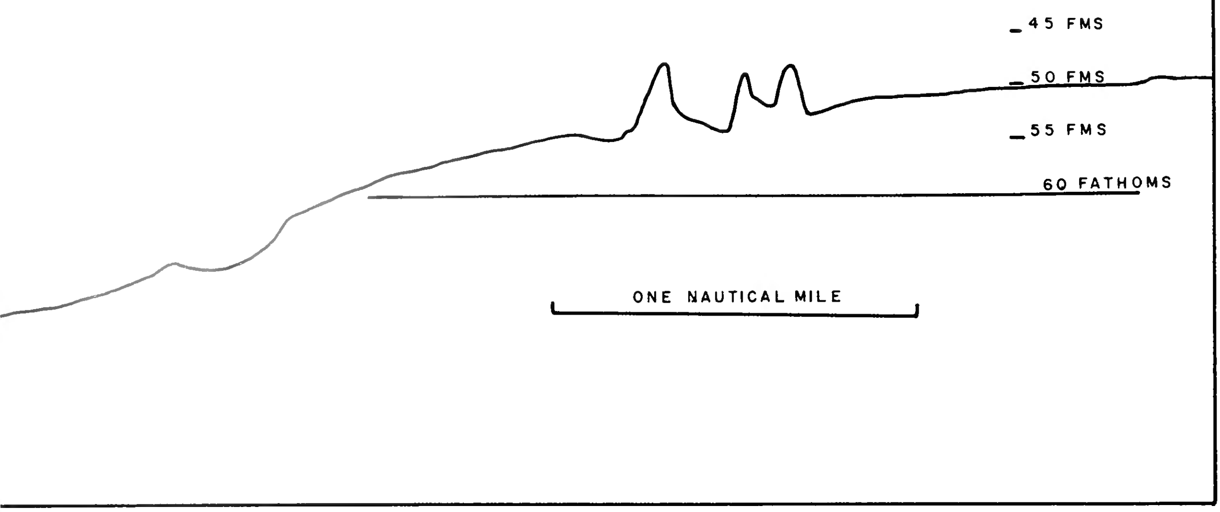
On deck all are silent. The coming sounds of those who burst from the lighted spaces below are at once subdued; then cease. Thoughts carry across the night in contemplation of the sea; then onward over the curve of earth to those beloved, dimly remembered in voice and feature, but at this moment a presence vividly recalled.

The mate and lookout stand apart, watching the sea and the ship as duty requires. What words they need are few and passed in lowered tones. The helmsman gives his traditional repetition of orders, but softly, for even inside the wheelhouse this night has special qualities.

At length a figure by the rail owns quietly 'this is what we come to sea for,' and the silence of the others is clear acknowledgment that he put it well enough.

Anon.

Pinnacles on the Continental Shelf



by D. F. SQUIRES

A wall of cemented materials was discovered off the Orinoco River. The dredging of such material from small pinnacles proved a difficult task.

ALONG the margins of the continental shelf where the land gives way to the deep sea, one often finds masses of calcium carbonate and limestone which form spectacular topography. These masses of calcareous rocks can be grouped together as shelf edge prominences but are of diverse origins. The most conspicuous ones are the tropical coral reefs. Structures such as the Great Barrier Reef of Australia stretch for a thousand miles in a tremendous accumulation of carbonate rock derived from the skeletons of the animals living on the reef.

Deep coral

Less well known are the deep water coral banks such as those recently discovered by the 'Atlantis' on the Blake Plateau off the Carolinas. Along the edge of the shelf in the eastern Atlantic, coral banks form a conspicuous topography.

A third type of prominence is that formed by an accumulation of shell material of some antiquity which has become cemented to form a hard resistant rock. How the shells accumulate in such mounds varies from place to place, but the general procedure is linked to the lower sea levels which existed during the Pleistocene glaciation. In the Gulf of Mexico pinnacles have been left behind as eroded remnants of such former deposits.

Early studies of the Orinoco Shelf region disclosed the presence of masses of calcareous rock on the outer portion of the shelf. Preliminary reports indicated that these might be the remains of old coral reefs drowned during the post-glacial sea level rise. Echo-sounder records also suggested that some of these erosional stacks were small enough to qualify as pinnacles.

With this knowledge, it was planned, as part of the other shelf sediment studies to be carried out on 'Chain 35', to study the topography of the prominences by means of the Precision Graphic Recorder and to determine their composition by sampling with the pipe dredge and the rock dredge. The project was a great success.

Wall discovered

Among the more notable discoveries concerning the shelf edge prominences was that west of a position roughly corresponding to the mouth of the Orinoco River, the discrete pinnacles found to the east gave way to a continuous wall for which the name Orinoco Wall has been suggested. This structure extends along the shelf in depths of from 45 to 65 fathoms as an unbroken wall about five fathoms in height and varying from several hundred feet to nearly half a mile in width, and possibly extending for one hundred miles. To the east of the Orinoco River mouth, the wall has been broached and eroded. PGR tracings from some crossings of the shelf edge showed the prominence to be completely missing, others indicated that only narrow remnants were still present. Nevertheless, this more or less continuous structure is of great significance both to the interpretation of the physical environment of the shelf and to the biology of the region.

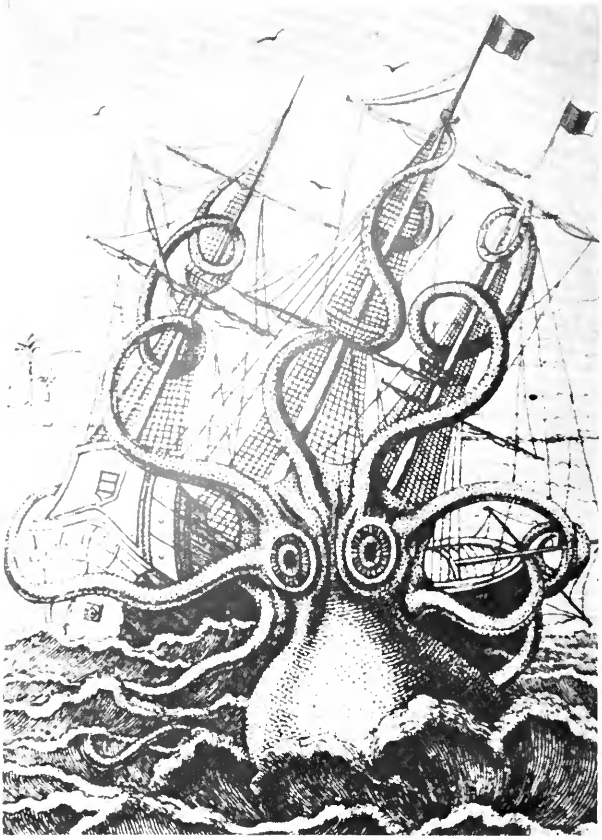
Sampling the structure of the wall was relatively easy, but dredging the pinnacles was another matter, for many of them were less than 200 feet in diameter and were about 30 feet high. This small target had to be hit from a ship hove-to in an area subjected to a current of from two to four knots. The technique for studying these pinnacles was based upon the ship maneuver, the Williamson Turn, which is used, in the event of a man overboard, to bring the ship back on its original track, but proceeding in the opposite direction. When 'Chain' approached the shelf edge, a marker buoy was readied on the fantail. If a pinnacle was crossed, the bridge was asked for a Williamson turn, and as 'Chain' passed over the pinnacle for the second time, the buoy anchor was kicked over the side. It is a tribute to the ship's officers that in one instance, four crossings were made at full cruising speed of a single pinnacle (two at right angles to the preceding two) the pinnacles being only two ship's lengths in total diameter.

Dredging of the pinnacles and of the shelf in their vicinity yielded much information concerning the setting and composition of the rock. However, it was not until after the Orinoco Wall was discovered that an attempt at knocking off rock was successful. There, where pinpointing the structure was not necessary, greater attention could be given to the placement of the gear. The wall is composed of masses of shell material, pebbles and sand cemented together by a means not yet known, all of which is grown over by a living mat of calcareous algae. A fauna of solitary corals, molluscs, sponges, and many other organisms were associated with this calcareous algae. There is no evidence that the wall or the pinnacles are a coral reef, or that they represent the remains of one. This information will have to wait complete study of all the samples collected.

Dr. SQUIRES is Associate Curator, Division of Marine Invertebrates, at the Smithsonian Institution.

Bottom photo of living coral (white) and dead debris (black) on deep coral bank on the Blake Plateau.

STETSON



Giant Squid

By H. J. TURNER

Ye monstrous of the briny deep, your masters praises shout. Up from the waves ye cuddlings peep, and wag your tails about.
(Bay State Hymn Book)

"O ye Whales and all that move in the waters. . . ."
(the Book of Common Prayer)

. . . . and little sharksey doyster, —A squiddly doyster too. . . . ."
(Mairsey dotes)

FROM the pious Pilgrim hymn to the solemn prayerbook and the childish prattle of a once-popular song, man frequently refers to the creatures of the sea. Denizens of the deep, particularly the big ones, have fascinated man ever since he decided to venture forth on the surface of the oceans. Fleeting glimpses of large sharks and whales have stirred the imagination and provided material for many a long sea story. However these are vertebrates and have a fairly commonplace and familiar body form in spite of their enormous size. Monstrous invertebrates, on the other hand, really can be startling, not only because of size but particularly because of a grotesque appearance.

In general the invertebrates are small. The average landsman seldom sees one any larger than an earthworm, spider or grasshopper, while a two inch tarantula or a six inch centipede may inspire terror. Some people have marvelled at a two-foot lobster in an aquarium, or admired the three-foot shell of a giant reef clam serving as a bird bath on a concrete pedestal, but these are not common, and not startlingly big. In fact the structural and functional biology of invertebrates is such that great size is almost impossible to attain. Nevertheless, one exceptional group of marine molluscs, the cephalopods, have managed to develop species of considerable size.

Strange creatures

The cephalopods, a group which includes the squids, octopuses, cuttle fishes and nautili, are molluscs like clams, oysters and snails. The cephalopods are quite advanced in a number of ways. They swim by means of jet propulsion and may be among the swiftest of marine organisms when they dart for short distances. They have extraordinarily well developed eyes which are similiar in many respects to the eyes of vertebrates. They capture their prey with sinuous arms provided with adhesive suckers and bite with beaks very much like those of birds of prey. When startled or frightened they release clouds of an ink-like substance which may either act as a smoke screen, or otherwise distract an adversary and permit a successful retreat. On the whole they are quite extraordinary creatures.

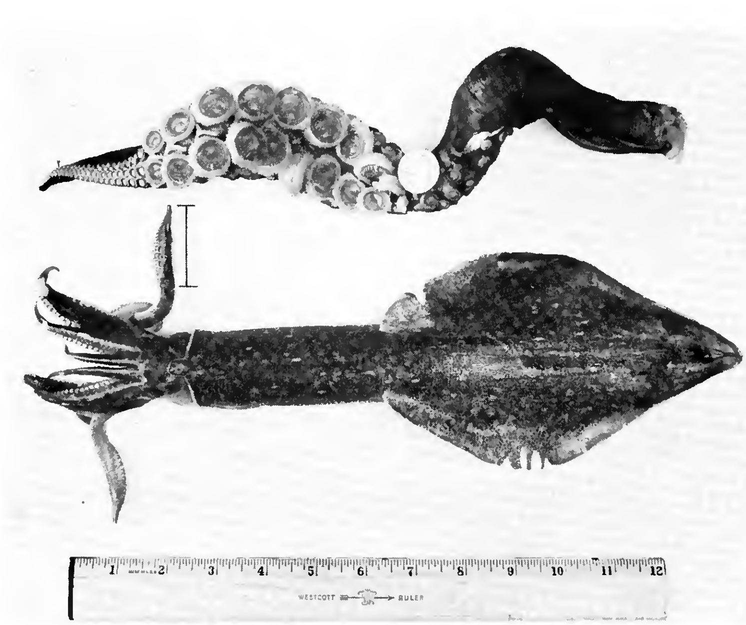
Largest invertebrates

One group of cephalopods, the squids, contains species that are the largest invertebrates in existence. While most of the squids are about a foot long or less, there are a few kinds that attain relatively great size. The giant squid, **Architeuthis,** may have a body as long as twelve feet and when the dimensions of the two tentacular arms are added, the total length may reach 50 feet. Another kind, **Sthenoteuthis,** is somewhat smaller but still may reach quite impressive dimensions.

Specimens of these big squid are rarely found since they are all inhabitants of the deep oceans. Those that have been seen have usually been stranded on beaches, or found in the stomach of sperm whales and almost always have been more or less decomposed before coming to the attention of the biologist. Consequently, the finding of a specimen, or even a portion of one, in good condition is an exciting event.

Mr. TURNER is a Marine Biologist on our staff and lecturer in Zoology at the University of New Hampshire. He has been with the Institution since 1944 when he came to work on the wave and surf project and subsequently on the anti-fouling program.

On the 'Chain-35' cruise, a portion of a squid tentacle of considerable size was caught between the top of a Nansen bottle and the hydrographic wire at one of the stations south of Bermuda. When the news first reached the laboratory, it had passed through several persons and had grown considerably with the telling. The tentacle was reported to be as big as a man's leg with sucker discs like dinner plates. More reliably informed sources indicated that it was quite a bit smaller, and when the ship docked the tentacle was found to be preserved in a pint mason jar although packed in very tightly. There is no way of knowing at what depth the tentacle was caught. The Nansen bottle had been tripped at 3100 meters but probably encountered the squid on the way up and wrenched off a portion of the tentacle as the wire was reeled in rapidly. The tip was still writhing when it hit the deck.



Part of the tentacle of an 8 to 10 foot long squid, found by the 'Chain', as compared to the equivalent tip of a one foot squid. The two tentacular arms deflected to the side are not much longer than the other eight arms of the small species. In the body of the giant squids these arms are about one third longer than the body of the animal. The size of the suction cups is indicated by a five cent coin.

SPOONER

The specimen proved to be the club-shaped, sucker-equipped, end-portion, or manus, of the long arm of a squid, probably of the genus **Sthenoteuthis**. The biggest sucker was about as large as a nickel. By comparison with the published dimensions of intact specimens of this genus, it was possible to reconstruct the size of the original animal. The body was at least three feet long and possibly nearly four feet. The two long arms were from four to six feet long so that the total length of the squid was nearly ten feet. This is by no means a record but would have been quite impressive if the entire animal had landed on the deck with writhing arms, and jetting ink.

Our interest in these big squid is somewhat more than academic. We suspect them of biting the mooring ropes of deep sea installations and setting the buoys adrift. The mooring ropes of at least two drifting buoys have been recovered which give some indication that this may be the case. Two of the three strands of polypropylene rope were cut off cleanly and the third was frayed out as if from simple stress failure. A siphonophore, a long, stringy jelly-fish-like organism, was wound around the rope near the cut ends.

We believe that the siphonophore may have been one of the luminescent variety and may have flashed its lights when it became entangled with the rope. The squid, seeing the flashes, may have then seized the rope with its tentacles and attacked the siphonophore with its beak. When it cut through two of the strands of rope, the third parted with a quick snap which must have surprised the squid considerably. Some day we hope to catch one of these large squid alive and perhaps determine whether or not this hypothesis could be correct.

New Aircraft

THE Institution's new four-engined airplane (Capt. Wm. Ewing), and which has what almost amounts to a novel written on her tail, left Woods Hole on June 3d for her first scientific flight in co-operation with the U.S. Weather Bureau. Meteorological observations will be made over the Indian Ocean, using Bombay as the home port.

Mr. Andrew F. Bunker, who has logged many thousands of hours on our planes, is chief scientist, assisted by Messrs. F. C. Ronne, C. P. Brown and R. B. Bachelder.

Associates' News

THE Associates' dinners held in May were well attended by Associates, their guests and prospective Associates. 216 people attended the meeting in Wilmington, Delaware, 212 were present in New York and 215 dined in Boston. Our Director, Dr. Paul M. Fye, was the principal speaker and provided a review of our new ships, and other facilities. He also discussed the Thresher search and the two international programs, in the Indian Ocean and along the Atlantic Equatorial region.

Yacht Club Visit

THE Commodore of the New York Yacht Club, Mr. H. Irving Pratt, has accepted the Institution's invitation for an open house visit when the fleet of yachts dock in Woods Hole this summer during their annual cruise. This will be the second affair, the yachtsmen visited also about ten years ago. Last summer several hundred members of the Cruising Club of America received a welcome and listened with pleasure to a series of informal talks by staff members

THE ASSOCIATES of the Woods Hole Oceanographic Institution are a group of individuals, corporations and other organizations who, because of their love for the sea and interest in science and education, support and encourage the research and related activities of the Institution.

Membership dues in the Associates are as follows:

Member	$50
Contributing Member	$100
Patron	$500
Life Member	$1,000
Corporate Member	$1,000
Sustaining Corporate Member	$5,000 or more.

All contributions and dues are tax deductible to the extent provided by law.

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