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OCEANUS

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THE COVER PHOTO IS BY

The scientific party on board the 'Erika Dan' had its rough moments but, one could retire to the comfort and spaciousness supplied by the size of the ship, the co-operation of officers and crew and the solicitousness of the owners, the J. Lauritzen Co. (see: page 21.)

VOL. IX, No. 1, September 1962

. . . IT IS THUS that science, which is gradually preparing the means for converting the globe into one great organism for the benefit of mankind, points out the way for making it the abode of that harmony, peace and plenty which has been dreamed of by the poets of all time. For it is only necessary that our moral progress should keep pace with our advance in knowledge. The globe will never become the abode of perfect harmony until men are united in a universal league of justice and peace. And in aiding toward the production of this most desirable consummation, what has been here written will show how important has been the part taken by the ocean.

From: "Ocean's story"
or
Triumphs of Thirty Centuries;

A graphic description of Maritime Adventures, Achievements, Explorations, Discoveries and Inventions: and of the Rise and Progress of Ship-building and Ocean-Navigation from the Ark to the Iron Steamships,

By Frank B. Goodrich, Esq.

With an account of adventures beneath the Sea; Diving, Dredging, Deep Sea Sounding, Latest Submarine Explorations, &c., &c., Prepared with great care by Edward Howland, Esq.

Hubbard Bros., Philadelphia, Boston and Cincinnati.
1873

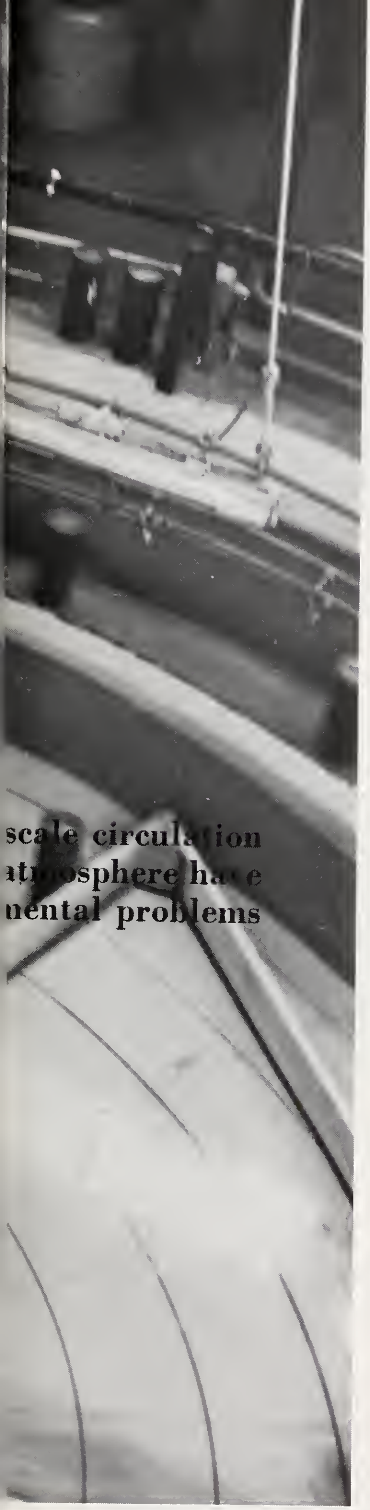
The 'Erika Dan' at Godthaab, Greenland

WRIGHT

**Model studies of large
in the ocean and in the
led to studies of fund
in fluid dynamics.**

Suspended on a platform over the old 4-meter rotating model basin, Dr. Faller (right) studies the circulation in the North Atlantic Ocean.

Dyes are added to the water in the sectors to simulate the Gulf Stream and test a specific theory why currents are strongest on the western sides of the oceans.



Atmospheric Model Studies

By A. J. Faller

MODEL studies of fluid circulations in rotating systems at the Institution began with the successful attempts by von Arx to simulate the wind-driven circulations of the oceans. These experiments are now a matter of record[1] and need not be elaborated upon here except to note two pertinent points: 1) the availability of the large rotating apparatus was the single factor which was responsible for the presence of this author at Woods Hole; and 2) these experiments provided certain background information and methods which indicated the feasibility of other more quantitative experiments related to the ocean circulation.

Some of the first results of our attempts, starting in 1954, to "model" atmospheric flow patterns are shown. In these experiments (and many other which are not illustrated here) it was demonstrated that the structures of atmospheric fronts, wave cyclones and even the "jet stream" could be simulated readily in an exceedingly simple model. For example, these models were symmetrical in that they contained no topography and no land-ocean contrasts. Furthermore, water replaced air as the fluid and there was no physical process to simulate the effects of precipitation. Thus, these experiments demonstrated that many of the complex weather systems which we observe might well occur in the atmosphere without the complicating influences mentioned above.

[1] See: "A Small World", Oceanus, Vol. IV, No. 4.

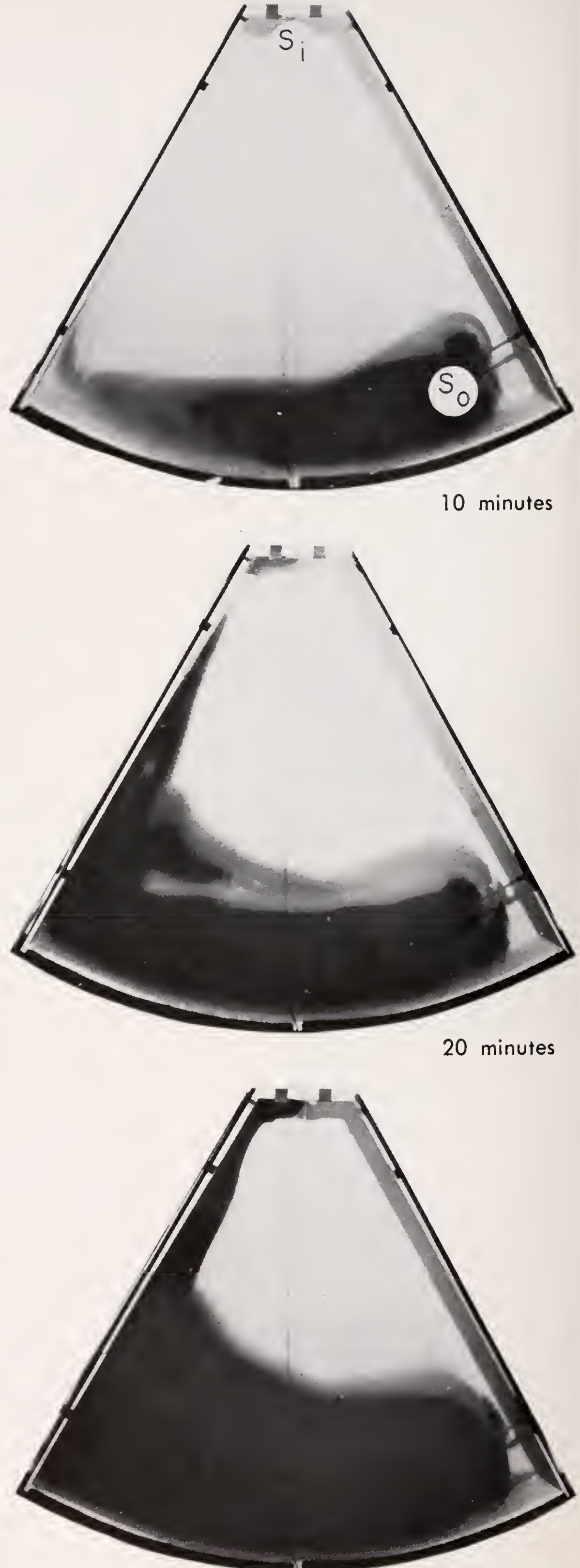
Model Studies

Nevertheless, as interesting as these experiments may be, their contribution to our understanding is limited. Without elaborate measurements little useful information can be obtained for detailed comparison with the atmosphere; and even when such comparison can be made it often has little meaning unless it is accompanied by theoretical understanding.

A somewhat more simple experimental study, to test a specific theory related to the ocean circulation, is illustrated here by a sequence of photographs. In this example the circulation was generated by inserting water slowly through a tube at the source (So) and by withdrawing at the same rate at the sink (Si). The relevant question was: What will be the path which the water follows in flowing from So to Si? The result, which is somewhat contrary to one's intuition, fully confirmed the theoretical prediction. The volume rate of flow from the source to the left hand boundary of the sector was ten times the source rate. Of the flow to the left nine parts recirculated to the source and one part moved rapidly toward the sink in a narrow boundary.

With some stretch of the imagination the 60 degree sector may become the North Atlantic Ocean[2]. Furthermore the narrow boundary current on the "western" side of the model may be thought of as similar to the Gulf Stream. The generation of a circulation by sources and sinks of fluid may be thought of as similar to the effect of a distribution of evaporation and precipitation, although it is also possible to obtain theoretical analogy with wind-driven circulation. This experiment then, is one in which similarity with a system existing in nature was planned and is apparent, but which is simplified to the extent that theoretical analysis and understanding is possible.

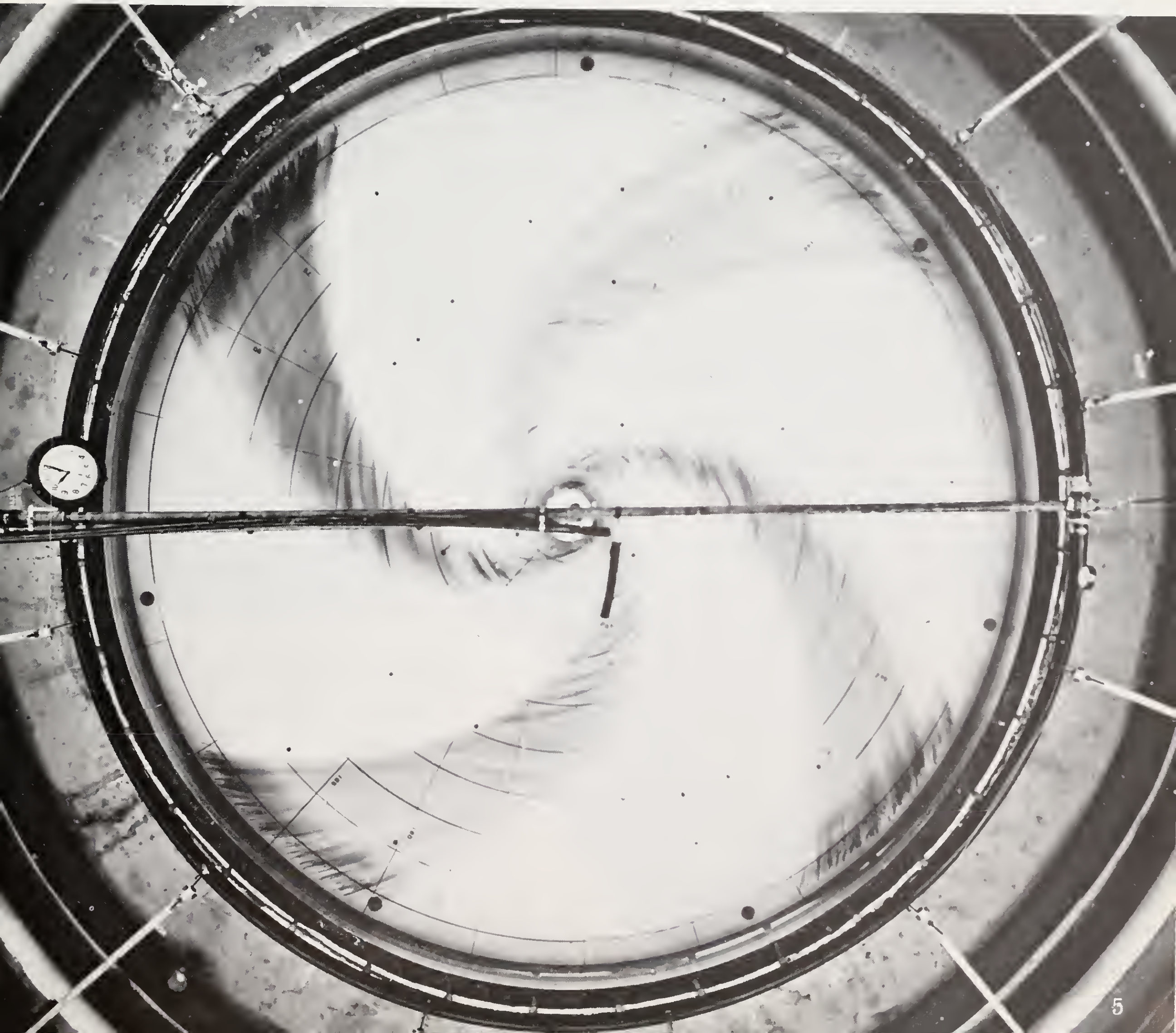
[2] Here a concession must be made to practicing physical oceanographers who will claim that the North Atlantic offers obstacles not encountered in the laboratory.



Simplified model of an ocean circulation caused by the flow of colored water in a sector spun at 10 r.p.m. The water at the rim was twice as deep as the apex. (see text).

Spiral Flow

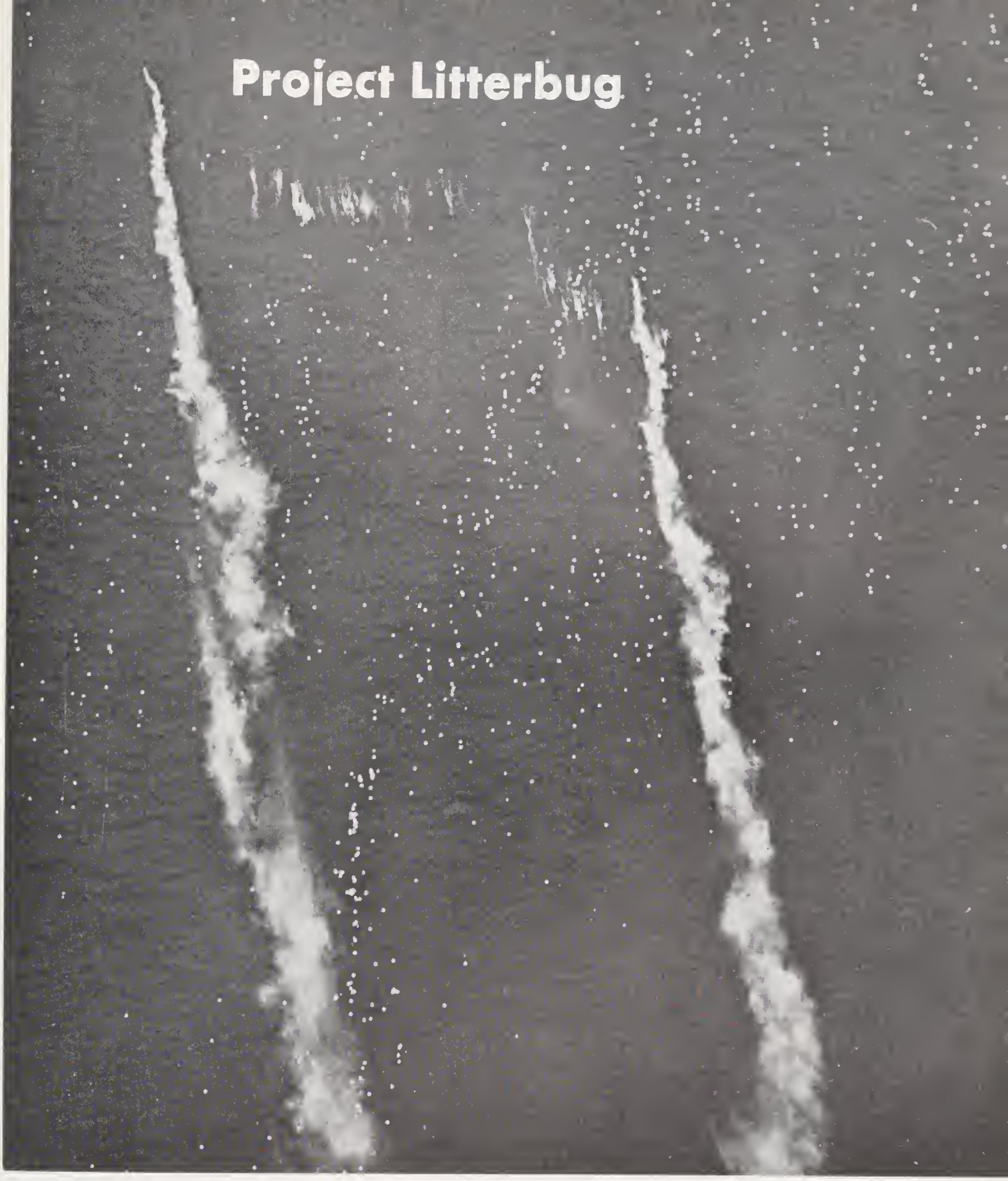
More recently experimental studies were shifted to the 4-meter rotating tank which was housed in the old hydrodynamics laboratory on the dock. Although this apparatus eventually became useless (because of periodic inundations by salt water, seaweed, and sand) a successful series of basic hydrodynamic experiments on the stability of the Ekman boundary layer was accomplished. By pumping water from the center of the tank and resupplying it at the rim, a vortex circulation was generated. The required radial flow from the rim to the center took place entirely in a very shallow boundary layer at the bottom of the tank approximately 1/10th of an inch deep in a total water depth of 10 inches. Streaks from potassium permanganate crystals near the rim show this spiral flow toward the center. Because the speed of flow increased toward the center, the boundary layer flow at the bottom of the tank became turbulent at a certain radius in the accompanying figure at approximately 6/10th of the radius of the tank. Within this radius, the dye first shows a spiral band structure, and closer to the center a more turbulent flow.



Although this study was designed to be an experiment in basic fluid dynamics it happens that there is similarity with two important natural phenomena. The first of these is the spiral bands of precipitation observed in radar photographs of hurricanes which heretofore have defied satisfactory explanation. The structure of the experimental vortex is similar in many respects to that of a hurricane where the speed of flow increases toward the center with a layer of frictional inflow approximately one mile deep. The hurricane bands spiral inward with an angle of about 18 degrees (compared to 15 degrees in the model.) Their average spacing is about twelve times the depth of the layer of inflow compared to the factor of eleven in the model. The dark bands of dye indicate regions of convergence near the bottom of the tank and upward flow just above the bottom, while of course the cloud and precipitation bands indicate similar rising motions in the atmosphere. The validity of this comparison is supported by other details, but the point to be emphasized is the relation of much simplified experiments to complex natural occurrences.

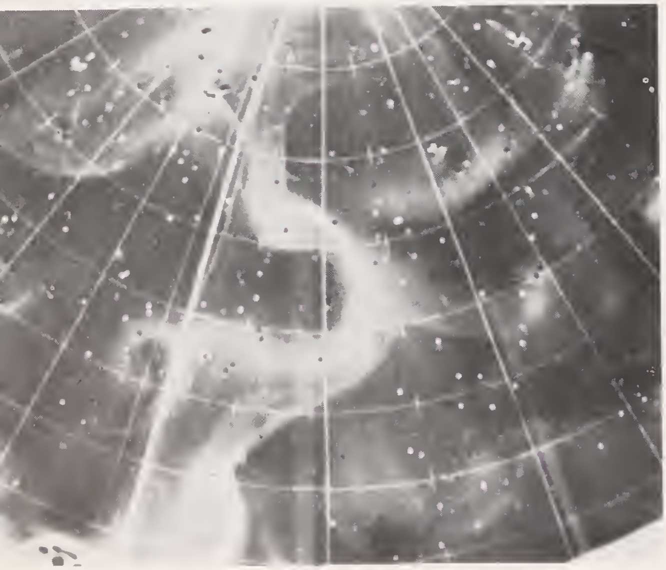
Mosaic of TIROS III photos taken on September 11, 1961, showing hurricanes "Debbie" and "Esther" at 31° N. 47° W. and 15° N. 38° W. respectively. The spiral band structure of the clouds is clearly evident although the well-defined regular bands which frequently appear on radar are somewhat obscured by higher clouds. Experimental studies suggest that the spiral bands are due to the fact that the upward motions, which cause the clouds, originate in the low-level flow spiraling into the storm center.

Project Litterbug



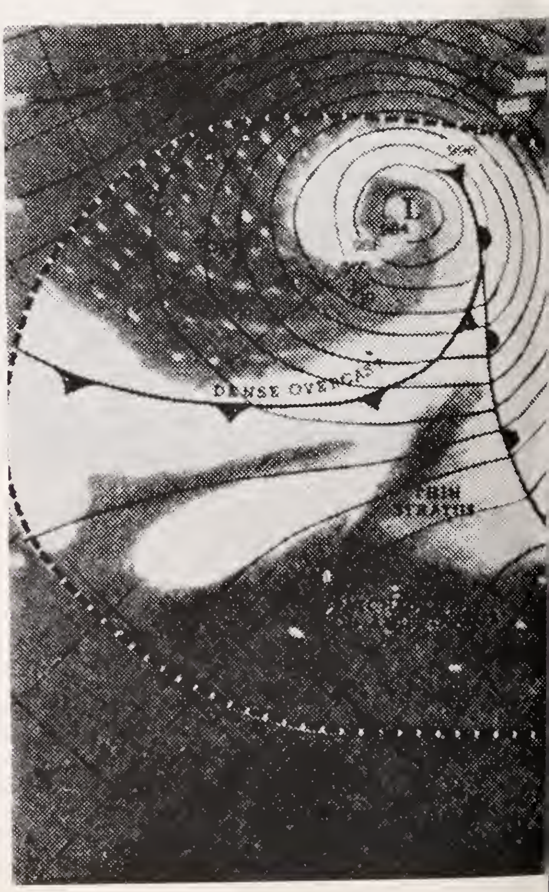
FALLER

In "Project Litterbug" sheets of 8½ x 11" writing paper were thrown out of our airplane from 1000 feet and smoke flares were dropped to show that an angle of about 8° exists between the wind direction and the lines of convergence at the water surface. The spiral bands of dye, shown on page 5, also may offer an explanation of these Langmuir circulation cells in the ocean which concentrate Sargassum weed and debris in long lines nearly parallel to the wind.



The progression of fronts and the evolution of cyclonic storms are shown in three photos made in the atmospheric model tank. Taken at intervals of two revolutions of the tank (representing two days in nature) the photos are printed in negative to emphasize the similarity between the patterns of dye, which are normally dark against a white background, and the patterns of clouds in the atmosphere as shown by a series of Tiros photographs over the North Pacific. A surface weather map is superimposed on the Tiros mosaic.

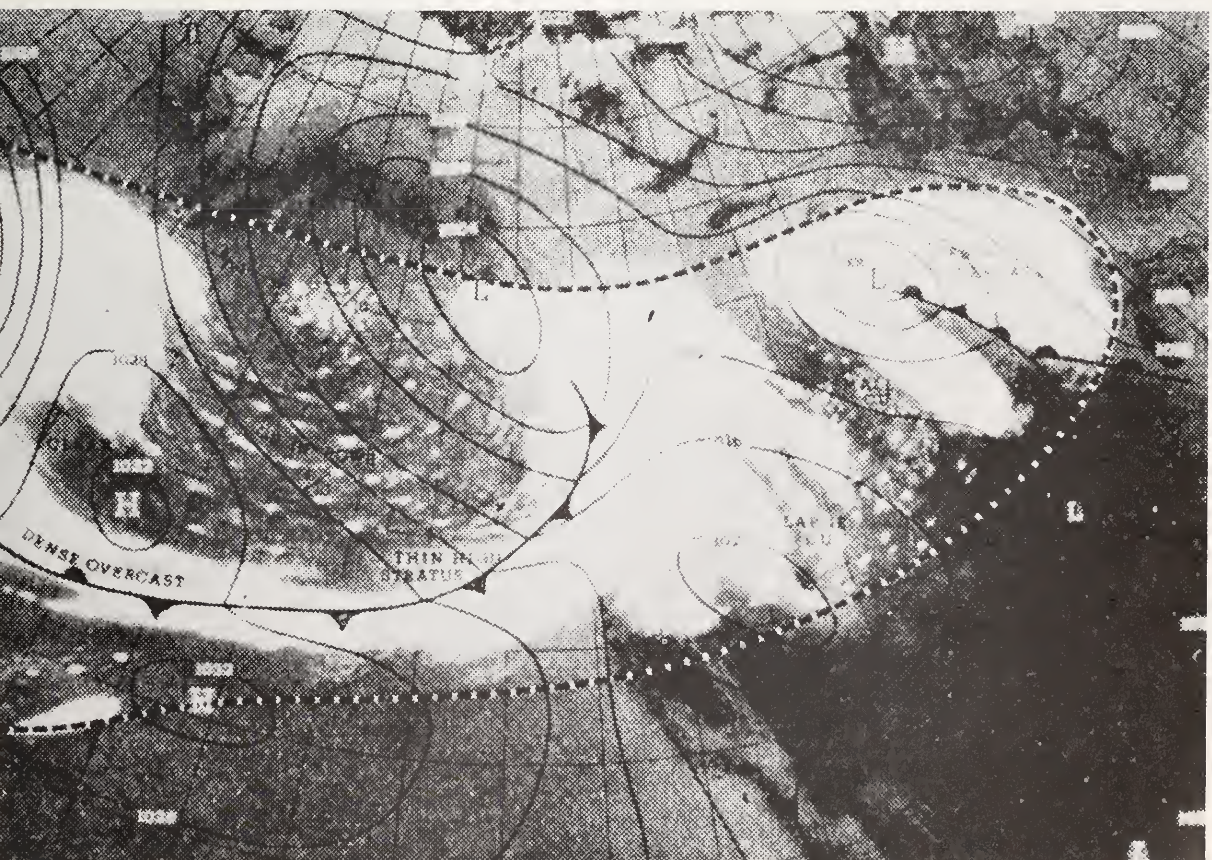
Cloud information from



The facilities of the new hydrodynamics laboratory and new rotating tank in the Laboratory of Oceanography offer new opportunities for expansion of our studies of the circulation of fluids in rotating systems. As the accompanying photographs show it is often necessary to observe details of the circulation while the tank is spinning rapidly. To observe these details we now have a closed-circuit TV camera which rotates with the tank so that the pattern of flow can be seen on a stationery TV screen. Other improvements in control of the apparatus and instrumentation will allow detailed measurements to test theoretical predictions and to prove basic information for further model studies.

DR. FALLER, meteorologist on our staff, joined the Institution in 1954 on a summer fellowship. In 1957-58 he was at the University of Chicago as primary investigator at the Hydrodynamics laboratory. In 1960-1961 he attended the International Institute of Meteorology at Stockholm on a Guggenheim Fellowship.

a series of Tiros photographs superimposed on a surface weather map.



(AFTER OLIVER, 1960)

A multiple flash photograph showing the circulation in an atmospheric model. From the five images of each paper disk, floating on the water surface, the speed, acceleration, and rotation of the flow are directly determined. A four wave pattern around the tank may be readily identified.

Mod

A comparison of a Northern Hemisphere weather map wit

The arrows indicate flow at the bottom of the tank as determined from streaks of dye. Lines of convergent flow become cold and warm fronts and are associated with the cyclones (C) and anticyclones (A).

tudies

Here the flow on the water surface is indicated by streaks from paper disks during a 20 second time exposure, while the camera was rotating with the tank. By confining the flow to a channel between two vertical walls and by cooling at the central wall, four to six equally spaced regular waves may be formed. The regularity and reproducibility of these waves makes them suitable for detailed measurement.

atterns from the rotating-tank model of the atmosphere.

A surface weather map for a day in March 1959 (chosen at random from the Historical Weather Map Series) showing a typical pattern of frontal systems, cyclones (L) and anticyclones (H) over the Northern Hemisphere to latitude 25° N.

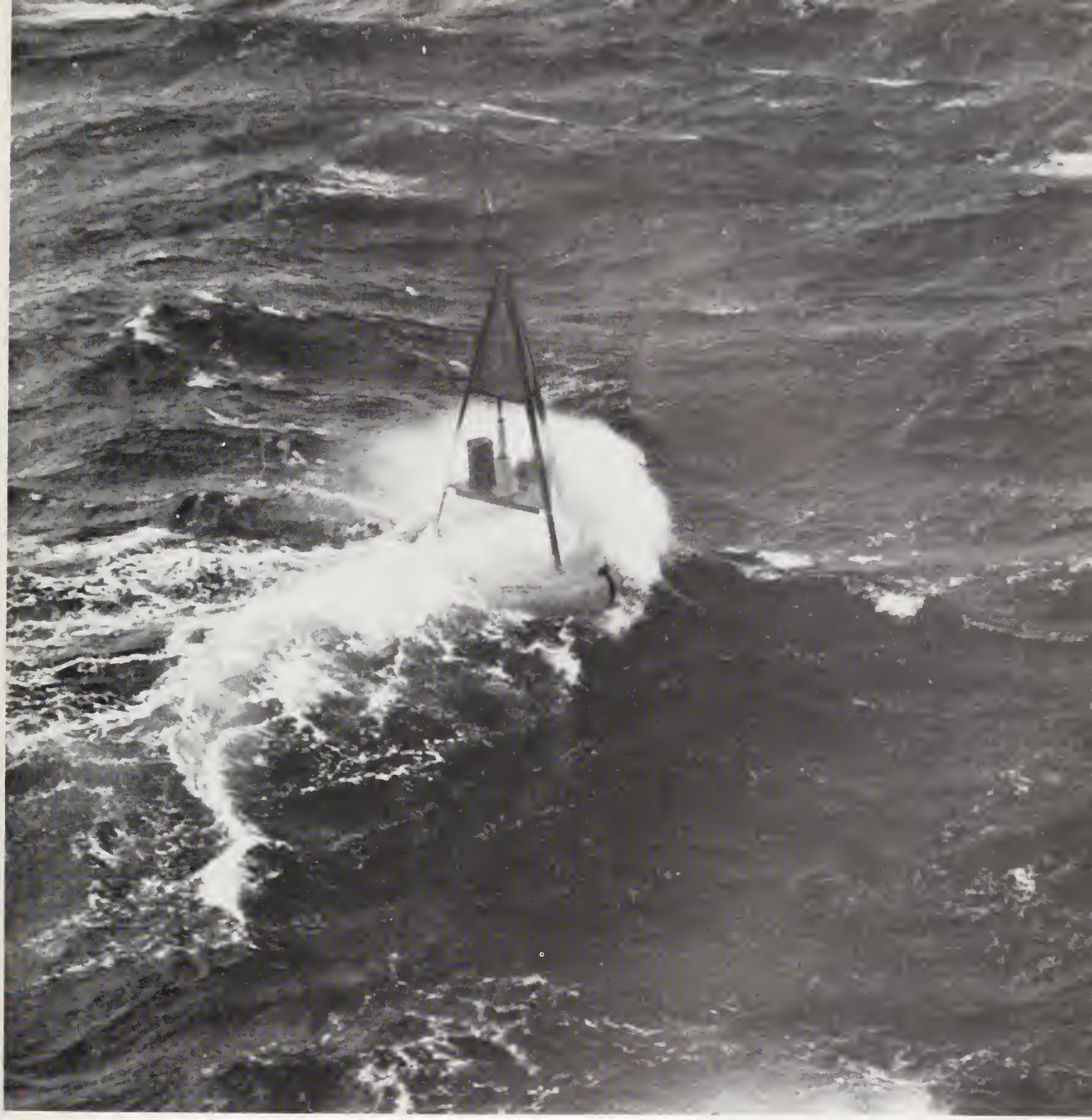
SAUNDERS

Clouds In Tanks

CUMULUS are atmospheric clouds with flat bases and round turreted summits. Strong vertical currents — a source of bumpiness to flyers — result from the buoyancy of the cloud air. The boxed region in the cloud photograph shows a region where buoyant air is ascending rapidly.

In an attempt to learn about the nature of ascending currents in cumulus clouds Peter M. Saunders, first Rossby Fellow at the Institution, has made some simple experiments in liquids. A mass of warm dyed water is released at the bottom of a tank of cold water: a photograph of the ascending 'cloud' is shown. Despite the great complexity of atmospheric clouds the experiments have proved valuable in interpreting the behaviour of cumulus.

A photo of Dr. Saunders and his cloud chamber also appeared in the August 17 issue of LIFE in an article on thunderstorms.



In the Gulf Stream

IN this dramatic photograph by Robert M. Snyder the full strength of the Gulf Stream-flowing at some 4 knots — is forcefully demonstrated. Since there are no reference points at sea it is difficult for the seaman or yachtsman to realize the Stream's velocity. One of our anchored buoys on the Bermuda Line (see: Oceanus, VIII, No. 3) provided an opportunity for a visual demonstration of the current's strength.

LEIGH

The bottle compared with a modern product of a noted brewer.

An Erratic Beer Bottle

A GREEN glass bottle was recovered from the seabed, together with a large heap of miscellaneous stones, by dredging on a seamount off Cape Finisterre, Spain. (DISCOVERY Station 4272; lat. 42°48′ long. 11°38′; depth 600 fm). The bottle has been subjected to a mechanical analysis (Krumbein 1941) with the following results:

size grade	ϕ	$= 5\frac{1}{2}$
(a = 245 mm	b = c = 63 mm)	
rounding index	R	$=< 0.1$
sphericity	Ψ	$= 0.52$
shape class (Zing)		= IV

The extreme angularity of the bottle suggests that it has suffered little abrasion during transport; this conclusion is supported by the fact that the bottle is unbroken. The absence of manganese encrustation indicates that it has not been on the bottom very long.

The bottle has sutures round its upper parts which are interpreted as the marks of a hand operated mould. The neck of the bottle, where the cork goes, has evidently been wound on as a single strip of glass after the manufacture of the rest of the bottle. An exhaustive review of previous literature on bottle taxonomy has been given by Chas. B. Hunt (1959). It appears from this work that the 'subsequent' application of neck, and the fact that it was designed for a cork rather than for a crown top, indicate a late 19th century date of manufacture.

On its base the bottle is inscribed: 2658 C.S. and Co. Ltd. This is considered to indicate an English-speaking origin.

It is concluded that this bottle was transported, probably from England about the year 1900, and thrown overboard from a ship off the coast of Spain.

The author wishes to thank Sir Edward Bullard, F.R.S. for his active support throughout the work, and for drawing attention to the key reference. The research is a remote by-product of O.N.R. Contract No. 62558-2704 for which we are grateful.

D. H. Matthews
Madingley Rise,
Madingley Road,
CAMBRIDGE,
England.

June 13th, 1962

REFERENCES

Hunt, C. B., 1959, Geotimes, **3**, 8-11.
Krumbein, W. C., 1941, J. Sed. Petr. **11**, 64-72.
Vansberg, N., 1952, Econ. Geol. **47**.

Although OCEANUS does not present original scientific contributions, but confines itself to providing the background of scientific developments, we felt that the paper by Dr. Matthews is of such vital interest that for once, we could not prevent ourselves of wanting to "scoop" the Scientific Press.

To do so properly we appointed a "referee" who commented as follows:

Dear Sir,

WITH reference to the paper by Dr. D. H. Matthews, entitled "An Erratic Beer Bottle", I would like to make the following cogent points:

a) Manganese deposition probably will not occur on glass. A close study of the literature provides no evidence for bottles, spectacles or tumblers ever having been recovered from the deep sea with manganese encrustation.

b) Dr. Matthews is apparently not aware of the stage of bottle manufacture when "screw tops" were used. He has provided no evidence that the bottle could not have been designed for use with a "screw top"; it is possible that although there is no evidence of **external** abrasion, that **internal** abrasion could have removed evidence of a screw thread.

c) The evidence for an "English-speaking origin" of the bottle is well justified. Dr. Matthews, however, should have pointed out that he was (as is becoming more necessary) excluding American 'English" since "and Co. Ltd." is restricted to Britain and parts of the British Commonwealth. The United States equivalent, as all your readers know, is "Inc."

d) It is not well established that the bottle was "thrown overboard from a ship off the coast of Spain." Personal observations (unpublished) indicate that bottles can float and it can therefore be deduced that they will be subject to movements of the surface water. Dr. Matthews may not be aware of the existence of surface currents, although this is strange since in the same area on the same expedition a dredge (doubtlessly filled with more bottles from wider geological horizons) was lost through the existence of such currents.

e) It is interesting that Dr. Matthews considers it likely that the bottle contained beer. If this is so, and if the bottle was cast overboard (empty) near where it was retrieved, then it is likely the ship was outward bound from Britain. In those days bottled beer would not keep long enough to be carried to the far flung outposts of the Empire and back again. If it was flung over when full, then the ship could have been homeward bound and the beer rotten.

f) We note the acknowledgement of the help of Sir Edward Bullard, himself a noted Director of a large brewery. We are surprised that the full resources of the brewery were not used to interpret the numbers and initials on the base of the bottle.

I am sorry to write such criticism of Dr. Matthews, who at one time was a student of mine. I would not, however, wish it to be believed that inadequate research and conclusions such as are given in this paper represent the usual quality coming from my students.

I am,

Your obedient and
humble servant,
M. N. Hill.

University of Cambridge


PRATT

Although this bottle was not dredged up, hence cannot be analyzed, it may be another beer bottle, providing evidence of substantial bottle deposits in the deep ocean. The photograph was made during 'Atlantis' cruise #260, during the first lowering of an underwater camera in the Hydrographer Canyon at a depth of 450 to 500 fathoms. The murkiness of the photograph is no doubt due to the fact that it was taken in the murky ocean depths.

Dr. J. C. Swallow on board the 'Erika Dan' last winter

Bigelow Medal

During the Annual Trustees' meeting held on August 15th and 16th, the H. B. Bigelow Medal was awarded to Dr. J. C. Swallow of the National Institute of Oceanography: Dr. Bigelow presented the medal, while Dr. W. S. von Arx read the following citation:

ALUMINUM scaffold tubing served its purpose ashore for many years, but remained unnoticed by oceanographers until John Swallow found that it can be used to form a floating volume that is less compressible than sea water. A short length of tube, fitted with end plugs and properly weighted, will sink to a predetermined level in the ocean and remain there to drift with the surrounding currents. Since the tube needs ballast, it is convenient to stack batteries and electronics within it to provide power for a high-frequency sound generator, or "pinger", which reveals the position of the tube without direct physical contact that might disturb its free drift.

This forthright instrument, the Swallow Float, has become the principal tool for the study of deep water circulations. The results of these studies have revolutionized our conceptions of the character of the deep water motions. Instead of the sluggish widespread drift anticipated from continuity considerations, the deep layers seem to be moving briskly and not in accordance with any known process. Here then, is a scientific fact that challenges the imagination.

No one is more aware of this than Dr. Swallow. Since 1955, when the first trials of the float were made, there has not been a year in which he has not been at sea in pursuit of further understanding of the character of the deep layer motions. In 1955 and 1956 he worked in the eastern basin of the North Atlantic aboard 'Discovery II'. In the following year he brought 'Discovery II' to join 'Atlantis' in a cooperative study of a deep countercurrent off South Carolina. In 1957 he worked again in the eastern basin from the Norwegian research ship 'Helland-Hansen'. Next, in 1958, he worked off Gibraltar. By 1960 he had concluded a year-long investigation of the deep motions to the south of the Gulf Stream. In 1961 he took part in the International Expedition to investigate the Faeroe-Shetland overflow from the Norwegian Sea. During the past winter he joined the 'Erika Dan' to measure the deep currents off Greenland and Labrador.

John Crossley Swallow was born at Newmill, Yorkshire, England, on 11th October, 1923. He began his education at Holme Valley School. In 1940 he was awarded a Scholarship at St. John's College, Cambridge. He read mathematics and physics for two years after which he joined the Admiralty Signal Establishment, working mainly at the East Indies Station until 1947, He then returned to Cambridge was graduated with First Class Honors in Physics, and then joined the Department of Geodesy and Geophysics to work on techniques for seismic prospecting at sea. He applied these techniques extensively during a round-the-world voyage of H.M.S. 'Challenger' during the period 1950-1952 and continued this work in the North Atlantic during 1953. He was awarded the Cambridge Ph.D. Degree in 1954 for a thesis on "Seismic Investigations at Sea". He joined the National Institute of Oceanography in 1954 where, one year later, he used his first neutrally-buoyant float for tracking deep water movements.

Dr. Swallow has the rare quality of being almost equally at home with theoretical or practical problems and has a quiet relish for arduous work at sea. The forethought he gives to each fresh effort has won him a reputation for accomplishment in the face of the severe odds which confront anyone who attempts to do new things at sea.

It is also characteristic of Dr. Swallow to be modest. On being informed of his nomination as Henry Bryant Bigelow medalist, his first impulse was to think that there must be some mistake, and his second, to go out and clean a few drains to regain his sense of proportion.

The Henry Bryant Bigelow medal is a new symbol of recognition and honor. In John Crossley Swallow we find not only one to honor by this symbol but also one whose qualities as a scientist and as a man bring significance to the Bigelow medal as a mark of scientific accomplishment.

See: "The Pinger", Oceanus, Vol. V, 3 and 4; "Deep Currents in the Open Ocean", Vol. VII, 3; "A Medal for Dr. Bigelow", Vol. VII, 4.

New Building

ON JUNE 14th, the Institution received a grant of $2,000,000 from the National Science Foundation for the construction of a Marine Research Laboratory. Construction work was started immediately.

The new building will provide much needed space since the older two laboratories and various temporary buildings have been extremely crowded. It is intended to move all the biological and chemical laboratories to the new site, thereby freeing space for use by physical oceanographers, meteorologists and submarine geologists.

The building will be of concrete slab construction and will consist of three floors providing about 50,000 square feet of floor area with space for about 150 investigators.

An auditorium seating 250 will be attached to one side. Outside there is to be a parking area for 25 cars, a reflecting pool and a landscaped area.

In the planning stage for several years, the building was designed by Kilham, Hopkins, Greeley and Brodie, Boston architects. Laboratories and offices will be located around a central core of services, including freight elevator and deep freeze plants. The structure is to be air-conditioned, if funds hold out, and will also contain a small salt water aquarium for research purposes.

There will be a sigh of relief when the new laboratory is finished in 1963. During the summer months our chemical and biological investigators have been reduced to about 80 square feet per person and are also occupying space originally intended as a warehouse. This will be the third large laboratory built by or for the Institution. The original building was erected in 1930 with the aid of funds from the Rockefeller Foundation and the Carnegie Institution. The Laboratory of Oceanography, dedicated in 1954, was constructed for our use by the Office of Naval Research.

Larva of blackfin tuna, 11.5 mm (± ½ inch) in fork length, taken in drifting plankton net by the R.V. 'Crawford' off San Salvador in the Bahamas (22°54′ N — 75°01′ W). The exterior view and a soft x-ray photograph (retouched) of the larvae are approximately 18 times enlarged. Blackfin tuna have 19 precaudal (1-19) and 20 caudal vertebrae (20-39). This count distinguishes them from the other 4 species of tuna which share alike a count of 18 + 21 vertebrae. As the five species of larval tunas in the Atlantic Ocean are essentially identical in external appearance, the analysis of soft x-ray photographs offers the only solution for distinguishing one from another.

Tuna Larva

By M. WATSON

An x-ray technique makes it possible to distinguish larva of various tuna species.

A KNOWLEDGE of the time and area of spawning is one of the basic requirements for the intelligent development of a fishery. In the case of tuna this information is largely unknown.

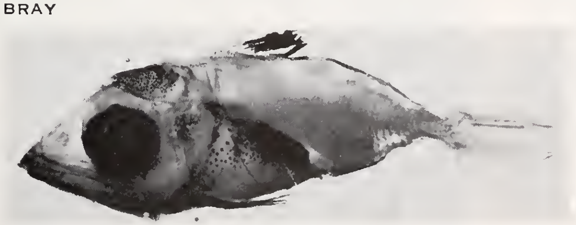
Tuna eggs are difficult to obtain and hard to identify. However, we have been able to obtain a considerable collection of tuna larvae—mostly less than one inch long — by dipnetting at night from our own ships and through loans of collections from the University of Miami Marine Laboratory and from the U.S. Fish and Wildlife Service. An excellent series of tuna larvae and juvenile tuna taken in the Straits of Messina came from a private collector, G. Arena.

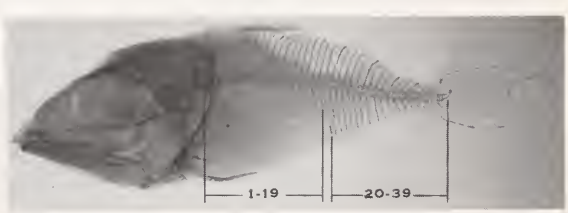
There are six known species of tuna in the world: the blackfin which is restricted to the western Atlantic, the long-tail found only in the Pacific, and four circumglobal travelers: the bluefin, albacore, yellowfin and bigeye. The larvae of these six species appear identical but have been distinguished from one another, by previous investigators, on the basis of differences in pigmentation. We found pigmentation such a variable characteristic that precise identification was untenable. Thus,we explored a new method by using the soft x-ray technique. Through the co-operation of Dr. Dorothy Travis of the Orthopaedic Research Laboratory of the Massachusetts General Hospital, the author was able to use their equipment and succeeded in photographing the vertebral characteristics of four of the five western Atlantic species of larval tuna. Thus, certain identification became possible for the first time.

The characteristics of the vertebrae of adult tuna are detectable by using hard x-ray techniques which can be made with ordinary hospital equipment. Larval fish, however, do not have calcified vertebrae, the segments show clearly only on soft x-ray photographs. The expensive technical equipment found in medical and industrial research finds more and more applications in fishery research. As we could not obtain the expensive equipment from a governmental grant — already delegated to an assigned budget — a donation from a philanthropic source was needed. We are truly appreciative of a generous gift from the Charles W. Brown Jr. Memorial Foundation which made it possible to purchase soft x-ray equipment. The gift enabled us also to convert a power supply donated by F. Hess of the Institution. Dr. Ulf Friberg of the Massachusetts General Hospital designed and supervised the construction of the equipment which is not available commercially. Dr. R. H. Backus and Dr. G. Mead also are planning to use the equipment in their study of bathypelagic fishes.

MRS. WATSON is research assistant to F. J. Mather, III, who is in charge of the study of large pelagic fishes.

BRAY





WRIGHT

A gale in the northern north Atlantic covers the foc's'le and the rigging of the 'Erika Dan' with a coat of ice. Gales, ice, snow and rain were encountered as well as unusually pleasant and calm weather.

WRIGHT

It was difficult to learn to work with gloves or mittens and often it became necessary to work bareheaded.

J. C. Swallow, G. W. Metcalf and an unrecognizable helper at work during a snow storm fixing the transducer of the echosounder. The fiberglass covers of the transducer were used as sleds by the scientific party while going down the glaciers in Godthaab , Greenland.

With the conclusion of the 'Erika Dan' cruise the general oceanographic survey of the North Atlantic has been completed. The I.G.Y. surveys left only one large gap and that was the Labrador Basin. More detailed studies are necessary in many areas, particularly accompanied by direct current measurements, but the physical geography of the North Atlantic is now known on a broad basis.

BY L. V. WORTHINGTON

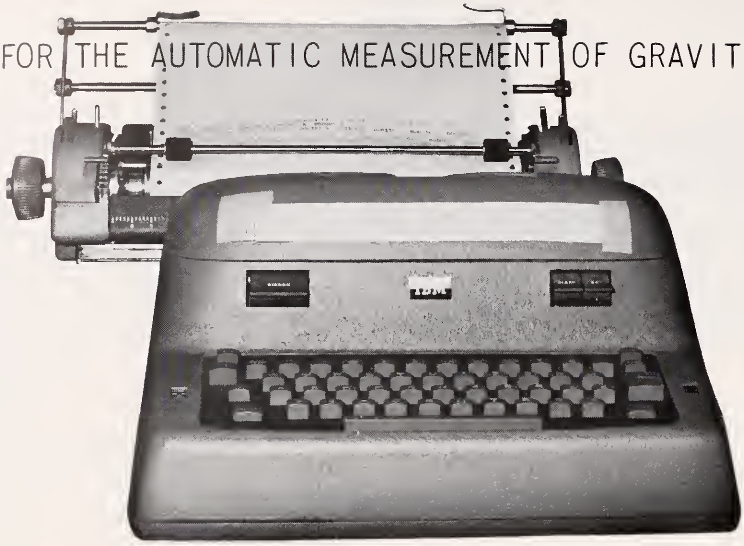
From 17 January to 4 May the Danish ice-breaker 'Erika Dan' was under charter to the Institution for a cruise to the Labrador Sea and Davis Strait. The ship sailed from Copenhagen on January 20th and made a section across the Atlantic at latitude 53°30′ North. Following this she made seven sections across the Labrador Basin and the Davis Strait before returning to Copenhagen. On the return voyage a section was completed across the Atlantic at 59°31′ North. A total of 213 hydrographic stations were made during this cruise, and continuous echo-soundings were made.

The basic purpose of the cruise was to examine late winter conditions in the Labrador Sea where the highest surface water densities are found in the Atlantic. It has been contended that North Atlantic Deep Water which comprises about half the total volume of the Atlantic Ocean is formed in this area each winter*. In the winter of 1961-1962 our observations showed that no such process was taking place as the density in the upper layers was a great deal too low to replace deep water. The data from this cruise are under-going the laborious process of checking, and a closer analysis of this matter will be undertaken.

The process which does appear to be active, at the present time, is the overflow of water from the Norwegian Sea into the Labrador Basin through the Denmark Strait. The progress of this overflow was traced from the neighborhood of Cape Farewell across the Davis Strait and down the Labrador Slope as far as the Grand Banks. We were fortunate in having Dr. J. C. Swallow participate in this cruise. Under his direction deep current measurements were made off Cape Farewell and off Newfoundland. The Swallow floats indicated that the deep overflow water was moving at about 8 cm/sec (± 1/5 knot) off Cape Farewell and about 5 cm/sec off Newfoundland. Richardson current meter measurements were made at both Swallow float sites. Unfortunately, the Richardson buoy was carried away in a gale off Cape Farewell and the current meters were lost. Off Newfoundland the current meters gave velocities closely comparable to those obtained by Swallow floats. There is a puzzle about the current direction; the current meters indicated predominantly southerly flow while the Swallow floats showed predominantly easterly flow. Hydrographic stations accompanied the measurements, possibly the distribution of pressure gradients in the area will account for the discrepancy in current directions.

*See: "How old is deep water?" Oceanus, Vol. VIII, 3.

A NEW SYSTEM FOR THE AUTOMATIC MEASUREMENT OF GRAVITY AT SEA



GRAVITY measurements from surface ships have been made for several years but involved several months of data processing. A new system installed on the R.V. 'Chain' reduces this tedious work to one minute.

In the early 1920's F. A. Vening Meinesz of Holland developed a method of swinging two pendulums at the same time in the same swinging plane which allowed him to make gravity measurements in the mobile soil of northern and western Holland. In the summer of 1923 this instrument was taken on aboard a submarine of the Royal Netherlands Navy. The success of these and following experiments led Vening Meinesz into an impressive career as a pioneer of marine gravity studies. In 1956 Anton Graf of Germany published a description of a sea gravimeter he had developed and the results of tests made on Lake Starnberg. LaCoste and Romberg of Austin, Texas modified one of their submarine gravity meters for surface measurements. This meter was first tested in the spring of 1958. Since these earlier trials gravity measurements from surface ships have become increasingly common and routine.

BY C. BOWIN

TO the few people watching a particular typewriter at 1723 GMT on July 17, 1962 there was a thrilling sense of importance. The indicator lights on the control panel of a computer were blinking at their microsecond pace, and then after seven seconds the typewriter printed the world's first values of gravity to be collected and reduced automatically at the same time as the measurements were being made. Thus, a year's planning came to fulfillment in the North Atlantic aboard the R.V. 'Chain' during Cruise #28.

The Institution obtained the thirteenth sea gravity meter made by the La Coste and Romberg Company of Austin, Texas. The instrument and its attendant IBM computer system were housed in an air conditioned structure built on the main laboratory deck of the 'Chain'.

The reduction of gravity data is complicated even ashore, on a ship the situation is made more difficult by the effect of waves on the vessel, and by the motion of the ship over the solid earth. The ground speed of the ship has the effect of increasing or decreasing the centrifugal force exerted on masses within the ship (including the weight on the beam in the gravity meter) depending on whether the ship is moving with or against the rotation of the earth. Lack of accurate knowledge of the ship's speed over the bottom is the largest single source of error. The effect of the waves on the ship are more easily surmounted. The rolling of the ship is automatically compensated by an analog computer and a horizontal reference system built into the Sea Gravimeter. The pitching is accounted for by averaging the output of the gravity meter over periods ranging from five to ten or more minutes.

The automatic system that successfully had its first sea trials on 'Chain' Cruise #28 consisted of a Sea Gravimeter, data conversion units electrically connected to the gravity meter, the ship's gyrocompass, and the ship's Electro-Magnetic speed log, an IBM 1710 computer (the combination of a 1620 Computer and a 1711 Analog to digital converter), and typewriter and paper tape output units. The system automatically scanned the position of the gravity meter beam, the gyrocompass, and the ship's log. The spring tension of the gravimeter and the depth of ocean were inserted manually. During 'Chain' Cruise #29 it is planned to make these last two inputs also automatic.

The gyrocompass and the log provide the heading of the ship and its speed through the water. This information is used in dead reckoning computations made every minute and gives the ship's position between astronomical fixes.If the heading and speed of ocean currents are approximately known, this information may also be inserted. Topography of the ocean floor is also needed for the calculation of certain gravity anomalies and for the interpretation of the structure of the earth's crust beneath the waters of the sea.

The typewriter output is used for checking the functioning of the system and for analyzing data while at sea. The paper tape is used for later processing of the data by computer and electrical plotting techniques.

The system described here did not, and could not, appear magically. It developed from the aid, support, and encouragement of many people in many capacities. To all of these, the author is deeply appreciative.

The Sea Gravimeter and part of the IBM system were built into a small air-conditioned hut in the main laboratory of the 'Chain'.

BERNSTEIN

In Memoriam

Captain W. Scott Bray

CAPTAIN W. Scott Bray, former Master of the R.V. 'Atlantis', succumbed to a long illness on June 23, 1962. A native of Indianapolis, Indiana, Captain Bray began his sea-going career in 1930 when he enlisted in the U.S. Navy. He served a four year term and, after gaining experience as a seaman on cargo vessels and tankers, he was graduated from the U.S. Maritime Training School in 1944. In 1948 he received an unlimited masters license.

He came to the Institution in the fall of 1952 and in June of 1953 was made Master of the 'Atlantis'. Those of us privileged to sail with him were well aware of his ability as a seaman and the ease with which he made friends for the Institution afloat and ashore. Few, if any, suspected the technical skill he exhibited as a photo-microscopist during the past few years, after illness forced him to retire from the sea. A versatile and ingenious experimenter, he made excellent photo-micrographs of subjects ranging from tuna larvae to sand grains. His latest efforts included investigation of a method of correlating the environmental history of sand grains with their surface texture when examined by polarized light.

R. S. Edwards

Harry Wexler (1911-1962)

IT has been a privilege for many summers to have Dr. Wexler at Woods Hole, bringing his enthusiasm, vision, friendly skepticism, and energetic discussions to so many phases of our work in oceanography and meteorology.

Although he was far from old at his sudden death, Harry Wexler was one of the real pioneers in American meteorology; he was one of Professor C. -G. Rossby's first students at pre-war M.I.T. His main role in recent years has been Director of Research of the U.S. Weather Bureau. He stood out as one of the few scientific administrators who continued as a first-class contributor to his field, so that his direction was by example, inspiration, and the sound criticism of a respected peer. He contributed original research to a broad range of topics, including arctic meteorology and ocean currents, low-level jet streams, and hurricane rain bands. He dedicated himself to furthering international cooperation in meteorology, for which he recently received a Presidential Award.

With all this responsibility, Harry Wexler found time to think, and to study and explore with us at Woods Hole. In 1960, he participated as both student and teacher in our Geophysical Fluid Dynamics Summer Program; he will live long therefrom as an illustration that a man's learning and productive years do not stop at age forty.

Just this summer, Dr. Wexler had accepted a position on the Institution's Scientific Visiting Committees. His loss to us in this role is deeply felt. But his example will remain to guide us for many years: it demonstrates that a man can both successfully contribute to and guide the direction of his science — and live as a warm and kindly human being as well.

Joanne S. Malkus

G. BOLZ

Associates' News

The British twelve meter 'Sceptre' and the successful defender 'Columbia' as seen by our Associates during the 1960 America's Cup Races.

America's Cup Race

THE Annual Meeting and Summer Cruise of the Associates of the Woods Hole Oceanographic Institution will take place on September 15th. Associates have been invited to watch the first race for the America's Cup off Newport, R. I., from the R.V. 'Atlantis'.

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.

HOMER H. EWING, **President**

RONALD A. VEEDER, **Executive Assistant**

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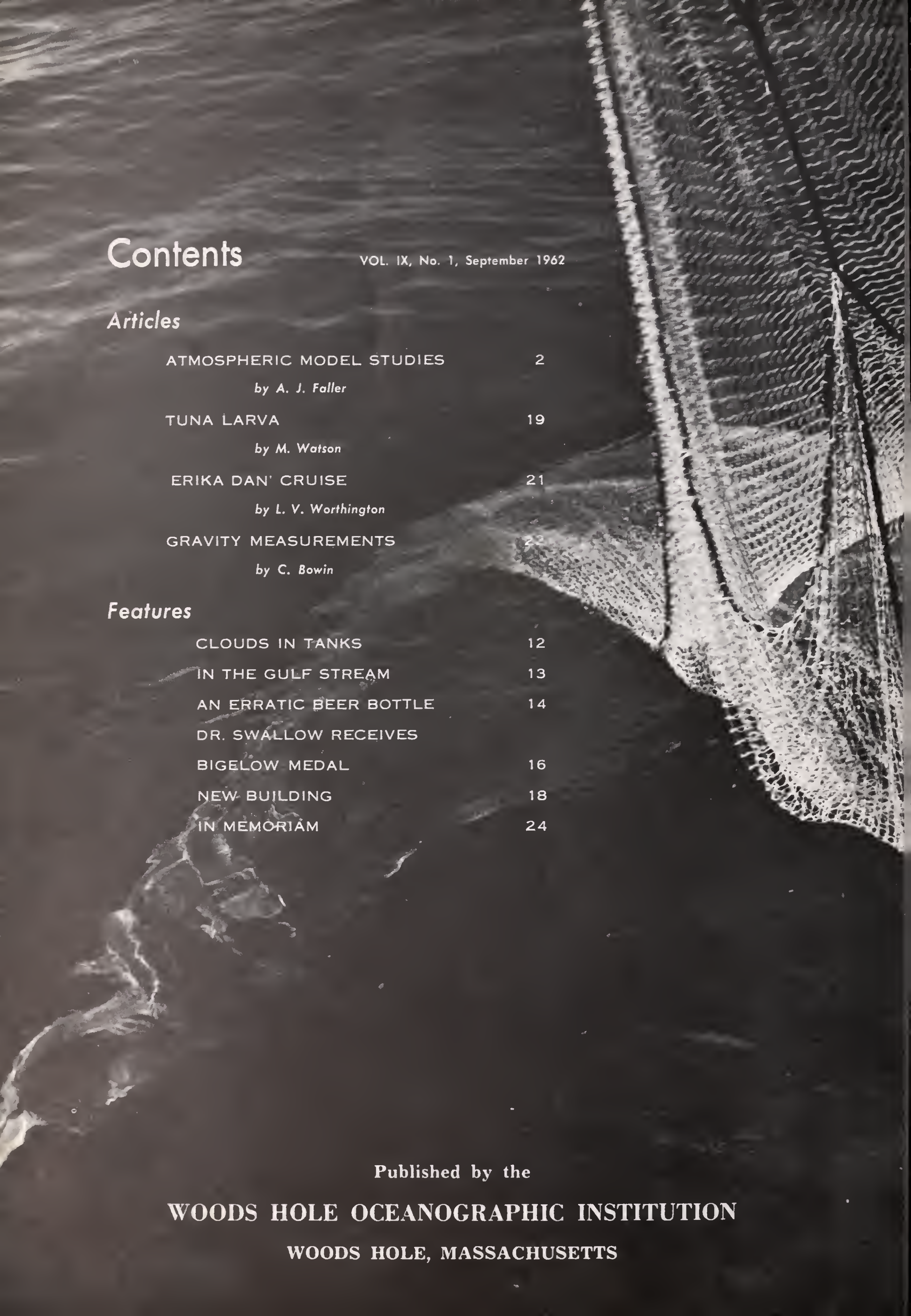

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