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The Marine Observer

A quarterly journal of Maritime Meteorology

Volume XXVII No. 178

October 1957

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THE MARINE OBSERVER

A QUARTERLY JOURNAL OF MARITIME METEOROLOGY PREPARED BY THE MARINE DIVISION OF THE METEOROLOGICAL OFFICE

VOL. XXVII No. 178 OCTOBER, 1957

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Letters to the Editor, and books for review, should be sent to the Editor, "The Marine Observer," Meteorological Office, Headstone Drive, Harrow, Middlesex

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Editorial

Sailing ships have figured rather prominently in the news lately: Her Majesty the Queen officially opened the *Cutty Sark* (now in her permanent berth at Greenwich) to the public; *Mayflower II* successfully completed her voyage from Plymouth, England, to Plymouth, Massachusetts; and the Sail Training Race Committee have announced their plans for holding a race from Brest to the Canary Islands (with a subsidiary race from Brest to Coruña for vessels of less than 150 tons) in the summer of 1958.

Although the commercial sailing ship has now virtually disappeared from the ocean, the controversy about the value of sailing ships for training seamen continues. Relatively large ocean-going sail training ships are still used to some extent by Argentina, Brazil, Chile, France, Germany, Italy, Portugal, Yugoslavia and by the U.S. Coast Guard. In the United Kingdom certain nautical colleges—notably Southampton and Cardiff—own a small sailing vessel and are thus able to provide a certain amount of sail training, and the Outward Bound Trust also has a small sailing vessel, but there is no large ocean-going British sail training ship in existence at present. The advantages of sail training (to quote the Sail Training Ship Association) are that it develops " character building and a more intimate acquaintance with the ways of the wind and sea and therefore seamanship ". Those who are opposed to sail training argue that it is of little practical value to an officer who is going to serve in a tanker or in any other modern power-driven ship where the type of seamanship he needs is quite different from that needed in a sailing ship, and that he needs all his available time to concentrate on the modern technical aspects of ship operation. But there does seem little doubt that a ship's officer who has had some experience of handling a boat or a ship under sail, and of setting and taking in sail, is a better " sailorman " than one who has not had that experience; he is probably more resourceful in emergency and in the event of having to " take to boats " would certainly be more " at home " and more capable of taking charge. It seems, therefore, that considerable credit is due to those navigation schools in this country who have had the courage to provide even small sailing craft for the better training of their pupils.

If one goes to the National Boat Show, which is held annually in London, or visits any harbour or river around the coasts, one sees evidence of the growing interest in small boat sailing by all sections of the community, which is a very healthy sign and shows that our traditional interest in the sea is not being lost.

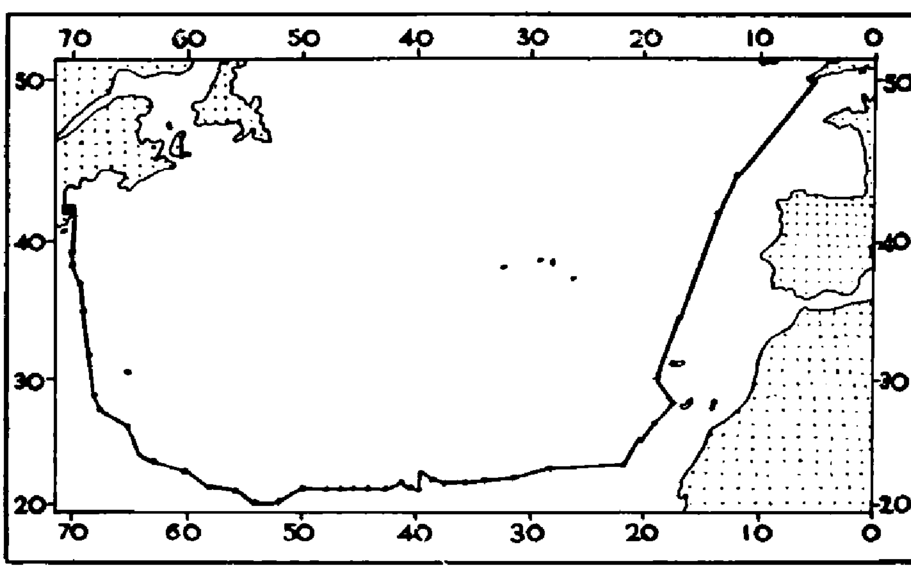
Everybody who goes in for sailing—whether it be in a ship or a small boat—needs to be weather conscious and to understand something about meteorology. Thus the R/T weather bulletins issued by the G.P.O. and B.B.C. have a very critical audience in the owners of small sailing craft, which increase year by year, as well as aboard merchant ships. There is many a yachtsman who plots his own weather map from the five-minute bulletin for coastal waters issued on the B.B.C. Light Programme.

It is perhaps a pity that the *Cutty Sark* (see photographs opposite page 205) after she had finished her commercial career was never able to be actively used as a sail training ship, but one of her uses in future will be to provide facilities for evening classes in seamanship, navigation and meteorology for yachtsmen and others. Launched as long ago as 1869 she was in the tea trade until 1877, and from 1879 until 1895 was in the Australian wool trade, after which she was sold to the Portuguese and renamed *Ferreira.* In 1922 she was bought by Captain Dowman who refitted her as a clipper and she lay at Falmouth until 1938, and from then until 1951 she lay alongside H.M.S. *Worcester.* It says a lot for the ship that during this long period of inactivity she did not more seriously deteriorate. And now, thanks to the energetic work of the *Cutty Sark* Preservation Society and the generosity of the public who had provided the funds, *Cutty Sark* finds herself in her permanent " dry berth " at Greenwich. A plaque near her gangway reads:

> Here to commemorate an era, the *Cutty Sark* has been preserved as a tribute to the ships and men of the Merchant Navy in the days of sail.
> " They mark our passage as a race of men,
> Earth will not see such ships as these again."

Prince Philip, who is himself a professional seaman, is Patron of the Society and he has shown a lot of personal interest in the project, and it was a singular tribute to all that the *Cutty Sark* stands for that Her Majesty the Queen performed the opening ceremony.

Judging by the newspapers and radio reports, the voyage of *Mayflower II* (see photograph opposite page 204) seems to have been very successful and to have shown that British seamen have by no means lost the art of sailing. The successful handling of a vessel of such ancient design and rig (the original *Mayflower* sailed in 1620) is in itself no mean feat, but the ship was in good hands under the command of Alan Villiers who has had such wide sailing-ship experience, not only in square-rigged ships but even in Arab dhows. He wisely chose the " southern route " (via the vicinity of Madeira and the Canaries), reaching as far south as latitude 20° 41'N., which is broadly in accordance with that recommended in *Ocean Passages of the World*. It seems that the ship had fair winds for her passage down to the



Voyage of *Mayflower II*

Canaries but thereafter the trades were weak until about longitude 50°W. and for the remainder of the voyage she seems to have made good progress. She arrived at Plymouth, Mass., on 12th June, her total time on the passage being 53 days—which was 14 days better than her predecessor, which covered considerably less mileage on a more northerly route where she had the disadvantage of more adverse winds. We tried to enlist *Mayflower II* as a selected ship as we thought the meteorological record from her would be of considerable interest since part of her route was through relatively unfrequented waters, but Captain Villiers explained that with such an unusual type of vessel and a new crew, he regretted that he did not think it was practicable to do this work.

It is good news that another sail training race is to take place again in 1958; the inaugural race in 1956, which was won by the Southampton Navigation School's *Moyana*, was an outstanding success and there is little doubt that international sporting and educational events of this nature can do nothing but good. The loss of *Moyana* on her homeward passage was a tragedy, but the Southampton authorities have a temporary replacement for her and are making great efforts—by voluntary subscriptions and otherwise—to replace her by a larger vessel.

In the April 1956 number of *The Marine Observer*, we referred to the tragic loss of the two British trawlers *Lorella* and *Roderigo* to the northward of Iceland, due to their superstructures becoming heavily coated with ice during very cold weather associated with a prolonged gale. As a result of this tragedy, the British Shipbuilding Research Association carried out a detailed investigation into the icing of trawlers and a study was made of the ice build-up on a 1/12th scale model of a modern British trawler, set afloat in a tank, inside a climatic chamber. The icing experiments were carried out in climatic conditions thought to be similar to those prevailing when these two trawlers were lost. The report goes into very considerable detail and contains some most interesting diagrams and photographs taken of the model inside the tank. The advantage of such an experiment was that a detailed study could be made of the gradual building up of the ice on the superstructure, rigging, etc., and of its effect upon the stability of the vessel. The tests were carried out under varying conditions until the model capsized. During the tests, the water temperature was maintained at approximately 34°F and the air temperature at 14°F to 21°F; the wind speed represented full-scale Beaufort forces 9-10. Periodically the weight of ice on the model was determined by reading the drafts and calculating the increase in displacement. The change in stability (G.M.) was determined by carrying out inclining experiments.

The report gives some detail as to the rate at which ice forms aboard such a ship in heavy weather and refers in particular to the great danger due to ice building up aloft on stays, rigging, boats, etc., because of the consequent large reduction in G.M. The last paragraph of the report, which reads as follows, seems to emphasise the difficulty of the problem, and the last sentence bears out the meteorological advice which was given in the above-mentioned article in *The Marine Observer*.

> It is considered that both a probable weight of ice and an icing pattern similar to that encountered at sea were reproduced on the model; but the rate of icing produced cannot be related to the rate of icing encountered at sea because of lack of information regarding time scales.
>
> Comparison of the icing of a normally-rigged trawler with one fitted with tripod masts (with consequent reduction in the number of stays and shrouds) had indicated that the loss of stability in the latter is approximately two-thirds that occasioned in the normally-rigged ship for the same weight of ice deposited. This is due to the fact that the centroid of the ice deposited is much lower.
>
> This also points to the advisability of stowing derricks and tackle in the lowered position to keep the centroid of the ice deposit as low as possible.
>
> It is emphasised that while the removal of ice-catching rigging and deck rails will reduce the rate at which ice will form on the ship, the same weight of ice will ultimately be deposited and thus the same loss in freeboard will occur if the vessel remains in icing conditions. Accordingly it is stressed that when icing conditions are encountered the only sure protection for the ship is to withdraw from these conditions as quickly as possible.

MARINE SUPERINTENDENT.

THE MARINE OBSERVERS' LOG

October, November, December

The Marine Observers' Log is a quarterly record of the most unusual and significant observations made by mariners.

The observations are derived from the logbooks of marine observers and from individual manuscripts. Photographs or sketches are particularly desirable.

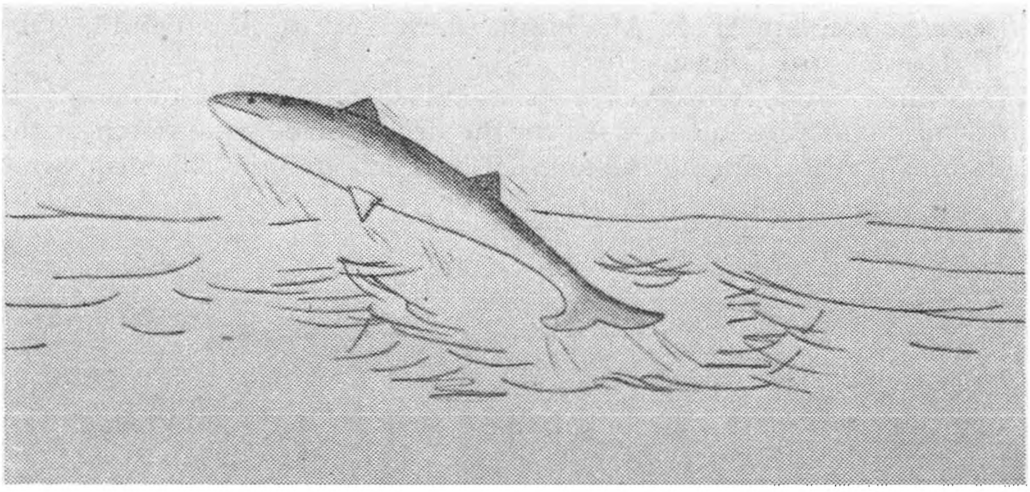
Responsibility for each observation rests with the contributor.

SHARK

South Pacific Ocean

M.V. *Tyrone*. Captain J. D. Blake. Balboa to Wellington. Observers, Mr. J. G. Campbell, 2nd Officer, and the Watch.

On 26th October, 1956, at 1510 A.T.S., a large fish, estimated to be over 20 ft long, was seen jumping out of the water. As the weather was clear and the sea calm, the fish, which was close to the vessel, was plainly seen. It had a black back which changed through grey to white underneath. The fish jumped completely clear of the water once only, the other jumps being similar to those of a porpoise. The Y-shaped tail, together with two dorsal fins on top and one fin underneath,



were plainly visible. Very explosive noises were heard as the fish fell back to the surface, but at no time did it " blow " or " sound ", and after leaping for over 5 min it made off, in a series of small porpoise jumps, in a SE'ly direction.

Position of ship: 19° 17'S., 134° 16'W.

Note. Mr. N. B. Marshall, of the Natural History Museum, comments:

" The description and drawing would appear to be of a galeoid shark. Certain species of this shark group are known to leap clear of the sea, for instance, thresher sharks, mako sharks, basking sharks and certain of the blue sharks. But none of these species, except the basking shark, grows to a length of 20 ft.

" I suggest that the animal is a galeoid shark rather than a cetacean because of the two dorsal fins. The squaloid sharks also have two dorsal fins but they are not active or jumpers."

CUTTLEFISH

West African Waters

S.S. *Umtali*. Captain F. E. J. O'Hea. Cape Town to Las Palmas. Observer, Mr. G. M. Cozens, 2nd Officer.

9th November, 1956, 1836–1845 G.M.T. A large quantity of cuttlefish was observed, floating on the surface, in a long line parallel to the ship's course, 334°. This line extended for about 2 miles, but was rarely more than 15 ft wide. At 1845 the line of fish was seen to end very abruptly. Air temp. 82°F, sea 82°.

Position of ship: 10° 20′N., 17° 00′W.

Note. Dr. W. J. Rees, of the Natural History Museum, comments:

" I think that the sudden mortality may have been caused by a sudden drop in temperature although the linearity and sharp delimitation of the shoal of cuttlefish is surprising. The species involved may well have been *Sepia officinalis*. We shall keep the record in mind in case it can be correlated with other observations."

FIREFLY

Atlantic Ocean

S.S. *Gothic*. Captain L. J. Hopkins. Curaçao to London. Observer, Mr. T. I. Oliver, 3rd Officer.

On 22nd December, 1956, an insect presumed to be a glow-worm was found sticking to wet varnish work on " monkey island ". It was kept alive for two days. On the third day it died but it was preserved in a solution of formalin and water, for delivery to the Port Meteorological Officer, London.

Position of ship: 20° 54′N., 61° 15′W.

Note. Miss von Hayek, of the Natural History Museum, comments:

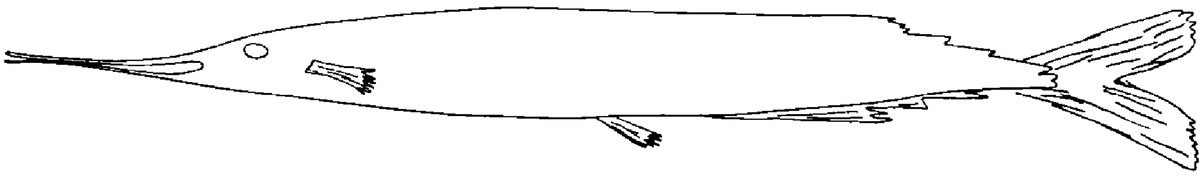
" This insect is an *Aspidosoma Ignitum L.* (*Collepetra Lampyridae*). This firefly has been recorded from British Guiana, Venezuela, Brazil and the West Indies."

FISH

North Atlantic Ocean

S.S. *Hororata*. Captain H. R. M. Smith. New York to Avonmouth. Observer, Mr. L. E. Howell, 3rd Officer.

2nd December, 1956. Observer saw a seagull snatch a fish from the sea; the fish struggled loose and subsequently fell on the deck. Below is a sketch of this fish, the predominant feature being the unusual beak-like mouth. The fish, which was



12 in. long, was very dark blue in the upper half while the lower half was silver coloured.

Position of ship: 47° 58′N., 27° 38′W.

Note. Mr. N. B. Marshall, of the Natural History Museum, comments:

" This is a skipper or saury, *Scomberesox saurus* (Warbaum), a fish related to the garfishes and flying-fishes. It occurs in the surface waters of the open ocean, often in great shoals. Distribution: temperate parts of the Atlantic, Pacific and Indian Oceans."

South Pacific Ocean

M.V. *Port Pirie*. Captain G. G. Langford. Lyttleton to Balboa. Observers, the Master and Mr. D. E. Kemp, 2nd Officer.

12th October, 1956, 2315 G.M.T. A fish approximately 10 ft long was sighted close to the vessel. It was leaping almost vertically out of the water, yet never exposing its tail, then falling back on to its side. There was a lot of disturbed water close to the fish, evidence of the presence of one or more other large fish, which may have been attacking it. The fish appeared to be light grey in colour, with well-defined orange spots, or blotches, on its body. It had a long pointed head similar to that of a swordfish, but with virtually no protrusion from the nose, its mouth being in a similar position to that of a swordfish.

Position of ship: 7° 06′S., 95° 03′W.

Note. Mr. N. B. Marshall, of the Natural History Museum, comments:

" Perhaps the fish observed was a garfish (family *Belonidae*) but the larger species hardly grow to 10 ft in length. However, garfish do have the habit of standing on their tails and even of skittering over the surface. And, of course, they have long pointed heads."

ABNORMAL SWELL

Western North Atlantic

S.S. *Grelmarion.* Captain L. M. Davies. Galveston to United Kingdom. Observer, Mr. R. Dixon, Chief Officer.

8th October, 1956. At 1235 G.M.T. while on a course of 043°, speed 12 kt, a small area of extremely turbulent sea was encountered, with steep swell and white-crested waves 12–15 ft in height running from a N'ly direction. As waves struck the vessel she was momentarily thrown off course and one large sea was shipped amidships. The phenomenon consisted of some four swells which approached the vessel and passed away on the quarter. Wind 045°, force 4–5. Sea and swell moderate, direction 045°.

Position of ship: 31° 10′N., 79° 01′W.

Note. At 1200 G.M.T. on 6th October a storm was centred 300 miles NE. of Newfoundland. The National Institute of Oceanography state that the winds recorded in this storm would not lead one to expect any swell at the ship's position on the 8th, but long waves of 15–20 sec period could just cover the distance in the time if the storm could generate them.

TIDE RIPS

Panama Bay

S.S. *Hororata.* Captain H. R. M. Smith. Wellington to Balboa. Observers, the Master and Mr. L. E. Howell, 3rd Officer.

On 7th November, 1956, between 0900–0930 S.M.T., the vessel sailed through a series of tide rips. These rips extended for about 10 miles on either side of the vessel in a 058°–238° direction and gradually got progressively rougher, the final line having the appearance of a force 6 wind on the sea. Each line was about 100 yd in width, with 100 yd stretch of smooth water to the next one. On passing through the final rip, the vessel swung 10° to starboard. The rips showed clearly on radar, and the P.P.I. screen had the appearance of a neatly ploughed field. There was no change in sea temperature. Air temp. 79°F, sea 80°. Light variable winds.

Position of ship: 10 miles W. of Perlas Islands.

PHOSPHORESCENCE

Atlantic Ocean

M.V. *Arabistan.* Captain R. B. Arthur, M.B.E. Las Palmas to Umm Said. Observer, Mr. J. E. Parker, 2nd Officer.

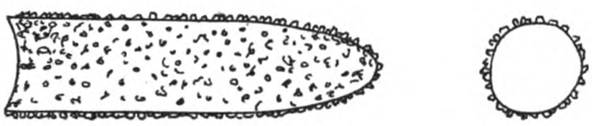
On 30th December, 1956, at 0155 G.M.T., a very bright patch of phosphorescence was observed ahead, at a distance of about ¼ mile. On approaching the patch it was seen to be composed of numerous bright bands, varying in width from 20 ft to 30 ft, close together and very well defined. They appeared to be stationary and lying with the wind in a direction 160°–340°. The bands consisted mainly of small pieces from 3 in. to 9 in. in length, though considerably larger pieces were seen well below the surface—unfortunately the size and shape of these could not be determined. The smaller pieces seemed to be elongated or cigar-shaped, being very bright at each end and dark in the middle. At 0220 the vessel ran out of these bands, but numerous very faint though well-defined isolated bands were seen until 0330. Previously no appreciable amount of phosphorescence had been seen on the surface, though the wake had shown up very blue for about an hour before entering the bands. Air temp. 75·4°F, sea 77·5°. Wind 160°, force 3.

Position of ship: 00° 06′N., 10° 16′W.

South Atlantic Ocean

M.V. *Avonmoor.* Captain J. A. Barton. Port Louis to United Kingdom.

24th October, 1956. From dusk, approximately 1900 G.M.T., until after 2130, much phosphorescence was seen all around the vessel, but in no regular pattern; the glow from the wake was especially bright. The phosphorescence was in blobs and some was brought aboard in a bucket. Investigation showed that the blobs of light emanated from hollow tubular marine organisms approximately 3½ in. long and 1¼ in. in diameter, closed at one end. In colour and appearance they resembled whitish boiled tripe. They were not a type of transparent jellyfish, but were quite firm to the touch. There were no feelers attached. They were quite rough on the outside, being covered with small protuberances like warts, but the inside was smooth. When the water in the bucket was agitated they glowed brilliantly, the



colour being white, turning blue after a few seconds and then fading. This was repeated several times. When the tubular organisms were fingered, the phosphorescence seemed to be transferred to the fingers. Nothing could be felt on the fingers, however, nor could anything be seen on them in a light, but when dipped into the water, fingers and hands glowed. After being in the bucket for about 10 min, the objects no longer glowed and seemed a clearer white. They shrank steadily and were finally about 3 in. by ¾ in. Wind SE., force 4. Air temp. 76°F, sea 76°.

Position of ship at 1900: 01° 20′S., 10° 30′W.

Note 1. Dr. H. W. Parker, Keeper of Zoology at the Natural History Museum, comments: "The record of phosphorescence certainly refers to a tunicate of the order *pyrosomida*. These animals are allied to the sea squirts and they form tubular colonies exactly as described in the observation. The tube is made of a jelly-like substance with the shape mentioned, i.e. cylinder closed at one end but open at the other. The animals themselves are embedded in this gelatinous tube and they pass a continuous current of water from the outside of it into its cavity. This water current passing out of the open end drives the whole colony along. They are often colourless or transparent but may have a slightly yellowish or green colour. The outer surface is never quite smooth. They are said to be the most luminous of all marine organisms and the name 'Pyrosoma', meaning fire body, reflects this. The luminosity in these animals is believed to be produced by colonies of bacteria which live symbiotically in certain specialised cells of the host animal."

Note 2. From Dr. Parker's remarks it seems certain that the luminous objects observed by the following ships were also pyrosoma: S.S. *Clan Forbes* and M.V. *Port Pirie* (pages 198 and 199 of the October 1956 number) and S.S. *Captain Cook* (page 143, July 1957). It also seems probable that the larger objects observed by M.V. *Cambridge* (page 198, October 1956) and those seen by M.V. *Tintagel Castle* (below) were pyrosoma.

M.V. *Tintagel Castle.* Captain A. E. F. Payne. Dakar to Mombasa. Observer, Mr. A. D. Mildren, 2nd Officer.

14th November, 1956, 0200–0400 G.M.T. The sea was covered with phosphorescent bands, about 10–12 ft wide and 15–20 ft apart. When these were broken by

(*Opposite page* 204)

Paul Popper, Ltd.

A photograph of *Mayflower II*, shortly before she left Brixham (see page 199).

(*Opposite page* 205)

A recent photograph of *Cutty Sark* in dry dock at Greenwich (see page 198). Note the scrollwork and figure-head.

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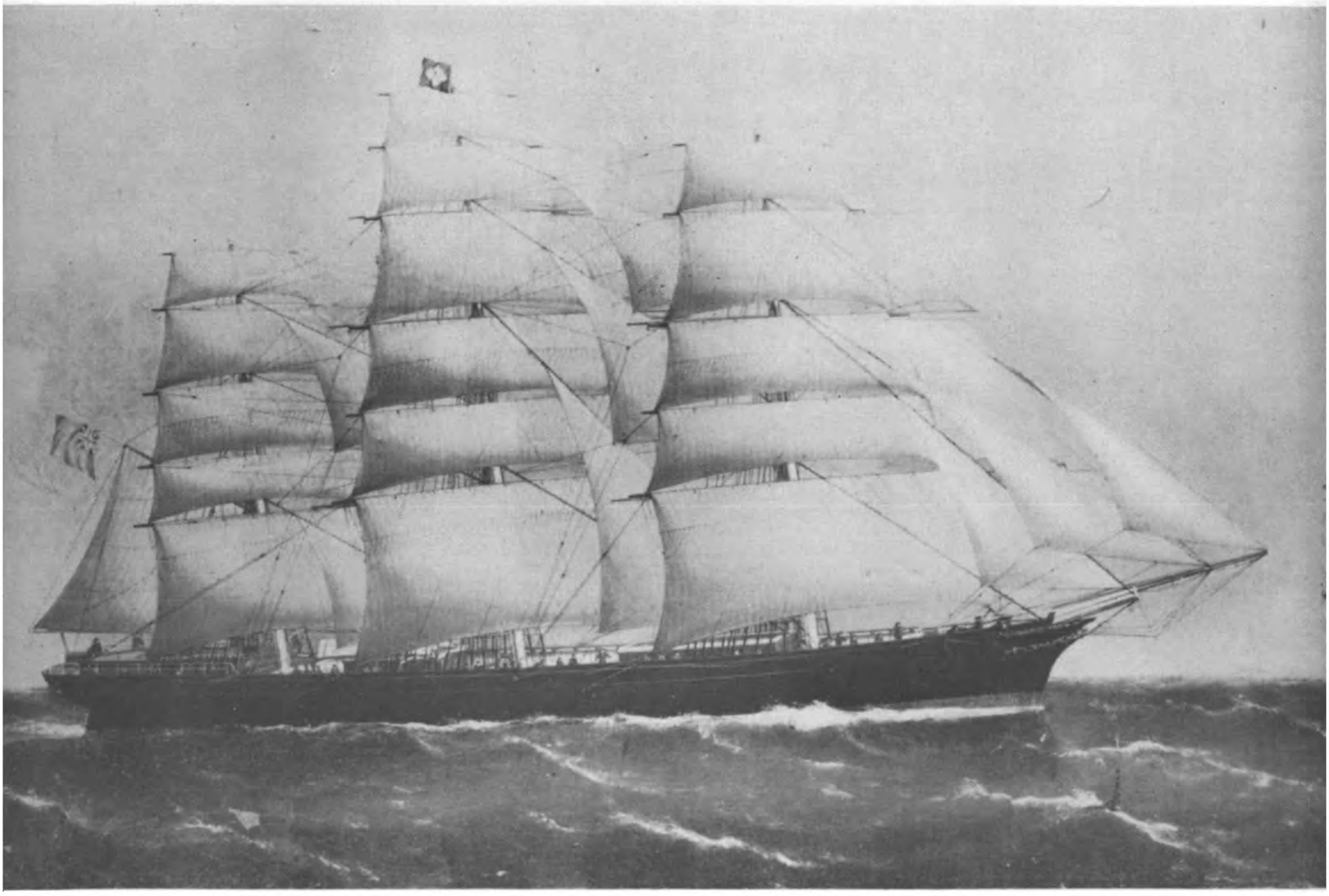


Cutty Sark in 1872, from a painting by F. Tudgay.

the ship, and the troubled water was illuminated by the ship, the phosphorescent material appeared as large white flakes, similar to rubbish lying in a tide rip eddy. The bands ran SSE–NNW. The ship's wake was a bright phosphorescent trail. Cb cloud, with frequent rain squalls of varying intensity. Wind SE's., force 4–5. Waves 10–15 ft, period 7–9 sec. Air temp. 75°F, sea 78°.

Position of ship at 0200: 02° 40'S., 06° 45'W.

See note to observation of M.V. *Avonmoor* on page 204.

West African Waters

M.V. *Ajana.* Captain F. W. Mould. Durham to Avonmouth. Observer, Mr. J. M. Hunter, 2nd Officer.

15th December, 1956, 0330 G.M.T. Numerous blobs of phosphorescence up to about 2 in. in diameter were seen on either side of the ship, apparently at some distance beneath the surface. Frequently many of these shapeless blobs became quite well-defined rectangles measuring about 6 in. by 1 in.

When the Aldis lamp was trained on them, small fish, bluish-green in colour, could be seen swimming about quite vigorously. Occasionally one would break the surface, when all that could be seen were yellow and red pinpoints of light, having the appearance of " cats' eyes " when caught in the headlights of a motor car. Air temp. 74·5°F, sea 76°. Slight sea and swell.

Position of ship: 01° 40'S., 07° 20'W.

Note. Dr. H. W. Parker, of the Natural History Museum, comments:

" It is probable that a number of different organisms were involved here. The phosphorescent blobs up to 2 in. in diameter may have been luminous jellyfish. These would not, however, change shape to become rectangles of 6 in. by 1 in.

"A luminous object of this shape and these dimensions is more likely to have been one of the colony pelagic tunicates, such as a Pyrosoma. A colony of Pyrosoma is a cylinder of about these proportions and is of varying size up to about a couple of feet. A cylinder seeming silhouetted would of course appear as a rectangle. The small fishes seen at the surface could have been a mixture, maybe of young horse mackerel and others which commonly associate with jellyfish or lantern fishes (family *Myctophidae*) which live at considerable depths by day and come to the surface by night. They have luminescent organs on their bodies provided with reflecting layers and coloured screens, and these behave like ' cats' eyes ' to external light sources. The general work on luminosity in animals is Newton Harvey's *Bioluminescence*, published in 1952."

Indian Ocean

M.V. *Bellerophon.* Captain H. H. Sanderson. Aden to Penang. Observers, the Master and Mr. D. Malcolm, 3rd Officer.

3rd September, 1956, 1730 G.M.T. Patches of phosphorescence were observed which started as small spots from a point a few feet below the surface of the sea, and grew rapidly in size. The final size of the patches was 100–200 ft and the shape roughly circular. The patches near to the observer appeared quite dull, but those at a distance were extremely bright. The display lasted till 2030. Sea waves 5 ft in height with period of 6 sec.

Position of ship: 09° 56'N., 65° 58'E.

Ceylon Waters

S.S. *City of Lichfield.* Captain G. R. Jackson. Colombo to Lourenço Marques. Observer, Mr. P. M. Field, 3rd Officer.

3rd November, 1956. Between 1600 and 1700 G.M.T. unusually brilliant phosphorescence was observed. The sea ahead was covered with numerous bright green flashes, and long streaks of pale green luminosity. Where the sea was churned up by the ship's bow the phosphorescence, pale green in colour, was very bright indeed. Air temp. 81°F. Wind SW, force 2.

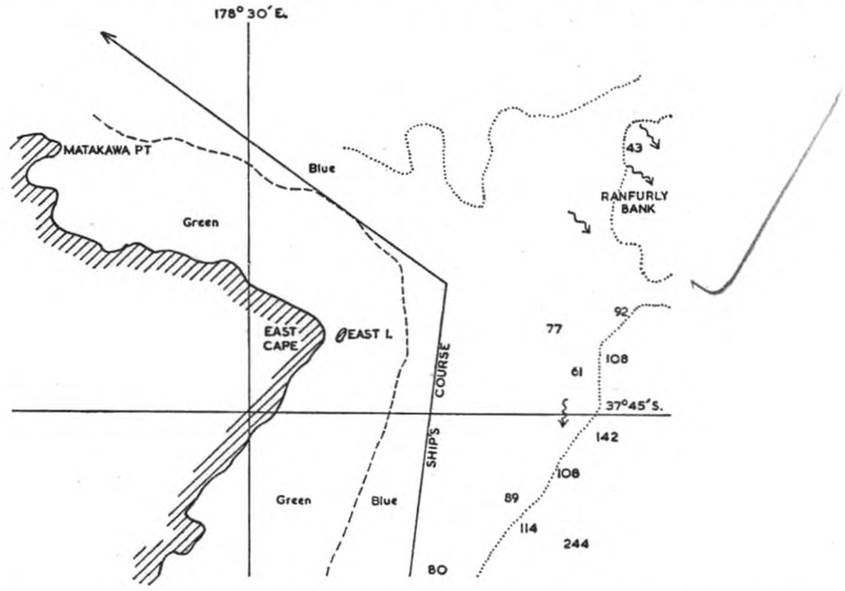
Position of ship: 07° 03'N., 78° 34'E.

SEA COLORATION

North Island, New Zealand

M.V. *Cambridge*. Captain P. P. O. Harrison. Wellington to Auckland. Observers, the Master and Mr. P. Bower, 2nd Officer.

On 8th October, 1956, at 1545 G.M.T., a remarkable difference was observed while rounding East Cape, between the colour of the sea water inshore and that offshore. The former was a light pea-green, while the latter was a dark blue-grey.



Before the ship entered the green water, sea temperatures were taken, the average being 37·5°F. The average temperature of the green water was 55·2°. Air temp. 55°F. Wind s'ly, force 6–7, 8/8 Sc and Ns.

Note. A similar observation in this area, by M.V. *Port Pirie*, was published on page 140 of the July 1957 number of this journal.

WATERSPOUT

North Atlantic Ocean

S.S. *Hudson Firth*. Captain A. Crosby. San Juan to London. Observer, Mr. M. A. Smith, 3rd Officer.

31st October, 1956. At 1455 G.M.T. a waterspout was seen forming, about 45° on the port bow, at a distance of about 3 cables. The first sign was an anticlockwise movement of wave crests slowly spinning. The diameter was about 10 ft, rising about 3 ft in height. The formation moved south-eastward across the bows, gradually increasing in speed, size and height, until it appeared to stop about 1 mile on the starboard beam. This movement took about 8 min to complete. There it increased speed of rotation and size until the diameter developed to about 40 ft, the spray being whipped up to a height of about 12 ft. The funnel was then observed to descend from Cb cloud at about 1,000 ft above sea level. The colour of the funnel was white, and as it descended a violent spinning motion could at times be clearly seen. The funnel tapered gradually towards the end, and bent before reaching down. It then collapsed without reaching the sea surface and disintegrated. One minute later the turbulence on the sea surface vanished. The time then was 1510. Rain was falling about 10 miles to NNE. Wind 320°, force 4. Air temp. 60°F, bar. 1009·5 mb.

Position of ship: 38° 01′N., 35° 21′W.

Samoa Islands

M.V. *John Williams VI*. Captain F. Bottoms, M.B.E. Approaching Samoa. Observer, the Master.

On 2nd November, 1956, at 1543 S.A.T. while approaching the Apolima Strait, a disturbance was seen on the surface of the sea, approximately 60° on the starboard bow, at a distance of about 400 ft. The weather was partly cloudy, wind E., force 2–3, sea slight.

Very shortly afterwards the vessel had passed the disturbance and I observed it from a height of 25 ft when it was abeam at a distance of about 300 ft. It appeared to be travelling very slowly more or less downwind, in a WSW. direction, leaving a narrow, very white wake for perhaps 20–30 ft on the sea surface.

The disturbance itself was circular, about 15–20 ft in diameter, and it had a high speed, clockwise rotation. The whole area of sea, within the circle, appeared to consist of white foam; also, what looked like steam and vapours were rising from it to a height of nearly 20 ft in a fast-spinning clockwise motion, and then dispersing into windspray and spume. The vapours arising from this whirlpool were of a dirty white colour, having a variety of shades. As the ship passed the disturbance, it was seen that the windspray from it was not following the same course as that of the whirlpool itself.

A few minutes later, the whirlpool being then about ¼ mile astern, a very fine rain descended on the ship, although there was only blue sky above, and in more than a full quadrant to windward, no cloud whatever.

Position of ship: 14° 17′S., 173° 00′W.

Note. This is a very interesting account, giving more detail than we usually receive, of the sea disturbance associated with a waterspout which in this instance did not develop further.

CLOUD

Bay of Bengal

S.S. *Clan Chattan.* Captain R. R. Baxter.

3rd October, 1956, 0800 G.M.T. The photographs (between pages 212 and 213) were taken on passage from Calcutta to Vizagapatam. Precipitation can be seen in both photographs but none fell at the station. The barometer was steady and there was no change in the wind direction or force. Wind 130°, force 3. Sea slight. Bar. 1010·2 mb at 0600. Air temp. 86°F, sea 86°.

Note. The Cu and Cb clouds shown in these excellent photographs are typical of the showery weather which occurs over the Bay of Bengal during the post-SW. monsoon period (October to November).

Off Great Barrier Reef

S.S. *Caltex Glasgow.* Captain J. L. Harris. Singapore to Botany Bay.

30th November, 1956, 1700 G.M.T. The photograph opposite page 213 was taken by Mr. M. J. Head, apprentice, off Dunk Island. He gives the following details. The air temperature was 82°F, having dropped 5° during the previous hour. Bar. 29·81 in., within the normal diurnal range. Wind moderate, N'ly, visibility clear. The cloud formation dispersed after about 40 min. Heavy radio interference was occurring.

Position of ship: 17° 50′S., 146° 20′E.

Note. This is a fine photograph of well-developed mammatus cloud, though taken in conditions of weak light. A previous observation of this type of cloud by M.V. *British Might,* with three photographs, was published on page 99 of the April 1955 number of this journal. In the note following this observation an explanation was given of the conditions in which cloud of this type occurred and it was pointed out that it is not very often seen in a well-developed form and that good photographs of it are consequently rare.

FOG BOW

Gulf of Aden

S.S. *Tagelus.* Captain A. S. M. Jamieson. Miri to Rotterdam. Observers, the Master and Mr. D. G. Whiteley, 2nd Officer.

23rd October, 1956. At 0745 S.A.T. the vessel ran into a low, dense fogbank, above which at an approximate altitude of 40° the sun was clearly visible. Above the shadow cast by the ship's bow was observed a brilliant white halo, edged in brown; after 5 min a faint spectrum was visible, extending to the halo's inner circumference and filling the shadow area. Of this spectrum, the orange was nearest the ship, and the violet furthest, adjacent to the white halo. Duration of fog and of phenomena, 15 min. Dry bulb 70°F, wet 68°, sea 82°/73°. Wind light and variable.

Position of ship: 12° 00'N., 51° 05'E.

South Indian Ocean

S.S. *Orion*. Captain A. E. Coles. Cape Town to Fremantle. Observer: Mr. D. T. Hughes, Junior 3rd Officer.

On 24th November, 1956, at 0230 S.M.T., during a period of thick fog, the moon which had previously been obscured by cloud suddenly shone through and formed a fog bow on the starboard quarter.

The most notable features of the display, which lasted about 5 min, were the unusual brightness of the moon and of the bow. The bow was colourless and consisted of a series of luminous bands decreasing in intensity towards the inside of the arc. As far as could be ascertained, the altitude of the moon was about 30° and the top of the bow about 22½°. The bow was rather less than 2° wide.

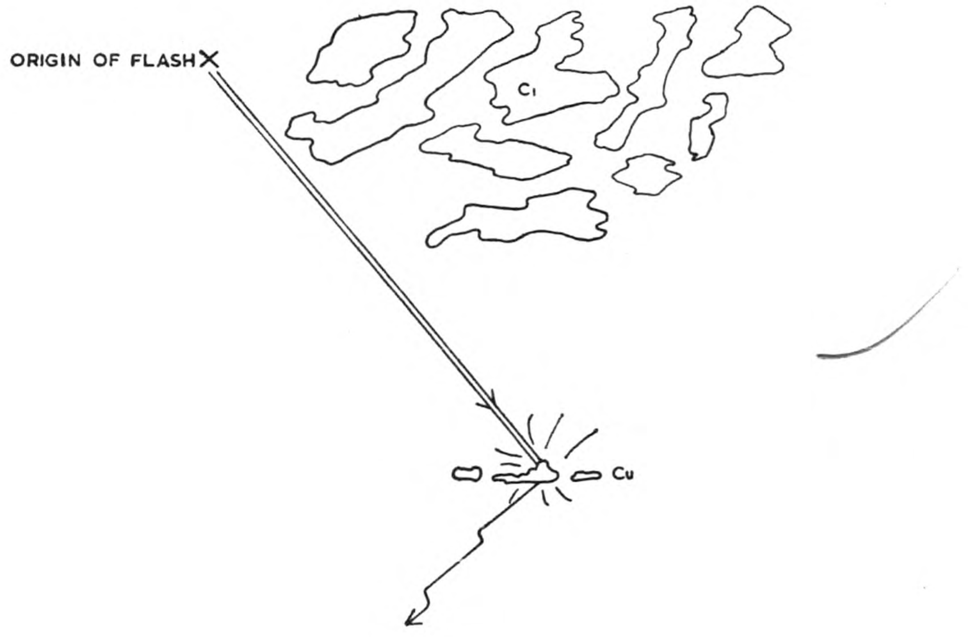
Position of ship: 36° 59'S., 85° 53'E.

LIGHTNING

Atlantic Ocean

S.S. *Oronsay*. Captain N. W. Smith. Las Palmas to Cape Town. Observers, Mr. E. Pickles, Senior 2nd Officer, and Mr. J. M. V. Boyde, Junior 3rd Officer.

17th October, 1956. At 0330 G.M.T. there was about 3/8 cloud, consisting of patches of tangled Ci which in the opinion of the observers was associated with Cb; there were also three small fair weather Cu almost directly beneath the Ci. In the light of the full moon the height of the Ci was estimated at 25,000–30,000 ft and that of the Cu at about 2,500 ft. Lightning started to flash from a point slightly behind the Ci and travelled in a path about 30° from the vertical in an absolutely straight line, at what seemed to be a comparatively slow speed, towards the small Cu. It appeared to enter the Cu and then reappear, moving downwards in a different direction at normal speed.* The lightning track from the Cu, which had a greenish glow when " hit ", did not seem to be so wide as the original one. Similar flashes occurred at regular intervals of between 2–3 min and each followed the same



path to the Cu. The watch was relieved at 0400 but it is believed the lightning continued regularly for another 15–20 min. Neither of the observers had ever seen lightning before seeming to emerge from an almost cloudless part of the sky, and which travelled so straight and apparently slowly. Air temp. 79°F, wet bulb 75°, sea 84°.

Position of ship: 08° 24′N., 15° 00′W.

Note. This is an extremely interesting observation of an abnormal form of lightning, differing entirely from other forms of unusual character, a few observations of which have been published in this journal in recent years. The origin of the flashes in a region of clear sky is very remarkable.

Dr. B. F. J. Schonland, who is an international authority on lightning, makes the following comments:

"The observation described by Captain Smith in which a lightning flash travelled downwards to a small cloud and then emerged in a different direction has been made from time to time in the past. The first person to report it was Benjamin Franklin, who carried out model experiments in which the small cloud was replaced by tufts of cotton wool. It would seem that the effect is due to the positive charging of the small cloud by ions rising upwards in the negative field due to the cloud above. These ions are captured on the water drops of the small cloud and the result is to direct the field from the main cloud to the small one below, from which the flash travels on to earth. That the subsequent portion of the discharge was weaker could be accounted for by the neutralisation process involved in the first portion.

"One would expect this effect to occur several times if conditions remain the same, though I do not recall any incidents of the regularity reported by Captain Smith.

"The other point which is interesting from the description is the apparent slowness of the discharge. This could be explained if its lower portion did not reach the sea, for flashes which do not involve a return stroke from the ground are composed of comparatively slow leader discharges. If, however, the lightning passed to the sea I cannot offer any explanation of its apparently slow speed."

UNIDENTIFIED PHENOMENA

South Pacific Ocean

S.S. *Gothic*. Captain L. J. Hopkins. Wellington to Balboa. Observers, Mr. T. I. Oliver, 3rd Officer, and Quartermaster Tavener.

5th December, 1956. At 0643 G.M.T. a harsh, brilliant flash, bluish-white in appearance, covering the whole of the night sky, appeared, lasting for approximately 1½ sec. The sky was completely covered by a thick layer of Sc.

The possibility of a meteor was ruled out as the cloud would not have permitted it to be visible, and the character and intensity of the flash did not conform to lightning or other electric phenomena. The forecastle head was plainly visible from the bridge and the horizon clearly defined. The source of the light appeared to issue from the NE. sky at an altitude of approximately 60°. The lookout confirmed this. The radio officer did not hear any static at the time. Bar. 1022 mb. Air temp. 63°F, wet bulb 58°, sea 65°. Wind E., force 5.

Position of ship: 32° 00′S., 144° 06′W.

Pacific Equatorial Waters

M.V. *Cape Grafton*. Captain C. A. Jones. Thio, New Caledonia, to Panama. Observer, Mr. W. Cowan, 3rd Officer.

On 7th October, 1956, between 0530 and 0630 G.M.T., in the middle of a heavy rain area, light streaks were observed to the northward, running E. and W. across the sky at an altitude of 50°. These very straight streaks of milky-white light extending over a horizontal distance of 30° were thought at first to be clouds, but as the sky was overcast and the moon was not up, this was hardly probable. The streaks varied in width, but not counting faint lines, the most important ones consisted of two upper streaks about 0° 50′ wide and a lower one 1° 50′ in width. The glow reached greatest intensity at 0600 and then slowly faded. The clouds were hard to distinguish but appeared to be Fs.

Position of ship: 6° 40′N., 131° 35′W.

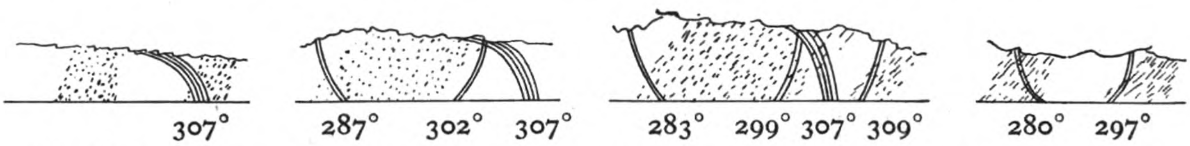
RAINBOWS

South Atlantic Ocean

M.V. *Arabistan*. Captain R. B. Arthur. Cape Town to Las Palmas. Observers, Mr. H. Sennett, 3rd Mate, Cadets G. Bashford and R. Tusler.

22nd October, 1956. At 0802 G.M.T. during generally cloudy conditions giving light showers of rain near the vessel, the end of a rainbow of large radius was seen on the horizon, the rest of the bow being hidden by low Sc (sketch 1). The band was 4° wide and fairly bright. Reading from the inside, the colours were red, yellow, green, blue, yellow, white, pink and red. The sun was then clear of cloud.

At 0805, the colour sequence from the inside was yellow, purple, blue, green, yellow, orange and red. By now the sun was shining through thin As.



At 0806, during showers in the area, the bright, white ends of a second bow became visible inside the rainbow (sketch 2). The ends of these bands were 1° wide. At 0813 yet another fainter white bow, 2° wide, appeared outside the others. The bearings then were as shown in sketch 3. When the rain ceased at 0820, the original rainbow disappeared, as did the second white arc, leaving the first two faintly visible (sketch 4). At 0833 these also faded out.

Position of ship: 09° 47′s., 04° 08′w.

Note. This is a very interesting observation. The colours of the main rainbow seem to be somewhat abnormal even if allowance is made for a possible supernumerary bow inside and in contact with it. The white rainbows are abnormal phenomena which cannot be explained on the ordinary geometrical theory which accounts for the primary, secondary and supernumerary bows. An observation in which a white bow was seen crossing a rainbow was made by M.V. *Laguna* (see page 215 of the October 1951 number).

LUNAR RAINBOW

South Pacific Ocean

M.V. *Port Dunedin*. Captain W. M. Clough. Gisborne to Balboa. Observer, Mr. R. C. Case-Green, 3rd Officer.

17th October, 1956, 1405 G.M.T. A lunar rainbow, with an accompanying secondary bow, was observed. Both rainbows were white, the primary being visible for approximately 5 min, while the secondary was seen for only 2 min. The highest part of the primary bow bore 101°, at an altitude of 36½°, the moon being almost full on the reverse bearing. A light rain shower with a slight sea and low ssw'ly swell prevailed at the time, and although the sky was 7/8 clouded, mainly Sc with some Cb, the moon was seen through a thin veil of cirriform cloud. The ends of the primary rainbow were more luminous than the remainder, though the whole was considerably brighter than the secondary.

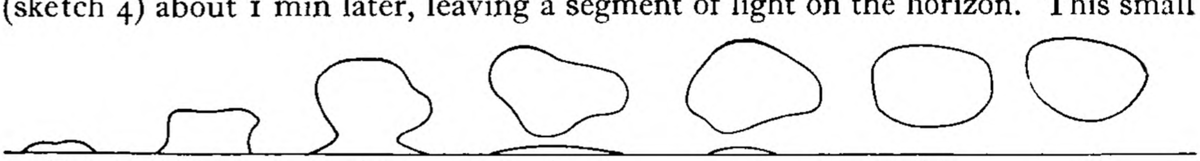
Position of ship: 37° 06′s., 166° 58′w.

ABNORMAL REFRACTION

Gulf of Aden

S.S. *Tagelus*. Captain A. S. M. Jamieson. Miri to Rotterdam. Observer, the Master.

23rd October, 1956. Moonrise was observed from 1744 (sketch 1) to 1751 G.M.T. (sketch 7). The weird shapes were due to excessive refraction, and most notable was the "vase" shape (sketch 3) which became detached from the "base" (sketch 4) about 1 min later, leaving a segment of light on the horizon. This small



segment gradually faded and disappeared about 1½ min later. Six minutes after its first appearance, the moon had assumed its normal shape (sketch 7), observed through binoculars. The age of the moon was 18·8 days. Weather, clear and cloudless. Sea slight.

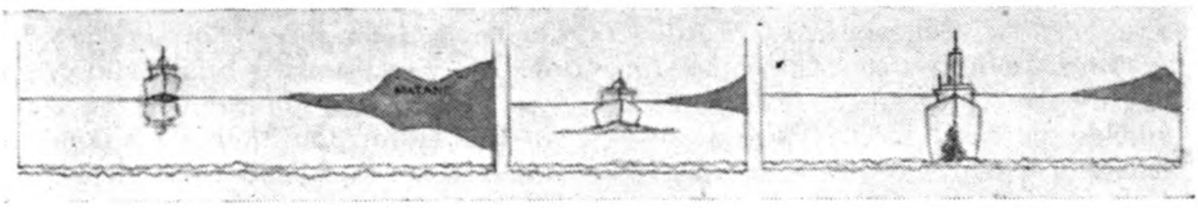
Position of ship: 12° 16′N., 48° 08′E.

Note. Distortion of this type, frequently recorded in the case of the sun, has not been so often seen at the rising or setting of the moon.

River St. Lawrence

S.S. *Warkworth.* Captain N. Thompson, M.B.E. Sorel P.Q. to London. Observer, Mr. W. J. Childerstone, 3rd Officer.

14th November, 1956. Throughout the morning exceptional visibility and pronounced and varied abnormal refraction were observed. The Quebec coastline was frequently inverted and elongated, and objects were difficult to distinguish. Two or three horizons were observed at times, and ships appeared at great distances above the true horizon. In sketch 1 the ship was approximately 10 miles away, and appeared on a second horizon (about 2° above true) completely inverted, but otherwise in normal shape. The coastline about Matane was also inverted. In sketch 2, the ship was approximately 6–7 miles away, and still appeared above the horizon with the bow wash showing clearly. At 5 miles (sketch 3) the ship settled on the true horizon, but it appeared very tall and narrow, especially the hull and bow wash. This distortion lasted for 3 min after which the ship assumed its normal

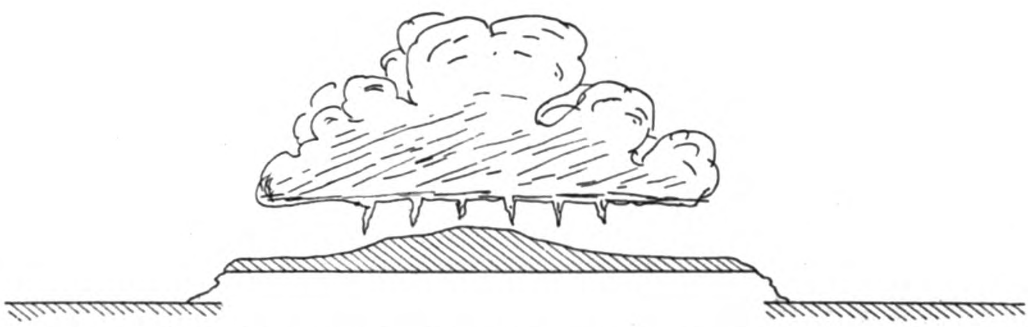


shape. A second horizon was clearly visible all the time, and the true one had a very ragged appearance. Air temp. 24°F, wet bulb 23·5°, sea 36°. Wind variable, force 1. Sea smooth. 6/8 St.

South China Sea

S.S. *Tagelus.* Captain A. S. M. Jamieson. Singapore to Miri. Observer, Mr. J. A. Legg, 3rd Officer.

2nd October, 1956. At 1350 G.M.T. the horizon between bearings 000° and 050° seemed to be upwardly displaced over an angular distance of about 3°, the displaced portion appearing as an island. This apparent island was capped by a formation of heavy, towering Cu with hanging festoons. Otherwise the sky was clear except for a few patches of fine Ci. A ship appeared right ahead and on checking by radar



its distance was found to be 16 miles. Strong echoes were also received of the towering Cu at 15 miles. At 1415 the phenomenon disappeared, leaving the Cu formation only. Air temp. 89°F, wet bulb 79°, sea 85°. Wind, light airs. Bar. 1014·6 mb.

Position of ship: 3° 44′N., 111° 10′E.

AURORA

North Sea

M.V. *British Bugler.* Captain C. V. Harrison. Stockholm to Isle of Grain. Observer, Mr. G. F. T. Smith, 2nd Officer.

10th November, 1956, 0200 G.M.T. A display of aurora commenced bearing 280° and then spread slowly through N. to 060°. Most brilliant in sector 280°–300°. Approximate altitudes of coverage 9°–36°, approximate altitude of most brilliant display 30°. It commenced as a light red illumination, becoming a bright deep red in dense patches with occasional shafts of greenish-white light; no other colouring was observed. The sky was cloudless with particularly frequent meteor activity. Stars could be seen through the aurora.

Position of ship: 53° 18′N., 02° 56′E.

M.V. *Catford.* Captain S. B. Smith, M.B.E. London to Hartlepool. Observer, Mr. J. B. H. Thomas, 2nd Officer.

11th November, 1956. At 0440 G.M.T. a horizontal red glow, crossed at 90° by white streaks, appeared in the sky at an approximate altitude of 20°. The glow appeared in the NW. and slowly moved to N. and disappeared, taking about 5 min to traverse this distance. Altogether it was visible for about 10 min. Weather, clear sky with light haze and moderate visibility.

Position of ship: 52° 54′N., 01° 31′E.

North Atlantic Ocean

S.S. *Scythia.* Captain F. G. Watts, R.D. Quebec to Le Havre.

26th October, 1956, 2245–2300 ship's time. An exceptionally bright and extensive display of aurora was seen during this period. It first appeared in the S. and quickly increased to cover the whole sky, when it assumed an umbrella shape, the centre of which was on the zenith. To S. and SW. were two brilliant patches about 10° in depth at an altitude of 30°–35°. The whole display seemed to undulate about the centre and continued to a lesser extent for 40 min. The moon had risen at 2130.

Position of ship: 52° 13′N., 52° 19′W.

S.S. *Manchester Mariner.* Captain E. W. Raper. Manchester to Montreal. Observers, the Master, Chief Officer, 3rd Officer and extra 3rd Officer.

10th November, 1956, at 2445 G.M.T. on passage westward through Belle Isle Strait, aurora observed. Display commenced as a continuous band of light passing from W. to E. over the observers' zenith. This band then spread into two bands and pointers were given off therefrom. The colouring was yellow and a light green. Unfortunately cloud covered the area shortly after and terminated the observation. Sky 6/8 clouded by cumulus.

The accompanying photographs (on opposite page) were taken by Mr. A. S. Bashford, 3rd Officer.

Position of ship: 50° 37′N., 58° 38′W.

Note. These excellent photographs are believed to be the first ones we have received of aurora.

S.S. *Cairndhu.* Captain J. W. Scott. Montreal to Leith. Observer, Mr. A. I. McDonald, 2nd Officer.

18th November, 1956, at 0110 ship's time. A total eclipse of the moon was observed bearing approximately 260°, the moon was completely visible again by 0340.

During the period 0400 to 0800 a fine bright display of aurora was observed consisting of a white, " steamy " pulsating arc which appeared to radiate from a point bearing 060° and finally disappeared at a point bearing 280° and approximately 5° above the horizon.

(Opposite page 212)

Photo by A. S. Bashford

Aurora observed from S.S. *Manchester Mariner* (see opposite page).

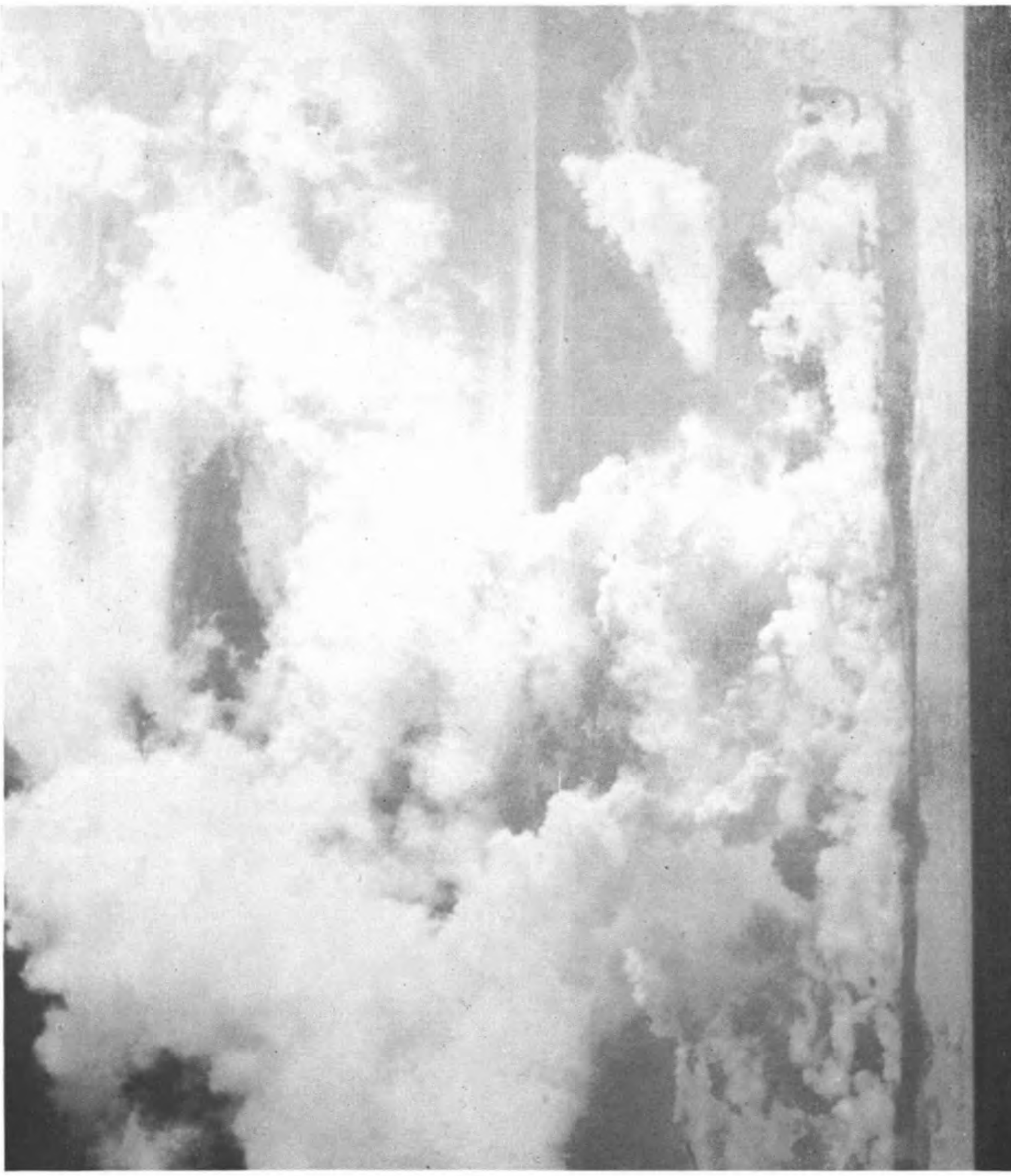


Photo by R. R. Baxter

Cloud observed from the *Clan Chattan* (see page 207).

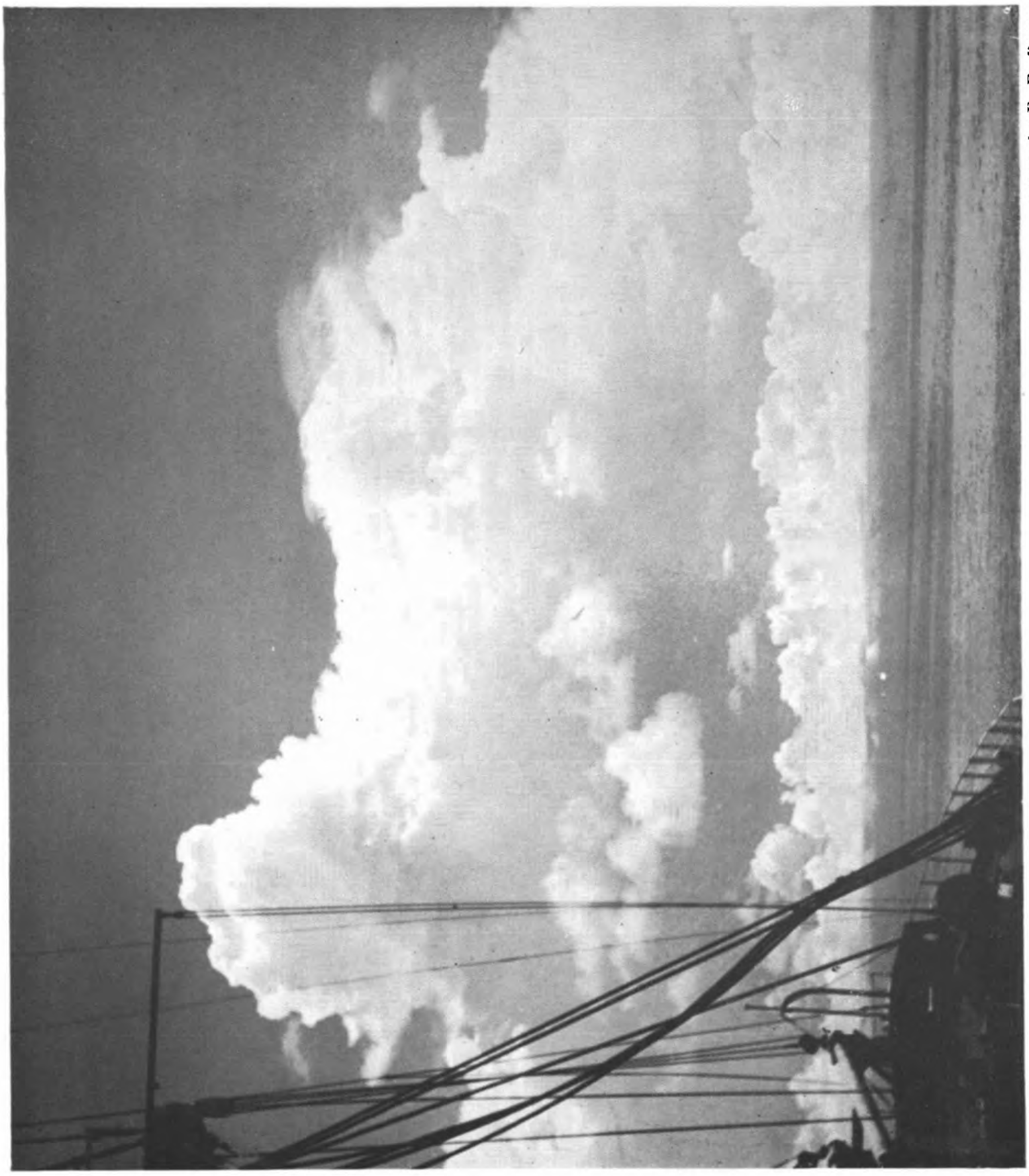
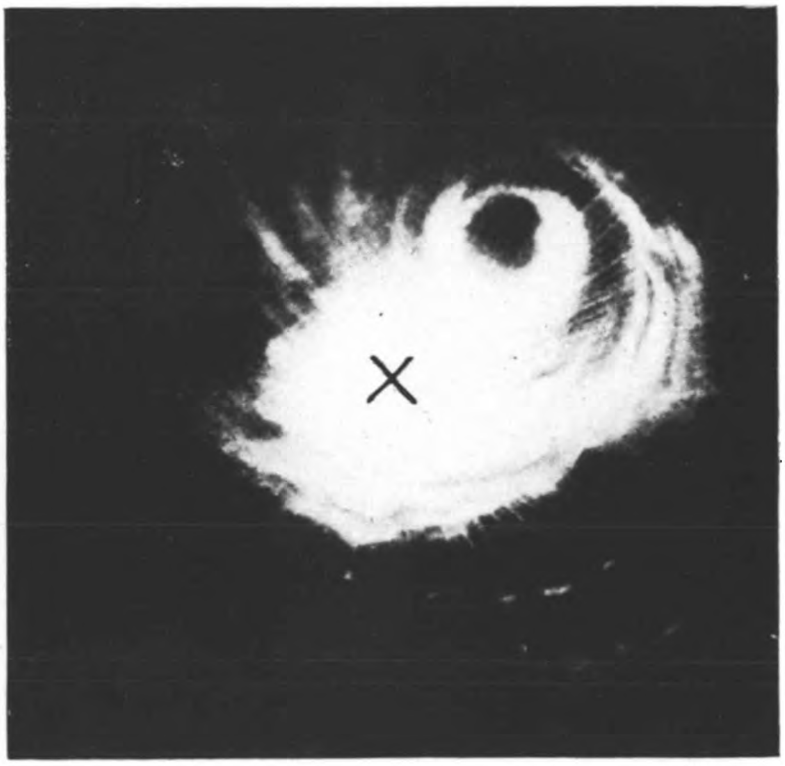


Photo by R. R. Baxter

Cloud observed from the *Clan Chattan* (see page 207).

(*Opposite page* 213)



U.S. Navy

Radar scope photograph of typhoon in Philippine Sea, 18th December, 1944 (see page 216).

(Structure of the typhoon is clearly indicated in this photograph: spiralling cloud pattern, extensive precipitation area, "eye" of storm surrounded by closed circle of cloud. Typhoon centre was 37 miles distant, bearing 042° true. Wind 42kt, with gusts exceeding 75kt. Ceiling less than 500 ft. and visibility ⅛ mile, owing to heavy precipitation. Seas over 40 ft.)

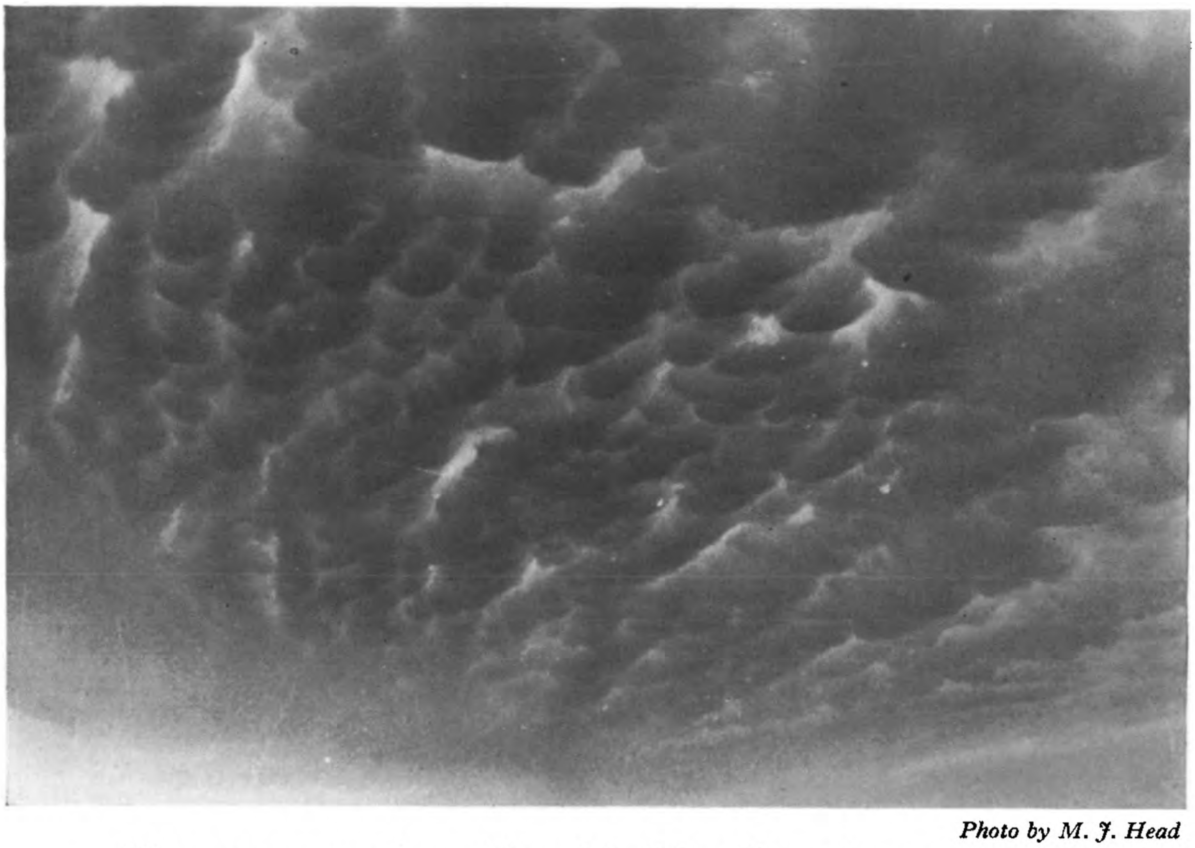


Photo by M. J. Head

Mammatocumulus observed from S.S. *Caltex Glasgow* (see page 207).

The width of the arc at the north point of the horizon stretched from 30° altitude to the zenith. The point where the pulsation was greatest was at an altitude of 40°, bearing of approximately 050°. The maximum intensity of light was at a point of a few degrees above the horizon bearing 060°. On a bearing of 000° no pulse was observed at an altitude of 30° and only a moderate pulse at the zenith. At a bearing of 280° it gave the effect of a thin white mist. The visibility was excellent throughout and the sky cloudless.

Position of ship: 50°N., 61°W.

South Indian Ocean

S.S. *Helenus*. Captain F. G. Radford. Observer, Mr. F. J. Pink, 3rd Officer.

25th November, 1956. Observed a reddish glow above the horizon at 1300 G.M.T. This gradually spread and by 1345 it extended from 130° to 170°, the colour then being red from 130° to 145° and white from 145° to 170°. The glow extended from the horizon to 10° altitude and was steady. Five vertical shafts of light, all white, were spread at even intervals of about 5° between each beam. These beams were not bright, resembling shafts of sunlight seen when the sun is behind dark cloud. Without flickering or changing colour or direction the vertical shafts of light and then the glow slowly faded. One more, however, a white glow, appeared briefly bearing 190°. By 1405 all light had completely faded. The night was fine with excellent visibility.

Position of ship: 35° 56'S., 115° 07'E.

Note. In addition to those published above, aurora observations have been received from 16 other ships as follows:

S.S. *Beaverlake*, S.S. *Cairnavon*, S.S. *Cairnesk*, S.S. *Cairngowan*, S.S. *City of Edinburgh*, S.S. *Corfu*, M.V. *Cretic*, S.S. *Manchester Pioneer*, S.S. *Manchester Regiment*, S.S. *Manistee*, S.S. *Marengo*, M.V. *Otaki*, M.V. *Somersby*, M.V. *Sussex*, S.S. *Rialto* and S.S. *Table Bay*.

In some cases more than one night of observation is included. A few of the observations have been made in relatively low latitudes. In the present state of the sun's activity, with the resulting frequency of aurorae, space does not permit of our publishing all the observations received. Every one has, however, been forwarded in full to Mr. Paton for inclusion in the Auroral Survey and he continues to express his appreciation of the number and value of the observations he is receiving from voluntary observing ships.

METEOR

Gulf of Aden

M.V. *Calchas*. Captain F. N. Fisher. Colombo to Aden. Observer, Mr. R. S. Montgomery, 3rd Officer.

9th October, 1956. At 1828 G.M.T. a meteor was observed. At first it appeared to be a mere incandescence in the sky, but about 2 sec later it developed into an unusually large, brilliant green meteor, bearing 270°, altitude 55°. It headed towards the horizon in a perfect arc, leaving a long, green trail. Before disintegrating about 6 sec later, it changed first into a deep yellow and then into crimson, leaving a purplish glow in the sky for about 1½ sec after its disappearance.

Position of ship: 11° 19'N., 54° 00'E.

Thames Estuary

The following observation was made on 2nd December, 1956, by Mr. W. J. Glassborow, Trinity House Channel Pilot, while piloting the Norwegian M.V. *Straum*. The sky was clear, with haze on surface reducing visibility to 15 cables. At 2052 a light appeared above the haze bearing approximately 080°, altitude about 15°, travelling rapidly westward and leaving a trail subtending an arc of about 15°. The leading point was not noticeably brighter than the first 10° of the trail, the whole of which shone with a silvery light tinged with yellow and much brighter than any planet or star. The remaining 5° tailed off to a yellowish orange and finally brown, the width of the whole being comparable with that of the vapour trail immediately behind a high-flying aircraft. The meteor passed just below the Pole Star and disappeared bearing about 270° at an altitude of about 15°, the transit from E. to W. taking about 4½ sec. The light from the meteor did not produce any appreciable increase of light on the ship.

Note. This is an interesting observation since the head of a bright or relatively bright meteor is almost invariably brighter than any part of the trail which follows it. In some of the smaller meteors the head may not be distinguishable, the whole appearing as a streak of uniform light passing across the sky.

Indian Ocean

M.V. *Arabistan.* Captain R. B. Arthur. Mauritius to Cape Town. Observers, Mr. H. Sennett, 3rd Officer and Mr. J. Sorrenti, 4th Engineer.

11th October, 1956. At 2000 G.M.T. a meteor was observed, originating in the region of the Dolphin. It travelled almost horizontally and more slowly than the majority of meteors, past Altair and on towards the moon, at an elevation of about 30°.

At first the meteor had a diamond-shaped head, about 1° long, of silvery appearance, but during flight it developed what appeared to be a trail of orange-coloured flame about 20° in length. As it passed through a layer of Ac, the whole cloud was lit up and the brilliance of the meteor was comparable to that of the moon. The trail appeared to break near the middle into two parts, while the meteor itself flared up bright green and vanished, without leaving any trace behind. The whole flight lasted for 6 sec.

Position of ship: 32° 50′S., 30° 36′E.

M.V. *Eucadia.* Captain J. L. Gibson, O.B.E. U.K. to Bombay. Observer, Mr. J. A. Scrimgeour, 2nd Officer.

On 27th November, 1956, at 2320 G.M.T., a blinding blue flash occurred, and a meteor, vivid blue in colour, was observed bearing N., at an altitude of about 60°. It moved in a westerly direction, through an arc of approximately 20°, before disappearing.

A bright silver trail was left, which lasted for about 6 sec.

Position of ship: 33° 40′S., 27° 15′E.

Pacific Ocean

M.V. *New Zealand Star.* Captain E. N. Rhodes. Wellington to Balboa. Observer, Mr. R. Dawson, 2nd Officer.

On 29th October, 1956, at 1849 S.M.T. a brilliant white meteor was sighted at an elevation of 25° and bearing 200°. It appeared to travel in a curve, leaving a long white trail. When bearing approx 150°, it broke up into two major pieces which continued to move together, and into about four smaller pieces which moved more slowly than the larger portions.

The meteor disappeared at an altitude of 18°, bearing 095°. Towards the end of its path it was seen through gaps in Ac cloud.

Position of ship: 23° 16′S., 116° 10′W.

SPECIAL LONG-SERVICE AWARDS

This is the tenth successive year in which the Director-General of the Meteorological Office is making special awards to the four voluntary marine observers whose long and zealous service on behalf of the Meteorological Office is considered as deserving of special recognition.

All officers who have sent in meteorological records in 15 or more years come within the zone for the presentation of the awards and the names of the four selected are arrived at by a mathematical formula which considers the number of years observing, together with the assessment given to each individual logbook bearing the officer's name.

This year the Director-General is pleased to make these awards to the following:

1. CAPTAIN J. SOAME (Canadian Pacific Steamship Company), whose first meteorological logbook was received here in 1921. In 18 years he has sent us 99 records, 40 of which have been classed excellent.
2. CAPTAIN J. P. DOBSON, D.S.C., R.D. (Canadian Pacific Steamship Company), a voluntary observer since 1922. In 17 years he has sent us 38 records of which 19 have been classed excellent.
3. CAPTAIN W. B. TANNER, R.D. (Cunard Line). A voluntary observer since 1925 who in 17 years has sent in 69 logbooks, 32 of them having been classed excellent.
4. CAPTAIN D. H. CHADWICK (New Zealand Shipping Company), whose first meteorological record was received here in 1930. Since then he has, in 16 years, sent us 30 records of which 19 have been classed excellent.

The award will, as in past years, be in the form of a suitably inscribed barograph. We congratulate these captains on this recognition of their voluntary work over many years. They will be personally notified of the award and of the arrangements which will be made for its presentation.

International Symposium on Tropical Cyclones

Held at Brisbane, Queensland, 10th-14th December, 1956

By Captain BRETT HILDER, F.R.G.S., F.I.N., Extra Master
(President of the Australian Institute of Navigation)

This Symposium was attended by the world leaders of research into tropical cyclones, hurricanes and typhoons, and involved the presentation of the most recent work on the subject. This would fill a large textbook by itself, without the discussions which were an essential part of the programme. Most of the work assumed a knowledge of the previous 10 years' work in many aspects of tropical meteorology, and as many of the scientists present had only worked in limited fields, it seems probable that some of the speakers were often only fully understood by a small percentage of the delegates.

Two very prominent experts on hurricanes who were present, Professor Riehl of Chicago and Professor Palmen of Finland, were frequently called upon to elucidate the more complicated problems.

Apart from the scientists present there was a large body of practical meteorologists, and representatives of Army, Navy and Air Force branches dealing with weather reconnaissance. Civil aviation was represented by the Government Department, and I was one of two delegates from the Australian Institute of Navigation. Finding myself the only seafarer present, it became my duty to speak up for the body of voluntary marine observers. They are surely entitled to a brief report on the Symposium, for so many of us are vitally concerned with the behaviour of hurricanes and the attempts being made to forecast their tracks.

This track-forecasting has proved to be the most difficult part of hurricane research. The question of what forces " steer " a hurricane is being tackled from all angles. The winds at all levels of the atmosphere up to 50,000 feet, and the related pressure systems, temperature gradients and humidity are being analysed to find the guiding factors. Some of the techniques have shown promise, including the study of the behaviour of previous storms in the same areas at the same time of the year. High-pressure systems in the neighbourhood have been found to exert some influence on the track, but they can only block the path of a cyclone when they are strong enough, or when they can provide a stream of cold air causing a rise in pressure at the centre.

The whole energy of a cyclone depends on a large supply of water vapour, i.e. of warm humid air. The latent heat set free when this water vapour condenses in the ascending currents of air is transformed into the kinetic energy of the winds. This energy has been calculated at various stages of the life of a cyclone, and is said to be equal to the explosion of a Hiroshima atom-bomb every half-second.

Professor Palmen has found that the genesis of a cyclone requires, among other factors, a sea-surface temperature of 26°C (79°F) or higher. This appears to be the reason why tropical cyclones are limited to certain areas of the tropic seas, namely the four tropical corners of the Indian Ocean, the China Sea, the South-west Pacific, the tropical western coast of North America and the West Indies. Each area has a hurricane season of several months, chiefly in the summer or autumn. The area within about 8° of latitude from the equator is out of bounds for tropical cyclones because the deflecting force due to the earth's rotation, depending as it does on the sine of the latitude, becomes too weak for a cyclonic circulation to be established.

Most hurricanes form, or are first discovered, between 8° and 18° of latitude, either north or south. The conditions in which they form are now fairly well known, but these conditions often extend over large areas for weeks without any hurricanes forming. Why more do not form is a puzzle, but this is mainly of academic interest, compared with the problem of "steering". According to the old law of storms, tropical revolving storms follow a curved path like a parabola, the point of recurvature, i.e. the position where the original westward movement changes to an eastward movement, being about 20° latitude, north or south. It has been found that less than half the storms studied follow this rule, but the other paths are so varied that the parabolic path is still considered normal.

One of the methods used for forecasting the future path of a hurricane is the use of analogues. This involves studying all previous tropical cyclones which have occurred in the area and comparing and grouping them (possibly using punch-card methods) so that situations of similar development, position and season to any new cyclone can rapidly be found and used as forecasting aids. There are other methods but they are rather beyond the reach of seafarers. No evidence has been found of any frontal structure in tropical cyclones, in fact frontal analysis has been found to have no application in the tropics, where other methods have to be used.

Other useful guides are provided by drawing hodographs,* and constructing vertical cross-sections of the atmosphere, either along the path of the storm or at a fixed position with change in time, with isopleths of the various elements drawn in.

The analysis of the thickness of the layer of air between different pressure levels and the use of thickness and thickness tendency charts may also be helpful. Also discussed were the Riehl & Haggard Objective Method, the Wang Objective Method, Fletcher's Rule and the Fujiwara Effect! The method of extrapolation appeared to be based on the hope that the storm would continue its course and speed, like a vessel "standing-on" with the right of way.

A great deal has been found out about the structure of the hurricane and its eye by special weather-reconnaissance aircraft and by radar photographs. The films, photographs, sketches and descriptions of the centre are most graphic and illuminating, for so much more is visible from the air than can ever be seen from a surface vessel. The "eye" has been found to be generally a hollow core, about 40 miles in diameter, with a dome-shaped mass of low cloud right in the centre, surrounded by a moat which is broken in places. These points would be where a ship sometimes sees a patch of blue sky above. Around the moat tower the vast walls of cloud which rise to perhaps 35,000 feet, containing the central core of high winds. The hollow eye is therefore similar to the core of air which can be seen down a whirlpool or down the bath plug-hole (see radar photograph opposite page 213).

While it has long been believed that an anti-cyclone must exist in the upper layers of air over a cyclone, it has now been found that a cyclonic core often extends up to 50,000 feet, but it may be surrounded at different levels by eddies or cells of high

* A hodograph is a diagram showing changes of wind with height.

pressure. Only once have aircraft found the centre to have a perfectly calm sea, covered with resting birds in thousands.

And so the general picture of hurricane-structure becomes clearer, if more complicated. Modern radar photographs, showing rain masses, have been taken from sets with ranges of 150 miles, giving a type of X-ray plan of the structure. Towering walls of rain-cloud are seen to sweep in a spiral towards the " eye ", causing it to appear to open and close hour by hour. Because the storm gains its energy from precipitation and heating there is a theory that the centre will tend to follow the sector of most rain, and this theory gives some promise in forecasting the path of the storm. Radar photographs could be taken by ships, and if the range of their sets was made to be shown on a scale of 150 miles they should be able to pick out the " eye " of the storm and watch its movement. At a distance of 100 miles the view of the " eye " given on the set would be a section of the core over 10,000 feet above the surface, but this would generally give a similar picture to one obtained by a horizontal section through the " eye " at a lower level.

Hurricanes often have cloud systems extending over a 400-mile radius, and therefore visible to an observer at great altitudes above the earth. Experiments are being made with cameras carried by rockets to 150,000 feet, and it is even proposed to take such photographs from an earth satellite at much greater heights.

Descending once more to ships and the sea, it is quite possible to take photographs of the radar screen without any elaborate gear, and I have personally done so after reading how to do it in an article in *The Marine Observer*.[1]

The old method of detecting hurricanes by the precursory swell has fallen into disfavour lately, partly because of the swell being difficult to notice in the disturbed waves at sea, and partly because the direction of the swell is deflected by land masses.

The precursory swell which travels at about one mile a minute is not a sufficient warning by the time it is detected and analysed. It comes from the centre of the storm and therefore has to travel a long way to get ahead of the storm in its path. The centre of the storm may be travelling up to 35 knots, and is therefore going at about half the speed of the swell. A much better form of wave warning may turn out to be that of the seismic waves which pulsate through the earth's crust and the sea from the centre of a hurricane. These tiny waves travel at 100 times the speed of sea-waves, and so may give much earlier warning. They are called microseisms, have a period of about six seconds, or half that of the great waves in a storm, and are so small that they are magnified about 10,000 times before they are able to be seen and measured on the seismograph records. Tropical storms can thus be detected at about 1,000 miles distance, but the seismograph gives neither the bearing nor the distance of the storm. It merely indicates whether or not there is a tropical cyclone within range and this information is not sufficient in most cases. When an observer becomes sufficiently experienced, and the seismograph has been calibrated roughly by records from storms at known distances off, it is possible to estimate the distance of a cyclone from a study of the microseisms produced. Using three stations in a triangle it is possible to get an approximate bearing of the centre of the storm, but this method fails when the earth's crust is folded or cracked as it is around the Pacific basin and along the arcs of island groups. Better success is promised by another technique, called micro-ratios, and this is being tried out along the coast of Queensland with passing hurricanes.

The strangest thing to me about the microseisms is that they have been found to work quite well when the storm is over land, and that throws doubt on the theory that they are caused by the cross-seas in the centre of the storm. Another method tried out over long distances is called " Sferics ". This is an abbreviation of " atmospherics ", noise in radio reception caused by electrical discharges in storms. Individual flashes can be fixed by radio D/F, but the big catch about this technique is that tropical cyclones are not necessarily accompanied by lightning.

Meteorologists agree on one thing about hurricane forecasting, and that is that no one method is sufficient by itself in our present state of knowledge. The field of research is so great that we must congratulate our weather men on their efforts to keep up to date with all the new techniques on top of their normal work. Trying to collect my thoughts and impressions after this Symposium resulted in only one simplification: that the whole subject could be divided into two parts, the taking of observations and the transmission of reports, and the analysis of the reports in accordance with the various theories.

In regard to the reporting of data, I must mention the use of balloons, radio-sondes and other automatic radio-reporting stations, including some anchored or drifting in the open sea where they would function for a month or two. Several of these, and weather-reporting aircraft, require a coverage of Decca, Loran or some such " radio " system of navigation to fix positions, and so are not applicable to the seas around Australia.

Aircraft flying through hurricanes cannot be expected to keep an accurate D.R. plot, or make use of astro sights. In spite of this a suitable high-level aircraft could fly right over the top and fix the position of the eye as well as the general extent of the storm. Radio-sondes can be dropped into the eye to get reports from lower levels, and it has been suggested that a balloon could be dropped which could maintain its position in the core of the hurricane long enough to give a good record of the track of the centre. Aircraft unable to fly over the top could fly around the edge of a huricane, and suitable observations of pressure could fix the position of the centre. These aircraft have been used for several seasons in the Far East and the West Indies by the U.S. services, and they have been successful in enabling the paths of hurricanes to be forecast to warn maritime settlements in time to take avoiding action. This has reduced loss of life to one-tenth its previous figure, although little can be done to prevent property damage by the sea. A lot of damage results from flooding due to the heavy rains when a storm travels ashore and inland, and some precautions can be taken when sufficient warning is given.

I regret that so little of the Symposium was directly concerned with ships at sea, but I hope that a general knowledge of the work being done ashore will be interesting to marine observers. I was surprised to hear the experts complain that ships' barometric reports were " notoriously incompatible ", but they praised other ship observations on wind and sea as much better than those of aircraft, especially wind velocity and wave heights, made without the use of any instruments. We shall have to be more careful with our barometer readings and reports, to make our work more valuable.

REFERENCE

[1] LE PAGE, L. S. Photographing radar echoes. *Mar. Obs., London*, **24**, 1954, p. 22.

The Application of Meteorology to the Care of Cargo in a Ship's Hold*

By H. C. SHELLARD, B.SC.
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1. Introduction

Appreciable damage, due to moisture effects, sometimes occurs to cargoes carried aboard ship. Some evidence of this is provided by contact with shipping interests and from inquiries received in the Meteorological Office for information about weather conditions at ports and along shipping routes on specified occasions when damage has occurred, but it is difficult to obtain any precise figures regarding the

* This paper is based on a lecture given by the author to Navigation School instructors at a meeting in London during April 1957 at the invitation of the Ministry of Education.

overall amount of damage. It is obvious, however, that any contribution that meteorology can make to the improvement of cargo care in British ships would be of appreciable economic importance, e.g. by helping to keep down the prices of food and other commodities which have to be imported.

2. The general problem

Cargo damage includes such effects as mould formation, germination of grain, corrosion of metals, caking of sugar or chemicals, etc., and may arise either from " hold sweat ", i.e. water which condenses on cold deckheads, etc., and thence wets the cargo, or from " cargo sweat ", i.e. condensation directly on to the cargo itself. In studying the problem account must be taken of the special properties of cargoes, especially of those which are hygroscopic or which generate heat and release gases. Various sources and sinks of heat within the ship itself must also be considered, particularly when the cargo spaces are not insulated. These include the lower part of the ship's hull plates whose temperature is largely controlled by the sea temperature; the ship's structure above the water-line whose temperature changes due to radiation effects, from night to day and also from shaded to sunny sides; and hot or cold bulkheads adjacent to engine rooms or refrigerated spaces respectively.

Another very important factor in this complex problem is the type of ventilation system provided. This may range from the old-fashioned cowl-type natural ventilation to the more modern forced ventilation with all-weather ventilator heads, or even, in a few cases, to full air-conditioning. Except where such expensive air-conditioning equipment is available, however, the ventilation of cargoes to remove unwanted heat or moisture can only be accomplished with the air that happens to surround the ship. If properly used, natural ventilation can give good results on the majority of occasions, but sometimes it is quite inadequate, e.g. when there is no wind relative to the ship. A number of rules of thumb have been developed, based on long experience, which have proved to be fairly sound when applied aboard such ships but they are far less reliable when applied on ships with more modern systems, for with these it is much easier to over-ventilate and to cause a lot of damage in a relatively short time. An officer who believed in ventilating whenever the weather was fine, for example, could do far less damage with natural ventilation than he could with mechanical ventilation. It is therefore essential that all officers should understand the relatively simple physical principles involved in correctly using any system of ventilation.

3. The properties of moist air and of various cargoes, and the principles of ventilation

The main cause of damage to cargo arises from condensation of moisture from the air in the hold, either directly on to the cargo or on to the ship's structure, whence it may affect parts of the cargo. Thus the primary aims of ventilation are to remove excess moisture before it can do any damage and to avoid the introduction of such moisture in the ventilating stream. In some cases of course ventilation may be necessary to remove heat or gases generated by a particular type of cargo and there are also circumstances in which all ventilation must be stopped because of heavy weather or other hazard. In general, however, the ventilating air must be capable of carrying away moisture and a method is therefore needed to determine accurately whether or not it is doing so. This involves making measurements of the " moisture content " of the air, and before going any further it is desirable to discuss some of the properties of moist air and to consider some of the ways in which humidity is commonly expressed.

The amount of water vapour in the air can vary within wide limits, ranging from almost none to an upper limit which depends only on the temperature and which increases as the temperature increases. At low temperatures it is small, while at 100°F it can amount to 4 per cent by weight or 6½ per cent by volume of the air and water vapour mixture. Fig. 1 shows how the maximum vapour density, expressed in grams of vapour per cubic metre, varies with temperature. It is important to note that the maximum amount of moisture that the air can hold increases more rapidly with temperature as the temperature increases. Between 20°F and 100°F the capacity of air to hold water vapour is roughly doubled with each 20°F rise in temperature. The lower layers of the atmosphere nearly always contain appreciable

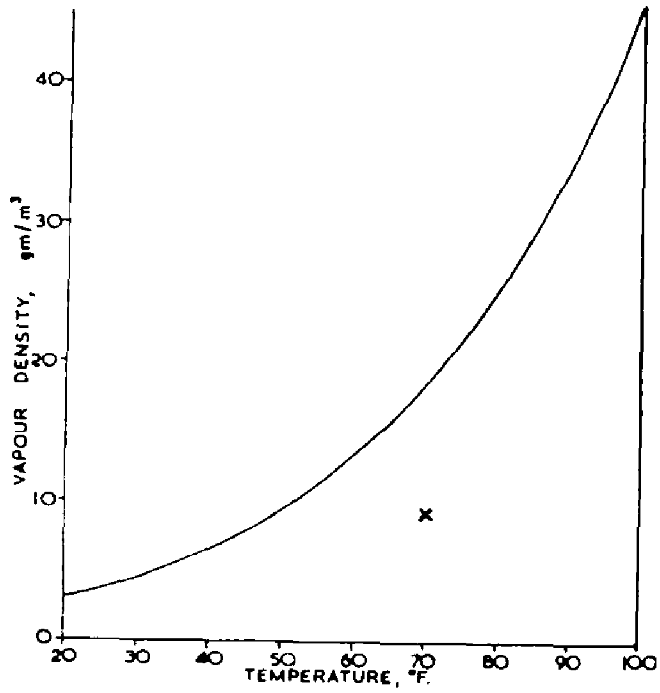


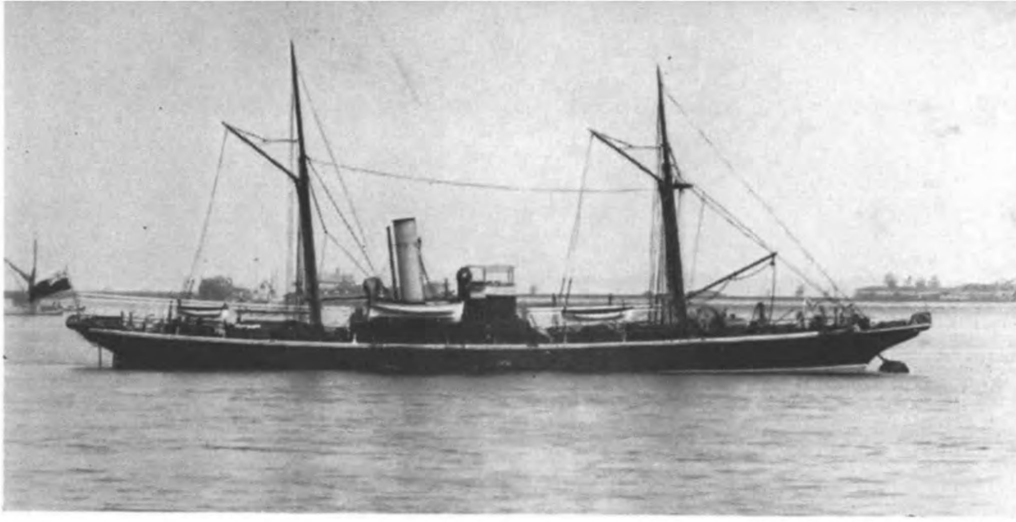
Fig. 1. Values of vapour density at saturation.

amounts of water vapour because evaporation, i.e. the escape of water vapour into the air from water, snow or ice surfaces, is going on for much of the time over most of the earth's surface. The amounts are greatest in air lying over or originating from the warmer parts of the oceans.

When a mass of air contains the maximum possible amount of water vapour for its temperature, it is said to be saturated and this condition is usually expressed by saying that the relative humidity is 100 per cent. The relative humidity is the ratio of the actual amount of water vapour held, to that amount which the air could hold if saturated, expressed as a percentage. Thus the point X in Fig. 1 represents air whose temperature is 70°F and whose relative humidity is 50 per cent.

Usually the air contains less water vapour than is needed for saturation. There is little to distinguish visually between air which is at or very near saturation and air which is relatively dry, but if the former is cooled slightly condensation will take place. This means that if it is cooled by coming into contact with the ground or other objects which are at a lower temperature, dew will be deposited. The temperature at which condensation first occurs is called the dew point. The dew point is defined as the temperature to which air must be cooled in order that it shall be saturated; in general it will be equal to or lower than the actual air temperature. The greater the difference between the air temperature and the dew point the drier is the air, the greater the amount of cooling necessary before condensation can occur, and the greater the capacity of the air to take up additional moisture. By itself the dew-point temperature is an accurate index of the amount of water vapour in the air, an increase in dew-point implying that moisture has been taken up and a decrease that moisture has been condensed. Thus in dealing with ventilation problems the dew-point temperature, used in conjunction with the air temperature, is the most directly useful humidity parameter.

The most reliable method of measuring temperature and dew point is to use dry-bulb and wet-bulb thermometers. The degree to which the wet-bulb tempera-



National Maritime Museum

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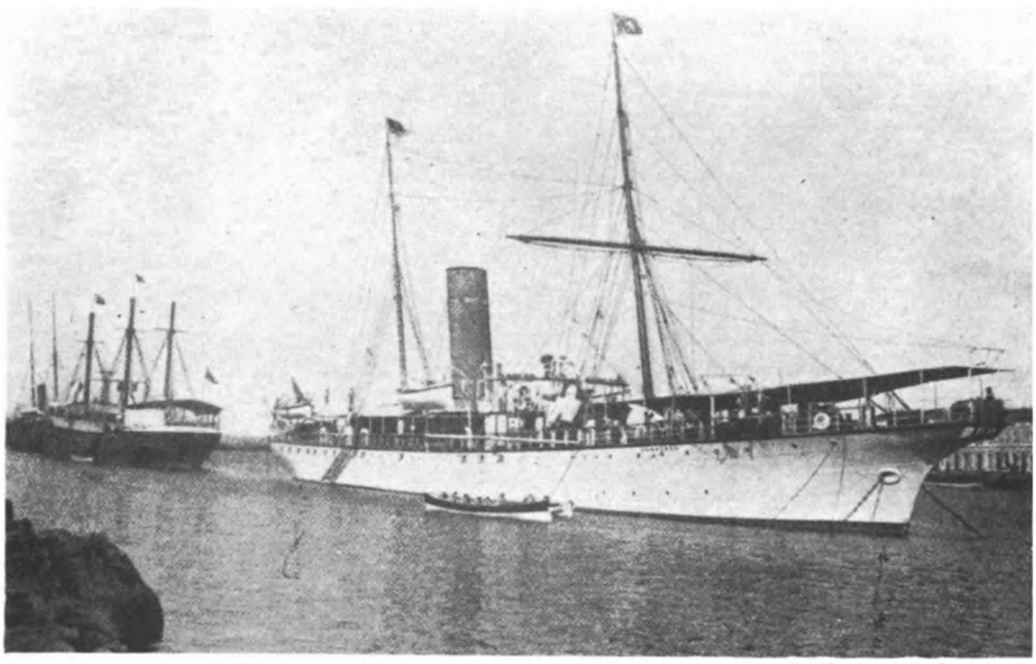
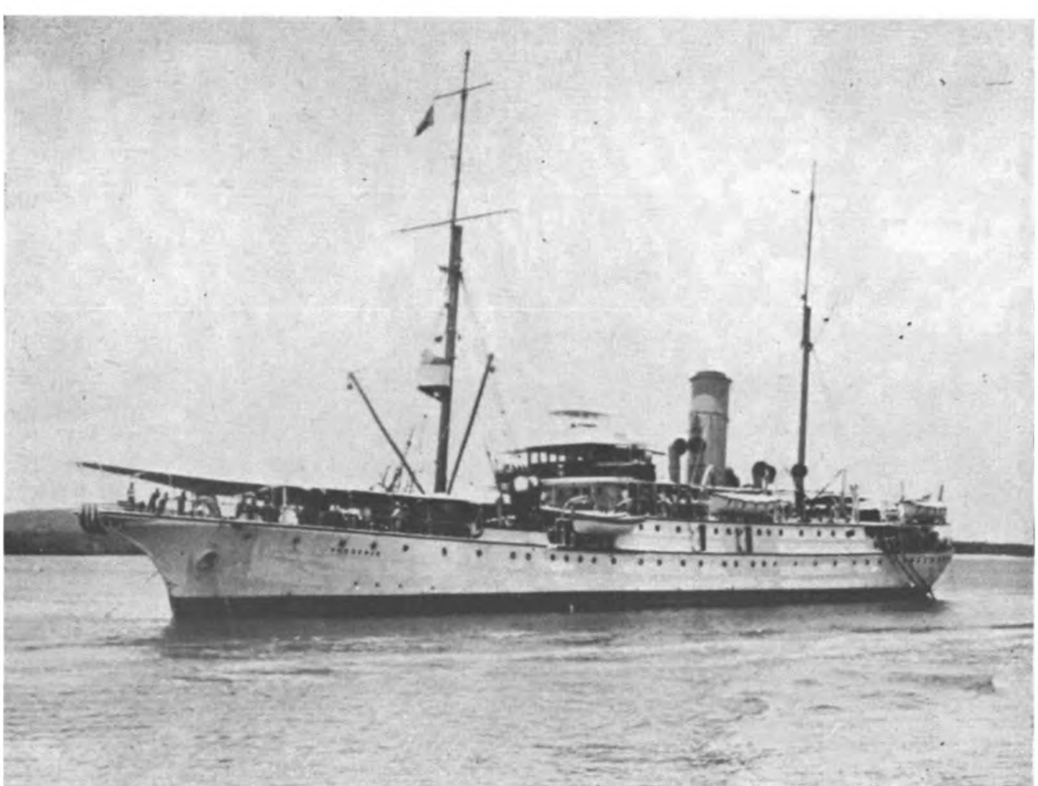


Cable & Wireless, Ltd.

Third *Norseman* (Western Telegraph Co.).



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Fourth *Norseman* (Cable & Wireless, Ltd.).

(*Opposite page* 220)

(*Opposite page* 221)

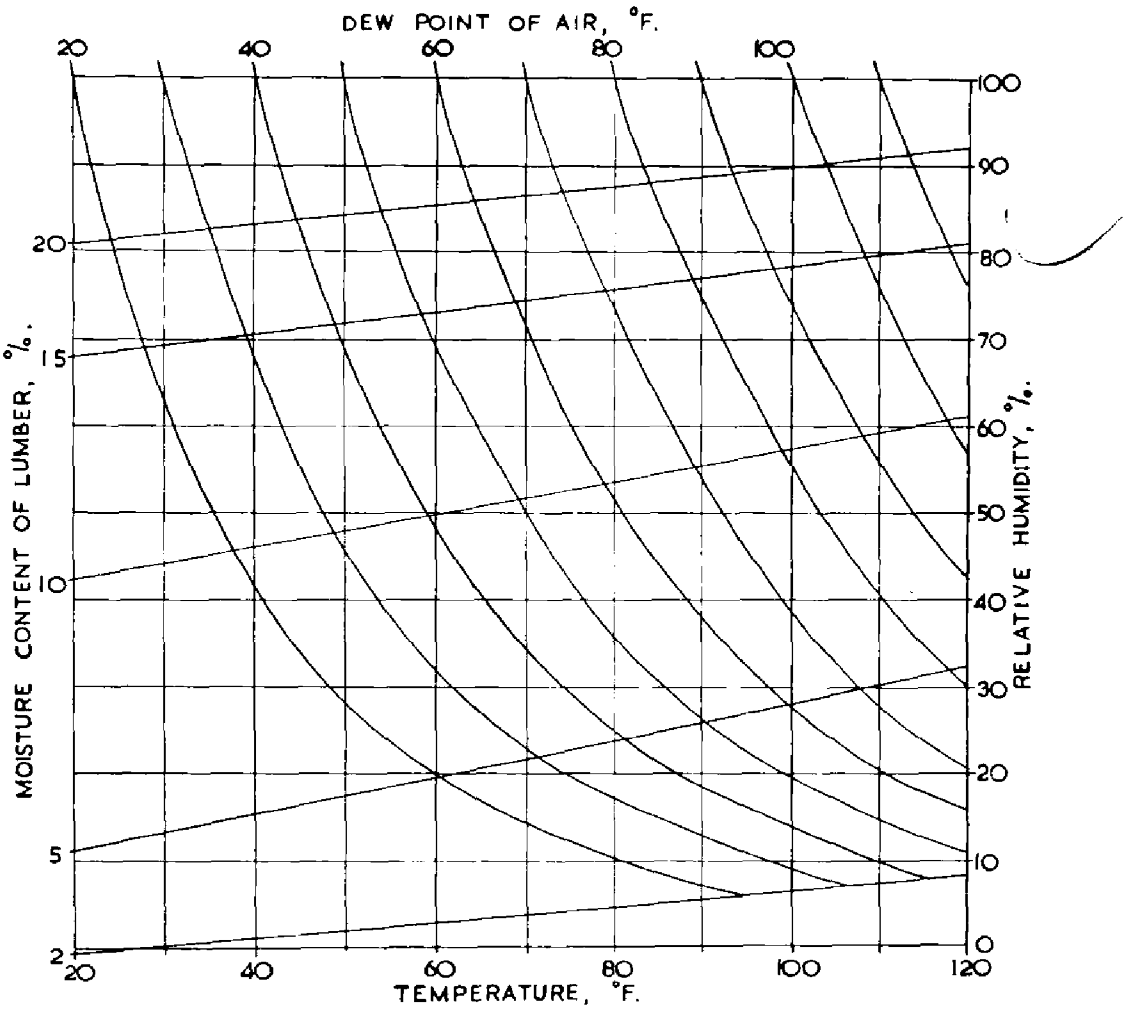
Presentation of Excellence Award by Mr. L. J. Dwyer, Director of Australian Bureau of Meteorology, to Captain J. Gilbertson of M.V. *Westralia* (see page 234)

Mr. Dwyer with managers of Huddart Parker, Ltd., and officers of M.V. *Westralia* (see page 234) ture falls below the dry-bulb temperature (the depression of the wet bulb) depends on the dryness of the air and also to some extent on the air speed past the bulb. Tables are available which give the various humidity parameters, relative humidity, dew point, vapour density, etc., in terms of the dry-bulb temperature and the depression of the wet bulb. The tables differ somewhat according to whether they are to be used with thermometers in screens, as used at British meteorological stations and on British selected ships, or with aspirated psychrometers. In the former an average air speed past the bulbs of about 2-4 kt is assumed while in the latter air is drawn past the bulbs by means of a fan at a speed exceeding 7 kt, the critical speed above which the wet-bulb reading is independent of the rate of ventilation. The aspirated psychrometer is capable of the more accurate results but is generally more expensive. A dew-point table for use with an aspirated psychrometer is given below. It might be thought that the directly measured wet-bulb temperature and wet-bulb depression could be used in ventilation problems instead of the dew-point and dew-point depression, which have to be derived from tables. The wet-bulb temperature, however, is not by itself an accurate index of the amount of water vapour in the air, thus the wet-bulb temperature will rise simply as a result of an increase in temperature, without any addition of moisture. Moreover, the table shows that for the same wet-bulb depression colder air shows a greater depression of dew-point, so that the wet-bulb depression is not a good indicator of the margin for cooling before there is any danger of moisture being deposited.

Table of Dew-Point Temperature

Air temperature °F	Depression of wet bulb														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
20	15	10	5	−2											
25	21	17	13	8	2										
30	27	24	20	16	11	6	−1								
35	33	30	27	24	20	16	11	5	−4						
40	38	35	33	30	27	24	20	16	11	4	−4				
45	43	41	39	36	34	31	28	24	21	16	11	5	−4		
50	48	46	44	42	40	37	35	32	29	25	21	17	12	5	−3
55	53	51	50	48	46	43	41	39	36	33	30	27	23	18	13
60	58	57	55	53	51	49	47	45	43	40	38	35	32	28	25
65	63	62	60	59	57	55	53	51	49	47	45	42	40	37	34
70	69	67	66	64	62	61	59	57	55	53	51	49	47	45	42
75	74	72	71	69	68	66	65	63	61	59	58	56	54	52	49
80	79	77	76	74	73	72	70	68	67	65	64	62	60	58	56
85	84	82	81	80	78	77	75	74	72	71	69	68	66	64	63
90	89	87	86	85	84	82	81	79	78	76	75	73	72	70	69

Before returning to the question of ventilation aboard ship it is also desirable to refer to the special properties of different types of cargo, as these need to be clearly understood by ships' officers responsible for their care. Many cargoes of an organic nature such as wood, grain, wool, paper, cotton, etc., are hygroscopic, i.e. they can absorb water vapour from the air. For any particular hygroscopic substance having a specified moisture content and temperature, there is a value of relative humidity at which the surrounding air will be in equilibrium. If the actual relative humidity of the air is below this value, the substance will give up moisture to the air; if it is above this value then the substance will absorb moisture from the air. For a given temperature, this equilibrium relative humidity is higher the higher the moisture content of the substance; for a given moisture content it rises as the temperature rises. The moisture content of a hygroscopic commodity loaded in a warm climate is usually very large compared with the amount of moisture that can be taken up by the air in the hold of a ship, or even by a continuous stream of atmospheric air during the duration of a normal voyage, and it can therefore be assumed that it will remain more or less constant during such a voyage. Moisture equilibrium charts are available for some of the more common hygroscopic cargoes and Fig. 2 indicates in outline the form which they usually take.



It will be seen that this commodity (lumber), when it has a moisture content of 20 per cent by weight and a temperature of 80°F, will be in equilibrium at about 87 per cent relative humidity. This means that if the surrounding air is also at 80°F, it will take up or give up moisture according to whether its dew point is below or above 76°F. If this lumber were in a confined space such as an unventilated hold, the dew point of the air in the hold would fairly quickly become 76°F. In other words, in the absence of ventilation a hygroscopic cargo will control the dew point of the air in the hold at a level which depends on the temperature and moisture content of the cargo. It follows, first, that it is desirable that hygroscopic commodities should be shipped with as low a moisture content as possible and, second, that such cargoes should be ventilated whenever possible to prevent the dew point in the hold from building up so as to increase the probability of condensation on cool deckheads, bulkheads or plates. When dealing with hygroscopic cargoes it also follows that it is particularly important to consider all possible sources of heat and any cold surfaces in the hold. The presence of a hot bulkhead near a hygroscopic substance will raise its temperature and hence its equilibrium relative humidity, so causing the dew point of the surrounding air to rise. This moisture may then be condensed on the colder parts of the cargo or on a cold bulkhead or deckhead. Insulation of such a cargo from any hot or cold surfaces is thus very desirable.

It is also relevant to consider some of the properties of non-hygroscopic cargoes.

These neither absorb nor liberate moisture and if they are stowed in a dry unventilated hold, the dew point of the surrounding air will remain more or less constant even though its temperature may rise considerably during a voyage. Common cargoes of this type are steel products and canned goods. Steel products, because of their high heat capacity and good thermal conductivity, warm up relatively slowly as the temperature of their surroundings increases. Unless very well protected by grease or some other coating they are therefore specially liable to condensation and rust damage. Such a cargo loaded in a cold climate will, as the ship sails into warmer waters, retain a temperature lower than its surroundings but if the hold is not ventilated the dew point in the hold will be lower still and all will be well. If ventilation is begun, however, with outside air having a dew point higher than the cargo temperature, then condensation on the metal surfaces will immediately result. If there is a hygroscopic cargo in the same hold there may also be trouble because the dew point in the hold will then rise as the temperature increases and there is then some risk of condensation on the colder metal cargo, whether the ventilators are operated or not. Thus canned goods packed in boxes made of wood having a fairly high moisture content are specially prone to damage in this way. It has even been known for steel products to be corroded due to moisture originating in the wooden dunnage used to protect them. In general, hygroscopic and non-hygroscopic cargoes should not be mixed in the same hold because they require different treatment in regard to ventilation. The same sort of thing would apply to two hygroscopic cargoes with appreciably different equilibrium relative humidities arising from differing properties and moisture contents.

Returning to the ventilation problem aboard ship, it has already been stated that if ventilation is to be useful the ventilating airstream must carry away moisture or heat or both and that to find out whether ventilation is necessary, or is likely to be harmful, in any given situation, the temperature and dew point of the airstream must be measured. First these quantities must be measured for the outside air; this being the air which will be drawn into the ship when the ventilating system is put into operation. On ships which are not specially equipped for making meteorological observations this may raise certain difficulties which will be referred to later. Assuming however that the ship's officer is able to measure the temperature and dew point of the atmospheric air accurately from the weather side of the ship's bridge, he will have some valuable information to go on. For example, if the air is very warm and has a small dew-point depression it must contain a large amount of moisture and, unless it is considerably warmed, cannot be expected to take up much additional moisture; if cooled slightly it is likely to deposit moisture. On the other hand, if the air shows a large dew-point depression it is capable of taking up a considerable amount of water vapour and is likely to be suitable for ventilating unless the cargo is a cold one. Before a decision can be reached about ventilating, however, it is necessary to have a fairly good idea of the temperature of the cargo. Direct measurement of cargo temperature is a difficult matter. Conditions in a hold might be measured by placing recording thermo-hygrographs either directly on the cargo or in spaces between the cargo, but this method would be of little value for day to day use because cargo spaces are often inaccessible and the readings taken by one or even two such instruments may not be representative of conditions in cooler and more critical parts of the hold. A more useful but much more costly method would be to use distant reading electrical resistance thermometers and electrical dew-point hygrometers placed at various points in the hold with indicating dials, or even a multiple recorder, on the bridge or at some other central point. Such a system would not be easy to manage because it requires frequent checking and calibration if the readings are to remain reliable and a large number of sensing elements would probably be necessary to give a reliable average overall picture of conditions. In general the temperature of the air in contact with the cargo will tend to be the same as that of the surface of the cargo and it will be noted that the methods just described would strictly speaking measure the condition of the air and not that of the cargo. It is believed that some ships' officers take hold temperatures simply by lowering an ordinary thermometer down a ventilator or perforated bilge sounding pipe. Such measurements are subject to considerable error but will serve as a rough guide in estimating the probable cargo temperature, particularly if taken in conjunction with information about the conditions under which the cargo was loaded, its nature and stowage, recent weather conditions, including sea temperatures (particularly if dealing with the lower hold) and whether proceeding towards warmer or colder conditions. If the dew point of the outside air is appreciably lower than the estimated cargo temperature, then it will usually be safe to begin ventilating. It is clear however that moisture will only be removed from the hold if the dew point of the outside air is below the *dew point* of the air in the hold. Generally it will not be possible to measure the dew point in the hold although in the case of a hygroscopic cargo, as has already been indicated, it will be possible to estimate it if the temperature and moisture-content of the cargo is known and a moisture equilibrium chart for the commodity is available. Once ventilation has been started, however, the problem becomes much simpler because it is then possible to find out whether the ventilating stream is removing or adding moisture by direct measurement of its dew point at or near the point of discharge. It is obvious that if the dew point of the exhaust air is higher than that of the atmosphere then moisture is being removed, and vice versa. If a reasonably close watch can be kept both on the atmospheric dew point and on that of the emergent airstream then the ventilation can be properly controlled. This is also the main conclusion reached in a booklet which is being prepared on the subject of cargo ventilation by a working group of the Commission for Maritime Meteorology of the World Meteorological Organisation and which is expected to be published soon. The procedure recommended for moisture control is therefore as follows:

(i) Measure the dew point and temperature of the outside air.

(ii) Place the ventilation system into operation, unless the outside dew point is higher than the estimated cargo temperature and the cargo is one likely to be seriously affected by a short period of condensation, e.g. metal goods.

(iii) Shortly afterwards measure the dew point of the air flowing out from the ventilators to make sure that it shows a higher dew point than that of the outside air. Unless it does there can be no removal of moisture from the hold and it will be useless or perhaps damaging to continue ventilation.

(iv) At reasonable intervals repeat the measurement of dew point in the discharge stream to make certain that it is still higher than that of the input air.

(v) At longer intervals (not less than 6 hours apart) re-check the dew point of the atmosphere around the ship to provide a new basis for comparison.

Some typical situations are considered below:

(*a*) Ship proceeding from a cold to a warm climate. Atmospheric temperature 70°F, dew point 60°F. Temperature when cargo was loaded about 45°F.

If the cargo is a non-hygroscopic one, e.g. steel products, then it will still have a relatively low temperature, and the dew point in the hold, assuming it to be dry, will also be quite low, certainly not more than 45°F. Ventilation will thus increase the moisture in the hold and if the cargo temperature is still below 60°F, serious condensation, resulting in corrosion, may occur. On the other hand, ventilation will accelerate the rate of warming of the cargo and this will reduce the risk of condensation when unloading at the port of discharge: thus if a period occurs when the cargo temperature has risen sufficiently to exceed the dew point of the outside air, then ventilation will be advantageous. (Recirculation of the air within the hold, if this is possible, will serve the same purpose.)

If the cargo is hygroscopic it will also warm up slowly but in this case the hold dew point will rise as well. Ventilation before the dew point in the hold exceeds the outside dew point will serve no useful purpose and might cause some condensation on the cold cargo.

(*b*) Ship proceeding from a warm to a cold climate. Atmospheric temperature 75°F, dew point 60°F. Temperature when cargo was loaded about 85°F.

If the cargo is non-hygroscopic then the risk of condensation on it is small because it is warm and will cool down only slowly. There is some risk of condensation on the ship's sides and deckhead as these cool but this will usually be prevented by light ventilation. Ventilation should therefore be started and continued unless at any time the discharged air shows a lower dew point than the atmospheric air.

If the cargo is hygroscopic then the air in the hold will receive large quantities of moisture and perhaps some heat from it, especially if its moisture content is high, or if it was loaded in a wet condition. Thus there is danger of heavy condensation on the ship's hull and deckheads. Vigorous ventilation is necessary so long as the dew point of the discharge stream remains higher than that of the atmospheric air.

It will have been noted that hygroscopic cargoes being shipped from a warm to a cold climate should always be ventilated by air of lower dew point to prevent the possibility of hold sweat, but that in practice this will not always be possible either because the atmospheric dew point is too high or because of bad weather. This is where a ship equipped with air-conditioning equipment has an advantage (which needs to be considerable in view of the installation cost). One writer has stated that used intelligently a mechanical ventilation system can eliminate as much as 80 per cent of the condensation and that the remaining 20 per cent can be eliminated if the ship is equipped with a dehumidifier and connecting ducts which are used correctly.[1] But nothing will be effective, not even the most expensive apparatus, unless the ships' officers understand the principles involved.

4. Making the necessary measurements of temperature and dew point on board ship

The difficulty of making the necessary measurements of temperature and dew point with the required accuracy has already been mentioned. The average ship* has no wet-bulb thermometer and even if both dry-bulb and wet-bulb thermometers are provided they may be of doubtful accuracy and may perhaps not be correctly exposed or shielded from radiation effects or have a wet bulb that is properly cared for. Thus reliable measurements are often unobtainable. It is essential to proper ventilation management that ships' officers should have the means of making the required measurements easily and accurately. There is little doubt that they can best be made by means of a portable aspirated psychrometer of the Assmann type. Being portable it can be safely stored in its box where it will remain clean when not in use, and can easily be taken to the best position on the weather side of the bridge to take atmospheric readings, or to the discharge stream or sampling port in the ventilation system, as required. Such a psychrometer may be driven by clockwork, mechanically (by turning a handle) or by electricity.

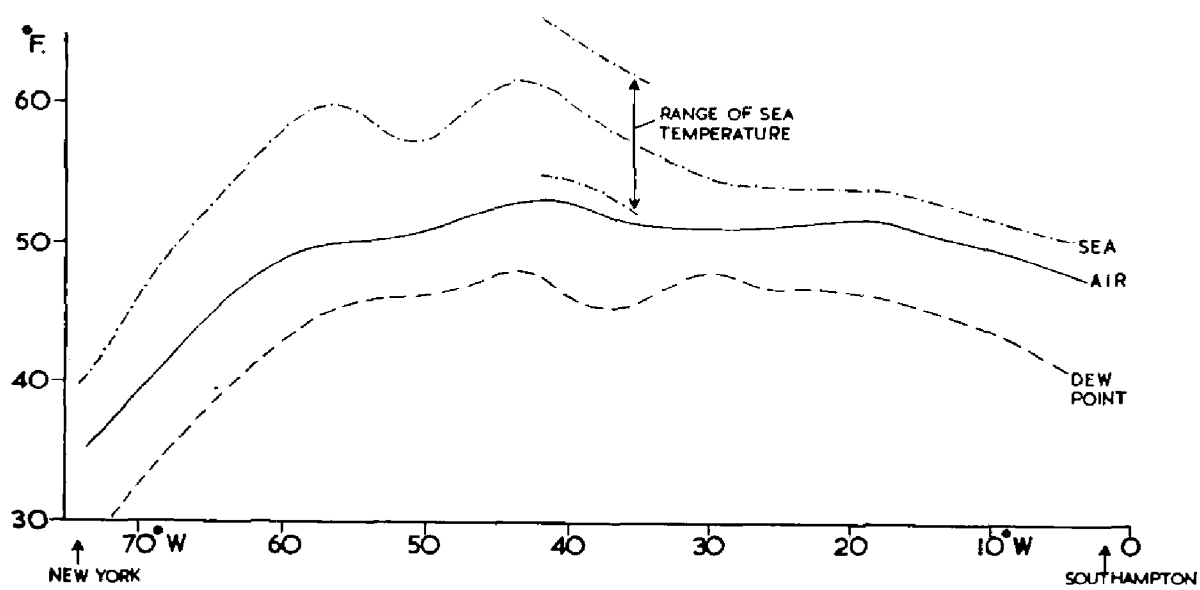
5. The use of climatological information

It has been mentioned already that hold sweat occurs when the temperature of the ship's hull or the deckheads falls below the dew point of the air in the hold. It is therefore evident that the danger of this occurrence must be greatest in those areas where a large fall in air temperature or in sea temperature or a large rise in dew point may occur over a relatively short distance. Such areas can be regarded

* These remarks do not refer to selected ships, which are supplied on loan by the Meteorological Office with an accurate hygrometer (wet and dry bulb thermometer) in a readily portable screen. Assuming that the instructions about care of the thermometers and exposure of the screen are complied with, accurate observations are thereby obtainable. But this instrument is intended solely for measuring the temperature and humidity of the outside air for meteorological purposes and it has proved generally suitable for that purpose; it would be difficult to obtain readings in the " discharge stream " of air from ships' ventilators by this means. The hygrometer readings in a screen are easier to make than those with an aspirated instrument, which needs some care and patience in order to achieve accuracy.

as danger zones for cargo damage and they can be defined by a study of the variation of these elements along the main shipping routes. Unfortunately it is not possible to obtain the required information from the existing marine climatological atlases without considerable difficulty and dew point information has not yet been portrayed at all because it is only in recent years that the dew point has been punched on the Hollerith cards which are used for marine climatological work. Some work on this subject is being carried out in the Marine Division of the Meteorological Office and it is hoped to make available in due course a series of diagrams for each main shipping route showing the mean and extreme values of air temperature, dew-point temperature and sea temperature experienced along that route in each month of the year. Fig. 3 shows the kind of way in which the data might be presented but the eventual product may well be different from this. The upper set of curves shows the variation of the mean values for January along the main Atlantic shipping route. The lower set of curves indicates possible extreme falls in air and sea temperature and rises in dew-point temperature in the next 24 hours for a ship

Variation of mean air temperature, sea temperature and dew-point temperature along route United Kingdom to U.S.A., January.



Possible extreme falls in air and sea temperature and extreme rise in dew-point temperature in next 24 hr for ship westbound at 10 kt in January.

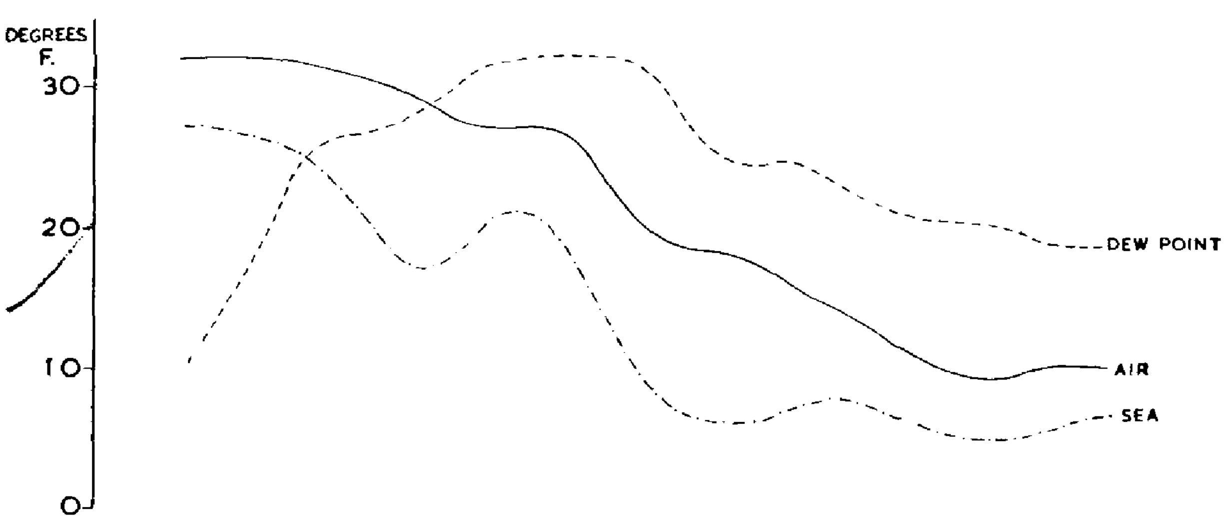


Fig. 3. Diagram showing a method of presenting climatological data along a shipping route.

steaming towards the west at 10 knots. The lower curves have been derived from the upper ones plus the corresponding 5-percentile maximum and minimum curves* (only short sections of the latter curves for sea temperature are shown in order not to confuse the diagram). In whatever way the data are presented the object would be to show clearly the areas in which the risks of rapid falls in sea or air temperature or of a rapid rise in dew-point temperature are greatest. It can be seen from Fig. 3, for example, that in January on this route a rapid rise in dew point is most likely to occur in about longitudes 40–45° and the greatest risk of large falls in both sea and air temperature occurs towards the American coast. Similar work is in hand in the German Meteorological Service who are showing great interest in the subject of cargo care and have even sent some of their meteorologists on voyages equipped with special instruments with which they can study the meteorology of ships' holds[2].

6. Possible future developments

There are many ways in which the duty of the ship's officer to ensure that his cargo is delivered in the best possible condition may be made easier. The first essential is that he should understand the physical principles involved and it is here that tuition in the Navigation Schools is so important, but if he is to apply these principles he must be provided with the equipment to take accurate readings of temperature and dew point. Next, the ventilation system provided should if possible be mechanically operated. Ultimately it is possible that this will always be the case and the natural cowl ventilation system may eventually disappear. It is desirable that the ventilation system be provided with sampling ports which can be used to measure, by means of a portable psychrometer, the conditions in the air-stream emerging from any hold. Eventually an increasing number of ships may be provided with dehumidifiers and wired for distant recording of temperature and dew point but the cost of the apparatus generally and need for frequent calibration checks of the instruments is likely to delay such developments.

It is hoped that climatological information related specifically to this subject and to the main shipping routes will become more generally available and, as has been said, a start has been made on this work.

Another way in which ships' officers might be helped is by the provision of moisture equilibrium diagrams for most of the common hygroscopic cargoes, together with details of the actual moisture content of each such cargo when it is loaded. Instruments have been made for measuring this directly for some types of cargo, but they are delicate and appear to need further development before they can be generally adopted for routine use.

The forthcoming publication of a booklet by the World Meteorological Organisation has also been mentioned. Each meteorological service receiving this might use it as the basis for a publication of its own which can be widely issued to its shipping interests.

The research voyages being made by the German meteorologists have also been referred to and it is possible that similar work may be done in other countries although the author's opinion in this matter is that in view of the great variety of ships, voyages, cargoes, conditions of stowage, etc., a very large amount of work of this kind might be done without yielding any very great advance, let alone a complete answer. Very great improvements in ventilation management can undoubtedly be achieved by the application of the simple principles that have been outlined and this seems a much more fruitful line of approach.

7. Conclusion

This is a very complex problem but it is believed that a ship's officer will be in a very good position to take proper care of his cargo in all circumstances if he is familiar with the meteorological principles involved, if he is provided with the

* *i.e.* the curves between which 90 per cent of the observations lie.

means of measuring accurately the temperature and dew point of the outside air and of the air emerging from the ventilating system (which should preferably be mechanical) and with background information on the probable trends and possible variations in air temperature, dew point and sea temperature along his route at any time of the year. He will of course need also to take into account the nature of the cargo and its stowage, the peculiarities of his ship, and his own experience.

REFERENCES

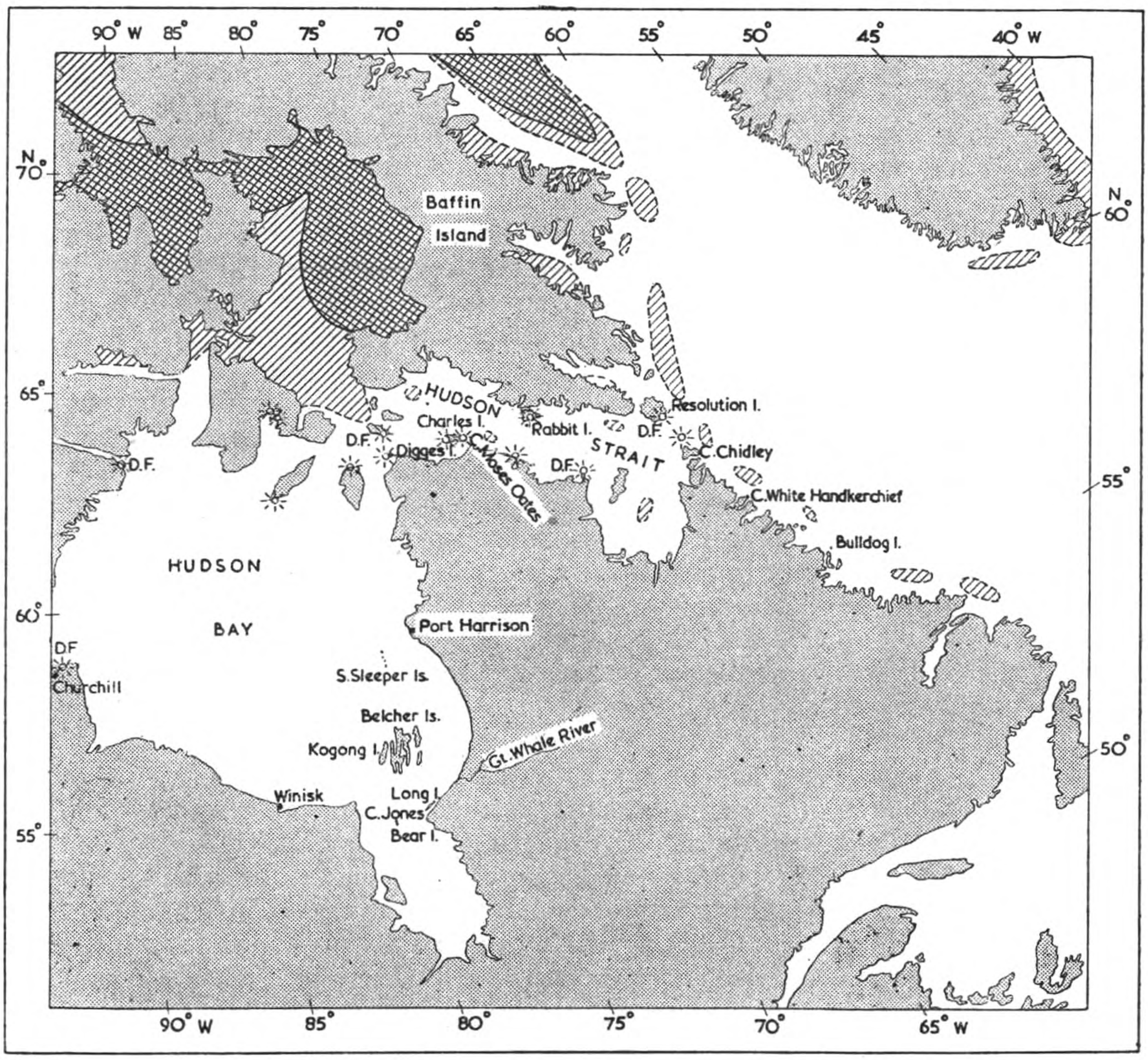
1 SAUERBIER, C. L. Marine Cargo Operations. Chapman & Hall Ltd., London, 1956, p. 455.

2 Deutscher Wetterdienst. Einzelveröff, Hamburg, No. 9, 1956.

VOYAGES TO HUDSON BAY, 1956

The S.S. *Sheldrake* (General Steam Navigation Co., Ltd., Captain C. C. Reynolds) made two voyages to the south-eastern part of Hudson Bay during the 1956 season. During these voyages she was on charter to a Canadian company, trading from Montreal up the Labrador coast. The following remarks are taken from her meteorological logbook.

The ship sailed from Montreal on 15th July and experienced fine clear weather across the Gulf of St. Lawrence until reaching the approaches to Belle Isle Strait



Unnavigable or generally unnavigable ice.

Ice navigable by heavily built vessels. Parts of these areas are navigable also by unreinforced vessels.

Map of Hudson Bay region, showing average ice conditions in August.

when fog patches were encountered. These lifted before the ship cleared the Strait on 19th July and from Belle Isle to Resolution Island fine weather continued.

The first ice in the form of medium-size bergs was sighted in the north-eastern entrance to Belle Isle Strait, and these gradually increased in number during the run up the Labrador coast as far as Bulldog Island (56° 53′N., 61° 10′W.). Forty miles past Bulldog Island, in the evening of 19th July, the first pack-ice was encountered, not particularly heavy but sufficient to prevent the ship proceeding in darkness without the risk of damage. Although showing up well on the radar screen, it was not possible to pick out the leads, and the ship was therefore stopped for the night until daybreak. This became our standard practice when in pack-ice at night.

On 20th July permission was obtained by radio from the Canadian Government vessel *N. B. Maclean* to enter Hudson Strait, together with the advice that the best route lay along the coast of Baffin Island. This was soon proved to be very true, as from Cape White Handkerchief (59° 17′N., 63° 21′W.) to Resolution Island, which was passed on the morning of 22nd, the pack was particularly heavy and our speed was seldom above dead slow or slow, it being necessary to pick our way from lead to lead with caution.

On the afternoon of 22nd, the pack became too thick for navigation and the ship was turned about. After four hours a clear lead was seen to the westward 10 miles off the coast and a course was set to pass 4 miles south of Rabbit Island, Ashe Inlet, thence 5 miles north of Charles Island.

Clear water but misty weather was experienced between Rabbit Island and Cape Moses Oates, where the responder beam was not working, when numerous small floes and growlers were encountered.

Digges Island was rounded early on the morning of 24th, still in conditions of poor visibility, but further ice of sufficient quantity to impede progress was not encountered until a position 20 miles west of Kugong Island in the Belcher group was reached, when pack-ice of varying thickness again held us up until late in the morning of 25th. The ship was turned about and a course set to the northward.

At 5 p.m. on 26th, while attempting to pass between the South Sleeper Islands and the North Belcher Islands, the water started to shoal so rapidly that we again turned about and steamed to the northward until west of Port Harrison when, after steaming due east towards the mainland, a course was shaped to pass 6 miles off the off-lying islands down to Great Whale River. This route proved to be completely free of ice and in poor visibility with continuous rain the ship came to anchor off Great Whale River on 28th July.

On 4th and 5th August we proceeded on to Cape Jones, once again meeting with no ice but steaming in poor visibility with fog patches. An unusual sight was seen at 8 p.m. on the 4th in the form of a baby polar bear with presumably one of its parents swimming strongly in a north-westerly direction 10 miles off Long Island.

During 8th August, once more in thick fog, the ship crossed to Bear Island in James Bay, encountering scattered ice floes all the way. At Bear Island at which, despite its name, only one bear was seen during a stay of 16 days, these scattered floes dispersed after about a week and on leaving on 25th August, apart from a few scattered bergs sighted in Hudson Strait, no further ice was encountered on the passage back to Montreal. From Cape Chidley to Bulldog Island poor visibility with continuous rain was experienced accompanied by strong breezes varying between NNE. and NNW., force 4–5. Similar conditions prevailed in Belle Isle Strait with the wind from SW.

On the second voyage to Hudson Bay, the ship left Montreal on 15th September and experienced fine weather as far as Bulldog Island, when light rain and drizzle reduced visibility until Cape Chidley was rounded on 21st.

During the afternoon of 21st a moderate gale, force 7, blew from a north-east by easterly direction but with the glass steady at 30·05 inches. However, the following day when passing through Digges Sound and up to arrival at Winisk on 24th September, fine clear weather prevailed.

At Winisk, where the ship was anchored 8 miles off the shore, conditions were unsettled, particularly during the periods 8th–10th October and 13th–14th October. On these two occasions, the wind and glass behaved as shown below, times being given in Canadian Eastern Standard Time. The first heavy snow showers of the autumn this year also made their appearance but the air temperature did not fall below 32°F until the night of 14th–15th October.

Date	Time	Barometer (in.)	Wind		Date	Time	Barometer (in.)	Wind	
			Direction	Force				Direction	Force
7 Oct.	Midnt	29·18	E'S.	4	10 Oct.	0800	30·21	W'N.	6
8 Oct.	0400	29·20	E.	2/3		1200	30·28	W.	5
	0800	29·28	NE.	4		1600	30·31	NW.	4
	1200	29·49	NE'N.	4/5	13 Oct.	Midnt	29·51	SE'S.	3
	1600	29·68	N.	6	14 Oct.	0400	29·40	S.	2
	2000	29·85	NNW.	6/7		0800	29·31	S.	2/3
	Midnt	29·95	NNW.	6		1200	29·32	W'N.	3/4
9 Oct.	0400	30·00	WNW.	6/5		1600	29·62	W'S.	7/8
	0800	30·03	W'N.	6		2000	29·87	NW.	7
	1200	30·09	NW.	6		Midnt	30·03	NW'W.	7
	1600	30·12	WNW.	7	15 Oct.	0400	30·12	W'N.	6
	2000	30·18	NW'N.	7		0800	30·19	W.	2/3
	Midnt	30·16	NW'W.	7		1200	30·07	W.	3
10 Oct.	0400	30·16	NW.	6		1600	30·03	SE.	2

The ship left Winisk on 19th October and no ice was sighted on the passage back to Montreal, apart from a few large bergs in Hudson Strait. From Winisk to Cape Chidley the weather was largely overcast and cold with continuous snow flurries and squalls. After passing Cape Chidley on 23rd and until making Belle Isle on 26th, a strong gale with winds of up to force 9 was experienced with high seas and continuous snow. From Belle Isle to Montreal the weather was mainly fine with fog patches on the river at night.

DUNSTABLE'S APPRECIATION OF A DETAILED REPORT FROM A SHIP

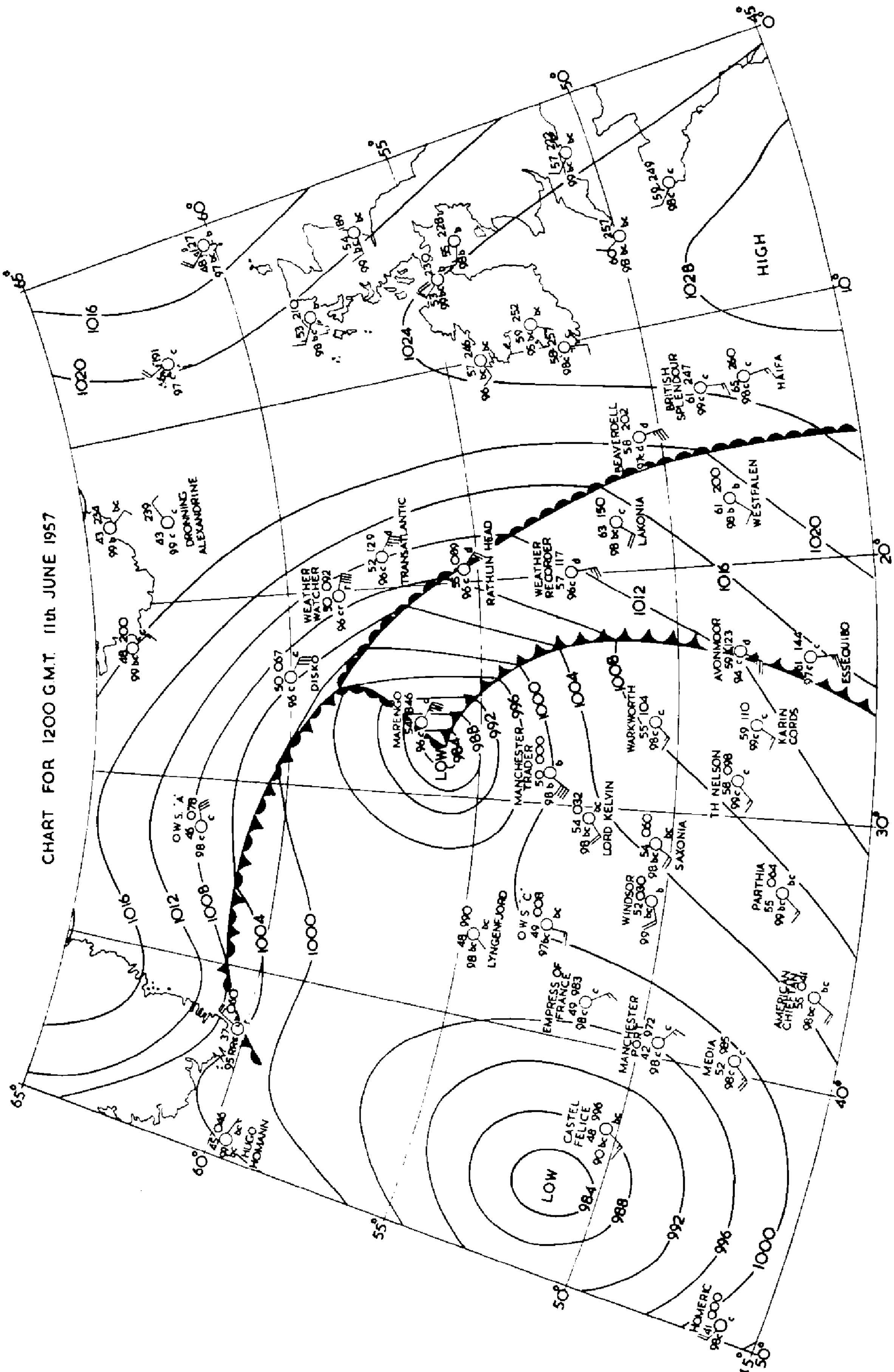
At 0600 G.M.T. on 11th June, 1957, a depression with an estimated central pressure of 994 mb. was situated in the North Atlantic at 55°N., 28°W. and was moving north-northeast. S.S. *Marengo* was 150 miles northeast of the centre and sailing west.

By 1200 the depression should have passed to north of the *Marengo*, but the report from that ship gave a 35-knot wind from east-southeast and a pressure of 984·6 mb. If the report as received was correct the wind direction indicated that the northward speed of the depression was being overestimated; moreover, a slowing down was consistent with the deepening of the system required by the *Marengo's* pressure. Nevertheless, from other considerations the forecaster was in doubt as to whether there was an error which had found its way into the report during transmission, so the 984·6 mb. remained under suspicion.

At 2030 the 1800 report from S.S. *Marengo* had not reached Dunstable, so the forecaster asked the *Weather Watcher*, on station " I ", if it was possible to make contact with her.

Shortly after midnight the *Weather Watcher* passed the following report from S.S. *Marengo*:

> Between 0000 G.M.T. and 1320 G.M.T. wind increasing slowly from southeast barograph falling rapidly from 1015 mbs to 984 mbs stop At 1320 G.M.T. position 56° 55′N., 27° 32′W. wind veering rapidly to southwest and reaching storm force eleven this continued until 1410 G.M.T. when wind veered to west and decreased to force eight stop Barograph meanwhile very unsteady and jumping and visibility greatly affected by driving spray stop Since then barograph rising rapidly to 1002 mbs at 2100 G.M.T. and steadying stop Wind backing to southwest and decreasing —



This detailed picture of the weather sequence left the forecaster in no doubt about the history of what had become the dominant depression on the North Atlantic. On this occasion it so happened that the forecast error resulting from the uncertainty was fairly localised, but there is no knowing how vital a single routine observation may be, particularly of pressure or wind.

To the observer on board ship the forecaster may seem to have been unnecessarily sceptical about the 1200 G.M.T. report from S.S. *Marengo*. What may not be realised is that, particularly on account of errors that develop during transmission, the analyst finds it necessary to check from earlier charts every ship report which is significantly different from what was expected. The first thing he looks for is a 10° error in longitude or latitude, or a 10 mb error in pressure. Such corrections can often be made with a fair degree of certainty but only if consecutive 6-hourly reports are available. Four reports in one day are much more useful than four in two days, because their consistency can be checked and because they give a fairly continuous picture of the weather passing the ship.

C. J. B.

The National Oceanographic Council—Annual Report

The Annual Report of this Council for the year 1st April, 1955, to 31st March, 1956, published by Cambridge University Press, price 5s., gives a detailed account of the work carried out by the National Institute of Oceanography during this period.

The Council's research ship *Discovery II* was fully employed during the year and it is interesting to note that she spent the equivalent of about seven and a half months at sea.

The year's work on marine physics included the analysis of wave records taken by the ocean weather ship *Weather Explorer* which is fitted with a wave recorder, to obtain measurements of swell from hurricanes off the Atlantic coast of the United States of America. Situations were chosen when the swell travelled mostly through areas of light wind after leaving the generating area, and comparison of the measurements with previous results based on wave recordings made off the coast of Cornwall may give further information about the suspected strong dissipation of wave energy by tidal streams and other factors near the coast. Statistical studies of wave records from ocean weather stations I and J, and from the coast of Cornwall and Casablanca, confirm similar work in the United States showing that the distribution of mean or maximum wave height over a whole year is approximately a logarithmic normal error curve* and that nearly the same curve is obtained in several successive years.

The theoretical study of long waves and storm surges taking account of the geostrophic forces due to the rotation of the earth continued. It has been shown that energy from long waves is propagated into what might otherwise be expected to be a " shadow region " behind a barrier which projects polewards into their path. The work may have a bearing on storm surges in the North Sea since it implies that long waves approaching the British Isles from the west can be turned round the north of Scotland. Although the height of the waves travelling southward along the east coast of Scotland and England is expected to decrease rapidly away from the coast, the height along the coast itself may be considerably greater than that of the incident waves in the Atlantic Ocean.

A long-wave recorder has been installed at Newlyn and the records are being studied in relation to local meteorological conditions and the movement of depressions over the deep ocean. The site has been chosen to afford measurements as near the ocean as possible. The gauge has hydraulic filters to filter out tides and ordinary waves, but the recording is electronic and the sea unit can be laid anywhere in moderate depths and connected to the shore by cable. Simpler instruments with mechanical recording are being developed for use in isolated places.

* i.e., the logarithm of the variable is normally distributed about the average value.

Investigation into interchange of energy between ocean and atmosphere has continued. More measurements have been made of wind profile over water, particularly for the study of the effect of air stability. Further useful material has been obtained from observations of wind and current at light-vessels round the British Isles.

Drift cards put out over the eastern North Atlantic in 1954, in connection with investigations into the reasons for oil pollution on the British coasts, are still being returned to the Institute, but now almost entirely from the more distant parts of Scandinavia. The total percentage returned is now 39 per cent.

Five British light-ships are engaged in the continuous measurement of currents: *Varne*, *Smith's Knoll*, *Lynn Well* (Wash), *Kentish Knock* and *Seven Stones*.

The results from *Lynn Well* may have useful application to the problems of coastal flooding.

The following note on water circulation in the ocean is of interest. Although the water movements at great depths in the ocean are usually not faster than several miles a day, they comprise large volumes of water carrying large amounts of heat and dissolved nutrients from one part of the ocean to another. They must be known before the surface currents can be satisfactorily understood, and they are known to exert a marked influence on distribution and abundance of marine plants and animals. A knowledge of the tidal streams in the deep ocean will be very useful to the theory and practice of tides.

The technique of measuring the deep-water movements in the ocean by following floats drifting at predetermined depths, mentioned in the last Annual Report, has proved remarkably successful. The floats have to be less compressible than sea water so that they gain buoyancy as they sink, and it was found that aluminium alloy scaffold tubing has the required mechanical properties and can be made into convenient containers for the electrical circuits and batteries needed to send out the regular sound pulses which give the position of the float. Two lengths of the tubing, each 10 feet long, fastened together give the necessary buoyancy and space.

The original plan was that besides sending out a steady series of pulses the transmitter in the float would respond when it received a signal from the ship's echo-sounder, but the narrowness of the beam of the echo-sounder made searching for the float very difficult and an alternative method had to be used. This was to stop the ship head to wind, and lower two non-directional hydrophones over the side, as far apart as could conveniently be arranged. Pulses from the float are received at different times at the two hydrophones and the magnitude and sign of the time difference measured on an oscilloscope. As the ship's head falls away from the wind direction the time difference decreases to zero when the float is directly on the beam. The process is repeated with the ship in other positions and the intersections of the bearings locate the float in a horizontal plane. The depths of the float can be estimated from the same measurements since the ratio of the maximum time difference (when the ship is head on to the float) to the direct travel time from one of the ship's hydrophones to the other gives the cosine of the angle of depression of the float. To avoid errors in bearings and time differences the hydrophones were kept shallow (about 20 feet) and weighted to prevent the cables from straying too far from the ship's side. The ship's position was determined by radar range and bearing from an anchored dan buoy, and the movement of the dan buoy was checked by sounding over small but recognisable features on the sea bed.

In the section of the report concerning marine biology, the work of Mr. S. G. Brown in endeavouring to obtain a better knowledge of the world-wide distribution of whales and smaller cetacea is mentioned. Much of the information required for this investigation would come from the reports of voluntary observers in merchant ships and other vessels.

A. D. W.

NORSEMAN

Each year we publish in the October number photographs of a present-day observing ship together with those of two of her predecessors of the same name and ownership.

The series is continued opposite page 220 by three ships named *Norseman* belonging to Messrs. Cable & Wireless Ltd. or to two of the companies which were merged into the present organisation in 1929, the Western Brazilian Telegraph Company and the Western Telegraph Company.

Actually, the Company or its predecessors have owned four ships of this name, the first having been built in 1865, but unhappily no photograph of her is available.

Our first photograph, therefore, shows the second *Norseman.* She was built in 1893 and carried the name until 1904 when she was re-named *Norse.* Her only meteorological logbook came to us in February 1899 when she was commanded by Captain J. O. Williams.

Our second picture shows the third *Norseman.* She was an older ship than her predecessor having been built in 1886 and launched with the name *Mirror.* She took the name *Norseman* in 1904 and 20 years later became the hulk *Norna.* She was sold in 1933. We received her first meteorological logbook in 1907 when she was commanded by Captain A. S. Gibb and in the early 1920s she was observing for us whilst working on the Brazilian Cable grounds.

The fourth and present *Norseman*, depicted in the third photograph, was built in 1923. Her first meteorological logbook was received here in July 1924 when she was working off the Brazilian coast under the command of Captain H. O. Barter, and now, 33 years later, she is still sending in regular observations. One of her exploits, that of riding out the hurricane which devastated the town of Kingston, Jamaica, in August 1951, has been recorded at the foot of page 136 of *Meteorology for Mariners.* Her service as an observing ship has not been continuous but she is now, under the command of Captain R. E. Small, one of the oldest ships observing for us.

EXCELLENCE AWARDS TO AUSTRALIAN OBSERVING SHIPS

(This report has been received from the Director of the Australian Bureau of Meteorology)

Following the practice of last year when the first " Excellence Award " was made, the Bureau has, this year, selected three ships for the award as a recognition of the high quality maintained in the making of observations and the regularity in the furnishing of such reports.

The form of award, presented to the ship, in each case consisted of a suitably inscribed framed print of an Australian scene together with a framed citation (see photographs opposite page 221).

The vessels selected to be the recipients of the award were:

M.V. *Charon*	(Alfred Holt & Co.)
M.V. *Asphalion*	(Alfred Holt & Co.)
M.V. *Westralia*	(Huddart Parker Ltd.)

The presentation to *Westralia*, a coastal passenger ship engaged on the Sydney–Fremantle route, was made at Melbourne by Mr. L. J. Dwyer, Director of the Bureau of Meteorology on 12th April, 1957, whilst those to *Charon* and *Asphalion*, Australia–Singapore trade, were made at Fremantle by Mr. G. W. Mackey, Deputy Director, Western Australian Divisional Office.

Although the world fleets of selected ships have varied little over the past year or so it is pleasing to note that the number of reports received by the Australian Service for the year ending 30th June, 1956, showed an increase of approximately 19·5 per cent and this increase shows signs of being maintained for the year ending 30th June, 1957. Such increases can therefore be attributed to a general increase in interest by ships' observing personnel and a greater regularity of reports taken and transmitted.

During the past whaling season the Japanese whaling fleet co-operated extremely well, the number of reports received showing a marked and very substantial increase over previous years. Another fruitful source of reports from Antarctic regions was through ships of various nationalities whilst on voyages connected with the setting up of stations in Antarctica for the International Geophysical Year.

Book Reviews

Middellandse Zee: Oceanografische en Meteorologische Gegevens (The Mediterranean: Oceanographic and Meteorological Data). $11\frac{3}{4}$ in. × $11\frac{1}{2}$ in. pp. xix. + 91. Koninklijk Nederlands Meteorologisch Instituut. Price: 20 Dutch florins.

No other recent marine meteorological atlas has been produced specifically for the Mediterranean and so these monthly charts specially meet the need of anyone making a detailed study of the climate or surface ocean currents of this area. The only recent comprehensive atlases which included the area did so with the representation of this sea as a small adjunct to the North Atlantic or even the whole Atlantic; most of the charts of this area were on so small a scale that they could not be used for an exhaustive study in an area where local variations necessitate more detailed charts than for the open ocean.

The atlas is based on observations by Dutch, British, German and Swedish ships and a few by Israeli vessels. The observations used of hours of fog and precipitation were made by Dutch ships only.

Some of the data in this atlas have been computed for one-degree squares and some for 47 larger areas into which the Mediterranean has been divided, partly on a geographical and partly on an arbitrary basis. The information computed for one-degree squares is vector means of sea-surface currents and winds, mean pressure, mean air and sea-surface temperature, the percentage duration of fog, and the percentage duration of precipitation. The information given for the 47 areas is sea-surface current roses and wind roses; tabulated data and standard deviations of mean air temperature, sea temperature and pressure; tabulated data of duration percentage of fog and precipitation, percentage frequency of gales, mean cloud amount, and mean cloud amounts worked separately for day and night.

The advantage of using such a small basic area as a one-degree square instead of a larger area is that the statistics so obtained are more akin to those for a land station or fixed ship, particularly for those areas where there are strong horizontal gradients of the elements being considered: the use of a one-degree square also has the advantage that if data are required for a large area they can generally be obtained by combining those given for the one-degree squares which the area incorporates. Observations available in each one-degree square are, however, often very few, particularly in the less frequented ocean areas, and in this atlas there are many for which no data are available.

The standard deviations of air and sea-surface temperature as given in this atlas are generally more convenient for scientific use than the 5-percentile maximum and minimum, but the latter (which are used in the United Kingdom marine atlases) doubtless mean more to the average mariner.

Even where isopleths are drawn, it is advantageous for scientific and for operational purposes to print in the actual data on which they are based as is done in this atlas. Not only can this procedure be useful when one has to carry out a study requiring exact values but, by showing the number of observations in each square, it also gives some idea of the confidence that can be placed in the isopleths. This procedure is satisfactory in such a large-scale atlas—but in an atlas of a major ocean, where the scale has necessarily to be much smaller, the printing of both numbers and isopleths is apt to be confusing.

The printing and whole production of this publication is first class, as is always so with Dutch marine atlases. The inclusion of 12 pages of blank overlay maps at the back of the atlas is a new and useful idea. It should be noted when using the charts on fog that the word "mist" is the Dutch for fog and has no connection with the English definition.

The Royal Netherlands Meteorological Institute state their indebtedness to the seamen of the various nationalities who made the observations, and it should not be forgotten that without their aid it would not be possible to produce marine meteorological atlases as we know them. P. R. B.

The Abridged Nautical Almanac for the Year 1958. 11 in. × 7½ in. pp. 276 + xxxv. Her Majesty's Stationery Office, London, 1956. 15s.

The 1958 edition of the *Abridged Nautical Almanac* is the first volume wherein the British nautical almanac and the American nautical almanac become identical in content. It is produced jointly by H.M. Nautical Almanac Office and the Nautical Almanac Office of the U.S. Naval Observatory, although still printed separately in the U.K. and the U.S.A.

Unifying the two former publications has necessitated a number of minor changes in the book. Most of these relate to presentation rather than to content and will be readily apparent to the user, whilst none of them has any effect on the use of the almanac for navigation.

The chief difference from the previous editions lies in the arrangement of three days to an opening instead of one day on each page. The positions of the 57 selected stars are now given at every opening (i.e. every three days) and the main list of 273 stars is given towards the end of the book as previously. The arrangement of the auxiliary tables follows in general the layout of the earlier British volumes, while the daily pages follow more closely the layout of the former American editions. The latter have been reproduced photographically from copy prepared on a card controlled typewriter. British eyes, accustomed to the printers' type used in the Nautical Almanac for many years past, will at first undoubtedly be disturbed at the sight of this unfamiliar type, but a few days' use will bring out its clarity.

In our review of the *Abridged Nautical Almanac*, 1952 (*The Marine Observer*, January 1952), which marked a major change in the presentation of astronomical data to seamen, we mention that the volume was rather bulky and had no stiff cover, both of which faults would be felt by the junior officer working his sights on a wind swept bridge. We are glad to note that the 1958 edition not only has 276 pages as against the 410 in 1952, but is also bound in a very robust fashion. L. B. P.

Mathematics is Easy, by D. S. Watt. 8¾ in. × 6 in. pp. 488. *Illus.* Princes Press Ltd. 48s.

In this rather unusual book the author assumes that the reader has no mathematical knowledge whatever and takes him through elementary geometry, arithmetic, algebra, trigonometry and calculus to the fringes of higher mathematics. In so doing he makes an admirable attempt to justify his choice of title, which is clearly an exaggeration, although it must be mentioned that he frequently points out that hard work is essential if a good working knowledge of the subject is to be acquired.

There is an obvious danger that the type of reader at which the book is primarily aimed will become discouraged as the going inevitably becomes harder towards the middle of the book, particularly as the author has deliberately repeated himself a good deal and made things particularly clear in the earlier chapters. Nevertheless the reviewer is not aware of any similar book on the subject which is likely to carry him so far over such a wide field. To the reader who already has some mathematical knowledge the early chapters may seem a little tiresome but the book may be very useful to him if he wishes to do some rapid revision. It will not only remind him of fundamental ideas which may perhaps have been forgotten or which may have been only partly understood when first learnt at school, but will also refresh his memory on the subject from first principles up to approximately Advanced Level, G.C.E.

There are 80 chapters and an index and the book is well printed and illustrated with clear diagrams. The chapter headings include such subjects as addition, subtraction, decimals, binomial theorem, permutations and combinations, logarithmic theory, determinantal manipulation, basic trigonometry, analytical geometry, the progressions, remainder theorem, differential calculus, and integration. Very few mistakes were noted and the book is quite well bound but somewhat expensive, even for these days, at 48s.

H. C. S.

Exploring the Deep Pacific, by Helen Raitt. $8\frac{3}{4}$ in. × $5\frac{3}{4}$ in. pp. 253. *Illus.* Staples Press, 1957. 18s.

It is not often that a woman has an opportunity (or the wish) to do a voyage in an oceanographical research ship. The author of this book is the wife of one of the senior geophysicists aboard the U.S. Research Ship *Spencer F. Baird* which, in company with the *Horizon*, was engaged on oceanographical research in the central Pacific Ocean.

The author is not a qualified oceanographer; she merely happens to be married to one and to have an inquiring mind and to have a pleasant and easy style of writing. She joins the ship about half way through the voyage in the Tonga Islands and remains aboard throughout the remainder of the voyage which takes the vessel to the Samoan Islands, Palmerston Island, Society Islands and Marquesas Islands and thence to San Diego after a " dog leg " across the Albatross Plateau in about 15°s., 115°w.

The author gives an interesting " laywoman's " description of the various scientific activities aboard this vessel, which was originally a U.S. Navy tug but which was specially fitted up for the oceanographical work, including the fitting of an enormous "A" Frame or gantry on the after deck in order to assist in making coring observations. The scientific work carried out aboard this ship included coring, bottom photography, seismic work, observations beneath the ocean by temperature probe, magnetic measurements, chemistry of water samples and diving with the aid of aqualungs. Much echo sounding work was also carried out.

The author wisely quotes conversations with the scientists and gives extracts from their reports in order to explain the nature and purpose of the observations which are made and she has included an admirable collection of photographs and of drawings and plans which give the non-scientific reader quite a vivid impression of the scope of the expedition. The result, for those who have any interest in the physics and topography of the ocean, is a book that is well worth reading.

C. E. N. F.

A CHAIN OF EVENTS SET IN MOTION BY THE PASSAGE OF A HURRICANE

We print below, by kind permission of the Editor of the *Manchester Guardian*, a letter from a bricklayer in Barbados to his employers.

RESPECTED SIR,

When I got to the building, I found that the hurricane had knocked some bricks off the top. So I rigged up a beam with a pulley at the top of the building and hoisted up a couple of barrels full of bricks. When I had fixed the building, there was a lot of bricks left over. I hoisted the barrel back up again and secured the line at the bottom, and then went up and filled the barrel with extra bricks. Then I went to the bottom and cast off the line. Unfortunately, the barrel of bricks was heavier than I was, and before I knew what was happening the barrel started down, jerking me off the ground. I decided to hang on and halfway up I met the barrel coming down and received a severe blow on the shoulder. I then continued to the top banging my head against the beam and getting my fingers jammed in the pulley. When the barrel hit the ground it bursted its bottom, allowing all the bricks to spill out. I was now heavier than the barrel and so started down again at high speed. Halfway down, I met the barrel coming up and received severe injuries to my shins. When I hit the ground I landed on the bricks, getting several painful cuts from the sharp edges.

At this point I must have lost my presence of mind, because I let go the line. The barrel then came down giving me another heavy blow on the head and putting me in hospital. I respectfully request sick leave.

Personalities

RETIREMENT.—CAPTAIN J. SMITH, R.D., R.N.R., retired from the sea recently after 38 years' service with the Royal Mail Lines.

John Smith was a native of Broughton Ferry and began his career with the Gardiner Line, afterwards serving with the Clan Line. During the latter part of the first war, as a R.N.R. Officer, he commanded a torpedo boat. He joined the Royal Mail Lines in 1919 and received his first command in 1946.

During the 1939–45 war Captain Smith was again with the R.N.R., serving chiefly as Commodore of ocean convoys. For a time he was in the Office of the Naval Assistant to the Second Sea Lord and responsible for the appointment of many R.N.R. officers. After the war he commanded 9 ships including the *Highland Brigade*, *Asturias*, *Andes* and *Alcantara* which were selected ships.

Captain Smith's association with the Meteorological Office goes back to 1934, when he was an officer in the *Atlantis*, and he subsequently observed for us in 11 separate years.

We wish him health and happiness in his retirement. L. B. P.

RETIREMENT.—CAPTAIN G. C. STEELE, V.C., R.N.R., retired from the position of Captain Superintendent of H.M.S. *Worcester* in July 1957.

Gordon Charles Steele was a Cadet in H.M.S. *Worcester* from 1905–1907 and was runner-up for the Gold Medal presented by King Edward VII. He joined the P. & O. Line and was appointed midshipman R.N.R. in 1909. During the 1914–18 war he served in submarines and Q ships and was transferred to the Royal Navy for distinguished service in 1915. He was at the Battle of Jutland and in 1917 and 1918 commanded H.M. ships *P.* 63 and *Cornflower*.

As a Lieutenant he took part in the landing on Kronstadt Harbour in August 1919 and won the Victoria Cross in this action. He retired from the Royal Navy in 1923 and was appointed Captain Superintendent of H.M.S. *Worcester* in 1929. During the second world war he was recalled and served as Inspector of Anti-Submarine equipment. After the war he returned to H.M.S. *Worcester* and was appointed a Honorary Captain R.N.R. in November 1949.

Captain Steele always took a keen interest in the meteorological instruction of the Cadets in H.M.S. *Worcester* and the meteorological logbook has been regularly kept there for a number of years. Much of the efficiency of the present voluntary observing fleet is no doubt due to this early training.

We wish him health and happiness in his retirement. L. B. P.

OBITUARY.—We regret to record the sudden death of CAPTAIN W. P. BAKER which took place shortly before his ship, the *Planter*, left Liverpool in November 1956.

William Pitt Baker was born in London in October 1902 and served his time with Messrs. Rankin Gilmour and Co., with whom he stayed as 3rd Officer for some time after he obtained his second mates certificate. He joined Messrs. T. & J. Harrison's as 3rd Officer of the *Chancellor* in December 1924 when Rankin Gilmours was absorbed into that company. He was promoted to 2nd Officer in January 1929, chief officer in November 1939 and was given his first command, the *Tribesman*, in August 1951.

Captain Baker was one of our more senior observers and the year of his death was the fifteenth in which he had sent observations to us. His first logbook came in May 1923 when he was 3rd Officer of the *St. Patrick*, and in all he had sent us 29 books, 9 of which had been classed excellent. L. B. P.

OBITUARY.—It is with regret that we learn of the death of CAPTAIN EDWARD GOUGH, O.B.E., master of the *Clan Mactavish.*

Captain Gough began his seafaring career with the Houston Line, subsequently absorbed into the Clan Line group, as an apprentice in 1915, and served in many of the company's vessels. He was torpedoed once during the 1914-18 war. He was appointed to his first command, *Clan Ogilvy*, in 1940. A year later this vessel was lost through enemy action and Captain Gough was picked up after being adrift in a lifeboat for 14 days. Before reaching home he was torpedoed twice again, and both the *Clan Skene* and the *Clan Macpherson* which he subsequently commanded were lost through torpedo attack. For his war services Captain Gough was made an O.B.E. and was mentioned in dispatches. In 1953 he was awarded the Coronation Medal.

Captain Gough's association with the Meteorological Office goes back to 1932 when in the *Clan Keith* and from 1952 onwards when in command of the *Clan Mactavish.* J. C. M.

Notices to Marine Observers

Ships' Radio Weather Messages in the Dakar Area

In order to meet a requirement of the search and rescue service operating from Dakar, the centre for the collection of ships' radio weather messages in that area, (FGA—see *Marine Observer's Guide*, page IV—7,) has requested that observing ships shall include in their reports a group indicating their course and speed.

Selected ships already satisfy this requirement by the group $D_s v_s$app. Supplementary ships and " auxiliary " observing ships when in the Dakar area are now requested to include in their messages the group $D_s v_s$xxx in accordance with the provision of M.O.509 (Decode for the use of shipping) page 2, lines 30-34, beginning " The group ($D_s v_s$xxx)............................."

Form 2451, Weather Forecasts and Warnings for Coastwise Shipping and Fishing

Some marine observers may not yet have come across this handy-sized pamphlet. We give a summary of its contents here, in view of its potential value to the seaman in home waters.

1. **Gale Warnings.** Details are given of warnings issued by W/T and R/T from G.P.O. coastal radio stations; warnings issued by the B.B.C.; and visual signals which are hoisted at coastguard stations and other places.

2. **B.B.C. Broadcasts.** Details are given of the contents of the shipping bulletins which are broadcast on 1500 m.

3. **Weather Bulletins for Shipping.** This section includes tables which give details (including the weather forecast and gale warning area for each station), of coastal radio stations which broadcast weather forecasts on W/T and R/T.

4. **Special Forecasts for Shipping.** This advises masters of ships at sea, ships about to sail, and others who may be interested, on how to obtain special weather forecasts for a specified area.

5. **Local Weather Forecasts.** This consists of a list of forecast centres which are near ports, and gives their addresses and telephone numbers.

6. **Reports of Present Weather.** There is a list of coastal stations from which reports of present weather may be obtained.

7. List of Port Meteorological Officers and Merchant Navy Agents in the United Kingdom.

Copies of Form 2451 may be obtained free from any Port Meteorological Officer or Merchant Navy Agent or on application to the Director, Meteorological Office M.O.1, Headstone Drive, Harrow, Middlesex.

NAUTICAL OFFICERS AND AGENTS OF THE MARINE DIVISION OF THE METEOROLOGICAL OFFICE, GREAT BRITAIN

Headquarters.—Commander C. E. N. Frankcom, O.B.E., R.D., R.N.R., Marine Superintendent, Meteorological Office, Air Ministry, Headstone Drive, Harrow, Middlesex. (Telephone: Harrow 4331, Ext. 324.)

Captain A. D. White, R.D., Lt.-Cdr. R.N.R., Deputy Marine Superintendent. (Telephone: Harrow 4331, Ext. 323.)

Lieut.-Commander L. B. Philpott, D.S.C., R.D., R.N.R., Nautical Officer. (Telephone: Harrow 4331, Ext. 31.)

Mersey.—Captain J. R. Radley, Port Meteorological Officer, Room 709, Royal Liver Building, Liverpool 3. (Telephone: Central 6565.)

Thames.—Mr. J. C. Matheson, Master Mariner, Port Meteorological Officer, Room 1, Second Floor, Adelaide House, London Bridge, London, E.C.4. (Telephone: Mincing Lane 8232.)

Bristol Channel.—Captain F. G. C. Jones, Port Meteorological Officer, 2 Bute Crescent, Cardiff. (Telephone: Cardiff, 21423.)

Southampton.—Lieut.-Commander E. R. Pullan, R.D., R.N.R., Port Meteorological Officer, 59 Berth, Old Docks, Southampton. (Telephone: Southampton 24295.)

Clyde.—Captain R. Reid, Port Meteorological Officer, 136 Renfield Street, Glasgow. (Telephone: Glasgow Douglas 2174.)

Forth.—Captain G. N. Jenkins, "Fairwind", Kings Road, Longniddry, East Lothian. (Telephone: Longniddry 3138.)

Humber.—Lieut.-Commander W. H. Carr, R.N.R., c/o Principal Officer, Ministry of Transport, Trinity House Yard, Hull. (Telephone: Hull 36813.)

Tyne.—Captain P. R. Legg, c/o F. B. West & Co., Custom House Chambers, Quayside, Newcastle upon Tyne. (Telephone: Newcastle 23203.)

RADIO WEATHER MESSAGES

The master of any ship which experiences frequent difficulties in clearing radio weather messages to coast radio stations in any part of the world is requested to make a note in the ship's meteorological logbook, mentioning the time and date of the occurrence and to give any other information which it is thought might be helpful. The complaint will then be forwarded by the Meteorological Office to the Director of the Meteorological Service to which the message was addressed, with a view to the circumstances being investigated and of improving if possible the reception conditions at the radio station concerned.

It is only by receiving reports of this nature that we are able to know of the difficulties the radio officers aboard the selected ships experience in this respect. On receipt of all such reports we will do our best to rectify matters. Generalised reports merely stating that difficulty was experienced from time to time in clearing a message to such-and-such a station are not sufficiently explicit to enable us to take remedial action.

ERRATUM

The Marine Observer, July 1957, page 157. Under **Data**, para. 4, line 6:
For " 40 sightings of large whales " *read* " 140 sightings of large whales ".

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Meteorological Office (Marine Division) Atlases

The following are published by the Marine Division of the Meteorological Office and may be purchased from the bookshops of Her Majesty's Stationery Office at any of the addresses on the title page. Copies are available for reference by shipmasters and shipowners in the offices of Port Meteorological Officers.

Meteorological Atlases

Monthly Meteorological Charts of the Atlantic Ocean. M.O.483, 1948. (60°S–70°N, 80°W–40°E) *Reprinting*

Monthly Meteorological Charts of the Western Pacific. M.O.484, 1956. (60°S–60°N, 100°E–155°W) (16¾″ × 23¾″) 105*s*. (post 2*s*. 9*d*.)

Monthly Meteorological Charts of the Eastern Pacific. M.O.518, 1956. (60°S–60°N, 160°W–60°W) (17½″ × 24½″) 147*s*. (post 3*s*. 3*d*.)

Monthly Meteorological Charts of the Indian Ocean. M.O.519, 1949. (50°S–30°N, 20°W–120°W) (16½″ × 22½″) 63*s*. (post 1*s*. 9*d*.)
The above four atlases contain monthly charts of wind, barometric pressure, air and sea temperature, and all meteorological elements including some typical tracks of tropical revolving storms.

Monthly Sea Surface Temperatures and Surface Current Circulation of the Japan Sea and Adjacent Waters. M.O.M.447, 1944. (20°N–47°N, 110°E–150°E) (20″ × 17″) 7*s*. 6*d*. (post 8*d*.)

Monthly Sea Surface Temperatures of Australian and New Zealand Waters. M.O. 516, 1949. (50°S–10°S, 100°E–180°) (19¾″ × 12¼″) 10*s*. (post 6*d*.)

Monthly Sea Surface Temperature of the North Atlantic. M.O.527, 1949. (30°N–68°N, 80°W–15°E) (19¾″ × 12¼″) 10*s*. (post 6*d*.)

Monthly Meteorological Charts and Sea Surface Current Chart of the Greenland and Barents Seas. M.O.575. (60°N–80°N, 30°W–120°E) *In the press*
This atlas contains a generalised surface current chart for the area and monthly charts of wind, barometric pressure, air and sea temperature, and all meteorological elements.

Current Atlases

Currents of the Indian Ocean. M.O.392, 1939. (50°S–30°N, 20°E–140°E) (30″ × 20″) 10*s*. (post 6*d*.)

South Pacific Ocean Currents. M.O. 435, 1938. (60°S–0°, 140°E–70°W) (22″ × 34″) 10*s*. (post 1*s*.)

The above two atlases contain quarterly " current arrow " and " current rose " charts.

Quarterly Surface Current Charts of the Atlantic Ocean. M.O.466, 1945. (60°S–70°N, 80°W–20°E) (22½″ × 18″) 21*s*. (post 1*s*. 9*d*.)

Quarterly Surface Current Charts of the Western North Pacific Ocean with monthly chartlets of the China Seas. M.O.485, 1949. (0°–60°N, 98°E–160°W) (21″ × 16″) 25*s*. (post 10*d*.)
The above two atlases contain current rose charts, predominant current charts, and vector mean current charts.

Ice Atlases

Monthly Ice Charts of the Arctic Seas. M.O.M.390a, 1944. (60°N–80°N, 80°W–110°E) (12″ × 7″) 3*s*. 6*d*. (post 4*d*.)
Polar ice, mean limits of sea ice, extreme limits of sea ice, extreme limits of bergs.

Monthly Ice Charts of Western North Atlantic. M.O.478, 1944. (37°N–53°N, 72°W–35°W) (12″ × 7½″) 4*s*. (post 6*d*.)
Mean limits of pack, extreme limits of pack, mean limits of bergs, extreme limits of bergs.

Her Majesty's Stationery Office

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