Of the promontories above mentioned, the one which extends towards the west is a lofty mountain rising precipitously from the sea on the N.E. and S.W., and terminating in two peaks. Between these two peaks a glacier descends to the edge of the cliff overhanging the sea on the north-east side, over which the ice-masses fall with a thundering noise. The other promontory or peninsula is covered by a flow of very recent lava, the eddies and ripples on the surface being still quite fresh. This stream of lava proceeds from the base of a recent but much dilapidated crater, which having sprung up close to the sea could only have been preserved by renewing its substance with constant eruption. When this ceased, the degrading action of the waves began to tell; and at present it is worn into a group of fantastic-looking peaks, the vertical sides of which are marked by the layers of scoriæ dipping away from the centre. The lava-stream covers the whole of the peninsula, and from having been worn by the waves it forms a range of low black cliffs along the north side of Corinthian Bay. In the face of these cliffs many large cavities, bubbles in the once molten lava, had been opened, and were tenanted by the nesting Cape pigeon.

The glaciers which cover the whole of the southern side of Corinthian Bay have been prevented from encroaching on the beach at the head of it by a sharp conical hill of scoriæ, behind which the ice-covering stretches from sea to sea.

H.M.S. 'Challenger,'
December, 1875.

[The Tables which accompany this paper are preserved for reference in the Society's Archives.—Sec. R.S.]

VII. "Report to the Hydrographer of the Admiralty on the Voyage of the 'Challenger' from the Falkland Islands to Monte Video, and a Position in lat. 32° 24′ S., long. 13° 5′ W." By Prof. Wyville Thomson, F.R.S., Director of the Civilian Scientific Staff on board. Received May 5, 1876. Read June 15.

[Plates 25–33.]

H.M.S. 'Challenger,'
Ascension, March 1876.

Sir,—I have the honour to report that we left Stanley Harbour in East-Falkland Island for Monte Video on the afternoon of the 6th of February, and on the 8th we sounded in lat. 48° 37′ S., long. 55° 17′ W., about 200 miles to the N.E. of Stanley, in a depth of 1035 fathoms. The trawl was lowered, but it was unfortunately carried away, after the weights, which were at a distance of 300 fathoms in advance of the trawl, had been brought in board. The rope looked much chafed, as if it had been ground against rocks. The sounding-machine brought up no sample of the

bottom; but a tow-net attached to the dredge-rope at the weights contained a little gravel and one or two small organisms. The bottom-temperature was 1°·7 C.

The following day was fine, with light uncertain winds; on the 10th it was blowing half a gale and the sea was running too high for sounding-operations. On the 11th the weather was fine, the wind becoming more moderate towards noon; at 10 A.M. we sounded and put down the trawl in 2040 fathoms, with a bottom of bluish mud containing many *Globigerinæ*, and a bottom-temperature of +0°·3 C. The position of the sounding was lat. 42° 32′ S., long. 56° 27′ W., about 200 miles to the eastward of Valdes Peninsula. Temperature-soundings were taken down to 1500 fathoms (Curve 318, Plate 27). This sounding gives a singularly rapid fall from 14°·2 on the surface to 2° C. at 125 fathoms; the edge of the Antarctic indraught appeared to be pushed up against the American shore by the western border of the southern branch of the reflux of the equatorial current, as the Labrador current is banked up by its northern branch, the result being no doubt increased in both cases by the flinging up of the polar water against the western land-barrier on account of its low initial velocity.

On the 12th we sounded in 2425 fathoms, and took a series of temperatures; the upper temperatures were decidedly higher than they were the day before, 5° occurring at 125 fathoms, 2°·5 at 700, and 2° C. at 1100 fathoms. The position of the sounding was lat. 41° 54′ S., long. 54° 46′ W.; it was nearly double the distance of the previous sounding from the 100-fathom line, which here nearly corresponds with a steep submarine cliff of great height. The bottom-temperature was −0°·4 C. (Curve 319, Plate 27). On the 14th we sounded in 600 fathoms on the plateau extending from the South-American coast, opposite the estuary of the River Plate, 144 miles from Lobos Island. We took a set of temperatures to the bottom, and found the gradation, so far as it went, much the same as the day before; the bottom-temperature was 2°·7 C. On this occasion the trawl was most successful, and gave us a very fair idea of the fauna of moderate depths along the coast; probably not fewer than sixty species of different groups were recovered, including a very handsome *Pennatula* between two and three feet in height, some deep-sea corals of very special interest, which are being worked up by Mr. Moseley, and some fine Echinoderms and sponges. On the 15th we anchored in Monte-Video Roads.

We left the anchorage at Monte Video at daybreak on the 25th of February, and after swinging ship for errors of the compasses, we proceeded down the estuary. In the afternoon the trawl was put down in thirteen fathoms to get an idea of the fauna of the brackish water. The species procured were comparatively few; but among them was a plentiful supply of an interesting Alcyonarian Cœlenterate of the genus *Renilla*, which was new to us. On the two following days we crossed

the shallow-water plateau, and on the 28th we sounded and trawled in 1900 fathoms over the ledge. A serial temperature-sounding gave a bottom-temperature of 0°·0 C., 1°·0 at 1725 fathoms, 3°·0 at 600 fathoms, and 20° at 50 fathoms (Curve 323, Plate 29). The trawl was not very successful, but it brought up a few things of some interest; among them an example of a small sea-urchin, of which we had previously taken single specimens at widely distant stations, off the coast of Nova Scotia, near Gomera Island, near New Zealand, and near Japan. The bottom was chiefly river-mud with very little carbonate of lime.

On the following day we sounded in 2800 fathoms, and again lowered the trawl. The bottom was a greyish mud, with little or no carbonate of lime, and the bottom-temperature was −0°·4 C. The trawl-line parted near the ship in heaving in.

On the 1st of March we proceeded on our course, and on the 2nd we sounded in 2650 fathoms, with a bottom of grey mud and a bottom-temperature of 0°·4 C. The trawl was put over, and a series of temperature observations was taken to 1500 fathoms. (Curve No. 325, Plate 29.) This sounding is very instructive; the isothermobath of 3° C. is found at 600 fathoms, so that we have a mass of water at a lower temperature 2000 fathoms in thickness; 2°·5 C. occurs at 1900 fathoms, and zero at 2400. The very marked hump of the curve extending from a depth of 125 fathoms to a depth of 255, and corresponding with the wide spaces between the isothermobaths of 15° C. and 6° C. on Plate 28, evidently indicates the position and volume of the Brazil current, the southern deflection of the equatorial current after its bifurcation at Cape St. Roque. The trawl came up containing an unusually large number of organisms for this depth, including two specimens of an undescribed species of *Euplectella*, some corals, several Echinoderms illustrating three of the orders, some beautiful examples of a species of *Stylifer* commensal on one of the Holothurians, and several fishes.

Next day we sounded in 2775 fathoms, and took temperature-soundings. This series (Curve 326, Plate 29) presented a marked difference from that of the previous day. All the lines from that of 1°·5 C. had risen most palpably, most of them between 100 and 200 fathoms. Even the surface participated in the fall of temperature, having sunk from 21°·6 C. to 19°·9. This is evidently a space in the Brazil current occupied by colder water, like the peculiar cold interdigitations which are so marked in the Gulf-stream. The position of this sounding was lat. 37° 3′ S., long. 44° 17′ W. A serial temperature-sounding on the following day, at a distance of 80 miles to the eastward, where the depth was 2900 fathoms and the bottom-temperature −0°·3 C., showed by the sinking of all the isothermobaths that we had again entered the normal flow of the Brazil current.

On the 6th of March it was blowing hard from the S.W. with a heavy sea. We sounded in 2900 fathoms, with a bottom of grey mud and a bottom-

temperature of $-0^{\circ}\cdot3$ C.; but the weather was too boisterous to admit of a serial temperature-sounding. On the 7th the sea was more moderate, and we sounded in 2675 fathoms, with a bottom-temperature of $-0^{\circ}\cdot6$ C., and took the temperature series represented by Curve 329 (Plate 30). The bottom was again a very fine grey or slightly reddish mud, almost free from calcic carbonate; samples of water were obtained for specific-gravity determinations and analysis down to 2000 fathoms.

On the 8th of March we sounded in 2440 fathoms, with a bottom of light red mud, and a bottom-temperature of $-0^{\circ}\cdot3$ C.; and on the 9th, somewhat to our surprise, we sounded in 1715 fathoms, with a bottom of "*Globigerina*-ooze" and a temperature of $1^{\circ}\cdot3$ C. The sea was heavy, and trawling-operations were consequently rather difficult; the trawl was lowered, however, on account of the remarkable shallowness of the sounding; but it unfortunately came up foul, and the observation was lost.

It seems that this sounding was on the central meridional rise which separates the western from the eastern trough of the Atlantic at a depth apparently nowhere much beyond 2000 fathoms, near its western edge. As usual, the lower isothermobathic lines showed a tendency to rise slightly in the shallower water.

On the 10th the morning was misty and raining, with the wind northerly, shifting to the southward towards noon. We sounded in 2200 fathoms, "*Globigerina*-ooze," with a bottom-temperature of $+0^{\circ}\cdot4$ C. The trawl was put over; but on being recovered, it was found to have been down on its back, and it contained only a few fragments of one or two sponges, Crustaceans, and Echinoderms.

We ran on during the 11th and 12th, and on the 13th we sounded on "*Globigerina*-ooze" at a depth of 2025 fathoms, with a bottom-temperature of $1^{\circ}\cdot2$ C. The trawl again came up empty and reversed, some fragments adhering to the net, showing that there was a varied fauna, and that much interesting material must have been got from a successful haul.

The position of the sounding on the 14th was lat. 35° 45′ S., long. 18° 3′ W.; the depth was 1915 fathoms, the bottom "*Globigerina*-ooze," and the bottom-temperature $1^{\circ}\cdot5$ C., the distance from Tristan d'Acunha 310 miles. The trawl came up again foul, with only some fragments to indicate the presence of an abundant fauna. As we had already crossed our outward track in 1873, and as the temperatures at depths uninfluenced by the changes of the seasons seemed to verify in every way our former work, we thought it unnecessary to go further to the eastward on the direct line, and we took a north-easterly course towards a point in the meridian of the Island of Ascension, which was distant from us about 1685 miles.

We ran on next day, and on the 16th the position of the ship was lat. 32° 24′ S., long. 13° 5′ W., 1470 miles almost due south of Ascension, and 280 miles north by west of Tristan d'Acunha.

We sounded in 1425 fathoms on "*Globigerina*-ooze," with a bottom-temperature of 2°·3 C. The trawl had failed so frequently of late, that we determined to send down instead a large light dredge, which we had had made at Hong-Kong for the shallow-water sponge-producing seas of the Philippines. It came up with scarcely any ooze, and with only a small number of animal species; but among them were many very perfect specimens of the rare little sea-urchin, *Salenia varispina.* It is singular that although there were a large number of hempen tangles attached to the dredge, and they seemed to have done their work well, none of the Bryozoa so characteristic of moderate depths, with a bottom of "*Globigerina*-ooze," in the Atlantic were taken on this occasion. In the evening we made sail due north.

This portion of the voyage divides itself into two parts with very different conditions—the nearly meridional passage from the Falkland Islands to Monte Video, a distance of 1100 miles; and the line from Monte Video to Station 335, a little to the south of the parallel of 35° S. for a distance of 2100 miles.

Between Stanley and Monte Video four observing-stations were established, numbered on the charts and diagrams from 317 to 320. Two of these were in comparatively shallow water near the edge of, but still upon, the plateau which extends from the coast of South America to a distance of nearly 400 miles, and includes the Falkland Islands; the two remaining soundings, 318 and 319, were well beyond the cliff of the plateau at depths greater than 2000 fathoms. The shallow-water soundings were upon hard ground; in the two others the bottom was a greyish mud, to a great extent composed of land detritus. All these soundings, the two deep ones particularly, indicate the presence of a great underlying mass of cold water, the isothermobath of 2° C. occurring at Station 318 at a depth of 125 fathoms. At Station 319 the 2°-C. line is at 1100 fathoms, and the other isothermobaths up to 5° C. show a corresponding rise. I attribute this remarkable difference between two soundings so near one another to the banking of the cold water against the submarine cliff by the Brazil current; sounding 118 seems to have fallen directly upon the "cold wall."

At the deeper sounding (319) the thermometer fell, for the first time in our experience in the South Atlantic, below the freezing-point; but the relations of this very low bottom-temperature will be better understood when we come to consider the section between Monte Video and Tristan d'Acunha.

On the line between Monte Video and Station 335, fifteen observing-stations were established. The first three of these, 321 to 323, were on the estuary of the River Plate, or (323) just beyond the edge of the delta at its mouth; the next seven, 324 to 330, gave a section of a wide inlet into the western trough of the South Atlantic with a mean depth of 2750 fathoms; and the remaining five stations, 331 to 335, were on the

central rise, with an average depth of 1850 fathoms. The mean bottom-temperature of the seven deep soundings is $-0^\circ\!\cdot\!4$ C., and that of the five soundings on the rise $1^\circ\!\cdot\!3$ C.; the isothermobath of $0^\circ\!\cdot\!0$ C. is at a depth averaging 2400 fathoms, a depth which it never much exceeds except where the cold water rises against the American coast, as at Stations 319 and 323; it therefore occurs in the line of the seven deep soundings only; and there it forms the upper limit of a mass of water with a temperature below zero, 320 square miles in section. Perhaps the isothermobath of $1^\circ\!\cdot\!5$ C. may fairly be taken as the upper limit of the very cold water; the section of the Antarctic indraught below that temperature is here about 800 square miles. (The transverse section of the Gulf-stream is about 6 square miles; there is no volume of water at all in the Labrador current below $1^\circ\!\cdot\!5$ C. opposite Halifax, that temperature being only found at the bottom.)

The isothermobaths of 2°, $2^\circ\!\cdot\!5$, 3°, and 4° C. are very constant at 1500, 900, 600, and 400 fathoms respectively for all the stations on the parallel except Station 323 on the "cold wall," where all the lower temperature-lines are at a much higher level, and at the shallow sounding at Station 331, where all the lines below that of 4° C. rise slightly. We must be careful, however, not to attach too much importance to slight deviations of the colder lines. On the scale used in Plates 26, 28, 32, and 33, the mean interval between the isothermobaths of 2° and 3° C. in the Atlantic is 1000 fathoms; so that a rise or fall of 100 fathoms, which is very prominent on such diagrams, actually represents only one tenth of a Centigrade degree, an amount very small in itself, and, it must be remembered, entirely within the limit of error of observation with a deep-sea thermometer; it is only where there is a concordance among several lines in such a rise or fall that the indication is of any real value.

The mean temperature of the surface of the water at the anchorage at Monte Video was $22^\circ\!\cdot\!5$ C.; at Station 320, just before entering the estuary, it was $19^\circ\!\cdot\!7$ C.; at Station 323, on the edge of the plateau, it rose to 23°; and a temperature of 20° C. or a little above it was maintained up to Station 328, except at Station 326, which I have already referred to as occupying a cold space. After reaching Station 328 the temperature began to sink, and only recovered its former height when we moved northwards.

The curves deduced from the serial temperature-soundings along this line are represented in groups of four on Plates 29, 30, & 31. At Station 323 the temperature of the water fell rapidly and tolerably evenly, with only a slight prominence between 150 and 250 fathoms, to 5° C. at 350 fathoms; it then took a slower, but still a symmetrical sweep down to zero at 1900 fathoms. At Stations 324 and 325 the lines fell, with still only a slight protuberance in the same position as before, to 3° C. at 600 fathoms, when they sank very slowly to 1° C. at 2000 fathoms, and then

again a little more rapidly to $-0^{\circ}\cdot4$ at the bottom. At the next Station (326) all the upper temperatures were remarkably low, corresponding with the cold "interdigitation" in the Brazil current. Stations 328 and 329 repeat Stations 324 and 325 with little variation; at the three Stations 330, 331, and 332 there was a most marked hump on the curves, occupying roughly the space between 150 and 250 fathoms; and at the three succeeding stations, 333, 334, aud 335, the hump wore out and finally disappeared.

The high surface-temperatures between the mouth of the River Plate and Station 328 are doubtless due to solar radiation (early autumn temperature) *plus* the additional warmth of the Brazil current, which is logged from the 29th of February to the 10th of March as running in a generally southerly direction at an average rate of 20 miles a day. The rapid fall for the first 150 fathoms represents mainly the loss of the heat due to direct radiation, which does not affect the curve to a depth much greater than 100 fathoms; and the hump from 150 to 250 fathoms represents the extra effect of the current, which appears to have there an average depth of 250 fathoms; it seems, however, not to be very constant, either in volume, direction, or rate.

To recapitulate briefly the more important points with regard to the distribution of temperature:—

1. The section between Monte Video and the meridian of Tristan d'Acunha includes, besides the soundings on the South-American plateau and the sounding on the "cold wall," a series of soundings in a western trough with an average depth of 2750 fathoms and an average bottom-temperature of $-0^{\circ}\cdot4$ C.; and a series of soundings on the middle bank of the Atlantic, with an average depth of 1850 fathoms and a mean bottom-temperature of $1^{\circ}\cdot3$ C.

2. In the trough a huge mass of Antarctic water at temperatures ranging from $1^{\circ}\cdot5$ C. to $-0^{\circ}\cdot6$ C. is creeping northwards at depths greater than 1800 fathoms; on the rise very little water at a lower temperature than $1^{\circ}\cdot5$ C. passes northward; but that is only on account of the absence of the required depth, for the isothermobaths of $1^{\circ}\cdot5$ and 2° C. are practically at the same level over the central plateau and over the trough.

3. On the surface a warm current, perhaps about 800 miles wide, and affecting the temperature of the water to a depth of 250 fathoms, continuous to the northward with the southerly deflection of a part of the equatorial current, passes to the southward, taking a slightly easterly direction on account of its higher initial velocity.

4. As a rule, the temperature falls rapidly throughout the section to a temperature of 3° C. at 600 fathoms, and then extremely slowly to the bottom.

We had always attached special importance to the temperature-soundings on this section, for we had expected them to throw some additional

light upon the observations taken in the West Atlantic in the year 1873. These seemed at first sight to present certain anomalies; thus in our somewhat hurried run from Bahia to Tristan d'Acunha, we appeared to have missed the source of supply of water at an unusually low temperature which we found near the island of Fernando Noronha. The result has fully justified our anticipations.

Diagram A, Plate 32, represents the vertical distribution of temperature at Station 112, lat. 3° 33′ S., long. 32° 16′ W., 21 miles to the N.E. of Fernando Noronha. Diagram B gives the temperatures at Station 129, lat. 20° 12′ S., long. 35° 19′ W., nearly halfway between A and C, which represents the distribution of temperature at Station 327, one of the most characteristic in the section at present under consideration. The depth at Station 327 is 2900 fathoms, and the depths at the two other stations 2150 and 2200 respectively; and it will be seen that at the latter stations the bottom-temperatures correspond almost precisely with the temperature at Station 327 at like depths. The isothermobath of 2° C. is at the same height, 1500 fathoms, at the two southern stations; and at the northern station only, near the equator, it sinks to 1800 fathoms. The isothermobaths of 2°·5 and 3° C. correspond almost exactly in level at Stations B and C; at Station A all the isothermobathic lines under that of 4° C. down to the line of 1° C. are much lower than at Stations B and C; that is to say, that at the equator between 4° C. and 1° C. the water is considerably warmer than it is further south. The isothermobathic lines of 4° and 5° C. seem everywhere in the Atlantic to mark broadly the line of demarcation between the upper zone, where the temperatures are obviously affected by the diffusion of water by wind-currents, and the lower zone, where the temperatures are continuous with those of the Southern Sea. In the North Atlantic they are markedly lower than they are to the south of the equator; that is to say, there is a much larger body of water above them heated by conduction, convection, and mixture.

I have given in Plate 33 a general diagrammatic scheme of the vertical distribution of temperature in the western trough of the Atlantic, constructed from our serial temperature-soundings in the years 1873 and 1876. The diagram extends from lat. 42° S. to lat. 42° N., and includes as its southern limit the banking up of the Antarctic indraught against the South-American coast, and as its northern the "cold wall" of the Labrador current. This Plate seems scarcely to require much comment; but there are one or two points to which I would wish to direct attention.

At Station 327, so often referred to as a typical sounding on our present line, there is a mass of water 400 fathoms thick at a temperature below zero. Station 131, 600 miles south of Martin Vas, is on the edge of the central plateau, with a depth of 2275 fathoms and a bottom-temperature of 0°·7 C.; the deep passage therefore probably lies, if it have not

already come to an end, between long. 28°·9 W. and the coast of America.

The distribution of the lower temperatures is much the same at station 131 as it is at station 327, the isothermobaths sinking slightly. At station 129, which is right in the middle of what may be supposed to be the direction of the current, the depth is 2150 fathoms, and the temperature 0·6 C.; the cold-water trough has therefore probably stopped before reaching this point; all the belts of water at given low temperatures are evidently continuous, although the isothermobaths of 3° C. and 2°·5 C. are now sinking rapidly. The accumulation of water above 3° C. in temperature is still more apparent at Station 112, nearly under the equator.

The next station, No. 15, is the first of a series of rather deep soundings taken after crossing the "Dolphin Rise" (the central bank of the Atlantic) on our voyage from Teneriffe to Sombrero in 1873. The deepest of these soundings are a little above 3000 fathoms; and they look from their position very much as if they were in the axis of the Antarctic indraught; but the temperature in no case falls below 1°·3 C.; and, tracing southwards, we find that a belt of shallow soundings (not more than 2000 fathoms) extends from the central plateau about lat. 21° N., long. 46° 30′ W., to the coast of South America, somewhere about Cape Orange. Going northwards, we encounter much greater depths, but no temperatures lower than 1°·3 C.; the whole mass of water to the very bottom rises steadily, though only slightly, to the northward, the merely local depression, which never reaches 1°·3 C. along the line of the Labrador current, being scarcely worth mention. It is evident that the water of the Atlantic is not generally affected by an indraught from the Arctic Sea. The diagram (Plate 33) shows very well the effect on the relative positions of the isothermobathic lines of the rapid removal of the warm surface-water over the region of the equatorial current and counter-current in the gathering up of the higher lines near the equator, and of the curl of the warm water to the north and south as the Gulf-stream and the Brazil current after the bifurcation of the equatorial current, in the depression of the isothermobaths of 20°, 15°, and 10° C. to the north and south of the equatorial region.

The causes of the very perceptible rise in temperature of the whole mass of the water of the North Atlantic will require further investigation. As I have said elsewhere, I am inclined to attribute it mainly to the banking in and accumulation of the northern reflux of the equatorial current, and its gradual mixture with the water beneath; and it seems to me that this cause is adequate to the effect. Still, even if this be so, we have to discover how that mixture takes place; and as there appears reason to believe that evaporation is in excess of precipitation in the Atlantic, it seems almost certain that differences in specific gravity and

other causes come into play, though not very obviously. It is most probably a phenomenon of considerable complexity.

I will not refer to the thermal conditions of the eastern trough of the Atlantic at present; they are somewhat different, and will require separate illustrations after we have recrossed the basin, which we hope to do in the next six weeks.

To recapitulate the general facts and conclusions with regard to the distribution of ocean temperatures in the western trough of the Atlantic, it seems to me :—

1. That this trough (and the Atlantic as a whole) must be regarded in the light of an inlet or gulf of the general ocean of the "water hemisphere," opening directly from the "Southern Sea."

2. That the water of the Southern Sea simply wells up into the Atlantic, and that all the temperature bands of the Western Atlantic are essentially continuous with like temperature bands in the Southern Sea, with these modifications :—that (*a*) above a certain line, which may be roughly represented by the isothermobathic lines of 5° and 4° C., the temperature of the water is manifestly affected by direct radiation and by the very complicated effects, direct and indirect, of wind-currents; and (*b*) that the whole mass of under-water gradually and uniformly rises in temperature towards the head of the gulf.

3. That water at any given temperature (below 4° C.) can only occur in the Atlantic where there is a direct communication with the zone of water at the same temperature in the Southern Sea without the intervention of any continuous barrier. (The actual result of the present arrangement of such barriers is, that, however great the depth may be, no water at a temperature lower than 1°·3 is found to the north of the equator, and no water below the freezing-point in any part of the trough except in the depression already described between the mouth of the River Plate and Tristan d'Acunha.)

4. That the water of the Atlantic is not sensibly affected in temperature by any cold indraught from the Arctic Sea. (I purposely neglect the Labrador current and the small branch of the Spitzbergen current; for these certainly do not sensibly affect the general temperatures of the North Atlantic.)

5. That although there is a considerable flow of surface-water through the influence of wind-currents from the Atlantic into the Southern Sea, that flow does not seem to be sufficient to balance the influx into the basin of the Atlantic (the constant influx being proved by the maintenance of a general uniformity in the course of the isothermobathic lines, and by the maintenance in all the secondary basins of the minimum temperature due to the height of their respective barriers); that for several reasons (the lower barometric pressure and the supposed greater amount of rainfall in the Southern Sea, the higher specific gravity at the surface than at greater

depths in the Atlantic, the higher specific gravity of the surface-water in the Atlantic to the north than to the south of the equator), it is probable that the general circulation is kept up chiefly by an excess of evaporation in the region of the North Atlantic, balancing a corresponding excess of precipitation over evaporation in the water hemisphere.

Determinations of the specific gravity of the surface-water have been made daily. The mean of these for the section between Stations 323 and 335, the temperature reduced to 15°·56 C., is 1·02620. Of the eighteen days occupied in running the section nine were dry and fine, and on nine rain fell either continuously or in showers. The mean for the nine dry days is 1·02639, and for the nine wet days 1·02591. The maximum surface specific gravity for the section (1·02680) was at Station 323, at the point where probably the Brazil current has most effect on the surface, and the minimum (1·02494) was at Station 326 after a heavy fall of rain. The mean specific gravity of the surface-water at the temperature at which it was procured was 1·02502.

The specific gravity of the bottom-water was determined at ten stations on the section. Reduced to a temperature of 15°·56 C., the mean was 1·02601; the maximum, 1·02650, was at Station 323 at a depth of 1900 fathoms; and the minimum, 1·02580, was at Station 326 at 2775 fathoms. The mean specific gravity of the bottom-water at the depth at which it was procured was 1·02811, showing a difference between the two means of 0·00210, due to difference of temperature alone.

It seems from these observations that the differences of surface specific gravity due to differences of salinity along the section are very small, and that, with the exception possibly of station 323, which is abnormal in many respects, they depend mainly on the rainfall.

The difference between the mean surface specific gravity, the temperature reduced to 15°·56 C., and the mean bottom specific gravity under the same conditions is also very slight; the actual specific gravity at every point is practically determined by the temperature; and consequently the bands of equal density are, like the bands of equal temperature, virtually continuous with those of the Southern Sea.

There seems to be little doubt that the specific gravity of the surface-water is considerably higher in the North Atlantic than it is on the present section. On one section between Teneriffe and Sombrero, in 1873, Mr. Buchanan found the mean specific gravity at the surface (the temperature reduced to 15°·56 C.) to be nearly 1·02760; from the surface it fell rapidly to 1·0260, at a depth of about 600 fathoms, after which it remained nearly the same to the bottom.

Throughout the whole of this section the trawling-operations have been singularly unsuccessful. Out of ten trials in depths over 1000 fathoms only four produced any thing like satisfactory results; and this was the more unaccountable, as the comparatively moderate depths of most of them were such as usually to make the process almost certain.

In many cases, however, even when the line parted or the trawl came up foul, fragments sufficient were preserved to show that the fauna of the region was by no means deficient.

The first successful trawl was at a depth of 600 fathoms, on the edge of the South-American plateau. As at most places where we have had a fair opportunity of working at such depths, the number of species procured was very large. Sponges were abundant, including a large number of corticate forms, and several specimens of a species of the fine hexactinellid genus *Rossella*, identical with or very closely allied to *R. antarctica*, so common at Kerguelen. I have already referred to the large Pennatulids and to the remarkable corals belonging to the family *Stylasteridæ*, a group which Mr. Moseley, in an important paper which I beg to submit along with this, has determined to belong, with the *Milleporidæ*, to the HYDROZOA, and not to the ANTHOZOA, as previously supposed.

All the orders of Echinodermata were well represented. Bryozoa were abundant, and included fine masses of *Tubulipora*, *Idmonea*, and *Cellepora*, such as are found in like depths off the west coast of Ireland. Numerous crustaceans occurred, among them large species of *Arcturus*, of *Gammarus*, and of other genera, recalling the northern crustaceous fauna, along with species of *Serolis* and markedly southern Schizopods. Mollusca were, as usual, few; there were two or three fishes of deep-water types.

The next trawling-station was on the 28th of February in 1900 fathoms (No. 323); the number of species was not so great as on the previous occasion, but the different groups were fairly represented. We got here a single stem only of *Rhizocrinus lofotensis*, one of the rare crinoids belonging to the Apiocrinidæ. We have been unfortunate in never having found perfect specimens of this pretty little species, although fragments have come up frequently at widely separated stations.

Bryozoa were abundant, of more characteristic deep-water types than on the last occasion. There were two species of deep-water fishes belonging to the Macruridæ. At Station 325 the depth was 2650 fathoms, and the number of species procured was, as I have already mentioned, unusually large for so great a depth. The assembly of forms was of the usual deep-sea character. There were a considerable number of species of *Fungia symmetrica*, a generally distributed deep-sea coral; and the specimens at this station were of a much larger size than we had previously met with. There were many Echinoderms, including several species of a singular group of Holothuridæ, allied in some respects to *Psolus*, which we find widely distributed at great depths; they are principally characterized by an almost continuous calcareous plating, which runs out over long, tubular, spine-like appendages.

The next three trawlings were unsuccessful; and at Station 335, on the 16th of March, we determined to try a large light dredge. This was

dragged along the bottom freely for a considerable distance; and although the number of species procured was small, we thought ourselves fortunate in securing fine examples of *Cidaris varispina.*

The following Table gives the general distribution of the principal animal groups at the different stations between the Falkland Islands and Tristan d'Acunha:—

	Station 317. 1035 fms.	Station 318. 2040 fms.	Station 320. 600 fms.	Station 321. 13 fms.	Station 322. 21 fms.	Station 323. 1900 fms.	Station 325. 2650 fms.	Station 331. 1715 fms.	Station 332. 2200 fms.	Station 333. 2025 fms.	Station 334. 1915 fms.	Station 335. 1425 fms.
Pisces	...	*	*	*	*	*	*	...	*	...	...	*
Cephalopoda	...	...	*	*	...	...	...	...	...	*		
Gasteropoda	...	...	*	*	...	*	*	...	...	...	...	*
Lamellibranchiata	*	...	*	*	*	...	*	...	...	...	...	*
Brachiopoda	...	...	*									
Tunicata	...	...	*									
Pycnogonidæ	...	...	*									
Decapoda	...	*	*	*	...	*	*	*	...	...	...	*
Schizopoda	...	...	*	...	...	...	*	...	*			
Stomatopoda.												
Edriophthalmata	...	...	*	*	...	...	...	...	...	...	*	
Phyllopoda.												
Ostracoda.												
Copepoda.												
Cirripedia	*	...	*	...	...	*	...	...	...	...	...	*
Annelida	...	...	*	*	*	*	*	...	...	*	...	*
Gephyrea.												
Bryozoa	...	...	*	...	...	*	*	...	*	*		
Holothuroidea	...	...	*	...	...	*	*					
Echinoidea	...	...	*	...	...	*	...	...	...	...	*	*
Ophiuridea	...	...	*	...	...	*	*	...	*	*		
Asteridea	...	...	*	...	...	*	*	...	...	...	...	*
Crinoidea	...	...	*	...	...	*						
Hydromedusæ	...	...	*	...	...	*	...	...	...	...	...	*
Zoantharia	...	...	*	*	...	*	*	...	*	...	...	*
Alcyonaria	...	...	*	*	...	...	...	...	...	*		
Porifera	*	...	*	...	...	*	*	...	*	*	*	
Rhizopoda	...	...	*	...	...	*	*	...	*	*	*	

Note.—At Station 317 the trawl carried away, and the few specimens came up in a tow-net attached to the trawl-rope. At Station 318 the trawl did not reach the bottom. At Stations 331, 332, 333, and 334 the trawl came up foul, and fragments of animals only were got adhering to the net. At Station 235 a large dredge was used.

It has not of course been possible to determine the species in detail; but the general characteristic of the fauna throughout the section is much the same as we have found almost invariably at like depths in temperate regions. The general assemblage certainly tends to confirm me in the opinion that the distribution of the deep-sea fauna mainly sets from the Southern Sea into the Atlantic.

I beg leave to report that the departments under my charge are in a satisfactory condition. I hope to have an opportunity of sending from

St. Vincent some notes of the general results of our observations on the physical and biological conditions of the eastern trough of the Atlantic.

I have the honour to be, Sir,

Your obedient Servant,

C. WYVILLE THOMSON,

Director of the Civilian Scientific Staff on board.

Captain Evans, C.B., V.P.R.S.

DESCRIPTION OF THE PLATES.

PLATE 25.

Track of the ship from Stanley Harbour, East-Falkland Island, to Station 335, lat. 32° 24′ S., long. 13° 5′ W., in the meridian of the Island of Ascension.

PLATE 26.

Diagram showing the vertical distribution of temperature between the Falkland Islands and Monte Video.

PLATE 27.

Curves constructed from the serial temperature-soundings at Stations 317, 318, 319, and 320 between the Falkland Islands and Monte Video.

PLATE 28.

Diagram showing the vertical distribution of temperature between Monte Video and Station 335.

PLATE 29.

Curves constructed from the serial soundings at Stations 323, 324, 325, and 326.

PLATE 30.

Curves constructed from the serial soundings at Stations 327, 329, 330, and 331.

PLATE 31.

Curves constructed from the serial soundings at Stations 332, 333, 334, and 335.

PLATE 32.

Diagram showing the vertical distribution of temperature at Stations:—

A. No. 112. Sept. 1st, 1873, lat. 3° 33′ S., long. 32° 16′ W.

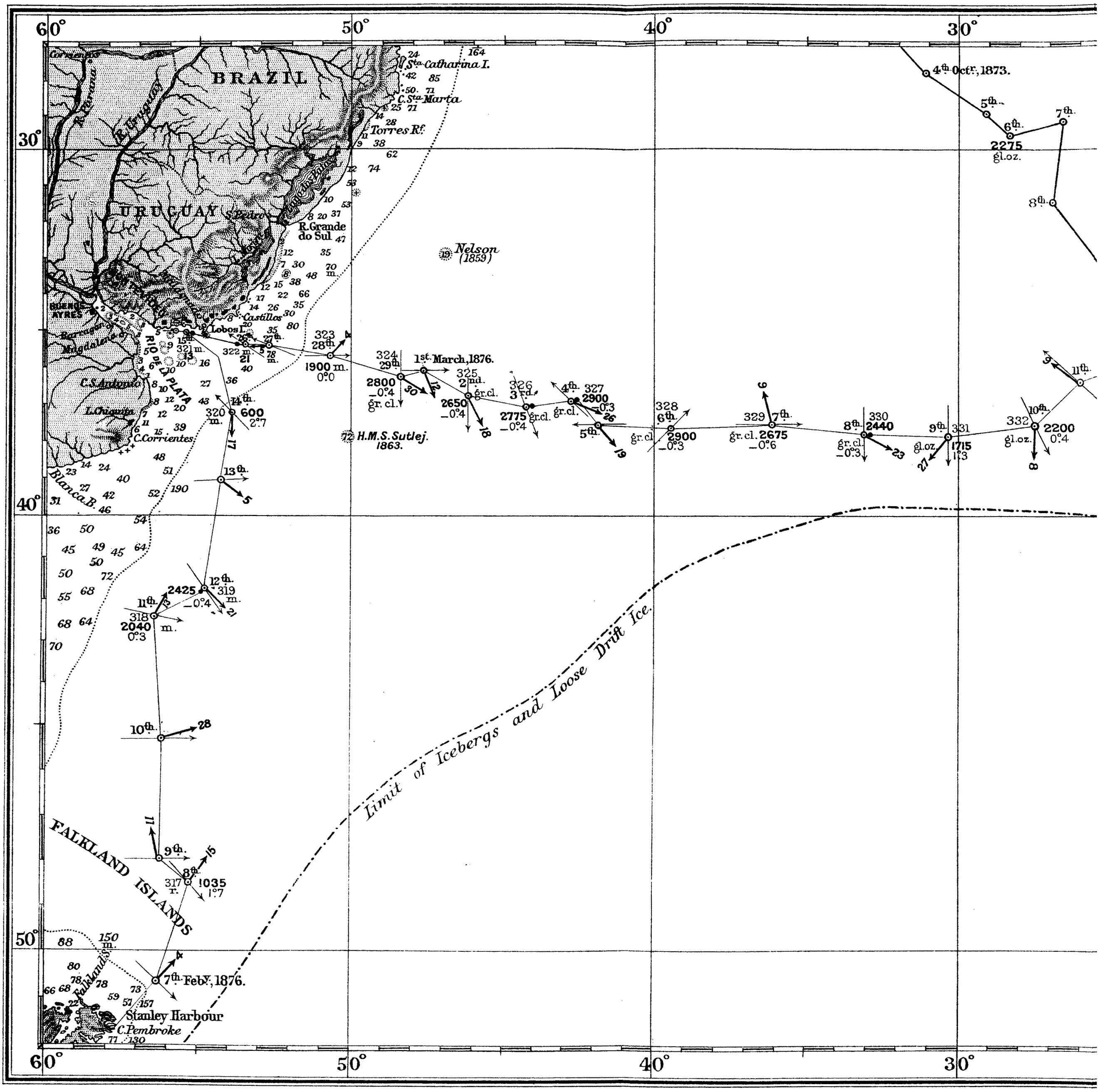
B. No. 129. Sept. 30th, 1873, lat. 20° 12′ S., long. 35° 19′ W.

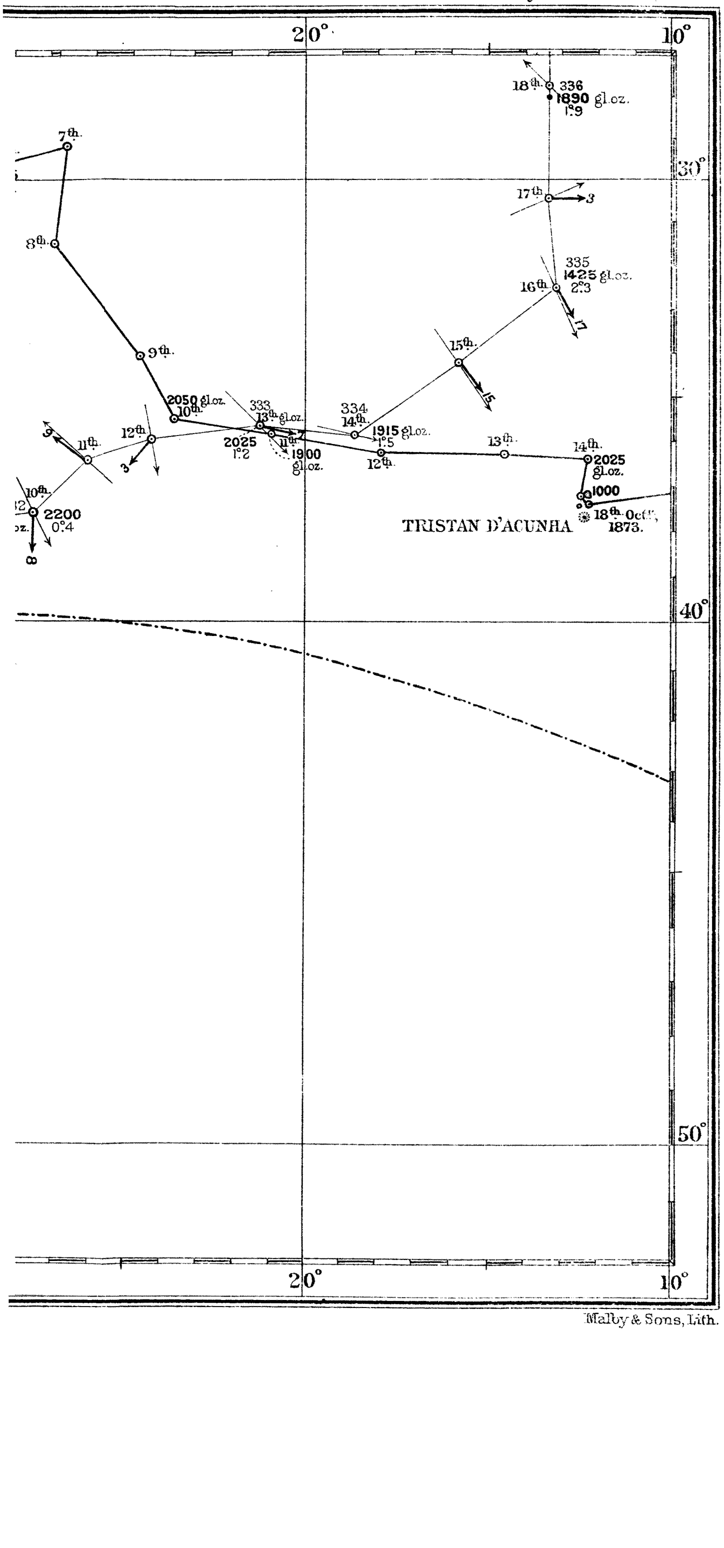
C. No. 327. March 4th, 1876, lat. 36° 48′ S., long. 42° 45′ W.

PLATE 33.

Diagram showing the vertical distribution of temperature, as far as possible, in the axis of the western trough of the Atlantic, from lat. 42° S. to lat. 42° N.

Thomson.

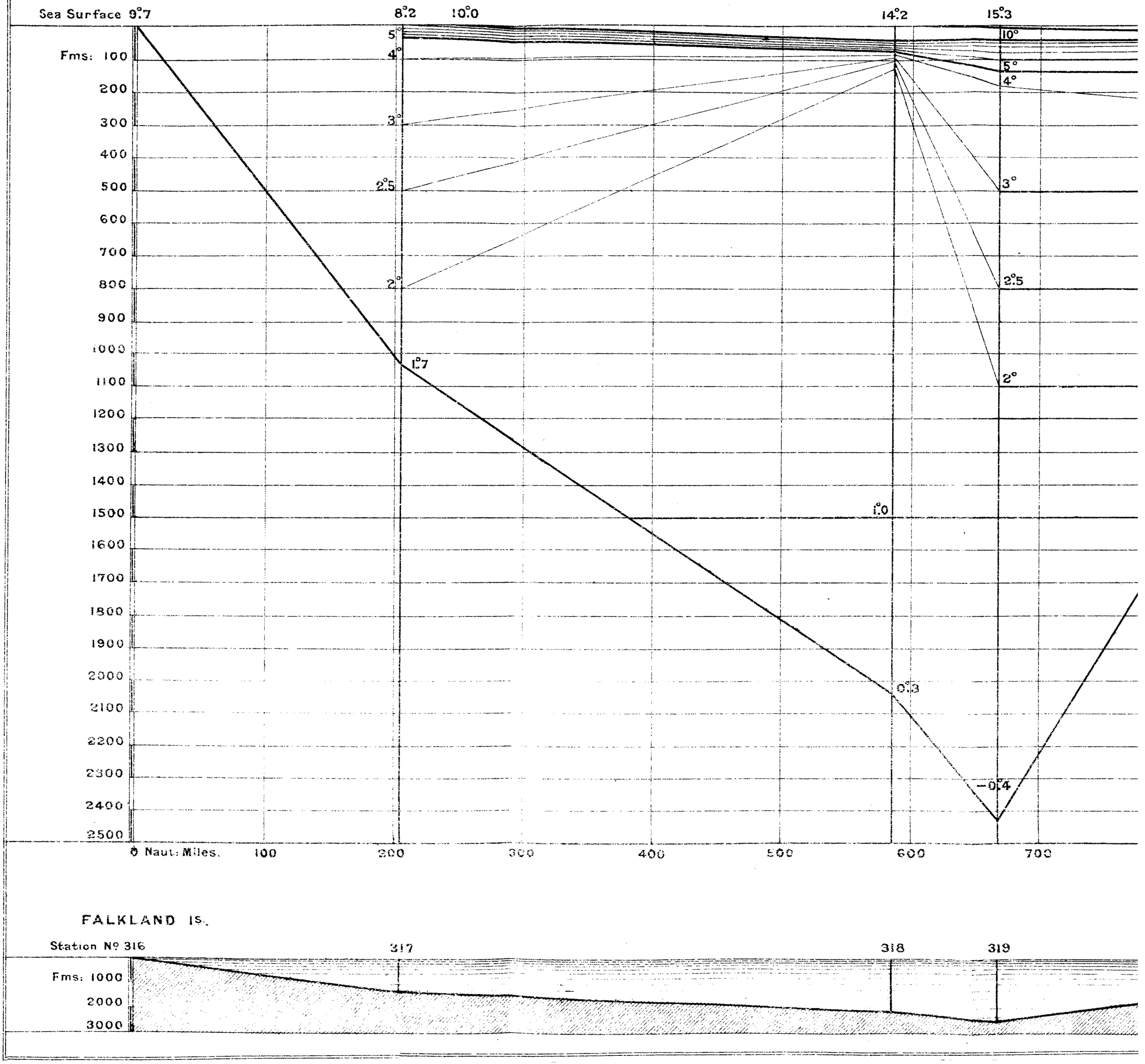

60°
50°
40°
30°
BRAZIL
URUGUAY
St.a Catharina I.
C. St.a Marta
Torres Rf.
R. Grande do Sul
S. Pedro
Nelson (1859)
BUENOS AYRES
Lobos I.
Castillos
RIO DE LA PLATA
C. S. Antonio
L. Chiquita
C. Corrientes
Blanca B.
H.M.S. Sutlej. 1863.
4th. Octr. 1873.
1st. March, 1876.
7th. Feby. 1876.
Stanley Harbour
C. Pembroke
FALKLAND ISLANDS
Limit of Icebergs and Loose Drift Ice.



Malby & Sons, Lith.

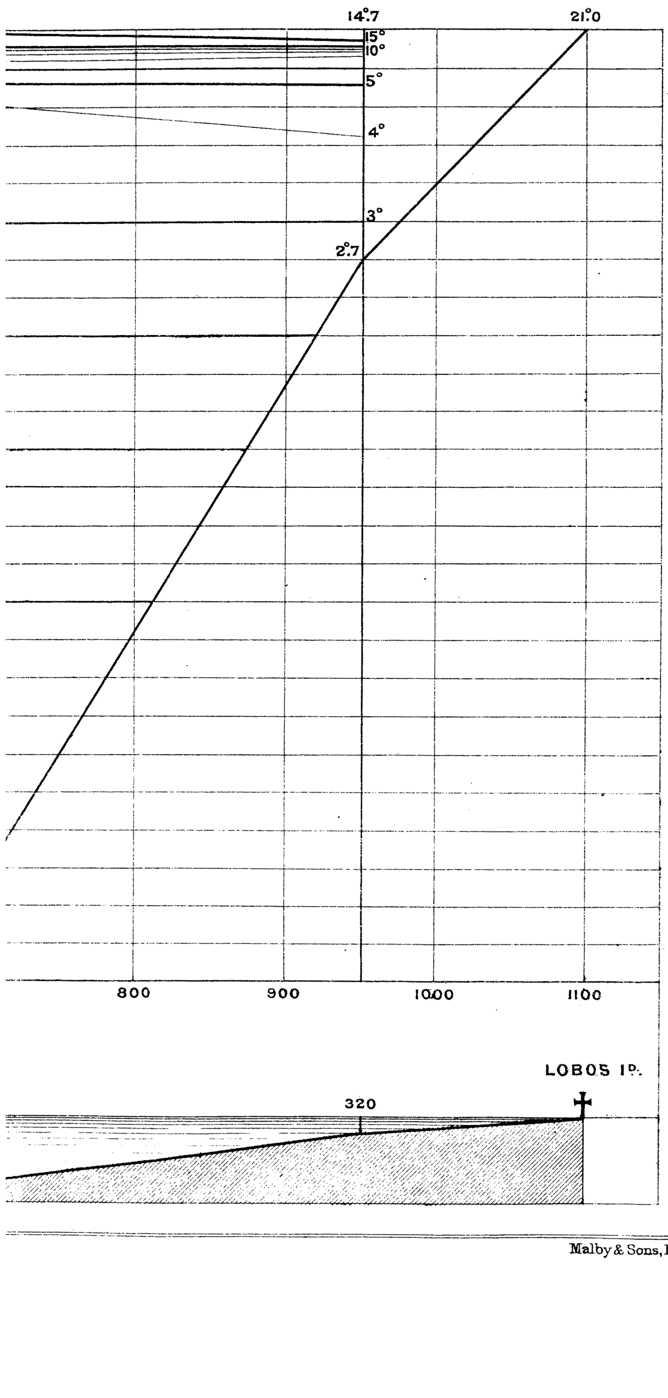
Thomson.

DIAGRAM SHOWING THE VERTICAL DISTRIBUTION OF
BETWEEN THE FALKLAND ISLANDS AND MONTE VI



OF TEMPERATURE

TE VIDEO.

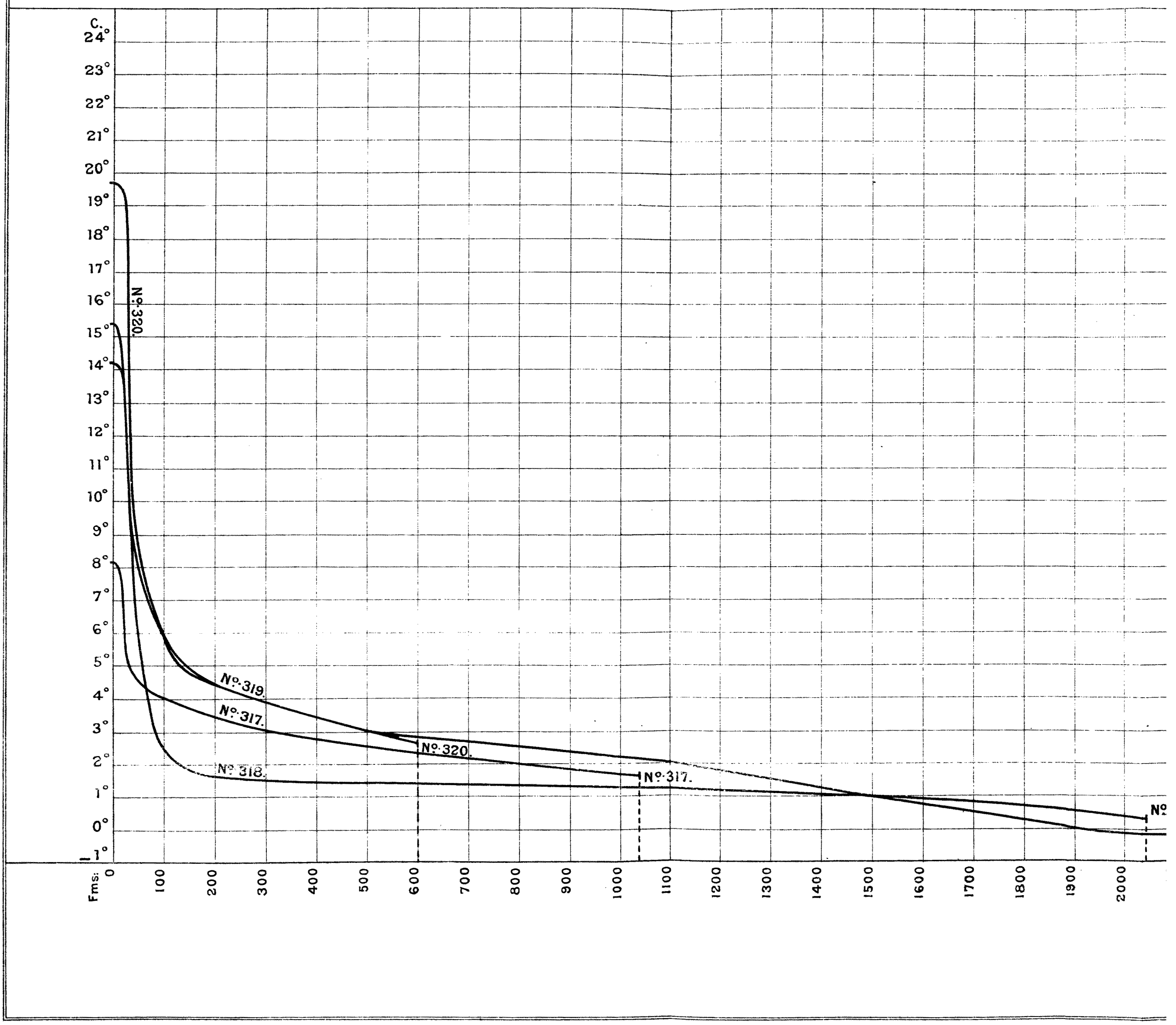


Malby & Sons, Lith.

Thomson.

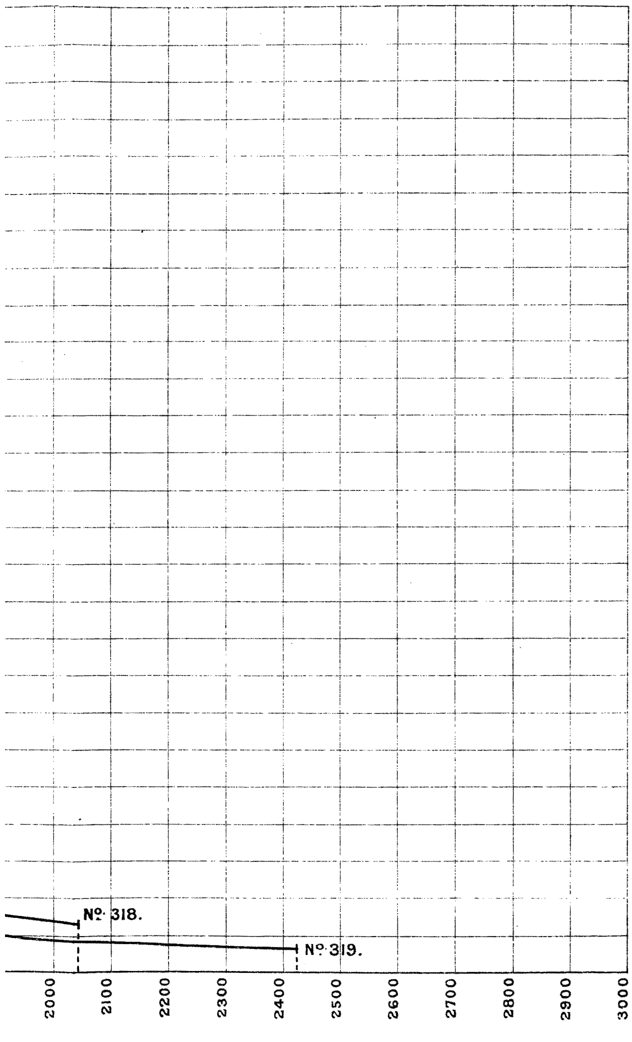
CURVES CONSTRUCTED FROM THE TEMPERATURE SOU

BETWEEN THE FALKLAND ISLANDS AND MONTE VID



E SOUNDINGS

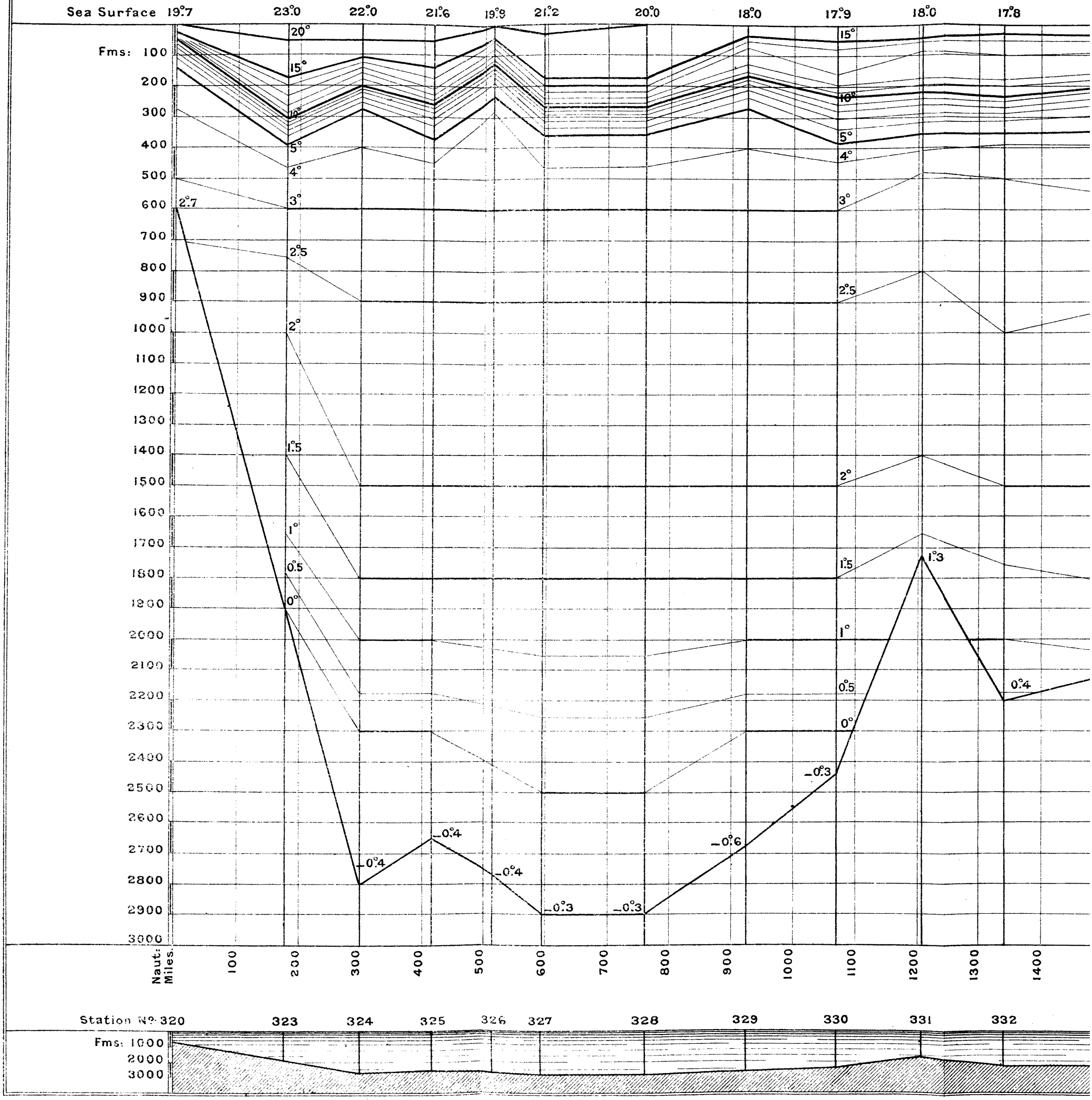
TE VIDEO.



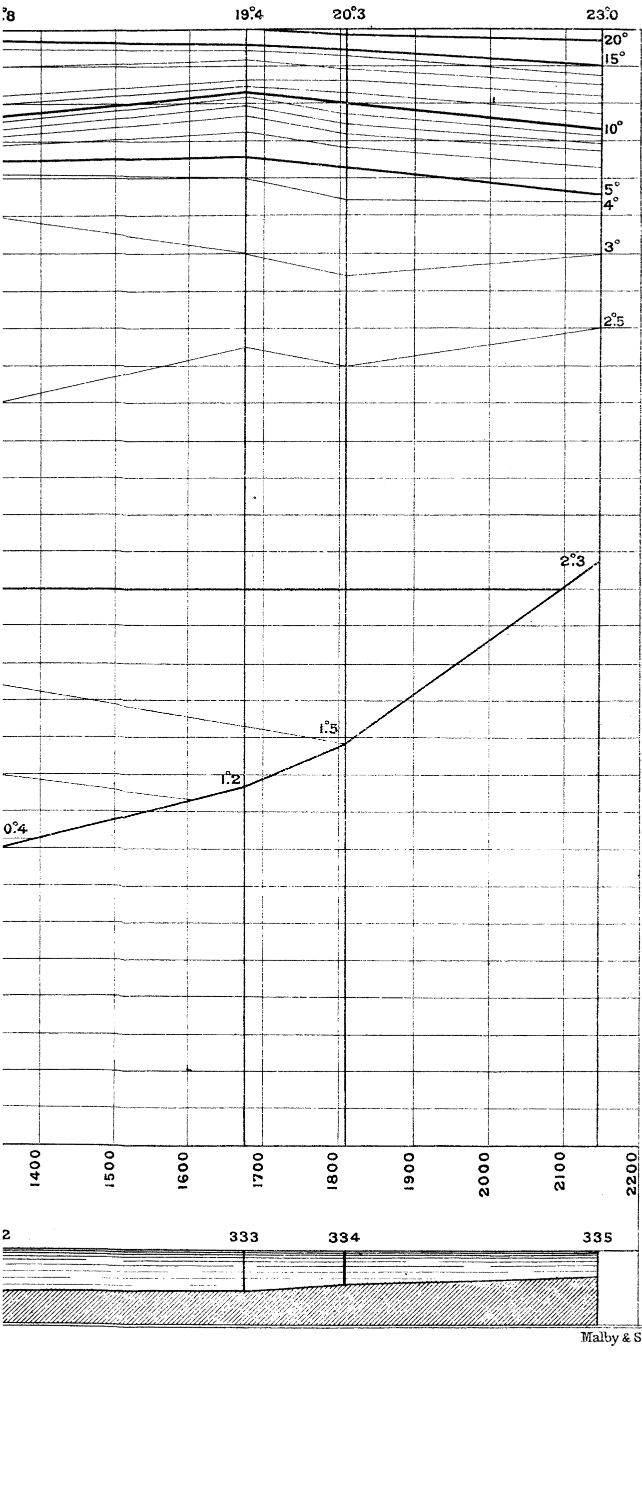
Malby & Sons, Lith.

Thomson.

DIAGRAM SHOWING THE VERTICAL DISTRIBUTION OF
BETWEEN MONTE VIDEO AND STATION 33



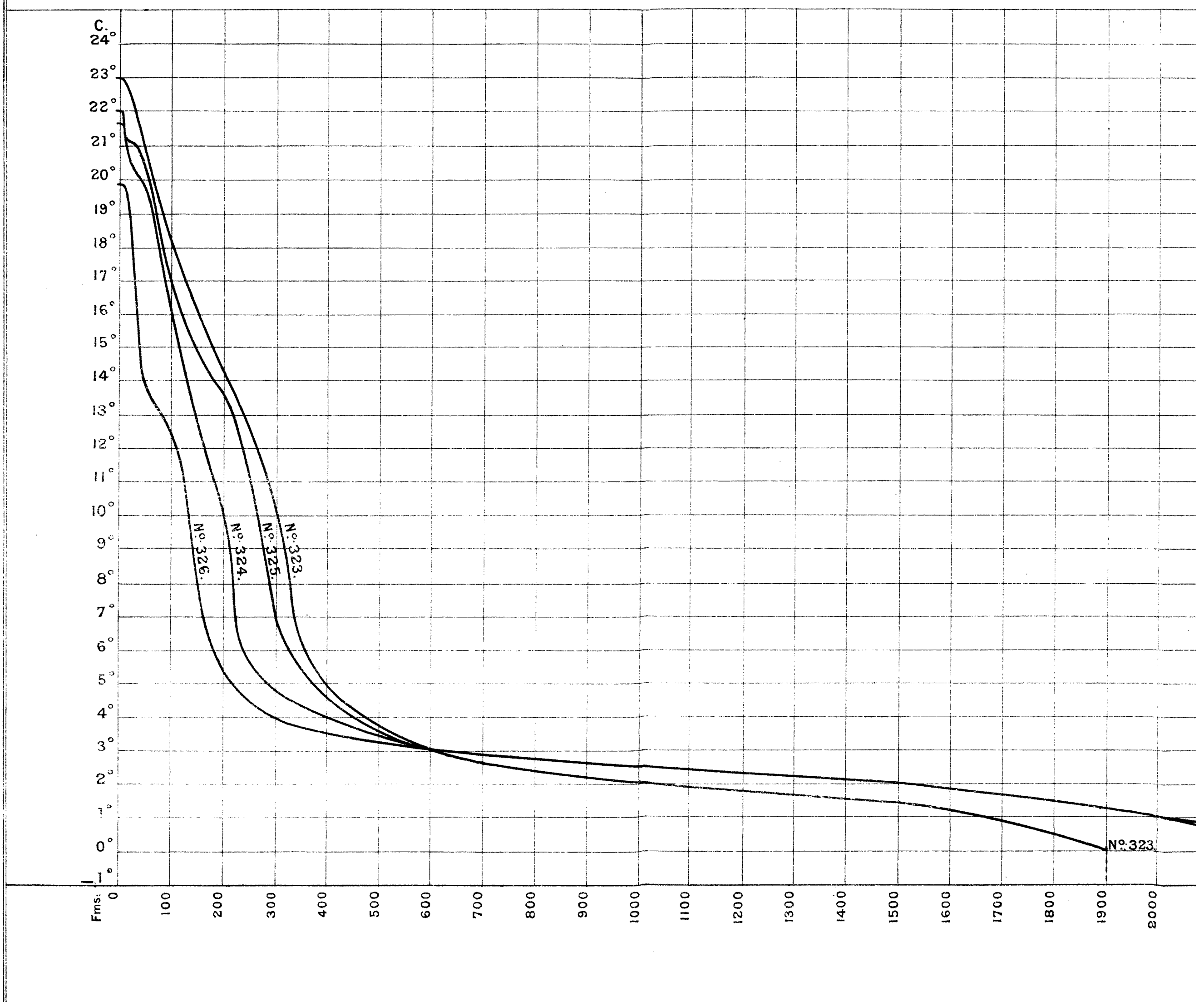
[OF TEMPERATURE
)N 335.



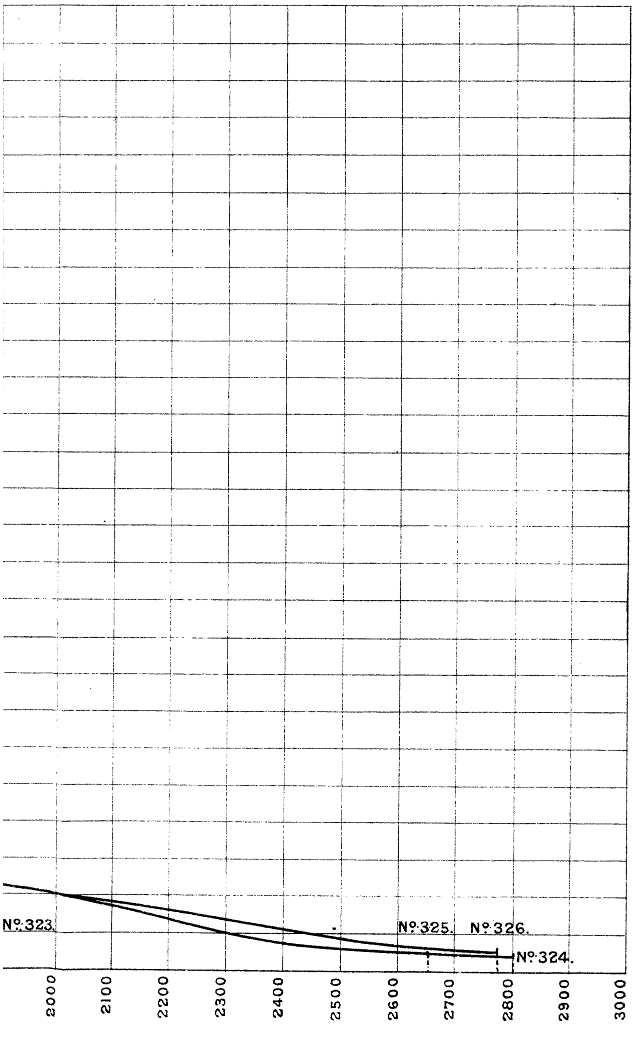
Malby & Sons, Lith.

Thomson.

CURVES CONSTRUCTED FROM SERIAL TEMPERATURE S
AT STATIONS 323 – 326.

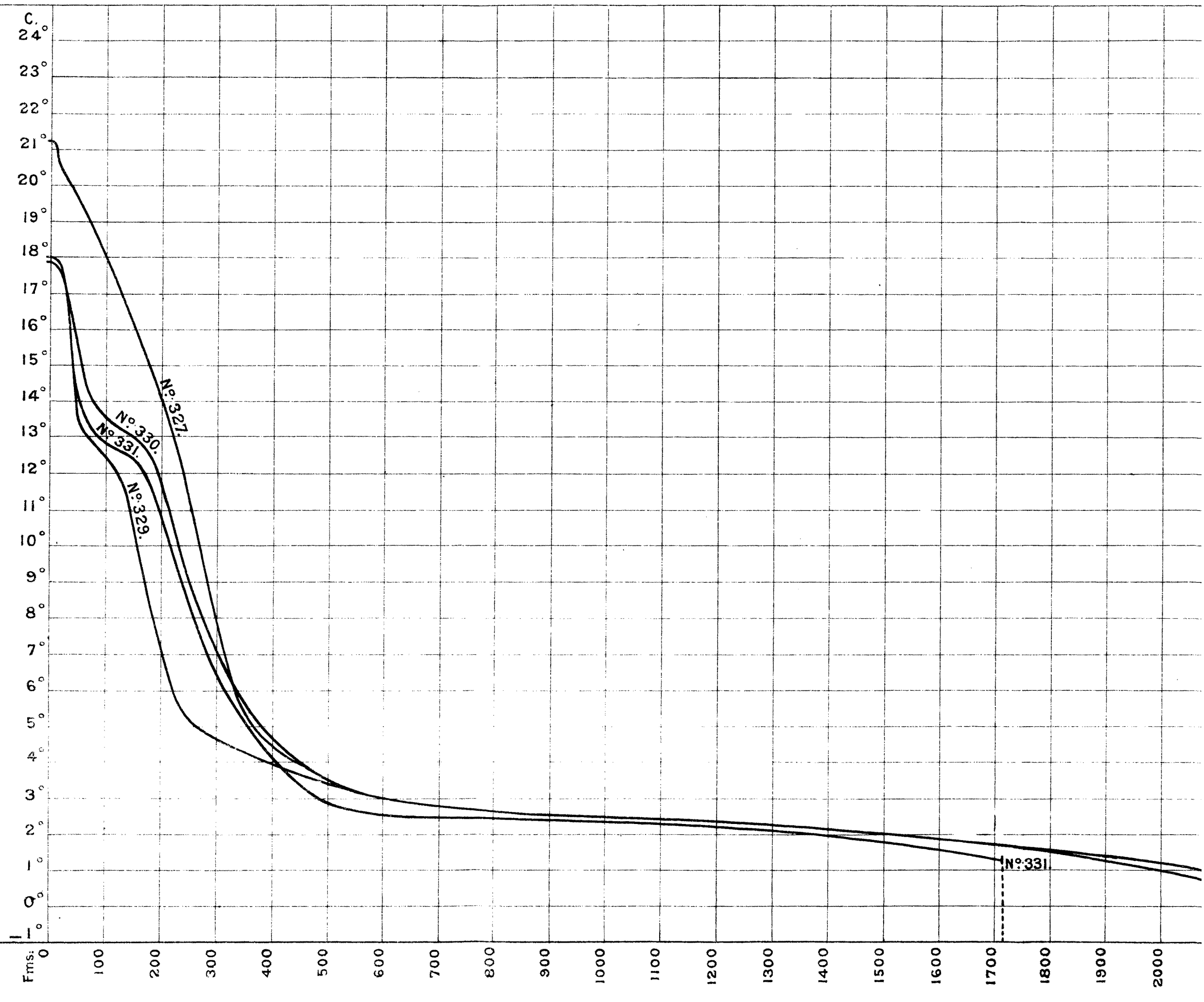


JRE SOUNDINGS



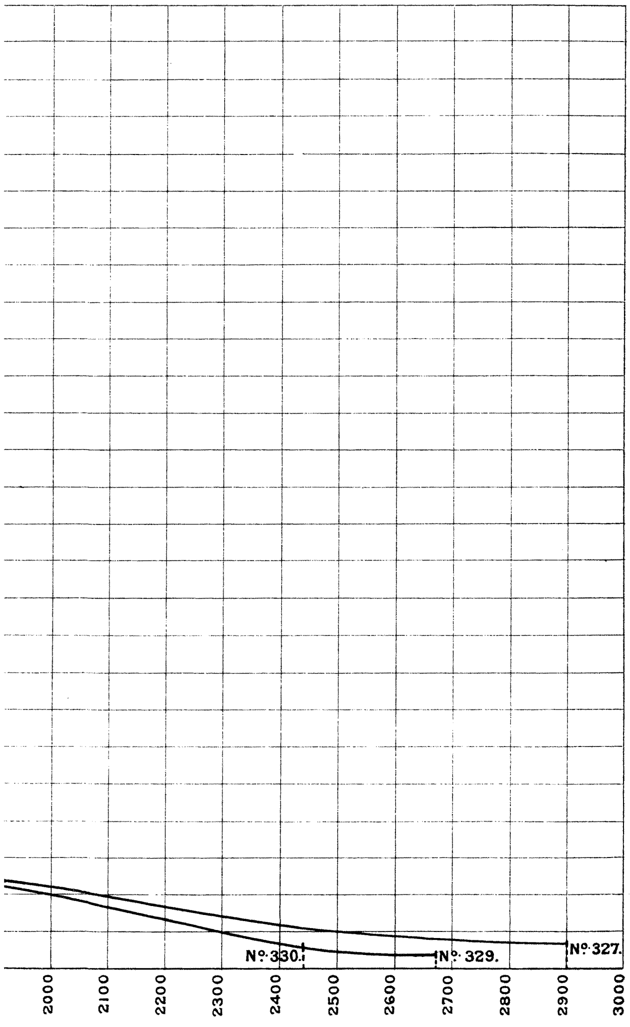
Malby & Sons, Lith.

CURVES CONSTRUCTED FROM SERIAL SOUNDIN
AT STATIONS 327, 329, 330 AND 331.



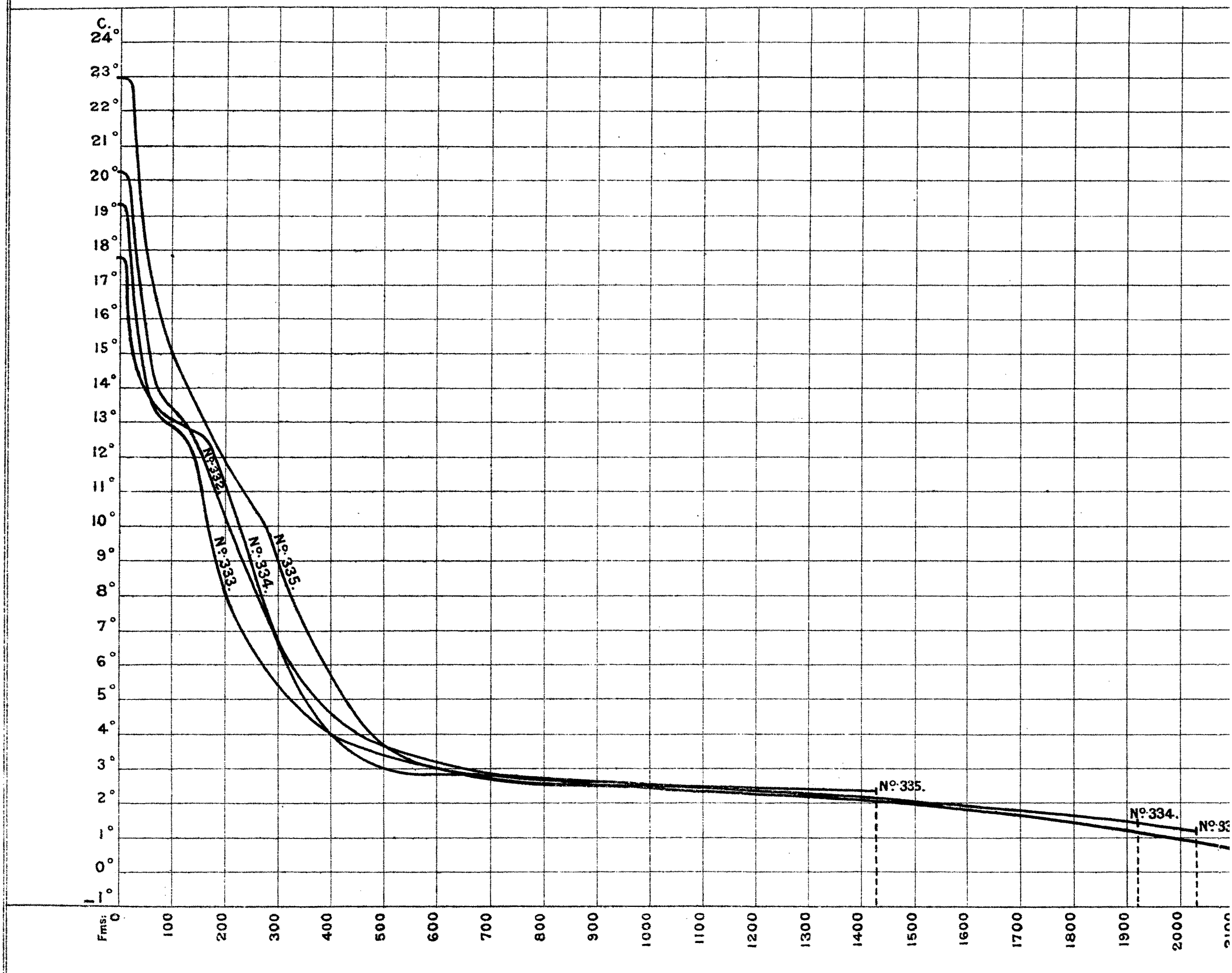
NDINGS

31.

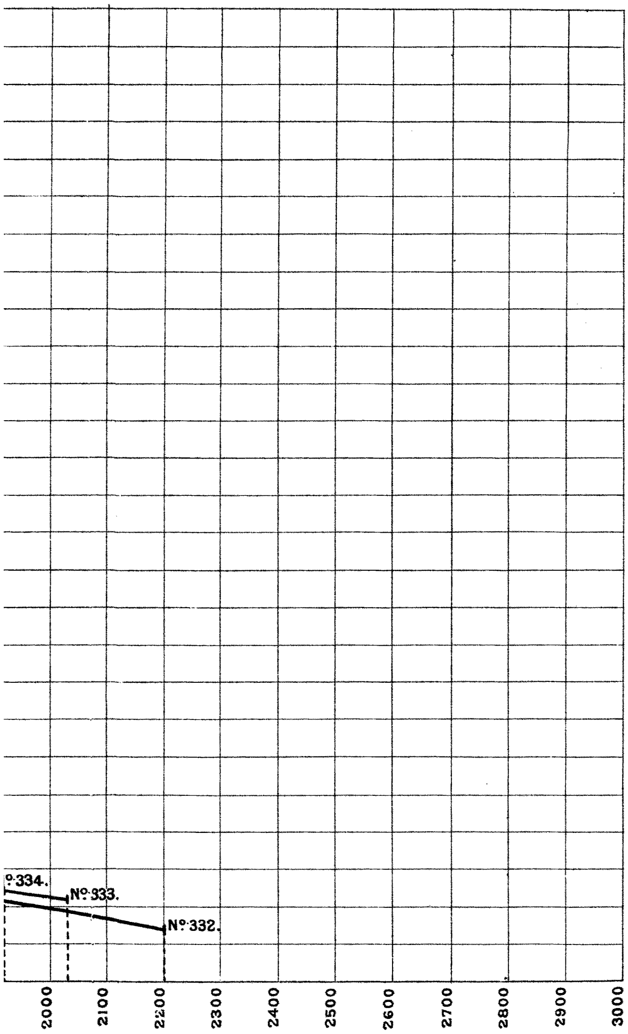


Malby & Sons, Lith.

CURVES CONSTRUCTED FROM SERIAL SOUNDING
AT STATIONS 332 – 335.

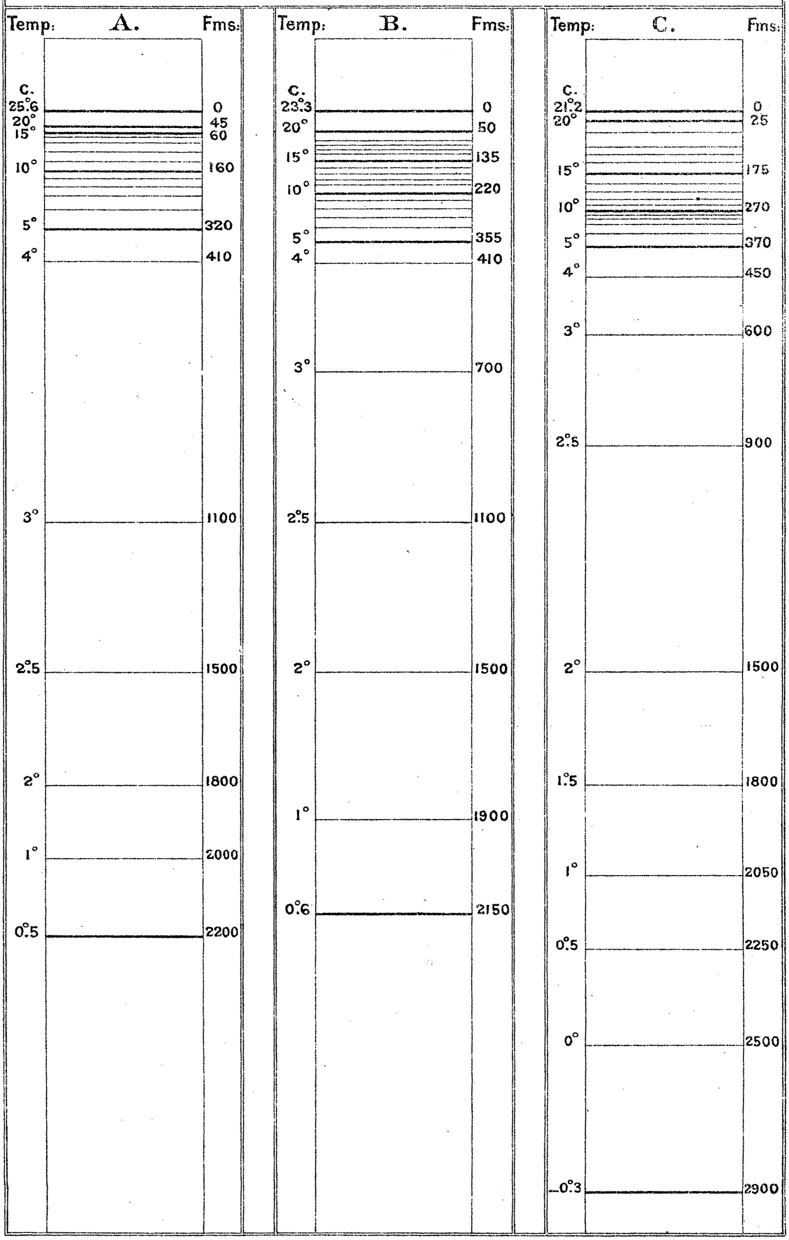


NDINGS



Malby & Sons, Lith.

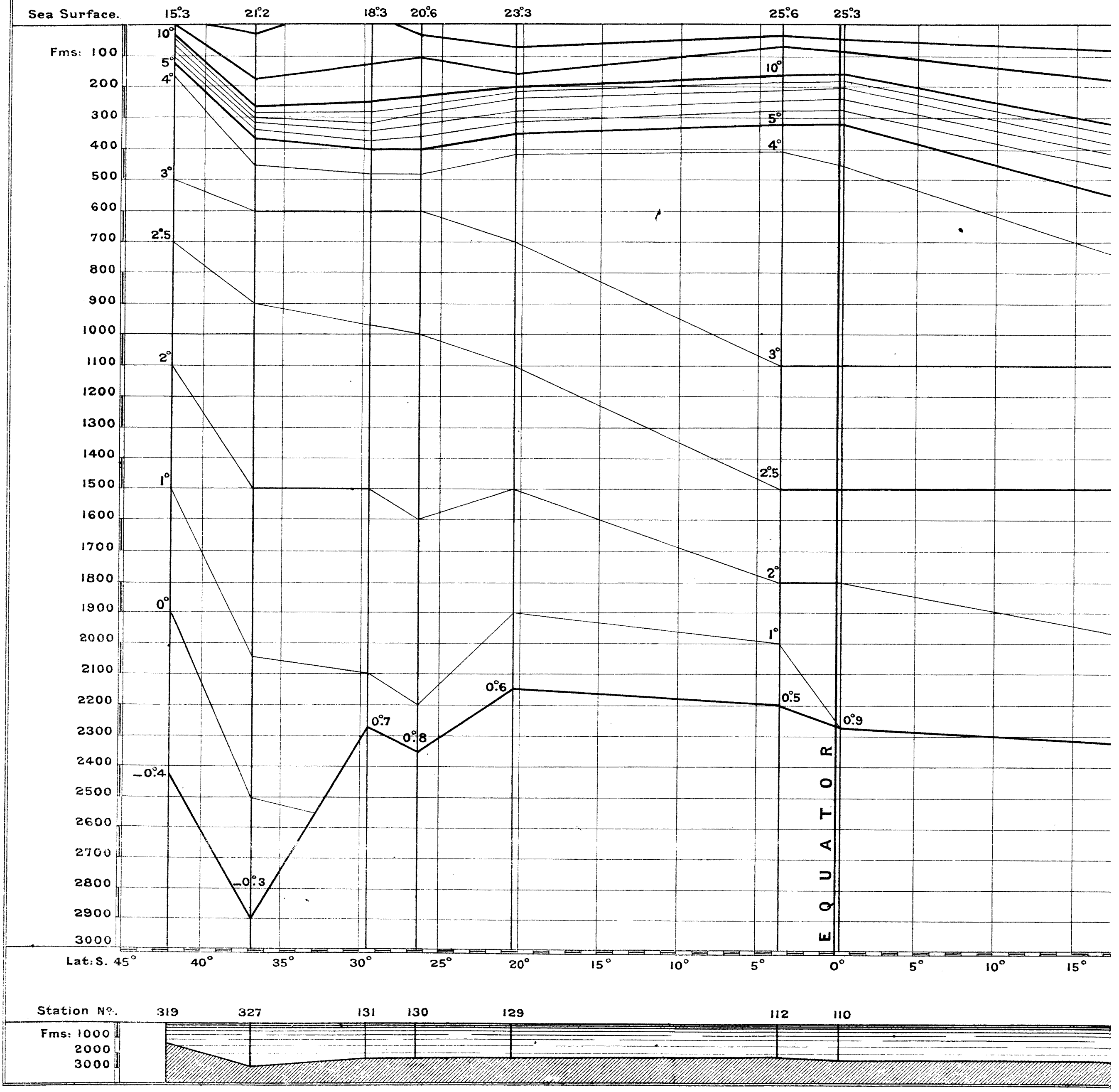
DIAGRAM SHOWING THE VERTICAL DISTRIBUTION OF TEMPERATURE AT STATIONS (A) No. 112, (B) No. 129, (C) No. 327.



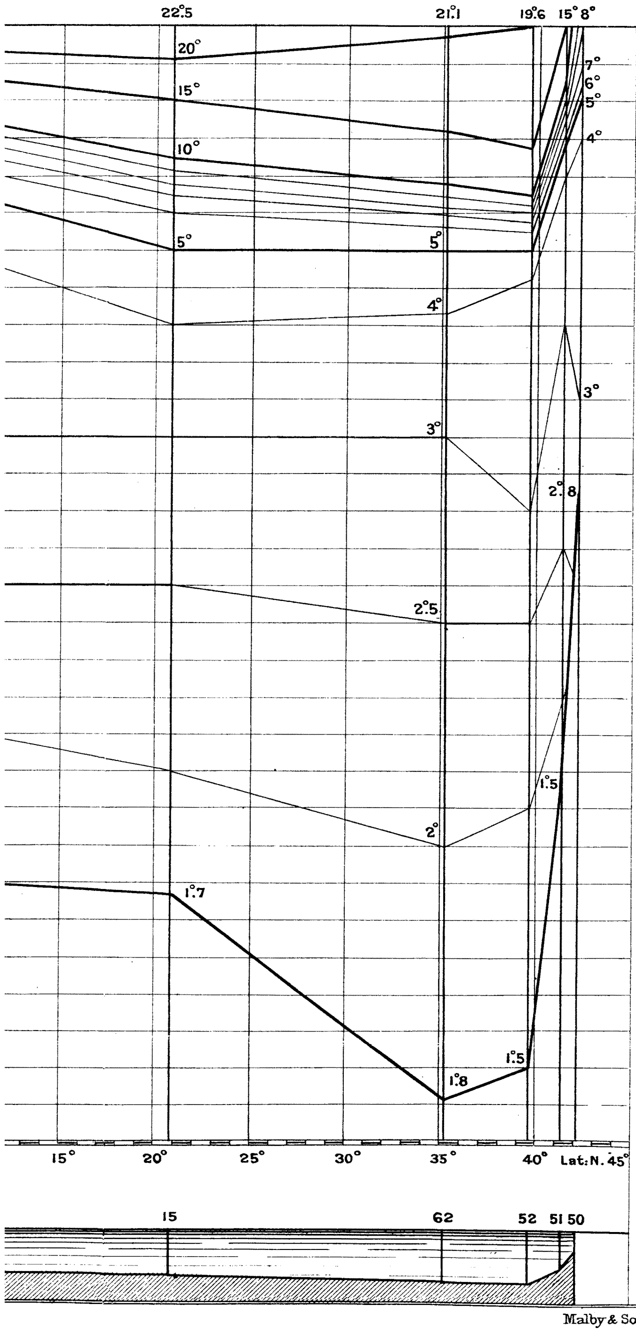
Malby & Sons, Lith.

Thomson.

DIAGRAM SHOWING THE VERTICAL DISTRIBUTION OF T
IN THE WESTERN TROUGH OF THE ATLANTI



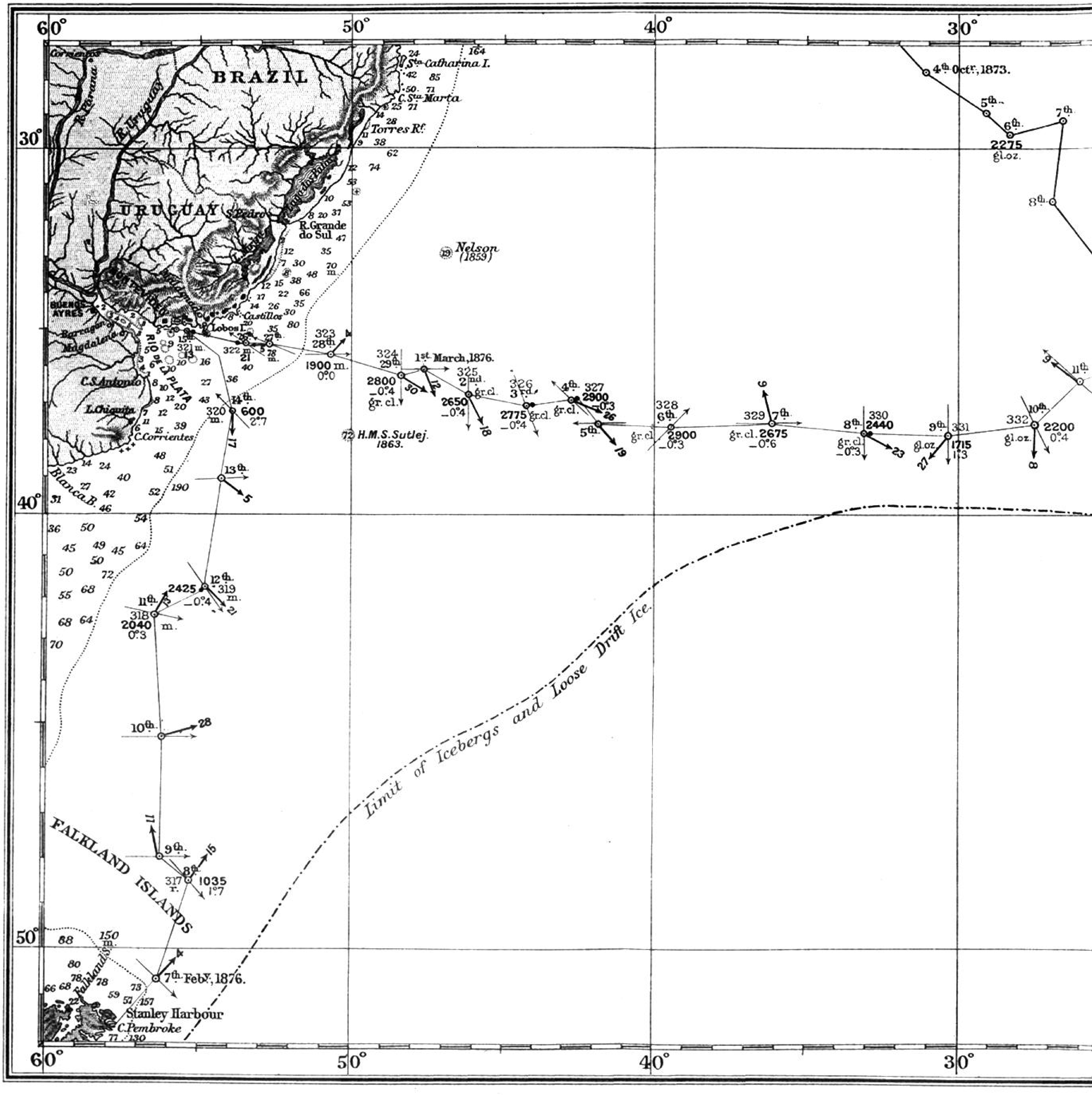
OF TEMPERATURE
LANTIC.

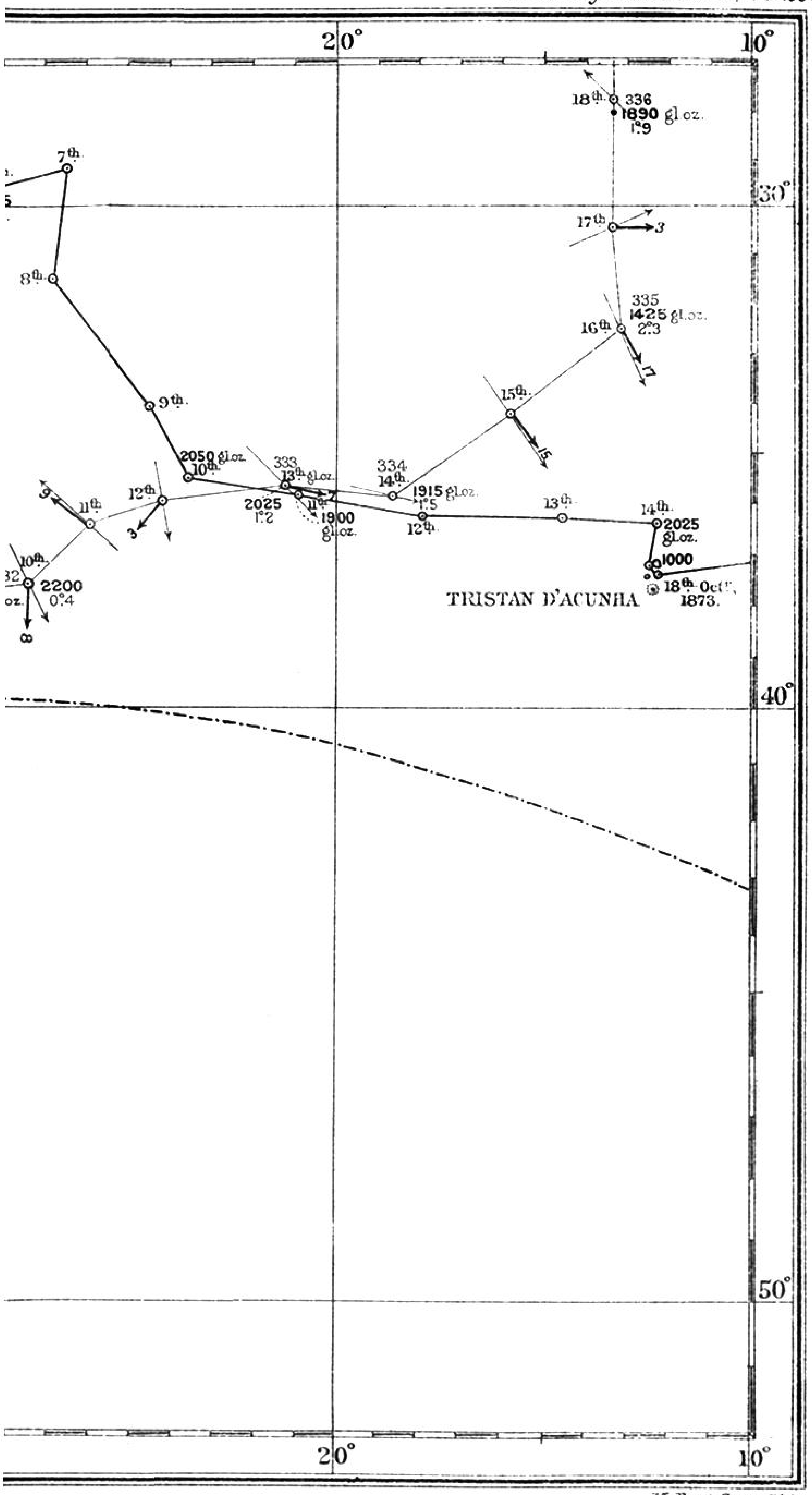


Malby & Sons, Lith.


BRAZIL
URUGUAY
BUENOS AYRES
RIO DE LA PLATA
Sta. Catharina I.
C. Sta. Marta
Torres Rf.
R. Grande do Sul
S. Pedro
Lobos I.
Castillos
Barragan
Magdalena
C. S. Antonio
L. Chiquita
C. Corrientes
Blanca B.
Corrientes
Nelson (1859)
H.M.S. Sutlej. 1863.
4th Octr. 1873.
18th Octr. 1873.
1st March, 1876.
7th Feby. 1876.
TRISTAN D'ACUNHA
FALKLAND ISLANDS
Falklands
Stanley Harbour
C. Pembroke
Limit of Icebergs and Loose Drift Ice.
60°
50°
40°
30°
20°
10°

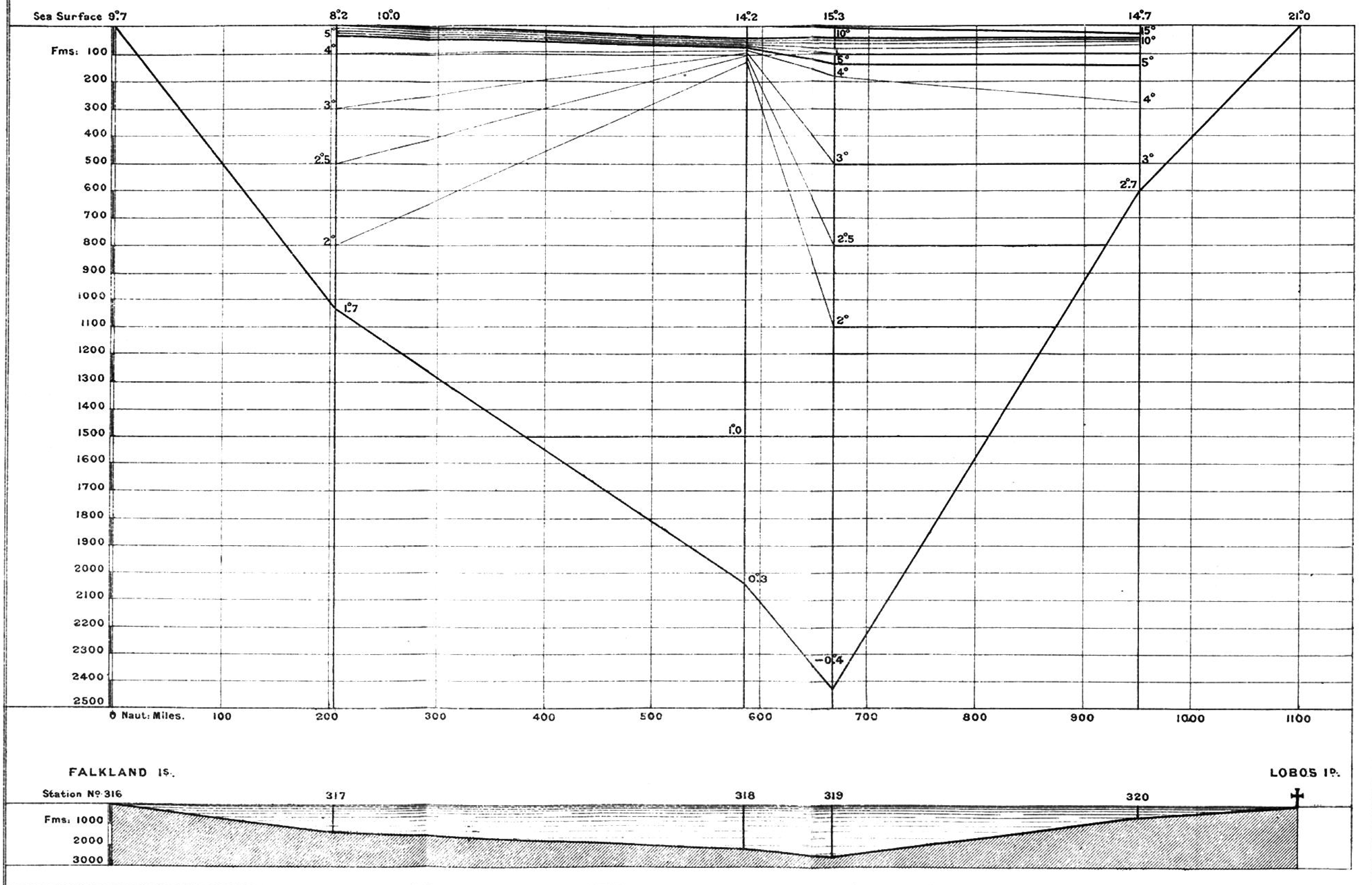
Thomson.


BRAZIL
URUGUAY
R. Uruguay
Corrientes
Sta Catharina I.
C. Sta Marta
Torres Rf.
S. Pedro
R. Grande do Sul
Nelson (1859)
BUENOS AYRES
Lobos I.
Castillos
Magdalena
RIO DE LA PLATA
C. S. Antonio
L. Chiquita
C. Corrientes
Blanca B.
H.M.S. Sutlej. 1863.
4th Octr., 1873.
1st March, 1876.
7th Feby., 1876.
Limit of Icebergs and Loose Drift Ice.
FALKLAND ISLANDS
Stanley Harbour
C. Pembroke
60°
50°
40°
30°



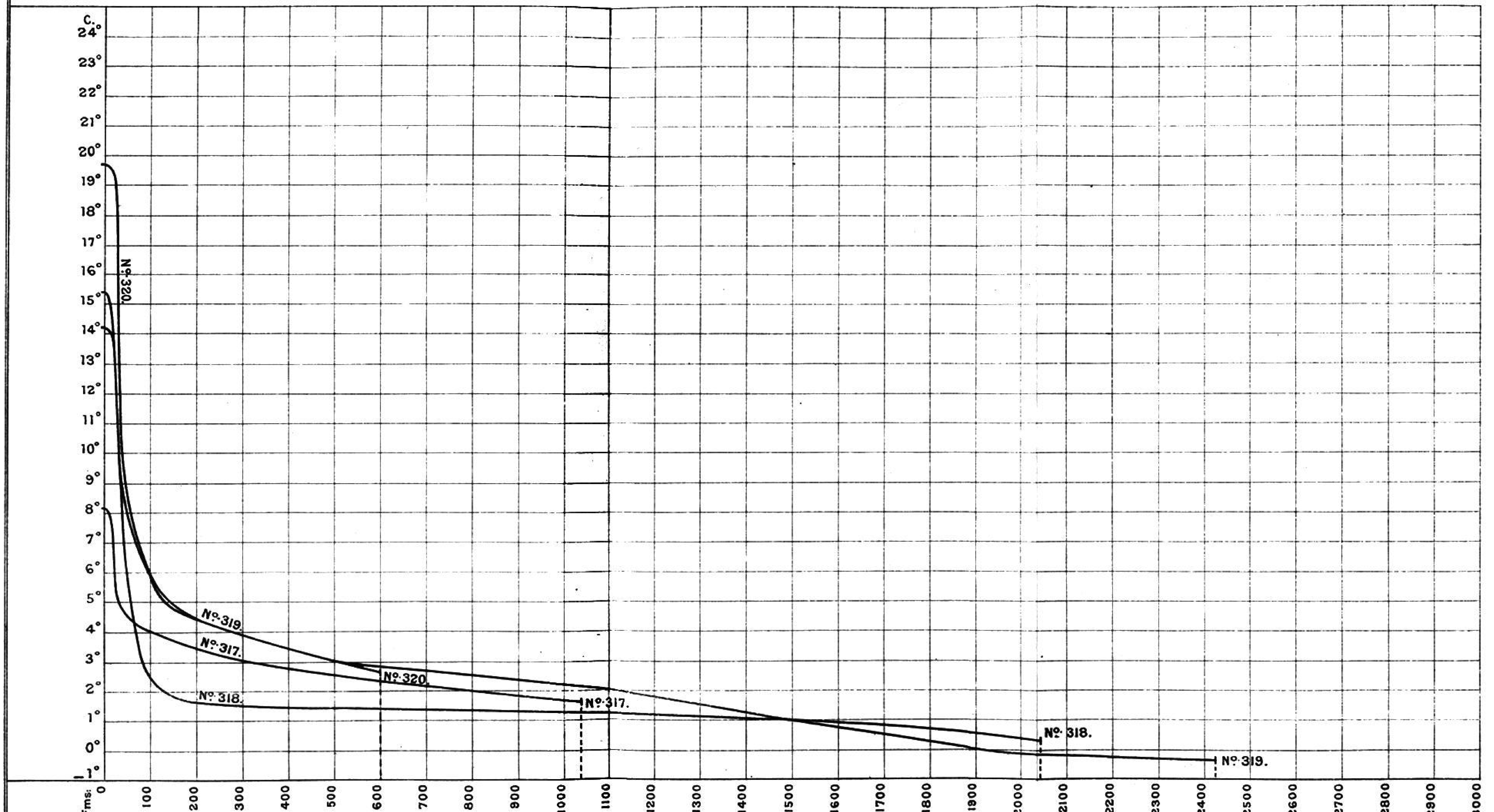
Malby & Sons, Lith.

DIAGRAM SHOWING THE VERTICAL DISTRIBUTION OF TEMPERATURE BETWEEN THE FALKLAND ISLANDS AND MONTE VIDEO.



Malby & Sons, Lith.

CURVES CONSTRUCTED FROM THE TEMPERATURE SOUNDINGS BETWEEN THE FALKLAND ISLANDS AND MONTE VIDEO.

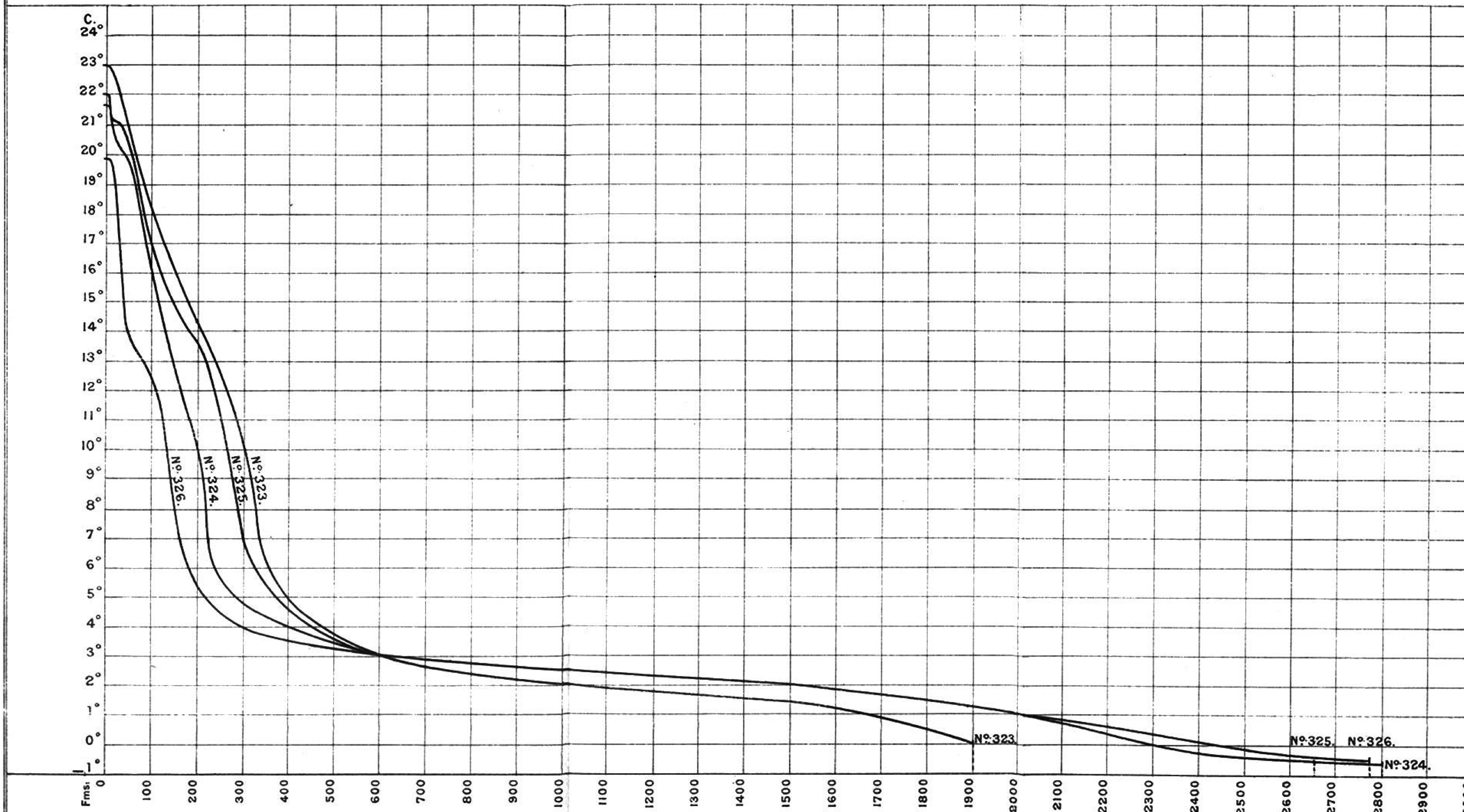


Malby & Sons Lith.

DIAGRAM SHOWING THE VERTICAL DISTRIBUTION OF TEMPERATURE BETWEEN MONTE VIDEO AND STATION 335.

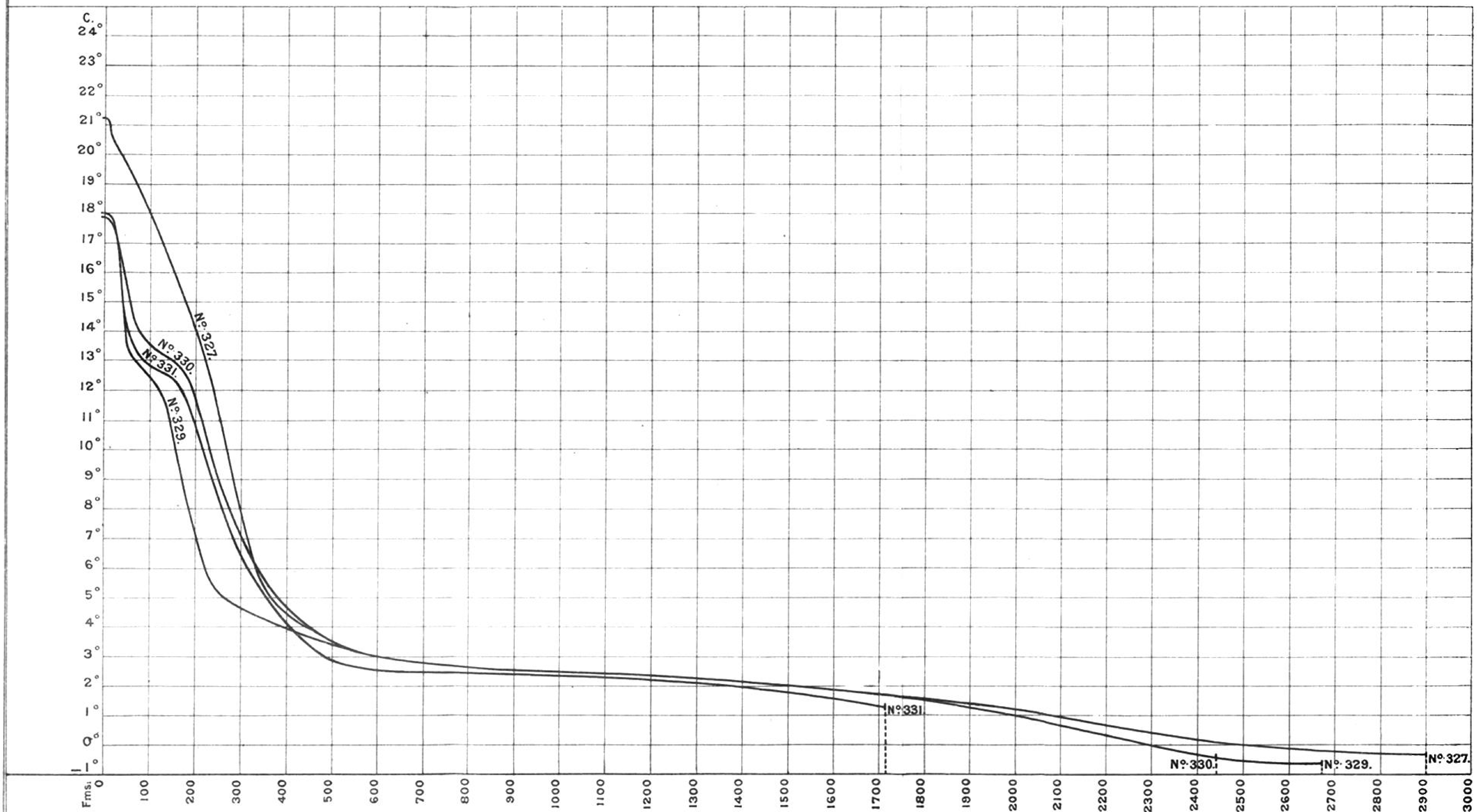
Malby & Sons, Lith.

CURVES CONSTRUCTED FROM SERIAL TEMPERATURE SOUNDINGS AT STATIONS 323 – 326.



Malby & Sons, Lith.

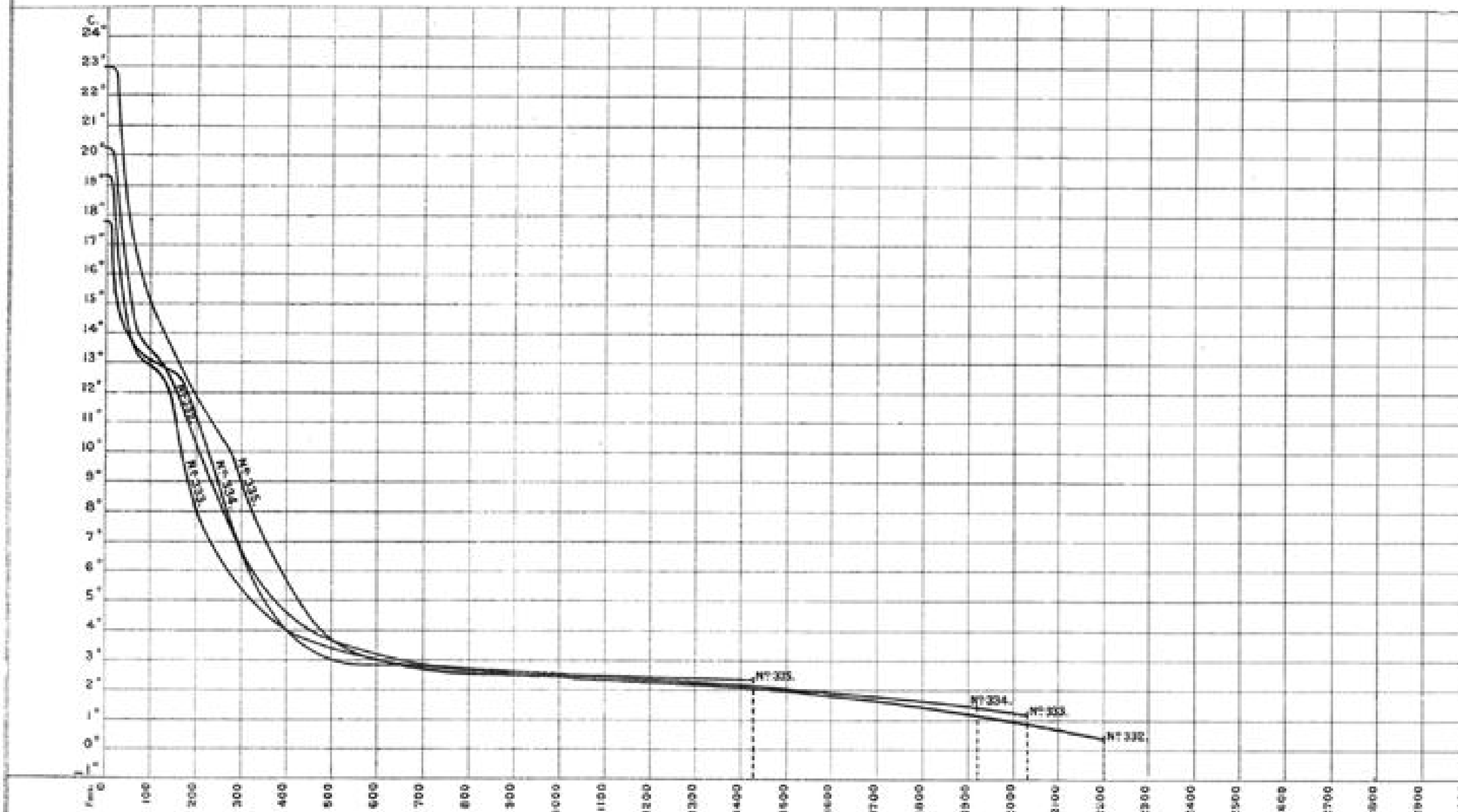
CURVES CONSTRUCTED FROM SERIAL SOUNDINGS AT STATIONS 327, 329, 330 AND 331.



Malby & Sons, Lith.

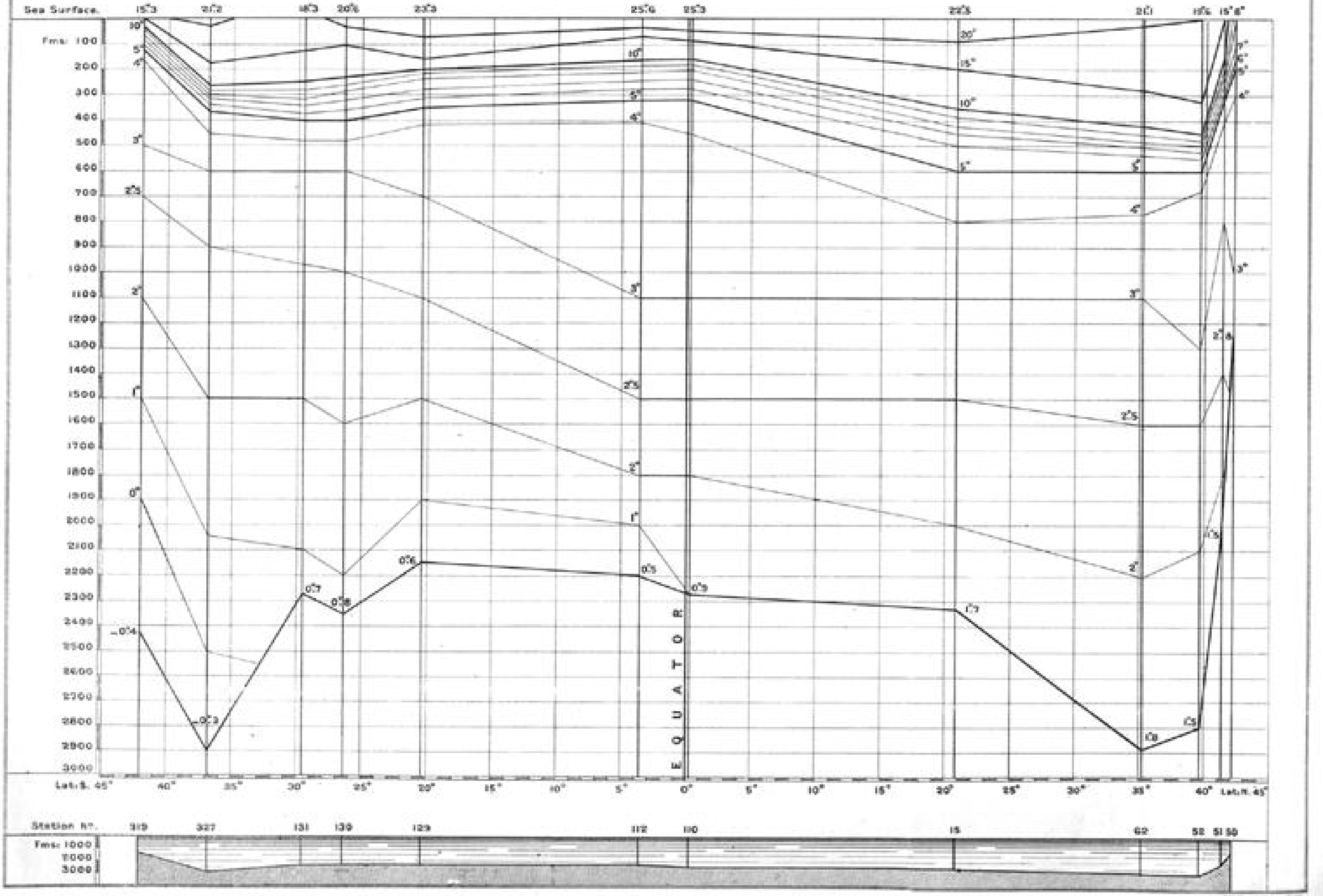
Proc. Roy. Soc. Vol. 24, Pl. 31.

CURVES CONSTRUCTED FROM SERIAL SOUNDINGS
AT STATIONS 332 – 335.



Mintern Bros. Lith.

DIAGRAM SHOWING THE VERTICAL DISTRIBUTION OF TEMPERATURE IN THE WESTERN TROUGH OF THE ATLANTIC.



Mintern Bros. lith.