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PART 4.

HYDROLOGICAL OBSERVATIONS

BY
DOUGLAS MAWSON.

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HYDROLOGICAL OBSERVATIONS.

BY

D. MAWSON, D.Sc.

I.—Routine Surface Water Observations.

Routine observations on board the "Aurora" included surface water temperatures taken every four hours and density determinations with a salinometer taken at noon each day. Such were recorded by the ship's officers under direction of Captain J. K. Davis. Also, whenever reliable fixes of the ship's observed noon position could be related to the ship's position by dead-reckoning, an estimate of the strength and set of the surface drift current was determined and recorded.

Such data is set forth in table form below. There the noon position and the surface water temperature is given, but not those of each four-hourly period. These four-hourly periods have, however, been used to determine the Mean Daily Temperature, which, of course, applies to a limited region centred about the ship's position at noon. The figures in the column recording Daily Range represent the difference between the highest and lowest surface temperature readings made in the 24 hours. The temperature observations were made on deck on a sample of the surface water taken in a canvas bucket.

At noon the additional observation of density of the water was recorded by a hydrometer. From this the density has been deduced and appears under column $\rho_{17.5}$. Finally S, the weight of salt in grammes found in 1,000 grammes of seawater, has been determined by reference to Knudsen's hydrographic tables.

The temperature determinations appear to be of sufficient accuracy to provide useful hydrological data. In the case of density determinations, however, the record is disappointing and of little use. It appears that over a considerable period the hydrometer was read merely to the nearest whole number, whereas it should have been read to at least one decimal place. On some days density observations were omitted altogether. Such determinations as were noted prior to 23rd January, 1912, are of some value. The hydrometer in use prior to that date was then broken and replaced by another with a large and uncertain error. Consequently though the daily S value has been computed for all the voyages it has, nevertheless, been decided to omit in this publication all mention of sea water densities after the date of 23rd January, 1912.

TABLE I.—DAILY SURFACE WATER HYDROLOGICAL OBSERVATIONS.

Date.	Noon Position.		Sea Water Temperature.				Salinity.			Remarks, including Current Observations.
	S. Latitude.	E. Longitude.	Noon, Deg. F.	Daily Range, Deg. F.	Mean Daily Temperature. Deg. F.	Mean Daily Temperature. Deg. C.	Hydrometer Reading.	$\rho_{17\cdot5}$.	S.	
1911.	deg. min.	deg. min.	-							27th Sept. Departed from Capetown.
30 Sept. ...	37 7	22 50	65·8	4·2	66·1	18·9	27	27·27	35·70	30th, 4 a.m. Very high temperature, 69·2° F., verified.
1 Oct. ...	38 53	23 37	66·7	10·7	62	16·7	28	28·42	37·19	1st Oct., 4 p.m. Temperature very low, 56·5° F., verified.
2 ,, ...	40 59	24 56	65	1	64·4	18·0	27	27·18	35·58	
3 ,, ...	42 43	27 10	56	3	54·2	12·3	28	27·16	35·55	
4 ,, ...	43 20	30 12	51	5	50·3	10·2	28	26·71	34·97	
5 ,, ...	43 25	32 57	47	4	47·4	8·5	28	26·39	34·55	
6 ,, ...	43 27	36 17	45	1	45·2	7·3	...	...	...	
7 ,, ...	43 37	39 40	44·2	3	43·7	6·4	28	26·21	34·32	
8 ,, ...	43 47	43 8	42	3	41·2	5·1	27	25·12	32·89	8th. During the last ten days the surface current set has been variable.
9 ,, ...	44 27	47 2	40·2	2	39·5	4·2	...	...	...	
10 ,, ...	44 30	50 55	38·9	1	39·5	4·2	...	...	...	
11 ,, ...	44 11	56 5	45	10	44·3	6·9	...	...	...	11th. A marked rise in temperature from noon on.
12 ,, ...	43 47	60 37	53	7·5	49·5	9·7	...	...	..	
13 ,, ...	43 24	64 55	53	6	51·5	10·9	...	...	...	
14 ,, ...	42 20	69 5	51	5	50·5	10·3	...	...	...	
15 ,, ...	42 27	72 36	50	3	50·3	10·2	...	...	...	
16 ,, ...	41 50	76 7	48·8	3·5	50·5	10·3	...	...	...	
17 ,, ...	42 26	79 55	51	3·5	51·2	10·7	...	...	...	
18 ,, ...	42 18	84 43	51·3	2	51·1	10·6	...	...	...	18th. During the past ten days the average movement of the surface drift current has been to the N.E. at rate of about 6 miles per day.
19 ,, ...	42 20	89 2	50	...	...	...	...	...	...	
20 ,, ...	42 19	93 5	51	2	50·3	10·2	...	...	...	
21 ,, ...	42 15	96 43	51	1·5	51·0	10·6	...	...	...	
22 ,, ...	42 32	100 0	50·5	1·0	50·4	10·2	...	...	...	
23 ,, ...	42 44	103 30	51	1·0	50·6	10·4	27	25·73	33·69	
24 ,, ...	42 42	107 30	50	0·5	50	10·0	...	...	...	
25 ,, ...	42 40	111 17	49·5	0·5	49·9	10·0	...	...	...	
26 ,, ...	43 0	115 10	50·2	1·2	50·2	10·2	28	26·64	34·88	
27 ,, ...	43 10	118 49	50	0·5	49·7	9·8	...	...	...	
28 ,, ...	43 26	122 40	51	2·0	50·7	10·4	28	26·40	34·56	28th. During the last ten days the surface drift current has made, on the average, to the S.E. at about 5 miles per day.
29 ,, ...	43 19	126 13	50·2	1·0	50·4	10·2	...	...	...	
30 ,, ...	43 26	129 56	50·5	1·5	51	10·6	...	...	...	
31 ,, ...	43 39	133 10	51·3	0·8	50·8	10·5	27	25·76	33·73	
1 Nov. ...	43 36	136 56	51	0·5	50·8	10·5	...	...	...	1st Nov. For the past three days the average set of the surface drift current has been about 5 miles per day to the S.E.
5 Dec. ...	45 5	152 46	52·2	...	...	...	...	...	...	4th. Arrived Hobart.
6 ,, ...	45 29	152 41	52	1·2	51·7	10·9	...	...	...	2nd Dec. Departed from Hobart.
7 ,, ...	47 9	152 1	49	4	49·3	9·6	...	...	...	
8 ,, ...	49 56	152 28	48	2	49·2	9·6	...	...	...	
9 ,, ...	51 48	154 4	43·5	6	44·5	6·9	...	...	...	9th. The water temperature fell suddenly between 4 a.m. (49° F.) and 8 a.m. (44·5° F.).
10 ,, ...	53 44	156 13	43	1·5	42·1	5·6	...	...	...	10th. During the past five days a strong E.S.E. drift noted.
11 ,, ...	...	...	44	0·5	43·8	6·5	...	...	...	11th. Off Caroline Cove, Macquarie Island.
12 ,, ...	...	...	42·5	1·6	43·1	6·1	...	...	...	12th. Off Caroline Cove and later North-East Bay.
13 ,, ...	...	...	43	...	43	6·1	...	...	...	13th. Anchored in Hassleborough Bay.
14 ,, ...	...	...	44	1	43·5	6·4	...	...	...	
15 ,, ...	...	...	42	1	42·3	5·8	...	...	...	
16 ,, ...	...	...	44	2	43	6·1	...	...	...	
17 ,, ...	...	...	43	1	43	6·1	...	...	...	
18 ,, ...	...	...	43	1·5	42·9	6·0	...	...	...	
19 ,, ...	...	...	43	1	42·5	5·9	...	...	...	
20 ,, ...	...	...	44·5	2	44·1	6·7	...	...	...	
21 ,, ...	...	...	43·5	1·7	43·9	6·7	...	...	...	
22 ,, ...	...	...	45·6	1·7	45·3	7·4	...	...	...	
23 ,, ...	...	...	44	1·5	44·7	7·0	...	...	...	
24 ,, ...	...	...	45	1·5	44·7	7·0	...	...	...	24th. Departed from Hassleborough Bay to Caroline Cove.
25 ,, ...	54 14½	158 38	44	1	44·6	6·9	...	...	...	25th. Departed from Macquarie Is.
26 ,, ...	57 15½	157 25	41	4	43·1	6·1	28	26·04	34·09	

TABLE I.—DAILY SURFACE WATER HYDROLOGICAL OBSERVATIONS—*continued.*

Date.	Noon Position.		Sea Water Temperature.				Salinity.			Remarks, including Current Observations.
	S. Latitude.	E. Longitude.	Noon, Deg. F.	Daily Range, Deg. F.	Mean Daily Temperature. Deg. F.	Deg. C.	Hydrometer Reading.	$\rho_{17.5}$.	S.	
1911.	deg. min.	deg. min.								
27 Dec. ...	59 38	157 21	42	3	41·4	5·3	28	26·09	34·16	
28 ,, ...	61 58	157 11	38	2·5	37·5	3·0	...	...	...	
29 ,, ...	63 49	156 14	37	5	35·5	1·9	28	25·88	33·88	29th. During the last few days noted a slow drift to the E.
30 ,, ...	65 14	156 5	33	3	32·3	0·2	28	25·77	33·74	
31 ,, ...	65 40	155 39	31·5	1·5	30·6	—7·0	27	24·80	32·47	
1912.										
1 Jan. ...	65 18	151 50	31	1	30·9	—0·6	27	24·79	32·46	
2 ,, ...	65 30	147 59	29	3	30·7	—0·7	...	...	...	
3 ,, ...	65 46	143 21	30	0·5	29·8	—1·2	26	23·82	31·18	
4 ,, ...	65 55	143 50	30	3	29·7	—1·2	26	23·82	31·18	4th. During the last four days the surface drift has set to the W.
5 ,, ...	65 41	144 0	30·5	0·8	30	—1·1	26	23·83	31·20	
6 ,, ...	66 37	144 58	31	1	30·8	—0·6	26	23·84	31·22	
7 ,, ...	66 55	144 52	31	1	31·2	—0·5	28	25·74	33·70	
8 ,, ...	66 47	143 14	33	2·3	31·8	—0·1	27	24·82	32·50	8th. During the past four days noted surface drift to the N.
9 ,, ...	67 0	...	31·5	3·5	30	—1·1	26	23·85	31·23	9th. At anchor, Commonwealth Bay.
10 Jan. ...	67 0	142 27	30	3	30	—1·1	27	24·77	32·43	
11 ,, ...	...	...	33·5	2·5	32·7	0·4	27	24·83	32·51	
12 ,, ...	...	...	35	4·5	30	—1·1	27	24·86	32·56	
13 ,, ...	...	...	31·2	2·3	30·4	—0·9	...	...	...	
14 ,, ...	...	...	31·5	2	30·6	—0·8	26	23·85	31·23	14th. A prolonged off-shore gale in progress.
15 ,, ...	...	...	32	1·5	31·8	—0·1	...	...	...	
16 ,, ...	...	...	32·5	2	32·1	0	27	24·82	32·50	
17 ,, ...	...	...	32·2	2·2	31·3	—0·4	...	...	...	
18 ,, ...	...	...	33	3	31·8	—0·1	27	24·82	32·50	18th. Bottom (9 fathoms) temperature 31° F.
19 ,, ...	...	...	33·2	2·5	32·9	0·6	27	24·83	32·51	19th at 9 p.m. Departed from Commonwealth Bay.
20 ,, ...	66 32	140 26	33·5	1·5	33	0·6	27	24·83	32·51	
21 ,, ...	65 39	139 0	33	1	32·5	0·3	...	...	...	
22 ,, ...	65 2	135 20	34	1	33·5	0·9	27	24·84	32·52	

Date.	Noon Position.		Sea Water Temperature.				Remarks, including Current Observations.
	S. Latitude.	E. Longitude.	Noon, Deg. F.	Daily Range, Deg. F.	Daily Mean Temperature. Deg. F.	Deg. C.	
1912.	deg. min.	deg. min.					
23 Jan. ...	65 2	132 26	34	1	33·7	1·0	25th. During the last 6 days the ship has experienced a decided set to the west of about 7 nautical miles per day. On same day there has been also a slight drift to the N., but on others to the S.
24 ,, ...	65 26	132 31	35	3	33·3	0·8	
25 ,, ...	65 16½	129 10	31·2	0·8	31·7	—0·2	
26 ,, ...	64 48	129 10	32·1	2·2	32·5	0·3	
27 ,, ...	64 0	127 0	34	2	33·7	1·0	
28 ,, ...	64 41	127 14	33	2·8	32·9	0·6	
29 ,, ...	64 54	127 6	33	3	31·9	—0·1	
30 ,, ...	65 34	125 0	32	2	32	0	
31 ,, ...	66 0	119 30	29·5	1·5	30·4	—0·9	
1 Feb. ...	64 49	115 57½	30·5	1·5	31·2	—0·4	1st. During the last couple of days there has been a strong surface drift to the west.
2 ,, ...	65 9	111 43	30·2	1·5	30·6	—0·8	
3 ,, ...	...	...	32	1	31·2	—0·5	
4 ,, ...	65 38	108 36	32·3	3·5	30·9	—0·6	
5 ,, ...	65 7	106 30	30	2·8	30·9	—0·6	
6 ,, ...	64 31	106 28	34·5	4·5	32·5	0·1	
7 ,, ...	64 30	102 9	32·5	3·0	34·1	1·1	7th. During the last 4 days the surface drift has set strongly to the west with a slight northing as well.
8 ,, ...	64 2	98 0	34	3	33·8	1·0	
9 ,, ...	64 33	97 11	32	1·3	31·9	—0·1	
10 ,, ...	64 26	97 11	31·5	0·8	31·2	—0·5	
11 ,, ...	64 24	97 15	31	1	31·3	—0·4	
12 ,, ...	64 43	94 39	29·8	3·6	29·7	—1·5	
13 ,, ...	65 54½	94 25	...	...	...	...	13th. Anchored to the floe during the night hours.
14 ,, ...	66 10	94 15	29·5	...	29·3	1·9	14th. Part time anchored to the bay ice, at other time steaming along the edge of it. 14th. During the last 4 days there has been a slight set to the north and a definite movement to the west.
15 ,, ...	66 21	94 51	32	3	31·1	—0·6	15th. Anchored to the bay ice at the Western Base Station.
16 ,, ...	66 21	94 51	32	2	32	0	

TABLE I.—DAILY SURFACE WATER HYDROLOGICAL OBSERVATIONS—*continued.*

Date.	Noon Position.		Sea Water Temperature.				Remarks, including Current Observations.
	S. Latitude.	E. Longitude.	Noon, Deg. F.	Daily Range, Deg. F.	Mean Daily Temperature. Deg. F.	Mean Daily Temperature. Deg. C.	
1912.	deg. min.	deg. min.					
17 Feb. ...	66 21	94 51	30·5	1·7	29·9	1·1	
18 „ ...	66 18½	95 2	28	2·7	28·9	—1·7	
19 „ ...	66 18½	95 2	30·5	3	29·9	—1·1	
20 „ ...	66 18½	95 2	29	3·2	29·1	—1·6	20th. Noted a surface current setting to the N.W. carrying the loose bay ice with it.
21 „ ...	65 48½	95 11	28·5	3·7	29·3	—1·5	21st at 7 a.m. Ship left the West Base for Hobart.
22 „ ...	64 11	95 52	33	3·5	32·9	0·6	
23 „ ...	63 45	96 44	35	2	34·3	1·3	
24 „ ...	62 29	97 57	37	2·5	36·7	2·6	
25 „ ...	62 7	102 41	38	...	37·7	3·1	25th. Record of water temperature is imperfect; at 4 p.m. 37° F. There was evidenced a set to the S.E. at 12 miles per day.
26 „ ...	61 23	107 41	...	...	...	...	
27 „ ...	60 33	112 7	38	2·6	37·7	3·1	27th. A set to the west observed both yesterday and to-day.
28 „ ...	60 2	117 49	38·6	1	38·2	3·4	
29 „ ...	59 29	123 4	39	0·7	39	3·9	29th A set to the S.S.E. noted both yesterday and to-day.
1 Mar. ...	58 40	126 1	41	1·5	40	4·4	
2 „ ...	58 42	129 19	41·2	2·5	40·2	4·5	
3 „ ...	58 37	131 4	40·1	...	...	...	
4 „ ...	57 27	133 10	41	1·3	41·1	5·0	
5 „ ...	54 56	133 54	42	1·7	42·2	5·7	
6 „ ...	53 57	135 56	43·2	0·2	43	6·1	
7 „ ...	52 19	137 17	45	2·3	44·4	6·9	
8 „ ...	49 52	140 30	49·5	5	48·4	9·1	8th. The surface drift has set steadily to the east during the past 5 days at the rate of 18 nautical miles per day. There is a small northerly component as well.
9 „ ...	47 38½	141 59	51·2	3	51·8	11·0	
10 „ ...	46 19	142 47	53·5	4	55·4	13	
11 „ ...	...	...	56	2·5	57	13·9	12th March. Arrived at Hobart.
25 „ ...	43 7	147 31	...	...	...	...	25th. Left Hobart for Sydney.
26 „ ...	42 1	149 42	66·5	1·5	66·3	19·1	
27 „ ...	39 23	150 6	68	2·3	67·3	19·6	
28 „ ...	37 38	150 7	71	4	68·8	20·5	
29 „ ...	35 59	150 18	...	3	70	21·1	30th. Arrived at Sydney.
20 May ...	36 0	150 43	67	3	65·7	18·7	20th May. Departed from Sydney for Subantarctic cruise.
21 „ ...	38 1	149 18	62	2·5	62·2	16·8	
22 „ ...	38 58½	146 56	59·3	1·8	59·6	15·4	
23 „ ...	39 32	143 56½	59	3·2	59·6	15·4	
24 „ ...	40 32	141 25	58·2	2	57·9	14·4	
25 „ ...	42 27½	141 1	57	2	56·2	13·4	25th. Surface drift setting to S. 30° E. at rate of 10 nautical miles in 24 hours.
26 „ ...	43 57	140 26	56	2·6	54·9	12·8	
27 „ ...	45 29	140 6	52	2	52·2	11·2	
28 „ ...	47 32	139 28	50	4·5	50	10	28th. To-day's observations indicated a strong set towards S. 21° W.
29 „ ...	49 17	139 37	46	4·2	46·5	8	
30 „ ...	51 41	140 13	42	1	42·3	5·8	
31 „ ...	52 32	143 33	45·2	1·2	44·4	6·9	
1 June ...	52 23	142 14	43	5	42·1	5·6	
2 „ ...	52 46	142 0	39·7	4·8	40·7	4·8	
3 „ ...	52 1	146 59	44	3·7	45·1	7·2	3rd. The surface drift during the 2nd and 3rd inst. moved to the E.N.E. by N. at rate of 18 miles per day.
4 „ ...	51 55	151 5	41	7	44·7	6·9	4th. Noted high temperature of water at 8 p.m. (48° F.).
5 „ ...	53 28	154 22	42	3	43	6·1	
6 „ ...	53 45	158 12	42·8	3	42·4	5·8	
7 „ ...	54 38	159 0	42	2	41·3	5·2	7th. Arrived at Macquarie Island.
8 „ ...	54 38	159 0	41·4	0·8	41·3	5·2	
9 „ ...	54 38	159 0	42	0·9	41·9	5·6	
10 „ ...	54 38	159 0	43	1	42·4	5·8	Remained at Macquarie Island between the 7th June and 22nd June, either within harbour or within a few miles of the island.
11 „ ...	54 38	159 0	40·8	0·9	40·8	4·9	
12 „ ...	54 38	159 0	40	0·2	40	4·4	
13 „ ...	54 38	159 0	40·5	0·8	40·6	4·8	
14 „ ...	54 38	159 0	42	0·9	41·8	5·5	
15 „ ...	54 38	159 0	41·8	1	41·5	5·3	
16 „ ...	54 38	159 0	41·5	1·5	41·1	5·0	
17 „ ...	54 38	159 0	41·3	1·2	41·8	5·5	
18 „ ...	54 38	159 0	40·5	0·5	40·8	4·9	
19 „ ...	54 38	159 0	41·2	1·8	40·9	5·0	
20 „ ...	54 38	159 0	41·1	0·6	40·7	4·8	
21 „ ...	54 38	159 0	40·8	1·4	40·1	4·4	
22 „ ...	54 38	159 0	41	...	...	...	22nd at 8·30 a.m. Left Macquarie Island, set course for the Auckland Islands.
23 „ ...	52 41	162 38	45·9	2·8	45·3	7·4	

TABLE I.—DAILY SURFACE WATER HYDROLOGICAL OBSERVATIONS—*continued.*

Date.	Noon Position.		Sea Water Temperature.				Remarks, including Current Observations.
	S. Latitude.	E. Longitude.	Noon, Deg. F.	Daily Range, Deg. F.	Daily Mean Temperature. Deg. F.	Deg. C.	
1912.	deg. min.	deg. min.					
24 June ...	51 6	165 34	46·8	0·8	46·7	8·1	24th at 2·45 p.m. Entered Carnley Harbour, Auckland Islands.
25 ,, ...	51 6	165 34	47	2·4	46·8	8·2	
26 ,, ...	51 6	165 34	46·2	1	46·5	8·0	
27 ,, ...	51 6	165 34	46·5	1·3	46·1	7·8	
28 ,, ...	51 6	165 34	45·2	0·7	44·9	7·2	
29 ,, ...	51 6	165 34	45·1	1·1	44·5	6·9	29th. Anchored at Port Ross.
30 ,, ...	51 6	165 34	45·8	1	45·6	7·6	30th. At Sandy Bay, Auckland Islands.
1 July ...	51 6	165 34	46	1	45·6	7·6	
2 ,, ...	51 6	165 34	45·8	1·2	45·4	7·5	
3 ,, ...	51 6	165 34	45·8	1·4	45·6	7·6	
4 ,, ...	51 6	165 34	46	0·7	46·3	7·9	
5 ,, ...	51 6	165 34	47	0·4	46·8	8·2	
6 ,, ...	50 35	166 25	47·3	1·3	46·3	7·9	6th July, at 10 a.m. Proceeded to sea, leaving for New Zealand.
7 ,, ...	49 17	167 36	46·3	2	46·8	8·2	
8 ,, ...	48 0	169 18	47	1·8	48·1	8·9	
9 ,, ...	47 16	169 52	47·8	1·9	48·6	9·2	
10 ,, ...	45 30	171 2	49	0·4	49·6	9·8	
11 ,, ...	...	...	...	...	...	...	11th. Arrived at Lyttleton.
6 Aug. ...	43 19	143 5	45	...	...	...	6th Aug. Departed from Lyttleton.
7 ,, ...	41 2	174 32	52	5	51·6	10·9	
8 ,, ...	40 10	172 4	56	2·9	55·6	13·1	
9 ,, ...	39 56	170 16	55·2	2	55·9	13·3	
10 ,, ...	39 40	167 40	56·5	3	56·5	13·6	
11 ,, ...	39 34	165 1	54·6	1·1	54·7	12·6	
12 ,, ...	39 10	161 15	56·4	3·5	56·8	13·7	
13 ,, ...	38 57	156 24	59	2·4	58·5	14·7	
14 ,, ...	38 30	153 3	58·1	2	57·6	14·2	
15 ,, ...	38 26	149 18	59·5	4·1	58·9	15	
16 ,, ...	39 0	145 57	55·1	1	55·5	13·1	17th Aug. Arrived at Melbourne.
3 Nov. ...	38 59	145 57	58	2	57	13·9	2nd Nov. Departed from Melbourne.
4 ,, ...	38 12	148 45	60	4·2	59·7	15·4	
5 ,, ...	36 13	150 13	63·5	6	62·9	17·2	
6 ,, ...	...	...	...	...	...	...	6th. Arrived at Port Kembla in morning and departed in the evening.
7 ,, ...	36 5	150 35	65	7	64	17·8	
8 ,, ...	38 13	150 2	60·5	1·5	59	15	
9 ,, ...	40 32	149 13	57·5	2·2	57·9	14·4	
10 ,, ...	43 13	147 40	56	...	...	...	10th at 4 p.m. Arrived at Hobart.
12 ,, ...	...	...	...	...	...	...	12th. Departed from Hobart on Second Subantarctic Cruise.
13 ,, ...	44 21	147 35	55·8	1	55·4	13·0	
14 ,, ...	45 26	147 26	54	6·1	53·6	12·0	
15 ,, ...	47 7½	147 31	50·7	2	49·7	9·8	
16 ,, ...	48 1	146 49	48·8	1·8	48·5	9·2	
17 ,, ...	48 38	146 24	49	3	48	8·9	
18 ,, ...	49 36	149 12	47·5	1·8	47·3	8·5	
19 ,, ...	50 36	151 43	45	2	46·1	7·8	
20 ,, ...	51 50	155 17	45	3·1	45·4	7·5	
21 ,, ...	53 27	157 39	47	4	45·3	7·4	
22 ,, ...	53 58	159 5	44·1	2·9	44·4	6·9	
23 ,, ...	...	...	44·5	1·7	44·3	6·9	23rd. Anchored at Macquarie Island.
24 ,, ...	...	...	43·7	2·5	43·8	6·6	
25 ,, ...	54 34½	159 2	43·1	1	42·7	5·9	25th at 10 a.m. Departed from Macquarie Island.
26 ,, ...	53 23	161 27	46	3·5	45	7·2	
27 ,, ...	51 51½	164 40	46·8	1·4	46·8	8·2	
28 ,, ...	50 43	166 58	48·5	1·7	47·8	8·7	
29 ,, ...	49 48	165 43	49·9	1·9	48·5	9·1	
30 ,, ...	49 50	163 32½	48·6	0·9	48·6	9·2	
1 Dec. ...	48 28	160 27	50	4	50·4	10·3	
2 ,, ...	49 2	156 53	51·2	4	50·7	10·5	2nd Dec. The surface drift current S. 73° E., 7 miles in 24 hours.
3 ,, ...	48 35½	154 40	49·7	1·2	49·3	9·6	
4 ,, ...	48 25	152 5	51·1	3	51·4	10·8	
5 ,, ...	48 22	149 53	51·6	1·7	52·1	11·1	
6 ,, ...	47 57½	147 41	51	1	51·6	10·9	
7 ,, ...	47 27½	149 5½	51	2	51·8	11	
8 ,, ...	46 46½	148 23	53·8	1·5	53·3	11·9	
9 ,, ...	46 20	147 37	53	1	53·1	11·7	
10 ,, ...	44 53	148 11	55·1	2·8	54·9	12·8	
11 ,, ...	43 13	148 32	57·5	3·2	57·7	14·2	
12 ,, ...	42 44	148 41	61	4·5	58·8	14·8	
13 ,, ...	42 49½	148 41	58·8	2	58·5	14·7	14th. Arrived at Hobart.

TABLE I.—DAILY SURFACE WATER HYDROLOGICAL OBSERVATIONS—*continued.*

Date.	Noon Position.		Sea Water Temperature.				Remarks, including Current Observations.
	S. Latitude.	E. Longitude.	Noon, Deg. F.	Daily Range, Deg. F.	Daily Mean Temperature. Deg. F.	Daily Mean Temperature. Deg. C.	
1912.	deg. min.	deg. min.					
26 Dec. ...	...	...	65	...	...	...	26th at 10 a.m. Departed on Second Antarctic Cruise. At noon ship off the Bonnet, Derwent Estuary.
27 „ ...	44 22	146 26	55·8	1·9	54·9	12·8	
28 „ ...	45 10	145 39	54·5	2·8	54·9	12·8	
29 „ ...	47 13	145 30	53·6	1·9	53·9	12·2	
30 „ ...	48 54	145 17	49·5	3	49·4	9·7	
31 „ ...	49 47	144 52	48	2·5	47·5	8·6	31st. Between the 29th and 31st the average surface drift has been to the S.S.E. at about 10 miles per day.
1913.							
1 Jan. ...	51 24	144 16	45	2·3	44·8	7·1	
2 „ ...	53 18	146 36	46	4	43·8	6·6	
3 „ ...	54 27	146 36	40·8	1·5	41·3	5·2	
4 „ ...	56 8	146 36	39·9	4·5	39·9	4·4	
5 „ ...	57 34½	146 34	39·4	1·7	38·9	3·9	
6 „ ...	59 8	146 50	38	0·9	37·8	3·2	6th Jan. From this date on until arriving at Adelie Land there was evidence of a regular set to the west with a small northerly component.
7 „ ...	60 1	146 54	37	1	37·5	3	
8 „ ...	61 53½	146 39	38	2	37·6	3·1	
9 „ ...	63 12	146 41	36·6	1	36·5	2·5	Between the dates 6th and 12th January the westerly component of surface drift is indicated as averaging about 6 miles per day
10 „ ...	64 6	146 40	36	1·3	35·5	2	
11 „ ...	65 20	146 48	36·9	3	35·9	2·2	Between the dates 9th and 12th January the northerly component was of the order of 5 miles per day.
12 „ ...	66 14	143 37	32·8	4·2	32·3	0·2	
13 „ ...	...	...	32·8	2	32·6	0·4	13th. Arrived at the Main Antarctic Base. Remained at anchor until the 29th.
14 „ ...	...	...	33·6	2·3	32·5	0·3	
15 „ ...	...	...	32	2	32	0	
16 „ ...	...	...	33	1·8	32	0	
17 „ ...	...	...	32·1	1·5	32·3	0·2	
18 „ ...	...	...	32·8	1·8	31·9	0	
19 „ ...	...	...	34·5	4·3	32·6	0·4	
20 „ ...	...	...	33·8	2·3	33	0·6	
21 „ ...	...	...	32·6	2·3	32·6	0·4	
22 „ ...	...	...	32	1·2	32	0	
23 „ ...	...	...	32	1	31·6	—0·2	
24 „ ...	...	...	33	1·8	31·7	—0·2	
25 „ ...	...	...	30·8	2	30·9	—0·6	
26 „ ...	...	...	33·5	2·5	31·3	—0·4	
27 „ ...	...	...	32·8	0·9	32·8	0·5	
28 „ ...	...	...	33·5	2	32·8	0·5	
29 „ ...	66 53	143 8	32·8	3	32·2	0·1	29th. "Aurora" left the anchorage to cruise along the coast to the east.
30 „ ...	67 14	145 8	31	1	30·9	—0·6	
31 „ ...	66 57	144 38	30·2	0·6	30·2	—0·9	
1 Feb. ...	66 59	142 37	32	1·9	30·8	—0·7	1st Feb. Arrived back at the Main Base Station.
2 „ ...	...	...	30·1	1	30·4	—0·9	
3 „ ...	...	...	30	1	30·3	—0·8	Between the dates 2nd and 8th of February the "Aurora" steamed backwards and forwards off Cape Denison in a severe gale.
4 „ ...	...	...	29·9	1·9	29·9	—1·1	
5 „ ...	...	...	29·1	0·3	29·1	—1·7	
6 „ ...	...	...	29	1·6	29·5	—1·4	
7 „ ...	...	...	29	0·8	29	—1·7	
8 „ ...	66 57	142 35	29·1	2·6	30·1	—1	8th. Departed from the Main Base Station.
9 „ ...	...	...	30·5	1·5	30·2	—1	9th. Returned to Commonwealth Bay.
10 „ ...	65 53	142 48	...	4·2	31·5	—0·3	10th. Steaming west from Commonwealth Bay.
11 „ ...	64 23	140 53	35·1	4·8	34·1	1·1	11th. A strong westerly set of about 15 miles per day was observed on the 10th and 11th, following the E.S.E. gale.
12 „ ...	64 21	138 39	35·5	1·6	35·2	1·8	
13 „ ...	64 31½	135 35½	34·5	1·1	34·3	1·3	
14 „ ...	64 33½	131 50	34	2·9	33·2	0·7	
15 „ ...	64 39	124 52	33	2·4	33·2	0·7	
16 „ ...	64 52	118 8	35	1·5	34·1	1·1	Between the 16th and 19th the westerly component of surface drift amounted to about 6 miles per day.
17 „ ...	64 26	111 32	34	0·8	33·8	1	
18 „ ...	64 25	105 14	34·1	1·8	33·5	0·9	
19 „ ...	63 52½	100 6	31·2	2	32	0	
20 „ ...	63 19	97 20	32	2·1	32·8	0·5	During the 20th and 21st a brisk westerly set noted.
21 „ ...	63 12	95 9	32·5	2·3	31·5	—0·3	
22 „ ...	64 26	95 17	31	1·5	31·2	—0·5	
23 „ ...	...	...	29	1·5	29·7	—1·3	
24 „ ...	64 58½	94 52	31·2	1·7	30·9	—0·6	
25 „ ...	63 16	94 39	33·4	4·1	33·5	0·9	Between the 25th and 27th a westerly set noted.
26 „ ...	60 32	95 16	35	1·4	35	1·7	
27 „ ...	58 14½	96 59	36·5	2·9	37	2·8	
28 „ ...	56 15	98 56	39	2·6	38·5	3·6	28th. The surface drift now observed to be setting to the east.
1 Mar. ...	54 37	100 20	37·4	2·7	37·7	3·1	
2 „ ...	53 51	105 38	38·5	1·1	38·8	3·8	2nd March. The easterly component of surface drift during the last three days has been of the order of 4 miles per day.
3 „ ...	52 52½	110 11	39·5	1	39	3·9	

TABLE I.—DAILY SURFACE WATER HYDROLOGICAL OBSERVATIONS—*continued.*

Date.	Noon Position.		Sea Water Temperature.				Remarks, including Current Observations.
	S. Latitude.	E. Longitude.	Noon, Deg. F.	Daily Range. Deg. F.	Daily Mean Temperature. Deg. F.	Deg. C.	
1913.	deg. min.	deg. min.					
4 Mar. ...	52 15	115 40	39·6	1·9	39·3	4·1	
5 „ ...	51 12	120 32	41·8	3	41·7	5·4	
6 „ ...	49 31	123 39	46·5	4·2	45	7·2	The easterly component of surface drift movement during the 5th, 6th and 7th has averaged about 15 miles per day.
7 „ ...	48 16	127 47	49·2	2·6	49·4	9·6	
8 „ ...	47 17	131 49	50·5	0·9	50·3	10·2	
9 „ ...	46 8	135 26	52	1·8	51·4	10·8	Between the 7th and 11th there has been indicated a southerly component of drift amounting to about 8 miles per day; the actual direction of movement indicated has been to the E.S.E.
10 „ ...	45 14½	138 48	55	4·5	54·3	12·4	
11 „ ...	45 6½	140 40	55	3·2	55·7	13·1	
12 „ ...	44 57½	142 13	55·1	1·4	55·2	12·9	
13 „ ...	44 35	144 32	55·2	5·6	55·6	13·1	
14 „ ...	43 32	147 9	58·8	1·7	58·5	14·7	
19 Nov. ...	...	...	59·8	...	...	...	19th November. Departed from Hobart, off the Iron Pot at noon.
20 „ ...	44 54	146 47	54·5	5	53·9	12·2	The temperature of the open sea beyond Tasman Head between 8 p.m. and midnight was 54° F.
21 „ ...	47 68	147 16	52	4	52·8	11·5	
22 „ ...	49 9	148 1	48·6	1·2	48·2	9	22nd. During the last three days the principal component of
23 „ ...	50 25	148 22	48	5·3	47·4	8·7	observed surface drift has been to the south.
24 „ ...	52 18	148 10	49	6·5	46	7·8	For the nine days (20th to 28th) the surface drift has averaged
25 „ ...	54 31	148 18	38·5	6·5	40·9	5	6 miles to the S. and 6 miles to the E.
26 „ ...	54 35	151 4	40	2·9	40	4·4	
27 „ ...	54 28	154 29	41·9	2·8	40·9	5	
28 „ ...	54 22	157 51	40·3	1·7	40·4	4·6	28th at 4·20 p.m. Dropped anchor at Hassleborough Bay.
29 „ ...	...	...	41·3	1·5	40·4	4·6	
30 „ ...	...	...	40	0·7	40	4·4	
1 Dec. ...	...	...	40·4	1·4	39·6	4·2	
2 „ ...	...	...	41·5	2·2	40·5	4·7	
3 „ ...	...	...	42·8	2·8	41·3	5·2	3rd. Left the anchorage, steamed around the west of the island and anchored at Lusitania Bay in the evening.
4 „ ...	...	...	41·8	1·8	40·8	4·9	
5 „ ...	...	...	41·5	2·3	41·3	4·6	5th. Steamed up the E. coast of the island, arriving at North-east
6 „ ...	55 55	157 48	41·1	4·3	40·7	4·8	Bay at noon. Proceeded to sea at 4 p.m.
7 „ ...	58 65	155 55	38	4	37·3	3	
8 „ ...	59 29	154 14	36·6	2·8	35·5	2	8th. During past three days the surface drift appears to have
9 „ ...	61 55	151 41	33·8	2·9	32·7	0·4	been moving due E. at an average rate of 5½ miles per day.
10 „ ...	63 52	150 0	31·2	1·8	30·9	—0·6	
11 „ ...	64 56	147 8	31	1·1	30·5	—0·9	11th. During the past three days there appears to have been
12 „ ...	66 7	145 28	30·1	0·7	30	—1·1	a slight drift to the north and to the east.
13 „ ...	...	...	30·5	1·3	30·3	—1	13th at 7 a.m. Anchored in Commonwealth Bay.
14 „ ...	...	...	31	2·3	30	—1·1	
15 „ ...	...	...	30·1	1·3	30	—1·1	
16 „ ...	...	...	30·1	1	30·6	—0·9	
17 „ ...	...	...	31·5	3·5	31	—0·6	
18 „ ...	...	...	32·1	2·5	31·6	—0·3	
19 „ ...	...	...	31·6	2·1	31	—0·6	
20 „ ...	...	...	30·5	1·3	30·4	—0·9	
21 „ ...	...	...	31·6	2·5	31·5	—0·3	
22 „ ...	...	...	32	3	32·1	0	22nd at 9 a.m. Left the anchorage to trawl; returned in the
23 „ ...	...	...	32·3	1·5	31·7	—0·2	evening.
24 „ ...	...	...	...	0·5	30·2	—0·9	24th at 1 p.m. The anchor carried away. Driven out to sea.
25 „ ...	66 43	143 24	30·5	0·4	30·5	—0·9	
26 „ ...	66 44	144 31	30	1	30·4	—0·9	
27 „ ...	67 0	145 24	31·8	1·8	30·8	—0·7	
28 „ ...	66 55	145 21	30·6	1·3	30·7	—0·8	
29 „ ...	66 51	145 35	30·5	1·3	30·6	—0·9	
30 „ ...	66 54½	143 51	31·1	1·7	31·2	—0·4	
31 „ ...	66 46	141 41	31	2·5	30·6	—0·9	
1914.							
1 Jan. ...	65 43	140 19	30·8	1·2	31·1	—0·5	
2 „ ...	65 50	137 30	33·8	2·5	32·5	0·3	
3 „ ...	64 39	134 46	33·8	2·1	32·6	0·4	
4 „ ...	64 18	132 24	31	6·7	32·7	0·4	4th at 4 p.m. Temperature 37·1° F., checked.
5 „ ...	64 10	130 4	34·6	4·1	32·6	0·4	Observations between the 3rd and 6th suggest a small E.N.E. drift.
6 „ ...	64 34½	127 8	32·2	1·6	32·4	0·3	
7 „ ...	64 34	125 55	31·8	2·2	32	0	
8 „ ...	65 2	123 12	30·8	1	30·5	—0·9	
9 „ ...	65 30	120 40	32	1·7	30·9	—0·6	During the 8th and 9th a steady drift to the west and north.
10 „ ...	64 34	117 1	33·2	3·3	32·3	0·2	10th. A small easterly drift appears to have taken place to-day.
11 „ ...	64 50½	113 16	32	2·2	32·5	0·3	
12 „ ...	64 37	108 50	31·7	1·1	32	0	12th. For the past three days the drift appears to have made to the east slightly.
13 „ ...	64 14	104 35	32·5	3	31·1	—0·5	During the 13th and 14th there was indicated a marked set to the
14 „ ...	63 15	101 42	31·8	3	31	—0·6	west, with a very small component to the north.

TABLE I.—DAILY SURFACE WATER HYDROLOGICAL OBSERVATIONS—*continued.*

Date.	Noon Position.				Sea Water Temperature.				Remarks, including Current Observations.
	S. Latitude.		E. Longitude.		Noon, Deg. F.	Daily Range, Deg. F.	Daily Mean Temperature.		
							Deg. F.	Deg. C.	
1914.	deg.	min.	deg.	min.					
15 Jan. ...	62	46	98	56	33	4·5	32·7	0·4	
16 ,, ...	62	59	95	47	31	0·9	30·6	—0·9	
17 ,, ...	62	21	95	9	33·1	4	32·8	0·5	Between the 15th and 18th the drift variable.
18 ,, ...	63	40½	92	59	30·3	2·2	31·3	—0·4	
19 ,, ...	64	59	90	8	31·5	3·8	31·8	—0·1	19th. A marked westerly drift.
20 ,, ...	65	47	90	39	33	2·5	32·6	0·4	On the run west during the interval 1st to 19th January the resultant drift movement is indicated as slightly to the north and slightly to the west.
21 ,, ...	65	46	92	13	32·7	1·9	31·6	—0·2	
22 ,, ...	66	28½	92	27	30·8	2·1	31·7	—0·2	
23 ,, ...	66	4	93	33	32	0·8	31·9	0	
24 ,, ...	66	8	93	27	31	0·4	31·1	—0·6	
25 ,, ...	66	1	94	22	31·1	1·4	31·1	—0·6	25th. The fierce storm of the past three days has developed a drift to the W.N.W.
26 ,, ...	66	0	94	22	31·8	1·3	31·5	—0·3	
27 ,, ...	66	8	94	20	32·8	3·3	32·8	0·5	
28 ,, ...	65	18½	95	20	33	2	32·1	0	
29 ,, ...	65	5	96	8	33	2·4	32	0	
30 ,, ...	64	53	95	59	32·8	3·8	31·7	—0·2	
31 ,, ...	64	40	97	22	31·1	2·8	30·9	—0·6	
1 Feb. ...	64	26	97	45	31·9	2·1	31·1	—0·6	
2 ,, ...	63	56	96	40	31·2	1·3	30·8	—0·7	
3 ,, ...	63	54½	96	35	31·5	2·3	31·4	—0·4	3rd. Drift movements appear to have been slight and variable since the 27th January.
4 ,, ...	64	41	93	59	31	2	31·7	—0·2	
5 ,, ...	65	45	91	43	33	3·5	31·7	—0·2	
6 ,, ...	65	19½	90	16	30·9	3·8	31·6	—0·2	During the period 4th to 6th there has been a slight but decided drift to the N.N.W.
7 ,, ...	63	28½	90	22	35·6	1·9	35·2	1·8	
8 ,, ...	61	24½	90	57	35	0·9	35·2	1·8	
9 ,, ...	59	35	91	58	36·1	1	36·4	2·4	
10 ,, ...	58	56	93	15	36	0·3	36	2·2	
11 ,, ...	57	40	95	16	38·5	2·1	37·2	2·9	
12 ,, ...	55	9	95	58	38·1	0·8	38·2	3·4	During the period 10th to 14th there is indicated a decided drift, with a daily movement of about 3 miles to the north and 8½ to the east per day.
13 ,, ...	53	5	98	44	39·9	1·6	39·5	4·2	
14 ,, ...	51	25	103	35	40·5	2·1	40·4	4·6	
15 ,, ...	49	48	107	6	41·3	2·5	41·8	5·5	
16 ,, ...	48	5½	110	9	46·1	3	46·1	7·8	
17 ,, ...	46	8	113	44	47·8	3·8	49·6	9·7	
18 ,, ...	44	19	117	0	50·8	2·9	51·5	10·9	During the period 15th to 18th the drift indicated has averaged 4 miles per day to the E.S.E.
19 ,, ...	43	6	119	31	52·2	2·2	52·8	11·5	
20 ,, ...	41	32	122	39	54·7	2·6	55·3	12·9	In the interval 19th to 23rd the drift appears to have been to the N.W. at 3 miles per day.
21 ,, ...	40	4	125	51	59·1	6	58·7	14·8	
22 ,, ...	38	33	129	20	61	1·4	60·5	15·9	The average drift movement for the period 10th to 23rd (59° S. to 37° S.) appears to have been 3 miles per day to the east and 1¼ miles to the north.
23 ,, ...	37	13½	132	10	62·7	1·8	63·3	17·4	
24 ,, ...	35	55	134	18	65·1	1·7	65·5	18·6	24th. Trawling all day.
25 ,, ...	35	44	135	58	67·6	1·8	67·7	19·8	25th. At noon Cape Borda in view.
26 ,, ...	35	3	138	4	71	...	...	...	26th at 4 p.m. Arrived off Adelaide.

II.—Vertical Series of Temperatures and Salinities.

1. *Temperatures.*

During the last Antarctic cruise when the ship's staff was assisted by the relieved shore parties, a number of vertical hydrological stations were undertaken, with the results tabulated below. Lieut. Robert Bage was the chief assistant in this work, co-operating with Captain Davis and the ship's officers in working the gear. Richter thermometers were employed in conjunction with Ekman reversing water bottles.

Note that where latitudes and longitudes quoted in these tables differ from those set forth in relation to the identically same localities in the Report on "Sea Floor Deposits from Soundings" of this series (Series C, Vol. II, Part 1) these later figures are the correct ones.

During the two years' sojourn ashore at Cape Denison temperature and density observations of the shore waters were made by me from time to time. These relate more to the subject of glaciology and will be recorded elsewhere in the Expedition Reports.

SEA WATER TEMPERATURES.

Table II.—*Vertical Series.*

Date.	Hour.	Latitude.	Longitude.	Depth of Sea Floor (metres).	Sea Water Temperatures.	
					Depth (metres).	Corrected Temperature (deg. C.).
1913.		deg. min.	deg. min.			
18 January	10·00	67 00	142 39	51	0	—1·45
	.....	.....	.....	.....	25	—1·42
	.....	.....	.....	.....	50	—1·42
13 November.....	13·05	44 21	147 35	2,688	1,569	2·78
23 „	13·00	50 30	148 02	4,517	0	8·48
	.....	.....	.....	.....	18	8·22
	.....	.....	.....	.....	46	8·26
	.....	.....	.....	.....	92	8·22
	.....	.....	.....	.....	183	8·33
	.....	.....	.....	.....	275	8·35
	.....	.....	.....	.....	366	8·31
25 „	9·15	54 30	148 13	4,207	0	2·73
	.....	.....	.....	.....	18	2·72
	.....	.....	.....	.....	46	2·71
	.....	.....	.....	.....	92	2·69
	.....	.....	.....	.....	183	2·68
26 „	12·00	54 35	151 4	4,060	0	3·40
	.....	.....	.....	.....	18	3·39
	.....	.....	.....	.....	46	3·37
	.....	.....	.....	.....	92	3·35
	.....	.....	.....	.....	183	3·34
	.....	.....	.....	.....	Bottom	0·54
27 „	11·30	54 28	154 29	4,280	Bottom	0·60
28 „	7·30	54 22	157 20	3,987	0	4·51
	.....	.....	.....	.....	18	4·51
	.....	.....	.....	.....	46	4·44
	.....	.....	.....	.....	Bottom	0·69
	13·00	54 22	158 00	4,133	Bottom	0·73
7 December.....	16·00	58 19	155 39	3,660	0	2·35
	.....	.....	.....	.....	18	2·33
	.....	.....	.....	.....	46	2·32
8 „	13·00	59 30	154 10	2,855	0	2·32
	.....	.....	.....	.....	18	2·31
	.....	.....	.....	.....	46	1·08
10 „	6·30	63 33	150 29	3,840	Bottom	—0·15
12 „	16·30	66 25	144 50	457	Bottom	—1·92
	20·00	66 37	144 8	823	Bottom	—1·93

SEA WATER TEMPERATURES—*continued.*

TABLE II.—*Vertical Series—continued.*

Date.	Hour.	Latitude.	Longitude.	Depth of Sea Floor (metres).	Sea Water Temperatures.	
					Depth (metres).	Corrected Temperature (deg. C.).
1913.		deg. min.	deg. min.			
22 Dec.	12·00	66 50	142 6	777	Bottom	—1·85
27 „	19·30	66 51	145 35	527	Bottom	—1·74
28 „	15·30 to 17·00	66 55	145 24	582	0	—1·03
	.....	.....	.....	.....	46	—1·29
	.....	.....	.....	.....	92	—1·41
	.....	.....	.....	.....	137	—1·39
	.....	.....	.....	.....	183	—1·39
	.....	.....	.....	.....	366	—0·73
	.....	.....	.....	.....	549	—1·77
	.....	.....	.....	.....	Bottom	—1·79
29 „	13·45	66 49	145 42	439	Bottom	—1·64
31 „	16·00	66 32	141 39	287	0	—0·79
	.....	.....	.....	.....	46	—1·18
	.....	.....	.....	.....	92	—1·30
	.....	.....	.....	.....	137	—1·40
	.....	.....	.....	.....	183	—1·54
1914.	.....	.....	.....	.....	Bottom	—1·59
1 January	12·00	65 43	140 19	375	Bottom	—0·75
	16·30	65 21	139 48	2,634	Bottom	—0·38
2 „	15·00	65 48	137 32	604	0	—0·55
	.....	.....	.....	.....	92	—1·45
	.....			.....	183	—1·60
	.....	.....	.....	.....	366	—1·45
	.....	.....	.....	.....	549	—1·43
	.....	.....	.....	.....	580	—1·42
4 „	18·00	64 00	132 22	3,310	0	1·43
	.....	.....	.....	.....	27	0·45
	.....	.....	.....	.....	92	—0·51
	.....	.....	.....	.....	128	0·04
	.....	.....	.....	.....	183	1·19
	.....	.....	.....	.....	275	1·42
	.....	.....	.....	.....	366	1·10
	.....	.....	.....	.....	2,560	—0·23
6 „	10·00	64 34	127 17	3,110	Bottom	—0·31
9 „	8·40	65 28	120 59	2,562	Bottom	—0·32
10 „	10·00	64 35	117 01	2,469	Bottom	—0·77
11 „	8·30	64 44	113 46	1,810	Bottom	0·25
12 „	8·45	64 37	109 06	2,798	Bottom	—0·32
14 „	8·45	63 21	101 42	1,298	Bottom	—0·21
	11·00 to 15·00	63 15	101 42	1,591	0	—1·00
	.....	.....	.....	.....	46	—1·56
	.....	.....	.....	.....	92	—1·57
	.....	.....	.....	.....	137	—1·58
	.....	.....	.....	.....	183	—1·38
	.....	.....	.....	.....	366	—0·15
	.....	.....	.....	.....	549	0·16
	.....	.....	.....	.....	732	0·07
	.....	.....	.....	.....	915	—0·03
	.....	63 13	101 42	.....	Bottom	—0·22
15 „	9·00	62 47	99 20	4,115	Bottom	—0·21
16 „	19·00	62 58	96 2	3,035	Bottom	0·05
17 „	16·15	62 33	94 34	3,640	Bottom	2·17*
20 „	8·30	65 47	90 16	531	Bottom	—1·66
20 „	16·00	65 48	91 21	512	Bottom	—1·73
26 „	20·40	66 17	94 20	373	Bottom	—1·76
27 „	8·45	66 10	94 20	265	Bottom	—1·42
	20·35	65 53	95 18	600	0	—0·18
	.....	.....	.....	.....	46	—0·36
	.....	.....	.....	.....	92	—0·52
	.....	.....	.....	.....	137	—1·06
	.....	.....	.....	.....	183	—1·61
	.....	.....	.....	.....	275	—1·71
	.....	.....	.....	.....	366	—1·72
	.....	.....	.....	.....	549	—1·72
	.....	.....	.....	.....	Bottom	—1·73
28 „	8·00	65 31	95 18	412	Bottom	—1·63
	17·30	65 08	95 43	461	Bottom	—1·64
	19·40	65 07	96 03	585	Bottom	—1·70

* This temperature is evidently in error.

SEA WATER TEMPERATURES—*continued.*

TABLE II.—*Vertical Series—continued.*

Date.	Hour.	Latitude.	Longitude.	Depth of Sea Floor (metres).	Sea Water Temperatures.	
					Depth (metres).	Corrected Temperature (deg. C.).
1914.		deg. min.	deg. min.			
29 January	8·45	65 06	96 13	594	Bottom	—1·66
	21·00	65 02	96 13	640	Bottom	—1·66
30 ,, ...	12·00	64 53	95 59	677	Bottom	—1·71
31 ,, ...	17·00	64 32	97 17	188	0	—0·68
	.....	.....	.....	.....	16	—1·27
	.....	.....	.....	.....	33	—1·40
	.....	.....	.....	.....	46	—1·60
	.....	.....	.....	.....	92	—1·70
	.....	.....	.....	.....	137	—1·72
	.....	.....	.....	.....	183	—1·73
5 February	12·00	65 45	91 43	485	Bottom	—1·63
	16·40	65 46	91 47	485	Bottom	—1·63
7 ,, ...	18·00	62 55	90 28	3,877	Bottom	—0·17

2. *Salinities.*

On most occasions, when taking a vertical series of temperatures, water samples were also obtained. These samples were later chemically examined by the analytical section of the Mines Department, Sydney. Thanks for this help are due to the then Under Secretary for Mines, Mr. E. F. Pittman, who authorised the investigation and to J. C. H. Mingaye, F.I.C., F.C.S., for conducting the work with the assistance of Messrs. H. P. White and W. A. Greig, analysts of the Mines Department. The report on these water samples was completed for publication in the year 1915.

The samples were preserved in the usual small swing-stopper bottles employed for such work. The waters were not chemically examined until about one year after collection. Careful estimates of chlorine and sulphate radicle were made by Mr. Mingaye and his staff, also the specific gravity was determined at the same time.

The salinity column herewith is derived from the chlorine content by reference to Knudsen's tables. It will be observed that variations in specific gravity do not follow in strict accord the variations in the chlorine content. This suggests that possibly some of the samples had suffered from being held in the bottles too long before analysis.

TABLE III.—SEA WATER SALINITIES.

Date.	S. Latitude.	E. Longitude.	Depth of Sea (metres).	Depth (metres).	Specific Gravity at 15·5° C.	Cl* per 1,000.	SO_4 per 1,000.	*S.*
1913.	deg. min.	deg. min.						
23 November	50 30	148 02	4,517	0	1·0268	19·6448	2·7227	35·49
	.....	.....	.....	18	1·0265	19·7512	2·7120	35·68
	.....	.....	.....	46	1·0269	19·7157	2·7375	35·62
	.....	.....	.....	92	1·0267	19·7157	2·7383	35·62
	.....	.....	.....	183	1·0268	19·8576	2·7704	35·87
	.....	.....	.....	275	1·0267	19·7157	2·7211	35·62
	.....	.....	.....	460	1·0265	19·6448	2·7021	35·49
25 „ ...	54 30	148 13	4,207	0	1·0262	19·2193	2·6667	34·72
	.....	.....	.....	18	1·0265	19·7512	2·7120	35·68
	.....	.....	.....	46	1·0262	19·4321	2·6651	35·10
	.....	.....	.....	92	1·0261	19·5030	2·6832	35·24
	.....	.....	.....	183	1·0264	19·3611	2·6651	34·97
26 „ ...	54 35	151 4	4,060	0	1·0261	19·4321	2·6667	35·10
	.....	.....	.....	18	1·0264	19·3611	2·6733	34·97
	.....	.....	.....	46	1·0262	19·2902	2·6733	34·85
	.....	.....	.....	92	1·0264	19·4321	2·6618	35·10
	.....	.....	.....	183	1·0262	19·2193	2·6643	34·72
28 „ ...	54 22	157 20	3,987	0	1·0262	19·2193	2·6602	34·72
	.....	.....	.....	25	1·0262	19·3611	2·6725	34·97
3 December	3·3 statute miles W. by S. from Eagle Pt. Macquarie Isl.		750	0	1·0261	19·4321	2·6733	35·10
	.....	.....	.....	18	1·0265	19·3611	2·6647	34·97
7 „ ...	58 19	155 39	3,660	0	1·0261	19·2902	2·6601	34·85
	.....	.....	.....	18	1·0262	19·3611	2·6783	34·97
	.....	.....	.....	46	1·0262	19·4321	2·6708	35·10
8 „ ...	59 30	154 10	2,855	0	1·0261	19·5030	2·6667	35·24
	.....	.....	.....	18	1·0262	19·5030	2·6750	35·24
	.....	.....	.....	46	1·0266	19·4321	2·6667	35·10
†28 „ ...	66 55	145 24	582	0	1·0265	19·6448	2·6890	35·49
	.....	.....	.....	46	1·0267	19·6448	2·6914	35·49
	.....	.....	.....	92	1·0271	19·7157	2·6640	35·62
	.....	.....	.....	137	1·0269	19·6488	2·7104	35·49
	.....	.....	.....	183	1·0268	19·6488	2·7029	35·49
	.....	.....	.....	368	1·0269	19·7157	2·7202	35·62
	.....	.....	.....	550	1·0269	19·7866	2·7161	35·74

* Including also the bromine present.

†Record taken quite close to the ice wall of the Mertz Glacier Tongue.

TABLE III.—SEA WATER SALINITIES—*continued.*

Date.	S. Latitude.	E. Longitude.	Depth of Sea (metres).	Depth (metres).	Specific Gravity at 15·5° C.	Cl per 1,000.	SO_4 per 1,000.	*S.*
1913.	deg. min.	deg. min.						
31 December	66 32	141 39	287	0	1·0272	19·7866	2·6920	35·74
	.....	.....	.....	46	1·0271	19·8931	2·7449	35·93
	.....	.....	.....	92	1·0268	19·7157	2·6972	35·62
	.....	.....	.....	137	1·0268	19·6488	2·7120	35·49
1914.	.....	.....	.....	183	1·0267	19·5030	2·7087	35·24
2 January...	65 48	137 32	604	0	1·0269	19·6448	2·6640	35·49
	.....	.....	.....	92	1·0266	19·6488	2·6618	35·49
	.....	.....	.....	183	1·0266	19·6488	2·6791	35·49
	.....	.....	.....	366	1·0269	19·6448	2·7136	35·49
	.....	.....	.....	549	1·0268	19·6488	2·7219	35·49
4 „ ...	64 00	132 22	3,310	0	1·0264	19·4321	2·6408	35·10
	.....	.....	.....	92	1·0267	19·7157	2·6880	35·62
	.....	.....	.....	128	1·0267	19·7866	2·6780	35·74
	.....	.....	.....	183	1·0269	19·8576	2·7083	35·85
	.....	.....	.....	275	1·0272	19·8576	2·7227	35·85
	.....	.....	.....	366	1·0269	19·8576	2·7178	35·85
	.....	.....	.....	2,560	1·0271	19·7157	2·7326	35·62
14 „ ...	63 15	101 42	1,591	0	1·0260	19·0066	2·6190	34·34
	.....	.....	.....	46	1·0261	19·5739	2·6766	35·36
	.....	.....	.....	92	1·0263	19·5030	2·6569	35·24
	.....	.....	.....	137	1·0267	19·6448	2·6872	35·49
	.....	.....	.....	183	1·0268	19·4321	2·6862	35·10
	.....	.....	.....	366	1·0268	19·7157	2·7112	35·62
	.....	.....	.....	549	1·0275	19·8576	2·7227	35·85
	.....	.....	.....	732	1·0264	19·5739	2·6708	35·36
	.....	.....	.....	915	1·0270	19·8576	2·7252	35·85
27 „ ...	65 53	95 18	600	0	1·0262	19·5030	2·6777	35·24
‡	.....	.....	.....	46	1·0265	19·6448	2·6914	35·49
	.....	.....	.....	92	1·0265	19·5030	2·6750	35·24
	.....	.....	.....	137	1·0272	19·5030	2·6950	35·24
	.....	.....	.....	183	1·0268	19·6488	2·6906	35·29
	.....	.....	.....	275	1·0267	19·6488	2·6791	35·29
	.....	.....	.....	366	1·0265	19·5053	2·6659	35·24
	.....	.....	.....	549	1·0268	19·7157	2·6955	35·62
31 „ ...	64 32	97 17	188	0	1·0265	19·7157	2·6511	35·62
‖	.....	.....	.....	17	1·0269	19·7157	2·6990	35·62
	.....	.....	.....	33	1·0267	19·6448	2·6460	35·49
	.....	.....	.....	46	1·0267	19·6448	2·6906	35·49
	.....	.....	.....	92	1·0266	19·7866	2·6774	35·74
	.....	.....	.....	137	1·0266	19·5739	2·6873	35·36
	.....	.....	.....	183	1·0267	19·6448	2·6848	35·49

‡ Recorded about 1 mile from the ice wall of the Shackleton Ice Shelf.
‖ Recorded immediately west of the north-west extremity of the Shackleton Ice Shelf.

3. *Complete Analysis recording major constituents of Antarctic Seawater.*

With a view to ascertaining the complete content of dissolved solids in sea water from Antarctic seas Mr. John C. H. Mingaye, F.I.C., F.C.S., made a very careful chemical analysis of water obtained by mixing that sample got from a depth of 549 metres on the 14th January, 1914, with the sample got from a depth of 92 metres on the 31st January, 1914. The result of the analysis yielded as follows :—

In 1,000 parts of water—

Na	10·8390
K	0·3970
Cl	19·5618
Br	0·0287
SO_4...	2·6939
Ca	0·4326
Mg	1·3005
SiO_2	0·0088
Fe and Al	Absent.
Organic Matter	Trace.
CO_3	0·0400
Total	35·3023

The specific gravity of the water at 15·5° C. was 1·0271. Mr. Mingaye's report further states as follows :—

"The total solid matter, on 100 c.c. of the water evaporated down to dryness, heated to 220° F. and slightly over flame = 35·2480 parts per 1,000.

A separate estimation of bromine, the water being taken from several of the samples, other than surface waters, yielded : Br. 0·03144 parts per 1,000.

A number of the samples contain a small amount of suspended matter which under the microscope was found to consist of apparently transparent chitinous flakes, several of which were tubular in appearance—probably exo skeletons of minute organisms which are much broken up, although two or three varieties were observed which were perfect.

The total solid matter contained in the waters of the ocean is remarkably constant when collected far from land. The mean total solid matter is about 35·976 per 1,000, and the average specific gravity of sea water 1·02975 at 0° C.

Forchammer found that 1,000 parts by weight of the water of the mid-Atlantic Ocean contained 35·976 of dissolved salts, while the mean of analysis of sea water from different localities gave 34·082 for the total salts in summer and 33·838 in winter.

Dittmar from 77 specimens of sea water collected on board the "Challenger" in various parts of the world, concludes that the maximum salts contained in the waters of the Indian Ocean, south of latitude 66° is 33·01, and in that of the North Atlantic at about 23° latitude 37·37 per 1,000.

Dittmar's figures for the average composition of the ocean are :—

	In 100 parts.
O	85·790
H	10·690
Cl	2·070
Br	·008
Na	1·140
K	·040
Mg	·140
Ca	·050
S	·090
C	·002
	100·000

The average salinity of the ocean is not far from 3·5 per cent. and its mean density is 1·027 (Clarke).

Owing to the small quantity of the water received for analysis, no attempt was made to test the waters for the various elements which occur in sea water in minute quantities."

III.—Surface Water Movements.

1. *Deductions from Drift Observations on Board the "Aurora."*

Comparison of the daily noon positions of the "Aurora" as deduced by dead-reckoning and as ascertained by observation furnishes useful indications of the surface water movements. The results thus arrived at need, for the most part, to be interpreted in a broad and general fashion, for it is obvious that such observations, except when made under ideal conditions, are subject to various errors. In such wise have the following records been made.

On the voyage from Africa to Australia made in the spring season south of the Indian Ocean between latitudes 40 and 43 degrees, a surface drift current with an easterly component of about 4 miles per day was indicated.

Near Africa some southerly movement was observed locally superimposed upon the easterly drift. Further east as far as the Kerguelen Archipelago a tendency to move north as well as east was noted. To the east of Kerguelen a south moving component was usually indicated. Thus east of the 90th meridian an average movement to the south-east of about 5 miles per day was deduced.

In the case of several subsequent voyages in the region south of Australia, all made in the late summer season, the average current movement between latitudes 43 and 48 degrees appears to have been to the E.S.E. This movement in the westerly division, between longitudes 110 and 120, was recorded as at the rate of about 4 miles per day; but further to the east, between longitudes 128 and 140, a record in the month of March gave 8 miles per day.

In this same region the easterly movement of the surface waters was recorded to as far south as latitude 58° immediately north of Queen Mary Land, and to 60° in longitude 150° east. However, to the south of about latitude 50° a northerly component of drift is almost always to be detected superimposed upon the easterly drift. Some estimates of these drift movements are indicated by the following observations.

A run in February between latitudes 59° and 57° and longitudes 93° and 103° showed a drift with an easterly component of $8\frac{1}{2}$ miles and northerly component of 3 miles per day. An observation in the month of March on a voyage between latitudes 57° and 59° and longitudes 133° and 140° appeared to reveal an easterly drift of 18 miles per day in addition to a small northerly movement.

In the case of a winter, June, voyage between latitudes 52° and 53° and longitudes 142° and 147° a surface movement to the E.N.E. amounting to 18 miles per day was deduced. A March record in latitudes 48° to 57° and longitudes 120° to 128° indicates a drift to the east of 15 miles per day.

Turning to the region off southern Tasmania and south of the Tasman Sea as far east as Macquarie Island (158° E. long.), there appears to be a very regular surface movement to the south and east. This movement is both accelerated and more southerly in trend in the region near Tasmania. Further to the south and east the trend is more easterly and the rate of movement reduced.

As indications in support of the above general statement may be mentioned the following: A winter record of a drift of 10 miles per day towards S. 30° E. in the neighbourhood of lat. $42\frac{1}{2}$° S. and long. 141° E.; a summer record of 10 miles per day to the S.S.E. between latitudes 47° and 50° in longitude 145°; an early summer record of 7 miles per day towards S. 73° E. in lat. 49°, long. 157°; a winter record of a strong E.S.E. drift between latitudes 45° and 53° and longitudes 152° and 156°; finally on a long early summer run between latitude 45°, longitude 147°, and latitude 54°, longitude 158° an average daily movement amounting to 6 miles to the south and 6 miles to the east appeared to be indicated.

To the south of Macquarie Island at least as far as the 59th degree of south latitude the surface waters appear to be moving dominantly to the east. This is based on an observation of $5\frac{1}{2}$ miles daily average easterly drift on a voyage between lat. 56°, long. 158°, and lat. 59°, long. 154°.

Thus, in the region of the Southern Ocean lying to the north of 60° S. latitude, the records accumulated by Captain J. K. Davis and his officers on board the "Aurora" during the Expedition voyages, almost all agree in indicating an easterly movement with which, however, may in some localities be associated a northerly component, in others a southerly component is evident.

In still higher southerly latitudes their records indicate the prevalence of a westerly drift, superimposed on which a slow northerly movement is usually evidenced. The rate of movement is most marked near the land and it slackens further to the north; this applies both to the westerly and to the northerly components. There is, further, great irregularity in the rate of movement being temporarily greatly accelerated during the progress of the periodic severe off-shore gales. In the period intervening between gales there may be a complete slackening of the westerly and northerly movement. As a consequence the average movement taken over a long period is more significant than single observations.

The "Aurora" cruised south of lat. 60° only during the summer months, consequently the following observations refer only to the months of December, January and February.

On a run west between latitudes 64° and 66° and from longitude 142° to longitude 129° a westerly drift averaging 7 miles per day was indicated. On another occasion between longitudes 108° and 100° a westerly movement of 6 miles per day was noted.

In this region of ice-strewn sea, the difference between the ship's positions as determined respectively by dead-reckoning and by observation is not so reliable for deducing current movements, because frequent changes in direction of ship's head are necessitated in navigating amongst the obstructions; thus uncertainties are inevitably introduced. The prospect of thus obtaining useful data in this area is further reduced owing to the fact that it is a region of rapid change in magnetic declination introducing more than usual error in ship's course on compass bearings.

On several occasions observation suggested an easterly movement, but the evidence taken over the three voyages is overwhelmingly in favour of a westerly drift averaging 6 or 7 miles per day with a slight northerly component.

The pace of the current appears to be quickened around the north of the Shackleton Shelf. On the extreme east side of our area, north of and near the Balleny Islands, an exceptional movement to the east was noted south of lat. 60°, probably in the nature of a swirl resulting from the obstruction offered by the group of islands and the southward recession of the coast of the mainland.

That the surface layer of westward- and northward-moving water is probably of no great thickness was illustrated by the rather frequently-noted phenomenon of large icebergs ploughing south through the litter of smaller ice debris which latter floated

on westward-moving surface waters. Along the coast of King George Land and Adelie Land, an under layer of southward-moving water is suggested by the above fact that large bergs were frequently seen to be moving south against the direction of surface drift and wind.

That there is a steady west-setting current around the sector investigated by the Expedition is clearly attested by the fact that in all cases the pack-ice and bergs pile up on the eastern side of promontories along the coast; whilst free water is always to be found on their western margins. In all cases where large bergs are aground, the pack-ice is pressed against their eastern sides and pools of open water lie to the west.

2. *Ocean Messages.*

At the Main Antarctic Base Station at Cape Denison, lat. 67° 00′ S., long. 142° 40′ E., sealed bottles containing messages were cast into the sea at frequent intervals during the year 1912, in the hope that one or more might eventually be picked up after drifting to lower latitudes.

Had any of the messages been retrieved, not only would useful information have been gleaned relating to the movements of ocean currents in those Antarctic waters, but, further, the location of one of our Expedition parties would have become known, which fact would not otherwise have transpired had anything untoward have happened to the "Aurora" after departure to the west on January 19th, 1912. In the latter event neither our whereabouts nor the fact that we had landed would be known to the world unless one of our ocean messages should have chanced to be picked up.

These messages were always typed and were fairly uniform in the wording. A typical example was as follows:—

WINTER QUARTERS

(Lat. 67·00; Longt. 142·25)

Commonwealth Bay, Adelie Land.

August 20th, 1912.

This message is herewith despatched in the hope that it may be recovered on occupied shores, and thereby notify those interested of our whereabouts; and also give valuable information regarding ocean currents.

Whoever finds this paper is requested to forward it to Mr. J. H. Maiden, Permanent Hon. Secretary of the Australasian Association for the Advancement of Science, Sydney, with a note of the time and place at which it was found.

In all such messages despatched the request forming the last paragraph was repeated in three other languages, namely, French, German and Italian. Note that at that time the longitude 142° 25′ was adopted but subsequently corrected to 142° 40′.

Apparently not one of these messages ever reached other hands. Possibly the bottles were all broken whilst floating amongst the pack-ice. If, on the other hand, they escaped crushing, they might be expected to have reached the open Southern Ocean somewhere near longitude 132° E., or even further to the west. They would be expected then to enter the easterly drift and possibly make to the E.N.E.

Early in 1927 considerable interest was raised by a report in the Australian Press that a bottle engraved by the Expedition's Western Base Party wintering at the Shackleton Shelf, about long. 95° E., and consigned to the sea on midwinter's day, 1912, had been discovered on the beach at Tuggerah, New South Wales. On investigation, the report was found to be an error. It transpired that the bottle in question arrived at a bottle depot in Sydney from an unknown vessel sometime in 1917 or 1918. It was not picked up on an ocean beach as earlier reported.

There is, however, no doubt that this bottle was one of two that were engraved at " The Grottoes," Shackleton Ice-shelf, on midwinter's day, 1912. On that occasion, toasts were drunk in Madeira wine which had travelled around the world on the famous " Challenger " Expedition in 1872–73, and had been presented to me for our Australasian Antarctic Expedition by Dr. J. Y. Buchanan, the noted chemist and hydrologist of that classic undertaking. At the close of that midwinter's day festivities one of the bottles was engraved with the names of the party and the date and locality. It was Frank Wild's intention to present this bottle to Dr. Buchanan on return to England, but what became of it, nobody can say. A duplicate bottle was also engraved likewise and said to have been thrown into the sea. It is suspected that Wild's bottle was taken onto the " Aurora " when the party was relieved, but left on the vessel until eventually it reached the above mentioned bottle depot in Sydney.

Current papers sealed in bottles were thrown overboard daily from the " Aurora " during a considerable portion of her cruising time in Subantarctic and Antarctic waters.

One of these committed to the sea on 19th February, 1914, in lat. 43° 5½′ S., long. 119° 31′ E., was retrieved on the west coast of New Zealand at Hukatere on the 14th October, 1920.

If this bottle went direct it travelled nearly due east. The presumption is, however, that it did not make a direct course. It is most probable that the bottle reached the New Zealand coast long before 1920.

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