Observations on the Hydrology of the River Derwent, Tasmania

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(WITH 6 TEXT FIGURES)

Abstract

This paper records a series of hydrological observations made on the River Derwent over a twenty month period. The salinity, pH and temperature of the river are shown. The salinity of the water at the bottom of the river at Millbrook Rise (Station 47) is 0 gms/^{00}. The surface salinity is zero at Boyer (Station 45). At Cadbury's (Station 5) the salinity of the bottom water is 30 gms/^{00}. The salinity gradient has been also worked out.

Introduction

This work was commenced as part of a survey which was intended to include the relationship between salinity and the distribution of marine forms in the estuary of the River Derwent and to obtain an estimate of the toleration of some species for fresh water. Only the hydrological results are recorded here.

The only work of major significance dealing with the hydrology of Australian estuarine waters is that of Rochford (1951). In this paper, he also reviews the more important overseas literature.

Rochford gives some figures relating to the Derwent Estuary as well as to the Huon River and D'Entrecasteaux Channel in the South.

The River Derwent was chosen for survey because it is convenient to Hobart and is suitable for boat work over most of the area of salt water penetration. It has the advantage of being reasonably free from factory pollution with the possible exception of two small areas which will be described below. For the purposes of this work it is intended that the lower limit of the survey will be an imaginary line drawn from Blinking Billy Point to Howrah.

All the tributaries of the river are small, both in size and volume of output into the river. The largest tributary is the River Jordan.

There are several sources of entry of foreign products into the river. The first of these lies at the Paper Mills at Boyer, the second at the Zincworks, and the third is the major sewage outfalls in and around the Port of Hobart. By European standards the river is virtually unpolluted. In the case of the two major industrial concerns, care is taken that no products are emptied into the river which would cause serious pollution.

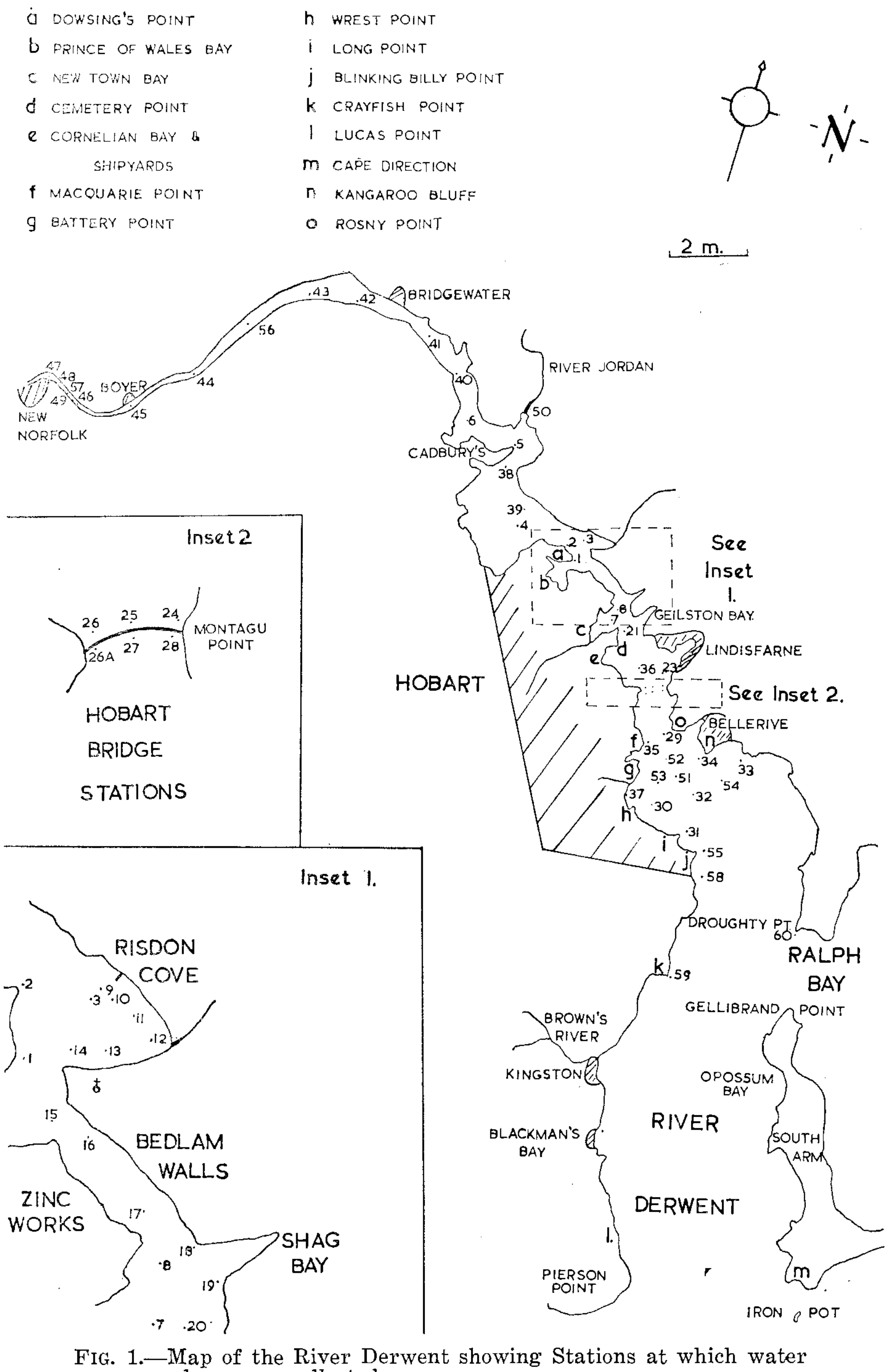

FIG. 1.—Map of the River Derwent showing Stations at which water samples were collected.

The Lower part of the river valley has been inundated by the sea since Glacial times. The shoreline of the area examined is rocky or stony with several areas of mud appearing at low water. The bottom, above Hobart Bridge, is muddy. Below the Bridge, this mud is slowly replaced by sand which is dominant at Long Point (Fig. 1).

A number of stations were established on the River. One of these stations (No. 1) was visited weekly and the remainder were the subject of occasional surveys. The stations are shown on the detailed list being deposited in the library of the Royal Society of Tasmania.

METHODS

(*a*) *Period of Sampling*

Water samples were obtained by means of a Copenhagen water bottle fitted with reversible thermometers. The whole apparatus was lowered into the river attached to flexible steel wire. On most occasions the Stations were visited in a motor launch but on a few trips, a dinghy was used. The samples were brought to the surface and poured into 4 lb. Kilner jars, each of which was etched with a serial number. For samples which were not required for sediment measurements, either 1-lb. Kilner jars or other glass containers were used. After pH observations were made, the bottles were screwed up and transported to the laboratory at the University.

(*b*) *Temperature*

The temperature at the required depth, as shown on the reversing thermometer, was noted immediately the sample was brought on board the boat.

(*c*) *Depth*

The depth was determined by passing the wire holding the bottle over a metre wheel. This reading was compared with the depth as shown on Admiralty Chart No. 960 to allow for the drift of the apparatus. At certain stations it became unnecessary to use the metre wheel, as at Stations which were regularly sampled, the depth was known to within 1 foot. This method is not recommended for use where the tidal range is considerable but in view of the small tides at Hobart (average over 12 months being 1 foot 10½ inches), the error involved is small. At the Stations in deep water, bottom samples were not taken. Bottom samples were not taken at the Bedlam Walls Stations due to the strong current operating there at all phases of the tide.

(*d*) *pH.*

pH readings were taken immediately the sample was poured into the Kilner Jar. Seven methods of pH determination were used. In the first stages of the investigation the pH was determined by a B.D.H. Thymol blue Capillator. A phenol red Capillator was used for one or two readings but was found to be unsatisfactory, since it gave readings which were widely different from those obtained by other methods. A diphenol purple capillator also was used.

Some readings were made using B.D.H. thymol blue, cresol red and diphenol purple comparators.

In the latter stages of the survey, a portable Jones pH electrometer was used. This instrument was very easy to use in the restricted space on the boat.

Table 2 shows the correlation between the readings obtained by the three methods.

TABLE 2

Correlation of pH readings obtained by the various methods.

Electrometer	Diphenol Purple Capillator 7·0-8·6	Thymol Blue Capillator 8·0-9·6	Thymol Blue Capillator	Diphenol Purple Capillator 7·2-8·6
9·6	....	9·5	....	....
8·3	8·4	8·6	8·3	8·1
7·62	7·6	....	....	7·5

(*e*) *Salinity*

The salinity was determined by a silver nitrate titration following the method outlined by Harvey (1945, p. 20). The correction factor given by Harvey was applied graphically to the result of the titration.

(*f*) *Sediment*

The amount of filterable sediment was obtained by passing the sample through a previously weighed Whatmans No. 1 Filter Paper. This was done as soon as possible after the sample arrived at the laboratory. The filter paper was washed with tap water and then distilled water to remove any salt. It was then dried and re-weighed. Each sample contained 1400 ccs. and the weight of sediment per litre was read off a graph.

(*g*) *Tabulation of Results*

The observations made on the boat were noted together with the bottle number of the sample. On arrival at the laboratory the relevant additional information was added and a note made of the index number of the filter paper used in the filtration of each sample. The filter paper weights and numbers were kept in a separate book with the bottle number and the date added as an additional check. When the filter paper was dry and re-weighed, all the information was transferred to stencilled sheets which were filed for future use.

On completion of filtration, all sample bottles were washed first in tap water and then in distilled water. They were then allowed to dry before being stored on board the boat for future use. It might be noted that all the usual precautions for obtaining accuracy were observed such as careful washing of the filtration apparatus, the burettes and conical flasks.

The results are shown in Tables 3 and 4 and graphed on figures 2-4.

TABLE 3

Hydrological data collected at various Stations in the Derwent Estuary.

Whenever a series of Stations was sampled in order to obtain a picture of the salinity gradient of the river, these results are all shown together and not under the records of each Station.

The methods of pH determination are indicated by:—

(1) Thymol blue capillator.
(2) Phenol red capillator.
(3) Thymol blue comparator.
(4) Diphenol purple comparator.
(5) Cresol red comparator.
(6) Electrometer.
(7) Diphenol purple capillator.

The data collected weekly at Station 1 are deposited in the library of the Royal Society of Tasmania.

STATION 1

Date	Station	Depth in fathoms S = Surface B = Bottom	Tide	River flow N.W. = normal winter; N.S. = normal summer	pH	Temperature (°C)	Salinity grs./mille	Sediment grs./litre
2/11/49	1	4 (B)	Flow	Heavy flood	7·6(1)	11·6	32·87	0·157
	....	3	Flow	Heavy flood	7·4(1)	11·9	21·43	0·162
	....	2	Flow	Heavy flood	7·0	12·5	5·1	0·072
	....	1	Flow	Heavy flood	7·0	12·7	5·5	0·060
	....	0	Flow	Heavy flood	7·0	12·4	5·1	0·048
	15	8 (B)	Flow	Heavy flood	8·0	11·55	33·2	....
	....	0 (S)	Flow	Heavy flood	7·0	11·9	3·8	....
	16	0 (S)	Flow	Heavy flood	7·0	12·75	3·6	....
	17	0 (S)	Flow	Heavy flood	7·0	12·3	3·72	....
	18	0 (S)	Flow	Heavy flood	7·0	12·3	3·5	....
	19	0 (S)	Flow	Heavy flood	7·2	12·8	3·67	....
	20	7 (B)	Flow	Heavy flood	8·0	....	32·75	....
	....	0 (S)	Flow	Heavy flood	7·0	12·2	4·1	....
	21	0 (S)	Flow	Heavy flood	7·0	12·3	4·85	....
	22	0 (S)	Flow	Heavy flood	7·0	12·6	5·4	....
	23	0 (S)	Flow	Heavy flood	7·2	12·6	5·4	....
	24	0 (S)	Flow	Heavy flood	7·2	13·0	5·3	....
	25	0 (S)	Flow	Heavy flood	7·2	12·7	5·1	....
	26	0 (S)	Flow	Heavy flood	7·2	12·9	6·0	....
	27	0 (S)	Flow	Heavy flood	7·2	12·5	10·36	....
	28	0 (S)	Flow	Heavy flood	7·4	12·5	11·17	....
	29	0 (S)	Flow	Heavy flood	7·6	13·1	12·19	....
	....	6 (B)	Flow	Heavy flood	8·2	11·3	33·65	....
	30	0 (S)	Flow	Heavy flood	7·4	13·6	13·19	....
	....	7 (B)	Flow	Heavy flood	8·4	11·4	33·62	....
	31	0 (S)	Flow	Heavy flood	7·7	13·4	18·73	....
	32	0 (S)	Flow	Heavy flood	7·7	13·0	20·62	....
	33	0 (S)	Flow	Heavy flood	7·7	12·9	17·03	....
	34	0 (S)	Flow	Heavy flood	7·7	12·45	18·23	....
	35	0 (S)	Flow	Heavy flood	7·0	12·8	10·16	....
	36	0 (S)	Flow	Heavy flood	7·0	12·5	5·938	....
11/1/50	1	4 (B)	Ebb	N.S.	8·4(1)	14·1	33·41	0·881
	1	3	Ebb	N.S.	8·0	14·2	30·11	0·410
	....	2	Ebb	N.S.	7·8	14·3	27·95	0·338
	....	1	Ebb	N.S.	8·0	14·7	25·18	0·380
	....	0 (S)	Ebb	N.S.	7·8	14·6	24·40	0·450

TABLE 3—*continued.*

Date	Station	Depth in fathoms S = Surface B = Bottom	Tide	River flow N.W. = normal winter; N.S. = normal summer	pH	Temperature (°C)	Salinity grs./mille	Sediment grs./litre
	3	6 (B)	Ebb	N.S.	8·4	14·0	33·02	....
	....	0 (S)	Ebb	N.S.	7·8	14·3	23·4	....
	39	4 (B)	Ebb	N.S.	8·2	13·8	33·02	....
	....	0 (S)	Ebb	N.S.	8·0	14·3	24·0	....
	38	3 (B)	Ebb	N.S.	8·0	14·3	28·15	....
	38	0 (S)	Ebb	N.S.	7·6	14·5	15·6	....
	5	4 (B)	Ebb	N.S.	8·0	14·5	33·04	....
	....	2	Ebb	N.S.	8·2	14·1	29·7	....
	....	0 (S)	Ebb	N.S.	7·4	14·55	14·20	....
	6	4 (B)	Ebb	N.S.	7·8	14·4	29·15	....
	....	0 (S)	Ebb	N.S.	7·4	14·4	12·99	....
	40	3 (B)	Ebb	N.S.	7·8	14·3	28·75	....
	....	0 (S)	Ebb	N.S.	7·2	14·3	11·48	....
	41	3 (B)	Ebb	N.S.	7·6	14·3	26·57	....
	....	0 (S)	Ebb	N.S.	7·4	14·15	9·36	....
	42	3 (B)	Ebb	N.S.	7·6	14·3	18·33	....
	....	0 (S)	Ebb	N.S.	7·0	14·3	3·8	....
	43	3 (B)	Ebb	N.S.	7·8	14·3	27·1	....
	....	0 (S)	Ebb	N.S.	7·0	14·3	3·2	....
	44	4 (B)	Ebb	N.S.	7·8	14·4	27·55	....
	....	0 (S)	Ebb	N.S.	7·0	....	2·1	....
	45	4 (B)	Ebb	N.S.	7·2	14·3	25·43	....
	....	0 (S)	Ebb	N.S.	7·0	14·3	not titratable	....
	46	5 (B)	Ebb	N.S.	7·25	14·4	20·13	....
	....	0 (S)	Ebb	N.S.	7·0	....	N.T.	....
	47	6 (B)	Ebb	N.S.	6·8	12·5	N.T.	....
	....	0 (S)	Ebb	N.S.	6·8	12·6	N.T.	....
	48	5 (B)	Ebb	N.S.	6·8	12·6	2·02	....
	....	0 (S)	Ebb	N.S.	7·0	....	N.T.	....
	49	5 (B)	Ebb	N.S.	7·2	13·0	7·54	....
	50	3 (B)	Flow	N.S.	7·6	....	21·97	....
3/3/50	1	4 (B)	Ebb	Subnormal S.	8·2	15·0	33·74	....
	....	3	Ebb	Subnormal S.	7·4	15·3	31·68	....
	....	2	Ebb	Subnormal S.	7·6	15·4	30·91	....
	....	1	Ebb	Subnormal S.	7·4	15·25	30·13	....
	....	0 (S)	Ebb	Subnormal S.	7·4	15·4	29·22	....
	3	0 (S)	Ebb	Subnormal S.	7·8	15·8	27·78	....
	18	0 (S)	Ebb	Subnormal S.	7·6	16·5	28·10	....
	22	0 (S)	Ebb	Subnormal S.	7·8	16·2	27·901	....
	23	0 (S)	Ebb	Subnormal S.	7·7	16·5	28·834	....
	24	0 (S)	Ebb	Subnormal S.	7·7	16·3	30·60	....
	25	0 (S)	Ebb	Subnormal S.	7·9	15·55	28·734	....
	26	0 (S)	Ebb	Subnormal S.	7·2	15·9	30·95	....
	26A	0 (S)	Ebb	Subnormal S.	7·5	15·55	29·72	....
	27	0 (S)	Ebb	Subnormal S.	7·9	15·45	30·80	....
	28	0 (S)	Ebb	Subnormal S.	7·7	15·45	30·61	....
	29	0 (S)	Ebb	Subnormal S.	8·3	15·8	31·26	....
	34	0 (S)	Ebb	Subnormal S.	8·6	15·8	33·036	....
	51	0 (S)	Ebb	Subnormal S.	8·4	17·0	31·29	....
	52	0 (S)	Ebb	Subnormal S.	8·2	16·0	32·26	....
	53	0 (S)	Ebb	Subnormal S.	8·3	15·95	32·068	....
22/6/50	1	4 (B)	Flow	N.W.	8·11	10·9	30·03	....
	....	3	Flow	N.W.	8·11	10·6	27·62	....
	....	2	Flow	N.W.	8·08	9·6	25·98	....
	....	1	Flow	N.W.	8·0	7·5	16·53	....
	....	0 (S)	Flow	N.W.	8·92	7·15	16·33	....
	3	6 (B)	Flow	N.W.	8·15	11·4	34·41	....
	3	0 (S)	Flow	N.W.	7·95	7·15	18·43	...

TABLE 3—*continued.*

Date	Station	Depth in fathoms S = Surface B = Bottom	Tide	River flow N.W. = normal winter; N.S. = normal summer	pH	Tempera-ture (°C)	Salinity grs./mille	Sediment grs./litre
	4	4 (B)	Flow	N.W.	7·58	9·0	33·54	....
	....	0 (S)	Flow	N.W.	7·85	7·4	19·73	....
	38	5 (B)	Flow	N.W.	7·43	....	31·67	....
	....	0 (S)	Flow	N.W.	7·82	6·1	16·23	....
	5	4 (B)	Flow	N.W.	7·89	7·4	19·63	....
	....	0 (S)	Flow	N.W.	7·68	....	14·49	....
	6	4 (B)	Flow	N.W.	7·79	....	30·12	....
	....	0 (S)	Flow	N.W.	7·78	....	12·89	....
	40	4 (B)	Flow	N.W.	7·79	7·05	19·23	....
	....	0 (S)	Flow	N.W.	7·89	7·05	12·39	....
	41	3 (B)	Flow	N.W.	7·6	6·3	12·5	....
	....	0 (S)	Flow	N.W.	7·5	....	9·45	....
	42	3 (B)	Flow	N.W.	7·7	....	15·23	....
	....	0 (S)	Flow	N.W.	7·5	....	9·96	....
	56	3 (B)	Flow	N.W.	7·71	....	19·33	....
	....	0 (S)	Flow	N.W.	7·6	....	10·48	....
	43	3 (B)	Flow	N.W.	7·61	....	20·62	....
	....	0 (S)	Flow	N.W.	7·48	....	8·55	....
	44	3 (B)	Ebb	N.W.	7·5	....	21·4	....
	....	0 (S)	Ebb	N.W.	7·4	....	3·2	....
	45	3 (B)	Ebb	N.W.	7·76	....	21·61	....
	....	0 (S)	Ebb	N.W.	7·45	....	2·3	....
	46	5 (B)	Ebb	N.W.	7·5	....	21·3	....
	....	0 (S)	Ebb	N.W.	7·3	....	N.T.	....
	57	4 (B)	Ebb	N.W.	7·47	....	20·43	....
	....	0 (S)	Ebb	N.W.	7·62	....	N.T.	....
	49	4 (B)	Ebb	N.W.	7·38	....	20·73	....
	....	0 (S)	Ebb	N.W.	7·4	....	N.T.	....
17/11/50	1	4 (B)	Ebb	Summer with some flood	7·68 (6)	14·7	30·89	1·419
	....	3	Ebb	Summer with some flood	7·26	13·7	16·43	0·412
	....	2	Ebb	Summer with some flood	6·8	13·6	11·25	0·217
	....	1	Ebb	Summer with some flood	7·52	13·15	8·15	0·112
	....	0	Ebb	Summer with some flood	7·41	12·9	5·34	0·089
	3	6 (B)	Ebb	Summer with some flood	7·7	13·7	30·02	1·019
	....	0 (S)	Ebb	Summer with some flood	7·39	13·6	4·12	0·067
	18	0 (S)	Ebb	Summer with some flood	7·9	15·1	5·13	0·412
	20	0 (S)	Ebb	Summer with some flood	7·4	14·3	5·24	0·429
	26	0 (S)	Ebb	Summer with some flood	7·19	15·3	16·51	0·218
	28	0 (S)	Ebb	Summer with some flood	7·83	15·1	14·7	....
	29	0 (S)	Ebb	Summer with some flood	7·7	14·75	14·4	0·109
	34	0 (S)	Ebb	Summer with some flood	7·7	14·1	20·82	0·201
	54	0 (S)	Ebb	Summer with some flood	7·56	14·9	19·03	....
	55	0 (S)	Ebb	Summer with some flood	7·79	14·95	6·3	....

TABLE 3—*continued.*

Date	Station	Depth in fathoms S = Surface B = Bottom	Tide	River flow N.W. = normal winter; N.S. = normal summer	pH	Tempera-ture (°C)	Salinity grs./mille	Sediment grs./litre
	30	0 (S)	Ebb	Summer with some flood	7·92	16·2	19·63	....
	35	0 (S)	Ebb	Summer with some flood	7·55	16·7	13·20	....
	39	5 (B)	Flow	Summer with some flood	7·78	13·7	30·70	....
	....	0 (S)	Flow	Summer with some flood	7·62	13·9	5·13	....
				SHORT RIVER SURVEYS				
7/7/49	1	4 (B)	Flow	Some flood	8·4(1)	9·0	....	0·520
	....	3	Flow	Some flood	8·3	7·8	....	0·200
	....	2	Flow	Some flood	7·6	6·1	....	0·018
	....	1	Flow	Some flood	7·5	6·1	....	0·078
	....	0 (S)	Flow	Some flood	7·2	6·1	....	0·105
	4	4 (B)	Flow	Some flood	7·9	8·9	....	0·400
	....	3	Flow	Some flood	8·2	6·2	....	0·100
	....	2	Flow	Some flood	7·7	6·1	....	0·185
	....	1	Flow	Some flood	7·2	5·9	....	0·375
	....	0 (S)	Flow	Some flood	7·2	6·1	....	0·200
	5	4 (B)	Flow	Some flood	8·0	8·9	....	0·525
	....	3	Flow	Some flood	7·9	7·1	....	0·185
	....	2	Flow	Some flood	7·6	5·6	....	0·015
	....	1	Flow	Some flood	7·1	5·6	....	0·038
	....	0 (S)	Flow	Some flood	7·2	6·0	....	0·086
	6	4 (B)	Flow	Some flood	8·2	7·1	....	0·167
	....	3	Flow	Some flood	7·9	6·9	....	0·188
	....	2	Flow	Some flood	7·4	5·8	....	0·100
	....	1	Flow	Some flood	7·1	4·9	....	0·035
	....	0 (S)	Flow	Some flood	7·2	5·25	....	0·033
	7	6 (B)	Flow	Some flood	8·1	9·9	....	0·625
	....	4½	Flow	Some flood	7·5	7·1	....	0·089
	....	3	Flow	Some flood	7·0	6·8	....	0·100
	....	1½	Flow	Some flood	7·2	7·1	....	0·089
	....	0 (S)	Flow	Some flood	7·0	7·0	....	0·050
13/10/49	1	4 (B)	Flow	Flood	7·8	11·0	31·1	0·305
	....	3	Flow	Flood	7·4	11·9	28·54	0·129
	....	2	Flow	Flood	7·0	11·9	18·2	0·127
	....	1	Flow	Flood	7·2	12·2	7·15	0·171
	....	0	Flow	Flood	7·0	12·6	5·54	0·150
	9	1	Flow	Flood	7·2	12·6	10·8	0·136
	10	1	Flow	Flood	7·2	13·0	10·6	0·113
	11	1	Flow	Flood	7·2	12·7	10·15	0·219
	12	1	Flow	Flood	7·2	12·8	10·60	0·258
	13	1	Flow	Flood	7·2	12·7	10·62	0·113
	14	1	Flow	Flood	7·2	12·2	10·89	0·038
8/6/50	1	4 (B)	Flow	N.W.	8·13	10·8	33·0	....
	....	3	Flow	N.W.	7·82	9·6	27·26	....
	....	2	Flow	N.W.	7·5	9·35	22·92	....
	....	1	Flow	N.W.	7·6	8·1	17·9	....
	....	0	Flow	N.W.	7·72	6·8	15·9	....
	17	6	Flow	N.W.	8·3	11·2	33·83	....
	....	0 (S)	Flow	N.W.	8·05	6·4	15·0	....
	19	0 (S)	Flow	N.W.	8·1	7·2	14·90	....
	20	0 (S)	Flow	N.W.	8·5	7·15	15·42	....
	26	0 (S)	Flow	N.W.	7·6	6·95	17·63	....

TABLE 3—*continued.*

Date	Station	Depth in fathoms S = Surface B = Bottom	Tide	River flow N.W. = normal winter; N.S. = normal summer	pH	Temperature (°C)	Salinity grs./mille	Sediment grs./litre
	29	0 (S)	Flow	N.W.	7·9	3·3	21·62	....
	34	0 (S)	Flow	N.W.	8·12	3·7	26·57	....
	31	0 (S)	Flow	N.W.	8·21	7·7	26·77	....
	32	0 (S)	Flow	N.W.	8·08	8·0	26·25	....
24/1/51	1	4 (B)	Ebb	Subnormal S.	8·1	17·65	30·3	0·929
	....	3	Ebb	Subnormal S.	7·7	19·1	24·59	0·392
	....	2	Ebb	Subnormal S.	7·6	18·95	19·23	0·195
	....	1	Ebb	Subnormal S.	7·6	18·05	18·72	0·079
	....	0	Ebb	Subnormal S.	7·4	18·3	17·3	0·020
	18	0 (S)	Ebb	Subnormal S.	7·6	17·1	15·22	0·107
	20	0 (S)	Ebb	Subnormal S.	7·9	16·9	16·23	0·039
	29	0 (S)	Ebb	Subnormal S.	8·0	18·6	22·22	....
	31	0 (S)	Ebb	Subnormal S.	8·1	19·6	25·38	0·142
	58	0 (S)	Ebb	Subnormal S.	7·9	20·6	20·42	0·200
	59	0 (S)	Ebb	Subnormal S.	8·2	20·5	30·98	0·121
	60	0 (S)	Ebb	Subnormal S.	8·2	19·0	30·40	0·094
			OCCASIONAL STATIONS					
16/6/49	2	3 (B)	Flow	N.W.	8·3	10·8	....	0·316
	....	2½	Flow	N.W.	8·0	10·5	....	0·178
	....	1½	Flow	N.W.	7·2	7·7	....	0·125
	....	1	Flow	N.W.	7·0	7·5	....	0·154
	....	0 (S)	Flow	N.W.	7·2	8·0	....	....
23/6/49	3	6 (B)	Flow	Slight flood	8·0	10·6	....	0·167
	....	4½	Flow	Slight flood	7·6	9·05	....	0·165
	....	3	Flow	Slight flood	7·6	6·4	....	0·095
	....	1½	Flow	Slight flood	7·1	5·9	....	0·085
	....	0 (S)	Flow	Slight flood	7·05	5·9	....	0·050
25/6/49	4	5 (B)	Flow	Slight flood	8·0	10·65	....	0·220
8/9/49	8	7 (B)	Ebb	N.W.	8·0	10·15	....	1·254
	....	5½	Ebb	N.W.	8·0	10·9	....	0·167
	....	3½	Ebb	N.W.	8·0	10·45	....	0·164
	....	1½	Ebb	N.W.	7·6	10·5	28·95	0·075
	....	0 (S)	Ebb	N.W.	7·2	10·7	....	0·084
24/9/49	9	2 (B)	Flow	N.W.	8·0	10·7	....	0·355
	....	1½	Flow	N.W.	7·2	10·7	....	0·115
	....	1	Flow	N.W.	7·5	9·9	....	0·103
	....	½	Flow	N.W.	7·5	10·1	13·65	0·137
	....	0 (S)	Flow	N.W.	7·2	10·3	....	0·138
24/12/49	3	6 (B)	Ebb	N.S.	8·0	14·2	32·86	....
	....	4½	Ebb	N.S.	7·8	14·45	27·16	....
	....	3	Ebb	N.S.	7·4	15·25	23·12	....
	....	0 (S)	Ebb	N.S.	7·2	15·8	14·20	....
	4	0 (S)	Ebb	N.S.	7·1	15·6	7·89	....
26/1/50	3	6 (B)	Ebb	N.S.	8·4	14·4	33·83	....
	....	3	Ebb	N.S.	8·0	15·6	29·92	....
	....	0 (S)	Ebb	N.S.	7·6	13·8	17·73	....
2/2/50	17	0 (S)	Ebb	Subnormal S.	7·2	20·1	18·83	....
	19	0 (S)	Ebb	Subnormal S.	7·0	17·0	19·03	....
	21	0 (S)	Ebb	Subnormal S.	7·0	17·5	21·12	....
10/11/50	39	0 (S)	Flow	N.W.	9·52	14·3	28·65	0·462
	4	0 (S)	Flow	N.W.	8·73	15·3	11·2	0·161

TABLE 4

Monthly averages of data obtained at Station 1

Date		pH	Temperature	Salinity
6/49	Bottom	7·9	10·2	....
	3	7·3	9·3	...
	2	7·2	8·0	....
	1	7·1	7·4	....
	0	7·3	7·3	....
7/49	Bottom	8·1	9·3	....
	3	7·6	7·7	....
	2	7·4	7·4	....
	1	7·2	7·6	....
	0	7·2	6·8	....
8/49	Bottom	8·5	10·25	33·77
	3	7·5	9·4	23·06
	2	7·6	8·5	22·07
	1	7·6	8·5	21·67
	0	7·6	8·8	20·44
9/49	Bottom	8·1	10·4	33·3
	3	7·9	10·1	26·17
	2	7·5	10·2	22·42
	1	7·3	9·6	19·40
	0	7·3	9·5	18·43
10/49	Bottom	8·0	11·3	32·16
	3	7·6	11·3	26·68
	2	7·3	11·1	17·79
	1	7·2	10·9	10·95
	0	7·2	11·2	10·07
11/49	Bottom	8·1	12·2	32·80
	3	7·9	13·4	26·36
	2	7·2	14·6	16·53
	1	7·4	14·5	10·92
	0	7·3	15·1	9·68
12/49	Bottom	8·2	13·8	32·56
	3	7·7	14·0	30·52
	2	7·3	14·2	23·76
	1	7·2	14·3	18·00
	0	7·3	14·1	17·35
1/50	Bottom	8·0	14·7	33·23
	3	7·7	14·8	29·74
	2	7·5	14·8	26·89
	1	7·5	14·8	25·64
	0	7·4	15·1	23·63
2/50	Bottom	7·9	15·6	33·08
	3	7·6	15·9	29·18
	2	7·2	15·8	26·77
	1	7·3	16·5	17·93
	0	7·1	16·5	16·98
3/50	Bottom	7·8	15·1	32·09
	3	7·4	14·8	26·89
	2	7·3	14·5	23·94
	1	7·2	14·3	21·91
	0	7·3	14·5	21·18
4/50	Bottom	7·4	14·4	31·87
	3	7·2	13·6	28·25
	2	7·0	13·7	24·69
	1	7·0	12·7	17·52
	0	7·0	12·8	16·71

TABLE 4—*continued.*

Date		pH	Temperature	Salinity
5/50	Bottom	7·6	13·8	30·65
	3	7·6	12·5	23·66
	2	7·6	12·7	21·91
	1	7·2	11·9	18·86
	0	7·4	11·7	18·42
6/50	Bottom	8·1	11·3	32·01
	3	7·8	10·3	25·38
	2	7·5	9·4	22·58
	1	7·5	8·4	16·04
	0	7·7	7·7	15·24
7/50	Bottom	8·2	....	34·50
	3	7·8	....	29·69
	2	7·7	....	24·09
	1	7·4	....	16·01
	0	7·3	....	13·59
8/50		No records		
9/50	Bottom	8·3	10·4	33·72
	3	7·0	....	6·84
10/50		No records		
11/50	Bottom	7·3	14·6	25·82
	3	7·3	14·1	20·61
	2	7·3	14·3	18·03
	1	7·3	14·1	14·15
	0	7·3	13·9	12·58
12/50		No records		
1/51	Bottom	8·2	18·1	30·30
	3	7·8	18·7	26·67
	2	7·5	19·5	20·47
	1	7·5	19·0	19·27
	0	7·2	18·8	17·01
2/51	Bottom	8·0	18·8	28·23
	3	7·6	18·3	23·10
	2	7·6	18·8	21·41
	1	7·5	18·5	20·76
	0	7·4	19·2	20·45
3/51	Bottom	8·2	17·9	31·86
	3	7·9	17·5	27·64
	2	7·5	17·3	26·68
	1	7·6	17·9	26·40
	0	7·8	18·2	27·31
Average salinity from 6/1949 to 3/1951 inclusive				31·76
				29·60
				22·92
				18·46
				17·44

TABLE 5

Estimated average monthly discharge (in cu. secs.) of River Derwent for period May 1949-December 1950. Data are based on figures supplied by the Hydro-Electric Commission.

May 1949	3366	March	2145
June	2920	April	2376
July	8510	May	2387
August	4640	June	2761
September	3663	July	3162
October	4884	August	4367
November	4333	September	5511
December	2778	October	3377
January 1950	2760	November	4169
February	2000	December	2453

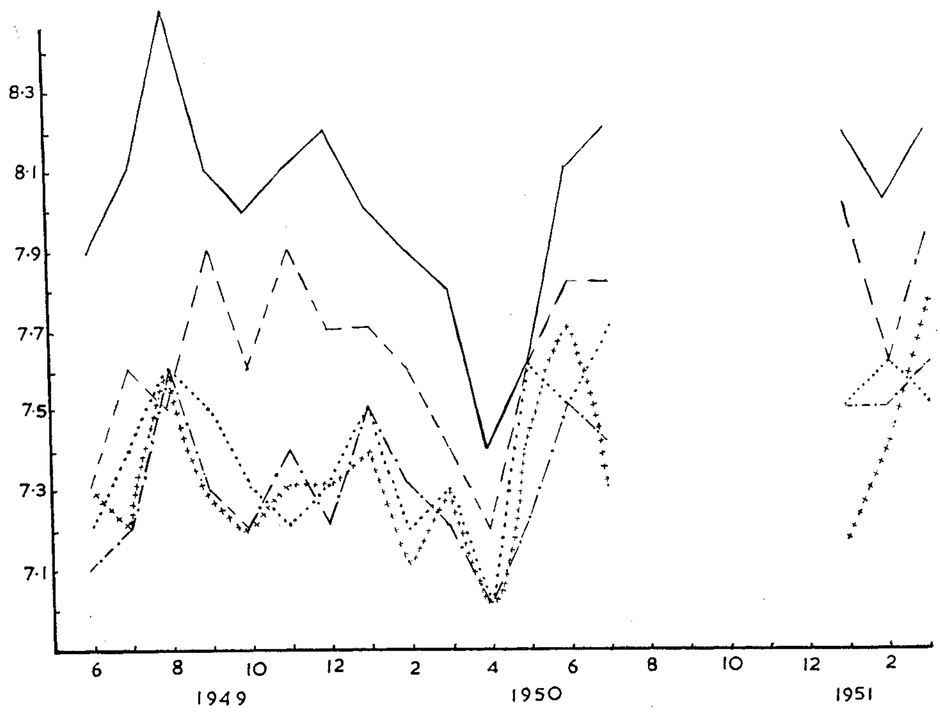

FIG. 2.—Average monthly pH values taken at Station 1 from June 1949 to March 1951. The unbroken line shows the pH at the bottom (4 fathoms); the pH at three fathoms is shown by a broken line; the pH at two fathoms by a dotted line; the pH at one fathom by a line of dashes and dots, and the surface pH by a line of crosses.

The monthly average for the period 1922-1953 is 5123 cu. secs. These results, as shown in Figs. 2-4 can be compared with Fig. 5, which shows the average monthly discharge of the river (Table 5) as kindly given to me by the Hydro-Electric Commission. The bottom salinity at Station 1 is fairly constant throughout the year, the greatest variation occurring during the winter months. This is to be expected since there is a greater flow of fresh water at that time of the year. The temperature varies considerably throughout the year. In general, the temperature variation follows that of the coastal waters further down the River Derwent (Station 37, see Guiler, 1950). The pH value does not appear to follow closely any of the other two factors though it apparently follows the amount of discharge from the river, the more acid freshwater being present during times of flood. The bottom pH varies more than that at other depths, this probably being due to more interchange with the alkaline salt water at this depth than nearer the surface where the pH is more acid.

Limits of saltwater and freshwater influences

The river is tidal as far as New Norfolk but the limit of salt water penetration ends below the town, in the part of the river below Millbrook Rise (Station 46). During a summer survey, the surface salinity became so low at Station 45, off Boyer, that it was not possible to estimate by titration the salts in the sample. The bottom salinity at this Station was still high (25-43 grs./°°) but at Station 47, below New Norfolk the bottom salinity was 1. Station 48 (see Fig. 1) had a bottom salinity of 2·02 grs./°°. The salinity gradient in this part of the river is steep. It is surprising that during the winter survey the salinities at these Stations were higher than those obtained during the summer. Reference to Fig. 5 shows that the actual discharge from the river was less during this period than in the summer, due to an abnormally dry winter period.

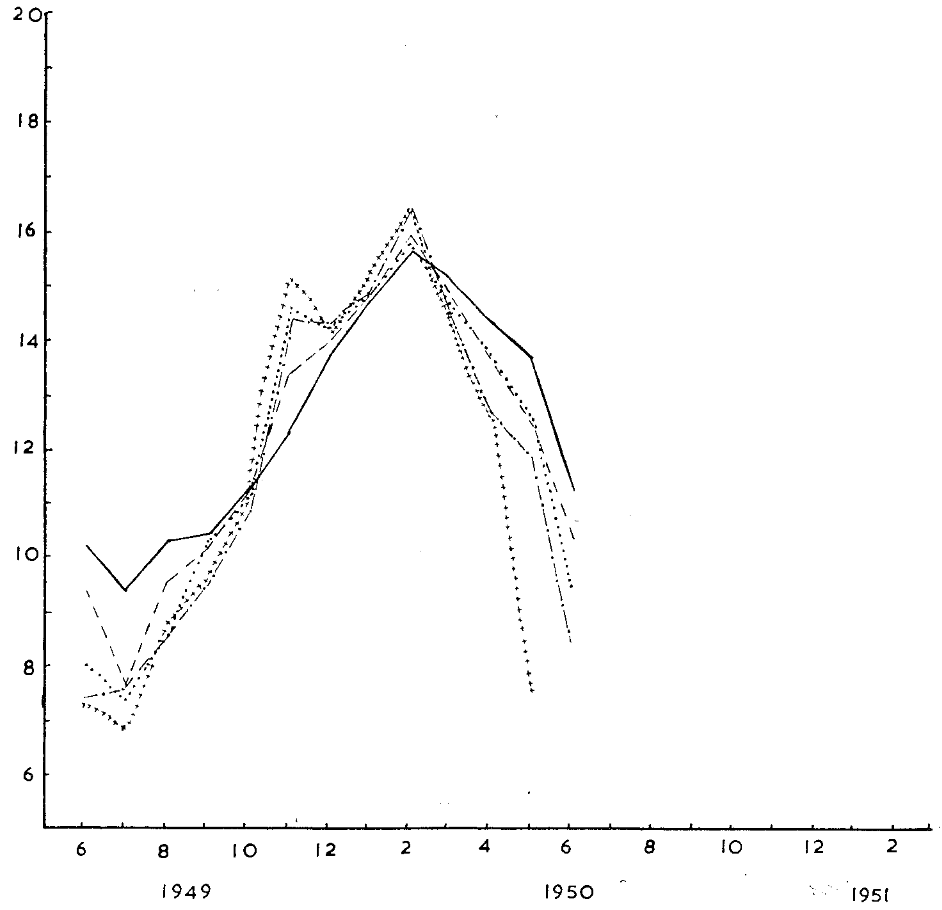

FIG. 3.—Average monthly temperature (° C) taken at Station 1 from June 1949 to March 1951. The conventions are the same as in Figure 2.

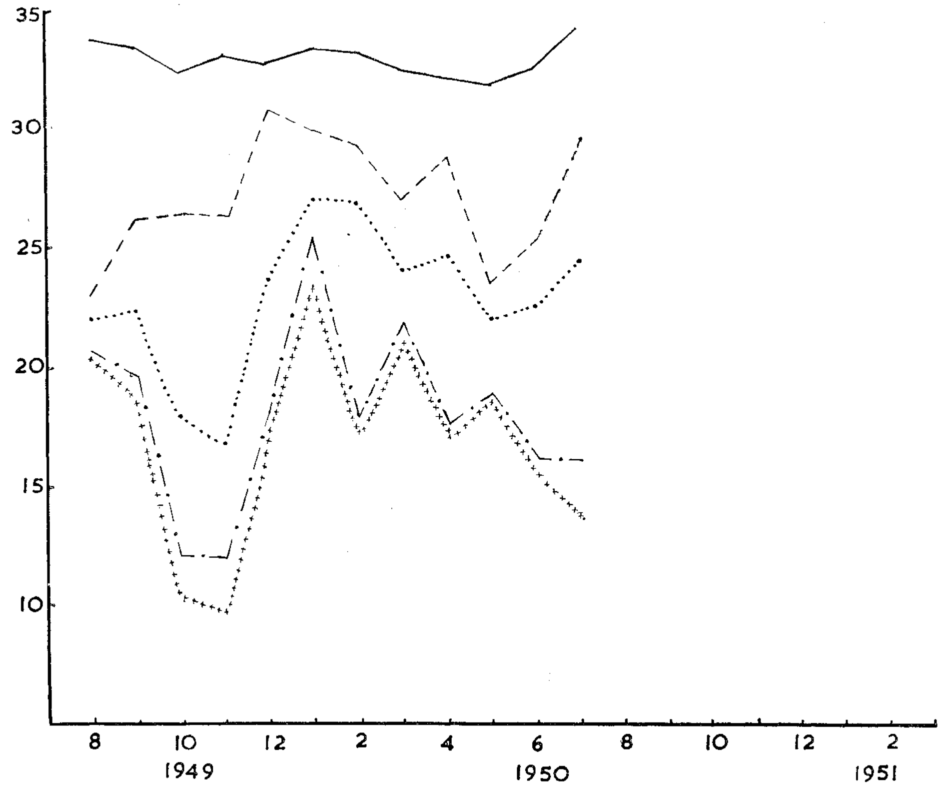

FIG. 4.—Average monthly salinities (in grs./^{00}) taken at Station 1 from June 1949 to March 1951. The conventions are the same as in Figure 2.

During flood periods the fresh water extends for considerable distances down either side of the estuary. The distance the freshwater extends down the eastern side of the river is greater than that on the western shore. During floods, the freshwater can be seen as a brown colouration carried down by the river, extending as far as Opossum Bay on the eastern shore while Blackman's Bay on the western shore is unaffected by the flood. During a period of flood the water on a line between Long Point and Howrah (Stations 31, 32, 33) had a surface salinity of 17-20 grs./^{00}, with a pH in accordance with marine figures. The result taken on 17/4/50 at Station 55 must be regarded as very doubtful since the Station is situated near drainage and sewage outfall.

It is thus possible to construct a salinity gradient diagram for the River Derwent (Fig. 6). It must be stressed that the salinity gradient at any one station may vary considerably from that shown above, depending on the flow of fresh water. Unfortunately, the period over which water sampling was carried out was exceptionally dry.

Following the nomenclature proposed by Rochford, the part of the river above Boyer (Station 45) falls into the freshwater zone, the region above Station 1 forms the gradient zone, the region below

Station 1 as far as Cornelian Bay is the tidal zone while below this area is the marine zone.

There is considerable biological evidence that there has been a comparatively recent change in the hydrological character of the river. Species which used to occur in several of the upstream bays about 20 years ago are no longer found there, e.g., Pectinidae in New Town Bay. The biological results of dredging in New Town Bay used to yield species characteristic of a sandy bottom but nowadays the bay is very muddy and the species found are characteristic of that habitat. Dredging off Station 1 produced a dredge full of *Echinocardium cordatum,* whereas in earlier times, oysters and scallops were found among other marine species.

These faunal changes were brought about by greater agricultural effort increasing the run-off as well as the amount of sediment brought down by the river. The sediment caused silting of the river bed and so altered the fauna.

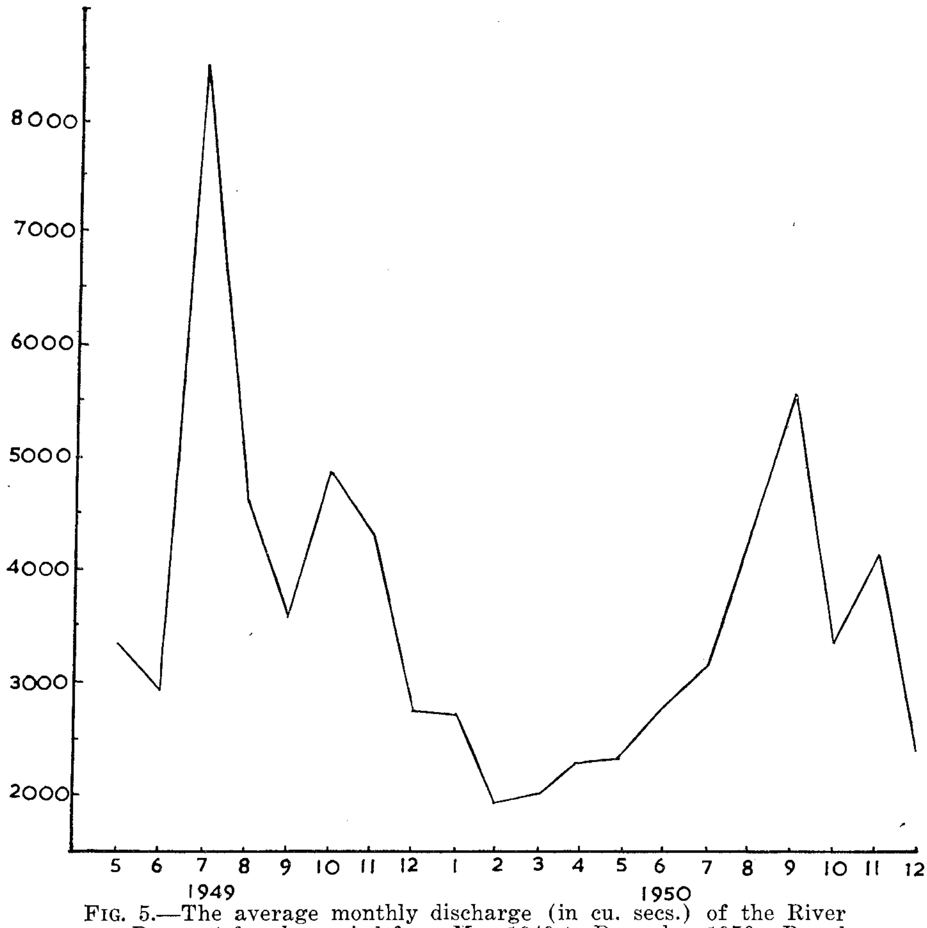

FIG. 5.—The average monthly discharge (in cu. secs.) of the River Derwent for the period from May 1949 to December 1950. Based on data kindly supplied by the Hydro-Electric Commission.

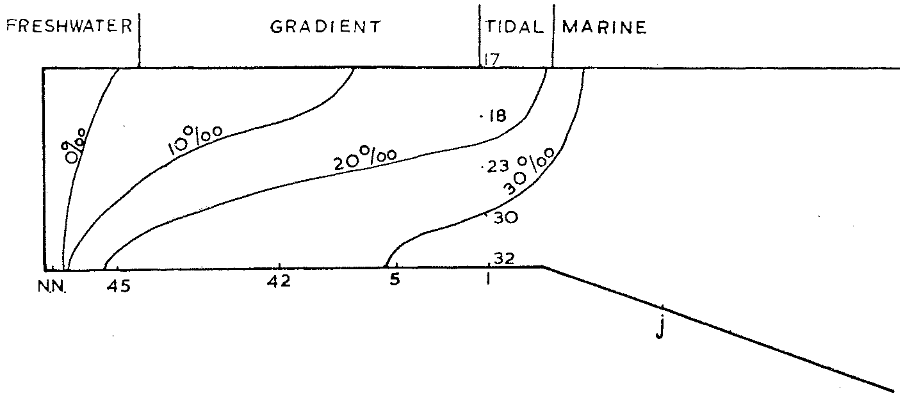

FIG. 6.—The salinity gradients of the River Derwent. The nomenclature used is that of Rochford (1951). The conventions are:—N.N.—New Norfolk; 45, 42, 5, 1—Station numbers inserted as reference points; j—Blinking Billy Point; 32, 30, 23, 18, and 17—the salinities at four, three, two, one and zero fathoms.

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