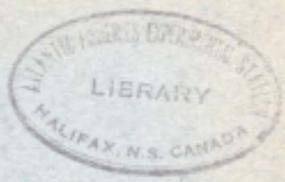


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HYDROGRAPHIC OBSERVATIONS IN 1929 WITH SPECIAL
REFERENCE TO pH.

by

A. W. H. Needler.



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March 1, 1938

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Hydrographic observations in 1929 with special reference to pH.

A. W. H. Needler

This report brings together the hydrographic data collected in various oyster areas in 1929 which include pH records. Other hydrographic data of that year are not given.

The general hydrographic data - temperatures and salinities are much more meagre for 1929 than for subsequent years, because the work of that year was preliminary exploration and regular stations had not been established. The pH data are, however, more extensive than for subsequent years because it was believed that they were less significant than the temperatures and salinities which, therefore, were then given most attention.

The temperatures in 1929 were taken with an accurate and calibrated surface thermometer and with a reversing thermometer of the usual Negretti and Zambra type. As presented they are considered reliable to within a tenth of one degree, bearing in mind, of course, that temperatures are very variable in small inlets within short distances and periods so that although the readings are accurate must less accuracy can be attributed to them as indications of temperatures close to them in time and space.

The salinities were made with a hydrometer calibrated by testing in salt water of known salinities and for which a rough temperature correction had been developed. The degree of consistency of the readings, and comparison with titrations in a few instances, indicated that the readings are significant within about 0.1 per mille. Here again it must be remembered that the actual salinities in the inlets studied vary greatly in very short distances so that samples taken almost simultaneously may show differences as great as one per mille. This is due in part to variations in seepage and springs and in part, probably, to disturbance of the stratification which occurs where fresh water is flowing into a highly sheltered inlet.

The pH determinations were made colorimetrically using Brom thymol blue, Cresol red, Phenol red and Thymol blue. Samples were compared with a series of buffer solutions (Clark and Lubs) and with the colour charts in "The Determinations of Hydrogen Ions" by W. M. Clark. While the readings are given below in some instances to .05 pH it is not believed that the method gave significant estimations closer than 0.1 pH and possibly less. Care was taken, when possible, to check estimations by using more than one indicator. A correction was made for salt error. No correction was made for temperature which causes, in sea water, a decrease of about pH 0.01 per 1°C rise. As the temperature at which the estimation was made was almost invariably within 5°C of the temperature of the sample in the sea the error from this source would usually be less than pH 0.05.

The data are presented below. They apply principally to the upper part of Bideford river but some are also included for other parts of the Malpeque bay region and for Hillsborough river, Savage harbour, and Percival and Ennore rivers.

The numbers in brackets following the names of the places where data were obtained refer to the accompanying sketch. They are provisional numbers given to the temporary stations occupied during the preliminary explorations in 1929. They were discontinued thereafter and the stations occupied regularly since that time are also given on the sketch (e.g. Station 2003).

Date	Time	Tide	Depth	Place	pH ¹	Salinity / mille	Temp. °C.		
July 15	10.40 AM	‡R	Sur.	Paugh's bed (7c)	7.4	29.1	19.9		
			Bot. 7 $\frac{1}{2}$ '	" "	7.4	29.1	19.8		
	11:30AM	H	Sur.	Ellis' cove	7.7	29.2	20.5		
			1:20 PM	H	Sur.	Mackinnon's creek	7.25	28.5	22.3
	1:40 PM	HF	Sur.	Paugh's creek centre (65-66)	7.14	28.3			
			Bot. 2'	" "	7.5		23.6		
		5:15 PM		Sur.	End of Port Hill wharf	8.35	29.5	20.3	
				5:30 PM		Sur.	Cooper bed (Sta. 2007)	8.2	29.4
	Aug. 6	33:45 PM	L	Sur.	Paugh's creek - mouth (69)	7.4	27.8	18.7	
				3:45 PM	L	Sur.	" " - head (62-63)	7.1	22.5
3:45 PM		L	Sur.	" " - mouth (70)	7.1	27.6	19.3		
			4:00 PM	L	Sur.	Ellerslie creek - (84)	7.3	28.6	20.2
4:20 PM		L	Sur.	Fred England bed (83)	8.2	27.6	20.2		
4:30PM		L	Sur.	Mud-digger point (14)	7.6	28.4	18.3		
4:40 PM		L	Sur.	Sta. 2003 (81)	7.4	28.8	18.0		
Aug. 7		9.10AM	M	Sur.	Paugh's creek - head (61)	7.3	26.8	17.8	
	9:20 AM			H	Sur.	" " - centre (65-66)	7.6	24.0	17.3
	9:30 AM	H	Sur.	" " - lower (67)	7.25	27.4	17.4		
	9:35 AM	H	Sur.	" " - mouth (69)	7.65	28.4	17.6		
	9:35 AM	H	Sur.	" " - mouth (70)	7.7	28.0	17.3		
	9:50 AM	H	Sur.	Ellerslie creek (84)	8.05	27.0	16.8		
	10.00 AM	H	Sur.	Mud-digger point (14)	7.4	29.0	17.5		
	10.05 AM	H	Sur.	Fred England point (82)	8.05	28.5	17.5		
	10.05 AM	H	Sur.	" " bed (83)	8.0	28.8	17.4		
	10.25 AM	H	Sur.	Sta. 2003 (81)	7.8	28.8	17.4		
Aug. 13	10.25 AM	LR	Sur.	Paugh's creek centre (67)	7.9	28.8	21.8		
			3.28 PM	‡	Sur.	" " "	8.15	27.7	23.8
	5.02 PM	‡	Sur.	" " "	8.4	27.3	23.2		
			8.15 PM	‡R	Sur.	" " "	8.15	27.4	23.0
			10.55 PM	‡R	Sur.	" " "	8.15	27.2	22.8
Aug. 14	1.25 AM	H	Sur.	" " "	8.1	27.4	22.4		
			3.16 AM	HF	Sur.	" " "	8.1	27.6	22.2
	5.05 AM	‡F	Sur.	" " "	8.15	27.7	22.0		
	6.33 AM	‡F	Sur.	" " "	8.3	27.6	21.7		
	8.50 AM	‡F	Sur.	" " "	8.35	25.7	22.1		
Aug. 13	9.45 AM	LR	Sur.	Station 2003 (81)	8.0	28.6	20.5		
			Bot.	" "	8.1	29.0	19.5		
	12.00 noon	‡R	Sur.	" "	8.0	29.0	21.2		
			Bot.	" "	8.1	29.0	18.9		

<u>Date</u>	<u>Time</u>	<u>Tide</u>	<u>Depth</u>	<u>Place</u>	<u>pH.</u>	<u>Salinity</u> <u>/ mille</u>	<u>Temp.</u> <u>°C.</u>	
Aug. 13	1.20 PM	‡R	Sur.	Station 2003 (81)	8.05	28.5	20.6	
			Bot.	"	8.0	29.0	19.5	
	3.55 PM	‡F	Sur.	"	8.0	29.0	21.6	
			Bot.	"	8.2	28.8	19.5	
	5.25 PM	‡	Sur.	"	8.1	29.1	21.4	
			Bot.	"	8.2	28.8	19.6	
	7.55 PM	‡R	Sur.	"	8.05	29.0	21.9	
			Bot.	"	7.8	29.1	20.3	
11.15 PM	HF	Sur.	"	8.0	29.3	21.0		
		Bot.	"	8.05		19.5		
Aug. 14	12.26 AM	H	Sur.	"	8.1	29.1	21.0	
			Bot.	"	8.2	28.8	20.4	
	2.50 AM	HF	Sur.	"	8.15	28.5	20.9	
			Bot.	"	8.1	29.1	20.1	
	4.40 AM	‡F	Sur.	"	8.0	28.8	20.9	
			Bot.	"	7.7	28.8	20.4	
7.05 AM	‡F	Sur.	"	8.2	28.5	20.9		
		Bot.	"	8.1	29.1	20.4		
Aug. 26	11.00 AM	HF	Sur.	Paugh's creek centre (65-66)	7.8	27.6	19.8	Clear, cool W. wind.
			Bot.	"	7.6	27.4	20.6	
	12.20 PM	HF	Sur.	" head (61)	7.2	16.5	22.5	
			Bot.	"	7.4	25.6	19.5	
Sept. 12	12.45 PM	HF	Sur.	Grant's creek	7.4	25.6	19.5	
			Bot.	"	7.65	10.4	20.0	Clear, cool frost on previous night.
	10.50 AM		Sur.	Paugh's creek head (61)	8.0	26.2	18.0	
			Bot.	" centre (67)	8.0	26.9	18.0	
	11.30 AM		Sur.	Paugh's bed (72)	8.1	27.0	18.9	
			Bot.	"	8.15	27.2	18.9	
	11.55 AM		Sur.	Station 2003 (81)	8.15	27.7	17.8	
			Bot.	"	8.15	27.6	17.1	
	3.40 PM		Sur.	Paugh's creek middle (67)	8.05	26.3	19.8	
			Bot.	"	8.1	27.0		
	4.22 PM		Sur.	Grant's creek	7.7	24.1	20.4	
			Bot.	"	8.15	27.2	18.2	
5.15 PM		Sur.	Paugh's bed (72)	8.15	27.2	18.2		
		Bot.	"	8.15	27.2	18.2		
5.40 PM		Sur.	Station 2003 (81)	8.15	27.6	17.7		
		Bot.	"	8.2	27.6	16.4		
Oct. 4	11.00 AM	H	Sur.	Paugh's creek - fresh water	8.7			Very heavy rain Oct. 3
			Bot.	" - centre (67)	7.2	2.7	13.9	
	10.50 AM	H	Sur.	" - " "	7.05	6.8	13.9	Oct. 4-
			Bot.	" - head (61)	6.2	0.0	13.0	S. wind.

Date	Time	Tide	Depth	Place	pH.	/ Mille	°C.
Oct. 4	11.30 AM	H	Bot.	Paugh's creek head (62-63)	6.55	0.9	13.4
	11.40 AM	H	Sur.	" bed (72)	7.05	5.1	14.0
			Bot. 6'	" "	8.05	24.0	
	3.00 PM	H	Sur.	" (72)	7.25	5.9	14.1
			Bot. 7½'	" "	8.1	22.5	
	4.25 PM	H	Sur.	Station 2003 (81)	8.1	24.5	13.4
		Bot.	"	8.3	25.8	13.1	

On October 4 all surface samples in Paugh's creek very red, others clear.

Malpeque bay general.

June 27	3.28 PM	2F	Sur.	Bridge over Nebraska creek	8.6	27.7	21.8	Warm, clear
	1.30 PM		Sur.	Malpeque wharf	8.6	27.8	22.6	
Aug. 9	1.20 PM	F	Sur.	Curtain Island bed	8.4	28.3	18.2	
			Bot. 6'	" "	8.45	28.5	18.0	
	2.00 PM	F	Sur.	Reef bed, near Curtain Is.	8.35	28.1	18.1	
			Bot. 20'	" "	8.4	28.8	18.0	
	3.20 PM		Sur.	Off Princetown	8.4	27.9	16.7	
			Bot. 35'	" "	8.35	27.9	16.7	
Sept. 16	4.20 PM	S	Sur.	Mouth of Bideford river.	8.4	28.5	17.7	
	7.05 AM	A	Sur.	Off Winchester cape	8.2	28.5	16.8	
			Bot. 25'	" "	8.2	28.4	16.8	
	7.40 AM		Sur.	Off Ram Island	8.2	28.5	17.0	
	8.30 AM		Sur.	Just inside Malpeque bar	8.2	28.5	16.0	
			Bot. 24'	" "	8.2	28.7	15.9	
	10.15 AM		Sur.	4.5 miles NNE Malpeque light	8.2	28.6	15.9	
			Bot. 7½'	" "	8.1	30.4	7.9	
	10.45 AM		Sur.	10	8.2	28.6	15.9	
			Bot. 96'	" "	8.0	30.8	5.1	

Percival and Enmore rivers.

July 23	10.15 AM	HR	Sur.	Bed near Mossy point	8.7	31.2	20.7	
	6.00 PM	L	Sur.	" "	8.5	28.7	23.0	
	11.00 AM	H	Sur.	Ballen's bridge	8.2	25.8	20.8	
			Bot. 10'	" "	8.2	29.0		
	7.30 PM	L	Sur.	" "	8.4		24.2	
Aug. 8	4.30 PM	2F	Sur.	Bridge over Beaton's creek	8.4	29.9	25.9	
	2.00 PM	H	Sur.	Ballen's bridge	8.45	28.7		
			Bot.	" "	8.35	29.0		
	3.55 PM	H	Sur.	McKie's shore, outer station	8.55	30.1	20.2	
			Bot. 5½'	" "	8.4	29.8	18.8	
	7.55 PM	L	Sur.	" "	8.75	29.6	21.4	
			Bot.	" "	8.55	30.0	20.4	

Date	Time	Tide	Depth	Place	pH.	/ Mille	°C.	
Aug. 8	3.05 PM	H	Sur.	McKie's shore, inner station	8.55	20.0	21.0	
Aug. 21	2.45 PM	LF	Sur.	" outer station	8.4	29.9	20.2	
			Bot. 4'	" "	8.45	29.9	19.9	
	2.20 PM	LF	Sur.	" edge of shore	8.5	29.8	21.3	
Aug. 28	3.10 PM	2R	Sur.	" inner station	8.6	29.4	20.4	
	2.50 PM	2R	Sur.	" edge of shore	8.65	30.4	20.4	
Sept. 9	2.30 PM	LR	Sur.	" " over	8.4	29.8	26.2	
		LR	Sur.	" outer station	"	29.8	19.6	
	2.50 PM		Bot. 3'	" " "	"	29.7	19.5	
	3.10 PM	LR	Sur.	Middle of Percival river	"	29.7	19.6	
			Bot. 10'	" "	"	29.7	19.6	
Sept. 20	3.00 PM	2F	Sur.	Balle's bridge	7.25	18.8	15.0	Heavy rain
	3.45 PM	2F	Sur.	McKie's shore, edge of shore	8.2	26.2	15.0	Sept. 17-18
	4.05 PM	2F	Sur.	" outer station	8.3	28.3	16.0	
			Bot. 4 1/2'	" "	8.3	28.3	16.0	
	4.18 PM		Sur.	Middle of Percival river	8.3	28.3	16.1	
			Bot. 11'	" "	8.3	28.3	16.1	
Hillsborough river.								
Oct. 8	9.00 AM	L	Sur.	Mt. Stewart, above bridge	8.1	12.3	11.5	
			Bot. 6'	" "	8.05	12.6	11.5	
	9.10 AM	L	Bot. 5'	" below bridge	8.0	12.9	11.8	
	2.20 PM	H	Sur.	" "	8.0	13.3	13.4	
			Bot. 13'	" "	8.05	16.5	12.1	
	10.30 AM	LR	Sur.	Scotchfort wharf.	8.05	19.5		
	3.45 PM	HF	Sur.	" "	8.15	22.0	12.5	
			Bot. 8'	" "	8.2	23.5	12.4	
	4.35 PM	HF	Bot. 10'	Wharf just above island	8.2	25.4	12.4	
	5.25 PM	HF	Bot. 21'	Hillsborough bridge	8.2	29.1	12.8	
Savage harbour.								
Oct. 9	10.30 AM	2R	Sur.	NW of Canavoy island.	8.2	26.5	10.6	
	11.30 AM	2/3R	Sur.	above Canavoy bridge	8.15	26.3		

Discussion. The pH of sea water from the open ocean is from 8.1 to 8.3 (H. W. Harvey: "Biological Chemistry and Physics of Sea Water) and observations above for the entrance to Malpeque bay and outside water (p.5) are in that neighbourhood. The data do, however, show a wide variation - from about 7 to almost 9. The data are obviously not sufficient to separate the various factors responsible for the variations but it may be worth while to mention some of them.

1. Fresh water. The pH is influenced apparently by the fresh water flowing into the inlet. Thus in Bideford river and in Percival and Enmore rivers the pH was always found to be below 8.0 when the salinity was below 22.5 per mille and there is some positive correlation between pH and salinity. It appears to be strongest at low levels of salinity and, although the correlation appears significant, there is a great variation of the pH of waters of the same salinity. In these inlets the fresh water is obtained from land of similar nature and close proximity. A sample of fresh water flowing into Paugh's creek was found to have a pH below 7 (p.4). In Hillsborough river, on the other hand, higher pH was found in several samples of quite low salinity and it is suggested that the fresh water may be of a different pH.

2. Plant growth. Active photosynthesis raises pH by lowering the amount of CO_2 in the water and, consequently, the concentration of hydrogen ions in equilibrium. In enclosed seawater, such as tide pools, with sun-light on a high concentration of plants the pH may be above 9.0. Excess of respiration over photosynthesis tends to reduce pH. Our data do not suffice to show the operation of this factor but it is probably responsible for very high pH in some instances in the summer. Variations in the concentration of the plants and in the light are doubtless responsible for the wide variation in pH to some degree at least.

3. Temperature. This had been mentioned above. pH decreases about 0.01 for each rise in temperature of $1^{\circ}C$. This would account for a variation of only about 0.1 in pH in the data presented which include a temperature range of about 14 degrees (omitting the deep water outside Malpeque bay, p.5). It is, therefore, a relatively unimportant factor.

The data are presented here principally for record as the effect of the pH on the various stages of the oyster's life history has not been analyzed. It might be mentioned, however, that Prytherch (U.S.B.F. Doc. 1054 - "Investigation of the physical conditions controlling the spawning of oysters and the occurrence, distribution and setting of oyster larvae in Milford Harbour") found that spawning took place only when the pH was 7.8 or more (exceptionally 7.6) in oysters in trays although higher temperatures occurred with lower pH. If this finding is applicable to our conditions pH might determine the time of spawning in the creeks at the head of Bideford river. There the pH was often found below 7.8 while farther down the inlet such low pH readings were infrequent. Further investigation of this factor is needed.