terpoise was heavier than the globe by 8 g. (brass), the effective volume of the globe and weights was 0.4 ml. less than that of the counterpoise.

The difference in weight between the two was then very carefully determined at intervals over a period of twelve months. In making the comparisons the globe and counterpoise were similarly treated preparatory to weighing and were suspended on opposite sides of a sensitive balance in a room maintained at nearly constant temperature throughout this time. The observations follow:

Date	Excess in weight of counterpoise over globe	Time	Loss in weight	Loss in weight per day
	g.	days	mg.	mg.
Nov. 11, 1927	8.08873			
Nov. 12	8.08875	1	0.02	0.02
Nov. 15	8.08876	4	0.03	0.007
Nov. 21	8.08882	10	0.09	0.009
Nov. 29	8.08886	18	0.13	0.007
Dec. 6	8.08890	25	0.17	0.007
Dec. 15	8.08893	34	0.20	0.006
Dec. 21	8.08896	40	0.23	0.006
Jan. 21, 1928	8.08916	71	0.43	0.0059
Feb. 8	8.08925	89	0.52	0.0059
Mar. 1	8.08939	111	0.66	0.0059
May 7	8.08958	178	0.85	0.0048
May 30	8.08965	201	0.92	0.0046
June 26	8.08975	228	1.02	0.0045
July 25	8.08996	257	1.23	0.0048
Oct. 23	8.09036	347	1.63	0.0047
Nov. 2	8.09040	357	1.67	0.0047
Nov. 11	8.09046	366	1.73	0.0047

Although the loss in weight per day at first shows a gradual diminution with the time, it is possible that a part or even most of this diminution is due to the difficulty in determining the loss in weight with sufficient accuracy. A diminution with the pressure certainly is to be expected. The total loss in weight of the globe filled with helium is 1.73 mg., or one per cent. of the total weight of helium contained in the globe (0.168 g.). That is, apparently 10.7 ml. of helium leaked through the glass in the course of one year. Since the globe weighs 151 g. and has an interior surface of 500 cm^2., this is at the rate of 0.059 mm^3. per day per cm^2. of Pyrex glass of average thickness 1.34 mm. This corroborates the result of the experiments described first.

One possible source of error in the experiment lies in the well-known difficulty of making perfect seals with Pyrex glass. Naturally this point received especial attention. Since the pressure in the globe was sometimes greater, but usually less, than that of the atmosphere, and since the loss of helium was so slow and so regular, mechanical leakage seems unlikely. Furthermore the globe held a high vacuum for a long period before it was filled with helium.

These observations raise the question as to the effect of leakage upon the recent determinations of the density of helium by Baxter and Starkweather,[2] which were carried out in Pyrex globes. The globes used in the earlier density determinations were practically identical with the one used in the foregoing leakage experiment, and may be assumed to have behaved in the same way. Those used in the later density determinations had capacities of a trifle over two liters, and an average thickness of 1.11 mm. Since the surfaces of these globes were 1.6 times as large and the thickness 0.8 that of the globe used in the leakage experiment, the leakage may reasonably be estimated to be twice as great, *i.e.*, 0.01 mg. helium per day. Because the weight of helium in each density experiment was in every case the average of several weights obtained ordinarily during the 24 to 48 hours following the filling, the error from this source can hardly exceed 0.005 mg. in the weight of one liter and 0.01 mg. in the weight of 2 liters of helium. This quantity lies outside the accuracy of the density determinations.

The leakage experiment is being continued.

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DIFFERENCES OBSERVED IN THE CONDITION OF THE SEA WATER AT THE MARGINS OF TWO OPPOSING TIDAL CURRENTS

IN bays and estuaries where the range of the tides is considerable, it is a familiar sight to observe the meeting of flood and ebb currents along a sharply defined line, rendered visible either by the agitation of the water, or by a narrow zone of flotsam, or by differences in the color of the water, as when one current is turbid and the other clear. When the currents thus meeting are of considerable velocity (in Puget Sound they may attain a velocity at times of five or six miles an hour), the water is agitated and thrown into eddies, producing a dull roar. A "tide-rip" of this description may be seen and heard for a distance of several miles.

On July 23, 1927, the authors, in conjunction with Messrs. George H. Hitchings and Seldon P. Todd,

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[2] Baxter and Starkweather, *Proc. Nat. Acad.*, 11: 231 (1925); 12: 20 (1926).

were collecting samples of sea water in the channel north of San Juan Island, when the characteristic roar of a tide-rip was heard. As it approached the boat, a marked difference in the color of the waters on each side of the rip was observed, the water of one current being a decided blue, while that of the other was a distinct green. The line of demarcation was very sharp. The boat drifted so that it was directly on this line, with the blue water on one side, the green water on the other. With the utmost haste, samples were taken simultaneously from both sides of the boat, approximately twenty feet apart. On analysis, these samples gave the following results:

	Green water	Blue water
Temperature, °C.	16.4	14.0
pH (corrected for salt error after Ramage and Miller[1])	8.16	7.94
Mobile CO_2, mg. per liter	0.84	1.83
Combined CO_2, mg. per liter	63.64	78.79
Total CO_2, mg. per liter	64.48	80.62
Chlorinity, gms. per kilo	11.94	14.74
Specific gravity (δt, after Knudsen[2])	15.40	19.77
Osmotic pressure (calculated from equations of Stenius[3])	14.79	18.91

The green water was without doubt sea water coming in from the Gulf of Georgia, which had been diluted by the inflow of the Fraser River. This would account for its higher temperature, lower chlorine content and specific gravity, and probably for the color, which may be attributed at least in part to suspended matter. The clearer blue water was that flowing in from the Strait of Juan de Fuca, thus representing less diluted sea water.

In explanation of the higher pH value and the lower content of carbon dioxide, both mobile and bound,[4] we may assume a more rapid rate of photosynthesis in the diluted water from the Gulf of Georgia, because of its higher temperature or for other reasons.

It is a matter of considerable interest, and of no little biological importance, that such marked differences in the condition of the water should occur but a few feet apart, in opposing tidal currents. A sudden change of 2.4° C. in temperature, 0.22 pH unit in hydrogen-ion concentration and 2.8 parts per thousand of chlorine, with corresponding changes in associated conditions, would be presumed to exert a decided effect on marine organisms.

The differences recorded occurred, of course, at the surface of the water. It is doubtful that bottom living forms would be exposed to so wide a range of conditions (the depth at this locality was 175 meters). Plankton organisms would be carried with their respective currents, and hence would be exposed to these differences only at the very margins of the tide rip. But fish and other nekton forms must be assumed either to make extensive and frequent migrations with the tides or to be able to accommodate themselves to differences in the condition of the water more sudden and marked than some authors have considered to be the case.

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[1] Ramage, W. D., and Miller, R. C., *Jour. Amer. Chem. Soc.*, 47, 1230, 1925.

[2] Knudsen, M., Hydrographische Tabellen, Copenhagen, 1901.

[3] Stenius, S., Öfversigt af finska vetenskaps-societetens förhandlingar, 46, No. 6, Helsingfors, 1904.

[4] Carbon dioxide was determined by aspiration into a standardized solution of barium hydroxide.

THE INFLUENCE OF CO_2 TENSION ON THE OXYGEN DISSOCIATION CURVE

The influence of acids or CO_2 tension in lowering the oxygen dissociation curve is a well-known phenomenon.[1, 2] This has been interpreted as an evidence that CO_2 in the capillary bed increases the dissociation of oxygen from its combination with hemoglobin.

Whereas we have an adequate account of the mechanism involved in the displacement of CO_2 by O_2 in the pulmonary capillaries, no adequate account has been offered for the reverse mechanism occurring in the tissues whereby, as mentioned above, CO_2 tends to displace oxygen and thus lower the oxygen dissociation curve.

It occurred to us that perhaps the process can be simply explained if we assume a double dissociation process of oxyhemoglobin ($HHbO_2$) as follows:

$$(1)\ HHbO_2 \rightleftarrows HHb + O_2\uparrow$$
$$(2)\ HHbO_2 \rightleftarrows H^+ + HbO_2^-$$

Equation (1) presumably takes place since O_2 is absorbed by the tissues and reduced hemoglobin is obtained. Equation (2) is evidently present if we accept the well-known fact that oxyhemoglobin acts as an acid and consequently would dissociate accordingly. It would therefore behave as a weak electrolyte as follows:

$$K = \frac{[H^+]\ [HbO_2^-]}{HHbO_2}$$

Now, with the formation of carbonic acid in the tissues the concentration of hydrogen ions $[H^+]$ is

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[1] Bohr, Hasselbalch and Krogh, *Skand. Arch. f. Physiol.*, 16, p. 602, 1904.

[2] Barcroft, "The Respiratory Function of the Blood," 1914.