suggesting that it is not capable of living a long time free from the colony, and the character of the cytoplasm indicating that when the ovum is set free it is very buoyant, and is probably fertilised and passes through the early stages of its development suspended in the water.

It is almost certain that the medusa does not digest food and nourish the ova after its escape from the ampulla, and I am inclined to believe that after a few pulsations which are sufficient to carry it away from the region of the colony, the ova are set free and the medusa dies.

Correction.—In a former communication to the Royal Society (4), I described certain cells in the cœnosarc of Millepore from Celebes as ova. Since the discovery of the female medusa, I have carefully re-examined my preparations, and satisfied myself that I made a mistake. These cells are not ova, but the cells which ultimately give rise to the large kind of nematocyst.

LITERATURE.

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2. Hickson, S. J. "The Medusæ of *Millepora Murrayi*," 'Quart. Journ. Micros. Sci.,' 1891.
3. —— "Notes on the Collection of Specimens of the genus Millepora, obtained by Mr. Stanley Gardiner at Funafuti," 'Zool. Soc. Proc.,' 1898.
4. —— "The Sexual Cells and Early Stages of Development of *Millepora plicata*,' 'Phil. Trans.,' B, vol. 179.

"Vapour-density of Bromine at High Temperatures." By E. P. Perman, D.Sc., and G. A. S. Atkinson, B.Sc. Communicated by Professor Ramsay, F.R.S. Received November 14,—Read December 7, 1899.

It has been proved by one of us in a previous paper* that the vapour-density of bromine is normal up to a temperature of 279° C., a result in entire opposition to the numbers obtained by J. J. Thomson.†

We have now determined the densities at temperatures ranging from about 600° C. to 1050° C. by a modification of the former method, the chief difference being that the globe was not filled with the vapour by boiling out the excess of liquid, as in the usual method, but by admitting the bromine, already in the form of vapour, to the globe which remained in the furnace throughout the experiment.

Apparatus used.—A is a porcelain globe (fig. 1), in some experiments

* 'Roy. Soc. Proc.,' vol. 48, p. 45.
† 'Roy. Soc. Proc.,' vol. 42, p. 345.

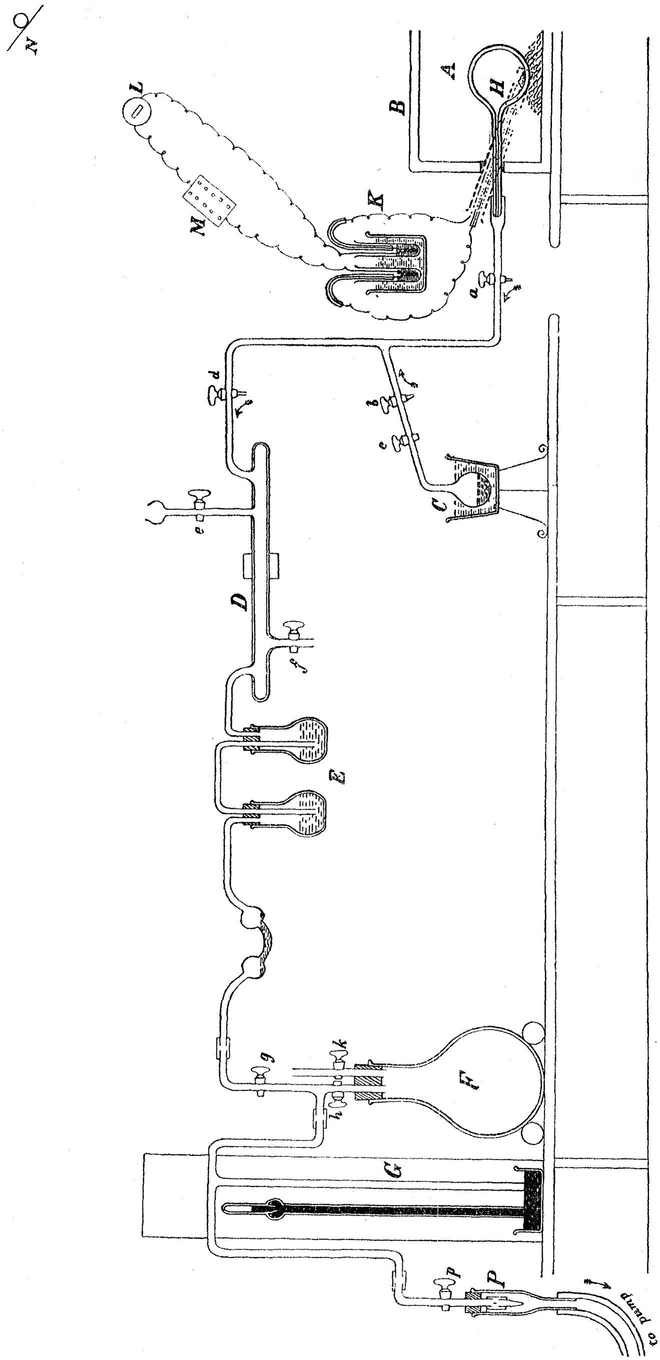


FIG. 1.

of a capacity of about a litre, in others of about 250 c.c.; its stem, of about 1 mm. bore, was cemented by means of a mixture of litharge and glycerine, to a cup on the capillary tube carrying *a*; B a muffle furnace, C a glass globe of about 200 c.c. capacity, placed in a water-bath; D and E absorption apparatus; F a large globe of about 8 litres capacity for steadying the pressure; G a pressure gauge; H a thermo-electric couple of platinum and platinum-rhodium enclosed in a porcelain tube; K the "cold junction," each wire of the couple being connected with a copper wire and placed in a test-tube containing alcohol, the two tubes standing in a beaker of water; L the galvanometer, which, with M, the resistance box and switch, and N, the scale and lamp, were in an adjoining room. P is a Bunsen valve to prevent back-rush of water from the pump; *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *k*, and *l* are stopcocks, *a*, *b*, and *d* being diagonal three-way stopcocks arranged so that air could be admitted from the outside in the directions shown by the arrows. These stopcocks were obtained from Messrs. C. E. Müller and Co., and have proved extremely satisfactory. The lubricant used on *a*, *b*, and *c*, which came into contact with liquid bromine, was phosphorus pentoxide which had become viscous by exposure to the air. Further action of the air was prevented by a covering of burnt rubber and vaseline.

Method of Procedure.

Filling the Globe.—The small globe C containing bromine was heated by means of the water-bath to about 60° C., *i.e.*, about the boiling point of bromine under atmospheric pressure. The globe A was exhausted by means of a water air pump, through the connections shown, to about one-sixth of an atmosphere, sometimes less. The stopcock *d* was then closed, and *b* and *c* opened to admit bromine into the globe A, the connecting tubes being warmed by means of a Bunsen burner to prevent the condensation of bromine in them. After a short interval (15 to 30 secs.) *b* was closed and *d* opened; the globe was exhausted to about the same extent as before, and all the bromine carried off was absorbed by strong caustic soda solution placed in the absorption tube and flasks D and E. (The arrangement of the flasks shown in the figure was found to be a very convenient one; it consists of two small wash-bottles with the long tubes connected, or in one piece; by this arrangement the liquid was never carried over in either direction.)

The large globe F was usually kept exhausted and the pump at work. If necessary the globe A could be connected directly with the pump by turning off stopcock *h*.

The globe was again put into connection with C, again exhausted, and so on, the filling process being repeated seven times. Some bro-

mine was then allowed to condense above the stopcock *a*, and the stopcock *b* was opened to the air; *a* was then turned on, when usually a little bromine entered, and finally began to blow out on reaching the hot neck of the globe; *a* was then turned off, and the tubes between *a*, *b*, and *d* cleared of bromine by a current of air; *a* was again turned on for a few seconds, and the tubes cleared again; this was repeated until no more bromine was seen to come out on opening the stopcock. During this process the neck of the globe and the stopcock were kept warm by heating with a Bunsen burner; considerable difficulty was sometimes experienced in getting the stopcock free from bromine.

The globe was thus filled with bromine vapour at the atmospheric pressure and the temperature of the furnace; the latter was read on the galvanometer scale at the moment of opening the stopcock *a* for the last time. The stopcock *c* was then closed, and the bromine removed from the tube *bc* by repeated exhaustion. The bromine in the globe C was thus cut off from the rest of the apparatus by the exhausted space *bc*.

Absorption and Estimation of the Bromine.—A strong solution of potassium iodide was placed in the tube and flasks D and E, and the globe A was exhausted to about one-sixth atmosphere as in the filling, the bromine drawn off being caught by the potassium iodide. Air was then admitted to the globe through *b*, and the exhaustion repeated.

After the seventh exhaustion the tube was washed out through the stopcocks *e* and *f*, and the solution added to that from the flasks E, and titrated with a standard sodium thiosulphate solution of about N/5 strength. The solution was standardised by means of pure bromine weighed in small bulbs and dissolved in potassium iodide solution. When a series of determinations was made at different pressures, the globe was filled in the usual way, and then slowly exhausted to the required amount, the bromine drawn off being absorbed by potassium iodide solution as usual, except that the absorption flasks were replaced by a straight tube with two small bulbs blown in it containing some of the solution; this arrangement was to obviate the back pressure caused by the solution in the flasks.

The residual amount of bromine was drawn off as before described.

Determination of Temperature.—The thermo-electric couple was standardised by means of boiling selenium and solidifying potassium sulphate. The latter was melted in a small porcelain crucible by means of the oxygen-gas flame; the porcelain was not appreciably attacked if the operation was conducted quickly. The galvanometer, a dead-beat d'Arsonval, was obtained from Messrs. Nalder Bros., and had a resistance of about 200 ohms; the focal length of the mirror was 40 inches. In order to bring the zero point and the reading for the highest temperature employed upon the scale, it was necessary to introduce a resistance of 11,000 ohms, which remained in the circuit

during the whole of the experiments. With this arrangement one scale division was equivalent to about 2° C. The porcelain tube containing the couple was supported by asbestos some distance above the floor of the muffle. The variation of temperature between the floor and the top of the muffle was found to be 6° C. at a temperature of about 600° C., and 8° C. at 900° C.; no correction was made for this difference as the couple was near the level of the centre of the globe.

Between the two fixed points obtained the scale reading was taken to be proportional to the difference of temperature, according to the method used by Roberts-Austen.

Determination of Pressure.—The pressure was read off on a standard barometer, or on the pressure gauge G in the case of pressures less than atmospheric.

Capacity of the Globe.—The porcelain globe was weighed full of air, and again weighed, filled with water, and the capacity calculated. The filling with water was effected by repeated exhaustion and letting in water.

Preparation of Pure Bromine.—Commercial bromine was purified by one of the processes previously employed, viz., by boiling with potassium bromide, distilling over red-hot manganese dioxide, shaking with strong sulphuric acid, and re-distilling. The greater portion came over at a perfectly constant temperature, 58·9° C. at a pressure of 761 mm. (*Cf.* former paper.)

Results.

Series I. About 650° C.

Weight of Br. grammes.	Volume of globe. c.c.	Pressure. mm.	Temperature.	Vapour-density.
0·6076	294·3	765·5	677·5°	79·3
0·6348	294·3	765·5	650·0	80·4
0·6013	275·1	758·0	631·0	80·4
			Mean.........	80·0

Series II. About 830° C.

Weight of Br. grammes.	Volume of globe. c.c.	Pressure. mm.	Temperature.	Vapour-density.
0·4914	276·0	758·0	828·0°	79·7
0·4656	276·0	758·0	873·0	78·6
0·4850	276·0	758·0	833·0	79·0
0·4896	276·0	758·0	830·0	79·6
1·9380	1052·0	767·0	799·0	79·6
0·5335	295·1	765·0	833·0	80·6
0·5371	295·1	765·0	820·0	80·1
0·5244	295·1	765·0	845·0	80·0
			Mean.........	79·7

Series III. About 900° C.

Weight of Br. grammes.	Volume of globe. c.c.	Pressure. mm.	Temperature.	Vapour-density.
1·7440	1053·0	767·0	903·0°	78·5
0·8340	1053·0	365·5	901·5	78·7
			Mean.........	78·6

Series IV. About 950° C.

1·6400	1053·0	764·0	956·0°	77·4
1·6490	1053·0	764·0	951·0	77·6
			Mean.........	77·5

Series V. About 1015° C.

0·4003	276·5	757·0	1016·0°	75·9
0·0275	276·5	55·75	1010·0	70·4
0·4099	276·5	757·0	1012·0	77·4
0·0302	276·5	60·0	1016·0	72·3
0·4078	276·5	757·0	1022·0	77·6
0·03195	276·5	62·7	1016·0	73·1
0·3982	276·5	755·0	1016·0	75·8

Mean of vapour-densities at atmospheric pressure ... 76·7

Series VI. About 1050° C.

0·3828	276·6	760·0	1057·0°	74·5
0·3860	276·6	760·0	1055·0	75·0
0·3771	276·6	760·0	1055·0	73·3
0·3891	276·6	760·0	1057·0	75·7
0·3773	276·6	760·0	1057·0	73·5
1·4390	1055·0	763·0	1055·0	73·5
1·4680	1055·0	764·0	1034·0	73·7*
			Mean.........	74·3

Series VII. About 1040° C., varying Pressure.

0·3943	276·6	755·0	1035·0°	76·0
0·1615	276·6	319·3	1039·0	73·9
0·3915	276·6	755·0	1041·0°	75·8
0·1608	276·6	318·5	1042·0	73·9
0·0947	276·6	188·7	1041·0	73·3
0·02323	276·6	47·3	1041·0	71·8

* This number is not included in taking the mean, as the temperature is considerably below the others.

Chief Possible Sources of Error.

(1) *Error in filling and emptying Globe.*—To avoid error in filling, the globe was exhausted and filled with bromine seven times, as mentioned above. Each exhaustion being to at least one-sixth atmosphere, the volume of the residual air would be theoretically $\left(\frac{1}{6}\right)^7$, *i.e.*, less than 1/250,000 of the volume of the globe. Similar remarks apply to the emptying.

As a practical test, a glass globe was filled in the manner described, and on opening it under water, only a negligible amount of air was found to be present.

(2) *The Low Temperature of the Stem.*—An approximate correction for this was made in the following manner:—

Let v = volume of globe.
δ = vapour-density of bromine in globe.
T = absolute temperature of globe.
v', δ', T' = corresponding quantities for the stem.
D = apparent vapour-density.

Then $$\delta = D - \frac{v'}{v}\left(\frac{\delta' T}{T'} - D\right).$$

The maximum correction thus calculated is only 0·4.

(3) *Loss of Bromine by Incomplete Absorption.*—The potassium iodide solution in the small bulbs of the absorption apparatus E remained uncoloured, showing that the absorption was practically complete.

(4) *Leakage at the Stopcocks.*—In the earlier experiments ordinary stopcocks were used, and were found to leak to such an extent as to be useless for the purpose. Well-made diagonal stopcocks were then employed and were found quite trustworthy.

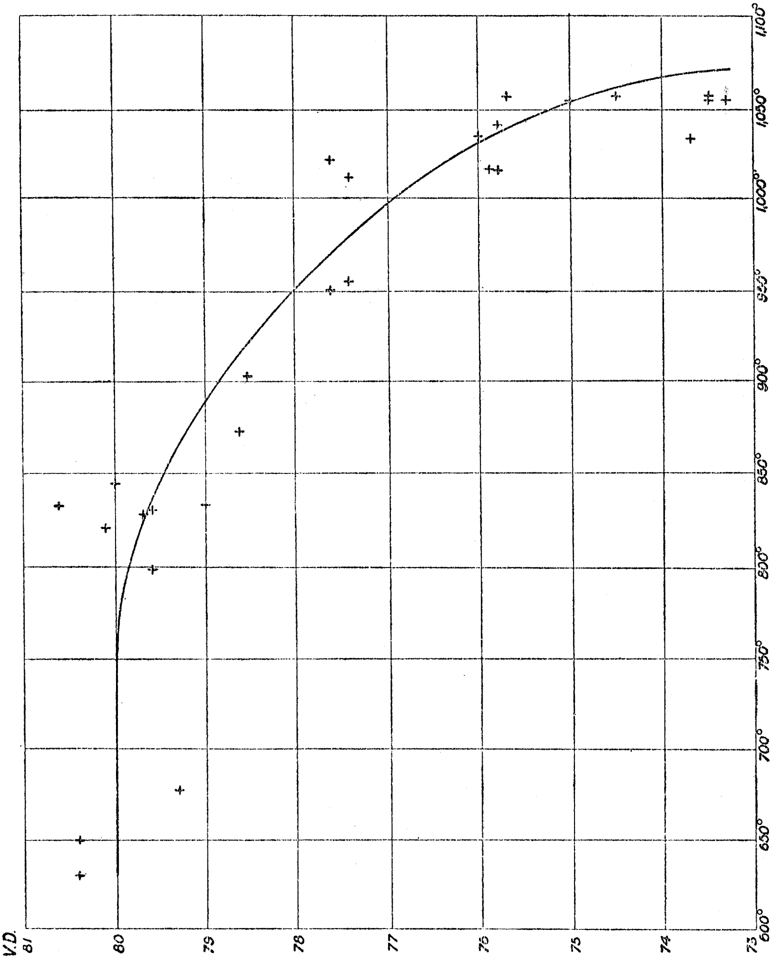
(5) *Error in Temperature Determinations.*—It is very difficult to say what the maximum error is; we think it to be not more than 10°, if so much. The chief source of uncertainty was the drift of the zero of the galvanometer; this was reduced to a minimum by switching in just before taking a reading.

(6) *Expansion of the Porcelain Globe.*—A correction was made for this, the coefficient of expansion found by Deville and Troost, 0·0000108, being used. This gives practically the same result at the temperatures considered as the formula of T. G. Bedford (British Association, 1899).

General Conclusions.—The results at atmospheric pressure have been plotted against temperature (see Curve I). From this it appears that the vapour-density of bromine is normal up to about 750° C.; at this point dissociation becomes appreciable and gradually increases with rise of temperature. At 1050° C. the density falls to 75·25.

The constants of dissociation were calculated as follows :—

Taking the fundamental equation $u/u_1^2 = c_1/c$, where u and u_1 are the number of molecules per unit volume of Br_2 and Br_1 respectively,



Curve I.

and c and c_1 the velocities of dissociation and recombination, we have, after reduction,

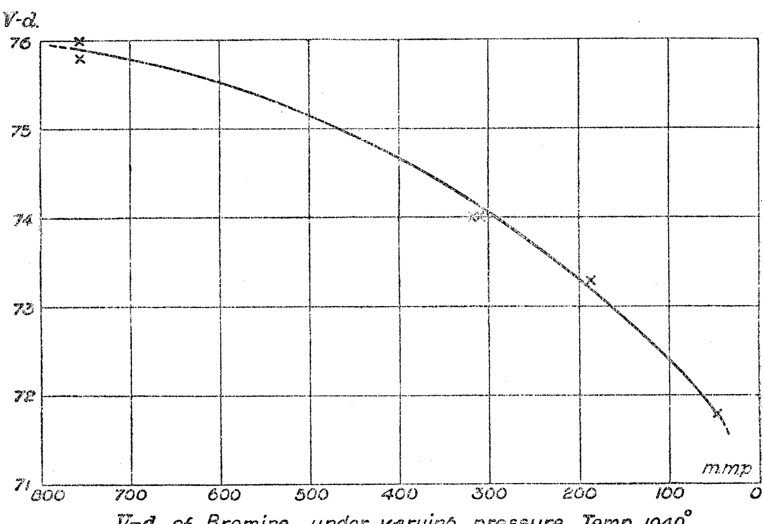
$$\frac{ac_1}{c} = \frac{40T(D - 40)}{P(80 - D)^2} = \gamma \text{ (say)},$$

where a is the number of molecules per unit volume of any gas under standard conditions.

T.	D.	γ.
800°	79·87	13320
850	79·48	8630
900	78·83	1750
950	78·01	620
1000	76·94	264
1050	75·26	110

The above values of T and D were read from the curve.

Series III, V, and VII show the effect of varying the pressure. The results of series VII form a smooth curve, vapour-density being plotted against pressure (Curve II), but the dissociation-constant calculated from them is irregular.



Curve II.

The authors regret that the apparatus available did not enable them to extend the experiments to higher temperatures than those employed. In conclusion they wish to thank the Government Grant Committee of the Royal Society for their assistance.

Addendum.

December 8.—It may be interesting to add the results obtained by other observers, and referred to in our previous paper.

Temperature.	Vapour-density.	Observer.	Remarks.
About 1570°...	53	V. Meyer and Züblin	Nascent bromine from $PtBr_4$.
" " ...	80 to 52·6	"	Free bromine.
" " ... (445°)	63·4 to 64·7 (75·7 instead of normal)	Crafts "	(To show the accuracy attained.)

It should be noted that in all these experiments the bromine was mixed with an indeterminate quantity of air, which makes them hardly comparable with our results.

"*Polytremacis* and the Ancestry of the Helioporidæ." By J. W. GREGORY, D.Sc. Communicated by Professor LANKESTER, F.R.S. Received November 21,—Read December 7, 1899.

(Abstract.)

The recent blue coral *Heliopora* presents striking resemblances in structure to the palæozoic *Heliolites.* All the earlier writers on corals accordingly regarded the two genera as intimately allied. But some later authorities consider the resemblances as accidental, and that the corals have no special affinities. Thus, according to F. Bernard, *Heliopora* and *Heliolites* belong to distinct subphyla. Lindström admits only one species of *Heliopora*, and regards the genus as quite isolated, as essentially distinct in structure from *Heliolites*, and as further separated from the latter by "the total absence of all connecting links from the end of the middle Devonian to the recent times." The author, however, considers that the original view of the close affinity of *Heliopora* and *Heliolites* is correct, that the two genera are essentially similar in structure, and that they are linked by a series of eocene and cretaceous corals. Amongst these fossils is the genus *Polytremacis*, which is redescribed, and a new species of *Heliopora* from the Cretaceous of Somaliland. It is suggested that *Heliopora* has descended from the palæozoic Heliolitidæ by degeneration in size and increase in number of the cœnenchymal cæca.

Fig. 1.