

determined by the method of distillation with chloride of barium is not very much higher in the one case than in the other. Further, in surface waters the amount of carbonic acid extracted along with the oxygen and nitrogen is always very small, amounting to from 2 to 4 c.c. per litre, in bottom waters it is almost invariably over 5 c.c., and reached in one case 13.5 c.c. in a water from the North Pacific, which gave 32 c.c. of carbonic acid by the distillation method. Although the absolute amount eliminated in this case was large, the relative amount or the percentage of what was present was, though considerable, not specially large. In two cases, again of waters from the North Pacific, the amount extracted by boiling *in vacuo* very nearly equalled that found by the distillation method. In the one case 15 c.c. were found by the distillation method, and 14 c.c. were extracted by boiling *in vacuo*; in the other 17 c.c. were found by distillation and 15.8 c.c. by boiling *in vacuo*. That these differences in the amount of carbonic acid extracted by boiling *in vacuo* are not due to accidental circumstances, of the duration of the boiling process or of the size of the gas tube, is shown by the fact that in all the cases where a second tube was attached and the boiling continued, the further amount of gas extracted was quite insignificant. It would appear therefore that the carbonic acid in sea water is retained in three different states—first there is a portion which is retained in a similar way to the nitrogen and oxygen, along with which it is extracted by boiling *in vacuo*; second, there is a portion in the half-bound condition which is eliminated by distillation at atmospheric pressure; and finally there is the portion present in the form of neutral combination or completely combined to bases. In surface water the carbonic acid belonging to the first category, which behaves to a great extent like a free gas retained by the simple absorptive power of the water, is present in comparatively insignificant quantity. This is only what might have been expected, as contact with the atmosphere would always tend to remove any excessive amount of it which might be present. This means of removal is not available to waters at great depths, hence the gases extracted from such are found to be contaminated with much more carbonic acid than is to be found in the gases from surface water.

If sea water, so long as it is at the surface, can only contain from 3 to 4 c.c. of carbonic acid in this state of solution, and the deep waters are found to contain a much larger quantity of it in the same state, how does it come to attain this state of freedom? It might be naturally expected that carbonic acid which was in the half-bound state at the surface would continue so when it passed into deeper strata, yet the reverse seems to be the case. If it be the presence of carbonates in the sea water which is the cause of the retention of a further amount of carbonic acid so that the two together form bicarbonate, then it would be expected that waters which give off their carbonic acid easily and in large quantity when boiled *in vacuo* would be found deficient in carbonates. Although Mr. Buchanan made a few experiments in this direction, the results which he obtained are of no great value, because it has been shown that, in eva-