The Penetration of Radioactive Sodium into \textit{Valonia} and \textit{Halicystis}

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The purpose of these experiments was to determine whether radioactive sodium would penetrate two physiologically different types of cells, one of which differentially accumulated K ions and the other Na ions. These types are illustrated by \textit{Valonia macrophysa} which normally accumulated a greater proportion of KCl in the sap as opposed to \textit{Halicystis Osterhoutii} which contains a lower concentration of KCl and a higher concentration of NaCl in the sap under normal conditions. It would be important to find out whether this relation exists when radioactive sodium was used and to measure its rate of penetration into each of these plants.

Method

$^{22}\text{Na}$ was obtained from the University of California cyclotron as 0.5 M NaCl. 16 ml. of this solution was added to 34 ml. of sea water, giving an activity of 246.9 counts per minute per 0.1 ml. The activity of this concentration was 0.045 $\mu$C. The half life of $^{22}\text{Na}$ is about 2½ years. The activity of this solution was assumed to be constant during the experiment. It was measured at various intervals by taking 0.1 ml. of the solution, drying it and testing it without finding any change. The term $^{22}\text{Na}$ “constant” was used here to indicate this procedure. The uranium standard was always used as a control to test the Geiger-Müller counter with the background subtracted. Various “backgrounds” were used for the experiments. In some cases only the stender dishes without sea water, while in other cases the stender dishes with sea water were used.

The volume of the total cells was measured by noting the sea water which they displaced in a graduated vessel.

The volume of the sap was measured by piercing the cell wall and extracting the sap. In the tables, the results are equated to a standard volume of 10 ml.
The experiments were done at the Bermuda Biological Station. The plants were collected about two weeks before experimentation, were washed, cleaned, and freed of other growths and only those remaining dark green and turgid were used. In order to test for viability after subjection to the experimental solution, some plants were replaced from the radioactive solution into sea water alone and observed for several days to a few weeks. In most cases, no injury was observed. Those plants which showed injury at the end of the experiment, such as lack of turgidity, or a mottled appearance, were discarded and not included in the measurements.

The $p_z$ of the sea water at Bermuda was 8.4. The experimental solution of $Na^+$ was adjusted to correspond to the sea water composition at Bermuda. "Reconstructed" experimental solution consisted of $Na^+$ which had been used several times and adjusted to its original volume by evaporating to dryness and making up to the original volume, thus ridding it of any organic matter that may have been introduced from the previous experimental plants. The activity of this solution was 360 counts per minute for 1 ml. The Na content was 0.466 M.

Two methods were used for handling the cells during experimentation; by perfusion of whole cells in a closed system, utilizing the constant drip method by which the cell was subjected to the same concentration during the course of the experiment, and by immersing the plants in the experimental solution without disturbance. After certain time intervals, some of the plants were taken out of the experimental solution, washed 4 to 6 times in sea water and then placed in the counting chamber either immediately or after a sojourn of 5 minutes or less in sea water for possible exosmosis of $Na^+$. Uniformity of distance from the counting tube was always carefully observed. Finally, the sap was extracted and the cell wall separated and both measured separately.

The dead and living cells were separated and measured separately for penetration of $Na^+$. The figure for dead cells was subtracted from the whole figure, leaving the difference as indicating the uptake by living cells. In the same way, the difference in uptake between the whole living cells and their sap and walls was used to indicate the amount taken up by the protoplasm. The figures in the table are computed on a basis of 10 ml. for comparison, i.e., volume of cells being considered as if they were of this capacity.

Each reading is the statistical average of 7 readings. The results at 89 hours appear out of line with reference to the figures both before and after. A sojourn of 5 minutes in sea water would hardly account for the relatively large exit of $Na^+$ as indicated in the third set (90 hours, 49 minutes).

Table 1 gives the results of one experiment (312) in which 21 small and medium-sized Valonia were immersed in 50 ml. of "reconstructed" $Na^+$ in sea water for various periods of time. They were removed at specified intervals, rinsed several times in sea water and placed in the Geiger-Müller