Letters to the Editor

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Bast-Sap in Plants

IN 1858 Th. Hartig directed attention to the fact that many trees yield drops of sap when their bark is punctured in summer and autumn. This sap issuing from the inner layers of the bast was said to include small quantities of nitrogenous substances with large quantities of various kinds of sugar. Obviously its motion and constitution might yield some information on the transport problem of organic substances. We found the most abundant flow when the puncture reaches the inner layers of the bast; deepening the puncture so as to reach the wood, causes the sap exuded to be instantly drawn in by the tensile water in the vessels. Hence the exuded sap is not driven out by root-pressure through the outer xylem. The exuding sap is transmitted by the sieve-tubes as we demonstrated by forcing a solution of potassium ferrocyanide into the puncture and afterwards tracing its path by means of ferric chloride.

In a stem of a young specimen of *Fraxinus excelsior* about 12 cm. in diameter all the seven or eight layers of soft bast transmitted the solution to some extent, while the inner layers transmitted it most readily. A pressure of 3 atm. drove the solution 3·5 cm. in 30 min. We have observed the flow of bast-sap in forty to fifty species of trees and in several herbaceous forms during June, July, August and September. All specimens of the same species in the same locality do not exude bast-sap simultaneously. The amounts exuded are variable. In active specimens the flow from a slit 1 mm. long continues for 30–45 min. and yields 0·1–0·2 c.c. Active flow from one puncture inhibits or reduces the flow from closely neighbouring punctures, and the amounts delivered from similar punctures at the same level, even when not influenced by neighbouring punctures, are not uniform.

Small quantities of proteins and glucose associated with considerable amounts of sucrose were found in the sap; the presence of tannin, an oxidase and a chromogen is also indicated. The sap is extruded by the turgor of a closed system in the bast (probably the sieve-tubes), and the flow only ceases when that pressure becomes negligible. Freezing point determinations give a measure of this pressure. Unexpectedly high pressures were observed ranging from 13 to 35 atm. The forces moving the sap through the bast and forcing it through the punctures are very high. Very different pressures have been observed in the same specimen on different occasions; but so far, it has always been found that the osmotic pressure of sap issuing from a higher level is greater than that coming from a lower one. Osmotic pressure gradients of 2·2–8·9 atm. per metre have been observed in the bast of *Fraxinus excelsior*.

Lateral motion is inconsiderable compared to longitudinal movement, hence from the amount exuded through a puncture of known size under the pressures available we obtain some idea of the ease with which the sap moves longitudinally in the bast. The gradient of pressure is presumably maintained by the production of carbohydrates in the leaves and their removal by condensation into products of growth (activity of the cambium) and materials of storage (sucrose, starch, etc., deposited in the bast-parenchyma, starch-sheath, cortex and medullary rays).

The difference in osmotic pressure above and below in the intact plant is available for forcing the solvent, water, of the less concentrated solutions below into the wood, thus creating a mass-movement of the solution downwards through the bast. These and other observations seem to us to support Münch's theory of mass-movement of organic substances in the bast, and probably bring into line the results of Mason's and Maskell's investigations.

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Stability of the Liquid Carbon Dioxide in the Ocean

IN NATURE of July 2, p. 26, Dr. Wattenberg of Berlin presented some objections to my paper "On the Field of Stability of Liquid Carbon Dioxide in the Biosphere".[1]

It is a pity that Dr. Wattenberg in formulating his criticism used, apparently, only the short notice of my paper which recently appeared in NATURE[2] and not the paper itself. Had he read my original paper he would have saved himself from misunderstanding of my point of view.

The water of the ocean, like the water of all the deep continental water-basins, is heterogeneous as to its baric properties, presenting a substance which cannot be reproduced by experiment since it has the properties of a specifically planetary phenomenon. In the ocean the water itself is subjected to pressures which can exceed 1000 atm./cm.^{2} and at the same time the dissolved gases in the same water (which are in an innate connexion with the troposphere) are subjected to pressures which can not exceed 1–2 atm./cm.^{2} In the thermodynamical conditions of the ocean's water all the carbon dioxide masses which are isolated (completely or partly) from the troposphere (that is, from the gases dissolved in the oceanic water), must exist in a special state of phases:

$$\text{liquid } CO_2 \rightleftarrows \text{gaseous } CO_2,$$

because the temperatures and the pressure of sea-water remain mostly below the critical point and above the critical pressure of carbon dioxide.

Marine organisms must have accommodated themselves throughout geological time to the specific state of carbon dioxide in the ocean. They have to obtain a special organisation in this respect.

I have indicated in my paper the following three examples among many of such accommodations:

1. The accommodation of plankton organisms in connexion with the low confines of their habitation.
2. The oxygen glands of deep-sea fishes in connexion with their respiration.
3. The conditions of life of micro-organisms in the bottom sediments of the ocean. The chemical processes in such sediments are regulated by micro-organisms. They are subject to changes under the influence of liquid carbonic dioxide, the possibility of existence of which in living environments cannot be denied.