not been tested for endurance in the gauntlet of life. For the most part they could not endure in the open because their selection is not based on fitness for survival, and because, without segregation, they would soon be lost by interbreeding with the prepotent mass. As is the case with actual species, the "creations" of the breeder begin with individual variation, this continued through heredity, restricted by selection and kept apart by segregation. In nature, species originate in essentially the same way, except the period of testing for endurance is enormously prolonged. Selection is "natural" and the segregation is a feature of geographical distribution. Where the breeder of flies segregates in bottles, nature uses mountains, deserts, seas, climates and food conditions, in developing her species. But every one of these rests on all of at least four factors or conditions, two internal, variation and heredity; two external, selection and segregation. In every species results of each of these traits are shown. Hence they are factors in evolution. By many recent writers, these external factors, especially the last, are overlooked or slurred, as though divergent change could take place *in vacuo* by the operation of a "law of evolution." The dictum of Wagner, *"Ohne Isolirung keine Arten,"* holds good, for the final segregation of all forms is associated with "räumliche Sonderung" or separation in space from the main stock. Precisely the same thing occurs with our temporary species or "creations," but these are too recent to be tested through "running the gauntlet of life" or the prevention of mass breeding.

The land snails called *Partula* consist of many species living on trees, the individuals relatively stationary and closely limited by local conditions. Dr. Crampton has undertaken the detailed study of these snails in all the minute features which concern their life and distribution. The "headquarters of the group" are in the Society Islands (Tahiti, Raiatea), though species are widely scattered elsewhere on various other island groups. None are found in the Hawaiian Islands, where their place is taken by a parallel group, the *Achatinellidæ,* already famous through the work of the late Dr. John T. Gulick.

Dr. Crampton has made four journeys to Tahiti and the other islands of the South Seas. In these trips more than 80,000 specimens, taken from two hundred different valleys, were obtained and studied, covering many different species and subspecies. The work had three purposes: first, the study of results of "isolation and environmental influences as conditions or factors of biological differentiation. These have been variously estimated in the writings of naturalists from Darwin, Wagner, Murray, Wallace, Gulick and Romanes to Allen, Jordan, Ortmann and others . . . who have accorded to the 'environment' almost all degrees of efficiency, from omnipotence to impotence."

The second purpose was to continue Dr. Albert G. Mayer's work on inheritance of shell and color characteristics; the third to bring back living material for studies in selective breeding of pure and hybrid strains. But the species must themselves be known before much advance in this line is possible. It was found that each island, even in the same group, had its own species of *Partula* which (except in rare cases) occur nowhere else. The study of these cases throws much light on dispersal and migration as well as on certain matters of geology. It was found that some species range widely over a whole island and others are restricted to a few valleys, or even to one. These conditions give rise to numerous subspecies or varieties. In connection with the singularly accurate observations of *Partula* by Andrew Garrett in the sixties, it has been possible to trace the relative age of several species. Mutations, or wide individual variations, occur frequently, "so that it can not be regarded as a unique feature." The effect of environment in originating new species is negligible. Dr. Crampton regards isolation as a "condition" rather than a "factor" in species forming. This seems a matter of words. Barriers act as obstructions behind which new species form, thus becoming a negative factor. Dr. Crampton finds in the distribution of *Partula* evidence of large subsidence in the Pacific Area, causing disconnection among islands and mountain peaks, with parallel effects on the snails they bear.

All the species and subspecies mentioned in this monograph are beautifully figured in color. There are also numerous maps and photographs illustrating the wild and picturesque scenery of the Society Islands.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE LABORATORY QUARTZ MERCURY LAMP

A SIMPLE and efficient quartz mercury lamp, with electrodes not sealed in, and easily constructed in the laboratory for from two and a half to five dollars, is shown in Fig. 1.

A is a quartz tube of 0.6–1.0 cm bore and 5–8 cm long. B and B′ are quartz capillary tubes of 1 to 2 mm bore and approximately 10 cm long, bent at C and C′ nearly perpendicular to A. The bend CD is approximately 2 cm long. Both capillary legs are

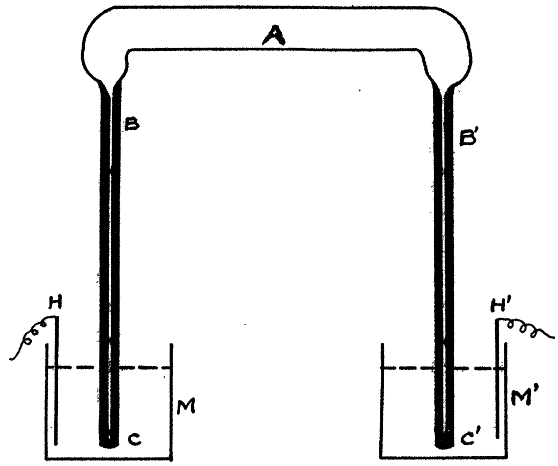

Fig. 1

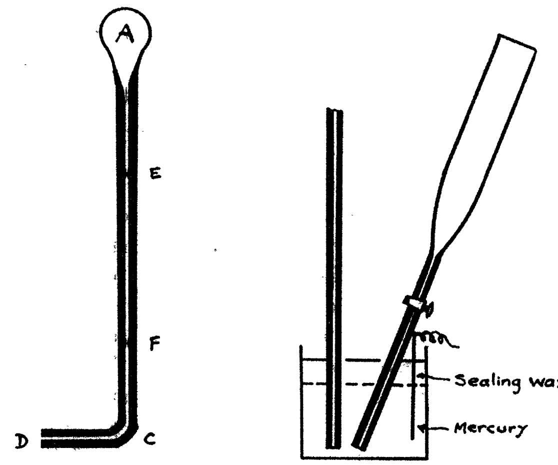

Fig. 2

constricted at two or three points, which serve to damp the oscillation of the arc.

The lamp stands in small beakers or cups M and M′, filled with mercury and provided with iron wire electrodes H and H′.

In order to fill the lamp with mercury, the ends of the legs are dipped in the mercury pools, while the portion A is tilted and lowered as far as possible. The portion A is then heated to expel a part of the air from the apparatus. As the tube cools, mercury flows down into A, which is now boiled to drive all the air and moisture out and to completely fill the lamp with mercury. The lamp, again brought to the upright position as shown in the figure, is ready to be operated.

To start the arc, a point of A is heated until the mercury in the tube boils and the arc starts. It becomes perfectly steady within five minutes.

A lamp was constructed with the following dimensions:

A	0.6 cm. inner diameter
	1.3 cm. outer diameter
	7.0 cm. long
B	0.2 cm. inner diameter
	0.6 cm. outer diameter
	10.0 cm. long
CD	2.0 cm. long

It was operated with 130 volts at the generator, through a 100-watt tungsten and a 20-watt carbon lamp in parallel and gave an extremely steady arc 4.5 cm long, the arc voltage being 78 volts and the current 0.7 amp. It has been in use nearly every day for over three months without causing any trouble. It has been operated for seventy-five hours continuously without a single readjustment. While the generator voltage varies between 120 and 150 volts, the potential drop across the arc varies from 67–110 volts, corresponding to 19–21.6 volt/cm gradient when the current is .65–.8 amp.

Another lamp of the same dimensions, except that A is of 0.7 cm outer diameter and 8.5 cm long, was constructed. Operated with 125 volts at the generator, this lamp gives an arc of 4 cm length, the arc voltage being 75 volts and the current 0.7 amp. With higher voltage, the tube A must be cooled by a strong air current. When fed with 150 volts, this lamp gives a very steady arc 7 cm long, the arc voltage being 100 volts and the current 1.2 amp. Air is blown through small holes along a tube against the entire length of the arc.

After the arc is run for from ten to fifteen hours, the mercury transferred to the negative pole may be brought back to the positive pole with a pipette.

This type of quartz lamp can be operated under various pressures by the simple modification shown in Fig. 2. A glass tube with stopcock is inserted in one of the mercury pools. With the stopcock open, it is partly filled with mercury. A thick layer of melted sealing wax is then poured over the mercury pools and allowed to cool. A mixture of water glass, silica and barium sulphate would probably be preferable. Constrictions on the legs of the lamp will be unnecessary to this modified form.

After the arc is started as above described and the desired length obtained, the stopcock may be closed and various currents and voltages applied. This lamp is successfully operated with generator voltages of 125 to 150 volts through a bank of lights.

With the stopcock open the arc voltage is 50 to 118 volts, corresponding to 18–20 volts/cm gradient, the current being .75–1.4 amp.

With the stopcock closed the arc voltage is 54 to 125 volts, corresponding to 23–30 volts/cm gradient, the current being 0.6–1.95 amp.

The advantages of the lamps described above are (1) simplicity of construction, (2) extremely low cost, (3) adjustable length of arc and (4) various pressures may be used.

The small quartz tubes can be blown very easily by means of an oxygen-gas blast burner, the gas being enriched by passing through casing head gasoline or petroleum ether.

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SPECIAL ARTICLES

SAP FLOW AND PRESSURE IN TREES

THE authors having been engaged in the study of movements of solutions in plants for several years arranged to collaborate in a series of experiments at the Desert Laboratory and at the Coastal Laboratory of the Carnegie Institution of Washington for a period of eight months in 1926. Professor Gilbert Smith joined us in some supplementary and anatomical studies for a few weeks. It seems advisable to present some of the results already obtained.

These support the theory of the upward movement of sap in trees in a cohesive column extending from the menisci in the walls of transpiring cells in leaves extending downward through dead wood cells and vessels and outward through the living cells of the root into the soil. The upward movement of water through such a system may continue at a diminished rate after the living cells at the upper and lower ends of the system are killed if the colloidal remains of the killed cells are not disturbed mechanically.

An examination of the assertions of Sir J. C. Bose that sap is pumped upward by pulsating action of living cortical cells has been made. Bose's claims as to the rate and mechanism of sap movements ignore well-established anatomical and mechanical facts, and are based upon imagined but impossible hydrostatic action of living cells. No single direct observation nor any measure of pulsatory action has ever been made, by Bose or any one else, yet his explanation of the ascent of sap is based on such an idea. It seems to be plainly evident to most beginners in botany that the drop of water applied to one smoothed end of a saturated branch is not identical with the drop appearing at the other end almost instantly, or that when water under pressure is turned into a hundred feet of filled garden hose the instantly resulting stream from the nozzle was made up of water that had traversed the length of the hose, yet Bose's estimates of sap-flow are based on preposterous assumptions that erection of flagging leaves is due to water passing from the base of stems to these organs at rates of 70 mm per second or as much as 70 meters per hour.[1]

Bose's conclusion that the wood serves as a reservoir from which living cells draw water and pump it by pulsating action not through wood, but from protoplast to protoplast at the rates given would imply transfer through two to four hundred living cells per second is too fantastic to be the subject of any serious comment.

To ascribe rhythmic variations in galvanometer readings connected with probes pushed into cortical layers[2] as due to hydrostatic pulsations is to throw aside all the safeguards of research. With Bose's suggestion that these pulsations may be the result of stimulation by friction of the roots with soil particles it is realized that the passage from pseudo-research to infantile fancies is an easy one. A sympathetic exposition of the Bose Institution and of the work of its director reprinted in *The Garland* (Calcutta) for May, 1926 (edited by S. M. Swaminathaiyer) includes the following passage: "For the mysteries of nature are probed in Sir Jagadish's institute not by study of libraries or by mechanical experiments, but primarily by communion with the unseen and the unknown. Inspiration, imagination, intuition, vision, this is an even more romantic touch."

The correctness of this characterization is attested by every page of Bose's book on the ascent of sap, which is utterly lacking in scientific significance. Such books appearing on the lists of scientific publications constitute a menace and danger to sound science.

Since the acceptance of Bose's work in America and since it has been widely proclaimed in the popular press of Great Britain, we are led to say that such recognition of Bose's work on ascent of sap and the nervous mechanism of plants has been confined to persons of non-scientific training, political propagandists and literary reviewers, whose capacity for judgment, motives and purposes may not be adequately discussed here.

Much attention has been given in our experiments of the past three years to the path of the upward movement of liquid in different types of woody stems and to the analysis of varying pressures which may be detected in the cortex, water-filled wood and gas mesh-work in the older wood. A comprehensive

[1] Bose, J. C. "The Physiology of the Ascent of Sap." London, 1923.

[2] This reaction has not been confirmed. See Dixon, H. H., "The Transpiration Stream," London, 1924.