PLANT PHYSIOLOGY

$1,000 AAAS Award Given For Paper on Root Pressure

Young Rockefeller Institution Scientist's Demonstration Revives 210-Year-Old Theory; Upsets Modern Concept

FOR SHOWING that the pressure of sap in plants is "vital," resulting in processes that are living and not just mechanical;

For demonstrating that tiny roots develop enough pressure to send sap higher than the world's tallest trees;

For upsetting radically the most widely held theory of plant science and showing that the father of plant physiology, Stephen Hales, had the right idea in his historic but hitherto outmoded experiments of over 200 years ago;

Dr. Philip R. White, youthful scientist of the Rockefeller Institute for Medical Research laboratories at Princeton, N. J., was awarded the $1,000 prize of the American Association for the Advancement of Science. His paper titled: "Root-Pressure, An Unappreciated Force in Sap Movement" was selected from among the more than a thousand for this high honor.

Working with minute tomato roots grown in glass flasks upon liquid nourishment, with "orphan" roots never serving the stems, leaves and luscious red fruit of tomato plants, Dr. White has substantiated the centuries-old theory of root pressure. (*See SNL,* Jan. 1).

These roots growing detached, much as the famous chicken hearts of Dr. Alexis Carrell beat in tissue culture testtubes for years, develop vast pressures. They push out the water amazingly.

Whereas Stephen Hales, likewise young and experimenting in old England of 1727, was able to show root pressures of only 1.4 atmospheres, some 20 pounds per square inch, enough to raise water 48 feet high. Dr. White 210 years later has found his tomato roots continued to do their stuff, secreting liquid even when opposed by pressures sufficient to raise water 200 feet high. No tomato plant ever grew nearly that high. Yet it had the pressure necessary to deliver water from the earth to the utmost tops of California's big trees.

This great pressure is "insignificantly small" compared with what Dr. White expects to demonstrate when he can get his delicate apparatus attached to the tiny root vessels to withstand such stresses.

Whence comes this amazing pressure? It is a manifestation of life. It is a victory for the vitalists. It is "metabolic," the result of the root cells' feeding and growing.

It may do more than win prizes. It may throw important, needed light on the mechanism of secretion, one of the basic processes in living things.

Science News Letter, January 8, 1938

PLANT PHYSIOLOGY

Winner "Flabbergasted" Sees Many Problems Ahead

By DR. PHILIP WHITE

Rockefeller Institute for Medical Research Princeton, N. J.

I CAN ONLY say that I am quite flabbergasted at the award but it will certainly spur me to continue my research.

Interesting as this particular problem is, and great as are its potentialities in helping to solve problems of glandular action, my own feeling is that it should be considered only one phase, one small limb of the tree of problems growing out of the field of root cultures.

Most of my efforts in the past have been devoted to studying the nutrition of these roots, to laying of sound background of knowledge of their normal behavior. An initial result was reported in the Boston meetings of the American Association for the Advancement of Science in 1933. That background has not yet been fully completed, but it is sufficiently so to make it possible to branch out into promising applications of the method.

Applications

Cultivation of viruses of the type studied by Stanley in these roots, reported at the Microbiological Congress in London in 1936, was one such application. This study of the glandular activities of roots is a second application.

It would be bad psychology to suggest what other applications we may find, but such certainly will arise. I am sure there will be no dearth of future problems.

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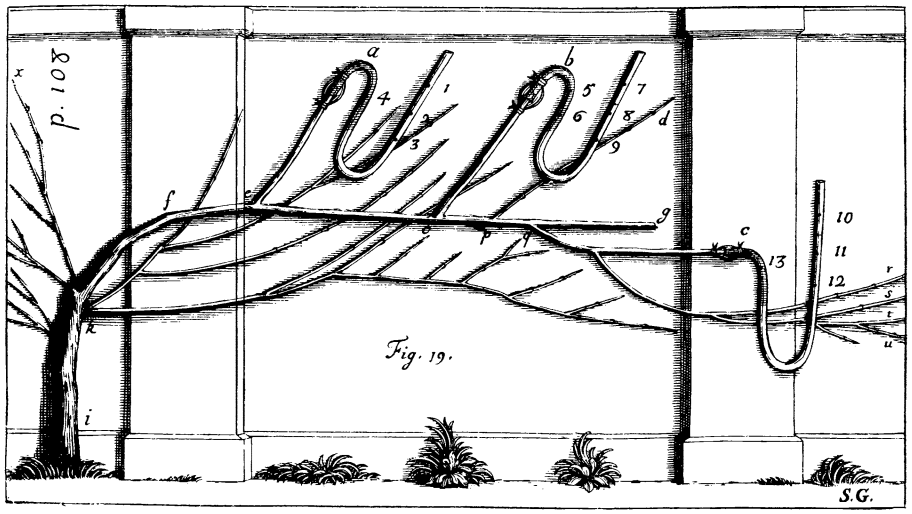
HONORED

Dr. Philip R. White upset a widely held theory of plant science and won distinction with his experiment demonstrating root pressure. On the right are shown four stages of assembling the manometer setup he used to measure the extremely high pressure generated by excised tomato roots. Particularly difficult was the problem of making the joint strong and tight without crushing the root.



SAP PRESSURE, 210 YEARS AGO

This figure, from Stephen Hales' "Vegetable Staticks," published in 1728, shows how the pioneer plant physiologist set up his manometers to measure the pressure of sap from "bleeding" grapevines trained against a wall.

BIOLOGY

Secret of Sex Determination Sought With X-Ray Studies

Sex Changes in Fish, Vitamin Needs of Plants, Homing Instincts of Toads Discussed at Meeting

SEARCH for the secret of sex determination was described by Prof. J. T. Patterson of the University of Texas, to the American Association for the Advancement of Science. It was a sort of microscopic game of billiards, with X-rays for cues and chromosomes, or rather bits of broken chromosomes, for balls.

Some years ago, Prof. Herman Muller, a former colleague of Prof. Patterson at the University, showed that chromosomes, with the genes or hereditary units they carry, can be broken apart and rearranged by bombarding the cells with X-rays. Prof. Patterson used this technique for the special purpose of locating if possible the sex gene or genes.

According to one of the two alternative theories of sex-gene location, this important hereditary unit is located on one particular chromosome, the so-called X-chromosome. This minute structure Prof. Patterson proposed to shatter with the X-rays. The animals used were the familiar little fruit-flies, classic subject for genetical experiments.

"If the X-chromosome does possess a major sex gene some of the fragments into which the chromosome can be broken would be certain to contain this gene," Prof. Patterson explained. "By adding separately each of the several fragments to the normal chromosomal complex of the male fly, one can determine whether any one of them possesses the postulated sex gene; for if it does, the male would be changed into a fly with female characteristics. By substracting the corresponding fragment from the chromosomal complex of the female, a change to maleness would result."

No Verdict

The experiments to date have come to a tantalizing state of no verdict. All fragments of the X-chromosome which have been broken off and re-attached elsewhere in the manner described by Prof. Patterson have yielded no results at all. Evidently the sex gene is not in or on them.

But there is one fragment, from near the middle of the X-chromosome, that has not yet been successfully attached in any male. Instead of surviving and developing the looked-for female characteristics, the insects simply die.

"The failure of such males to survive may lead some to assume that the small fragment contains a major sex gene," Prof. Patterson stated. "Such evidence is negative and not critical, so that it will be necessary to obtain positive evidence before a final decision can be reached."

Fish Change Sex

Females of Siam's famous fighting fish can be turned into males by surgical operation. If their ovaries are removed, new sex glands may form at the ends of the cut oviducts, but they will be male, not female.

So reported Drs. G. K. Noble and K. F. Kumpf of the American Museum of Natural History, before an audience of experimental zoologists. They obtained seven positive results from 150 operations.

With the growing of the new male sex glands came changes from femaleness to maleness in the external appearance of the fish. The typical trailing, veil-like fins and tails developed.

Three of the seven fish were killed for dissection. The remaining four were given females as mates. Three of them fertilized the eggs in normal manner. The fourth went through normal male behavior, but was unable to fertilize the eggs.

Vitamin B_1 For Roots

Vitamin B_1, preventive of the Oriental disease beri-beri in human beings, is necessary for the production of roots in plants, experiments reported by Dr. James Bonner of the California Institute of Technology have demonstrated.

In the normal seedling (peas were used in the tests) the roots get their vitamin from the cotyledons or thick seed-leaves. But if the root is detached and grown in a nutrient solution, it lives on its reserves of vitamin B_1 for a time, after which the vitamin must be supplied from an outside source.

Dr. Bonner's experiments have shown that two atom-groups in the vitamin's complex molecule are the really necessary parts so far as root growth is concerned. These are known respectively as vitamin thiazole and vitamin pyrimidine.

Toads Want to Go Home

Toads have homing instincts as strong as those of pigeons, though they may not travel quite so fast, Dr. Ray J. Nichols of the University of Mississippi discovered in studies reported.