BIOPHYSICS

Climates Made in Basement

Smithsonian Scientists Grow Plants in Atmospheres That Never Were on Land or Sea, to Learn Basic Life Facts

By DR. FRANK THONE

SMITHSONIAN Institution scientists are conducting a Twentieth Century Inquisition in the massively walled and vaulted basement chambers under the big brown castle-like building between the Capitol and the Washington Monument, where the Institution's headquarters are.

But those who are being put to question are not pallid and trembling wretches, suspect of heresy or witchcraft. They are neither human nor animal; they are vegetable. And they reply not unwillingly nor in dread. To the questions with which they are plied they answer automatically, by their own natural reactions. Which, any modern psychologist will tell you, is a much more likely way of getting at the truth than by third-degreeing somebody who may falsify his answers; trying to guess what you want him to say, and then either satisfying you by saying it or thwarting you by refusing to say it. Plants, having no wits of their own, make the best witnesses.

The questions that are put to the plants in the Smithsonian Institution basement laboratories have much immediate scientific interest and will ultimately have considerable practical importance. Tomato plants and stalks of wheat are asked such questions as these:

"How much more work could you do with an extra ration of light?"

"Could you do as much, with less light?"

"Can you work as well in red light as in blue, or must you have a mixture?"

"What would a double dose of infra-red do to you?"

Practical Applications Later

These and similar questions are put by the simplest and most direct method: plants are placed under the conditions outlined in them. The plants give answers as directly, by storing more food or less, by becoming darker or paler in color, by flowering and fruiting earlier or later, by making more or less of some desired product. While for the present, and probably for some time to come, the research will concern itself wholly in gaining information as to how light affects the fundamental processes of plants, eventually the answers will be pieced together and translated into terms of better crops in less time or with less labor or at lower expense.

This eventuality may not be so remote. While the Smithsonian men are still amassing data in "straight physiology," the U. S. Department of Agriculture is cooperating in the enterprise with some of its own scientists. These men are making direct application of the methods to questions connected with the strange desert plant *Ephedra,* source of a valuable drug. They are also studying some new and rather expensive citrus fruit varieties, and a few other plants whose high cash value justifies the present use of this costly experimental equipment in order to work out methods for propagating them rapidly and cheaply.

The whole enterprise is an excellent example of the modern method in experimental science, where not one lone genius does all the work, but where a group of men and women, each trained in a separate specialty, pool their knowledge, share the labor, and when success is achieved split the credit up among them.

The initiator of these cooperative experiments on radiation and plant growth—the Grand Inquisitor himself—is the Secretary of the Smithsonian Institution, Dr. Charles Greeley Abbot. Dr. Abbot has long been interested in solar radiation, and has been the moving spirit behind the Smithsonian expeditions that have established, on lonely desert mountains at the world's ends, observatories to record the daily and hourly changes in the amounts of light and heat given off by our sun, which is really one of the most fickle and flickering of stars, despite its apparent steadiness. It was only natural that he should be interested in the effects on plant life of this variability in solar radiation; so shortly after his election to the secretaryship of the Smithsonian Institution he had a new laboratory established in which variabilities not only in radiation but in other life conditions as well could be subjected to human control.

The research program receives substantial aid in the form of grants from the Research Corporation of New York.

Immediately in charge of the laboratory is Dr. F. S. Brackett, physicist. Associated with him are Dr. Earl S. Johnston, plant physiologist, Dr. E. D. McAlister and W. H. Hoover, physicists, as well as L. B. Clark, physical technician. Dr. Florence E. Meier, a National Research Fellow, is working with the group. Nor should one forget the skilled mechanic and apparatus maker of the Institution, L. A. Tillman, who helps them rig up the complicated set-ups of metal and glass whereby their prying questions are asked of the plants.

A Well-Fitted Laboratory

The skill and adaptability that have been shown in getting a really efficient laboratory into the basement of the Smithsonian building in themselves constitute a scientific and engineering triumph; for the space was never intended for laboratory purposes. The various pieces of apparatus fit the vaulted rooms as a snail fits into its shell: it is a good thing that none of the workers is fat, for in places there is very little room to spare; yet nowhere is one conscious of being crowded.

A tour of this basement laboratory offers many fascinating sights, even for one who has only a very general knowledge of things scientific. Down at one end of a long room is a tall glass tube about three inches in diameter, with a cluster of wheat plants growing inside it. It is surrounded by eight blazing bright electric lamps, like Jupiter in the midst of his nine moons. These lamps, you will notice, are rigged on clamps that slide on horizontal bars, so that the lamps can be moved closer to the plants in the tube, or pulled back from them, thereby regulating the intensity of the light they receive. At the experimenter's will, those stalks of wheat can be subjected to the sun of Algeria or the sun of Alaska. They can also be given any length of day the experimenter chooses, from a few minutes to the whole cycle of twenty-four hours.

But why confine the stalks inside a glass tube? For two reasons. First, notice that the tube is double-walled, and that between the walls a layer of water circulates, colored faintly blue with some kind of chemical. This is to keep the plants from being wilted and scorched by the battery of lamps, which naturally give off quite a bit of heat as well as a lot of light. The temperature of the air inside the tube can be quite closely controlled by this means.

Furthermore, by having the plants in a confined space, the experimenters can supply them with any kind of atmosphere they like. Normal air contains about three-hundredths of one per cent. by volume of carbon dioxide. Plants capture this small fraction and by the use of the light that falls on their leaves combine the CO_2 with water to form sugars and starches, and, ultimately, protein foods as well.

Could plants use more light if they had more carbon dioxide? Ten per cent. more? Fifty per cent.? Twice as much? An atmosphere consisting exclusively of carbon dioxide?

All the researcher needs do is adjust the proportions of the gases in this supply tank, and he can give his plants any kind of a synthetic atmosphere he chooses.

Thus, with control of intensity and time of light, control of temperature and control of the gases in the atmosphere, the experimenters in the Smithsonian basement are as gods on a small scale, making climates to suit their own purposes in getting information out of their plants.

At the far end of the same long room are two groups of what at first look like great copper boxes, with wires, tubes and pipes leading into them. But when one of the scientists lifts away a part of the casing, you see that here again is an apparatus for the making of synthetic climate, similar to the tube and its lamps, but on a larger scale.

Robots Regulate Climate

At the top, under a funnel-shaped reflector, is a big lamp, playing the part of the sun. Between it and the plants within is a big saucer-shaped glass vessel filled with a solution to screen away excess heat. The pipes and tubes carry the temperature-controlling water supply and the synthetic atmosphere—all watched over by automatic "robot" devices that take the troublesome job of regulation off the experimenter's hands. If it gets too warm, a pump starts. As soon as it is cool enough, the pump stops again. No questions asked by anybody; no orders given.

Within these copper cages are loops of glass tubing, bent like the tubes one sees in modern electric glow-signs in store windows. One of the researchers closes a switch. The tubes leap into light. They are glow-tubes: one helium, one hydrogen, one mercury, etc. These are supplementary to the mixed "white" light from the top lamps. They have been added to give each plant an extra dose of light of one particular color—"monochromatic" light, the scientist calls it—in an endeavor to find what the significance of certain special colors may be to certain plants.

Some of the tubes, for example, have light rich in ultraviolet rays. Mountain-top light, desert sunlight, seashore light, are said to be similarly rich. What do such lights mean to plants? There are many guesses, but as yet not much real knowledge. These copper cages, with their glowing tubes, will help us toward an answer.

The amount of moisture in the air supplied can be closely controlled. A plant may be given the humidity of a tropical swamp, the aridity of a desert or anything in between.

Climates of Past Ages Possible

Cooperating Department of Agriculture scientists are engaged in a practical study of the climate, light, temperature, humidity, etc., best for certain plants of vital economic importance. Among these is the medicinally important *Ephedra,* some specimens of which are in the copper cages. At present they are being raised under highly artificial conditions in greenhouses and at the Smithsonian in the hope of discovering the environmental conditions most favorable to the growth of this species. Once they are worked out in the laboratory, the next problem is to find where they occur out of doors. Workers are searching for conditions which will make them most productive and readily available for use in agriculture.

If the investigators ever want to go so far afield in their questioning, it will be perfectly practicable for them to try the effects of the climates like those of long-past geologic ages, or even like those that may prevail on other planets. The old picture of the climate of the Coal Age, for instance, was one of high temperature, very great dampness, and much more carbon dioxide than there is in the air at present. Not many geologists believe that now. No matter: if the Smithsonian scientists want to find out how modern plants, descended from those old-timers, would thrive on such a climate they can easily do so. Or they could find out how earth-plants might get along on Mars, with its low humidity, its rapid alternations between daytime heat and night cold, its feebler sunlight (Mars is farther from the sun than we are), and its thinner air. It is not likely that they will attack such problems as these soon, for there are too many questions of more immediate importance to be considered. But there is nothing to prevent them from doing so when they choose.

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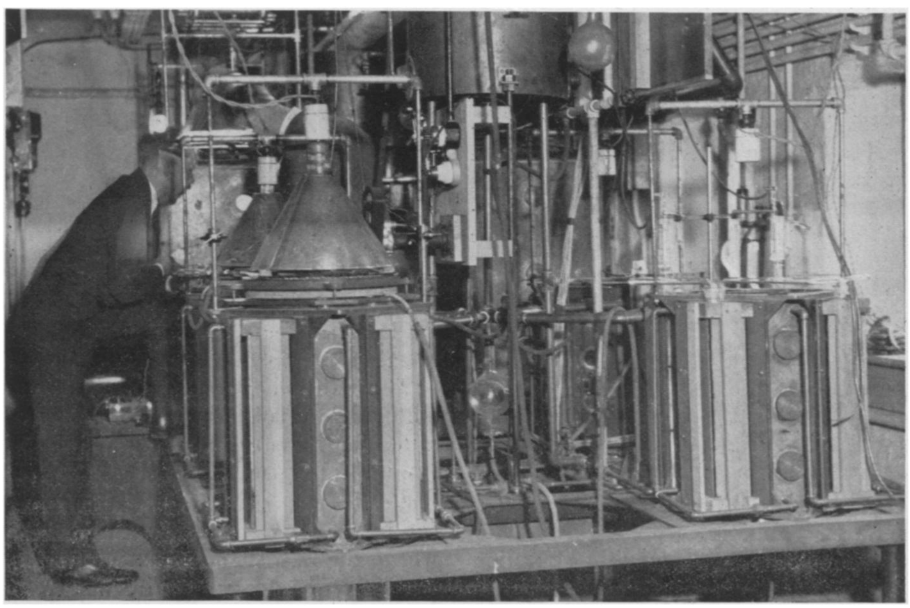

COPPER CAGES, HOMES OF PLANTS

Here they live and die under artificial light, in synthetic atmospheres and at controlled temperatures.