polarized with electric vector in the vertical plane and that the "skip distance" marks approximately the Snell angle of total reflection from the Heaviside layer. When Snell's law was incorporated in a Lorentz dispersion formula with one critical frequency, there resulted a relation between the dispersion constants and the height of the Heaviside layer, the skip distance and the wave-length of the radiation. The substitution of observed values into this equation determined the various constants, and with these constants the equation was found to agree with other observed skip distances within the error of measurement. The height of the Heaviside layer above the earth during broad daylight came out about 150 miles and the number of electrons per c.c. 10^5. These are reasonable values and in accord with estimates of these quantities from other sources. The values do not depend at all critically upon the exact value chosen for the fundamental wave-length, changing only by a few per cent. when this is changed from 120 to 200 meters, for example. The reason for this lies in the nature of the dispersion equation and is brought about by the fact that the wave-length region below 50 meters is considerably removed from the fundamental wave-length. Various facts and details of fading are explainable on the theory. Absorption of the radiation has been considered, as well as the effect of the earth's magnetic field in rotating the plane of polarization of the wave.

A theory of reflection is perhaps scarcely tenable in the form just outlined, for the optical constants of the air in all probability merge gradually into those of the Heaviside layer. As a result of this the radio wave, instead of being sharply reflected at the layer, is bent along a curved path. Without further detail, suffice it to say that this modification of the simple theory may be made and still retain practically the same agreement with the observed skip distances and about the same values of the height and dispersion constants of the Heaviside layer. The theory therefore supplements without disturbance the accepted ionic refraction theory of long wave transmission developed by Eccles, Larmor and others.

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CROWNGALL IN RELATION TO NURSERY STOCK[1]

As far back as records are available to the writers, it appears that a large percentage of apple nursery trees propagated by the root grafting method have been affected by enlargements, or overgrowths, most of which ordinarily develop about the union of stock and cion. Much difference of opinion has existed both as to the cause of these enlargements and their effects upon the plants. Following the discovery by Smith and his coworkers[2, 3] of the causal relation of *Bacterium tumefaciens* Smith and Town. to the production of galls, "tumor strands" and "secondary tumors" on various plants, and their demonstration of its parasitism on the apple, the enlargements so commonly found about the unions of apple root grafts have been rather generally attributed to the action of this organism, and the sale of crowngalled apple trees has been prohibited by law in many states. However, in recent studies of crowngall, Riker[4] and Robinson and Walkden[5] have succeeded in inducing the development of "tumor strands" and "secondary tumors" only in the region of rapid elongation near the growing points of their experimental plants. This work appears to minimize the potential importance of "tumor strands" and "secondary tumors" in relation to apple nursery stock. In view of the many important gaps in the knowledge of crowngall and of the importance to the fruit industry of the questions involved, various groups and individuals have cooperated in organizing a research project,[6] the aim of which is to investigate certain aspects of the crowngall problem, with special reference to its bearing upon the fruit industry.

One of the first lines of work started was an attempt to differentiate crowngall of apple from other

[1] Approved for publication by the director of the Wisconsin Agricultural Experiment Station.

[2] Smith, E. F., Brown, N. A., and Townsend, C. O., "Crown-gall of plants: its cause and remedy," U. S. Dept. Agr., Bur. Plant Indus. Bul. 213, 215 p., illus., 1911.

[3] Smith, E. F., Brown, N. A., and McCullock, L., "The structure and development of crown gall: a plant cancer," U. S. Dept. Agr., Bur. Plant Indus. Bul. 255, 60 p., illus., 1912.

[4] Riker, A. J., "Some morphological responses of the host tissue to the crowngall organism," *Jour. Agr. Res.*, 26: 425–437, illus., 1923.

[5] Robinson, W., and Walkden, H., "A critical study of crown gall," *Ann. Bot.*, 37: 299–325, illus., 1923.

[6] This project, which is supported financially by the American Association of Nurserymen and individual nurserymen in cooperation with the Iowa State College of Agriculture and Mechanic Arts and the University of Wisconsin, is being administered by the Crop Protection Institute through a committee consisting of Drs. I. E. Melhus (chairman), G. W. Keitt and M. F. Barrus. Coordinated research programs are in progress at the Iowa State College of Agriculture and Mechanic Arts and the University of Wisconsin.

abnormalities which may be confused with it. A preliminary report[7] on this phase of the work follows:

Malformations resembling certain types of crowngall and hairy root have been found at the union of apple root grafts which were made from cions and stocks treated with 1–500 mercuric cyanide, cut with knives dipped in 1–1,000 mercuric chloride, callused in clean sand and planted in steamed soil. Cultural and microscopic examinations failed to reveal the presence of the crowngall organism in these overgrowths. Other experiments have shown that fresh callus on apple grafts is not readily wet by water and have indicated strongly that it is not ordinarily an open infection court for the crowngall organism. These and other field experiments give added weight to the idea, which has been suggested from time to time, that gall-like formations, other than commonly known injuries by nematodes, woolly aphids, etc., may develop on apple nursery stock without the intervention of *Bact. tumefaciens*.

These and other considerations led us to initiate isolation and infection studies with the aim of determining the presence or absence of the crowngall organism in types of malformation found about the union on rejected nursery stock. Such studies are being made on apple trees which were discarded at the nursery because of malformations at the union (supposedly crowngall). So far, over 175 of these trees from seven nurseries in four states have been examined by making five attempts at isolations by the poured plate method, according to a standardized procedure, from the overgrowth on each plant studied. The technique used failed to reveal the presence of the crowngall organism in any of these plants. The efficiency of this technique was tested at frequent intervals upon crowngalls which had been produced by inoculation with *Bact. tumefaciens* upon apple nursery stock or by natural infection of peach or raspberry. Of 29 such plants thus studied, 27 yielded the crowngall organism, the identity of which was checked in each case by positive results from inoculation into tomato. The sharpness of differentiation in these results is surprising to the writers. From the nature of the situation, it would seem altogether unlikely that this degree of sharpness of difference will be maintained in further studies of rejected apple trees from various sources, since eventually a greater or less amount of typical crowngall will undoubtedly be encountered on such material. It is worthy of note that none of the malformations thus far encountered in the rejected apple nursery stock submitted to us for these studies were of the "soft gall" type.

[7] A more detailed account of this work is in process of preparation.

Of the several working hypotheses which might be advanced to conform with these results, the most promising one appears to be that the malformations dealt with on the rejected nursery trees were not induced by the crowngall organism. This suggests the further hypothesis that these overgrowths were merely incidental to the root grafting method employed in the propagation of this material. They appeared to have been associated in their development with imperfect unions and consequent disturbances in the translocation of water and food. Under these circumstances, from what is known of callus development, such malformations might be expected to occur.

In the event that these hypotheses prove to be correct, it appears that the chances of making more accurate diagnoses of crowngall will be much improved, and it may be possible to differentiate from the true crowngall problem an important confusing element. Furthermore, there appears to be promise that further investigation may lead to the satisfactory control of these overgrowths about the union. Such studies are in progress.

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NORTHERN CALIFORNIA CONFERENCE ON SCIENCE TEACHING

DR. EDNA W. BAILEY and Mr. Clyde M. Westcott, Pacific Coast members of the Committee on the Place of Science in Education of the American Association for the Advancement of Science, requested the school of education of the University of California to conduct two conferences on the problems confronting that committee. One was held in Berkeley, under the auspices of the summer session, on July 17 and 18; the other will be held at the Southern Branch in Los Angeles on August 3 and 4.

It was planned to make this a small working conference, composed of those who have certain responsibilities with regard to the teaching of science in this state. The plan outlined by Dr. Otis W. Caldwell, chairman of the committee, was used as a basis for the preparation of the program, which follows:

Friday, July 17

9:30 A. M.: General meeting and organization: *Chairman*, Professor George W. Hunter, Knox College, Galesburg, Illinois. Discussion: "Present situation in science teaching in California. What subjects are taught, where, when, in what year, in what sequence; the training of teachers and the load carried by teachers." Leader: Miss Elizabeth Bishop.