We are not entirely satisfied that the dosage of cortical extract was adequate, although supposedly ample amounts were given. We mention this because the animals in many respects have resembled those suffering from adrenal insufficiency.

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## MICROORGANISMS AND VITAMIN PRODUCTION IN GREEN PLANTS

EARLY in the history of vitamins, investigators on the sources of these essential factors in the food of animals discovered that the animal world has depended upon the plant world for its supply. Even when vitamins were present in animal tissue, they were shown to have originated elsewhere—usually from a vegetable source. But while the sources were investigated and the quantities occurring in plants were determined, while the effects on the body and functions of the animal were observed, and while numerous attempts were made to isolate the vitamins in a pure state, influences which might lead to the formation of these substances received comparatively little attention. Nevertheless, the possible action of microorganisms, both with regard to their capacity to form vitamins themselves and to their effect on the production in green plants, has been recognized.

Even before Drummond and Zilva[1] showed that Vitamin A was concentrated, rather than formed, in the cod's liver, and traced its production through a series of transfers to its ultimate origin in microscopic marine organisms, the suggestion had been made that green plants might not produce the vitamins, but instead might take them up and concentrate them after their formation by bacteria, molds or other microscopic life. A number of investigators have shown that bacteria are able to form vitamins, and Coward[2] in 1925 found that a freshwater alga (Chorella) synthesized vitamin A. Mockeridge[3] suggested that microorganisms liberated "auximones" (growth-promoting substances) from organic matter, which green plants absorbed and which enabled them to form the vitamins.

Recently, Viswa Nath,[4] from experiments in India, has observed that similar plants are markedly different in their content of vitamins (particularly in regard to B, with some indications of the same phenomenon with A), and this difference seemed to depend upon the amount of organic matter available during the growth of the plant. He concluded that bacteria either produced the vitamins from the organic matter and passed them to the plant, or formed some similar substance which plants could use as a stimulant for the vitamin synthesis, although he did not rule out the possibility that plants might form vitamins without these aids. On the other hand, C. H. Hunt[5] in 1927 had checked the vitamin B content of wheats grown on soils for 35 years under varying fertilizer treatments, and had found little difference due to the fertilizers. The quantity of B varied widely from year to year on the same soils, indicating that climate had a decided influence on its formation.

In 1932 Virtanen and v. Hausen in Finnland published a note—"Die Vitaminbildung in Pflanzen."[6] They grew peas under sterile and non-sterile conditions and determined carotin in the plants. No marked difference was found in the quantity formed. An estimation of vitamin C was also made by Tillman's 2.6 dichlorphenolindophenol solution with similar results.

In these laboratories, one of the duckweeds (*Lemna major* or *Spirodela polyrhiza*) has been grown for five years in the absence of microorganisms. These aquatic plants can produce flowers, but usually propagate asexually. They have been grown under sunlight and artificial light, and with or without organic matter.[7] Each frond puts out a new one, which grows to the size of the parent and later separates. The rate of reproduction under uniform conditions, with ample food supply, is logarithmic.

By feeding rats, a comparison was made of the vitamin A content in Lemna produced in a non-sterile mixture of 5 g of soil with 100 cc water, and those grown, free from microorganisms, in a sterile salt solution. The plants were collected each week, air-dried in the dark, and after being finely ground, were included in the basal ration to the extent of 0.5 per cent. dry weight. A third group of rats was fed daily, by hand, a quarter of a gram each of the undried plants from the soil—this provided approximately the same amount of dry matter from the Lemna as that consumed by those eating the dried plants. A fourth group was fed the basal A-free ration as control.

At the time the rats were put on the Lemna additions to the ration they had ceased to increase in weight for several days and had developed marked xerophthalmia. Three of the four controls died before the end of the experiment and the fourth two days later. The xerophthalmia in the group on the dry sterile Lemna cleared up at once and the rats started to gain weight. The average gain for the 24

1 *Jour. Soc. Chem. Ind.*, 41: 280, 1922.
2 *Biochem. Jour.*, 19: 240–1, 1925.
3 *Biochem. Jour.*, 14: 432–50, 1920.
4 "Some Aspects of Plant Nutrition," Coimbatore, 1932.
5 *Ohio Agric. Exper. Sta. Bul.*, 415, 1927.
6 *Naturwissenschaften*, 20: 905, 1932.
7 Clark, *Jour. Phys. Chem.*, 29: 935–41, 1925.

days was 29 grams for each rat. The growth curve for those on the non-sterile dry plants was closely parallel. The rats fed on the fresh Lemna put on weight faster and gained an average of 37 grams, suggesting that part of the vitamin was destroyed in the drying process.

The equal rate of growth made by the two groups receiving sterile and non-sterile plants not only shows that vitamin A can be formed in plants which have been free from all influence of microorganisms for hundreds of generations, but also is an indication that there is little or no difference in quantity produced. Further, while the non-sterile Lemna were grown by Mr. E. E. Frahm for the most part in sunshine, the sterile plants were produced altogether under artificial light—electric light bulbs in this case furnishing the illumination.[8]

From these results it appears that if conditions are favorable to the growth of green plants, the absence of microorganisms does not affect the formation of vitamin A and also that variation in light within limits has little effect. Virtanen and v. Hausen believe that the form or availability of nitrogen may be one of the controlling factors.

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[8] Clark, *Iowa State Jour. Sci.*, 7: 13–16, 1932.

## FUSARIUM BACTRIDIOIDES SP. NOV., ASSOCIATED WITH CRONARTIUM

IN March, 1932, Arthur Hinckley at the Desert Botanical Laboratory, Tucson, Arizona, sent to L. N. Goodding, cooperating with the Oregon Experiment Station, Corvallis, a mummied cone of the Chihuahua pine (*Pinus leiophylla* Schlechtendahl and Chamisso) from the Chiricahua Mountains in Arizona. The cone had been attacked by the cone blister rust (*Cronartium conigenum* Hedgcock and Hunt). Mr. Goodding found this rust to be thoroughly parasitized by a species of Fusarium. The spores of this Fusarium were viable, and cultures were easily obtained from spore dilutions on potato agar. Through the courtesy of S. M. Zeller, Oregon Experiment Station, cultures of Goodding's Fusarium were transmitted to the undersigned, who has found the organism to be a new species in the Section *Discolor*. The diagnostic description is presented as follows:

*Fusarium bactridioides* Wollenweber, nova species (Sectio Discolor, subs. Trichothecioides): Conidia minora aerio mycelio ex albo incarnato instrata, numerosa, ovoidea v. ellipsoidea, continua $7.3 \times 3.7$ plerumque $5.9–9 \times 3.4–3.9$ ($5–11 \times 3–5$), rarius 1–( (2–) ) sept. $13 \times 4.7$ pler. $11–14 \times 4.2–5.1$ ($7–21 \times 3–6.5$), majora in sporodochiis v. pionnote roseo-aurantiaca nec non instrata, pulveracea, incarnata, stromate plus minusve atro-violacea saepe discolorata, alia cylindrica v. fusiformia utrinque obtusa, recta v. curvula, alia fusoideo-subfalcata utrinque ellipsoideo-conica, apice interdum leniter constricta, basi apiculata, raro subpedicellata, 3–5, rarius 6–, rarissime 7–11 septata; 3–sept. $32 \times 5.6$, pl. $24–26 \times 5.2–6$ ($17–47 \times 4.5–7$); 5–sept. $41 \times 6$ pl. $31–50 \times 5.5–6.7$ ($25–60 \times 4.8–8$); 7–sept. $46 \times 6.2$ pl. $40–50 \times 5.5–6.7$ ($30–70 \times 5–8$). Chlamydosporae intercalares sparsae.

Hab. ad conum *Pini leiophyllae* Schlechtendahl & Chamisso, Arizona, socio *Cronartio conigeno* et ad cortices *Pini monticolae* socio *Cronartio ribicola*, et *Pini contortae* socio *Cronartio harknessii* et *Cronartio filamentoso*, Oregon.

Obs. Fungus a Fusario trichothecioide recedit macroconidiis crassioribus, interdum numero majori septorum idoneis, colore atro-violaceo stromatis, etc.

*Fusarium bactridioides* occurs naturally on diseased cone tissues produced by *Cronartium conigenum*. L. N. Goodding, however, has demonstrated its ability to attack other pine rusts by successful inoculations on *Cronartium ribicola*, *C. harknessii* and *C. filamentosum*.

The following note by Mr. Goodding is of interest in connection with the behavior of this Fusarium:

Inoculations with *F. bactridioides* were made on blister rust cankers on western white pine (*Pinus monticola*) in the region of Rhododendron, Clackamas County, Oregon, in July, 1932, and in four localities in Idaho and two in Oregon in July, 1933. Several reports have been received from Crystal Creek, Idaho, of numerous actively sporulating Fusarium infections on blister rust cankers which undoubtedly resulted from the inoculations made there. At Eagle Creek, Oregon, where blister rust attack is very abundant, fully 80 per cent. of the trees sprayed with Fusarium spores in July, 1933, showed all the blister rust cankers parasitized by the Fusarium by late October. In the case of July, 1933, inoculations on trees of *Pinus contorta* infected with *Cronartium harknessii* at Summit Meadows, Clackamas County, and with *C. filamentosum* near Tilly Jane Creek, Hood River County, Oregon, the Fusarium was found actively developing on both rusts by the latter part of October. All blister rust cankers inoculated in 1932 were dead by July, 1933. There is no doubt about the effectiveness of *F. bactridioides* in destroying *Cronartium ribicola* once it attacks the cankers.

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