Connecting forms among the polyporoid fungi. By L. M. Underwood.

Unused forest resources. By Stanley Coulter.

Distribution of certain forest trees. By Stanley Coulter.

Cleistogamy in Polygonum. By Stanley Coulter.

The Cactus flora of the southwest. By W. H. Evans.

Diseases of the sugar beet root. By Katherine E. Golden.

In some analyses of sugar beets made at the Purdue Experimenting Station by Prof. Houston, station chemist, the percentage of sugar was so low that an investigation as to the cause was made. Upon a microscopic examination by Dr. Arthur, station botanist, the low per cent. roots were found to have bacteria in them. After that the roots were observed closely, and it was found that individual beets among all the varieties grown were affected, to a greater or less extent, with this bacterial disease.

The roots thus affected do not differ in outward appearance from the healthy roots, but are much lighter in weight. The texture of a healthy root is firm and somewhat brittle, and in color is a clear white, while the diseased root is rather soft and tough and of a yellowish white color. If the diseased root be cut transversely, concentric rings of brownish dots are seen.* These rings are formed by the fibro-vascular bundles, the dots being the separate bundles. The cells of the bundles have a deposition of yellow coloring matter upon their walls, which becomes somewhat darker upon exposure to air.

*Circles of dark dots are found in all sugar beet roots, but in the diseased roots they assume a greater prominence, and thus are very effective in the determination of the disease.

During the early growth of the plants no difference can be seen between the diseased and healthy ones, but as they develop the outer leaves of the diseased plants wither, while the heart leaves curl up much more than the normal, are dull in color, and the under side has a mottled appearance, causing the leaves to resemble somewhat those of the Savoy cabbage. As the season advances the differences between the diseased and healthy plants become more and more accentuated. In the early season the bacteria are found in parts of the plant only, but that may be any part from the leaves to the extreme end of the tap root; on account of this it is difficult to surmise how the plants become diseased. In the late season the bacteria are found permeating every part of the plant.

Examined microscopically the bacteria are found to the greatest extent in the parenchymatous tissue, but the tissue is not broken down by them. They are found imbedded in the substance of the protoplasm as well as being in the cell sap.

In form the beet bacterium is shortly cylindrical, being about twice as long as broad. They occur mainly as isolated cells, though they are sometimes found in pairs. When vegetating rapidly the bacteria are very active, moving in and out among one another with great rapidity. From their arthrosporous character the bacteria of the sugar beet very probably belong to the genus Bacterium.

The pure germ is easily obtained by the ordinary gelatine or agar plate separation method, if a piece of the root that has no contact with the surface be used for inoculation. This gives the disease germ only, free from soil and air contamination.

Very good development of the bacterium has been obtained by test tube cultures of acid and neutral nutrient gelatine. Upon acid gelatine, using spot cultures, the bacterium forms round, irregular-edged, greyish-yellow masses, having beautiful iridescent surfaces. This iridescence is a peculiar characteristic of the organism grown upon solid acid media. The masses retain this iridescence for about two weeks; then the surfaces become crust-like and dry, and the masses decidedly yellow in color. The bacteria liquefy the gelatine, gradually forming hemispherical depressions into which they drop. In neutral gelatine cultures they form, in most respects, the same kind of growth as in acid, but the surface has simply a shiny appearance, and as the masses ages they do not form crust-like surfaces. They liquefy the neutral gelatine much more rapidly than the acid.

A curious feature of this organism is that it causes the gelatine to become distinctly alkaline, even though it be acid before the organism has grown on it. The diseased beet roots give a neutral or very slightly acid reaction.

In a Pasteur sugar culture the bacteria grow well, causing the liquid to become slightly turbid in 24 hours. As growth goes on, the turbidity becomes greater, and again decreases until at the end of nine or ten days, when the growth practically ceases, the liquid becomes clear, the bacteria forming a greyish yellow sediment in the bottom of the tube.

They also develop well in sterilized sugar beet juice, but as contact with the air causes the juice to turn black, they are not readily seen. In juice that had been cleared by filtering through bone black very poor growths were obtained.

Inoculation tests were made upon six apparently healthy roots that were brought from the garden into the greenhouse. Four of these now give indications of having the disease; the leaves are crinkled, the under side being dull and mottled in appearance. Bacteria were found in the leaves and petioles.

Considerable interest attaches to this disease from its reduction of the sugar content of the root, and its prevalence throughout the state. The study of the subject was begun too late to estimate the loss by the disease, but as was already mentioned, diseased plants were found among all the beets grown on the station grounds, which included eight varieties for the past year—Red Top sugar, Silesian sugar, Imperial sugar, Dippe's Vilmorin, Simon LeGrand improved white, Dippe's Kleiwanzleben, Flormond Desprez richest, and Bultean Desprez richest. Roots were sent to the station for analysis from twenty-seven different places in the state and from nineteen of these some of the roots were diseased. This is not a fair estimate of the prevalence of the disease, however, as the tendency is, in sending beets for analysis, to choose the best looking and most nearly perfect ones, and the proportion of infected specimens included is necessarily much short of the actual average.

There were more of the Kleiwanzleben and Vilmorin beets sent than of the other varieties, and these gave respectively 12.9 per cent. and 12.7 per cent. diseased roots. Counting all the varieties there were 434 beets sent, among which were 12.1 per cent. diseased. In analyzing for the sugar content one set gave 13.3 per cent for good beets, 11.9 per cent. for beets showing a trace of the disease; another set gave 10.2 per cent. for good ones, 7 per cent. for diseased ones; while still another set, that Prof. Huston thinks gives the fairest estimate of loss, gave 10.3 per cent. for good beets, and 5.7

per cent. for diseased ones, a loss of nearly 50 per cent. of the sugar content. The per cent. of sugar is expressed in terms of the beet, not of the juice.

Besides the bacterial disease that is general for all parts of the plant, the sugar beet roots are affected with diseases of a local character. These are in the form of surface scabs, discoloration of the tissue, and small masses of tissue different from that surrounding them.

The scabs are of two kinds, one resembling the so-called "deep scab" of potatoes, while the other protrudes from the surface.

The deep scabs are light brown in color when first affecting the root, but as the root is more deeply affected they become dark brown or rusty black. They vary in size from a mere dot to an extent sufficient to nearly cover the whole root, though the latter case is not so often found. The deep scabs are sometimes accompanied by a red discoloration of the tissue that, in some cases, extends fully two inches beneath the surface. Upon exposure to the air the red color changes to magenta. These scabs are not to be confounded with the breaks in the surface of the roots caused by uneven growth.

The raised scab differs essentially from the preceding in outward appearance, as it forms warty elevations on the surface of the roots. It has the same general color as the deep scabs, but has not been found covering so great an extent of surface as they. When found in large quantity, instead of extending itself over the surface, it seems to have a tendency to form bands encircling the root. It is oftenest found near the neck of the beet at or near the surface of the ground. Both forms of scab are found on the same root, sometimes in close proximity, and forms have been found seemingly intermediate between the two. It is probable that the two forms of scab are just different stages of the same disease; the raised scab being the first stage, where the irritated tissue with the corky modifications form elevations on the surface of the root; as the tissue outside the corky layers dies and is gradually eliminated, the depressions are left in the surface. This theory is given further force from the fact that the same organism has been obtained from plate cultures of both forms of scab. The organism has the characteristic of the potato scab germ described by Dr. Thaxter.* There are the same filamentous forms that break up into bacteria-like bodies, and the dark stain given to the culture medium.

The organism itself is perfectly colorless, but it excretes a substance

*Annual Report Conn. Agr. Exp. Sta., 1890, pp. 81-95.

which in the presence of oxygen becomes dark brown. Cultures have been made in the fermentation tubes brought out by Dr. Theobold Smith, which are so constructed that one arm of the tube remains free of all gases. In such a tube the part of the culture in contact with the air becomes a deep brown color and that in the opposite gas-free portion remains uncolored for even a month or more, and its final change to brown, if the culture be continued sufficiently long, is without doubt due to diffusion, both of the gas absorbed from the air and the oxydized substance, by which they pass from the open arm of the tube into the closed arm.

Prof. Bolley* has induced the scab on the sugar beets by inoculating with the organism from potato scab. The scab has also been transmitted to the beet directly from the potato, and also from soil in which pototoes affected with scab had been grown, by experiments made in a cool greenhouse at the Purdue station. In the former case a young potato tuber, just removed from a pot-grown plant and well covered with active scab, was laid in contact with a perfectly healthy root of a young beet. An examination was made eight days later, but with no distinct evidence of results. A further examination thirty-seven days later showed a well defined scab about a quarter of an inch across upon the beet, where the diseased potato touched it, and no trace of scab elsewhere. In the latter case ten healthy beets were transplanted to pots containing soil in which potatoes affected with the scab had been grown. These were examined sixty-four days after being transplanted, and eight of the ten roots were affected with the scab, five of them having the neck entirely surrounded with it.

The scabbing originates without doubt from the soil. How long the organism may maintain itself in the soil as a saprophyte is uncertain, but the data elicited by Professor Bolley and by the Purdue station appears to show that the time may extend over one or two years.

The tissue of the roots is found to be blackened occasionally. This blackening is in the parenchymatous tissues between the rings of fibro-vascular bundles, and is of varying extent. It is sometimes found in roots that are neither affected with the bacterial disease nor scab.

There also occur small spherical or spheroidal masses that differ from the rest of the interior tissue of the roots in having a uniform watery appearance, similar to that of a water-core apple, and may, for the sake of distinction, be called water-core spots. They occur in the parenchymatous tissue, and are sharply defined, not grading into the adjoining tissue.

*Bulletin N. Dakota Exper. Sta., No. 4, December, 1891.

They are colorless, or of a pale yellowish tint, and turn black upon immersion in alcohol, the rest of the beet remaining colorless. The spots are composed entirely of parenchyma tissue, the cells having fine delicate walls. The cells, in the specimens examined, measured .03 to .075 mm. in diameter, while the cells of the adjoining parenchyma measured .15 to .25 mm. in diameter. The measurements were taken in transverse sections of the root. No parasitic organism, either animal or vegetable, was found associated with them, and no explanation of their presence is known.

The scabs, discoloration, and water-core spots do not seem to affect the size of the beets, as they are oftener found in medium and large beets than in smaller ones. The effect of their influence on the sugar content is not known.

Plant zones of Arizona. By D. T. McDougal.

[abstract.]

The author, while collecting plants in Arizona during May to October, 1891, for the Botanical Division of the U. S. Department of Agriculture, made a series of observations resulting in additional data on a biological survey of the San Francisco Mountains made by Dr. C. H. Merriam in the previous year.

The feasibility of the correlation of the life forms of this region into the Alpine, Timberline, Hudsonian, Canadian, Pine, Piñon and Desert Zones was recognized. Detailed notes of the occurrence of plants peculiar to each zone were made, and the bounding lines of each were carried southward through the Mogollon, Graham and Chiricahua mountains, and over the edge of the Colorado Plateau into the Verdi Touti, Salt and Gila basins to the Mexican boundary.

Relation of available enzym in the seed to growth of the plant. By J. C. Arthur.

The potato tuber as a means of transmitting energy. By J. C. Arthur