DISCUSSION

THE NATURAL OCCURRENCE OF CROWN GALL ON THE GIANT CACTUS, CARNEGIEA GIGANTEA

THE presence of galls on the giant cactus, *Carnegiea gigantea,* has been known to the senior author for at least twenty years. Although he has regarded the galls as unmistakable crown galls in nature, his teaching duties and work with crop plants have hitherto prevented a laboratory study supplementary to his observations in the field. Recently, however, time has been found to do this.

Galls on the giant cactus are numerous in the cactus forest near the Rincon Mountains, which was recently acquired by the University of Arizona; also in the cactus forest a few miles north of the University Cactus Forest in the foothills of the Santa Catalina Mountains. On some areas in these forests we estimate that 5 per cent. of the giant cactus plants are infected. Crown gall is the most conspicuous disease of Carnegiea in the two forests.

Both aerial and root galls occur. The aerial galls reach a diameter of two or more feet, the tissues of the galls die, and chunks of the dead tissues are sometimes scattered on the ground for a distance of several feet from the diseased plant. Small galls form lumps in the surface of the cactus, which may leave holes in the columnar trunk when the galls are "abscissed" by a layer of cork. Other galls apparently grow so rapidly that the host fails to "wall off" the enlarging cell mass. In one case a branch appeared to arise from a large aerial gall to which it is certainly attached at the present time. The branch on the gall may have been displaced from its original position on the trunk by the subsequent growth of the gall. From the ground it was impossible thoroughly to investigate the member. The gall is approximately two feet in width and about twelve feet above the ground.

The root galls may be large. On a field trip a few days ago the junior author noticed a grayish mass which was lying approximately three feet from the base of a giant cactus and partly above the soil line. When struck by the foot of the observer the mass broke from its attachment; it proved to be a root gall of the stalked type. This gall weighed eight and one half pounds, was ten inches across, and had a short stalk five and one half inches thick; it consisted of spongy parenchymatous tissue covered with grayish bark, which was one eighth to three fourths inch in thickness. Throughout the spongy tissue of the gall woody strands were distributed in much the same manner in which they occur in the normal plant.

From the galls on *Carnegiea gigantea* we have isolated a motile, polar uni- to bi-flagellate bacterium which grows on Patel's medium. Cultures on potato-dextrose agar can not be told superficially from peach and cottonwood strains of *Phytomonas tumefaciens.* Measurements of numerous individual rods agree with those of the crown-gall bacterium. Although we are awaiting results from inoculations, there is in our minds no doubt concerning the identity of the organism.

The natural occurrence of crown gall on the giant cactus and on other wild plants in Arizona raises some interesting questions. Is crown gall indigenous to the Southwest? The giant cactus forests in which our material was obtained are removed from agricultural districts and separated from farms by a belt of desert vegetation. Crown gall occurs on several wild plants in isolated places.

Of course it is not impossible that the crown-gall bacterium, *Phytomonas tumefaciens,* was brought into the country by the early Spanish missionaries. Records show that fruit trees and the vine were planted near the old missions. According to Father Kino[1] there were in Arizona, about the year 1700, gardens and vineyards containing Castilian fruit trees, including figs, quinces, peaches, apricots, pears, apples, mulberries and other trees which are susceptible to crown gall. Hedgcock[2] states that "no one can be certain as to the time of the first appearance of the disease in this country (United States). In the opinion of the writer it was introduced with plants from Europe."

Although the disease may have spread far from its possible source at the missions within two and a third centuries, the extent of the infection in our cactus forests and elsewhere in isolated areas argues against the theory of the introduction of the disease by early missionaries or by later settlers.

Finally, the writers call attention to a recent paper[3] with the (probably not intentionally) misleading title of "Crown Gall on the Sahuaro." We (and other workers) inferred from the title that crown gall had been found on the giant cactus, whereas the author had merely demonstrated the susceptibility of the plant when it is artificially inoculated. A more ac-

[1] Frank C. Lockwood, "Pioneer Days in Arizona," Macmillan Company, New York. 1932.

[2] George G. Hedgcock, "Field Studies of the Crown Gall and Hairy Root of the Apple Tree," *U. S. D. A. Bureau Plant Industry Bulletin* 186. 1910.

[3] Michael Levine, "Crown Gall on Sahuaro (*Carnegiea gigantea*)," *Bul. Tor. Bot. Club,* 60: 9–15, 1933.

curate title would have been "Sahuaro Susceptible to Crown Gall."

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THE SPECIFICITY OF FROG FLUKES

THERE are few animals more subject to parasitism than are frogs, and the ease with which these animals are collected and kept in captivity makes them ideal for the study of parasites of many kinds. In recent years the life-histories of a few trematodes which infect the frog have been worked out, but unfortunately very little attention has been given to the interesting problem of the specificity of these flukes for their hosts. The experimental approach to this problem is attended with some difficulty, since the mollusk, insect and frog which are involved as hosts must be laboratory-raised, and the investigator has usually been content if he has been fortunate enough to have the necessary hosts to demonstrate the life-history, without trying to find out just how specific the parasite may be for its hosts.

Considerable light can be thrown on this problem if frogs are carefully examined both within their natural range and in regions where they have been successfully introduced. A good example of the latter is to be found in the Hawaiian Islands and in the Sacramento Valley in California. In the former there are no native frogs, but such species as *Rana rugosa* from the Orient and *Rana catesbeiana* from the eastern part of the United States are well established. In a correspondence with Dr. C. H. Edmondson, of the University of Hawaii, I am informed that several hundreds of the American species have been used in his laboratories during the past few years, and not a single fluke has been found in them. Apparently the introduced bullfrog lost its flukes because of the lack of suitable mollusks or insects which serve as hosts. However, trematodes from domestic mammals which were reared on the islands have been found.

The frog "plant" in the vicinity of Gridley, California, was made several years ago, and at present the bullfrog has spread over most of the rice fields in that part of the state. They are very common and are even penetrating the near-by mountain streams, where they are living side by side with two California species, *Rana aurora* and *Rana boylii*. Although the two latter frogs have been found to harbor eight species of trematodes, none has ever been found in the introduced *Rana catesbeiana*. We use this frog in the elementary classes in biology and physiology, and I have personally examined the intestine, bladder and lungs of a large number but without the trace of a trematode. This is of especial interest, because two species of snails of the genus *Gyraulus* and at least seven species of dragonflies belonging to the genus *Sympetrum* are found in California, and species of these genera serve as hosts for certain frog lung flukes in Michigan and for other frog lung flukes in California. Both of the above-mentioned genera are represented in this locality.

Young bullfrogs and a single eastern leopard frog, *Rana pipiens,* were fed the metacercaria of *Ostiolum oxyorchis,* a common lung fluke in *Rana aurora,* but without results.

These observations indicate that there is a rigid specificity for the hosts by frog flukes and that the introduction of frogs into new regions may result in the loss of flukes because of the lack of suitable hosts. If this specificity should prove experimentally to be as rigid as is indicated, it might be used as a means of determining the identity or assisting in the differentiation of species of mollusks concerning which there is at present a difference of opinion. Whether this freedom from these parasites plays any appreciable part in the success of the adventitious bullfrogs over the indigenous frogs can not be stated, because it is doubtful whether the frog flukes actually harm their hosts seriously, but in the Gridley rice fields the bullfrogs outnumber all other native species ten to one. However, many other factors might cause this difference in numbers.

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POST-BOLSON FAULTING IN NEW MEXICO

DURING a recent trip into the San Andreas Mountains, the writers noted two low but interesting scarps in an area of bolson deposits. These were located at 25.2 miles and at 29.1 miles, respectively, west of Tularosa, on New Mexico state highway number 52. Unfortunately, time did not permit tracing these features either way from the highway, but a few facts of some importance were observed.

Both escarpments are moderately straight, and about the same height, approximately fifteen feet. Both face east, and neither one, at least within sight of the highway, shows any indication of an opposite-facing cliff, as would be the case if they were the banks of arroyos.

Even more interesting is the fact that each scarp shows a gentle but unmistakable back slope to the west, that of the easternmost being about fourteen feet per mile and extending for 3.9 miles; that of the westernmost thirty feet per mile for 1.0 mile. Both are considerably west of the center of the Tularosa basin. As a result of the back slopes, the surface of the basin floor actually declines westward from the scarps towards the adjacent mountains, just the reverse of what would be expected, were the intervening