

Some Diseases of Cacti in Arizona

Stanley M. Alcorn, Robert L. Gilbertson and Merritt R. Nelson

Although cacti are used in some landscape designs, they do not directly contribute to the economy of Arizona as do agricultural and forest products. However, they are a part of the unique heritage of our State. As their acreage is reduced through urbanization and expanding farming operations, it becomes of increasing interest to know what "problems" confront the remaining stands. This report briefly describes several of their diseases.

Bacterial diseases

Probably the most conspicuous malady of all is bacterial necrosis of the saguaro cactus (*Carnegiea gigantea*) (Fig. 1). The disease is caused by *Erwinia carnegieana*, a bacterium about 1 x 3 μ in size (Fig. 2). This microbe is very closely related to several species of *Erwinia* which are known world wide (and in Arizona) for causing pre-and post-harvest soft-rots of various vegetables and fruits. In addition to the saguaro, soft-rotting bacterial have been recovered in Arizona from naturally infected organ-pipe, prickly-pear, barrel, and cholla cacti. In the laboratory, representatives of these isolates have been shown to cause a soft-rot of such fruits and vegetables as melons, cucumbers, and tomatoes.

Bacteria enter plants only through natural openings, wounds, or by means of penetrating insects. A night-flying moth has been reported capable of transmitting the bacterium from one saguaro to another. Larvae of the moth deposit the bacteria in tunnels made within the plant. Insects visiting rotting plants possibly also disseminate the bacteria. In addition,

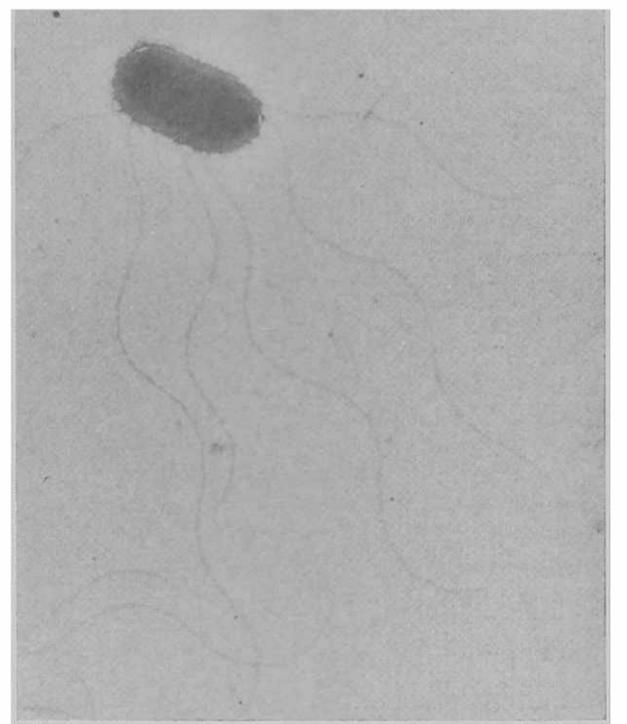
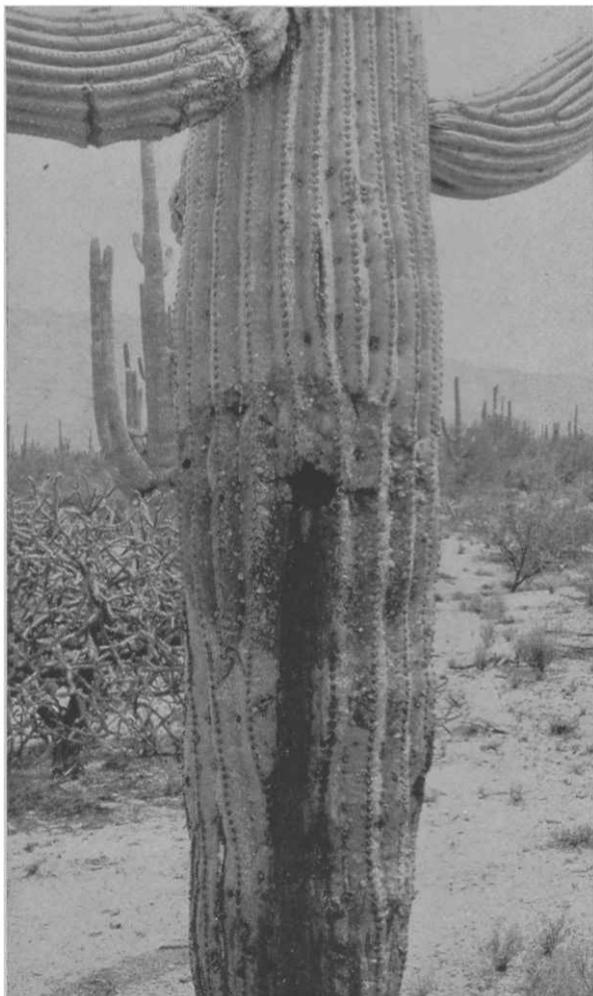


Fig. 1. Rotting saguaro cactus. Note the discolored area from which fluids are oozing.

Fig. 2. Electron microscope picture of *ERWINIA CARNEGIEANA*, the bacterium which causes the soft-rot disease of saguaros and other cacti, X 15,000.

plants probably can become infected by direct or root-to-root contact with other diseased plants. The first symptoms usually noted on saguaro and organ-pipe cacti are circular, dark, soft areas which can occur on the main stem or branches. Frequently the

tissues rupture, leaking a dark, foul-smelling liquid. The disease may progress, enveloping the entire plant, or it may be contained by the formation of hard tissues surrounding and walling-off the rotting area. Unfortunately, the conditions which facilitate the de-

About the Authors — Stanley M. Alcorn, Robert L. Gilbertson and Merritt R. Nelson are professors in the Department of Plant Pathology, University of Arizona.

velopment of such "walls" are not known.

The only practical control measure known is to remove the rotting tissues. If the infected area is small, removal of such debris, thoroughly cleansing the lesion with 10% household bleach (1 part bleach: 9 parts water), and leaving the injury "open" are usually sufficient to prevent further spread of the bacterium from the treated area.

Infected prickly-pear pads usually collapse; the internal tissues may become so liquified that the pad feels like a "bag of water." The bacteria may remain restricted to the initially infected pad or they may spread through the joint to the next pad. Usually, no more than two successive pads are infected at one time. Observations suggest that the central decayed areas, frequently noted in the larger clumps of the more procumbent prickly-pears, are the result of bacterial soft-rot.

Control of the disease in prickly-pears is best obtained by the removal of infected pads. These pads should either be burned or opened and thoroughly treated with the 10% solution of bleach.

Soft-rot of barrel and cholla cacti has not been studied under field conditions. In the laboratory, barrel cacti exhibit the typical, watery collapse of tissues. No control is known. Cholla tissues darken and also soften. However, leakage of liquid is not a characteristic symptom. Generally, infected cholla segments fall before the infection progresses to the next segment. With chollas, control also would be best effected by the prompt removal of infected segments.

Fungal diseases

Circular, tan, sunken lesions covered with minute black spots are frequently noted on pads of prickly-pears (Fig. 3). These lesions are caused by the fungus *Phyllosticta concava*. The method by which the fungus infects the pads is not known; presumably spores from the fungus germinate and penetrate the pads. Growth of the fungus in the pad causes a brownish, soft, frequently raised area to develop. Symptoms may simultaneously appear on opposite sides of the pad. Usually, after reaching a diameter of an inch or so the lesion does not further enlarge. However, coalescence of multiple infections of a given pad may re-

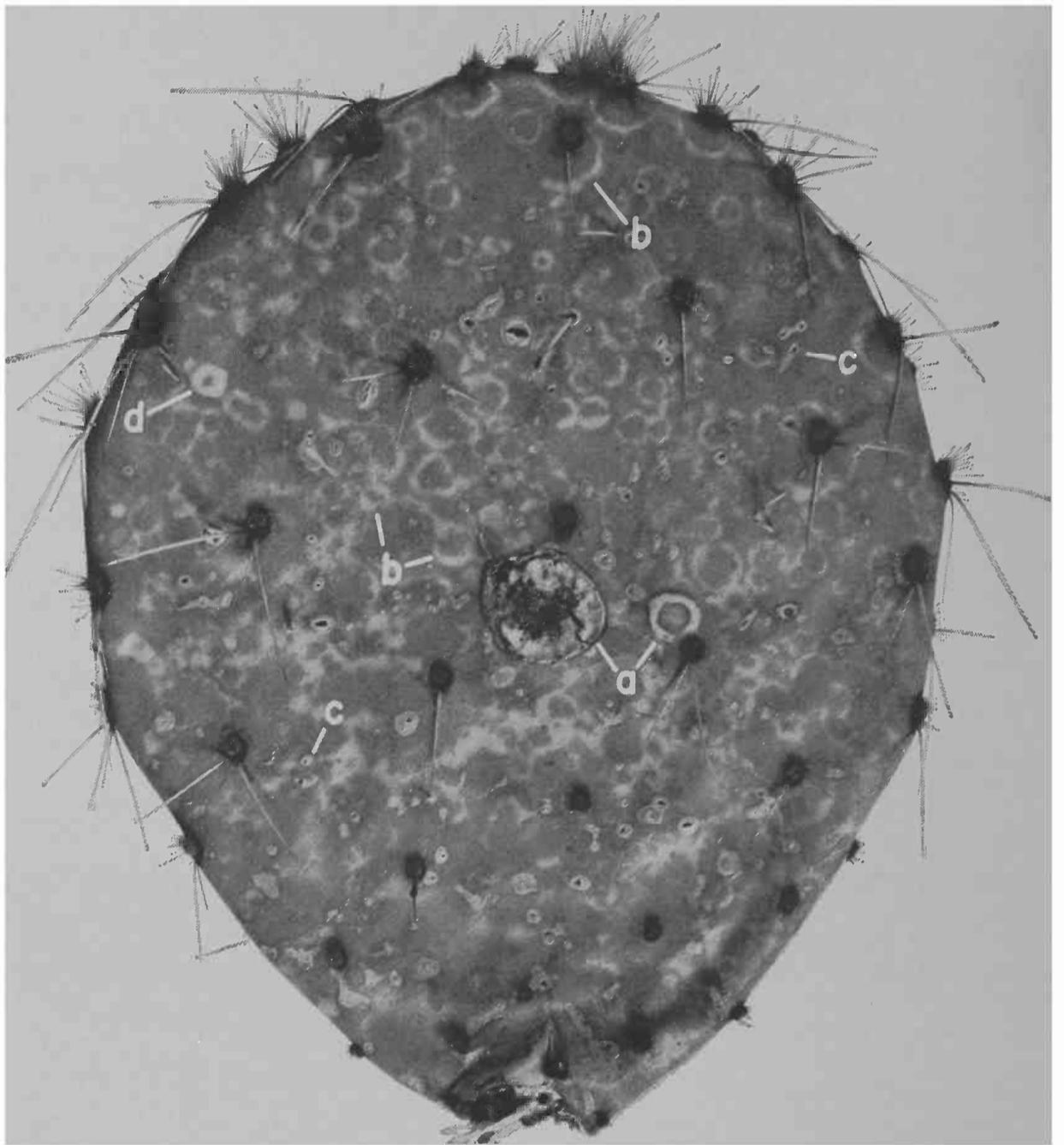
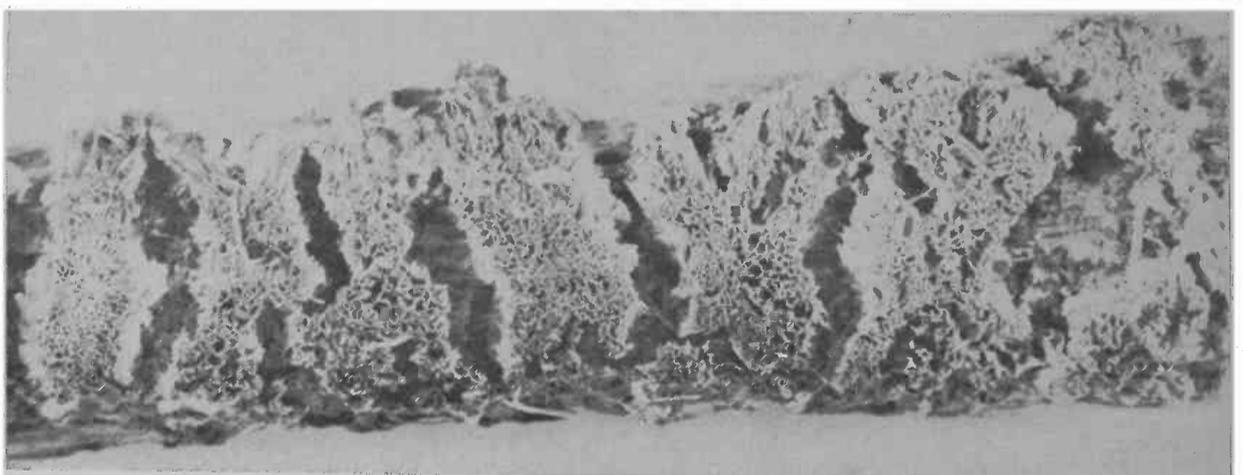


Fig. 3. Prickly pear. Infected by: (a) *PHYLLOSTICTA CONCAVA*; (b) *Opuntia* virus. Injuries: (c) penetration of cactus spines; (d) from feeding insects.



Fig. 4. Fruiting body of *FOMES TEXANUS* under an arm of a living saguaro.

Fig. 5. Fruiting body of *PORIA CARNEGIEA* growing on saguaro "ribs." (X 1)



sult in larger spots. Later the affected tissues shrink. About this time black, spore-bearing bodies are formed, appearing first in the center of the lesion. Eventually, infected tissues disintegrate; holes extending through the pad can occur. Although the disease has not been studied, the characteristics of the fungus suggest that the infectious propagules are most likely disseminated to adjacent pads by wind and/or splashing rains. Control presumably could be effected by spraying pads with fungicides, as the fixed coppers or Bourdeaux, or by removing and destroying infected pads.

Small (generally 2 inches or less in height), saguaro and organpipe seedlings grown under crowded conditions in the lathhouse have occasionally become naturally infected with the fungi *Fusarium solani* and/or *F. oxysporum*. Early, external symptoms appear as a dark-green to black softening of tissues, generally appearing first near the ground line or where spines of adjacent seedlings have penetrated the plant. Tissues just beneath the epidermis may become watery and dark with light-brown streaks occurring in the internal woody structures. Complete collapse of the plant usually occurs within a few days. Similar symptoms occur in larger seedlings except that infected, non-woody tissues generally do not evidence a watery collapse. *F. oxysporum* has been isolated from two naturally infected, field-grown senita cacti exhibiting symptoms similar to these in large saguaro and organ-pipe seedlings. Under greenhouse conditions *Opuntia fulgida*, *O. versicolor*, and *Ferocactus wislizenii* have proved susceptible to both fungi.

Specific procedures for controlling *Fusarium* rot have not been developed. However, it has been our observation that the disease is most prevalent among plants that either have been injured or raised in pots for prolonged periods under marginal growing conditions.

Some cacti have a large amount of solid, woody tissue which is invaded and decayed by wood-rotting Basidiomycetes. The only wood-rotting fungus found fruiting on living cacti is *Fomes texanus* (Fig. 4), a species that also causes decay of heartwood in many desert shrubs including cliff-rose, canotia, palo verde, creosote bush, and junipers. *Fomes texanus* has small, hoof-shaped or cushion-shaped,

brown, perennial fruiting bodies with minute pores on their lower surfaces. On saguaro these develop at the base of arms or, rarely, near the ground line on older plants. They may be very inconspicuous. The fruiting structures develop near the base of chollas, usually within 18 inches of the ground. *Fomes texanus* causes a white or yellowish rot of the inner woody cylinder and weakens the plants structurally, although it is not known to invade and kill living tissue. It is not known how this fungus enters living plants. However mechanical injuries, such as woodpecker holes or insect galleries that reach the woody tissues, are probably involved.

Poria carnegiea is a wood-rotting fungus known only on saguaro in Arizona. It is characterized by a whitish to buff colored, crust-like fruiting body with pores on the under surface (Fig. 5); it causes a white rot of the woody cylinder of roots and basal portion of older saguaros. The fruiting bodies of *Poria carnegiea* can often be found on fallen saguaros on which the outer, succulent tissues have deteriorated and fallen away to expose the internal woody cylinder. The presence of *P. carnegiea* in roots of newly fallen saguaros indicates that it can enter roots of standing plants and may predispose them to windthrow.

Both of these wood-rotting Basidiomycetes are probably normal factors in the natural ecology of the saguaro and cholla cacti and are not thought to represent any serious pathological problem at this time.

Virus diseases

Studies on viruses of cacti date back 87 years. The early work was mostly done in Europe, where highly prized collections of cacti from around the world were important parts of many botanical gardens. It was only ten years ago, however, that virus diseases of native stands of cacti were first studied. Prickly pear was found to have two viruses, both rod shaped. Infected prickly pears can show severe symptoms of infection such as chlorotic rings (Fig. 3) and distorted pads. These symptoms appear to have a marked effect on the growth of the infected plant. In contrast, we have discovered in the saguaro a virus that is spherical in shape (Fig. 6) and which causes no obvious symptoms on this plant. Work done in Arizona on the distribution of these viruses in native-plant populations has shown

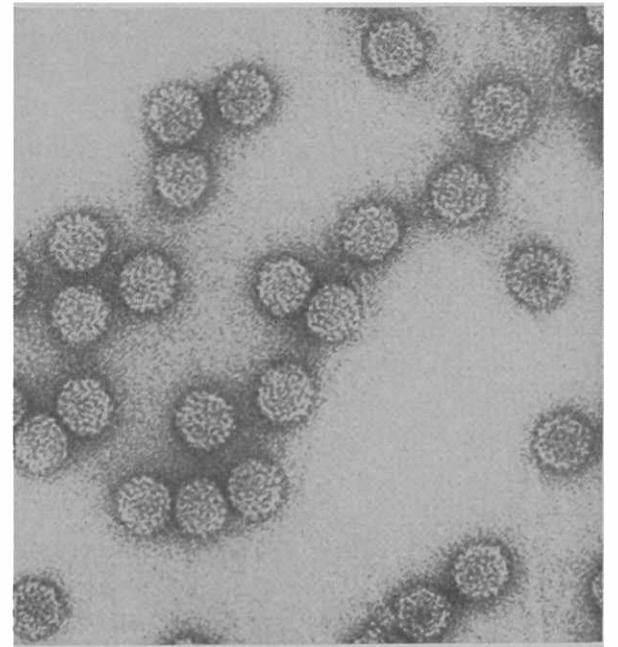


Fig. 6. Electron microscope picture of the saguaro virus, X 177,650.

that they are found only in regions where cultivated plants exist. For example, neither prickly pear viruses, nor the saguaro virus has ever been found in remote areas, such as Palm Canyon in Northern Yuma County or the saguaro virus in the Superstition or Catalina Mountains. This distribution pattern suggests that these viruses are not a natural part of the environment and that they were possibly introduced at sometime in the past 60-100 years on a cultivated plant.

At present, therefore, it appears likely that the viruses were introduced into the cactus population as a result of urbanization. No routine control recommendations can be made at present because of an incomplete understanding of the epidemiology of these diseases. Nevertheless, we would recommend that prickly pear plants showing yellow rings be avoided when selecting material for landscaping purposes.

Ringspot symptoms of non-viral origin are often found on prickly pears. These rings, while similar to those induced by viruses, are readily distinguishable on close examination by having a broad, chlorotic margin, an essentially circular appearance, and a relatively small ($\pm \frac{1}{2}$ inch) diameter (Fig. 3). With the aid of a hand lens, fine striations (oriented as spokes) can frequently be noted in the yellow areas. We know that the insects *Cheilinidea vittiger* and *Narnia inornata* can cause these symptoms as a consequence of feeding; other sucking insects also may be involved. Control, therefore, involves the use of appropriate insecticides.