ing a more modern tendency, that sum, again recognized as force, is regarded as due to reactions of (m) upon bodies that transmit force to it. It is clear that neither view preserves the scheme of equation (1); the first uses the real equilibrium condition of equation (7) in order to exhibit the actual departure from that condition in equation (1), and the second includes forces acting, not upon (m) but upon surrounding bodies. Either view is of course tenable, both within the original scope of the principle and in the field of modern dynamics to which it has been extended. But it is only in this peculiar sense that d'Alembert made the criterion of equilibrium a basis for the measurement of unbalanced force.

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SOME APPLE LEAF-SPOT FUNGI[1]

SINCE 1892 leaf-spot disease has been frequently reported as doing considerable damage in apple orchards in various parts of the United States. Its occurrence has been noted in fifteen different states. Very little seems to be known about the etiology of the disease. That it is a fungous trouble is indicated by the ease with which it is controlled in most localities by spraying. *Coniothyrium pirina*[2] (Sacc.) Sheldon, *Phyllosticta limitata*,[3] *Phyllosticta prunicola*,[4] *Sphaeropsis Malorum*[5] and *Hendersonia Mali*[6] have been variously reported as causing, or being associated with, the disease.

The number of fungi found fruiting on the leaf-spots is the most confusing thing in determining the real cause of the disease. In an examination of apple leaf-spot specimens belonging to the West Virginia Agricultural Experiment Station, the following fungi were found: *Coryneum foliicolum*, *Coniothyrium pirina*, an undetermined species of the Tuberculariae (found by Sheldon in the spring of 1907), *Sphaeropsis Malorum*, *Monochaetia Mali*, *Pestalozzia breviseta*, *Phyllosticta limitata*, *Torula?* sp., *Macrosporium* sp., *Ascochyta* sp., *Phyllosticta? piriseda?*, *Phoma Mali*, *Septoria piricola?*, *Metasphaeria* sp., and an undetermined species of the Leptostromaceae. Of these fungi, only the first four were common enough to indicate any economic importance. *Coryneum foliicolum* is probably the fungus which has been reported by different writers as a *Hendersonia* on apple leaves. *Coniothyrium pirina* will be better recognized as *Phyllosticta pirina* Sacc., from which it was recently transferred by Sheldon.[7] *Coniothyrium tirolense* Bubàk, a portion of the original collection of which was examined by the writer, seems identical with *C. pirina*. *Phyllosticta Mali* Prill. & Dela. var. *comensis* Tray, was found to resemble *P. limitata* in all characters except the shape of the spot, which in the former is decidedly angular. A part of the type specimen of *P. tirolensis* Bubàk on pear leaves differed from *P. limitata* by the slightly shorter spores and more gregarious pycnidia.

It seems to have been generally taken for granted that *Coniothyrium pirina* and *Phyllosticta limitata* are the most important fungi causing apple leaf-spot, exceptions noticed being the reports of Clinton[8] and Sheldon.[9] *Coniothyrium pirina* has, on the other hand, been declared by Stewart and Eustace[10] to be a saprophyte. A more detailed study of the fungus therefore became desirable.

Pure cultures of it were obtained and grown on the ordinary culture media, with varying success; they were also grown very success-

[1] Read before Section G of the American Association for the Advancement of Science, January 2, 1908.

[2] Alwood, W. B., Va. Agr. Exp. Sta., Bull. 17:62 (1892).

[3] Stewart, F. C., N. Y. Agr. Exp. Sta., Ann. Rep. 14:545 (1895).

[4] Tubeuf, Karl Freiher von, and Smith, W. C., Diseases of Plants induced by Cryptogamic Parasites, 463 (1897).

[5] Clinton, G. P., Conn. Agr. Exp. Sta., Ann. Rep. 27:300 (1903).

[6] Alwood, W. B., Proc. Am. Acad. Adv. Sci., 47:415 (1898).

[7] Sheldon, J. L., Torreya 7:143 (July, 1907).

[8] Sheldon, J. L., W. Va. State Bd. of Agr., Ann. Rep. 1:57 (1906).

[9] Stewart, F. C., and Eustace, H. J., N. Y. Agr. Exp. Sta., Bull. 220:228–230 (1902).

fully on fresh and sterilized twigs of apple, rose and plum. On sterilized twigs the pycnidia developed were often strongly flask-shaped, and in many cases hairy.

Repeated attempts were made to inoculate the fungus on the leaves of young seedling, Yellow Transparent, Ben Davis and York Imperial apple trees in the green-house, with spores taken from pure cultures on various media, and placed on the surfaces of leaves kept moist under bell-jars. Only negative results were obtained from this work, though it was continued for five months, and on leaves of widely differing degrees of age and vigor.

Inoculations were also attempted on leaf tissue which had been previously injured by various artificial means, scalding, abrasion of the epidermis, and punctures made with both hot and cold needles. Inoculation on scalded tissue was usually successful, and on abraded tissue always. Fruits of the fungus quickly appeared on tissue which had been killed by abrasion and inoculated, but the area of the leaf killed by the abrasion was seldom appreciably enlarged by the fungus. Of a number of attempts to inoculate the leaves at punctures made with needles, only two were successful. Hot needles were then used in making the punctures, small areas of leaf tissue being killed by the heat of the needle; the leaves were then sprayed with the atomizer, as in previous work, the spores spread over the surfaces of the leaves with the platinum loop, and the plant kept moist under a bell-jar. Within three to five days after inoculation a large number of the inoculated spots produced by the hot needle enlarged to three or four times their original diameter, and fruits of *Coniothyrium pirina* speedily appeared, usually in a ring near the outer edge of the spot. The fungus fruited on almost every such puncture inoculated. Checks were obtained by making a row of the hot needle punctures on each side of the mid-rib of the leaf, but placing spores only on the row on the right-hand side. A very few of the check spots on the left-hand side were evidently inoculated by spores accidentally washed over from the other side in watering. The rest of the check spots did not develop fungous fruits, and did not spread beyond the limits of the area originally killed by the heat. Punctures were sometimes made with a cold needle at the same time and on the same leaves as successful inoculations at hot needle punctures, but at only two such punctures were spots ever produced by the fungus.

These results of inoculation make it seem that *Coniothyrium pirina* is a facultative or wound parasite only, able to produce spots on apple leaves provided it has a little killed or injured tissue in which to get a start. That it causes a considerable amount of leaf-spot under orchard conditions is quite possible, but not as yet demonstrated.

An inoculation was also made on the living twig of a seedling apple tree in the green-house by making an incision in the bark and inserting with platinum loop a drop of water containing spores from a pure culture of *Coniothyrium pirina*. The wound was then wrapped with absorbent cotton, and kept moist for a number of days. Forty days later several excellent fruits of the *Coniothyrium* were found breaking through the bark at the very edge of the area injured by the incision. There was no further development of the fungus, nor was there any injurious effect noticed on the health of the shoot above the point of inoculation. This seems to confirm the statement that *Coniothyrium pirina* is a facultative parasite only. A number of subsequent attempts were made to inoculate the fungus on living apple stocks kept moist under bell-jars but not wrapped with cotton; these were uniformly unsuccessful. The trees on which these inoculations were made were nearly all growing vigorously at the time of inoculation.

The readiness with which the fungus grew on dead twigs in the laboratory suggested that it could probably be found on dead twigs in nature. On May 15, 1907, a fungus morphologically identical with *Coniothyrium pirina* was found at Cassville, W. Va., on dead twigs of a quince bush, the leaves of which were known to have borne many spots containing the fungus two years previously. Pure cultures were easily obtained from these twigs by plating, and spores taken from one of these cultures were used successfully in producing

spots on apple leaves which had been punctured with a hot needle. The fungus was later found on dead apple twigs in Morgantown, W. Va., almost touching a live branch whose leaves bore spots containing *Coniothyrium* fruits. There were but few spotted leaves on the remainder of the tree. Professor Alwood, in a letter to Dr. Sheldon which the writer was permitted to see, states that the fungus winters over on the fallen leaves. The writer has not so far been able to find fruits of the fungus on fallen leaves during the winter and spring.

Coniothyrium pirina, then, occurs in spots on living leaves of apple, cherry,[10] quince and pear,[11] and on dead twigs of apple and quince. It is able under certain conditions to produce spots on apple leaves, but nevertheless it is merely a facultative parasite, and probably does not cause the serious defoliation of apple trees in West Virginia, which has been attributed to it.[12] It seems able to winter over on twigs of apple and quince.

Since in the field *Coryneum foliicolum* gave more evidence of being important than *Coniothyrium pirina,* culture work with it was also done. The fungus was grown on the ordinary culture media, and on sterilized twigs of various kinds, including spruce twigs. On synthetic agar the hyphae at first bore conidia singly on short branches, and all the spores grown on agar were long, irregular, and with cells often subdivided, making the spores as many as seven-septate; this corresponds closely to the behavior of *Coryneum beyerinckii* recently reported by Smith. On some of the media cellular, subcarbonaceous structures developed, sometimes becoming flask-shaped with long necks. In August the fungus was found fruiting on a canker on a young apple trunk. Apparently the spores were borne inside subcarbonaceous pycnidia, but the immaturity of most of the fruits prevented definite determination of this point. A pure culture made from spores from this canker grew on agar just as did the cultures taken from leaf-spots.

Some inoculation work with *Coryneum foliicolum* along the same lines as that with *Coniothyrium pirina* gave similar results, except that the *Coryneum* gave even less evidence of vigorous parasitism than did the *Coniothyrium.* It is not likely, therefore, that it is any more important as a cause of disease.

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[10] Alwood, W. B., Va. Agr. Exp. Sta., Bull. 24: 23–40 (1893).

[11] Jennings, H. S., Tex. Agr. Exp. Sta., Bull. 9:26 (1890).

[12] Corbett, L. C., W. Va. Agr. Exp. Sta., Bull. 66:202 (1900).

A CYCAD FROM THE UPPER CRETACEOUS IN MAVERICK COUNTY, TEXAS

IN the fall of 1905 I found a cycad in the Upper Cretaceous of Texas. The locality was three miles north and one and one half miles west of the station called Paloma, on the Eagle Pass branch of the Southern Pacific Railroad, and about twenty miles south of Spofford. At this place the Upson clay is exposed on the east side of Sauz Creek, which joins with Cow Creek to form Elm Creek a half mile to the south. The exposure runs for a quarter mile north and south and is considerably cut up by gullies. At the north end the clay was dark and it contained a *Radiolites,* a small *Ostrea,* an *Anomia* and *Exogyra ponderosa.* This last shell is frequent over the whole exposure. Eight fragments of presumably the same silicified trunk were noted. Three of these matched by their fractures and showed a stem about ten inches wide, flattened considerably, and hollow. These three and one more fragment were all that I could carry, and they have been turned over to a specialist for study.

The clay containing these fossils has been by Dumble called the Upson clay and is described in Augustana Library Publications,