LEAF-HOPPERS INJURIous TO APPLE TREES.

SUMMARIZED BY
F. H. LATHROP.

PUBLISHED BY THE DEPARTMENT OF AGRICULTURE.
BOARD OF CONTROL.
GOVERNOR CHARLES S. WHITMAN, Albany.
COMMISSIONER CHARLES S. WILSON, Albany.
IRVING ROUSE, Rochester.
FRANK M. BRADLEY, Barkers.
CHARLES C. SACKETT, Canandaigua.
CHARLES R. MELLEN, Geneva.
JOHN B. MULFORD, Lodi.
C. FRED. BOSHART, Lowville.
PARKER CORNING, Albany.

OFFICERS OF THE BOARD.
COMMISSIONER CHARLES S. WILSON, President.
WILLIAM O'HANLON, Secretary and Treasurer.

STATION STAFF.
WHITMAN H. JORDAN, Sc.D., LL.D., Director.

GEORGE W. CHURCHILL, Agriculturalist and Superintendent of Labor.
REGINALD C. COLLISON, M.S., Agronomist.
JAMES E. MENSCHING, M.S., Associate Chemist (Agronomy).
†WILLIAM W. BAER, B.S., Assistant Chemist (Soils).
JAMES D. HARLAN, B.S., Assistant Agronomist.
WILLIAM P. WHEELER, First Assistant (Animal Industry).
ROBERT S. BREED, Ph.D., Bacteriologist.
HAROLD J. CONN, Ph.D., Associate Bacteriologist.
JOHN BRIGHT, M.S., Assistant Bacteriologist.
FRED C. STEWART, M.S., Botanist.
WALTER O. GLOYER, M.A., Associate Botanist.
MANCEL T. MUNN, M.S., Assistant Botanist.
LUCIUS L. VAN SLYKE, Ph.D., Chemist.
†RUDOLPH J. ANDERSON, B.S., ARTHUR W. CLARK, B.S., JOHN C. BAKER, PH.D., Associate Chemists.
MORGAN P. SWEENEY, M.A., OTTO McCREARY, B.S., RICHARD F. KEELER, A.B., WILLIAM F. WALSH, B.S., WALTER L. KULP, M.S., Assistant Chemists.

GEORGE A. SMITH, Dairy Expert.
FRANK H. HALL, B.S., Vice-Director; Editor and Librarian.
PERCIVAL J. PARROTT, M.A., Entomologist.
HUGH GLASGOW, Ph.D., *FRED Z. Hartzell, M.A. (Fredonia), Associate Entomologists.
HAROLD E. HODGKISS, B.S., BENTLEY B. FULTON, M.S., Assistant Entomologists.
ULYSSES P. HEDRICK, Sc.D., Horticulturist.
ROY D. ANTHONY, M.S.A., *FRED E. GLADWIN, B.S. (Fredonia), ORRIN M. TAYLOR, Associate Horticulturists.
†GEORGE H. HOWE, B.S.A., JOSEPH W. WELLINGTON, B.S., WILLIAM C. STONE, M.S., EDWARD H. FRANCIS, M.A., Assistant Horticulturists.
F. ATWOOD SIRRINE, M.S. (Riverhead) Special Agent.
JESSIE A. SPERRY, Director's Secretary.
FRANK E. NEWTON, WILLARD F. PATCHIN, LENA G. CURTIS, MAE M. MELVIN, MAUDE L. HOGAN, K. LORRAINE HORTON, Clerks and Stenographers.
ELIZABETH JONES, Computer and Mailing Clerk.

Address all correspondence, not to individual members of the staff, but to the New York Agricultural Experiment Station, Geneva, N. Y.
The Bulletin published by the Station will be sent free to any farmer applying for them.

*Connected with Grape Culture Investigations. †In military service.
Leaf-hoppers, important apple pests. Serious injury to nursery and orchard plantings in New York has been observed during recent years to result from attacks of three species of insects known as leaf-hoppers. These tiny creatures resemble minute grasshoppers, scarcely more than one-eighth of an inch in length. They spend most of the time on the undersides of the leaves sucking the juices from the plants. When the leaves are disturbed the young leaf-hoppers scurry away, dodging quickly out of sight, while the adults fly swiftly to a place of safety.

The loss of sap which these pests consume is detrimental to the infested trees, but far more damage is done by the curling of the leaves and the destruction of the green substance of the foliage. Incidental winter killing of injured tissues in many cases greatly aggravates the damage done by certain species.

Another source of danger is the relation of the leaf-hoppers to plant diseases. Field observations have shown that the prevalence of fire-blight may be associated with the presence of leaf-hoppers and other sucking insects. The habits of leaf-hoppers would seem to make them especially capable agents for the transmission of plant diseases, and experiments conducted at this Station have demonstrated that the species popularly known as the apple leaf-hopper may carry fire-blight from diseased to healthy tissues. It is not improbable that the other species are equally guilty.

The apple leaf-hopper. This species (Empoasca mali) is of a bright green color. It attacks the tender, rapidly growing terminal shoots, and it is perhaps for this reason that the species shows a marked preference for young, growing trees. The presence of this species in numbers is at once indicated by a curling of the terminal foliage in a way similar

---

*This is a brief review of Bulletin No. 451 of this Station on Leaf-Hoppers Injurious to Apple Trees, by F. H. Lathrop. Anyone specially interested in the detailed account of the investigations will be furnished, on application, with a copy of the complete bulletin. Names of those who so request will be listed to receive future bulletins of the Station, popular or complete edition as desired.
to that caused by an attack of green apple aphis (see frontispiece). Continuous attacks year after year result in a bushy, much branched tree. This malformed growth is frequently killed during the winter, thereby increasing the amount of damage. This species attacks various cultivated plants and weeds, as well as apple and nursery stock.

This species (*Empoasca unicolor*) very closely resembles the apple leaf-hopper in both the nymphal and adult stages. In fact, the two can scarcely be distinguished without the use of a microscope. For practical purposes, however, the grower can separate them by the differences in habits and injury. The unicolored leaf-hopper, altho it seems to prefer the younger trees, attacks the older leaves. Unlike the apple leaf-hopper, this species causes no curling, but, instead, produces a characteristic white stippling of the upper surfaces of the leaves. At the beginning of the attack these spots appear as isolated white points, but as the severity of the attack increases the spots merge and the entire leaf becomes pallid and functionless.

**The rose leaf-hopper.** (*Empoasca rosea*) is rather easy to distinguish from the other two species. Like the unicolored leafhopper, the rose leaf-hopper confines its attacks largely to the older leaves of the tree, where the injury also takes the form of a severe white stippling. However, it was noticed that the rose leaf-hopper is more prevalent on older trees, while the unicolored leaf-hopper prefers nursery or young orchard trees. Both of these leaf-hoppers have a habit of constantly discharging droplets of liquid, which fall upon the fruit and leaves, forming tiny round spots of a dark greenish or black color. In severe cases this may materially spoil the appearance of the fruit if it is not removed by rain.

In a general way the life histories of these three species are similar. Eggs are deposited either in the bark or in the leaves of the infested plants. The eggs hatch to produce tiny wingless creatures or nymphs. These nymphs feed on the undersides of the leaves, running rapidly when disturbed, and generally keeping out of sight. As the nymph grows older it increases in size, and wing pads are developed. Finally, the nymph matures, and the winged adult appears.

The activities of the several species differ, however, in important details. The rose leaf-hopper spends the winter in the egg stage, and by far the larger number of the winter eggs are deposited in the bark of the rose. These eggs hatch in late May, and the nymphs which appear mature during late June. The adults migrate to apple, where they produce the summer generation. In the fall the
return migration takes place, and the winter eggs are deposited in the bark of the rose.

The apple leaf-hopper was found to spend the winter in the adult stage. The nymphs appear on apple during late June. This species breeds through the summer on apple as well as on many other trees and plants, producing two or possibly three generations before activities cease in the fall.

The unicolored leaf-hopper spends the winter in the egg stage on apple. Nymphs appear in late May and mature in early July. The species is single brooded, and no eggs are deposited until fall.

For the protection of foliage, especially of nursery stock or of newly planted apple orchards, chief reliance should be placed on soap and nicotine mixtures of standard strengths. In spraying, the application should be made when the maximum number of nymphs in the younger stages are present, for the adults escape the spray by flying, and are probably resistant to the solution even when they are reached. In case of the apple leaf-hopper it is important to spray before the foliage has been curled, and for this reason it is well to examine nursery and young orchard trees from time to time during the season to determine whether or not nymphs are sufficiently numerous to require treatment. Coarse nozzles and fairly high pressure should be used, applying sufficient material to wet thoroughly the under-sides of the leaves and, generally speaking, the most satisfactory results can be obtained only by drenching the insects. With nursery stock and young trees, immersion of the growing tips into a receptacle containing a quantity of the spraying material is an effective method of treatment.

In a series of spraying tests in which soap, nicotine and kerosene emulsion were also compared, a high degree of effectiveness was indicated for a spraying mixture composed of nicotine sulphate 1 pint, lump lime 60 pounds, copper sulphate 4 pounds, and water 100 gallons. The copper sulphate was dissolved in four gallons of water, and then the lime was slaked to form a thin paste. These were then mixed together and diluted with water to make the required amount, after which the nicotine sulphate was added. After straining the lime thru a fine metal sieve directly into the tank, during which operation the agitator was kept in action to secure an even distribution of the materials, the suction intake was placed in the tank, when spraying was immediately undertaken. This formula or some modification of it, as may be suggested by future experience, will probably be found to have as its chief field of usefulness the treatment of young non-bearing orchards where it is desired to combat the green aphis as well as leaf-hoppers.

For bearing orchards it is probably not advisable to make a special application to control these pests. In orchards which receive the
routine insecticidal sprays these leaf-hoppers are usually sufficiently controlled during normal seasons to prevent any appreciable reduction of the crop.

One phase of this problem should, however, not be overlooked, and that is the activities of the leaf-hoppers in transmitting fire-blight. Proof of a vital relationship between these agents and the demonstration that the different leaf-hoppers are an essential or an important element in the spread of the disease during midsummer would certainly prove additional incentives for growers to adopt some system of spraying, aiming either at the individual or collective control of these pests.

Mention has been made of the fact that the apple leaf-hopper breeds on a large number of plants, including various weeds. To remove vegetation that harbors the insects, orchards should be cultivated or mowed to prevent the growth of weeds. Attention is also called again to the fact that the rose leaf-hopper breeds abundantly on currants and gooseberries, which should be considered in any plans that provide for the interplanting of apples with these bush fruits.