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A Study of the Oviposition and Nymphal Development of Paratrioza cockerelli (Sulc) Upon Various Host Plants

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A STUDY OF

THE OVIPOSITION AND NYMPHAL DEVELOPMENT OF PARATRIOZ COCKERELLI (SULC) UPON VARIOUS HOST PLANTS

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INTRODUCTION

The potato psyllid, Paratrioza cockerelli (Sulc) as stated by E. O. Essig, (1917) is a native of the western states.

Since the great outbreak of psyllid yellows in Utah potato fields in 1927 much interest has been given to this insect. The close relationship between the nymphs of P. cockerelli and the disease, psyllid yellows, is a well known fact, but as yet the causative factor by which this disease is produced still remains unknown.

Because of the severity of the disease to potatoes and the importance of knowing something of the host plants of P. cockerelli, the writer, upon the suggestion of Dr. G. F. Knowlton, began a study to, so far as possible, determine the uncultivated and cultivated host plants of this insect. The native plants of the solanaceous group used in these experiments were collected from Utah; other species of the potato family used were obtained from Dr. S. P. Doolittle of the U. S. D. A. Bureau of Plant Industry; Professor F. G. Weber, of the Florida Agricultural Experiment Station; and Dr. R. W. Samson of the Purdue University.

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REVIEW OF LITERATURE

Dr. Karl Sulc (1909) described the psyllid as Trioza cockerelli.

Patch (1912) stated that this species is receiving economic attention in Colorado.

Crawford (1914) recorded P. cockerelli as sometimes becoming a pest of cultivated plants, and listed the following as food plants: Pepper (Capsicum annum), tomato (Solanum nigrum), potato (Solanum tuberosum), Purshia sp., arborvitae (Thuja occidentalis), spruce (Picea sp.), pine (Pinus monophylla), and of alfalfa (Medicago sativa).

Compere (1915) reported that P. cockerelli attacked a large variety of plants. He reported that it injured Jerusalem cherry, Solanum capsicastrum, in the Golden Gate Park at San Francisco, and in the Capitol Park at Sacramento.

Essig (1917) stated that this insect had been of some economic importance for a number of years, and listed the following food plants: Tobacco, petunia, Solanum marginatum Linn., S. verbascifolium Banks, Datura sanguinea R. & P., and Iochroma tubulosa Benth, potato, pepper, tomato, and common nightshade (Solanum nigrum)Linn.

Van Duzee (1917) in his catalogue of Hemiptera gives the following Hosts: Capsicum, Solanum, Purshia, Thuja, Picea, Pinus, Medicago.

List (1925) reported that great injury occurred in the early-tomato-growing section about Denver and Littleton. He names purple ground cherry, Quincula lobata, Solanum rostratum, Physalis lanceolata, as wild host plants.

Klyver (1931) recorded the following host plants: Potato (Solanum tuberosum), tomato (S. nigrum), night-shade (S. umbelliferum),

pepper (Capsicum annum), morning-glory (Convolvulus sp.). As nominal hosts: Alfalfa, arborvitae, spruce, tobacco, petunia, pine, beets, willow, Datura, Iochroma, Covillea, Eriogonum, Sophia, Chrysothamnus, Lepidium, Hymenoclea, Norta, and Salsola.

Knowlton and Janes (1931) gave a detailed life history of this insect.

Daniels (1932) listed Physalis lanceolata, Quincula lobata, Solanium rostratum, S. triflorum as host plants.

Knowlton (1933) recorded the following host plants upon which P. cockerelli nymphs have not been found to develop. The maximum number of days that adult psyllids survived on each plant was as follows:

Host plant	Days of Life	Host plant	Days of life
Alfalfa	19	Colorado Blue Spruce	61
Arborvitae	44	Currant	26
Boxelder	28	Douglas Fir	96
Bridal Wreath	56	Grape	20
Honeysuckle	17	Raspberry	56
Juniper	56	Red Clover	56
Lilac	56	Roundleaf Mallow	20
Pear	35	Scotch Pine	93
Plum	56	Snowberry	56
Rainier Apple	20	Sugar-beet	20
		Tree of Heaven	56

GENERAL DISCUSSION OF THE INSECT

Adult:

The adult potato psyllid is a small insect, resembling a miniature cicada. In size it varies from 1.3 to 1.8 mm. in length and 0.39 to 1. mm. in width. The newly emerged adult is pale green in color for 24 to 36 hours, then a brownish tinge gradually appears; by the time the psyllid is 3 days old it is black with characteristic white markings on the abdomen and amber markings on the thorax and head. This insect is very active, and when disturbed springs quickly into the air by means of its powerful hind legs. From this characteristic habit psyllids are sometimes called jumping plant lice.

Life History:

The length of adult life varied greatly, depending on such factors as food and temperature. During the course of this study it was found that psyllids live as long as 3 months on conifer. Knowlton and Janes (1931) recorded the average length of life of females as 29.1 days and that of males 19.5 days.

Mating occured in from 3 to 4 days after emergence from nymphal stage. In this process the male approached the female's side, keeping his abdoman turned toward her, moving it up and down until the hypopigia of the two individuals came in contact. During copulation no movement except of the antennae was noticed. The time required for copulation varied from 1.5 to 14 minutes, with an average of 6 minutes. One mating will insure fertile egg production for a period of 2 or 3 days.

The length of the psyllid oviposition period usually varied from 8 to 40 days. However, Knowlton and Janes (1931) recorded that one female oviposited for 179 days. These writers reported that the average length of oviposition of 58 females was 21.45 days. After egg laying is completed the female survives but a short time, individuals rarely living longer than 3 days.

During the process of depositing an egg, the female lowers her abdomen and extrudes her ovipositor which comes in contact with the plant. This position is maintained for several minutes, during which time the egg stalk (or stipe) is firmly cemented to the plant. The female then withdraws her ovipositor, leaving the egg and stalk in an upright position. Frequently the female deposits a number of eggs in a row before moving to some other part of the plant. Females usually deposited about 10 to 50 eggs a day. Knowlton and Janes (1931) found that one female deposited 865 eggs between June 3 and 26, after which time she escaped. During one 24 hour period this female deposited 157 eggs. During the process of depositing eggs the females are not easily disturbed. In Northern Utah three to four generations a year occur in the field.

Nymph:

The newly-hatched nymph is very small, oval in outline, and has a characteristically flattened body. The eyes are red, and the body varies from semi-transparent to yellowish in color. The wing pads of the more mature nymphs are a conspicuous feature. If examined with a binocular microscope, small wax glands, which give rise to wax tubes, can be seen equally spaced around the outer margin of the body. These wax tubes are very brittle and if touched break readily. When exposed to intensive sunlight the nymphs prefer the shady under surface of leaves.

The nymphal development consists of five instars and molts. The duration of time in each stadium varied from 3 to 9 days. Temperature appears to play an important part in the development and retardation of immature forms. Knowlton (1932) stated that extremely hot weather in July and August appeared to be an important factor in retarding the development of large numbers of psyllids. Mortality in nymphs was found to be greatest during the first ecdysis. The length of time required for nymphal development varied from 14 to 18 days. Knowlton and Janes (1931) recorded one case that completed nymphal development in 12 days; the average time required for 133 nymphs was 15.35 days.

Egg:

The psyllid egg is very minute, spindle shaped, yellow in color, with an orange portion in the pedicle end. The egg measures 0.33 to 0.35 mm. in length, and 0.14 to 0.15 mm. in width. Eggs are deposited singly on a pedicle, most abundantly around the margins of the younger leaves. The pedicle on which the egg is deposited averages about 0.31 mm. in length.

The incubation period for eggs varied from 4 to 15 days. Such variations are probably due to variation in temperature during the incubation period. Pack (1930) stated that during June eggs hatched in from 7 to 15 days, while eggs in July hatched in 3 to 5 days. It was found that the majority of eggs hatched on the 6th day. One hundred percent of the eggs from some females hatched; the average hatchability, however, was about 73 per cent.

The hatching process starts by a spliting of the chorion (shell) on the distal end; the opening thus formed gives the nymph room to propel itself forward until the legs are free. After a short rest it frees itself from the chorion, descends the pedicle, and soon starts feeding on the plant juice.

DEFINITIONS AND RESEARCH TECHNIQUE

The term host plant as here used, refers to a plant upon which P. cockerelli has oviposited, nymphal development been completed, and upon which emergence of normal adults has occurred. Alternate host is the term applied to a plant on which adult potato psyllids feed, and upon which they may or may not oviposit, but upon which completion of nymphal development did not occur. Nominal hosts are plants from which psyllids have been taken without proof of the psyllid's feeding.

The tests indicated that plants in the potato family were by far the most important hosts, with the morning-glory family next. Many other plants used in the tests were rated as alternate host plants.

The plants were grown in a greenhouse during winter months, then moved to the laboratory where the tests were made. During this investigation the female psyllid oviposited upon every plant tested. The acceptability of the different plants to the psyllid was noted. Fewer eggs were laid upon sugar-beets, corn, and lettuce than upon more acceptable hosts, such as wanderberry. Although wanderberry was very acceptable for egg laying in the five tests conducted nymphs hatching from the eggs invariably died without surviving beyond the third instar. Jimson weed was also very acceptable for egg laying when the plants were small, but as the Jimson weed matures it become less acceptable.

Cages:

Two kinds of cages were used for these tests. One type was a cylinderical celluloid cage which covered the entire plant. It was constructed of a piece of celluloid bent in the form of a tube, and the overlapping edges cemented together with acetone. Over one end of this tube, gauze was placed and cemented to the celluloid. A small hole

was cut in the cloth end of the cage for the purpose of adding psyllids. A small piece of cotton stuffed in the hole prevented the escape of the psyllids after they were caged upon the plant.

The other type of cage was made especially for large, broad leafed plants which could not readily be caged. This smaller cage was constructed exactly like the first, except that the bottom was cemented into a slat base. The cage was then placed on the top of a leaf and another slat of the same size was placed under the leaf. The ends of the two slats were clamped together with elastic bands. In order to protect the leaf from injury, the inner surfaces of both wooden slats were padded with cotton and gauze.

Method:

The method used to determine host plants was to cage about 10 adult females and an equal number of male P. cockerelli upon each species of plant. When about 300 eggs were deposited on the plant the cage and adult psyllids were removed. The time required for this number of eggs to be deposited averaged about five days. Daily examination of each plant was made until the eggs hatched and the nymphs became adults. If the nymphs failed to complete their nymphal development on the plant, a second test was made. When the nymphs failed to mature during the second test, the plant was classed as an alternate host.

HOST PLANTS

This list of plants proved to be true host plants of P. cockerelli.

Scientific names	Common names
Atropa belladona	Belladona
Convolvulus arvensis	Wild morning-glory
Datura fatuosa	
D. innoxia	
D. metel	
D. Meteloides	
D. stramonium	Jimson weed
Hyoscyanus albus	
H. niger	
Lycopersicum pimpinellifolium	Currant tomato
Lycium halimifolium	Matrimony vine
Micromeria chamissonia	Tea vine
Nicandra physalloides	
Nicotiana glutinosa	
Nicotiana tabacum	Tobacco
N. texana	
Physalis angulata	Ground cherry
P. franchetti	
P. heterophylla	
P. peruviana	Winter cherry
P. pubescens	Husk tomato
Physaloides physaloides	
Salpiglossus sp.	

Scientific names	Common names
Solanum aviculare	Kangaroo apple
S. ballisii	
S. capsicastrum	Jerusalem cherry
S. Carolinense	Horse nettle
Solanum citrullifolium	
S. gracile	
S. ledoradorsum	
S. melongena	Eggplant
S. mexicanum	
S. nigrum	Black nightshade
S. phasianium	
S. pyracanthum	
S. racemigrum	
S. sanitwongsei	
S. sisymbriifolium	
S. triflorum	Wild tomato
S. tuberosum	Potato
S. villosum	

The nymphs of P. cockerelli matured upon several varieties of tobacco (nicotiana tabacum), including Broadbent, Havana, white burley, Connecticut broadleaf, and Turkish.

ALTERNATE HOST PLANTS

When nymphs of P. cockerelli failed to complete their development upon a plant, the plant was classed as an alternate host. Following is a list of these plants:

Scientific names	Common names
	Giant petunia
Antirrhinum sp.	Snapdragon
	Wanderberry
Capsicum frutescens	Pepper
Latuca saliva	Lettuce
Rhaphanus salivus	Radish
Pisum sativum	Peas
Zea mays	Corn
Beta vulgaris	Beets
Bassica nigra	Mustard
Convolvulus sp.	Tame morning-glory
Polygonum aviculare	Knotweed
Vicia villosa	Vetch
Atriplex rosea	
Mabla rotundafollium	Mallow
Asclepias Speciosa	Milkweed
Asclepias Speciosa	Sunflower
Amaranthus retriflexus	Redroot
Nepeta cataria	Catnip
	Daisies
Bassia hyssopifolia	
Viola sp.	Pansy

Scientific names	Common names
Vena fatua	Wild oats
Taraxacum officinala	Dandelion
Dactylis glomerata	Orchard grass
Delphinium sp.	Larkspur
	Marigold
Mentha spicata	Spearmint
Hiliscum trionum	
Solanum floavum	
Solanum munistrum	

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