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TB39: Canada Plum, Prunus nigra Aiton, as a Primary Host of the Green Peach Aphid, Myzus persicae (Sulzer), in Northeastern Maine

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CANADA PLUM, *PRUNUS NIGRA* AITON, AS A PRIMARY HOST OF THE GREEN PEACH APHID, *MYZUS PERSICAE* (SULZER), IN NORTHEASTERN MAINE

W. A. SHANDS[1], GEDDES W. SIMPSON[2], AND H. E. WAVE[3]

INTRODUCTION

Four aphid species infest potatoes, *Solanum tuberosum* Linnaeus, in Maine; of these the green peach aphid, *Myzus persicae* (Sulzer), is the most important vector of potato virus diseases. The virus, *Corium solani* Holmes, causes leaf roll disease of potatoes which since the outbreak in 1937 (Bonde 1938) has been a perennial problem for growers of seed potatoes in northeastern Maine. The other species are the buckthorn aphid, *Aphis nasturtii* Kaltenbach, the potato aphid, *Macrosiphum euphorbiae* (Thomas), and the foxglove aphid, *Acyrthosiphon solani* (Kaltenbach). Unless controlled, these and the green peach aphid can be sufficiently abundant to reduce potato yields in addition to being vectors of leaf roll and of other virus diseases.

Spring colonies of the green peach aphid were found on Canada plum, *Prunus nigra* Aiton, near Caribou, Maine, in 1924 by Bonde (Patch 1925) and in Presque Isle, Maine, in 1934 by one of us (G. W. S.). Gorham (1941) determined that Canada plum is a primary host of this aphid in New Brunswick, Canada, and we verified that Canada plum is also a primary host of the green peach aphid in Maine. The finding that Canada plum is a primary host of the green peach aphid in Maine is not surprising since several species of *Prunus* are known to serve in this capacity elsewhere in the United States and abroad.

Canada plum is generally distributed in the agricultural districts of northeastern Maine. Gorham (1943) reported it on more than 1,000 properties in the Province of New Brunswick. It was probably first introduced and distributed from nurseries in Woodstock, New Brunswick, Canada, and in Houlton and Ashland, Maine, in the 1880's as a root stock on which to graft horticultural plums to increase winter hardiness. When the grafted horticultural plums reached maturity and began to

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age, young Canada plum plants began to sprout and grow from the roots. Plants with living grafted tops have been observed to send up shoots of Canada plum from such rootstocks. Thickets occur largely in the vicinity of the initial plantings—in old apple orchards, along hedgerows, in the edge of woods, and around existing buildings (figure 1) or the foundations of old, abandoned homesteads. These plants yield few edible fruits which are of inferior quality except for jelly, and most plants bear unusable fruits that decay early from plum-pocket disease caused by *Taphrina* sp. fungus.

Since 1941 we have conducted studies to determine the importance of Canada plum as a host of the green peach aphid and a source of aphid infestation on potatoes in northeastern Maine. These studies have concerned (1) the seasonal history, development and abundance of the aphid on Canada plum, (2) flight studies, and (3) searches for previously unreported woody or herbaceous spring hosts.

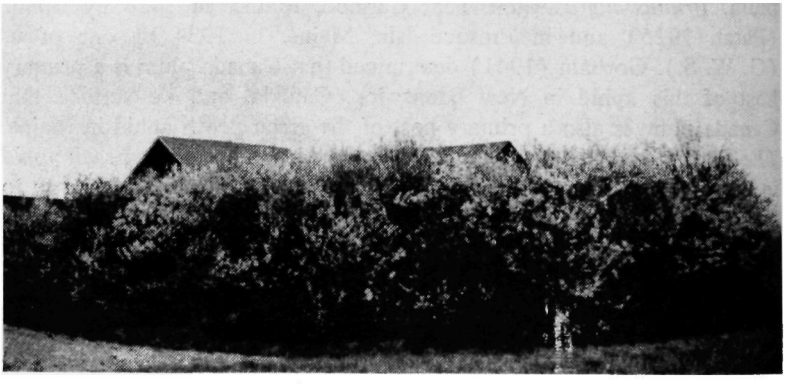


FIGURE 1. A thicket of Canada plum in full flower.

SEASONAL HISTORY, DEVELOPMENT AND ABUNDANCE OF THE GREEN PEACH APHID ON CANADA PLUM

In northeastern Maine, eggs of the green peach aphid overwintering on Canada plum usually hatch in late April. The nymphs from these eggs mature to wingless stem mothers (fundatrices). Stem mothers and their spring descendants feed on the developing leaves of Canada plum. The young leaves curl as the size of the aphid colony and feeding injury

to the foliage increase. Soon the leaves are tightly curled around the colony inside (figure 2). Many of the curled, injured leaves soon wither, become necrotic and unfit as food for the aphid colonies developing inside.

All descendants of the stem mothers until late summer are females. Winged spring migrant forms mature on Canada plum in late spring and move to many species of summer or secondary host plants including potatoes.

Spring migrants develop in the second to fifth generations on Canada plum under greenhouse and field conditions (table 1). Although the percentage is relatively large, the number of spring migrants in the second generation is very small because of the small aphid populations. The peak of spring migrants occurs in the third generation, but substantial numbers also mature in the fourth generation. Few spring migrants develop in the fifth generation, none have been observed in the sixth.

A B

FIGURE 2. Typical appearance of young foliage of Canada plum infested by the green peach aphid; (A) on sprout growth from the trunk of a tree, (B) on an undergrowing seedling.

The time of occurrence and duration of the spring migration of the green peach aphid is influenced largely by temperature which determines the rate of aphid development. Figure 3 and table 2 show respectively, the fractional development per day and the average developmental time

TABLE 1

The percent of progeny from eggs of the green peach aphid that matured as alatae on Canada plum in spring.

Generation	Field	Greenhouse
1 (stem mother, or fundatrix)	0	0
2 (first agamic generation)	26	27
3	68	69
4	40	35
5	8	9
6	0	0

of the aphid on Canada plum at various temperatures in spring. The developmental times shown in table 2 were computed by using the regression equations for temperature developmental requirements of 207 apterous and 187 alate forms in spring on caged Canada plum in the field and in the greenhouse. The progenitors were stem mothers hatched from overwintered eggs on Canada plum in the field. Based on these equations the apterae mature in from 7.5 to 13.5 days and the alatae in 9.9 to 14.5 days at daily mean temperatures of 70° to 50°F, respectively (table 2). Since 1942, the time of the spring migration has ranged from May 29 to about June 23 (tables 6, 9).

The size of the spring migration is influenced greatly by the percentage of the progeny of the stem mothers (second generation) that mature as alatae since these spring migrants leave for secondary hosts without contributing to further population increase on Canada plum.

Canada plum can serve as a host of the green peach aphid as long

TABLE 2

Developmental time of the green peach aphid on Canada plum in spring.

Mean daily temperature (F°)	Days Developmental Time[a]	
	Apterae	Alatae
50	13.5	14.5
55	11.2	13.1
60	9.6	11.8
65	8.4	10.8
70	7.5	9.9

[a] Computed from the regression equations for apterae:
$Y = 0.0029654X-0.0740308$; and for alatae:
$Y = 0.0015932X-0.0107077$ where X is mean temperatures F° and Y = fractional development per day.

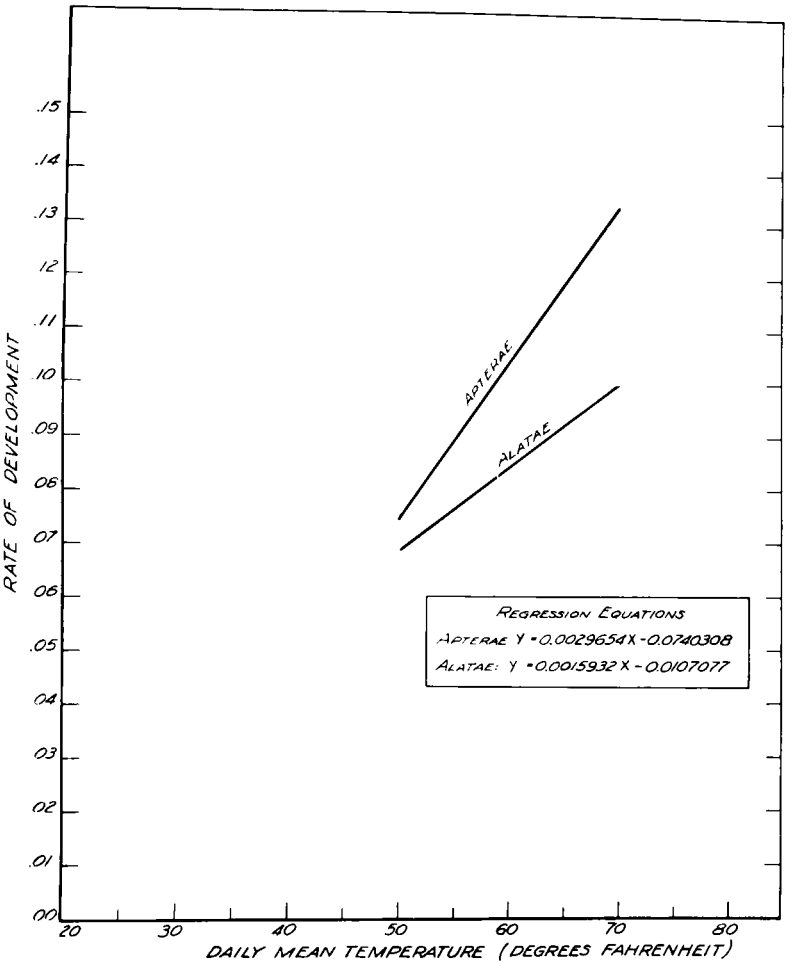


FIGURE 3. Fractional development per day of the green peach aphid occurring at variable temperatures.

as tender, succulent growth is present. Under caged conditions, aphid breeding on the same branch has occurred from early spring until about the time that fall migrants moved from secondary hosts to Canada plum. Under natural conditions Canada plum is of little or no importance as a breeding host of the green peach aphid where it occurs in reforested areas or in lands engulfed by forests.

Winged females which develop on secondary hosts during summer are called summer dispersal forms. Toward the end of the season,

however, some mature that are fall migrant forms. These fly to Canada plum and deposit nymphs on the foilage. These nymphs or, when matured, their progeny develop to be wingless, true females (oviparae). Winged males maturing in autumn on secondary hosts fly to Canada plum and fertilize apterous oviparae that deposit the overwintering eggs which are green when laid but turn black after undergoing partial development.

Except in 1951, when no observations were made, and in 1952 when no fall migration was detected because of scarcity of the aphid on its summer host plants, the start of the fall migration during 27 years ranged from approximately August 23 to September 22 (table 3), as determined by the occurrence of the first newly deposited nymphs situated beside alate forms on mature Canada plum leaves.

Reasons are not clear for the year-to-year variation observed in starting time of the fall migration (table 3). However, it is of interest that considerable delay occurred during most of a 12-year period from 1947 to 1958 following the advent of the general use of DDT for control of aphids on potatoes (table 3). Except in 1965, since 1959 the beginning of the fall migration has been nearly as early as it was prior to 1947. The slight retardation in starting time observed in 1943 may have been more apparent than real; that is, it was not detected until the small populations of progeny of fall migrants increased and became prevalent enough to be detected when 500 to 1000 or more randomly located leaves were examined at each station.

In autumn the green peach aphid has a characteristic population trend on Canada plum foliage in northeastern Maine (figure 4). After the start of the fall migration there is usually a rapid buildup in numbers of alate and apterous progeny on the older foliage until the first severe frost, gradually decreasing thereafter as the leaves drop from the Canada plum trees. The leaves drop due to natural maturity but mostly because of frosts, rains, and wind and rain following killing frosts. Ordinarily a bulk of the leaves has fallen by early October; few remain after mid-October, and practically none after November 1.

After the first killing frost the rate of Canada plum defoliation increases sharply, especially from storms, and the remaining leaves deteriorate rapidly in suitability as aphid food. Most of the immature apterae on fallen leaves probably die of starvation and few are successful in returning to foliage still attached to the trees. In late October and early November, large nymphs and oviparous adults have been observed feeding on buds of plum plants having no leaves. Doubtless oviposition by the aphid is influenced by the availability of adequate food in suitable condition as well as by temperature.

TABLE 3

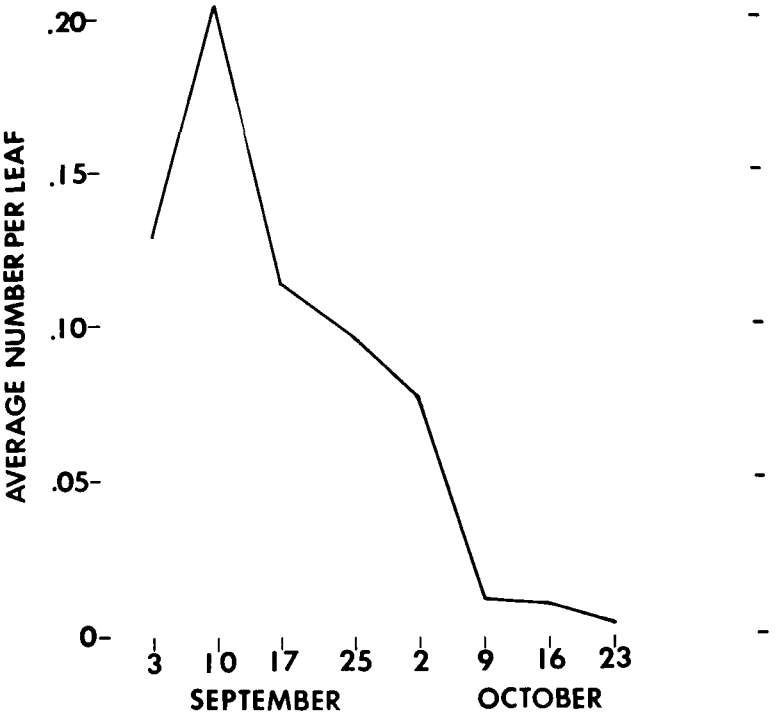
Approximate starting times of the fall migration of the green peach aphid to Canada plum in northeastern Maine, 1941 through 1967.

Year	Date
1941	Before August 31
1942	Before August 24
1943	Early September
1944	August 23
1945	August 21 to 29
1946	August 27 to 28
1947	September 12
1948	September 20 to 21
1949	August 25 to 26
1950	Before September 8
1951	— — — (no observations)
1952	Not detected—too few aphids
1953	August 30
1954	September 9
1955	September 16 to 22
1956	September 5
1957	September 2
1958	September 7 to 8
1959	August 31
1960	August 30
1961	August 28
1962	August 27
1963	September 1
1964	August 28 to 29
1965	September 13 or before
1966	September 2
1967	Before September 5

In most years, oviposition ceases by early November. During only a few of the 17 years for which data are available was there an appreciable overwinter increase in size of aphid egg population based on sampling done during the first week of November and again in late winter or early spring before the start of hatching (table 4). Prolonged temperatures suitable for oviposition likely were responsible for the increase after the November sampling. In most years the early onset of cold weather likely reduces the potential size of egg populations.

Green peach aphid eggs are most commonly found by the Canada plum buds but also occur in cracks, crevices, or pits in the bark on the

FIGURE 4



Fall Population Trends of the Green Peach Aphid on Canada Plum in Northeastern Maine, 1953 to 1959.

plant as well as in the crotches of limbs or branches. They occur more commonly in the pockets formed by double or triple buds than by single buds, however, multiple buds have been relatively scare.

The numbers of green peach aphid eggs deposited on Canada plum are related to the numbers of oviparous forms and the time they mature, the amount and condition of their food, and the duration of weather suitable for oviposition. The apterous oviparae may begin to mature in early October but ordinarily later than this. Recently deposited aphid eggs by buds on Canada plum trees heavily infested with the green peach aphid were found on October 3, 1942, and on October 4 in 1944 and in 1945. In these years the fall migration started early (table 3) and temperatures in September were much above normal. Mature oviparae were observed on these trees on September 27 in 1945.

TABLE 4

Abundance of aphid eggs in late fall[1] and in the following early spring by Canada plum buds and of aphid colonies on this plant in late spring in Aroostook county, Maine.

r	Number of stations		Average number eggs per 100 buds				Colonies found per minute in spring[2]	
			Late fall		Early spring			
	Fall	Spring	Total number	Percent shriveled	Total number	Percent shriveled	All species of aphids	Green peach aphid only
3	18	11	1.73	71.6	0.10	0	—	—
4	19	18	.08	12.5	1.87	65.7	—	—
5	26	24	.54	13.0	.01	50.0	—	—
6	26	26	2.70	35.9	.41	65.9	—	—
7	26	26	1.11	51.4	1.46	86.3	—	—
8	25	26	1.46	21.2	.56	64.3	—	—
9	25	25	1.54	14.3	.87	63.2	6.40	3.59
0	24	25	.44	34.1	.52	59.6	—	—
1	24	24	.25	1.6	.43	60.5	—	—
2	24	24	.54	1.5	.13	76.9	1.57	0
3	24	24	1.08	14.8	1.13	53.1	2.78	0
4	24	24	.94	14.9	1.01	38.6	4.40	.94
5	25	24	.21	33.3	.34	29.4	1.47	.01
6	26	25	.24	20.8	.13	23.1	1.62	.15
7	26	26	1.08	17.6	.16	81.3	.34	.07
8	26	26	.16	3.7	.53	83.0	2.70	.93
9	26	26	.12	7.7	.13	36.8	.48	.08
0	26	26	—	—	.06	32.7	.98	.05

[1] rst week in November.
[2] uring the third generation of *M. persicae* 1952 to 1956; during the second generation in the re- ining years.

Several seasonally interrelated phenomena have been observed to occur between the green peach aphid and its primary host which are influenced by weather factors, especially temperature. In spring, the eggs start to hatch when the buds of Canada plum begin to swell; the first stem mothers begin to mature about the time the plants burst into flower; the peak of the spring migration occurs usually about one month after the plant is in full flower. In autumn, the number of oviparous adults appears to depend to a considerable extent upon the time plum foilage drops, the time and size of the fall aphid migration and daily temperatures, but most importantly upon the time of first frost, the subsequent frequencies and severity of frosts, and rainfall and winds after frost. The plum buds do not appear to be suitable food for developing oviparae, although aphids have been observed feeding on them after the leaves fall.

RELATIONSHIPS AMONG APHID EGGS AND GREEN PEACH APHIDS ON CANADA PLUM

Canada plum serves as a host for several other species of aphids in addition to the green peach aphid. Those collected from natural infestations on it in northeastern Maine include *Amphorophora agathonica* Hottes probably, *Brachycaudus cardui* (Linnaeus), *Brachycaudus persicae* (Passerini), *Aphis rumicis* Linnaeus, *Aphis* sp., *Macrosiphum euphorbiae* (Thomas), *Myzus cerasi* (Fabricius), *Myzus* spp., *Tuberculoides annulatus* (Hartig), *Phorodon humuli* (Schrank), *Rhopalosiphum padi* (Linnaeus) probably, and *Rhopalosiphum* sp. The plant may serve as a primary host for several of these. Aphids utilizing the plant as a primary host overwinter on it as eggs.

In this locale, before the general use of aphicides on commercially grown potatoes, the green peach aphid was the most abundant species on Canada plum in fall. This has not always been the case since that time. In spring it has been and generally still is the most widely distributed species on the plant, but not always the most abundant one. In thickets where they occur, frequently *B. cardui, P. humuli,* and *Rhopalosiphum* spp. are more abundant.

Since we could not identify species of aphid eggs on Canada plum, we sampled to determine relationships of abundance of green peach aphid colonies in spring to that of total aphid eggs observed in fall or in spring. Over more limited areas weekly samplings were made in fall before the eggs were deposited to determine by species the numbers of aphids on the Canada plum. This should permit more accurate assessment of interrelationships of green peach aphid abundance in spring to that of the overwintering eggs.

In early November—after the onset of cold weather—and again in April of the following year after all or most of the winter's snow had melted, the numbers of fully distended, shriveled, or partly shriveled eggs on approximately 810 buds (typically the 9 distal buds on each of 9 subsamples of 10 twigs) at each of the stations in northeastern Maine were determined (Shands and Simpson, 1953). Populations of eggs are expressed as average number of fully distended and shriveled eggs per 100 buds. Shriveled or partly shriveled eggs are not viable.

During the first four years the aphid colony survey was conducted shortly before or about when the first alatae of the second agamic generation began to mature and thereafter near the beginning of maturation of alatae of the first agamic generation. The earlier time was chosen because some of the aphid "colonies" had been cleaned out by predators and parasites by the time of the later survey and therefore could not be counted; and because in some instances the "colonies"

contained no progeny since all had emerged as alatae in the first agamic generation. The earlier survey results in a much lower estimate of colony abundance but insures the presence of specimens for identification and provides some basis for estimation of probable abundance of spring migrants of the green peach aphid available to infest potatoes.

The survey to determine abundance of aphid colonies on Canada plum was made by one or two workers searching for 10 to 20 minutes in each thicket, depending on its size. Each part of a thicket was searched once only. Samples of aphids from each colony were preserved for subsequent identification. Colony abundance is expressed as number found per minute of search.

In a more limited area the sampling to determine aphid abundance on the foliage in autumn consisted of recording by species or in the grouping of "miscellaneous species" the numbers of apterous or alate aphids found on each of 100 randomly located leaves at each station. Aphid abundance is expressed as the average number per leaf.

The results of these studies are considered in the following two sections. In the first, all sampling stations—from Houlton to Stacyville and northward to Fort Kent—are included since the data for each include aphid egg abundance at the onset and at the end of winter and aphid colony abundance in spring. In the second section, the comparisons are drawn using the identical data for abundance of eggs and colonies from fewer stations since the comparisons are limited to those stations in the central and southern part of the potato area where abundance of aphids on the plum foliage in autumn had been determined.

A third study, involving data from only a few of the same stations, is made to determine whether there are relationships between the abundance of the green peach aphid on potatoes on one central farm and that of aphid colonies or of aphid eggs on Canada plum at stations within a circular area of about 45 sq. mi. The results of this study are discussed on pages 25-28.

ABUNDANCE OF COLONIES IN SPRING AND OF EGGS IN FALL AND SPRING

During the period 1943 to 1960, the average number of aphid eggs per 100 buds in northeastern Maine varied from 0.08 to 2.70 in early November to 0.01 to 1.87 in the early spring (table 4). The average winter loss in total population was 31.4 percent, while that for fully distended eggs was 66.3 percent. Only 37 percent of the aphid eggs in spring were fully distended. The number of shriveled eggs in spring was 1.75 times that at the start of winter.

During the 17-year period 1943-1960, the total number of aphid eggs in spring was correlated with that at the start of the preceding winter ($r=0.75^{**}$)[4] or with the number of fully distended eggs at the start of winter ($r=0.77^{**}$). Likewise, the number of fully distended eggs in spring was correlated with the total number of eggs or with that of only the fully distended eggs at the start of winter ($r=0.48^{*}$ or $r=0.52^{*}$ respectively).

During a 10-year period between 1949 and 1960 abundance of aphid colonies in spring was significantly correlated with the total aphid egg population earlier in spring ($r=0.78^{**}$), at start of the preceding winter ($r=0.85^{**}$), as well as with the populations of only the fully distended eggs at these times ($r=0.67^{**}$ and $r=0.78^{**}$, respectively).

Abundance in spring of colonies of only the green peach aphid was correlated with total aphid egg abundance at the start of winter ($r=0.77^{**}$) and with populations of only the fully distended eggs at that time ($r=0.65^{*}$). A trend was indicated toward a positive relationship between abundance in spring of green peach aphid colonies and of total aphid eggs since the correlation approached the 5 percent level of significance. However, the likelihood of a correlation between abundance in spring of green peach aphid colonies and of fully distended aphid eggs only was farther removed from this level of significance. Possibly the sampling technique was more adequate for measuring abundance of eggs at the start of winter than in spring when they were less abundant due to normal winter loss.

ABUNDANCE OF COLONIES IN SPRING, EGGS IN FALL AND SPRING, AND OF APHIDS ON FOLIAGE IN FALL

Abundance in spring of colonies of all species of aphids or of green peach aphids only, was not correlated with corresponding aphid populations at the fall peak of the preceding year on foliage of Canada plum. Neither was colony abundance correlated with that of aphid eggs on the plant at the start of winter (table 5). However, there was some tendency for abundance of green peach aphid colonies in spring to be correlated with spring populations of aphid eggs—either total egg populations or fully distended eggs only. The total egg population in spring in these thickets was correlated significantly both with that at the start of the preceding winter ($r=0.62^{*}$) and with that of only the fully distended eggs in late fall ($r=0.70^{*}$). Abundance of fully distended eggs in spring was correlated with total abundance of aphid eggs at the start of winter ($r=0.79^{**}$) but not with only the fully distended ones at that time.

[4] *–P=0.05; **–P=0.01

Here, again, the sampling technique likely was more adequate for measuring total egg abundance than that of only fully distended ones. Variations due to smaller numbers of sample stations doubtless were chiefly responsible for the smaller number of significant correlations found for the restricted area (table 5) as compared to those for all of northeastern Maine (table 4).

TABLE 5

Abundance of aphids, aphid eggs, and aphid colonies on Canada plum at the same places in central and southern Aroostook county, Maine.

Year	Number of stations	Average number aphids per leaf at the fall peak: Green peach aphids	Average number aphids per leaf at the fall peak: All species of aphids	Average number eggs per 100 buds: Late fall, Total number	Average number eggs per 100 buds: Late fall, Percent shriveled	Average number eggs per 100 buds: Early spring, Total number	Average number eggs per 100 buds: Early spring, Percent shriveled	Colonies found per minute in spring[1]: All species of aphids	Colonies found per minute in spring[1]: Green peach aphids only
1949	2	4.74	5.44	0.18	71.4	—	—	1.45	0.60
1950	2	.34	1.34	1.28	71.5	0.19	100.0	—	—
1952	8	0	.60	.49	12.4	.43	57.0	2.31	0
1953	9	.84	1.32	.26	10.7	.63	61.0	2.01	0
1954	18	.02	.11	.50	13.6	.44	49.9	5.18	.94
1955	19	.03	.42	.21	40.4	.17	28.6	.98	.01
1956	20	.17	.43	.13	27.2	.12	26.0	1.57	.65
1957	19	.03	.29	1.00	15.5	.12	68.3	.38	.07
1958	19	.02	.27	.15	5.2	.47	76.4	2.47	.93
1959	18	.04	.27	.09	7.6	.11	83.1	.53	.09
1960	—	—	—	—	—	.03	19.7	—	—

[1] During the third generation of *M. persicae* 1952 to 1956; during the second generation in the remaining other years.

PRODUCTION OF SPRING MIGRANTS OF THE GREEN PEACH APHID ON CANADA PLUM IN CAGES

PROCEDURE

A study was conducted during the period 1943 to 1950 to ascertain the importance of Canada plum as a breeding host for spring migrants of the green peach aphid. Naturally occurring single specimens or colonies of the aphid were caged in spring each year on new growth of Canada plum in thickets near Presque Isle. Usually, one stem mother nymph about to mature was caged on the branch where she was found. Rarely, the newly-matured adult stem mother alone or with her progeny, or the progeny alone (when maturing stem mothers were scarce) were caged on the same plant or were transferred to similar foliage in more accessible places in the same thicket or in another thicket. The transfers were accomplished by allowing the aphids to crawl from the infested to the uninfested foliage to be caged. Drawstring sleeve cages, 12 to 16 inches long and made of scrim, enclosed all the new growth on the terminal 6 to 10 inches of the infested stem or branch terminal. Each cage or colony contained the progeny and descendants of a single stem mother.

The caged colonies were observed at infrequent intervals until second generation adults began to mature. Thereafter the colonies were examined three times each week, at two or three day intervals, as long as living aphids were present. At each examination all alate forms were removed and preserved for subsequent identification and counts. Notes were taken concerning size and vigor of the aphid colony and the amount and condition of the caged foliage.

RESULTS

Figures 5 and 6 show the seasonal variation in spring migrant production. Table 6 shows the productiveness of these migrants. Results for 1943 and 1944 are not included in figures 5 and 6 or in the averages in table 6, because the procedure varied somewhat from that in subsequent years but they are used in table 9 and elsewhere.

The date of first maturation of stem mother aphids varied from May 27 in 1946 to June 6 in the late spring of 1947. Observations over a period of several years showed that the stem mothers begin to mature about the time that Canada plum comes into full flower. The latter phenomenon is determined more easily and with greater precision from year to year than the beginning of maturation of stem mothers *per se,* since difficulty is experienced in finding them and following their development, especially when scarce. During the 8-year period the first date

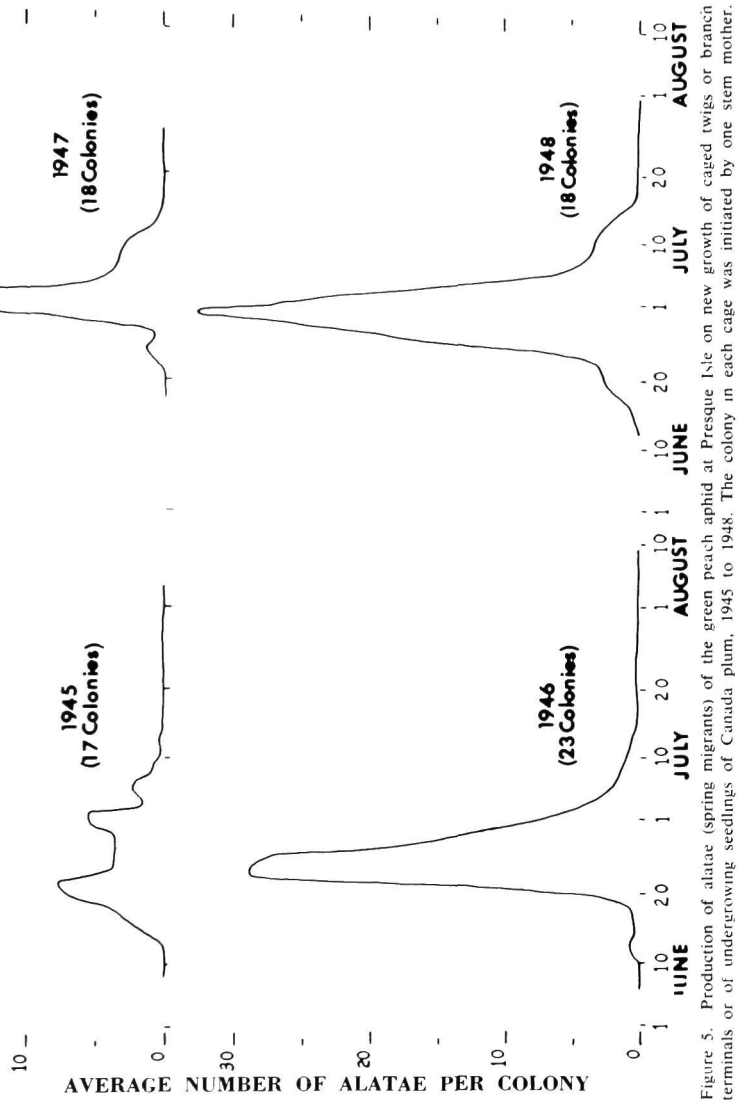


Figure 5. Production of alatae (spring migrants) of the green peach aphid at Presque Isle on new growth of caged twigs or branch terminals or of undergrowing seedlings of Canada plum, 1945 to 1948. The colony in each cage was initiated by one stem mother.

of full flower for Canada plum at Presque Isle varied from May 17 in 1945 and 1949 to June 6 in 1947, with the average being about May 24.

The start of maturation of the spring migrants has ranged from before June 1 in 1941 to June 17 to 21 in 1947; the average was June 6 to 10. The peak of maturation ranged from June 15 to 16 in 1950 to

July 1 to 2 in 1947; the average date of peak was June 22 to 23. The date of last maturation of spring migrants ranged from July 3 in 1944 to August 5 in 1946; the average was July 23 to 27. Apterous forms of the aphid continued to live on the caged foliage until as late as August 24, which was within two days of the start of fall migration that year.

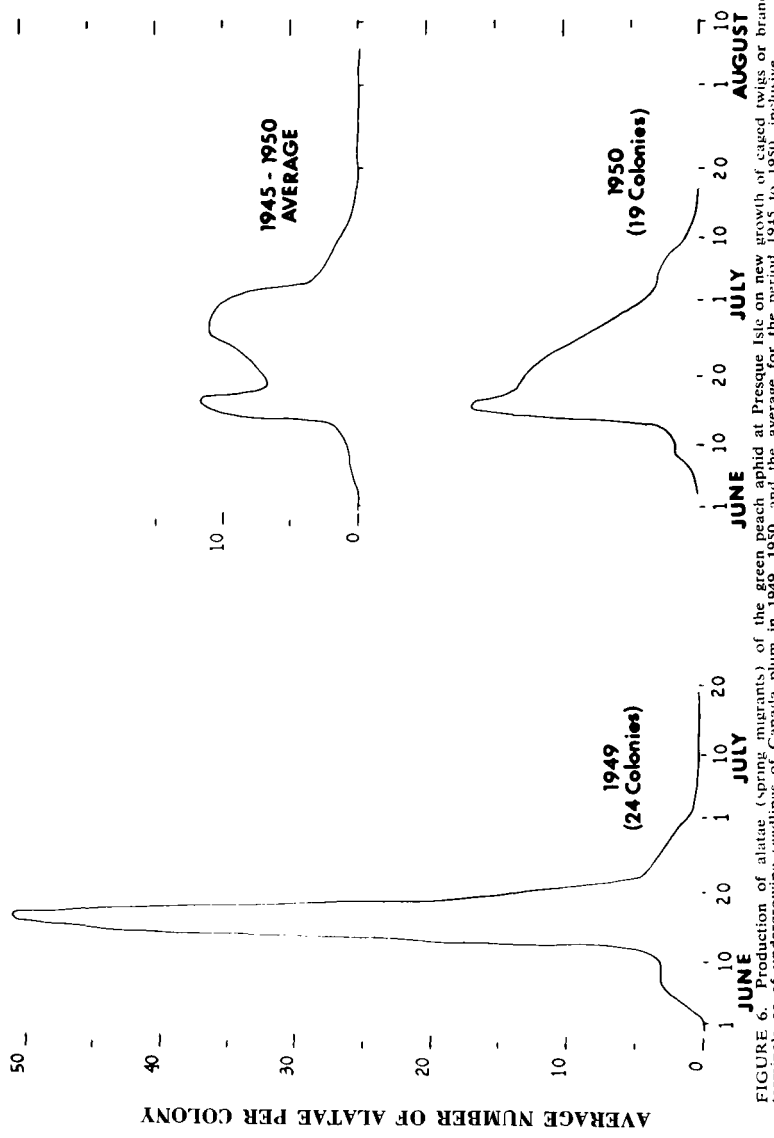


FIGURE 6. Production of alatae (spring migrants) of the green peach aphid at Presque Isle on new growth of caged twigs or branch terminals or of undergrowing seedlings of Canada plum in 1949, 1950, and the average for the period 1945 to 1950, inclusive.

The total period over which alatae matured in the cages ranged from 32 days in 1944 to 57 in 1946 but the 8-year average was 43 days. The duration of the period over which appreciable emergence occurred was considerably shorter than this. It varied from 14 days in 1947 to 26 days in 1948 or in 1950. The average was 24 days.

The minimum number of spring migrants to mature per cage varied from 4 in 1945 or 1947 to 42 in 1949. The maximum number per colony ranged from 383 in 1947 to 857 in 1949. The average number per colony for the 6-year period 1945 to 1950, inclusive, was 203.

DISCUSSION OF RESULTS

Several factors could have influenced the yearly variations in observed colony productiveness. These included the skills and techniques of observers, the amount and condition of foliage developing in the cages, the influence of temperature and precipitation upon the time and length of the period of maturation of spring migrants, and the proportion of second generation adults maturing as alatae.

We were unable in most instances to cage the same length of stem or branch. There were considerable differences among years as well as among cages during any one year in the number of caged buds that grew, the amount of new growth per bud, the total amount of new growth per cage, and the length of time that the foliage remained suitable for aphid feeding. The amount of new growth per bud depended to some extent upon the kind and location of branch or stem terminal caged. Ordinarily the new growth remained suitable for aphid reproduction longer and more growth per bud occurred on undergrowing seedling plants than on branch or stem terminals higher on the plants or in the upper periphery of the plants. Variation between years in amount and distribution of precipitation doubtless also influenced the amount and condition of the new growth from the buds. From our measurements, we estimate the yearly average of total length ranged from 10 to 16 inches of new growth per cage from the two to six buds that grew within.

Temperatures in spring and early summer largely determine the time of maturation of the stem mothers and of the spring migrants in the second and subsequent generations. Observations indicate that because of the relatively short period in spring when Canada plum is most favorable as a host, any substantial delay in maturation date of stem mothers or of second generation adults likely shortens materially the productive period of spring migrants. This is suggested by the shorter period of maturation of spring migrants in the cool, late spring of 1947 (table 6).

Normally about 25 percent of the second generation on Canada

TABLE 6

Productiveness of spring migrants of the green peach aphid on new growth of singly caged terminals of twigs or of undergrowing seedlings of Canada plum near Presque Isle, Maine

Year	Number of caged colonies	Stem mothers[1]	Approximate observed dates of maturation			Duration of appreciable maturation[2]	Number of alatae per colony		
			Spring migrants						
		(First)	(First)	(Peak)	(Last)	(Number of days)	(Maximum)	(Minimum)	(Average)
1943	17	June 8	June 7[3] - 17	June 29-30	July 21-27[4]	14	252	1	60.6
1944	23	June 7	May 29 - June 1	June 15-19	June 30 - July 3	13	384	2	70.0
1945	17	May 29	June 8-12	June 21-22	July 30 - Aug. 1	21	478	4	96.8
1946	23	May 27	June 6-10	June 23-24	July 30 - Aug. 5	16	806	6	254.1
1947	18	June 6	June 17-21	July 1- 2	July 20-24	14	383	4	99.8
1948	18	May 31	June 12-16	June 29-30	July 24-29	26	674	17	290.3
1949	24	May 10	May 31 - June 3	June 16-17	July 26-27	23	857	42	313.9
1950	19	May 25	June 3-5	June 15-16	July 11-14	26	513	14	220.3
Average — (1945-1950)		May 26	June 6-10	June 22-23	July 23-27	24	618.5	14.5	203.2

[1] Based on dates of flowering of Canada plum, the dates should have been about May 26 in 1943, May 22 in 1944, and May 17 in 1945.

[2] The period during which an average of 2 alatae per day per colony matured in the cages.

[3,4] Last observation before or after alatae were found, respectively.

plum matured as alatae whereas about 70 percent of the third generation and 35 to 40 percent of the fourth generation became spring migrants. With the normal increase in number of progeny in the third generation, it is apparent that a bulk of the spring migrants each year in northeastern Maine are adults of the third generation. In this study, colonies showing least productiveness of the spring migrants usually were those in which most or all of the second generation matured as spring migrants. Few if any nymphs were deposited on the plum foliage by alatae maturing in the cages. (The procedure was to remove all alatae three times weekly).

The numbers of aphids developing in the caged colonies were not limited by the action of parasites or predators. However, colony size was limited in many instances by an inadequate amount of foliage in the cage. Under natural conditions the actions of predators and parasites in some years severely limit the number of spring migrants per stem mother, but there always is an adequate amount of suitable foliage for her progeny. Therefore, the average number of spring migrants from a stem mother under natural conditions, probably is not less than the average of 203 found in our cage studies.

EVIDENCE AS TO THE SOURCE OF GREEN PEACH APHID INFESTATIONS ON POTATOES IN NORTHEASTERN MAINE

A substantial amount of evidence has been obtained over a period of years which indicates the principal source of spring migrants of the green peach aphid initially infesting potatoes each year in northeastern Maine. This evidence came from (1) examinations in spring of many species of annual, biennial, and perennial plants that could have served as overwintering hosts of the aphid, either as eggs or as viviparae, (2) operation of windvane aphid traps within and west of the agricultural districts during the spring migration of the aphid, (3) consideration of yearly variations in the time of first appearance of the green peach aphid on potatoes in relation to several phenomena in the seasonal history and movement of the aphid, and (4) comparisons between abundance of the green peach aphid in potatoes on Aroostook Farm and of aphid eggs or of aphid colonies on Canada plum near Presque Isle.

EXAMINATION OF PLANTS IN SPRING

Intensive examinations of many species of plants were made throughout spring for several years to determine whether the green peach aphid had overwintered on them. Some of the more common of these plants are listed in table 7. Of the three species of *Prunus* examined, the green peach aphid was found breeding in spring on Canada plum only; it was not found on any of the herbaceous species of plants before the time of the spring migration from locally occurring Canada plum.

TABLE 7

Some of the naturally occurring plants in northeastern Maine examined for green peach aphids in spring

Arctium minus (Hill) Bernh. (Burdock)
Barbarea vulgaris R. Br. (Yellow rocket)
Brassica arvensis (Linnaeus) Ktze. (Wild mustard) = *B. kaber* var. *pinnatifida* (Stokes) L. C. Wheeler
B. campestris L. (Wild rutabaga)
B. nigra (L.) Koch (Black mustard)
Capsella bursa-pastoris (L.) Medic. (Shepherd's purse)
Cerastium vulgatum L. (Mouse-eared chickweed)
Chenopodium album L. (Lambs-quarters)
Chrysanthemum leucanthemum L. var. *pinnatifidum* Lecoq. & Lamotte (Ox-eye daisy)
Digitalis purpurea L. (Foxglove)
Galeopsis Tetrahit L. var. *bifida* (Boenn.) Lej. & Court. (Hempnettle)
Hieracium spp. (Hawkweed)
Lactuca sp. (Wild lettuce)
Matricaria matricarioides (Less.) Porter (Pineapple weed)
Plantago major L. (Common plantain)
Polygonum lapathifolium L. (Jointweed, Knotweed, Painted lady's finger)
Prunus nigra Ait. (Canada plum)
P. pensylvanica L. f. (Birdcherry)
P. virginiana L. (Choke cherry)
Raphanus Raphanistrum L. (Wild radish)
Rumex acetosella L. (Sheep sorrel)
Stellaria media (L.) Cyrill. (Common chickweed)
Several species of perennial grasses

OPERATION OF WINDVANE TRAPS

In 1942 and 1943, windvane aphid traps (Shands *et al.*, 1942) were operated from early June until late July on fire towers on the tops of low mountains or hills west of agricultural districts in central Aroostook County to capture spring migrants. The bases of the fire towers above surrounding forest were 300 ft., 500 ft., or 1800 ft. on Oak Hill, Hedgehog Mountain, and Mount Chase, respectively. The traps were operated at approximately 25 feet above the bases of the fire towers, in each instance well above the surrounding forest canopy.

From seven to nine of the windvane traps also were operated each year for 15 years during the same period in the agricultural district at Presque Isle. The trap openings were centered 12½ feet above the soil surface.

No green peach aphids were caught in any of the traps situated on fire towers (table 8), but some were caught in June during most of

the 14 years in the traps operated within the agricultural area (table 9). Since the prevailing winds are from northwest-southwest and since the width of the forest to the west is 100 miles or more, this strongly suggests that the first trap catch each year represented green peach aphids arising within rather than outside the agricultural area in the central part of northeastern Maine.

TABLE 8

Results of operating windvane aphid traps on fire towers west of agricultural districts in central Aroostook County.

Year	Location	Period of operation	Number aphids caught		
			Green peach aphid	Other potato infesting species	Miscellaneous species
1942	Hedgehog Mtn.	June 2 - July 23	0	0	119
	Oak Hill	June 1 - July 30	0	2[1]	88
	Mt. Chase	June 1 - July 30	0	0	24
1943	Hedgehog Mtn.	June 13 - July 23	0	0	120
	Oak Hill	June 21 - July 29	0	0	14
	Mt. Chase	June 10 - July 27	0	0	20

[1] *Macrosiphum euphorbiae.*

VARIATION IN FIRST APPEARANCE ON POTATOES IN RELATION TO OCCURRENCE TIMES OF THREE PHENOMENA

Table 9 shows that only in 1943 were winged green peach aphids caught in windvane traps before the start of maturation of spring migrants on Canada plum growing locally. Scarcity of the aphid may have prevented accurate detection of the beginning time of maturation of the spring migrants on the primary host in 1943. With few exceptions, green peach aphids were caught in windvane traps before they were first found on potatoes or on weed hosts. In 3 of 9 years green peach aphids were found on weeds 3, 4, and 7 days respectively before they were found on potatoes. Lack of earlier detection on potatoes may have resulted from having too few samples to detect the presence of such small aphid populations. Furthermore, in only 2 of the 9 years were they found on weeds before they were caught in windvane traps; in none of the 9 years were they found on weeds before they had been observed to have matured on locally occurring Canada plum. The evidence indicates that initial colonization of green peach aphids on potatoes in northeastern Maine is by spring migrant forms developing on locally occurring Canada plum.

TABLE 9

Variations in appearance of the green peach aphid on potatoes in relation to three phenomena in central Aroostook County

Year	Start of maturation of spring migrants on *P. nigra*[1]	First record of green peach aphids near Presque Isle		
		Caught in windvane traps	Found on potatoes	Found on weeds
1942	June 4	June 6	June 20	June 8
1943	June 7-17	June 5	July 2	July 2
1944	May 29 - June 1	June 8	June 23	June 17
1945	June 4	June 20	June 28	June 21
1946	June 6-10	June 19	June 25	June 28
1947	June 14	June 29	July 4	July 5
1948	June 12-16	July 5	July 1	July 1
1949	May 31 - June 3	June 14	June 18	June 15
1950	June 3-5	June 22	June 23	July 15
1951	June 6-10	June 15	July 11	—
1952	—	—	July 2	—
1953	—	June 18	July 16	—
1954	June 13-14	0[2]	July 1	—
1955	—	July 19	June 29	—
1956	—	0[2]	July 6	—
1957	—	0[2]	June 18	—
1958	—	June 29	June 28	—
1959	—	July 1	June 26	—
1960	June 5	—	July 11	—
1961	June 17-18	—	July 26	—
1962	—	—	July 16	—
1963	Before June 23	—	June 27	—
1964	June 8	—	June 23	—
1965	June 11	—	June 30	—
1966	June 7-9	—	June 27	—

[1] From observations on Canada plum: in caged colonies or in thickets at Presque Isle, 1942 to 1952 and in 1954; from country-wide searching in many thickets, 1960 to 1966.

[2] Operation of traps discontinued in late July.

THE RELATIONSHIP OF OVERWINTERING EGGS AND SPRING COLONIES OF APHIDS ON CANADA PLUM TO ABUNDANCE OF GREEN PEACH APHIDS ON POTATOES IN SUMMER

A study was made to determine if the size of green peach aphid populations on potatoes not treated with insecticides was correlated with abundance on Canada plum of aphid eggs in fall or spring or with that of aphid colonies in spring on Canada plum in nearby thickets. The untreated potatoes each year were grown in replicated small-plot plantings or small fields in up to 12 or more places on Aroostook Farm, near Presque Isle. The 8 to 5 plum thickets included each year in the study were located within a circular area of about 45 square miles, in the center of which were the plantings of untreated potatoes. The procedures for determining abundance of the green peach aphid on potatoes and of aphid eggs were those described by Shands and Simpson (1953, 1954); that for aphid colonies is described on page 12.

Comparisons for 17 years showed that abundance of the green peach aphid on untreated potatoes July 15 to 25 and at the seasonal peak—three weeks to a month later—was correlated with populations of aphid eggs on Canada plum in spring ($r=0.51^*$ and $r=0.90^{**}$, respectively), but not significantly so with those of eggs in the preceding fall (table 10). The July comparison date was chosen because it represented the aphid population after the spring migration was about complete, but before the population on potatoes was supplemented by winged forms maturing on and moving to potatoes from other secondary host plants.

The percentages of potato plants infested with green peach aphids at the end of the spring migration and at the summer peak were significantly correlated with abundance of green peach aphid colonies on Canada plum in late spring ($r=0.54^*$ and $r=0.48^*$, respectively) (table 10).

Like comparisons were made using index numbers as an expression of green peach aphid abundance on untreated potatoes formed by the product of the percent of plants infested and the average number of green peach aphids per plant (table 10). The index numbers for infestation at the summer peak on potatoes were correlated with populations of the fully distended eggs only or with the total population of eggs on Canada plum in spring ($r=0.75^{**}$ for each), and with only the fully distended eggs in the preceding fall ($r=0.57^*$). Lack of significant relationships between populations of green peach aphids on potatoes and of aphid eggs on Canada plum in fall are not surprising. Several factors likely influenced this: egg deposition on Canada plum may not have

TABLE 10

Abundance of green peach aphids July 15-25 on untreated potatoes and at the seasonal peak at Presque Isle in relation to abundance of aphid eggs and aphid colonies on Canada plum in that vicinity

		On Canada plum						On potatoes			
		Average number eggs per 100 buds				Colonies found per minute in spring[1]		Green peach aphids on 3 leaves per plant			
								July 15-25		At seasonal peak	
Year	Number of stations	Late fall Total number	Late fall Percent shriveled	Early spring Total number	Early spring Percent shriveled	All Species	Green peach aphid only	Average number	Percent plants infested	Average number	Percent plants infested
1943	8[2]	3.26	26.5	0	0			0	0	4.3	4.6
1944	7	0	0	2.43	67.7			.03	20.0	493.8	40.1
1945	8[2]	.40	12.5	0	0			.02	22.2	19.2	30.7
1946	8	.29	39.1	.41	51.2			.03	.7	17.6	2.4
1947	8	1.15	72.8	.40	96.9			.02	5.6	15.1	4.5
1948	7	.60	26.2	.71	68.4			.08	6.3	188.6	47.2
1949	7	.26	20.1	.78	54.5	1.89	0.95	9.01	82.2	310.2	73.5
1950	7	.48	54.8	.27	42.1	—	—	.28	10.5	135.8	21.7
1951	7	.30	5.8	.28	43.7	—	—	.01	3.1	10.7	14.8

1954	6	.10	0	.61	26.4	1.44	0	.30	4.6	8.6	14.1
1955	7	.27	54.4	.08	28.3	2.04	0	.12	2.9	7.4	6.4
1956	5	.22	33.6	.12	0	2.06	0	.06	6.2	12.1	12.4
1957	5	.37	33.3	.05	100.0	.82	.02	.15	5.6	23.4	8.6
1958	5	.11	28.3	.19	37.1	1.17	.12	.16	16.5	9.1	32.5
1959	5	.06	0	.10	50.0	.38	.70	2.86	26.2	3.0	20.2
1960	5	—	—	0	0	.09	.02	.10	4.3	1.6	10.5

[1] During the third generation of *M. persicae* 1952 to 1956; second generation in the remaining years.
[2] Only 3 stations in the spring of 1943; 7 in the spring of 1945.

been complete at the time of the fall counts; aphids eggs in the samples from the plums likely included some eggs of other species also using the plant as a primary host; relatively few plum thickets were examined; and, furthermore, the untreated potatoes were located on only one small farm situated approximately in center of the 45-square mile area over which the sample thickets were distributed.

The number of fully distended eggs on Canada plum in spring was correlated with that of those in late fall of the preceding year ($r=0.92^{**}$), also with total egg populations in fall ($r=0.88^{**}$) (table 10).

For comparisons limited to 10 years of observation, abundance of the green peach aphid on potatoes at the summer peak was correlated with that of aphid eggs the preceding fall ($r=0.64^{*}$) (table 10). Abundance of green peach aphids on untreated potatoes was not correlated with that of aphid colonies on Canada plum in the 45-square mile area. On the other hand, abundance of aphid colonies of all species on Canada plum in spring was correlated with that of aphid eggs on the plant in spring ($r=0.60^{*}$), but not in the preceding late fall. There was some tendency for abundance of aphid colonies in spring to be associated with that of aphid eggs in spring but not significantly so.

In contrast for northeastern Maine as a whole we found that abundance of green peach aphid colonies on Canada plum in spring was correlated with aphid egg abundance on the plant in the preceding fall, and to some extent in spring (table 4). In smaller numbers of thickets there was some tendency for abundance of green peach aphid colonies to be correlated with that of fully distended aphid eggs in spring. Thus it would seem that abundance of the green peach aphid colonies on the Canada plum in the 45-square mile area may have been correlated with aphid egg abundance on the primary host in that area. Since the green peach aphid populations on potatoes in the 45-square mile area were not significantly correlated with green peach aphid colony abundance (table 10), the abundance of green peach aphids on potatoes in the center of the area may be influenced by spring migrants from Canada plum growing outside that area, as well as from that within it.

SUMMARY AND CONCLUSIONS

Studies were conducted to determine the role of Canada plum as a host of the green peach aphid in northeastern Maine and to assess its importance as a source of infestation by the aphid on potatoes in that area. The results presented and discussed related chiefly to chronological and phenological aspects of the utilization of Canada plum as a primary host of this aphid; temperature developmental requirements of the aphid

on this plant in spring; productiveness of spring migrants of the aphid in thickets and in cages; interrelationships between fall aphid populations on foliage, and egg deposition and overwintering to naturally occurring aphid colonies in spring and summer populations on potatoes. Results from studies of aphid flight and seasonal abundance of the aphid on plants other than Canada plum also aided in the assessment.

On Canada plum, eggs of the green peach aphid hatch when the buds begin to swell; the stem mothers begin to mature when the plants burst into flower; the spring migrants begin maturing about two weeks later; the peak of the spring migration is reached in about another two weeks; and ordinarily, maturation of spring migrants is virtually complete by early July.

The spring migrants developed in the second to fifth generations on Canada plum, but most occurred in the third generation when about 70 percent were alate. In cages, the numbers of spring migrants resulting from single stem mothers ranged from 4 to 857; the average was 203.

The start of the fall migration of the green peach aphid ranged from August 21 to September 22. Populations of the aphid build up rapidly on Canada plum until the peak in mid-September. Oviparae sometimes begin to mature and oviposit by early October. The size of overwintering populations of aphids eggs on this plant is influenced by the number of oviparae and the time they mature, the amount and condition of Canada plum foliage, and duration of weather suitable for oviposition. The average number of aphid eggs of all species per 100 buds over a 17-year period ranged from 0.08 to 2.70 at the onset of winter and, in spring, from 0.01 to 1.87. The average winter loss was 31.4 percent. Of the remaining 68.4 percent still present in spring, an average of 37 percent of the eggs were fully distended or viable.

In thickets of Canada plum distributed over northeastern Maine, the total aphid egg populations in spring were correlated with those of the fully distended ones at the start of the preceding winter; also, the abundance of fully distended eggs in spring was correlated with that at the onset of winter. Abundance of colonies of the green peach aphid on the plant in spring was correlated with egg populations at the end of winter or at the start of the preceding winter.

Similar comparisons were made for thickets in a more restricted part of northeastern Maine—central and southern Aroostook County. They showed that abundance of spring colonies of the green peach aphid was not correlated with that of populations of the aphid on Canada plum at its fall peak of the preceding year in the same thickets; however, there was some tendency for abundance of green peach aphid colonies to be related to that of the total aphid egg population or of only the fully distended ones in the spring. As for all of northeastern Maine, in this more

restricted area, populations of aphid eggs in spring were correlated with those of the preceding fall.

Locally growing Canada plum was considered to be the most likely local source each year for initial infestations of the green peach aphid on potatoes at Presque Isle since (1) the aphid was not found to overwinter on any of a large number of herbaceous plants or on two species of wild cherries, (2) the aphid was not caught during the spring migration in windvane traps operated on fire towers in the forested area west of the agricultural districts, (3) with minor, understandable exceptions, it was not until soon after spring migrants began to mature on locally growing Canada plum that the first green peach aphids were caught each year in windvane traps in agricultural districts or were found on secondary hosts, including potatoes, and (4) abundance of the green peach aphid on potatoes was or tended to be correlated with spring abundance of aphid eggs in fall or spring but not with that of green peach aphid colonies in spring on locally growing Canada plum. Some of the spring migrants initially infesting potatoes in the center of a 45-square mile circular area may have come from Canada plum outside as well as within that area.

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