THE SEASONAL HISTORY AND GEOGRAPHIC DISTRIBUTION OF APHIDS INFESTING RASPBERRY, BLUEBERRY AND STRAWBERRY IN THE LOWER PENINSULA OF MICHIGAN

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ABSTRACT

THE SEASONAL HISTORY AND GEOGRAPHIC DISTRIBUTION OF APHIDS INFESTING RASPBERRY, BLUEBERRY AND STRAWBERRY IN THE LOWER PENINSULA OF MICHIGAN

by Francis Edward Giles

The seasonal histories of aphids infesting raspberry, blueberry and strawberry are described. With the exception of two species, all of the aphids were found to be abundant and not restricted in distribution. Only two strawberry aphids were found to be migratory.

Amphorophora rubi (Kalt.) was commonly found on raspberry but not on strawberry. The preferred feeding location was found to be the terminal portions of the canes and the leaves. Specimens were collected more frequently from red raspberry than from black raspberry except in qualitative samples from commercial fields where the species was found to be about equally abundant on both hosts. This species appeared to prefer cultivated black raspberry to wild black raspberry. Large populations of this aphid were not found until the first or second weeks of August.

Amphorophora sensoriata Mason was commonly found on the canes of raspberry. A definite preference for both wild and cultivated black raspberry over red raspberry was shown. Large populations were not found until the last week of July or the first week of August. The sexual forms of this species are described for the first time.

Aphis rubifolii (Thomas) was found to be one of the most common aphids infesting raspberry and blackberry. Greater preference was shown for red raspberry than for black raspberry. There was some indication that wild plants of all types are preferred to cultivated stock. This species was found to be almost exclusively a leaf-feeder. The fundatrices appeared early in the spring and were present on the plants for over a month. Sexuales appeared late in the fall and remained on the plants for long periods. Egg production was usually high. Large populations of this species were encountered in late May and June and were present for long unbroken periods.

Masonaphis rubicola (Oest.) appears to be in the southerly limit of its range in Michigan. It was not found in quantitative samples from commercial fields and only rarely in other collections. The preferred feeding location appears to be the terminal leaves of raspberry plants. Because apterae were found throughout the season, and alate females were not particularly abundant in late fall, this species is not thought to be migratory.

The most common blueberry aphid collected was Masonaphis pepperi MacGill. This species was found in only the western counties of the Lower Peninsula. The preferred feeding location appears to be the leaves at the base of the plant.

Myzus scammelli Mason was a relatively rare blueberry aphid that was found in both the eastern and western counties. The preferred feeding location appears to be the leaves at the base of the plant.

No blueberry aphids were found on wild blueberry. The possibility of direct or indirect competition between these two species is discussed.

Colonies of Aphis spiraecola Patch were found on blueberry plants on two occasions. Rearing tests showed that it will maintain itself on blueberry plants for up to 20 days. Two of its natural hosts, Indian hemp and spirea plants, commonly grow in blueberry plantations. Since this aphid readily moves from these two plants to blueberry, further studies of A. spiraecola as a possible virus vector are indicated.

Acyrthosiphon pisum (Harris), a migratory species, was found infrequently on strawberry. Sexual forms were rarely collected. Infestations on strawberry plants appear to be a result of chance alightings during migrations between preferred host plants.

Acyrthosiphon porosum (Sand.) was found to be the most common aphid infesting strawberry. Preference was shown for cultivated plants over wild plants. This species also colonizes rose plants in Michigan.

Aphis forbesi Weed was the only small fruit aphid found on the roots of the host plant. It was not collected in abundance in the Lower Peninsula and showed a preference for wild strawberry and home grown plants to commercially grown stock.

Aphis gossypii Glov. is frequently mistaken for A. forbesi when found on strawberry. This species was collected on cultivated strawberry grown in greenhouses as well as in the field. It was never found on wild plants. Its scarcity on strawberry, and the fact that most collections consisted of nymphs, indicate that most colonies are the result of chance visits by alate females. A record of an oviparous female on strawberry, thought to be previously unrecorded, is given.

Macrosiphon fragaefolii (Cock.) was found to be one of the

rarest of the strawberry aphids. It was collected only in home gardens, nurseries and imported experimental hybrid plants. It is possible that this species is present in the Lower Peninsula only when it is introduced on imported plants.

Chaetosiphon minor (Forbes), the most important vector of strawberry viruses in the Lower Peninsula, preferred wild strawberry and home grown plants over commercial stock. Sexual forms have a long time span on the plants and egg production was noted to be moderately high on some occasions.

Macrosiphum euphorbiae (Thomas) is a migratory species that uses strawberry as at least one of its secondary hosts in the Lower Peninsula. Large infestations were found in the spring and fall but never in midsummer. Preference was shown for strawberries grown in home gardens and commercial fields.

Macrosiphum rosae (L.) was rarely found on strawberry; the primary host in the Lower Peninsula is probably rose.

The first appearances of the fundatrices of various aphid species are correlated with growing degree days. Evidence is presented to show that there is little difference in the time of the species' appearance in the western counties and in the midland, or at most, this difference amounts to only four days.

The distribution of the aphid species and the parasites, predators and ants associated with them are listed. The possibilities of aphid populations being influenced by changes in host plant physiology are discussed.

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INTRODUCTION

Aphids are small, delicate insects that are found on most plants throughout the world. Their ability to reproduce parthenogenetically and viviparously, and the short period required for maturation, enables them to reach epidemic numbers very rapidly. Most species can produce winged forms under certain conditions. These can fly into aphid-free fields and start heavy infestations.

Aphids are one of the most serious agricultural pests. Their common name, "plant lice" connotes the distaste with which they are regarded by commercial food growers, agricultural workers and consumers.

Aphids live entirely on plant sap. Continued feeding by large colonies can cause plants to become unthrifty and can lower the sugar content of a crop. Toxic substances injected by a feeding aphid may result in stunting, deformation of leaves or fruit, or the formation of galls on leaves, stems or roots. The excess sugars present in the sap are excreted by these insects as honeydew which may disfigure personal property and plants.

Frequently large deposits of honeydew support the growth of mold on the plants. These molds may lower the market value of a crop and interfere with photosynthesis and normal pollination.

The ability of some aphid species to transmit viruses results in diseases which reduce crop yields and may bring about the death of the host plant. The presence of only a few virus vectors, feeding for

only a short time, is all that is needed to inoculate a stand of healthy plants.

Since very little work has been done on aphids in Michigan, it is difficult to estimate how many species are present in the State. Leonard (1963) estimated that between 303 and 450 species occur in New York, and it is possible that as many can be found in Michigan.

It is unfortunate that so little is known about the aphid fauna of Michigan as it is one of the leading agricultural states in the union. It ranks first in the production of black raspberry, fourth in red raspberry, second in blueberry and, third in strawberry.

When this research was started, only four aphid species were definitely known to infest small fruits in Michigan. Nothing was known of their distribution, relative abundance and biology. Since small fruit farming is so important to the Michigan economy, and promises to become even more important in the near future, an investigation of these pests appeared to be a worthwhile project.

A brief outline of the generalized aphid life cycle follows. This will serve to acquaint the reader with terminology used by the author.

Nymphs hatch from overwintering eggs in the early spring; these develop into stem mothers or fundatrices. The fundatrices reproduce parthenogenetically and viviparously to give progeny which mature into the next morphs, or forms.

The summer viviparae consist of apterous and alate females which also reproduce parthenogenetically and viviparously. The wingless summer viviparae are commonly spoken of as apterous females or viviparous

females. The term apterae includes both the nymphs and sexually mature individuals, or imagines, of the apterous viviparous female. The winged summer viviparae are called alates, or alate females. Since the nymphs that will develop into winged forms have external wing pads, they are called alatoid nymphs. The summer viviparae are the most abundant forms and are present during the greatest portion of the season. Occasionally, anomalous specimens are produced which have abortive wing pads and show characteristics of both the alate and apterous females; these are known as intermediate forms.

In the fall of the year, the summer viviparae produce nymphs which mature into sexuales, or true male and female forms. After these morphs mate, the females produce eggs which overwinter and complete the life cycle. The oviparous females are usually apterous and are termed oviparae; males are usually winged.

Since the summer viviparae are most often encountered in the field, all taxonomic keys are based on these morphs, and especially upon the alate females. The identification of the other forms can be very difficult, if not impossible.

REVIEW OF LITERATURE

Amphorophora rubi (Kaltenbach)

Mason (1925) and Winter (1929) stated that this is a cosmopolitan species found mainly on the plants of the genus Rubus. Winter reported it to be the most active aphid on raspberry. He stated that it was a leaf-feeder and that it was most abundant on red raspberry. Populations fluctuated greatly and specimens were hard to find after hot, dry weather. Alates were uncommon in Minnesota. Eggs were laid on the leaves but were hard to find.

In testing seven varieties of red raspberry for resistance to this species, Winter found that the variety Latham ranked second in resistance. In Canada, Stace-Smith (1960) reported that Latham was susceptible to this species, and Daubeny and Stace-Smith (1963) reported large colonies of this aphid on Latham.

A. rubi is the principle vector of raspberry mosaic (Cooley 1936, Daubeny and Stace-Smith 1963) and has been shown to transmit black raspberry necrosis virus (Stace-Smith 1960). It is also a vector of Rubus yellow net (Kennedy, Day and Eastop, 1962). Cooley (1936) found that practically all wild red raspberry and some wild black raspberry were infected with mosaic in New York.

There are races of A. rubi that differ in ability to colonize different hosts and to transmit diseases (Russell 1962, Daubeny and

Stace-Smith 1963). In western United States, Canada and, to some extent, Nova Scotia, it is a pest of strawberry (Craig and Stultz 1964, Frazier 1951). Plakidas (1955) reported that it transmits some or all of the components of the strawberry yellows and crinkle virus complex. Mellor and Forbes (1960) cited Frazier as being successful in transmitting strawberry mottle virus with this species. Kennedy et al. (1962) listed this aphid as a vector of strawberry leaf banding.

Amphorophora sensoriata Mason

Mason (1923, 1925) erected this species but did not describe the sexual forms. He found it to be exclusively a cane-feeder and thought that it might be migratory as few specimens were found in the summer. Winter (1929) did not consider it migratory and reported that black raspberry was the preferred host. Both authors reported it widely distributed in North America with a range as far south as Virginia. Patch (1938) did not list it from any hosts except Rubus spp. Cooley (1936) stated that it is a minor vector of raspberry mosaic. Kennedy et al. (1962) listed it as a vector of black raspberry necrosis.

Aphis rubifolii (Thomas)

This species was reported only from the leaves of raspberry and blackberry plants (Patch 1938, Palmer 1952, Leonard 1963). Winter (1929) reported it common throughout North America and stated that it preferred the undersurfaces of wild red raspberry leaves. In early September he found an average of 54.7 specimens on a leaf but reported counts as high as 219 per leaf. He also observed that the eggs hatched

when the buds first turned green.

Cooley (1936) reported this species an inefficient carrier of raspberry mosaic and the sole vector of leaf curl in raspberry and blackberry. Kennedy et al. (1962) listed it as a possible vector of black raspberry necrosis.

Masonaphis rubicola (Oestlund)

This aphid was reported only from the plants of the genus Rubus (Patch 1938, Palmer 1952, Leonard 1963). MacGillivray (1958) recorded it from New Brunswick, Nova Scotia, Quebec, Ontario and British Columbia. Winter (1929) reported it from California, Minnesota and Maine. Cooley (1936) and Palmer (1952) found it rare in Colorado and New York. In Michigan, Bennett (1932) had to import colonies for experimental work.

MacGillivray (1958) stated that the life cycle was not clear; although specimens were found on raspberry all summer, it could have an alternate host. She recorded apterous and alate females from June 16 to October 22 and sexuales on October 4. In Colorado and Utah, Palmer (1952) recorded apterous and alate females from August 28 to October 23 and alate males on September 25.

Cooley (1936) did not consider it an important vector of raspberry mosaic. Kennedy et al. (1962) listed it capable of transmitting black raspberry necrosis.

Masonaphis pepperi MacGillivray

MacGillivray (1958) reported this aphid from Maine and Pennsylvania on Vaccinium augustifolium Ait., V. corymbosum L.,

V. stamineum L. and Vaccinium sp. Leonard (1963) reported it from New York on Vaccinium sp.

In Pennsylvania, MacGillivray (1958) recorded fundatrices on May 25 and June 1, apterous and alate females from May 25 to September 1 and oviparous females on October 16. In Michigan, Tuttle (1947) found only a few aphids. He reported that they appeared to be of one species and were causing no noticeable damage.

Myzus scammelli Mason

Mason (1940) recorded this aphid on cranberry in New Jersey. MacGillivray (1965) stated that it occurred on the low sweet blueberry (V. augustifolium) in Nova Scotia. Marucci (1964) found that it preferred the soft, succulent growth at the base of the cranberry plant. He considered it a rare aphid but stated that in recent years it has become more abundant. The greatest numbers were found in May and after June it became scarce. His attempts to transfer this species from cranberry to blueberry were not successful. He stated that the toughness of the leaves may have been responsible for the failure of this aphid to colonize blueberry.

No literature was found to indicate that M. pepperi or M. scammelli are known to transmit virus diseases. As shoestring disease is becoming more common in Michigan plantations it is interesting to note that Lockhart and Hall (1962) have found this disease to be present in all lowbush plants (V. augustifolium) tested in Nova Scotia. This blueberry species also occurs in Michigan.

Acyrthosiphon pisum (Waltenbach)

This is a cosmopolitan species that is found mainly on plants of the Leguminosae (Hille Ris Lambers 1947). Evans and Gyrisco (1956) stated that this aphid is generally considered to be nonmigratory although it flies from perennial to annual legumes. No records of this species transmitting strawberry viruses were found.

Acyrthosiphon porosum (Sanderson)

This species is found throughout North America on Rosa spp. and strawberries (Mason 1940). Palmer (1952) reported it only from rose in Colorado and Utah; Mason (1940) found that it was more common on rose than strawberry although the eggs were laid on both plants. Craig and Stultz (1964) found it to be the most abundant strawberry aphid in Nova Scotia where it represented 53.1% and 73.3% of the aphids collected in a two year period. Demaree and Marcus (1951) stressed the importance of knowing the exact status of this species as a strawberry pest in view of its potential as a virus disease vector. It has been shown to be capable of transmitting strawberry mottle and some, or all, of the components of the yellows and crinkle virus complex (Plakidas 1955, Kennedy et al. 1962, Craig and Stultz 1964).

Aphis forbesi Weed

This species is apparently restricted to strawberry (Patch 1938, Palmer 1952). It is distributed throughout North America but appears to be more abundant in the eastern section of the United States (Palmer 1952, Allen 1959). In Nova Scotia it comprised only 17.1% and 2.3% of

the collections made in a two year period (Craig and Stultz 1964). Many authors, including Hottes and Frison (1931) and Cutright (1925), reported that this aphid is carried to the plant's roots by ants. Marcovitch (1925) stated that Lasius alienus (Foerster) is an important ant in this respect but that Pheidola vinelandica is the most common ant doing this in Tennessee. Wheeler (1910) listed ants of the genera Myrmica and Crematogaster among those that commonly attend aphids but stated that the genera Lasius and Prenolepis are among those most perfectly developed in this respect. Attempts to transmit strawberry diseases with this aphid have never been successful (Kennedy, Day and Eastop 1962).

Aphis gossypii Glover

This is a cosmopolitan species (Patch 1925b) consisting of many races with different life cycles (Bodenheimer and Swirski 1957). Leonard (1963) listed 60 food plants for this aphis in New York. Patch (1925b) reared it on strawberry experimentally but reported that its primary host in Maine was orpine (Sedum purpureum Tausch). Kring (1959) found the primary host in Connecticut to be Catalpa bignonioides Walt. and showed that this species is a faculative migrant. Batchelder (1927), Walle (1933) and Kring (1955), described the many color and morphological variations of this aphid. Kennedy et al. (1962) listed this species as capable of transmitting strawberry mottle.

Chaetosiphon fragaefolii (Cockerell)

This is a cosmopolitan aphid (Schaefers 1960) that occurs on

rose, strawberry and Potentilla spp. (Hottes and Frison 1931, Palmer 1952); Schaefers (1960) stated that Potentilla spp. is not a preferred host. Patch (1938) and Plakidas (1955) reported it from rose and strawberry, and Leonard (1963) reported it only from strawberry in New York. Although Palmer (1952) observed migration of alates from rose to strawberry, this species has no alternate host and only makes dispersal flights (Dicker 1952, Schaefers and Allen 1962). This species is a serious pest in California but is relatively scarce east of the Mississippi (Demaree and Marcus 1951, Plakidas 1955, Schaefers and Allen 1962). Craig and Stultz (1964) did not collect it in Nova Scotia during a two year study, and Fulton (1954) did not find any aphids of this genus in Michigan during a four year study.

C. fragaefolii is the most important vector of strawberry viruses. Plakidas (1955) stated that it is the principle vector of xanthosis and crinkle, and that it also transmits stunt and witches broom. Craig and Stultz (1964) reported that it transmits mottle and vein banding and Kennedy et al. (1962) listed it as transmitting strawberry lesion, mild yellow edge and vein chlorosis. Plakidas (1955) stated that yellow edge is now present in wild strawberries east of the Rocky Mountains, but that wild roses in Washington and Oregon which harbor this aphid did not appear to be hosts of any strawberry viruses.

Chaetosiphon minor (Forbes)

This aphid is found throughout the United States but is more abundant east of the Mississippi (Demaree and Marcus 1951, Palmer 1952, Plakidas 1955). It appears to be restricted to strawberry (Hottes and

Frison 1931, Patch 1938, Palmer 1952, Leonard 1963), but Knowlton (1954) reported it from Potentilla sp. in Washington. Craig and Stultz (1964) cited Rorie as saying it was the dominant vector in Arkansas. However, in Nova Scotia these two authors did not find it in 1961, and in 1962 it accounted for only 0.5% of the collections. Fulton (1954) did not collect any aphids of this genus during a four year study in Michigan.

C. minor has been shown to transmit virus type 1 and 2 of Demaree and Marcus (Plakidas 1955) and strawberry mottle (Kennedy et al., 1962). Demaree and Marcus (1951) reported that Potentilla simplex Michx. can serve as a symptomless host of type 1 and 2 viruses. In Michigan, Fulton (1954) found that P. anserina L., P. argentea L. and P. recta L. acted as latent hosts of type 2 virus.

Macrosiphum euphorbiae (Thomas)

This is a polyphagous and cosmopolitan species (Eastop 1958). Patch (1925a) and Leonard (1963) stated that its primary host is Rosa sp. Patch observed some oviposition on strawberry in Maine but stated that the fundatrices rarely hatched. She also stated that spring colonies had been reported in New Jersey. Demaree and Marcus (1951), however, reported it was a frequent habitant of strawberry and stressed the importance of knowing this species' exact status in view of its potential as a virus vector. Craig and Stultz (1964) found that it account for 22.7% of their collections in 1961 and 15.5% in 1962 and stated that it is a possible vector of latent C virus.

Macrosiphum rosae L.

This is a cosmopolitan species that is apparently restricted to Rosa spp. (Patch 1914, Hottes and Frison 1931, Palmer 1952, Leonard 1963). Mellor and Forbes (1960) stated that this aphid is capable of transmitting mild yellow edge and vein banding viruses.

Fluctuations of Aphid Populations

Many investigations have been instigated to explain the fluctuations of aphid populations. In recent years, attention has been focused on the reactions of aphid populations to the physiological activities of the host plant. Bodenheimer and Swirski (1957) gave several examples in which aphid species apparently respond to physiological changes of the host plant. They also stated that indirect competition can occur when any sucking insect feeding on a leaf, changes the physiological condition of the leaf, and renders it unsuitable for future aphid feeding. Kennedy, Ibbotson and Booth (1950) showed that Myzus persicae (Sulz.) and Aphis fabae Scop. preferred young, growing leaves and senescing leaves to mature leaves. Ibbotson and Kennedy (1950) showed that this preference was modified by the rate with which the leaf was growing or senescing. The apparent reason for these reactions is the young leaves are areas in which nitrogenous substances are being mobilized for protein synthesis. The senescing leaves are areas where proteins are being hydrolyzed and translocated. Both leaf types by concentrating nutrients, apparently provide a more suitable site for aphid feeding and reproduction than do mature leaves.

Dicker (1952) working with C. fragaefolii on strawberry in

Great Britain, found that in first year plants the population of this aphid increased steadily throughout the season. In older plants, the aphid population peaked in early spring and then declined rapidly. His hypothesis, although admittedly not the complete explanation, was that the first year plants produced leaves steadily all season and the physiological activities of the plant, not being disrupted by fruit formation, yielded a steady supply of nutrients that permitted a steady build up of aphids. Older plants exhibited a spring flush of growth and this increased physiological activity enabled the aphid population to increase around the time of early fruit ripening. After the fruit had ripened, leaf production and development decreased, and the aphid population declined due to lack of suitable feeding sites. Dicker also suggested that at the time of fruit ripening, physiological changes occur in the leaves that are unfavorable to aphid reproduction.

Schaefers and Allen (1962) found evidence that C. fragaefolii populations also tended to follow fluctuations in strawberry physiology; however, under California conditions the population peaks were not as closely tied to fruit production as reported by Dicker.

Schaefers and Allen pointed out that the lower leaves of the strawberry provided a cooler and more humid microclimate that is more favorable to aphid survival and increase. They found, as did Dicker, that high aphid mortality occurred due to splashings of rain and mud, especially after fields had been topped.

STATEMENT OF METHODS

General Collecting

Most of the aphids collected were taken by means of a #1 water color brush, the ends of which were trimmed to a fine point. This instrument allowed the delicate specimens to be removed from the plant without damage and provided the collector with a positive record of aphid-host plant association.

Aphids were collected and stored in 95% ethanol. Storage in 70% alcohol, as recommended by Essig (1948) and Palmer (1952), resulted in poorly preserved specimens.

Nymphs found in the field were frequently caged and allowed to mature and reproduce; the entire colony was then removed for identification. Clip cages used by Mc Clanahan (1961) were found to be too small. New ones were fashioned from microscope cover slip boxes (Fig. 1). These boxes had plastic screen windows and were tied to the plant stem. Loose string or cotton packing was used to make the cages "aphid tight". Although adequate, the cages were awkward to handle and were replaced by cages made of plastic centrifuge tubes as described by Peschke (1959).

To collect alate forms, sticky traps and water traps were placed in test plots. Sticky traps were made from the bottoms of commercial one pint ice cream containers (Fig. 1). These were painted with Canary Yellow Effecto Enamel (Pratt and Lambert Co.) and coated with

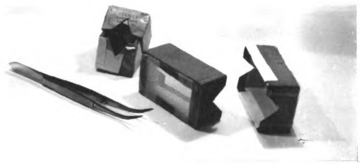

Fig. 1.--Aphid cages and sticky traps used by the author.

Mapco-Stikem (Michel & Pelton Co., Oakland, Calif.). These traps worked well but became covered with earth and debris. Trapped aphids were in such poor condition that identification was impossible and the use of sticky traps was discontinued.

Water traps were made from miscellaneous metal and plastic pans measuring approximately 18" X 12" X 8". Aphids collected in these containers were in fairly good condition except for mold and detritus which adhered to them. In addition to the problems described by McClanahan it was found that the traps had to be cleaned and refilled about every three days. This limited their value and it was decided to use the presence of alatoid nymphs to indicate the appearance of alates (Dicker, 1952).

Mounting

Freshly killed material was heated in the storage alcohol at just below boiling point for five minutes to eliminate internal air bubbles. Specimens preserved for more than 24 hours did not require this treatment.

Initially, aphids were cleared by the techniques recommended by Essig and mounted in Turtox CMC - 10 medium (General Biological Supply House, 8200 So. Hoyne Ave., Chicago). Both the techniques and mounting medium proved unsatisfactory and the clearing and mounting procedures developed by Hille Ris Lambers (1950) were followed.

Identification

Most specimens were identified by means of a compound microscope

equipped with a phase contrast optical system and a measuring eyepiece. Large samples of apterae were frequently determined with a Wild Model V dissecting microscope equipped with both substage and conventional illumination and having a magnification of up to 200 X; when this microscope was used, the aphids were first cleared and then examined while still in the clearing solution. Vibrations and convection currents made focusing difficult and questionable specimens had to be mounted for inspection with a compound microscope. In retrospect, it is doubtful if the use of a dissecting microscope saved any time over conventional methods of identification.

The two "standard" references, "The Plant Lice, or Aphididae, of Illinois" (Hottes and Frison, 1931) and "Aphids of the Rocky Mountain Region" (Palmer, 1952) were found to be inadequate. Publications proving helpful were those of MacGillivray (1958), Mason (1925, 1940), Schaefers (1960), Richards (1963), Bachelder (1927) and Hille Ris Lambers (1953).

Sampson's keys to nymphs (Sampson, 1946) were of limited value and most nymphs were determined through the aid of Miss Louise Russell of the U.S. Department of Agriculture. Through the cooperation of Miss Russell and Dr. M. E. MacGillivray of the Canada Department of Agriculture the author was able to accumulate enough determined material to enable him to make his own identifications.

Parasitized aphids were collected along with the leaf or stem to which they were attached and placed in screw cap vials. To avoid the growth of molds, the vials were left uncapped for 24 hours to allow the moisture from the plant material to evaporate. The parasites that

emerged were sent to the U.S. Department of Agriculture, Insect Identification and Parasite Introduction Research Branch for identification.

Heavy clearing of the parasitized aphid was necessary due to discoloration of the integument and the presence of exuviae and internal frass pellets from the parasite. This was accomplished by placing the plant material and the aphid on a slide in a drop of KOH and adding a cover slip. The slide was heated until the specimen was clear and pliable. The aphid was then washed, separated from the plant material, and mounted. Identification was made with a compound microscope.

Although many specimens could not be identified due to parasite-induced distortions, this method of identification is more positive than the common one of identifying the parasitized specimen by means of a normal specimen collected from the same plant.

Quantitative Collecting

The location and description of each test plot with the dates of collections and the numbers of aphids taken are presented in Appendices VI through IX.

Wild Red Raspberry, 1961 to 1963 (Fig. 2)

This stand was too small for true random sampling. To reduce personal bias, sampling was begun at different ends of the stand every week.

At every five paces a plant was selected. Three compound leaves were picked from each plant. These leaves--one from the tip of the plant, one from the base of the plant and one midway between top and

Fig. 2.--Stand of wild red raspberry on the Michigan State University campus.

bottom--were placed in separate jars of alcohol. Any aphids found on the canes were placed in vials of alcohol with a fine brush. Specimens were removed from the alcohol with the aid of a dissecting microscope and identified.

In 1963 an attempt was made to sample these raspberry plants by treating the leaves with heat and Methyl isobutyl ketone in Berlese funnels. It was found that Aphis rubifolii (Thomas) was too sedentary to pass through the apparatus and died among the leaves. As a result, leaf sample data from September 4, 11 and 18 are not available.

Cultivated Raspberry, 1963

The rows of plants were numbered consecutively. The plants to be sampled were selected by pacing off along the rows. The numbers used in selecting the samples were taken from a table of random numbers (Dixon and Massey, 1957).

Three plants in each plot were sampled at weekly intervals. The collections were made and the samples were treated as described for wild red raspberry. Sampling was without replacement.

Cultivated Blueberry, 1964

Blueberries growing on the Michigan State University Horticulture Farm were sampled without replacement until October 11. On this date all the plants in each varietal row had been sampled. Subsequent samples had to be made from plants which had been sampled earlier in the season.

Each plant was numbered and the plant to be sampled was chosen at random. Two plants of each variety were sampled at approximately

two week intervals.

Collections were made with the D-Vac model 12 Sampler (D-Vac Co., 1462 Callens Rd., Ventura, Calif.). An evaluation of the efficiency of this machine was made by Maki (1965).

In taking the sample, the running D-Vac machine was positioned in the foliage so that a branch was in the net. The machine was then pushed deeply into the plant until the branch stopped its forward motion. This operation was repeated five times around the top and around the bottom of the plant so that the plant was completely encircled. The collections from the crown and the base of the plant were treated separately with Methyl isobutyl ketone in a portable Berlese funnel designed by Niemczyk (1963).

In 1963 it was decided that the author would cooperate with Mr. T. L. Burger who was also doing graduate research on blueberry insects. Aphids collected by Mr. Burger from plantations in 1963 and 1964 were submitted to the author for identification and the results are presented in this thesis. For a description of the collecting and sorting techniques used in this part of the research see Burger (1966).

Cultivated Strawberry, 1964

The rows of plants were consecutively numbered and the areas to be sampled were selected by pacing off along the rows. The numbers used in this operation were drawn from a table of random numbers. Sampling, which was done at approximately two week intervals, was without replacement. Five areas were sampled in each field on each collecting date.

When the area of the strawberry row had been selected, the running D-Vac machine was lowered to the ground over the plants and then raised. This cycle was repeated ten times, allowing about one second for each motion. The contents of the net were then transferred to a portable Berlese funnel. As the amount of debris picked up in taking five samples was too great for the capacity of the Berlese canister, the samples were treated as follows. After placing the first sample in the canister, the second sample was taken. This was added to the canister and the two samples allowed to remain for fifteen minutes. The Berlese funnel was then sharply bounced on the ground five times to dislodge any aphids that were clinging to the vegetation. As the upper chamber was being cleared of debris, a search was made for any remaining aphids. This procedure was repeated for the remaining three samples.

When sampling strawberries on the Michigan State University Horticulture Farm, it was necessary to modify these methods slightly as the plants were planted by varieties in short rows. To select the sample area, a forked stick was constructed having a spread equal to the net diameter of the D-Vac machine. This forked stick was "walked" up the rows, as with a pair of navigational dividers, until the chosen area was reached. Two samples from each varietal row were placed in the Berlese funnel and treated in the manner previously described. Sampling without replacement was practiced until September 13 when the entire length of the varietal rows had been sampled. After this date subsequent samples were made from areas that had been sampled earlier in the season.

RASPBERRY APHIDS

Wild and cultivated raspberry plants were qualitatively examined from July 1, 1961 through 1964. Data summarizing the relative abundance of the aphid species in various collecting situations are presented in Table 1. No aphids were ever found on the roots of the plants or in the leaf litter from the raspberry beds.

TABLE 1.--The relative abundance of raspberry aphids taken in qualitative collections from 1961 through 1964

Number of Collections Made in Various Sites		Amphorophora rubi	Amphorophora sensoriata	Aphis rubifolii	Masonaphis rubicola
Commercial fields					
Red raspberry	12	33.3%	16.7%	33.3%	16.7%
Black raspberry	40	35.0%	42.5%	12.5%	10.0%
Home gardens					
Red raspberry	54	44.4%	18.5%	40.7%	7.4%
Black raspberry	1	0.0%	100.0%	0.0%	0.0%
Nursery stock					
Red raspberry	4	25.0%	0.0%	25.0%	25.0%
Black raspberry	3	0.0%	66.6%	0.0%	0.0%
Wild plants					
Red raspberry	18	38.9%	11.1%	55.0%	5.5%
Black raspberry	18	11.1%	38.9%	38.9%	16.7%
Blackberry					
Wild plants	3	0.0%	0.0%	100.0%	0.0%
Cultivated plants	7	0.0%	0.0%	42.9%	0.0%

Amphorophora rubi (Kaltenbach)

This was a common species that was found on cultivated red raspberry (*Rubus idaeus* L. x *Rubus strigosus* (Michx.)), wild red raspberry

(Rubus strigosus L.) and on cultivated and wild black raspberry (Rubus occidentalis L.) throughout most of the Lower Peninsula. In 1961, large infestations were encountered in Clare Co. on August 27, in Emmet Co. on September 19 and in Monroe Co. on September 30. In 1962 this aphid was not collected too frequently in May and June but appeared to become more abundant during the summer.

A. rubi was the most active aphid studied. When disturbed, this large, rapidly moving species would frequently release its hold on the plant and drop to the ground. Observations indicate that this species occurred most often on the terminal portions of the canes and on the upper leaves. There appeared to be no preference for either the top or bottom surfaces of the leaves. Copulation and oviposition were not observed.

Quantitative Studies (Fig. 3)

Wild Red Raspberry. 1961

The first samples were taken on July 4. This species was not found until August 9, when apterous females and nymphs were taken. The population of this species increased rapidly and reached its peak on August 14. The population maintained itself at this peak until August 21 and then began to decline. No specimens were collected from September 7 until September 27 when a number of nymphs were found. After that date, only a few scattered nymphs were taken.

Wild Red Raspberry. 1962

The first specimen, an apterous female, was collected on June 29. No specimens were found the following week, but on July 13 the numbers

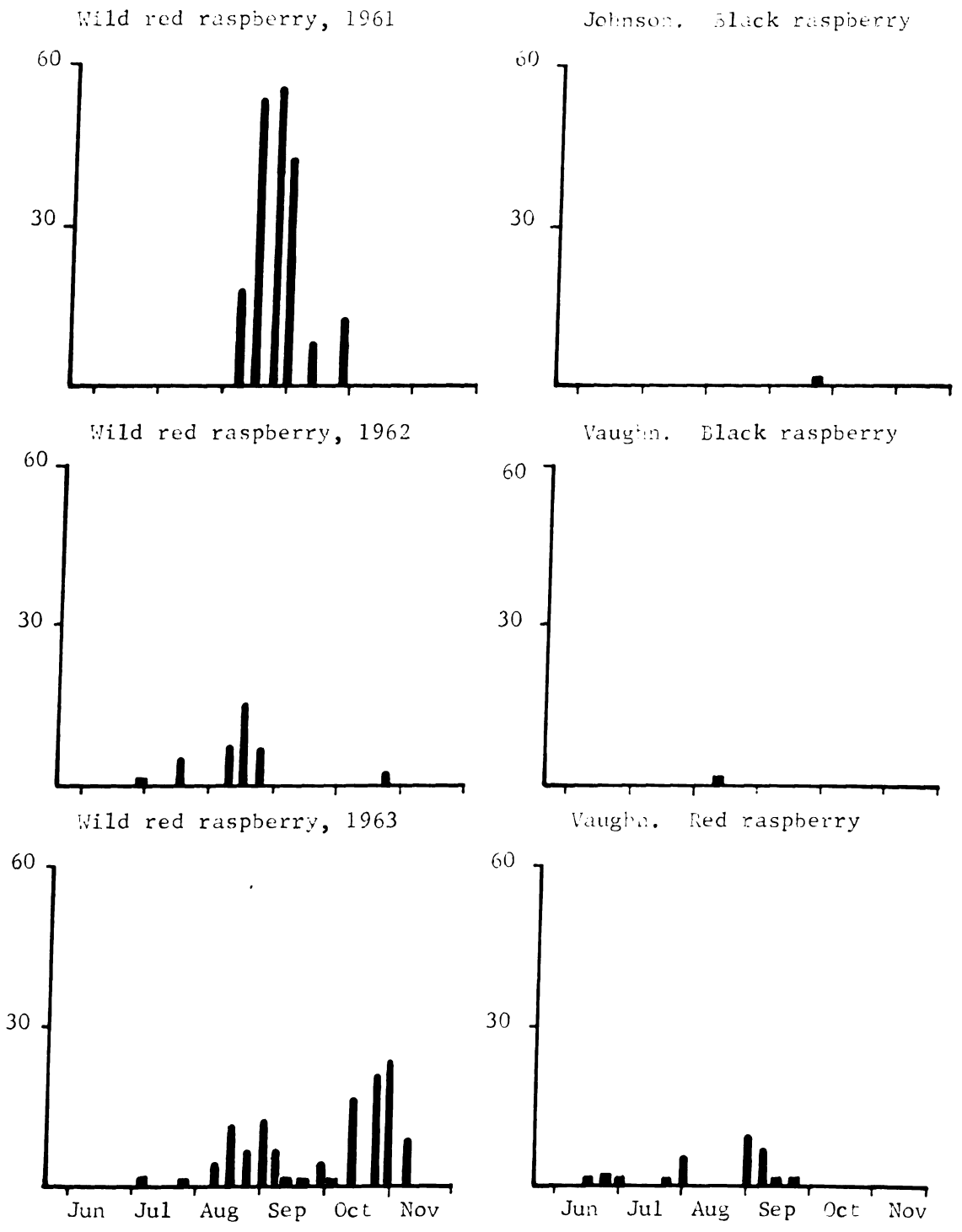

Fig. 3.--Seasonal population trends of Amphorophora rubi (Kalt.) on raspberry.

of apterae increased. This species was not found again until August 10, when its numbers again began to increase. The population reached its peak on August 17, and then began a steady decline. No specimens were taken from August 24 until October 12; on October 19 the numbers increased slightly, but this was the last time this species was found.

Wild Red Raspberry. 1963

This species was taken for the first time on July 3. No specimens were found again until July 24. On this day the population began to build up and reached a minor peak on August 14. After a decline on August 21, the population reached another minor peak on August 28. The numbers declined after this date, and this species maintained itself at a low level during mid-September until it began to recover on September 25. In the first part of October the numbers declined again; on the following week the population began to build up strongly and the peak occurred on October 23. The population fell off rapidly after this, and no specimens were found on the last day of collecting.

Leaf sample data for September 4, 11 and 18 are not available. The information presented for this time interval is for the numbers of this species taken only in the cane samples. It is assumed that the population decreased during these three weeks, for on September 25, very few specimens were collected.

Black Raspberry. Monte Farm. 1963

A. rubi was not found in this field.

Black Raspberry. Johnson Farm. 1963

A single nymph was taken on September 21.

Black Raspberry. Maxwell Farm. 1963

A. rubi was not found in this field.

Black and Red Raspberry. Walle Farm. 1963

A. rubi was not found in these fields.

Black Raspberry. Vaughn Farm. 1963

A single apterous female was collected on August 10.

Red Raspberry. Vaughn Farm. 1963

The first specimens of A. rubi were collected on June 15. The numbers increased on the following week but then began to decline at the end of June. No specimens were taken from July 6 to July 20. On July 27 the numbers of this small population increased but a steady decline then set in. From August 10 to August 29 no specimens were taken. On August 29 the largest number of specimens was taken. The population then began a steady decline that lasted for the rest of the season.

Amphorophora sensoriata Mason

This was a common species that was collected from both wild and cultivated red and black raspberry throughout most of the Lower Peninsula. In 1961, large infestations were encountered in Berrien Co. on July 26, in Kent Co. on July 30, in Hillsdale Co. on August 11 and in Newaygo Co. on September 17. Since Mason did not describe the sexual

forms of this aphid, descriptions of these morphs are presented in Appendix I.

In 1962 this aphid appeared to become more abundant during July and August. On August 18, an intermediate morph was collected in Berrien Co.

A. sensoriata was found most often on the canes of the host plant. It was easily noticed because of its habit of forming linear colonies on the canes. This species was noted to be fairly active; in any colony, there were always a few individuals, usually imagines, moving among the colony. The nymphs were usually fairly inactive. When disturbed, the individual aphids of the colony would move quite rapidly, but were not particularly prone to drop from the plant. Copulation and oviposition were not observed.

Quantitative Studies (Fig. 4)

Wild Red Raspberry. 1961

Nymphs of this species were taken on August 9. The population increased the following week and reached its peak on August 14. The numbers of this species then began to decline, until on August 30, no specimens were found. A single nymph taken on September 7 is the last record of this species in this plot.

Wild Red Raspberry. 1962

Only nymphs of this species were found. These were collected on July 13 and August 17.

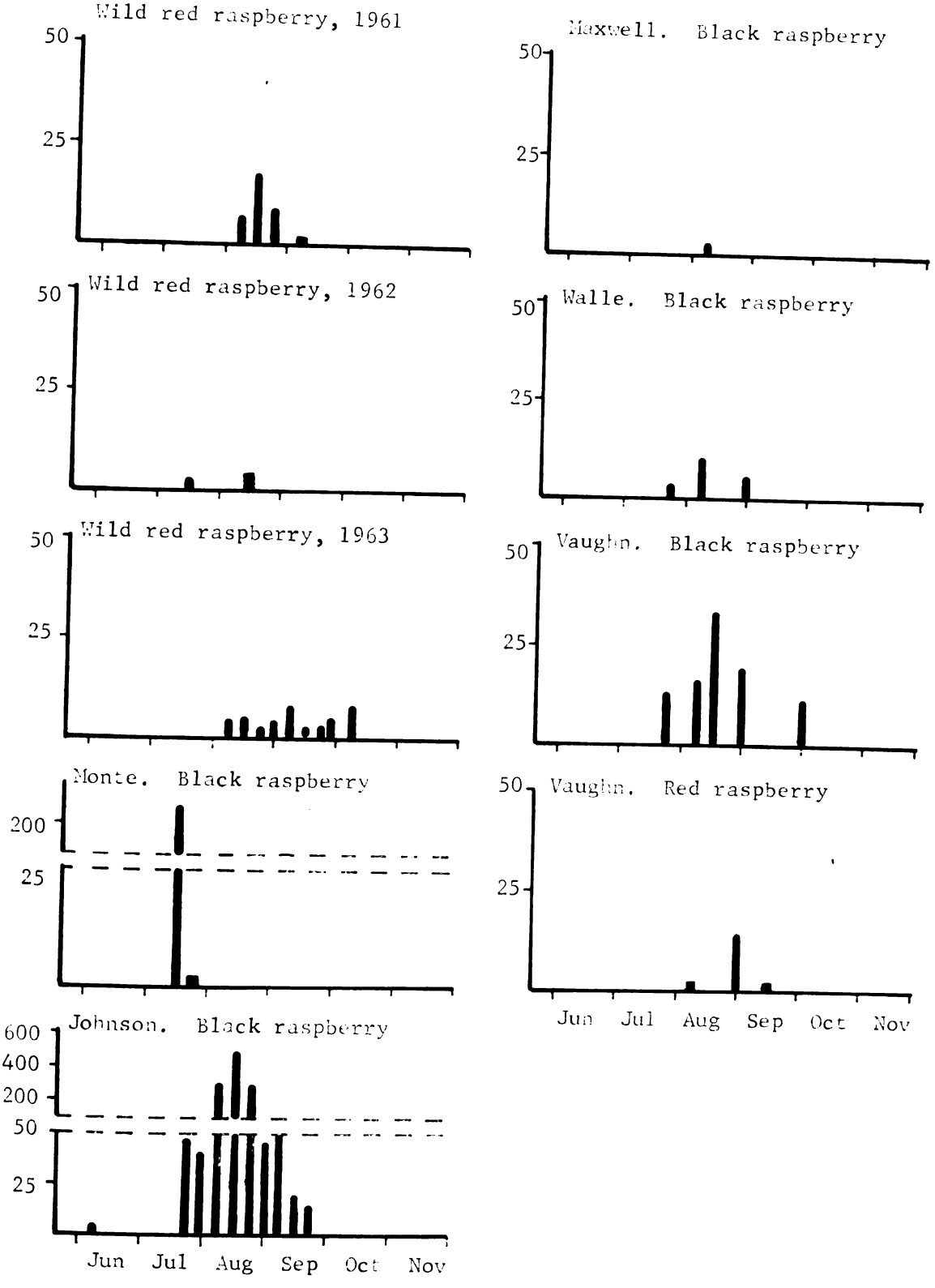

Fig. 4.--Seasonal population trends of Amphorophora sensoriata Mason on raspberry.

Wild Red Raspberry. 1963

A. sensoriata was not collected until August 7. The small population maintained itself at a fairly steady level until August 21 when it diminished. During the next two weeks, it began to recover and the largest number of specimens were taken on September 4. The numbers then diminished but began to build up again during the last of September. On October 2 no specimens were found. On October 9 the numbers again rose, but this was the last time the species was found in this plot.

Leaf sample data for September 4, 11 and 18 are not available. The information presented for this time interval is for the numbers of this species taken only in the cane samples, and it is possible that this species was present in larger numbers during this time.

Black Raspberry. Monte Farm. 1963

This species was not found until July 13 when the population abruptly reached its peak. The numbers declined rapidly in the following week, and after July 20 this aphid was not found again. However, a visual inspection of the plants showed that small numbers of aphids, believed to be A. sensoriata, were present throughout the collecting season.

Black Raspberry. Johnson Farm. 1963

On June 8 a single specimen of A. sensoriata was found. This species was not taken again until July 20 when a rapid build-up began. After a slight decline on July 27 the population began a steady increase that terminated in a population peak on August 17. During the next two weeks the population declined steadily but attained a minor peak on

September 7. From this date until the end of September, the population declined steadily, and none of this species was present in the samples of the last day.

Black Raspberry. Maxwell Farm. 1963

The only time that this species was taken was on August 10, when two apterous females were collected.

Black Raspberry. Walle Farm. 1963

This species was not abundant in this plot. The first specimens of apterae were taken on July 20. The following week no specimens were found. On August 10 the population reached its peak, but declined sharply the following week. No specimens were taken on August 17 and 24. On August 29 the numbers increased slightly, but this was the last time that this species was found in this field.

Red Raspberry. Walle Farm. 1963

A. sensoriata was not found in this field.

Black Raspberry. Vaughn Farm. 1963

This species was not found until July 20. On this date the population rose abruptly but immediately declined, and no specimens were collected on the following week. On August 10 the population had begun a steady increase that terminated in a population peak on August 17. The numbers declined in the following weeks and by September 7 no specimens were collected. On September 28 the population had begun to rise again.

Red Raspberry. Vaughn Farm. 1963

This species was not found until August 10. After this date the species was not present in the samples until August 29. On this date the population reached its peak and then declined abruptly. No specimens were found on September 7. The last specimen collected, a viviparous female, was found on September 14.

Aphis rubifolii (Thomas)

This was a common aphid that was found on both wild and cultivated black and red raspberry throughout most of the Lower Peninsula. It was also collected from wild and cultivated blackberry (Rubus allegheniensis Porter). Ants were frequently found in colonies of this aphid. A list of these ant species is presented in Appendix V.

A. rubifolii was found to be an extremely sedentary species that was not prone to move when disturbed. The preferred feeding location appeared to be close to the veins on the under-surface of the leaf. On a few occasions it was found on the canes or the leaf petioles.

Trouble was frequently experienced in removing this small aphid from the plant because of the tenacity it showed in maintaining its feeding position. Heat and chemicals were not successful in driving this species from the leaves.

Intraspecific copulation was not observed. However, on October 25, 1964, in Ingham Co., an oviparous female was taken en copula with an alate male of the genus Nearctaphis.[1] In 1963 oviposition was

[1]Determination by Dr. M. E. MacGillivray.

observed in Ingham Co. on wild red raspberry. Oviposition was first observed on October 9 and continued until October 25. The eggs were yellow when first laid but turned black with age. Some of these eggs were stored in 95% alcohol and later mounted in glycerine. The average measurement of seventeen newly laid eggs was .54 x .25 mm. The average measurement of twelve black eggs was .52 x .22 mm. The preferred oviposition site seemed to be the axils of the leaf petioles at the tips of the plant. As oviposition activity increased, the eggs were deposited over a greater area of the canes until the entire cane and its branches were black with eggs (Fig. 5). This was an extremely large infestation, and a leaf measuring 1-1/2 inches wide and 3 inches long contained 370 aphids.

Quantitative Studies (Fig. 6)

Wild Red Raspberry. 1961

The numbers of this species varied erratically during July and early August. On August 9 the population began to build up and reached its peak on August 14. The numbers of this species then began a fairly steady decline that lasted until the first week of September. On September 14 the population increased again and maintained itself at this level until the following week. On September 27 the population had begun to decrease. This decrease lasted until October 18 when the population recovered slightly. After October 24 the numbers began to dwindle. No aphids were collected on November 7 and only 2 were taken the following week.

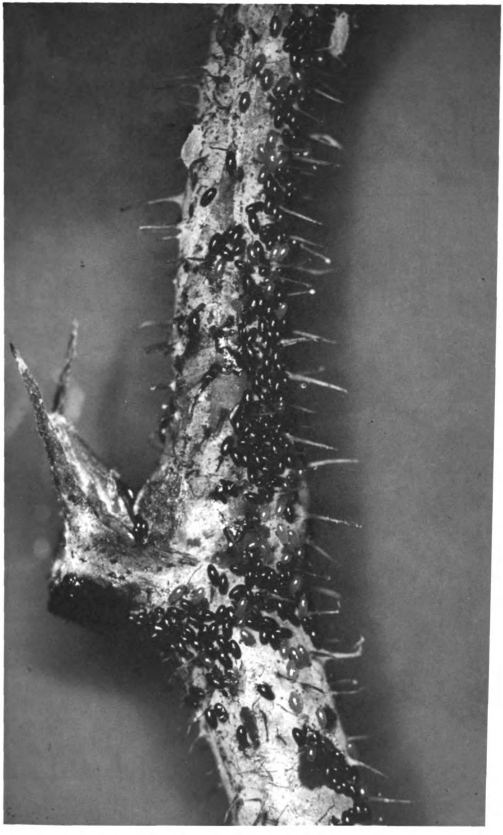

Fig. 5.--Aphis rubifolii (Thomas). Oviparous females and eggs on wild red raspberry.

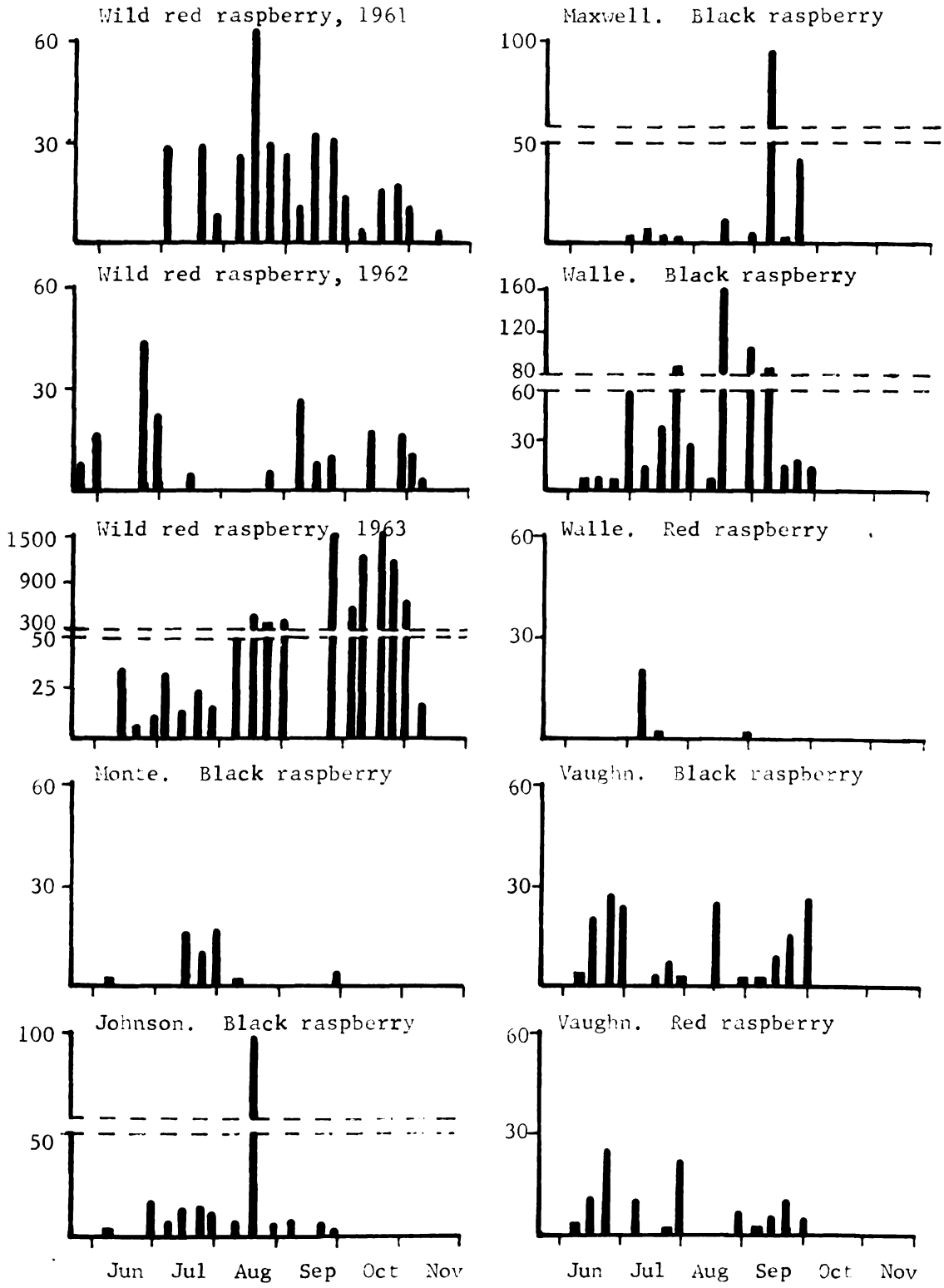

Fig. 6.--Seasonal population trends of Aphis rubifolii (Thomas) on raspberry.

Wild Red Raspberry. 1962

On May 25 a few apterous females and nymphs were taken. The population increased the following week, but no specimens were found on June 12. On June 22 the population abruptly reached its peak and then began to decline. This species maintained itself at low levels for the rest of the summer. No specimens were found in the samples of July 6 and 27 or those of August 3, 10 and 31. The population increased sharply to a minor peak on September 7. During the following week the numbers declined, then began a slow build up that lasted until the end of October. In early November the population began to dwindle. Only two specimens were found on the last day of collecting.

Wild Red Raspberry. 1963

A number of apterous females and nymphs were taken on the first day. The population of this species declined sharply on June 19, but toward the end of the month and early in July the numbers began to build up. On July 10 the numbers decreased again but recovered somewhat the following week. On July 24 the population had again decreased, but in the following week a build up began that resulted in the largest numbers ever observed in this stand or in any of the test plots of cultivated raspberry. The first population peak occurred on August 14; this was followed by a sharp drop in numbers, but on August 28 the population began to increase again.

In an effort to cope with the large number of specimens collected, the author attempted to berlese the leaf samples with heat and chemicals. It was found that most of the specimens were killed rather than driven from the leaves, and accurate counts could not be made. As a result

data from leaf samples collected on September 4, 11 and 18 are not available. On September 11, five viviparous females and two nymphs were taken from cane samples, but these were not included in the weekly counts.

The second peak occurred on September 25. The following week the population fell sharply but began to build up again on October 9. On October 16 the population peaked for the third time. In the following two weeks it began to decline although it continued to maintain itself in large numbers. On November 6, the last day of collecting, the population had dropped sharply.

Black Raspberry. Monte Farm. 1963

A single viviparous female was found on June 8. This species was not taken again until July 13 when the population reached its peak. The following week the numbers declined, but on July 27 the population reached another peak. During August the numbers declined steadily; no specimens were found from August 10 until September 28 when viviparous females were collected.

Black Raspberry. Johnson Farm. 1963

The first specimens were taken on June 8. This species was not found again until June 29 when the population increased sharply. The following week the numbers of this species declined abruptly but began to increase again on July 13. After that date this species began a steady decline that terminated on August 10. On August 17 there was a sharp increase in numbers, and the population reached its peak. The following week there was a sudden decline in numbers, and no specimens

were found. The population began to build up slightly during the last of August and the first week of September; on September 14 no specimens were taken. The following week a few specimens were collected, but on September 28, the last day of collecting, only one nymph was found.

Black Raspberry. Maxwell Farm. 1963

The first specimens of A. rubifolii were not found until June 29. The numbers began to increase but declined after July 6, and this species maintained itself at a low level for the rest of the month. No specimens were found on July 27 or August 10; on August 17 the numbers increased but diminished on August 24. In the last of August, this species began an increase that culminated in a population peak on September 7. On the following week the population declined sharply, but on September 21 the population again climbed to attain the second peak of the season. The numbers dropped to zero on September 28.

Black Raspberry. Walle Farm. 1963

On June 8 only nymphs of this species were taken. The population remained fairly steady until June 29 when it increased abruptly and attained the first peak of the season. The population declined sharply the following week, but on July 13 it again rose sharply. A second peak occurred on July 20 which was followed by a steady decline that continued into the first part of August. On August 17, the population increased sharply to attain the third and highest peak of the season. On August 24 the numbers had declined rapidly, and no specimens were found. Following this decline, the population increased rapidly, and the fourth peak of the season was realized on August 29. This species

maintained itself at this level, diminishing only a little on September 7, then it began a decline. On September 21 the population recovered a little and continued more or less at this level for the remainder of the collecting season.

Red Raspberry. Walle Farm. 1963

A. rubifolii was not found in high numbers in this field. The first specimens were collected on July 6 when the small population reached its peak; the numbers decreased sharply in the following week and on July 20 no specimens were found. The next collection of this aphid was made on August 29, when a single apterous female was taken.

Black Raspberry. Vaughn Farm. 1963

The first specimens of A. rubifolii were taken on June 8. The population built up quickly, reached its peak on June 22, and began a decline that lasted for two weeks. On July 6 no specimens were collected; then the numbers began a slow increase, but after July 20 the numbers again declined. No specimens were collected on August 10, but on August 17 the population increased sharply and attained the second peak of the year. In the following week the numbers decreased sharply and no specimens were taken on August 24. During the last days of August the population began a steady increase that continued until September 28. On this day the population of this species had reached a third peak that was second in magnitude to the peak that occurred in mid-June.

Red Raspberry. Vaughn Farm. 1963

The first specimens were found on June 8; the population rose

rapidly and reached a peak on June 22. In the following week the numbers declined rapidly but recovered slightly on July 6. No specimens were found on July 13, but on the following week the population began to recover. On July 27 the numbers increased and a second population peak occurred; after this date the numbers decreased, and no other specimens were taken from August 10 to August 29. On September 7 the population decreased, then began to build up during the last of September. On September 28, only nymphs were present in the samples.

Masonaphis rubicola (Oestlund)

This species was never found in abundance. It was collected from both wild and cultivated black and red raspberry.

Because M. rubicola was encountered infrequently, it is difficult to make any statements concerning its habits. In most cases when apterous forms were found, the author did not recognize the species until the specimens had been mounted on slides. Quite frequently individual specimens were found in collections of A. rubi. This would tend to substantiate the author's opinion that this species also tends to feed on the terminal portion of the host plant.

Very few large colonies of this aphid were ever found. Whether this is due to its relative scarcity in Michigan or to some innate characteristic is not known. When this species was recognized on the plant, it was observed to be only moderately active and not prone to drop from the plant when disturbed.

Quantitative Studies

Wild Red Raspberry. 1961

A few apterous females were collected on September 27. On October 18 oviparous females and immature males were found.

Wild Red Raspberry. 1962

Large numbers of M. rubicola appeared suddenly on September 21. The population then began a steady decline. The last specimen was collected on October 12.

Wild Red Raspberry and Commercial Fields. 1963

This species was not found in the quantitative samples taken in 1963.

Liosomaphis sp.[1]

In October of 1963 a large infestation of this aphid occurred in the test plot of wild red raspberry. A number of these aphids were transferred to potted wild red raspberry plants. These plants were placed in a growth chamber that was regulated to give a 12 hour day with temperatures ranging from 75 to 80° F. and relative humidity from 55 to 60%. These colonies failed to maintain themselves, and all specimens were dead within seven days. As the only recorded host of this genus are members of Gramineae, it is presumed that these aphids crawled to the raspberry plants from the tall grasses that were growing in this plot.

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[1] Determination by Miss Louise Russell.

Data from the quantitative collecting sites, showing the relative abundance and the preferred feeding locations of the aphid species, are summarized in Tables 2 and 3. The time of occurrence and duration of the morphological forms of the raspberry aphids, compiled from data gathered during four years of collecting, are presented in Table 4.

No great numbers of predators, parasitized or fungus infected aphids, were observed by the author. Lists of the parasites reared and the predators collected are presented in Appendices 3 and 4.

TABLE 2.--Relative abundance of the aphid species collected and the preferred feeding location. Commercial raspberry fields, 1963

Aphid Species	Total Collected	Relative Abundance	Location on Plant		Location in Leaf Strata		
			Canes	Leaves	Upper	Mid	Lower
Black Raspberry							
Amphorophora rubi	3	0.1%	66.7%	33.3%	100.0%	0.0%	0.0%
Amphorophora sensoriata	1,749	60.2%	99.9%	0.1%	0.0%	100.0%	0.0%
Aphis rubifolii	1,155	39.7%	0.1%	99.9%	40.1%	33.3%	26.6%
Masonaphis rubicola	0	0.0%	-	-	-	-	-
	2,907						
Red Raspberry							
Amphorophora rubi	27	18.5%	0.0%	100.0%	55.6%	0.0%	44.4%
Amphorophora sensoriata	18	12.3%	100.0%	0.0%	-	-	-
Aphis rubifolii	101	68.2%	0.0%	100.0%	21.8%	21.8%	56.4%
Masonaphis rubicola	0	0.0%	-	-	-	-	-
	146						

TABLE 3.--Relative abundance of the aphid species collected and the preferred feeding location. Wild red raspberry, 1961 - 1963

Aphid Species	Total Collected	Relative Abundance	Location on Plant	
			Canes	Leaves
Amphorophora rubi	346	3.8%	54.9%	45.1%
Amphorophora sensoriata	77	0.9%	39.0%	61.1%
Aphis rubifolii	8,518	94.5%	0.5%	99.5%
Masonaphis rubicola	78	0.9%	0.0%	100.0%
	9,019			

TABLE 4.--Time of occurrence and duration of the morphological forms of raspberry aphids compiled from records obtained during the years 1961 to 1964

Aphid Species	Earliest Nymph	Fundatrix	Apterous Female	Alate Female[a]	Sexuales[a]
Amphorophora rubi	May 20	-	June 22 to Oct. 7	May 20 to Aug. 26	Sept. 30 to Oct. 25
Amphorophora sensoriata	May 22	-	May 22 to Oct. 31	June 23 to Aug. 18	Sept. 18 to Oct. 31
Aphis rubifolii	April 17	April 24 to May 25	May 8 to Nov. 14	May 20 to Sept. 20	Oct. 25 to Nov. 19
Masonaphis rubicola	May 24	-	May 24 to Sept. 27	July 30 to Sept. 17	Oct. 12 to Oct. 25

[a]Data for alate forms are based on records of both alatoid nymphs and imagines.

BLUEBERRY APHIDS

Wild and cultivated blueberry plants were qualitatively examined from July 13, 1961 through 1964. Data summarizing the relative abundance of the aphid species in various collecting situations are presented in Table 5. No aphids were ever found on the roots of the plants or in the leaf litter from blueberry beds.

No aphids were found on wild blueberries (Vaccinium canadense Kalm.) in Alpena, Bay, Cheboygan, and Van Buren Counties, or on wild highbush blueberries (Vaccinium corymbosum L.) or wild "small cranberry" in Ingham Co. Mr. R. B. Willson[1] found no aphids in three large stands of lowbush wild blueberry (Vaccinium sp.) in Houghton and Marquette Counties in June and July of 1964.

Masonaphis pepperi MacGillivray

This was the largest and commonest aphid found on cultivated blueberry (Vaccinium corymbosum L.). The only large infestation noted by the author was found in Van Buren Co. on July 7 and 8, 1961. This species was observed to be quite active and would readily begin to crawl when disturbed. Most of the specimens were taken from the leaves. Preference seemed to be shown for the upper surfaces of the leaves growing at the base of the plant, but in one collection a few specimens were found on the green sucker shoots at the base of the plant. While

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[1]Graduate Student, Department of Entomology, Michigan State University.

TABLE 5.--Relative abundance of blueberry aphids taken in qualitative collections from 1961 through 1964

Number of Collections Made in Various Sites		Relative Abundance of Species	
		Masonaphis pepperi	Myzus scammelli
	1961		
Commercial plantations	15	13.0%	6.7%
Nursery stock	4	0.0%	0.0%
Home gardens	3	0.0%	0.0%
Wild blueberry	3	0.0%	0.0%
	1962		
Commercial plantations	38	34.2%	10.5%
Nursery stock	0	-	-
Home gardens	3	33.3%	0.0%
Wild blueberry	1	0.0%	0.0%
	1963		
Commercial plantations	30	20.0%	3.3%
Nursery stock	0	-	-
Home gardens	0	-	-
Wild blueberry	0	-	-
	1964		
Commercial plantations	25	28.0%	12.0%
Nursery stock	1	0.0%	0.0%
Home gardens	3	0.0%	0.0%
Wild blueberry	5	0.0%	0.0%

this species was found most often on young tender leaves, it showed a greater tolerance for leaf age and was often taken on older leaves than those preferred by Myzus scammelli Mason. Copulation and oviposition were never observed.

On August 10, 1963, in Van Buren Co. individual specimens of M. pepperi were found on Indian Hemp plants (Apocynum cannabium L.)[1] growing among blueberry plants. These Indian Hemp plants were between five and six feet tall. It is thought that the abnormal height of these plants was brought about by competition for sunlight and a dressing with chemical fertilizer.

In an effort to determine the host range of this species, specimens of M. pepperi were removed from blueberry plants and confined to Indian Hemp plants growing in a blueberry plantation. These transfer tests were made on September 21 and 28. All of these aphids were dead when the cages were removed after seven days.

Based on collection records of four years, this species appears to be restricted to the eastern portion of the Lower Peninsula (Fig. 7).

Quantitative Studies (Fig. 8)

Michigan State University Horticulture Farm

M. pepperi was not found on this test site.

Chickaming Plantation

This species was not collected until May 27. The population of this aphid was quite small, and it was not found again until July 27; that was the last time it was collected.

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[1]Identification confirmed by Dr. R. DeJonge, formerly of the Michigan State University Herbarium.

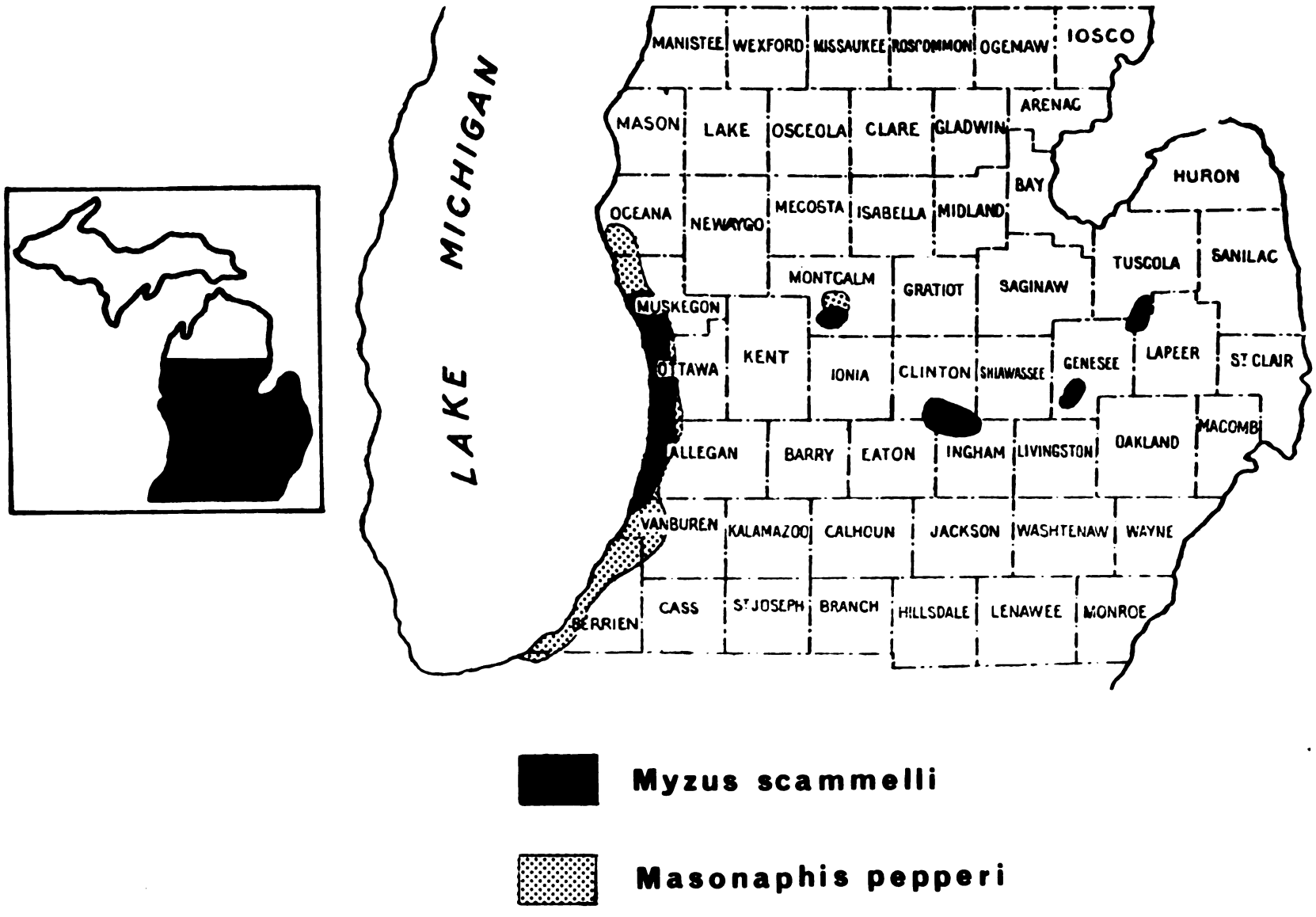

Fig. 7.--Distribution of blueberry aphids in the lower peninsula of Michigan.

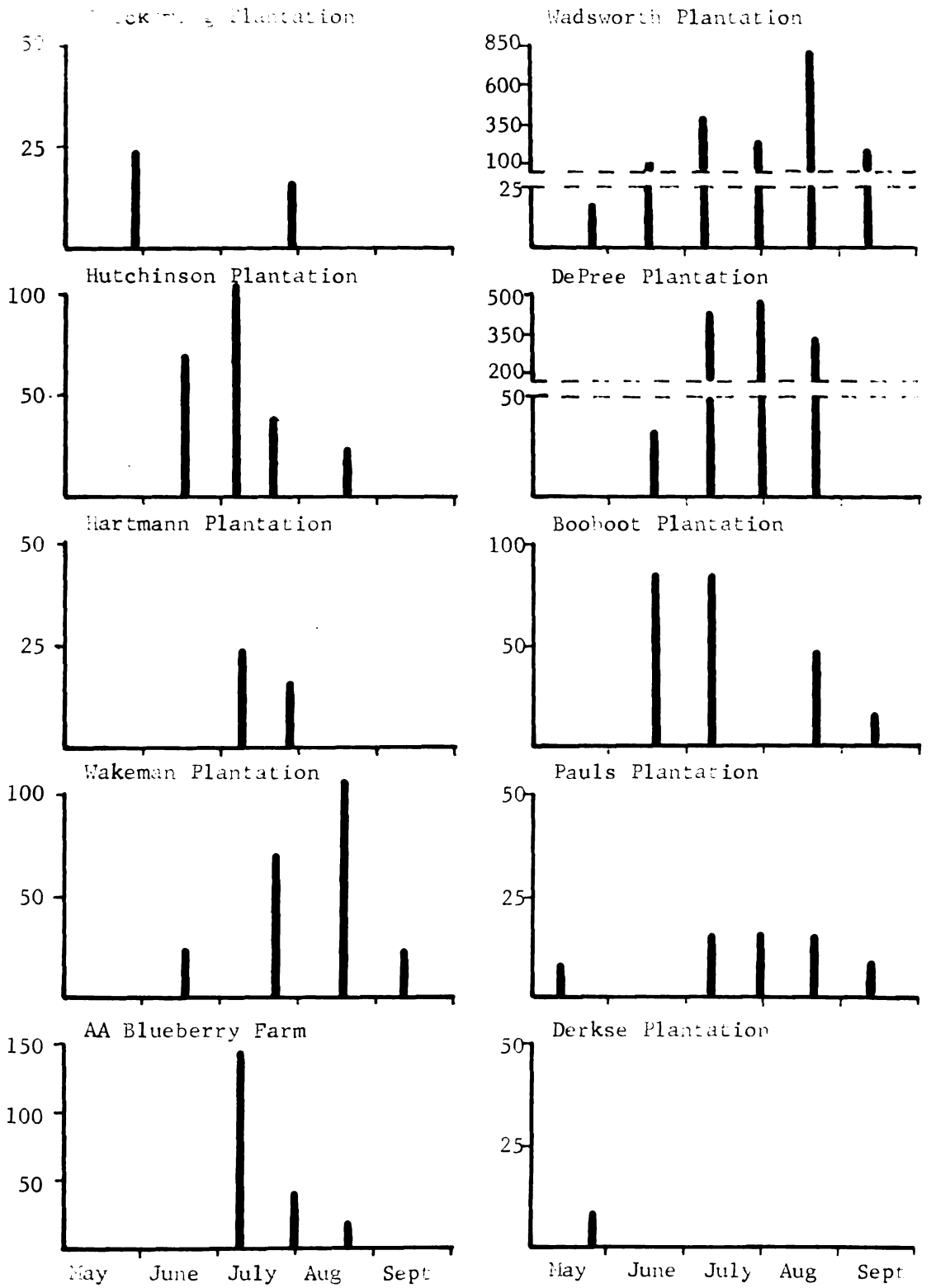

Fig. 8.--Seasonal population trends of Masonaphis pepperi MacGill. on blueberry.

Hutchinson Plantation

This aphid was collected for the first time on June 15. The population reached its peak on July 6 and then began a slow decline until on August 18 no specimens were found.

Hartmann Plantation

On July 8 the first specimens were found. The population then declined steadily, and no specimens were collected after July 28.

Wakeman Plantation

M. pepperi was taken for the first time on June 16. The population of this species declined in the following two weeks but began to build up during the last days of July. On August 11 the population reached its peak. By September 11, the last day of collecting, the numbers of this species had decreased sharply.

Double A Blueberry Farm

This species was not found until July 8, when the population reached its peak. On July 29 the population had declined sharply. This decline continued at a steady rate for the rest of the season.

Wadsworth Plantation

Specimens of M. pepperi were collected for the first time on May 10. The population increased slightly on May 25. Following that date the population began a rapid increase that terminated in a population peak on July 8. In the following weeks the population declined slightly, but on August 19 the second and major peak occurred. The numbers of this species then declined, but on the last day of collecting it was still present in large numbers.

DePree Plantation

The first specimens were collected on June 17. The population then increased rapidly and attained its peak on July 29. On August 20 the population had declined but was still strong. No specimens were found on the last day of collecting.

Boohoot Plantation

This species was not found until June 17, when the population reached its peak. The numbers of this species maintained itself at this level until July 9. After this date the population declined sharply. By August 20 the population had recovered somewhat, but by September 12 it had decreased and only a few nymphs were taken.

Pauls Plantation

Nymphs of M. pepperi were taken on the first day of collecting, May 11. The population of this species in this plantation was never large, and it was not found again until July 9. It maintained itself at a steady level until August 20 when it began to decline. Apterous females were found on September 12, the last day of collecting.

Derkse Plantation

M. pepperi was not abundant in this plantation. The only collection of this species was made on May 26, when nymphs were taken.

Myzus scammelli Mason

This relatively rare aphid was found in the eastern as well as the western counties of the Lower Peninsula (Fig. 7). No positive records of this species occurring in Berrien Co. were obtained. (Early

instar nymphs collected in this county in 1962 and 1964 could be only identified as Myzus sp.[1]).

Practially all specimens collected were taken from the leaves. The preferred feeding location appeared to be the upper surfaces of tender leaves growing at the base of the plant, but some were found on terminal leaves. In these cases the terminal leaves were always young, tender leaves growing on sucker shoots. Late in the season some feeding was noticed on senescing leaves. This species was observed to be a sedentary aphid that was not prone to shift its feeding position when disturbed.

On October 7 and 9, 1963, sexuales were taken en copula. Four acts of copulation observed on these days took place on tender green leaves growing from eight to eighteen inches above the ground level.

Oviposition was observed for the first time on October 9, 1963. Newly deposited eggs were smooth and light jade-green in color but turned wrinkled and black with age. Leaves containing green eggs were collected and taken indoors; within four days all eggs had turned black. Some eggs were collected in alcohol and mounted in glycerin. The average measurement of six green eggs was .71 x .34 mm. The average measurement of six black eggs was .57 x .29 mm.

With but one exception, all eggs were observed to have been deposited on the leaves. The upper surface of the leaves appeared to be the preferred oviposition site. The majority of these leaves were growing within eighteen inches of the ground. Oviposition activity apparently reached its height on October 27 when as many as 26 eggs

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[1]Determination by Miss Louise Russell.

were counted on one leaf. Sexuales (Fig. 9) were collected on October 25, but females were observed ovipositing as late as October 30. Green eggs collected on November 15 indicate that oviposition can continue until quite late in the season.

Quantitative Studies (Fig. 10)

Michigan State University Horticulture Farm

The population of M. scammelli was already strong on the first day of collecting. On June 8 the population reached its peak. After this date the population began a decline that lasted through most of July. During the last of July and the first days of August, the numbers of this species increased slightly. After August 2 the population declined and maintained itself at a low level for the rest of the season.

Chickaming and Hutchinson Plantations

M. scammelli was not found in these sites.

Hartmann Plantation

This species was not found in this plantation.

Wakeman Plantation

This aphid was not found until July 8. The population decreased after this date and maintained itself at a low level for the rest of the season.

Double A Blueberry Farm

M. scammelli was not found until July 8. The population reached

Fig. 9.--Myzus scammelli Mason. Sexuales and eggs on cultivated blueberry leaf.

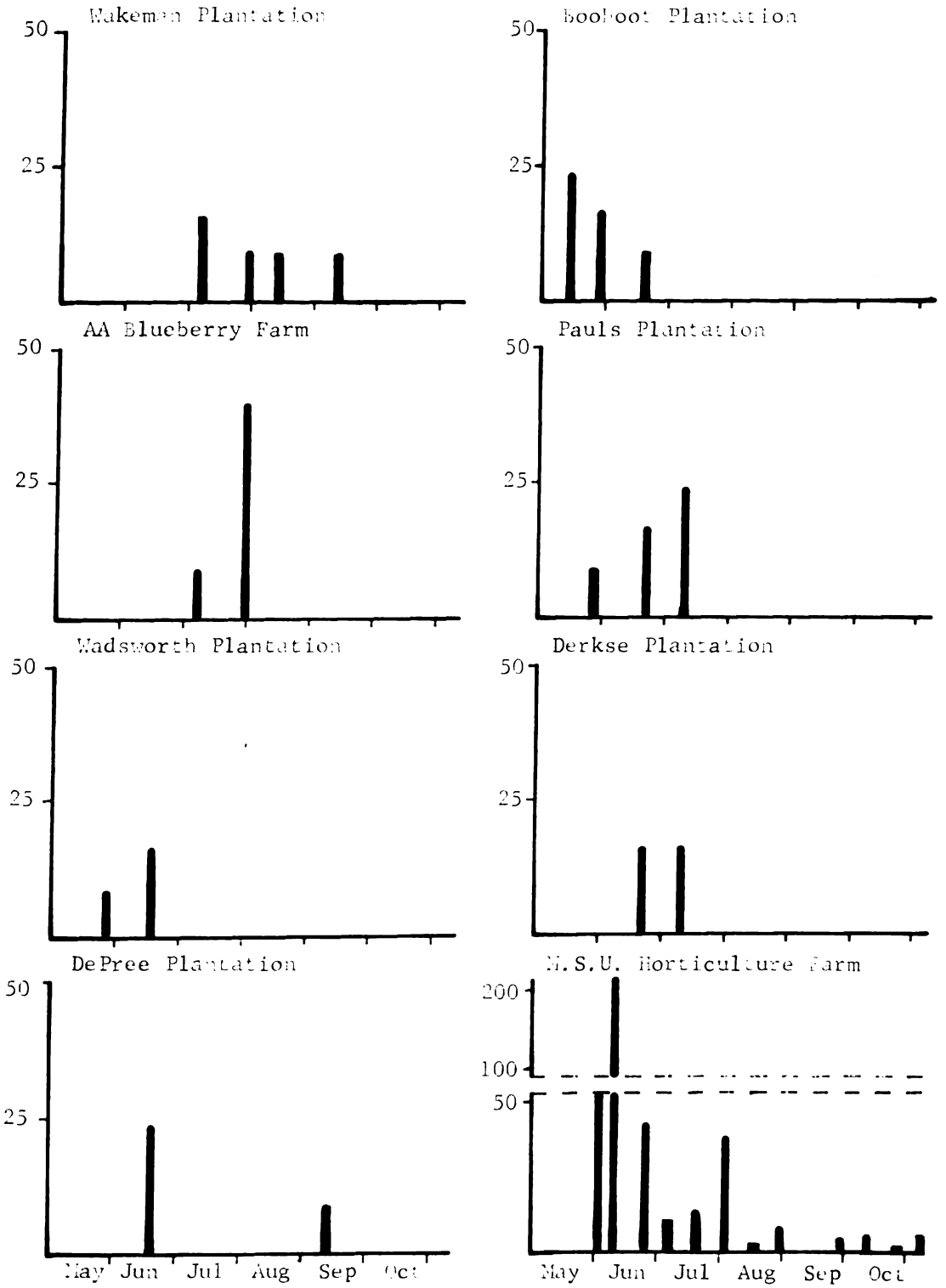

Fig. 10.--Seasonal population trends of Myzus scammelli Mason on blueberry.

its peak on July 29 but was not collected again after this date.

Wadsworth Plantation

The first specimens were collected on May 25. This species increased on June 16 but no specimens were found after this date.

DePree Plantation

This aphid was found in only small numbers on this site. Nymphs were collected on June 17--after this date the species was not collected again until September 12.

Booboot Plantation

The population of this species had already reached its peak when collecting started. After this date the population began a steady decline. The last specimen was collected on June 17.

Pauls Plantation

M. scammelli was not found until May 26. The population increased steadily in the following weeks until it reached its peak on July 9. After this date it was not collected again.

Derkse Plantation

The first specimens were collected on June 18. This small population maintained itself at a steady level until July 9. After this date it was not collected again.

Aphis spiraecola Patch

On July 7, 1962 a heavy infestation of apterous and alate females of this species was found in a plantation in Van Buren Co. The

preferred feeding location appeared to be the terminal leaves and stems, and almost every plant contained at least one colony. This aphid was also collected on July 15, 1962 in Berrien Co. and on July 20, 1963 in Allegan Co.

The site of the original infestation was visited again in 1963. There, on August 10, scattered colonies of this species were found on the terminal leaves and stems of Jersey blueberry. These aphids were also found colonizing Indian Hemp plants growing among the blueberry plants. These Indian Hemp plants were between five and six feet tall. It is thought that the abnormal height of these plants was brought about by competition for sunlight and dressing with chemical fertilizer.

In an effort to determine the host range of this aphid, the following transfer tests were made. On September 7, thirty apterous females were taken from Indian Hemp and confined to green blueberry leaves in a plantation. A week later all these aphids were dead. From the appearance of the bodies it is presumed that they had died within a day of the inspection. On September 14 this experiment was repeated. On September 21, six of the original thirty specimens were alive but when the cages were removed on September 28, all aphids were dead. On September 21 thirty more aphids were transferred, but these were dead when the cages were removed on September 28.

On October 16, colonies of A. spiraecola were taken from their natural host, an ornamental Spirea sp., and transferred to potted blueberry plants. These plants were placed in a growth chamber regulated to give a 12 hour day with temperatures ranging from 75 to 80° F. and relative humidity from 55 to 60%. Some reproduction was noted, but

by the end of 20 days the colony had died out. On November 6 this experiment was repeated using colonies that contained large numbers of oviparous females. This colony died out by November 13.

Data from the quantitative collecting sites, showing the relative abundance and the preferred feeding locations of the aphid species, are summarized in Tables 6, 7 and 8. The time of occurrence and duration of the morphs of these aphids, compiled from data obtained over a four-year period, are presented in Table 9.

No great numbers of predators, parasitized or fungus infected aphids were observed by the author; nor were many ants found in association with colonies of blueberry aphids. Lists of the predators and ants collected, and the parasites reared, are presented in Appendices III, IV and V.

TABLE 6.--Occurrence of two aphid species in blueberry plantations, 1963

Location and Name of Owner	*Masonaphis pepperi*			*Myzus scammelli*		
	July 22	Aug. 3	Aug. 29	July 22	Aug. 3	Aug. 29
Berrien Co.						
Chickaming	0	10	6	0	0	0
Hutchinson	0	0	4	0	0	0
Van Buren Co.						
Hartmann	2	3	1	0	0	0
Wakeman	21	2	33	0	0	0
Allegan Co.						
AA Blueberry Farm	8	3	2	0	0	0
Wadsworth	14	107	330[a]	0	0	0
Ottawa						
DePree	13	29	4	0	0	0
Boorboot	0	32	24	0	0	1
Muskegon						
Pauls	2	2	7	1	0	7
Derkse	1	1	0	0	0	0
Relative Abundance in 30 Collections	83.3%					10.0%

[a]Approximate numbers.

TABLE 7.--Relative abundance of two aphid species collected in quantitative samples in blueberry plantations. 1964

Location	Masonaphis pepperi	Myzus scammelli
Berrien Co.	100.0%	0.0%
Van Buren Co.	87.2%	12.8%
Allegan Co.	96.3%	3.7%
Ottawa Co.	94.7%	5.3%
Muskegon Co.	47.4%	52.6%
Total for Five Counties	93.6%	6.4%

TABLE 8.--Myzus scammelli Mason. Preferred feeding location and frequency distribution on five varieties of blueberry grown in the Michigan State University Horticulture Farm

	Total Number of Specimens Collected	Distribution
Variety		
Earliblue	118	29.5%
Bluecrop	100	25.0%
Rubel	87	21.8%
Jersey	52	13.0%
Blueray	43	10.8%
Location		
Crown	130	32.6%
Base	269	67.4%
	400	

TABLE 9.--Time of occurrence and duration of the morphological forms of blueberry aphids compiled from records obtained during the years 1961 to 1964

Aphid Species	Earliest Nymph	Fundatrix	Apterous Female	Alate Female[a]	Sexuales[a]
Masonaphis pepperi	May 10	-	May 20 to Oct. 31	May 20 to July 26	Sept. 21 to Nov. 14
Myzus scammelli	May 6	May 6 to May 11	May 18 to Oct. 25	May 25 to Sept. 2	Sept. 28 to Nov. 8

[a]Data for alate forms are based on records of both alatoid nymphs and imagines.

STRAWBERRY APHIDS

From June 29, 1961 through 1964 both wild strawberry (Fragaria virginiana Duchesne) and cultivated strawberry (Fragaria virginiana Duchesne x Fragaria chiloensis (L.)) were examined qualitatively. Data summarizing the relative abundance of the aphid species found in various collecting situations are presented in Table 10.

TABLE 10.--Relative abundance of strawberry aphids taken in qualitative collections from 1961 to 1964

Aphid Species	Number of Collections Made in Various Sites			
	Commercial Fields	Nursery Stock	Home Gardens	Wild Strawberry
	72	4	62	102
Acyrthosiphon pisum	6.9%	0.0%	1.6%	0.0%
Acyrthosiphon porosum	34.7%	50.0%	9.7%	1.0%
Aphis forbesi	15.3%	0.0%	9.7%	12.7%
Aphis gossypii	1.4%	50.0%	4.8%	0.0%
Chaetosiphon fragaefolii	0.0%	25.0%	1.6%	0.0%
Chaetosiphon minor	9.7%	0.0%	30.6%	23.5%
Macrosiphum euphorbiae	11.1%	0.0%	8.1%	0.0%
Macrosiphum rosae	4.2%	0.0%	0.0%	0.0%

With the exception of Aphis forbesi Weed no aphids were found on the roots of the plants. The only specimen recovered from the leaf litter and mulch of strawberry beds was a moribund nymph. This specimen

was collected on February 9, 1965 in Ingham Co. It could only be identified as belonging to the tribe Aphidini, possibly Macrosiphum sp.[1]

Acyrthosiphon pisum (Harris)

This was a very active species that was prone to change its feeding location when disturbed. Nymphs were often found on the young leaves and runners, but the imagines seemed to prefer to feed on the older and larger leaves. There appeared to be no preference for either the top or bottom surface of the leaf. Copulation and oviposition were never observed.

Quantitative Studies (Fig. 11)

Tidey Farm

A. pisum was not found in large numbers in this field. The only specimens were taken on July 19, August 9 and October 31.

Michigan State University Horticulture Farm

This species was not found until July 18. On this date the population reached its peak and then began a rapid decline. By mid-August the population had disappeared, and no specimens were taken again until September 13. This species maintained itself in very low numbers during September, then disappeared at the end of the month.

Wendzel Farm

A. pisum was not found in this field.

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[1] Determination by Miss Louise Russell.

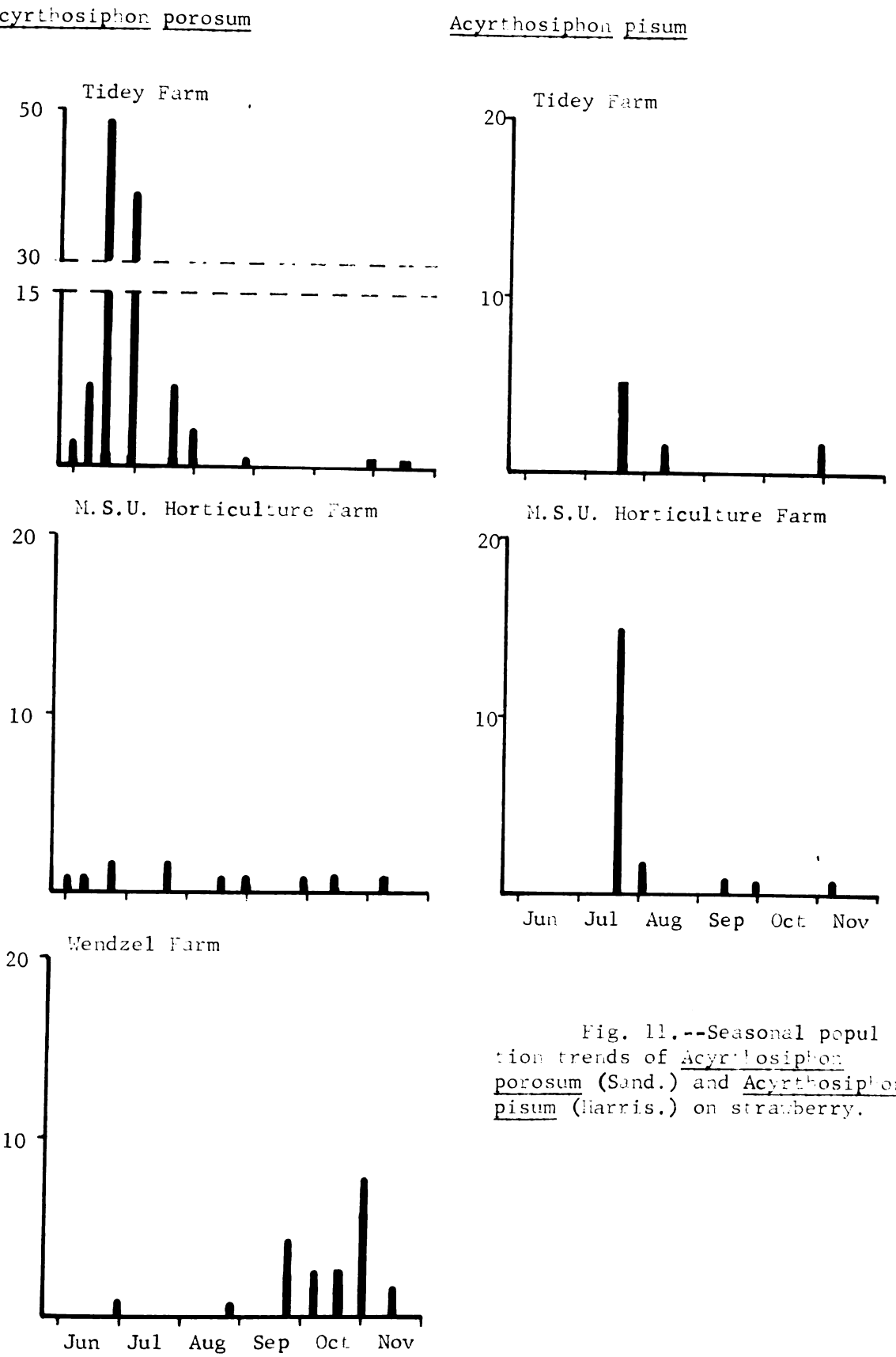

Fig. 11.--Seasonal population trends of Acyrthosiphon porosum (Sand.) and Acyrthosiphon pisum (Harris.) on strawberry.

Acyrthosiphon porosum (Sand.)

This species was observed to be moderately active on the plant. It did not appear to be too specific in its feeding location. Imagines were collected most often from the undersurfaces of the older leaves and from the stems. Nymphs also were found in these two locations and frequently on the runners and bud scales.

On August 25, 1961 a viviparous female was found on cultivated black raspberry. Apterous females were taken from ornamental rose plants (Rosa sp.) in Ingham Co. on October 14, 1964 and on July 20, 1965.

Quantitative Studies (Fig. 11)

Tidey Farm

Only a few nymphs were taken on the first day of collecting. In the following week, the population reached its peak and then began to decline. After July 26 this species maintained itself at an extremely low level, and only a few scattered specimens were collected.

Michigan State University Horticulture Farm

The population of A. porosum in this field was small. This species maintained itself at a fairly consistent level throughout the season, without any detectable population peaks.

Wendzel Farm

A. porosum was not abundant in this field in the early part of the season. Only single specimens were collected on June 28 and August 23. In late September the population increased. This increase was followed by a slight decline in numbers, but by the end of October the

population had reached its peak. After this peak the numbers declined, and only a few specimens were found on the last day of collecting.

Aphis forbesi Weed

This was observed to be a sedentary species. Small groups of nymphs were often taken from runners and bud scales, but when large colonies were found the aphids were fairly evenly distributed over the plant. In the latter cases, the stems seemed to be preferred to the older leaves. In 29 recorded observations, this species was found on the roots on three occasions and on the roots and other parts of the plant on three occasions. The remainder of these observations show that the preferred feeding location was fairly well divided between the stems and the leaves or runners.

Heavy infestations were found in Van Buren Co. on August 12, 1961. In this infestation the aphids were found on the roots, stems and leaves, and many young plants were destroyed. Found in association with this aphid was the cornfield ant, Lasius alienus (Foerster). On September 26, 1964 a large colony of A. forbesi was collected from the roots, stems and leaves of a wild strawberry clone in Genesee Co. Associated with this colony was the ant Crematogaster lineolata (Say).

On August 24, 1962, in Berrien Co., another large infestation was observed. The aphids were found only on the roots of the plant. No ants were collected in association with this aphid but this may have been due to the application of insecticides. A list of all the ant species found with this aphid is presented in Appendix V.

Copulation and oviposition of A. forbesi were not observed. On

October 18, 1961, in Ingham Co., oviparous females were collected. These specimens had been isolated the week before by means of a cage. When the cage was removed, three black eggs were noted on the stem of the plant. These eggs were placed in alcohol and later mounted in glycerin. The average measurement of these three eggs was .52 x .27 mm.

Quantitative Studies

A. forbesi was not found on the Tidey Farm. At the Michigan State University Horticulture Farm, a few nymphs were collected on September 28 and October 11. A single nymph was taken on the Wendzel Farm on August 23.

Aphis gossypii Glov.

This species seemed to prefer to feed on the runners, bud scales and young leaves. Copulation and oviposition were never observed, but an oviparous female was collected from strawberry in Ingham Co. on October 12, 1963.

In the winter of 1964, large numbers of apterous females and alatoid nymphs were sent to the author.[1] These specimens had colonized the young leaves of Fragaria vesca L. and an experimental hybrid strawberry growing in a greenhouse.

Quantitative Studies

A single nymph was taken on the Tidey Farm on June 14. On the Michigan State University Horticulture Farm, a single nymph was found

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[1] Mr. R. Scheffer, Michigan Department of Agriculture, Collector.

on July 5. On the Wendzel Farm nymphs were collected in small numbers on September 6 and 21, and on October 31.

Chaetosiphon fragaefolii (Cock.)

This species appeared to prefer the runners and young leaves; it was observed to be quite sedentary. The only record of note was made on July 27, 1964 when an apterous female was found on cultivated black raspberry in Ingham Co. Copulation and oviposition were never observed.

Quantitative Studies (Fig. 13)

C. fragaefolii was not found on the Tidey or Wendzel Farms.

Michigan State University Horticulture Farm

This species was not collected until September 28. The numbers of this aphid dropped sharply after this date and very few specimens were taken during the rest of the season.

Chaetosiphon minor (Forbes)

Feeding preference appeared to be runners and young leaves, but oviparous females were found most often on the stems of the plant. When this aphid was found on the older leaves, it appeared to prefer the bottom surfaces. C. minor was observed to be a sedentary type that was not likely to shift its feeding position when disturbed.

Oviparous females were taken in association with eggs in Gratiot Co. on October 22, 1961. In 1963, oviparous females and alatoid male nymphs were taken in association with eggs on October 15 in Ingham Co. On this same site, on October 25, sexuales were collected en copula.

Copulation was observed to take place while the aphids were on the leaves and stems. (Fig. 12).

Oviposition was noted for the first time in Ingham Co. on November 15, 1963. Most of the eggs were deposited on the stems, but as oviposition activity increased, many eggs were deposited on the undersurfaces of the leaves. Newly deposited eggs were smooth and ranged in color from ivory-white to light yellow. As the eggs aged, they became wrinkled and black. Some of these eggs were collected in alcohol and mounted in glycerin. Thirteen newly deposited eggs averaged .57 x .29 mm.

Quantitative Studies (Fig. 13)

Tidey Farm

This field did not support a large population of this species. The first specimens were collected on June 7; after this date this aphid was not taken again until the middle of July. On July 26 the numbers increased, but after this date the population declined and no specimens were collected until August 23. The population began to build up during the first week of September but again declined in the following weeks. No specimens were taken again until the middle of October. By the end of October the population had begun to increase again but on the last day of collecting, this species was not present in the samples.

Michigan State University Horticulture Farm

A single specimen of C. minor was found on June 1. This species was not collected again until August 16. The population began to build

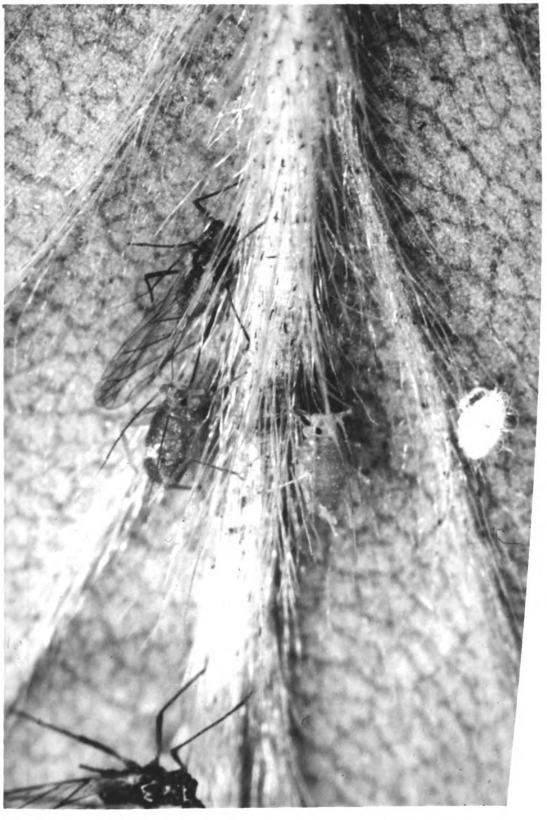

Fig. 12.--Chaetosiphon minor (Forbes). Sexuales on strawberry leaf.

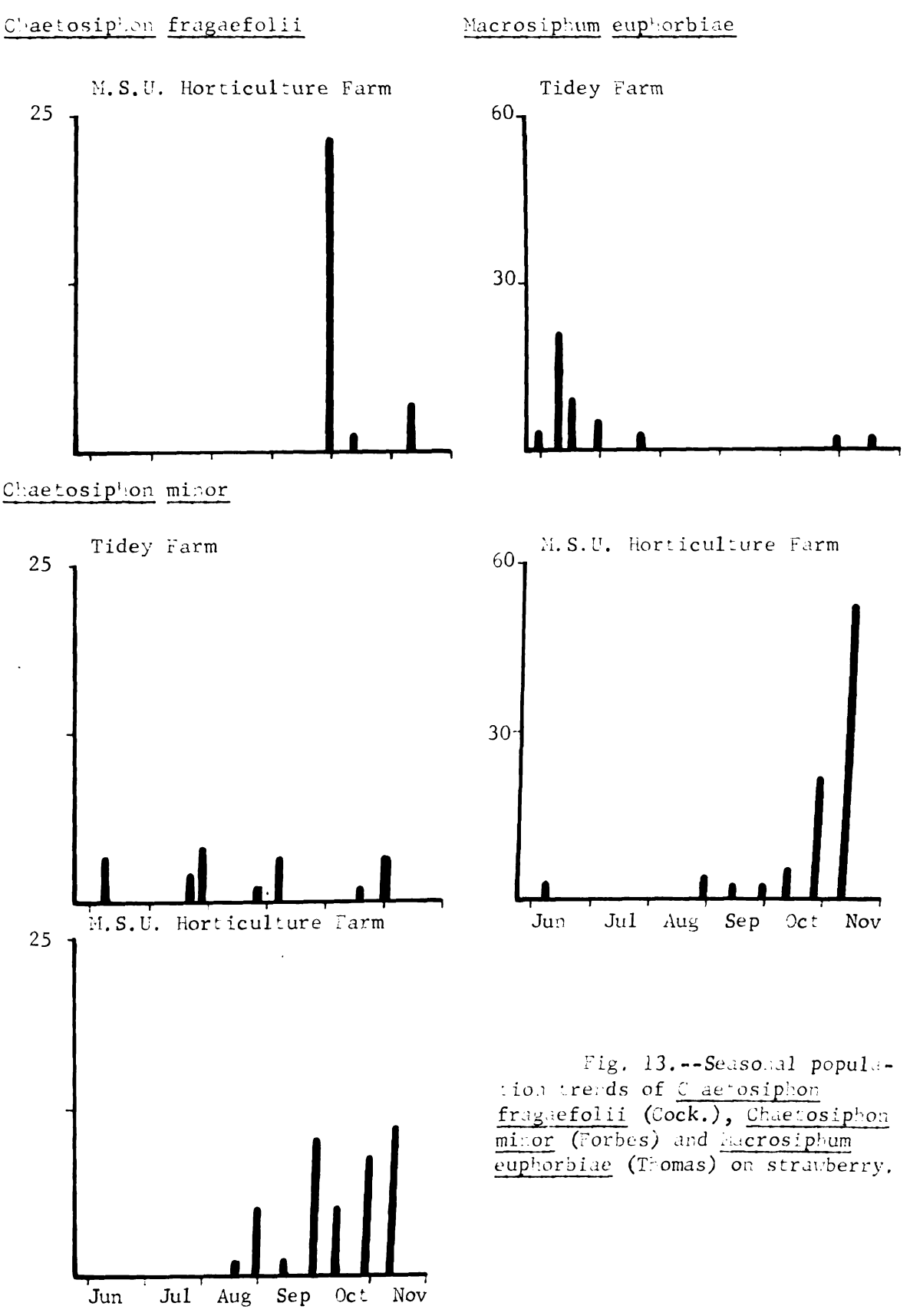

Fig. 13.--Seasonal population trends of Chaetosiphon fragaefolii (Cock.), Chaetosiphon minor (Forbes) and Macrosiphum euphorbiae (Thomas) on strawberry.

up at the end of August but declined again in mid-September. Toward the end of September the numbers of this species increased again. After a decline on October 11, the population began an increase that lasted into the first week of November.

Wendzel Farm

C. minor was not found in this field.

Macrosiphum euphorbiae (Thomas)

This was observed to be an active species that was prone to change its feeding position when disturbed. While the nymphs were frequently taken from the young leaves and runners, imagines were most often found on the older and larger leaves. There appeared to be no preference for either the top or bottom surface of the leaf. Copulation and oviposition were never observed.

Large colonies of this species found on F. vesca in a greenhouse in Berrien Co. were sent to the author on January 22, 1964.[1] Large infestations were found in cultivated strawberry fields in Berrien Co. on August 18, 1962 and on the Michigan State University Horticulture Farm from October 7 to 30, 1963.

Quantitative Studies (Fig. 13)

Tidey Farm

A few specimens of M. euphorbiae were collected on May 31. The population peaked abruptly the following week and then began a steady

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[1] Mr. R. Scheffer, Michigan Department of Agriculture, Collector.

decline [illegible] terminated on July 26. This species was not taken again [illegible] September 31. On this date and on November 14, only individual specimens were found.

Michigan State University Horticulture Farm

Only a few specimens were found on June 8. This species was not collected again until August 30. The small population maintained itself at a fairly even level until October 11; on this date a rapid build up occurred that terminated in a population peak on November 8, the last day of collecting.

Wendzel Farm

A nymph of M. euphorbiae was collected on October 18.

Macrosiphum rosae (L.)

This was observed to be an active species that would readily shift its feeding position when disturbed. Imagines were taken most often from the larger mature leaves. Specimens were collected from ornamental rose plants in Ingham Co. on October 14, 1964. Copulation and oviposition were never observed.

Quantitative Studies

M. rosae was not found in any of the quantitative test plots.

Data from the quantitative collecting sites, showing the relative abundance of the various aphid species and the frequency in which they were found on different strawberry varieties, are summarized in Tables 11, 12 and 13. The time of occurrence and the duration of the

morphological forms of the strawberry aphids, compiled from records gathered during four years of collecting, are presented in Table 14.

No great numbers of predators, parasitized or fungus infected aphids, were observed by the author. Lists of the predators collected and the parasites reared are presented in Appendices III and IV.

TABLE 11.--Relative abundance of aphid species taken from two varieties of strawberry. Tidey Farm

Aphid Species	Total Collected	% of Total	Distribution on Strawberry Varieties	
			Earlidawn	Tennessee Beauty
Acyrthosiphon pisum	10	5.2%	80.0%	20.0%
Acyrthosiphon porosum	124	64.3%	55.7%	44.4%
Aphis forbesi	1	0.5%	100.0%	0.0%
Aphis gossypii	1	0.5%	100.0%	0.0%
Chaetosiphon fragaefolii	0	0.0%	-	-
Chaetosiphon minor	17	8.8	52.9%	47.1%
Macrosiphum euphorbiae	40	20.7%	75.0%	25.0%
Macrosiphum rosae	0	0.0%	-	-
	193			

TABLE 12.--Relative abundance of aphid species taken from four varieties of strawberry. Michigan State Horticulture Farm

Aphid Species	Total Collected	% of Total	Distribution on Strawberry Varieties			
			Michigan 87	Midway	New Jersey 158	New Jersey 857
Acyrthosiphon pisum	20	10.3%	5.0%	45.0%	50.0%	0.0%
Acyrthosiphon porosum	11	5.7%	36.4%	45.5%	9.1%	9.1%
Aphis forbesi	3	1.6%	0.0%	0.0%	100.0%	0.0%
Aphis gossypii	1	0.5%	0.0%	0.0%	0.0%	100.0%
Chaetosiphon fragaefolii	27	13.9%	0.0%	3.7%	96.3%	0.0%
Chaetosiphon minor	43	22.2%	4.7%	2.3%	90.7%	2.3%
Macrosiphum euphorbiae	89	45.9%	12.4%	10.1%	39.3%	38.2%
Macrosiphum rosae	0	0.0	-	-	-	-
	194					

TABLE 13.--Relative abundance of aphid species taken from strawberry. Wendzel Farm

Aphid Species	Total Collected	% of Total
Acyrthosiphon pisum	0	0.0%
Acyrthosiphon porosum	24	58.5%
Aphis forbesi	1	2.4%
Aphis gossypii	15	36.6%
Chaetosiphon fragaefolii	0	0.0%
Chaetosiphon minor	0	0.0%
Macrosiphum euphorbiae	1	2.4%
Macrosiphum rosae	0	0.0%
	41	

TABLE 14.--Time of occurrence and duration of the morphological forms of strawberry aphids compiled from records obtained during the years 1961 to 1964

Aphid Species	Earliest Nymph	Fundatrix	Apterous Female	Alate Female[a]	Sexuales[a]
Acyrthosiphon pisum	July 18	-	July 19 to Sept. 14	June 7 to Nov. 8	Nov. 8
Acyrthosiphon porosum	April 29	May 10	May 9 to Oct. 29	May 15 to Sept. 3	Sept. 9 to Nov. 14
Aphis forbesi	April 29	May 3 to May 9	May 20 to Nov. 8	May 20 to Aug. 24	Oct. 18 to Oct. 24
Aphis gossypii	April 15	-	May 2 to Nov. 27	Aug. 22 to Nov. 27	Oct. 12
Chaetosiphon fragaefolii	July 27	-	July 27 to Nov. 8	-	Oct. 11
Chaetosiphon minor	April 15	May 4 to May 8	May 8 to Oct. 31	May 20 to June 14	Sept. 19 to Nov. 27
Macrosiphum euphorbiae	April 26	April 26	May 8 to Sept. 29	May 3 to Nov. 27	Oct. 7 to Nov. 27
Macrosiphum rosae	Sept. 9	-	Sept. 9	Sept. 2 to Oct. 7	Oct. 10 to Oct. 30

[a]Data for alate forms are based on records of both alatoid nymphs and imagines.

DISCUSSION AND CONCLUSIONS

Raspberry Aphids

The majority of the aphids infesting raspberry are common and not restricted in their distribution in the lower peninsula of Michigan; the one exception to this is Masoraphis rubicola. This species was not collected often. It appears to have a northern distribution and it is probable that Michigan lies in the lower limits of its range. The lack of numerous alate females in the fall and the presence of apterae during most of the season, preclude any statement that this is a migratory species.

Amphorophora rubi, another common species, was found throughout the lower peninsula. It was never found on strawberry, even when these plants were grown adjacent to raspberry plants that had large colonies of this aphid. As this species is recognized as a "complex", there is a possibility that the physiological strain of this aphid which reproduces on strawberry is not present in Michigan.

A marked preference was shown for red raspberry except in qualitative collections in commercial fields (Table 1). In these sites this species was taken with about the same frequency from red and black raspberry. Since the few fields of red raspberry examined were of smaller acreage than corresponding fields of black raspberry, a more intensive collecting effort probably would have shown the same preference for red raspberry. Table 1 also shows a marked difference

in the relative abundance of this species in commercial black raspberry fields and in stands of wild black raspberry. This could be due either to a host preference brought about by selective breeding of black raspberry, or to the fact that cultivated fields provide a superabundance of host plants. Although Cooley (1936) states that this species does not prefer wild black raspberry, further studies are needed to determine if real preference does exist.

The author agrees with Winter (1929) that the preferred feeding location is the terminal leaves and cane tips. This is not fully substantiated in the quantitative collecting records (Tables 2, 3) because the selected feeding site categories were too rigid to include a separation of aphids collected from petioles and those collected from the main cane. Leaf sample data in these tables, however, show that the upper leaves were preferred to the mid- and lower leaves. Since this was observed to be a most active aphid that would readily drop from the plant, there remains a possibility that some specimens feeding in the upper regions of the plant were ultimately collected from the lower leaves and canes. This is a source of error that is inherent in hand-collecting.

Winter (1929) reports that in Minnesota the eggs of this species were deposited on the leaves in great numbers, but in Michigan oviposition was never observed and sexuales were not particularly abundant. Since the conditions necessary to produce sexuales are not completely understood, there is the possibility that ecological differences result in fewer sexuales being produced in Michigan than in Minnesota.

If the eggs of A. rubi are commonly deposited on the leaves

there must be a tremendous mortality rate in this stage of the life cycle. Raspberry leaves rarely stay on the plant all winter, and the chances of a newly emerged nymph crawling from a fallen leaf to a plant are too poor to consider.

This species was rarely found in great numbers in either qualitative and quantitative collecting before midsummer. In the quantitative collecting of wild red raspberry in 1961 and 1963 (Fig. 3), the population did not start to build up until the first week of August. In 1962, a few specimens were found in this site in late June and July, but the major increases did not start until mid-August. Although this species was not taken in abundance in the quantitative sampling of commercial fields in 1963, the same midsummer build up of the population was apparent. The only exception to this was the field of red raspberry on the Vaughn Farm, where a fairly large infestation was found in mid-June. If a high mortality rate does occur in the fall because of few sexuales being present or eggs being lost on fallen leaves, or both, the resulting spring population would be weak in numbers and might require a longer period to build up. This could explain the reason why this species was never found in abundance before midsummer.

Amphorophora sensoriata was commonly collected throughout the lower peninsula of Michigan wherever the host plant was present. A definite preference for black raspberry was noted at all collecting sites (Tables 1, 2). In commercial plantings (Table 2), it was almost invariably found on the canes. However, in the test site of wild red raspberry (Table 3) it was taken more frequently from the leaves.

Since only nymphs of this species were collected in 1961 and 1962 and very few imagines in 1963, it is doubtful if any colonies maintained themselves in this test site. Most of these specimens were probably the progeny of alate females which alighted on the leaves and left after depositing a few nymphs; these were then collected before they could migrate to their preferred feeding position.

A large number of sexuales of this species were collected, especially in 1964. This was the result of a diligent search and does not reflect the true abundance of these morphs. In the course of regular collecting, very few were found and oviposition was never observed.

Records of both qualitative and quantitative collecting show that A. sensoriata was seldom found in large numbers in the early spring. In the quantitative samples from wild red raspberry (Fig. 4) this species was not taken until the first week of August in 1961 and 1963. In 1962 only a few specimens were found in mid-July and in mid-August. In the quantitative sampling of commercial fields in 1963 the earliest population build up occurred on July 13 on the Morte farm. On black raspberry on the Johnson, Walle and Vaughn farms the population did not start to increase until July 20. On red raspberry on the Maxwell and Vaughn farms, the population did not build up until the first week of August. There is a possibility that the scarcity of sexuales in the fall results in a smaller spring population that takes until mid-summer to build up to large numbers. Assuming that the eggs are oviposited on the stems, the survival rate should be higher than that of A. rubi, but it is possible that the sexual stage of both species is

one of the limiting factors to their early abundance. From the data secured, it would appear that large populations of this species can be expected to appear about a week earlier than those of A. rubi.

Both quantitative and qualitative sampling data show that Aphis rubifolii prefers to feed on red raspberry, but that it is also commonly found on black raspberry and blackberry. Table 1 indicates that there may be preference shown for wild plants of all types to cultivated stock.

All collection data show that A. rubifolii, one of the commonest raspberry aphids in the Lower Peninsula, is almost exclusively a leaf-feeder. It is almost invariably found on the under surface of the leaf close to a vein. This may indicate that this species is negatively phototactic or that it prefers the thinner surface of the underside of the leaf on which to feed. The few records of this aphid on the canes were usually those of gamic females which had migrated to the canes to oviposit, and of fundatrices and their progeny. The fundatrices apparently remain close to the location from which they hatch. The first generation produced by these morphs would remain near the fundatrices and eventually migrate to the leaves. Although it is a sedentary species, extreme crowding causes this aphid to become restless and to wander. Under these conditions, all forms of this aphid can be found on the canes.

The change in feeding locations is well illustrated in the quantitative collections made in wild red raspberry in 1963. On June 12, the ratio of specimens found on the canes and leaves was over four to one. In the collections made on the following week, all

specimens were found on the leaves. This remained the preferred feeding location until the August build up in population. From this time to the end of the season, only scattered irdividuals were found on the canes.

In quantitative collecting in commercial fields (Table 2), A. rubifolii was found most often on the upper leaves of black raspberry and on the lower leaves of red raspberry. This may be due to some morphological or physiological difference between these two plants, or to a seasonal morphological or physiological change within one of the plants. Since a graph of the numbers of aphids taken from the three leaf locations shows no seasonal trends or patterns and large numbers were found on the mid-leaves, it is probable that this species is fairly evenly distributed throughout the leaf strata.

One of the most interesting observations made was the duration of the fundatrices of A. rubifolii on the plant. These forms were found early in the spring and were present on the plants for a little over a month. In contrast, the fundatrices of other aphids, when found, were present on the plant for only a few days. It is possible that due to the abundance of this species the chances of collecting it were greater, and had other aphids been more common, equally long spans for their fundatrices would have been recorded. On the other hand, the time interval of the fundatrices of A. rubifolii may be due to some inate characteristic of the species. Since fundatrices are a relatively scarce morphological form that is rarely collected, this paradox is not likely to be resolved.

The sexuales of this species were frequently collected but

appeared later in the season than those of other raspberry aphids. These morphs, and viviparous females, also were found to remain on the plant well past the date when other species had disappeared. Egg production by colonies usually seemed to be quite large, which could account in part for the relative abundance of fundatrices in the spring and the early build up of colonies. Quantitative data for all years show that this aphid not only builds up in numbers earlier, but tends to remain on the plants in larger numbers later than any other of the raspberry aphids.

On wild red raspberry (Fig. 6), the population was already strong when collecting started on May 25, 1962 and on June 12, 1963. In commercial fields of raspberry the population had begun to build up during the first two weeks of June on the Vaughn Farm. On the Maxwell, Walle (black raspberry) and Johnson Farms, this increase began during the last weeks of June. Only on the Monte and Walle (red raspberry) Farms did the population increase start in the first weeks of July.

With the exception of the Monte and Johnson Farms, A. rubifolii was not only the dominant species, but the aphid population tended to be present for longer, unbroken periods than any other species. Evidently this species is either less demanding in its requirements or is not as readily affected by factors which control populations as other species.

Bodenheimer and Swirski (1957) and Dicker (1952) have suggested that aphid populations are influenced strongly by changes in the physiological activities of the host brought about by fruit formation. In the Lower Peninsula wild red raspberries were ripe about July 3;

cultivated raspberries were fully formed on June 15 and were picked from July 6 to 20. If this relationship holds true for raspberry plants and the aphids colonizing them, aphid populations would be expected to increase during these times and then to decline.

The only aphid species which increased its numbers prior to these dates was A. rubifolii (Fig. 6). But the populations of this species invariably increased later in the season; thus, it is not clear whether the initial rise in population was due to this fruit formation factor. Since the populations of Amphorophora rubi and A. sensoriata (Figs. 3 and 4) did not begin to increase until after the fruit was ripe or was picked, it is possible that there is some correlation between the termination of fruit formation and the increase in aphid population. A tentative explanation might be that once the fruit has matured or has begun to senesce there is a translocation of nutrients within the plant that is favorable to the growth of aphid populations. As no work has been done along these lines on raspberry plants, no definite conclusions can be arrived at.

Wild plants and home gardens harbor a large number of raspberry aphids; nurseries are probably less important reservoirs because they are frequently inspected and treated with insecticide (Table 1). Alate females from any of these three situations can readily fly to adjacent commercial fields and innoculate virus-free stock.

Blueberry Aphids

The most common aphid found on blueberry was Masonaphis pepperi which appears to be restricted to the extreme western part of the state

(Fig. 7). The only record that extends the range eastward is a single collection made in Montcalm Co. As this species has never been found on wild blueberry, there is a possibility that this species has not been able to extend its range to the east due to the lack of a "host bridge".

Myzus scammelli is a relatively rare aphid that is found in the eastern as well as the western parts of the Lower Peninsula. Quantitative sampling in the Michigan State University Horticulture Farm (Table 8) show that it occurred less frequently on the varieties Jersey and Blueray. However, prior to the sampling, large numbers of this species were observed on the variety Jersey. A varietal test, using larger numbers of plants, would be needed to show any host preference.

Although sexual forms of this aphid appeared quite early (Table 9), microscopic examinations for gravid females, and observations of oviposition and the first appearances of eggs indicate that oviposition probably commences between October 9 and 11. Most of the oviperous females and eggs were found on the leaves. Since very few leaves remain on the blueberry plant over the winter, the mortality rate during this stage of the life cycle must be very high. This could be one of the factors that account for the relative scarcity of this species.

From the data obtained (Table 8) this aphid appears to prefer a feeding location on the lower leaves of the plant. This data supports the author's observations in the field.

Marucci (1964) reports that in New Jersey he was not successful in transferring this aphid from its natural host (cranberry) to blueberry. Since this species has been reported from wild blueberry in Canada and on cultivated blueberry but not on cranberry in Michigan,

there exists the possibility that physiological races occur in this species.

Marucci apparently believes the condition of the leaf to be an important factor in this aphid's success in colonizing a plant and reports that this species becomes rarer as the season progresses. The author's field observations tend to confirm that this aphid prefers young, tender leaves, and data from the Michigan State Horticulture Farm (Fig. 10) show a marked decline in numbers after the beginning of August. Since the leaves growing from the new sucker growth remain tender and succulent for the longest time, it is likely that these leaves may support the largest numbers of this species. Verification of this hypothesis was not possible because of the relative scarcity of this species and because sampling with the D-Vac portable sampler does not allow for a visual inspection of the feeding locality.

In the Michigan State University Horticulture Farm, the new sucker growth on most varieties had reached the top of the leaf canopy on August 16. If the aphids were feeding mainly on this growth, a shift in feeding position from the base to the crown of the plant should have been observed. This was not apparent when the aphid data from the two feeding locations were graphed separately. However, the population of this aphid diminished noticeably after mid-August and it is possible that this was due to the new leaves hardening or to physiological changes in the sucker growth.

Bodenheimer and Swirski (1957) and Dicker (1952) have suggested that aphid populations are strongly effected by changes in host plant physiology brought about by fruit formation. Since most Michigan

blueberries are formed during the first two weeks of June, aphid populations would be expected to increase about this time and then taper off.

On the Horticulture Farm (Fig. 10), most berries were formed on June 1 although a few blossoms remained on the plants. Since the population of M. scammelli peaked on June 8 and then began to decline, it would appear that the population increase might have been in response to the increased physiological activity of the host.

Graphs of the aphid populations of commercial plantations (Figs. 8 and 10), do not show such a pattern. On the Wadsworth, DePree, Boohoo:, Pauls and Derkse Plantations, the populations of M. scammelli increased early enough to have been influenced by fruit formation. On the Wakeman and Double A Plantations the increase of this species came too late to be influenced by increased physiological activities of the host.

The populations of M. pepperi from the Wakeman, Wadsworth, Boohoo:, DePree, Chickaming, Hutchinson and Derkse Plantations all show an early build up, but with the exception of the last two sites, this increase in numbers lasted for too long a time to have been initiated mainly by fruit formation. On the Hartman, Double A and Pauls Plantations the population increase of this species came after the period of fruit formation, although on the Pauls Farm there was a small increase in mid-May.

If these aphid populations are to some extent controlled by the variations in host plant physiology, it would appear that M. scammelli is more responsive to these changes than is M. pepperi. On the other hand, since the fruit of the blueberry has a long ripening season, the

responses of aphids to physiological changes may extend to a later part of the season. If this is the case, then much of the mid-season increase in the population of M. pepperi may be a response to such a prolonged physiological stimulus. Since there are so many factors (including the insecticides applied) that could affect or modify these population responses, further investigations employing both field work and growth chamber studies are needed to clarify this problem.

Most of the plantations that were collected quantitatively in 1964 had populations of both blueberry aphids. An inspection of the graphs of these populations (Figs. 8 and 10) show that the population peaks of M. scammelli never coincided with those of M. pepperi, nor did a population of M. scammelli maintain itself when M. pepperi was strong in numbers. As previously mentioned, this could be due to a difference in response of the two species to changes in leaf morphology, or to changes in the physiology of the new sucker growth or the plant as a whole.

Since both of these aphids prefer to feed on the leaves at the base of the plant and since M. pepperi is the more prevalent and active of the two, there is the possibility that competition exists between these two aphids. This competition could be direct, in which case both species would be contending for the same feeding position, or the competition could be indirect. The latter situation might be brought about by the more active species feeding over a wide area of the plant and rendering leaves unsuitable for further feedings because of honeydew deposits or physiological changes within the leaf. Controlled rearing experiments may determine if any competition does exist.

Data presented in Table 5 show that there are no known reservoirs to harbor blueberry aphid populations in the Lower Peninsula. No aphids were ever found on wild blueberry or cranberry and very few specimens were found in home gardens. Since very few home gardens contain blueberry plants these situations can be disregarded as sources of infestation.

In attempts to determine the vectors of blueberry virus diseases, Aphis spiraecola should not be disregarded. This is a very common, polyphagous species which includes among its hosts, Indian hemp and spirea plants. Both of these plants have the same soil requirements as blueberry and are commonly found in blueberry plantations. Since host transfer tests in both the field and a growth chamber show that this aphid will accept blueberry as a temporary host for periods ranging up to twenty days, transmission tests for this species are indicated.

Strawberry Aphids

None of the eight species of strawberry aphid in the Lower Peninsula are restricted in their distribution, but five of them were not found in sufficient numbers to label them serious pests.

Acyrthosiphon pisum, a common polyphagous aphid, was not found to colonize strawberry plants to any great extent. In qualitative collecting it was taken infrequently in home gardens and commercial fields but never on nursery stock or on wild plants (Table 10). In quantitative collecting, it was not found on the Wendzel Farm and was present in only small numbers on the Tidey Farm and in the Michigan State University Horticulture Farm. The population peaks of this aphid

on the latter two sites occurred in mid-July (Fig. 11). This may have been the result of dispersal flights which this species makes whenever its host plant becomes undesirable due to physiological changes (Evans and Gyrisco 1956). Because of its abundance and fecundity (especially in producing alate females late in the season), it has the great potential of starting infestations at almost anytime of the year. As only one sexuale was ever found on strawberry and field observations did not indicate that the few infestations were particularly long in duration, permanent populations of this species on strawberry probably are not likely to occur.

Aphis forbesi, one of the best known of the strawberry aphids and the only species ever found feeding on the roots of the plant, did not prove to be as abundant as commonly supposed. In the quantitative collections of 1964 (Tables 11-13) it was one of the most infrequent species taken; qualitatively (Table 10) it ranked second in abundance but never accounted for a major portion of the collections. It was found to readily colonize wild strawberry and plants being grown in home gardens. These facts, in addition to its great destructive potential, render it a constant danger to commercial growers. The destructive potential of this species is apparently only realized when the aphids are found on the roots of the plant. Since it has been reported that ants carry the apterous females to the roots, it is possible that destructive infestations do not occur except when certain ant species are present. All of the ants found in association with this aphid belong to genera which commonly attend aphids, or are the most perfectly developed for attending aphids (Wheeler 1910). In the only two

destructive infestations observed by the author no ants were found in one field. The other field yielded large numbers of this aphid in association with the cornfield ant, Lasius alienus. As this ant is known to be responsible for destructive infestations of the corn root aphid Anuraphis maidiradicis (Forbes), further studies of these associations may indicate that the most practical approach to the control of A. forbesi is the elimination of colonies of specific ants from the fields.

It is doubtful that Aphis gossypii should be included in a list of species having strawberry as their true host. Only one oviparous female was ever found and evidently gamic reproduction on strawberry has never been recorded by other researchers. This species was found in small numbers in all collecting situations except wild strawberry (Table 10). Most collections consisted of nymphs, which suggests that these were deposited by alate females rather than from apterae that were colonizing the plants. However, its polyphagous nature, the frequency with which it is encountered in the field and in the greenhouse, and its ability to produce alate females late in the season render it able to start an infestation at any time. Because of its wide variability as to form and color, it is frequently mistaken for Aphis forbesi when found on strawberry plants.

Chaetosiphon fragaefolii, the most important vector of strawberry virus diseases, proved to be one of the rarest of aphids in the Lower Peninsula. It was never collected from wild strawberry or in commercial fields (Tables 10, 11, 13). The fact that it was found in small numbers in home gardens, nurseries and on the Michigan State University Horticulture Farm strongly suggest that this aphid is being introduced into

Michigan on strawberries shipped from other areas. (The fact that in the Horticulture Farm most specimens were found on the experimental hybrid, New Jersey 158, may be significant.)

On the few occasions that Macrosiphum rosae was collected, it was taken in commercial fields or on the Michigan State University Horticulture Farm. It apparently does not colonize strawberry to any extent in the Lower Peninsula. Since it was taken from cultivated rose bushes in Michigan, it probably prefers this plant as its primary host. About the only thing that can be said of this species, based on the few records obtained, is that it produces alate females very late in the season.

Acyrthosiphon porosum was found to be the most common aphid infesting cultivated strawberry. Wild strawberry accounted for only one record in four years of collecting (Table 10). Based on the few records of the author, this species appears to colonize rose plants as readily as strawberry. If further studies should show that rose plants are an important host in Michigan it would mean that this species has natural reservoirs from which to infest strawberry fields. This would more than compensate for the fact that it does not readily colonize wild strawberry. The most interesting observation made of this species is that it produced the earliest record of mature sexuales of all the small fruit aphids.

Chaetosiphon minor, the most important vector of virus diseases of strawberry in the lower peninsula of Michigan, was found to be the most abundant aphid colonizing wild plants and strawberries grown in home gardens. It was collected infrequently in commercial fields in

both qualitative and quantitative collecting (Tables 10, 11, 13). Since this aphid appears to prefer wild plants and the usual home-grown everbearing varieties to commercial varieties, it is possible that these plants may prove of value in a breeding program for developing aphid resistant strawberries. Sexual forms of this aphid appeared to have a long time span on the plants. Under certain conditions, egg production was observed to be moderately high.

Macrosiphum euphorbiae was found to infest commercial fields and home gardens fairly regularly but was never found on wild strawberry. In the Lower Peninsula this aphid uses strawberry as at least one of its primary hosts, and large infestations are sometimes found in the spring and fall. Like many migratory aphids, a residual population appears to remain on the primary host as long as this plant is in acceptable condition for feeding. This residual population, in addition to stray alates and the nymphs that they produce, accounts for the apparent steady colonization of strawberry in Table 14. The true migratory nature of this species is shown in the quantitative collections of 1964 (Fig. 13). On the Tidey Farm, a heavy spring build up tapered off and the species was not collected after July 26. Fall migrants returned to the field on October 31, but in no great numbers. Since by this date the fields were overgrown with weeds, it is likely that alate females were not attracted to the plants. The unthriftiness of the plants at this date would also have been detrimental to reproduction, so that a large fall population was not possible.

On the Horticulture Farm, the small spring population disappeared after June 8. Alate females on dispersal flights began to

build up a population at the end of August. It was not until mid-October that fall migrants began to return and the large fall population was produced.

A good population of M. euphorbiae was found on the Horticulture Farm in the fall of 1963. Since many varieties of plants growing in this garden are colonized by this aphid, it is possible that migrating females were readily attracted to the strawberry plots; thus, large populations were produced. The fact that this aphid was never found on wild strawberry would appear to be inconsistent with this species' characteristically wide tolerance of host plants. Since wild strawberry plants are usually found in scattered numbers hidden by other vegetation, alate females may not be attracted to them. This also may account for the fact that other common and polyphagous species were not found on wild strawberry.

No evidence of varietal resistance to aphids is apparent in the data secured in the quantitative collections of 1964. On the Tidey Farm (Table 11), the greatest number of all species was found on the variety Earlidawn. However, as the field was neglected after picking and both varieties became very unthrifty, this difference was more likely caused by one part of the field being in better condition than the other.

On the Wendzel Farm (Table 13), the scarcity of all aphid species may have been due to host plant resistance, or to cultural practices. As mentioned previously, the plants in this field were thinned out and cultivated regularly. These disturbances may have produced a micro-environment that was detrimental to population increase. Since the

canopy that is produced by densely grown plants was not formed until late in the year (when the population of Acyrthosiphon porosum began to increase), it is possible that the aphids were exposed to higher temperatures and insolation, and lower humidities than is optimum for survival and reproduction. In addition, the spaces between the rows were almost devoid of weeds that would normally have provided cover for the soil. As a result, splatterings of mud and layers of dust accumulated on the plants. This might have interferred with aphid feeding and respiration or actually contributed to the mortality rate, an observation reported by Dicker (1952) and Schaefers and Allen (1962). However, these conditions were not present early in the season when the plants were quite dense and were irrigated daily. At this time the habitat seemed quite normal yet produced extremely few aphids.

On the Horticulture Farm, not enough aphids were found to make a comparison of varieties, but it was obvious that the variety Midway had about as many aphids as the others. The most marked varietal difference was the percentage of Chaetosiphon fragaefolii and C. minor specimens taken from the variety, New Jersey 158 (Table 12). This variety was quite thrifty and succulent for most of the season and it is possible that the well being of these plants allowed for a greater increase in the numbers of the two species. It is also possible that one or both of these aphids were transported into Michigan on these plants.

With the exception of the Tidey Farm, none of the aphid populations showed any evidence of being influenced by physiological changes in the host plant due to fruit formation. On the Tidey Farm both the

populations of Macrosiphum euphorbiae and Acyrthosiphon porosum (Figs. 11 and 13) built up at about the time the strawberries were ripe and being picked. On the same farm however, the population of Chaetosiphon minor remained at low levels all season and showed no pattern that could be attributed to physiological changes in the host. Since the well defined early spring peaks and subsequent summer declines of M. euphorbiae and A. porosum follow so well the description given by Dicker (1952), further studies of this phenomena are in order. It also is possible that had the strawberries grown on the Michigan State University Horticulture Farm not been sprayed with insecticide on June 4 the aphid populations may have shown this same early seasonal peak.

Early Appearance of Aphids

In an effort to correlate the earliest appearances of small fruit aphids with some standard, Table 15 was prepared listing the date of collection of fundatrices and the growing degree days accumulated on this date. Only fundatrices found within a reasonable distance from a recording weather station are listed. Most of these specimens were collected on the Michigan State University campus where daily weather data are recorded. Growing degree days listed for specimens taken at a further distance from a weather station may be in error. Thus, the fundatrix of Macrosiphum euphorbiae was found in East Lansing, in a sheltered environment, about 1-1/2 miles from the weather station. The fundatrix of Myzus scammelli collected on May 11, was taken about five miles north of Holland, where the data were obtained.

Most of these morphs appeared over a wide range of temperature,

ranging from 76 to 244 growing degree days. Field observations indicate that within this range the leaves of blueberry and raspberry had just emerged at the lower figure, or were fairly well out at the upper level. Strawberries had not yet blossomed at the lower temperature level but were in full blossom at the upper level.

TABLE 15.--The appearance of the fundatrices of various aphid species correlated with growing degree days

Aphid Species	Date Collected	Growing Degree Days[a]
Acyrthosiphon porosum	May 10, 1964	269
Aphis forbesi	May 3, 1963	96
Aphis rubifolii	April 24, 1963	76
	May 4, 1964	159
Chaetosiphon minor	May 4, 1964	159
	May 8, 1964	244
Macrosiphum euphorbiae	April 26, 1964	83
Myzus scammelli	May 6, 1964	200
	May 11, 1964	210

[a]Accumulated from April 1, base 50° F.

The only morphs that invite comparison are those of M. scammelli. The fundatrix collected at East Lansing on May 6 was taken when 200 growing degree days had accumulated. The morph taken north of Holland on May 11 was found when 210 growing degree days had accumulated. If these figures are accepted as meaningful, there is apparently no difference in the time of appearance of aphids in the midland and in the coastal regions of Michigan, or at most, a differential of only five

days exists. However, if the true time span of the fundatrices of all species is equal to that of Aphis rubifolii, then this assumption may be incorrect.

Conclusions

With the exception of Macrosiphum euphorbiae, and possibly Acyrthosiphon pisum, none of the species studied show any evidence of being migratory. No aphids were ever observed feeding on the roots of raspberry or blueberry plants. Aphis forbesi was the only species collected from the roots of strawberry plants. Since only one nymph was ever recovered from leaf litter, and sexual forms of all species were found on the host plants, it is safe to assume that no imagines overwinter in this substrate.

LITERATURE CITED

Allen, W. W.
1959. Strawberry pests in California. Calif. Agr. Expt. Sta. Ext. Serv. Cir. 484. 39 pp.

Batchelder, C. H.
1927. The variability of Aphis gossypii. Ann. Entomol. Soc. Amer. 20:263-278.

Bennett, C. W.
1932. Further observations and experiments with mosaic virus of raspberry, blackberry and dewberry. Mich. Agr. Expt. Sta. Tech. Bul. 125. 32 pp.

Bodenheimer, F. S. and F. Swirski
1957 The Aphidoidea of the Middle East. Weizmann Science Press of Israel. Jerusalem. 378 pp.

Burger, T. L.
1966. A survey for possible virus disease vectors occurring on the cultivated blueberry Vaccinium corymbosum Linnaeus. M.S. Thesis, Mich. State Univ., East Lansing. (Unpublished.)

Cooley, L. M.
1936. Wild brambles in relation to spread of virus diseases in cultivated black raspberry. N.Y. Geneva Agr. Expt. Sta. Bul. 665. 15 pp.

Craig, D. L. and H. T. Stultz
1964. Aphid dissemination of strawberry viruses in Nova Scotia. Canad. J. Plant Sci. 44:235-239.

Cutright, C. R.
1925. Subterranean aphids of Ohio. Ohio Agr. Expt. Sta. Bul. 387. 175-238.

Daubeny, H. A. and R. Stace-Smith
1963. Notes on the immunity to the North American strain of the red raspberry mosaic vector, the aphid, Amphorophora rubi Kalt. Canad. J. Plant Sci. 43:413-415.

Demaree, J. B. and C. P. Marcus
1951. Virus diseases of strawberry in the United States with special reference to distribution, indexing, and insect vectors in the East. Plant Disease Rept. 35:527-537.

Dicker, G. H. L.
1952. The biology of the strawberry aphid, Pentatrichopus fragaefolii (Cock.) with special reference to the winged form. J. Hort. Sci. 27:151-178.

Dixon, W. J. and F. J. Massey, Jr.
1957. Introduction to statistical analysis. 2d ed. MacGraw-Hill Book Co., Inc., New York. 488 pp.

Eastop, V. F.
1958. The history of Macrosiphum euphorbiae (Thomas) in Europe. Entomologist 91:198-201.

Essig, E. O.
1948. Mounting aphids and other small insects on microscopic slides. Pan-Pac. Entomol. 24:9-22.

Evans, W. G. and G. G. Gyrisco
1956. Notes on the biology of the pea aphid. J. Econ. Entomol. 49:258-259.

Frazier, N. W.
1951. New aphid vectors of strawberry viruses. J. Econ. Entomol. 44:258-259.

Fulton, R. H.
1954. A study of virus diseases of strawberry in Michigan. Ph.D. Thesis, Mich. State Univ., East Lansing. (Unpublished.)

Hille Ris Lambers, D.
1947. Contributions to a monograph of the Aphididae of Europe III. Temminckia 7:179-319.

1950. On mounting aphids and other softskinned insects. Entomol. Ber., Amst., 13:55-58.

1953. Contributions to a monograph of the Aphididae of Europe V. Temminckia 9:1-176.

Hottes, F. C. and T. H. Frison
1931. The plant lice, or Aphididae, of Illinois. Bul. Ill. Nat. Hist. Survey 19:121-447.

Ibbotson, A. and J. S. Kennedy
1950. The distribution of aphid infestation in relation to leaf age. II. The progress of Aphis fabae Scop. infestations on sugar beets in pots. Ann. Appl. Biol. 37:680-696.

Kennedy, J. S., A. Ibbotson and C. O. Booth
1950. The distribution of aphid infestation in relation to leaf age. I. Myzus persicae (Sulz.) and Aphis fabae Scop. on spindle trees and sugar beet plants. Ann. Appl. Biol. 37: 651-679.

Kennedy, J. S., M. F. Day and V. F. Eastop
1962. A conspectus of aphids as vectors of plant viruses. Commonwealth Inst. Ent. London. 114 pp.

Knowlton, G. F.
1954. Capitophorous and Amphorophora aphid notes. Bul. Brooklyn Entomol. Soc. 49:8-11.

Kring, J. B.
1955. Biological separation of Aphis gossypii Glov. and Aphis sedi Kalt. Ann. Entomol. Soc. Amer. 48:442-444.

1959. Life cycle of the melon aphid, Aphis gossypii Glover, an example of faculative migration. op. cit., 52:284-286.

Leonard, M. D.
1963. A list of aphids of New York. Proc. Rochester Acad. Sci. 10:289-432.

Lockhart, C. L. and I. V. Hall
1962. Note on an indication of shoestring virus in the low-bush blueberry, Vaccinium augustifolium Ait. Canad. J. Bot. 40:1561-1562.

MacGillivray, M. E.
1958. A study of the genus Masonaphis Hille Ris Lambers, 1939 (Homoptera, Aphididae). Temminckia 10:1-131.

1965. Personal correspondence, Sept. 9.

Maki, J. R.
1965. A comparison of sampling methods used in field pesticide side effects studies. M.S. Thesis, Mich. State Univ., East Lansing. (Unpublished.)

Marcovitch, S.
1925. The strawberry root louse in Tennessee. J. Agr. Res. 30:441-449.

Marucci, P. E.
1964. Research specialist, Rutgers State Univ., Pemberton, New Jersey. Personal correspondence, Feb. 3.

Mason, P. W.
1923. The raspberry cane aphid (Hom.). Proc. Entomol. Soc. Wash. 25:188-190.

1925. A revision of the insects of the aphid genus Amphorophora. Proc. U.S. Nat. Museum 67:1-92.

1940. A revision of the North American aphids of the genus Myzus. U.S. Dep. Agr. Misc. Publ. 371. 31 pp.

Mc Clanahan, R. J.
1961. The role of insects in the epidemiology of cucumber mosaic virus. Ph.D. Thesis, Mich. State Univ., East Lansing. (Unpublished portion of thesis.)

Mellor, F. C. and A. R. Forbes
1960. Studies of virus diseases of strawberries in British Columbia. III. Transmission of strawberry viruses by aphids. Canad. J. Bot. 38:343-352.

Niemczyk, H. D. and G. E. Guyer
1963. The distribution, abundance and economic importance of insects affecting red and mammoth clover in Michigan. Mich. Ag. Expt. Sta. Tech. Bul. 293. 38 pp.

Palmer, M. A.
1952. Aphids of the Rocky Mountain Region. Thomas Say Foundation 5. 452 pp.

Paschke, J. D.
1959. Production of the agamic alate form of the spotted alfalfa aphid, Therioaphis maculata (Buckton). Univ. Calif. Pub. Ent. 16:125-180.

Patch, E.
1925a. Potato aphids. Maine Agr. Expt. Sta. Bul. 323:9-36.

1925b. The melon aphid. op. cit., 326:185-196.

1938. Food plant catalogue of the aphids of the world. op. cit., 393:35-431.

Plakidas, A. G.
1955. Virus diseases of strawberry, a review. Plant Disease Reptr. 39:525-540.

Richards, W. R.
1963. The Myzaphidines of Canada (Homoptera: Aphididae). Canad. Ent. 95:680-704.

Russell, L. M.
1962. Taxonomist, Insect Identification and Parasite Introduction Research Branch, U.S. Dept. Agr., Wash., D.C. Personal correspondence, Sept. 17.

Sampson, W.
1946. A generic classification of California aphids by means of first instar nymphs. Univ. Calif. Pub. Entomol. 7:365-402.

Schaefers, G. A.
1960. A systematic study of the strawberry aphid complex (Pentatrichopus spp.). Ann. Entomol. Soc. Amer. 53: 783-793.

Schaefers, G. A. and W. W. Allen
1962. Biology of the strawberry aphids Pentatrichopus fragaefolii (Cockerell) and P. thomasi Hille Ris Lambers, in California. Hilgardia 32:393-431.

Stace-Smith, R.
1960. Studies on Rubus virus diseases in British Columbia; varietal susceptibility to aphid infestation in relation to virus acquisition. Canad. J. Bot. 38:283-285.

Tuttle, D. M.
1947. A study of the insect fauna of the cultivated blueberry Vaccinium corymbosum, Linnaeus. M.S. Thesis, Mich. State Univ., East Lansing. (Unpublished.)

Wall, R. E.
1933. A study of color and color variation in Aphis gossypii Glover. Ann. Entomol. Soc. Amer. 26:425-460.

Wheeler, W. M.
1910. Ants; their structure, development and behavior. Columbia Univ. Press, N.Y. 663 pp.

Winter, J. D.
1929. A preliminary account of the raspberry aphids. Minn. Ag. Expt. Sta. Tech. Bul. 61. 30 pp.

APPENDIX I

A description of the sexual forms of *Amphoroplora sensorinia* Mason

P. W. Mason (1923, 1925) erected this species in 1923. He described the apterous and alate viviparous females and an intermediate form having brachipterous wings and characteristics of both the female morphs. In 1925 he revised the genus Amphorophora and again described the same three morphs of A. sensoriata. As a search of the literature fails to reveal a description of the sexuales of this species, there follows a description of these forms, which were collected by the author:[1]

Apterous Oviparous Female

Color of specimen in alcohol.--Head light brown, eyes red, rostrum dusky with apical segment dark. Antennal segments I and II dusky, segments III, IV and V brown, and the whole of segment VI black. Thorax, abdomen, cauda and cornicles whitish (presumably green in life) with tips of cornicles dusky. Legs light brown with distal part of tibia and tarsi dusky.

Morphological characteristics.--Body length (excluding cauda) 2.58, across eyes .55. Rostrum reaching hind coxae; last segment .13, obtuse. Antennae: 1st segment .12(?) & .16, slightly scabrous; 2nd segment .15(?) & .14, slightly scabrous; 3rd segment .88 & .84 with 15 & 20 sensoria more or less in a straight row, hairs .010-.015; 4th segment .59 & .54; 5th segment .40 & .39; base of 6th segment .17 & .16, ungues .71 & .62. Cauda .26, slightly tapered, with no construction, bearing two pair of lateral hairs and one dorsal preapical hair.

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[1] All measurements are in millimeters.

Cornicles: length .52 & .49; widest part .09 & .08; narrowest part .04 & .04; flange distinct, .042 & .045. Hind tibia 1.92 & 1.91, with some 53 & 58 pseudosensoria on the basal 1/2 to 3/4 part. Second hind tarsal joints .17 & .16. All first tarsal joints with 3 hairs. Abdomen with a few, very small and faint, marginal sclerites.

Slide # R-143, labelled morphotype, taken on cultivated black raspberry (Rubus occidentalis L.), 11 Oct. 1964, E. Lansing, Michigan. Remounted 7 April 1965. Deposited in the Entomology Museum, Michigan State University, along with 19 slides of oviparous females.

Fig. 14.--Amphorophora sensoriata Mason. Oviparous female.

Measurements of Apterous Oviparous Females

No.	Body Length	Cornicle	Cauda	Sensoria on III	Antennal Segments III	IV	V	VI
R-143a	2.29 (?)	0.52	0.23	15	0.78	0.60	0.41	0.19 & 0.81
		0.52		14	0.75	0.60	0.44	0.19 & 0.83
R-146b	2.58	0.58	0.29	28	0.85	0.67	0.43	0.18 & 0.66
		0.55		31	0.91	0.73	0.46	0.20 & 0.80
R-146b	2.81	0.53	0.27	29	0.90	0.62	0.42	0.16 & 0.30 (?)
		0.53		30	0.88	0.61	0.42	0.15 & 0.31 (?)
R-147	2.43	0.51	0.25	19	0.79	0.55	0.36	0.16 & 0.69
		0.50		17	0.80	0.54	0.38	0.18 & -
R-147a	2.24	0.47	0.20	14	0.72	0.43	0.33	0.16 & 0.64
		0.46		12	0.73	0.42	0.31	0.16 & 0.65
R-194c	2.35 (?)	0.47	0.22	14	0.71	0.47	0.37	0.16 & 0.76
		0.49		16	0.70	0.50	0.35	0.16 & 0.74
R-197c	2.27	0.47	0.25	20	0.84	0.60	0.46	0.19 & 0.78
		0.48		24	0.82	0.60	0.45	0.18 & 0.74
R-198	2.50	0.50	0.26	17	0.84	0.56	0.41	0.18 & 0.80
		0.48		14	0.81	0.54	0.42	0.17 & 0.79
R-198a	2.76	0.55	0.28	22	0.92	0.61	0.49	0.19 & 0.86
		0.54		23	0.93	0.63	0.51	0.20 & 0.84
R-198b	2.77	0.53	0.27	22	0.90	0.65	0.45	0.19 & 0.80
		0.52		17	0.89	0.61	0.44	0.19 & 0.84
R-200	2.79	0.53	0.25	27	0.87	0.62	0.44	0.17 & 0.82
		0.53		23	0.82	0.62	0.45	0.17 & 0.78
R-201	1.98	0.47	?	29	0.80	0.55	0.38	0.15 & 0.40 (?)
		0.50		26	0.78	0.56	0.41	0.15 & 0.64
R-203	2.56	0.54	0.26	19	0.84	0.66	0.46	0.19 & 0.19 (?)
		0.52		13	0.84	0.62	0.42	0.19 & 0.87
R-204	2.82	0.52	0.24	18	0.88	0.64	0.46	0.17 & 0.86
		0.52		24	0.87	0.64	0.46	0.16 & 0.85
R-205	2.48	0.53	0.23	19	0.98	0.69	0.52	0.19 & 0.87
		0.54		13	0.95	0.70	0.51	0.19 & 0.84

R-207	2.76	0.57	0.27	21	0.92	0.69	0.49	0.19 & 0.90
		0.54		26	0.93	0.69	0.47	0.18 & 0.91
R-208	2.42	0.54	0.25 (?)	17	0.88	0.64	0.47	0.18 & 0.81
		0.53		14	0.87	0.64	0.47	0.19 & 0.82
R-209	2.58	0.54	0.24	22	0.83	0.60	0.42	0.17 & 0.76
		0.53		23	0.85	0.62	0.43	0.17 & 0.80
R-212	1.98	0.50	0.29	25	0.80	0.57	0.43	0.18 & 0.81
		0.50		19	0.81	0.57	0.42	0.18 & 0.74

(R-143a from cultivated black raspberry, 11 Oct. 1964, E. Lansing, Mich.; R-146b, R-146h from wild black raspberry (Rubus occidentalis L.), 12 Oct. 1964, E. Lansing, Mich.; R-147, R-147a from cultivated black raspberry, 12 Oct. 1964, E. Lansing, Mich.; R-194c from cultivated black raspberry, 31 Oct. 1964, Lincoln & Marquette Woods Road, Berrien Co., Mich.; R-197c from cultivated black raspberry, 16 Oct. 1964, E. Lansing, Mich.; R-198, R-198a, R-198b from wild black raspberry, 16 Oct. 1964, E. Lansing, Mich.; R-200, R-201, R-203, R-204, R-205, R-207, R-208, R-209, R-212 from wild black raspberry, 16 Oct. 1964, E. Lansing, Mich. All specimens from U.S.A.)

Apterous Male

Color of specimen in alcohol.--Head light brown, eyes red, rostrum dusky with apical segment dark, antennae black. Thorax, abdomen, cauda, cornicles and femora whitish (presumably green in life), with cornicles dusky near flange and distal part of femora light brown. Tibia light brown with distal 1/3 becoming dusky. Tarsi dusky.

Morphological characteristics.--Body length (excluding cauda) 2.26, across eyes .49. Rostrum attaining hind coxae; last segment .12, rather obtuse. Antennae: 1st segment .12 & .12, scabrous; 2nd segment .90 & .80, scabrous; 3rd segment .81 & .80 with 47 and 46 sensoria in irregular row over the entire length; 4th segment .55 & .54 with 11 & 12 sensoria in more or less straight row over the entire length; 5th segment .36 & .38 with 8 & 10 sensoria in more or less straight row over the entire length; 6th segment .15 & .14, ungues .60 & .82. Hairs; on vertex .005, on 3rd antennal segment .005 -.01. Cauda .20, tapering but not constricted, bearing three pair of lateral hairs and one dorsal preapical hair. Cornicles: length .40 & .41; widest part .060 & .065; narrowest part .04 & .04; distinct flange .045 & .040. Hind tibia 1.70 & 1.71 with 1 & 1(?) pseudosensoria. Second hind tarsal joints .165 & .155. First tarsal joints on left side with 3 hairs, on right side with 2 hairs. Prothorax with small, dark marginal sclerites. Abdomen with medium sized, dark marginal sclerites and large dark intersegmental sclerites. Abdominal II & III with dorsal dark spots, abdominal IV with smaller dark spots.

Slide #R-146i, labelled morphotype, taken on wild black

raspberry (Rubus occidentalis L.), 12 Oct. 1964, E. Lansing, Michigan. Remounted 12 April 1965. Deposited in the Entomology Museum, Michigan State University, along with 11 slides of apterous males.

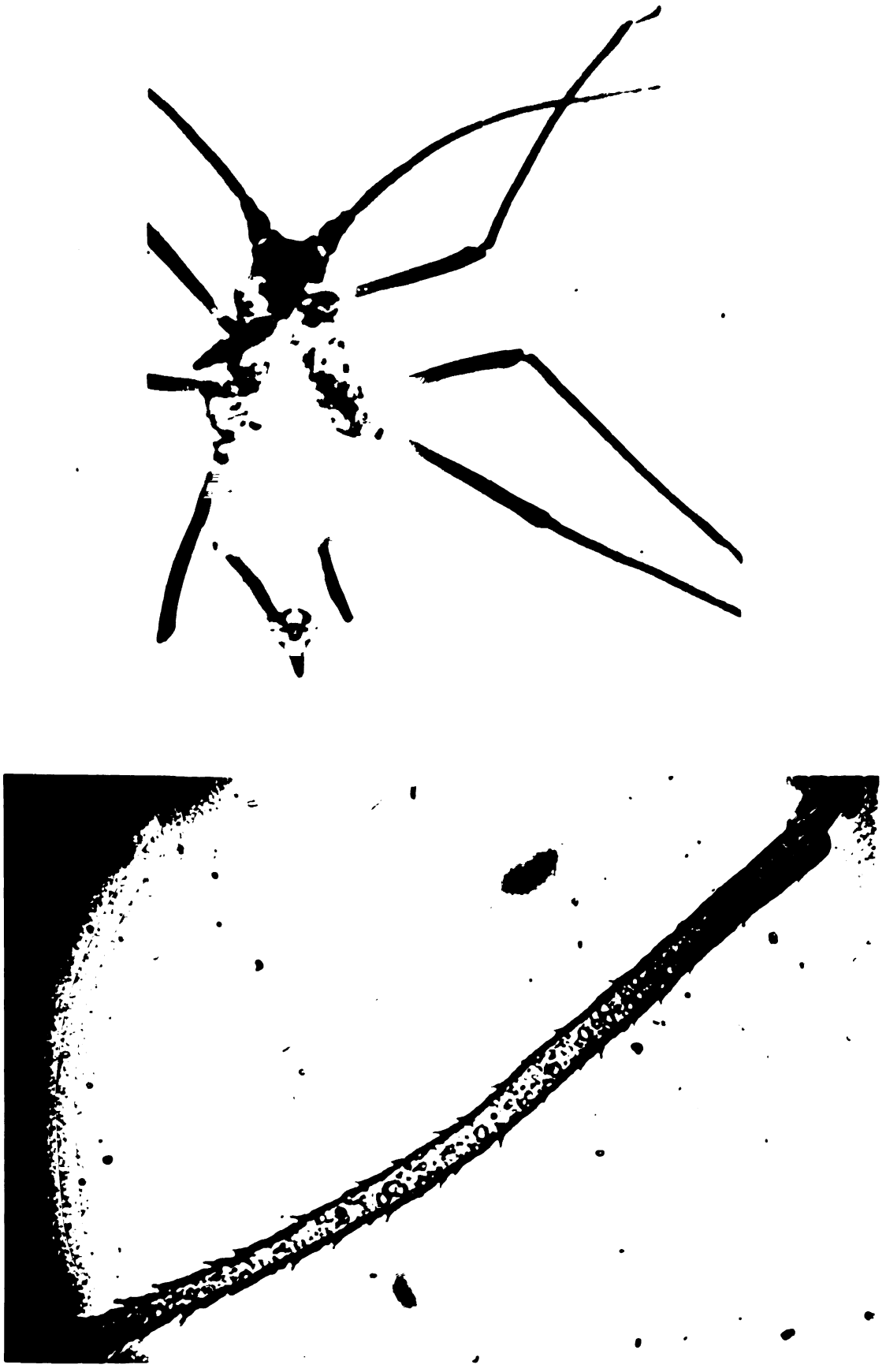

Fig. 15.--Amphorophora sensoriata Mason. (Top) Male. (Bot.) Hind tibia of male, slide R-206.

Measurements of Apterous Males

No.	Body Length	Cornicle	Cauda	Pseudosensoria on Tibia	Antennal Sensoria III	Antennal Sensoria IV	Antennal Sensoria V	Antennal Segments III	Antennal Segments IV	Antennal Segments V	Antennal Segments VI
R-146c	1.96	0.33	?	4	49	6	6	0.82	0.50	0.30	- & -
		0.36		6	45	6	6	0.77	0.51	0.26	0.12 & 0.70
R-146d	2.35	0.43	0.21	13	47	8	8	0.83	0.57	0.35	0.12 & 0.73
		0.43		3	45	8	7	0.83	0.56	0.35	0.14 & 0.70
R-146e	2.23	0.31	0.20	0	29(?)	10	10	0.76	0.51	0.33	0.13 & 0.71
		0.38		0	47	7	6(?)	0.80	0.49	0.32	0.14 & 0.74
R-146f	2.03	0.38	0.19	1	41	7	4	0.82	0.51	0.34	0.13 & 0.74
		0.40		1	38	6	2	0.83	0.52	0.34	0.13 & -
R-147d	1.96	0.38	1.10(?)	1	37	5	5	0.81(?)	0.42(?)	0.36	0.14 & 0.70
		0.38		0	37	4	6	0.80(?)	0.40(?)	0.31	0.14 & 0.75
R-194	1.89	0.39	0.18	31	35	12	5	0.76	0.52	0.35	0.15 & 0.87
		0.40		14	31	8	7	0.75	0.51	0.35	0.15 & 0.80
R-197a	1.84	0.35	0.18	1	35	6	6	0.66	0.43	0.29	0.15 & 0.67
		0.36		4	34	9	8	0.67	0.46	0.27	0.15 & 0.70
R-202	1.84	0.40	0.18	15	36	-	-	0.77	-	-	- & -
		0.40(?)		2	35	1	7	0.74	0.51	0.37	0.16 & 0.77
R-206	1.66	0.38	0.17(?)	25	32	12	6	0.67	0.52	0.35	0.14 & 0.81
		0.39		25	31	11	7	0.67	0.50(?)	0.32	0.13 & 0.74
R-215	1.57(?)	0.40	0.20	5	41	1	7	0.83	0.59	0.39	0.16 & 0.89
		0.41		9	44	5	9	0.86	0.60	0.42	0.16 & 0.84
R-216	1.90	0.40	0.22	21	43	12	6	0.72	0.57	0.33	0.14 & 0.79
		0.41		21	41	8	7	0.72	0.54	0.33	0.14 & 0.83

(R-146c, R-146d, R-146e, R-146f from wild black raspberry, 12 Oct. 1964, E. Lansing, Mich.; R-147d from cultivated black raspberry, 12 Oct. 1964, E. Lansing, Mich.; R-194 from cultivated black raspberry, 31 Oct. 1964, Lincoln & Marquette Woods Road, Berrien Co., Mich.; R-197a from cultivated black raspberry, 16 Oct. 1964, E. Lansing, Mich.; R-202, R-206, R-215, R-216 from wild black raspberry, 16 Oct. 1964, E. Lansing, Mich. All specimens from the U.S.A.)

APPENDIX II

The distribution of small fruit aphids in the lower peninsula of Michigan

	Acyrthosiphon pisum	*Acyrthosiphon porosum*	*Amphorophora rubi*	*Aphorophora sensoriata*	*Aphis forbesi*	*Aphis gossypii*	*Aphis rubifolii*	*Chaetosiphon fragaefolii*	*Chaetosiphon minor*	*Macrosiphum euphorbiae*	*Macrosiphum rosae*	*Masonaphis pepperi*	*Mesonaphis rubicola*	*Myzus scammelli*
Alcona			+				+							
Allegan	+	+	+	+	+		+					+	+	+
Alpena	+	+	+			+				+			+	
Antrim			+						+				+	
Arenac[1]														
Barry				+										
Bay								+						
Benzie							+			+				
Berrien	+	+	+	+	+	+	+		+	+		+		
Branch				+			+							
Calhoun			+	+			+		+					
Cass	+	+		+	+	+	+		+				+	
Charlevoix			+										+	
Cheboygan			+				+		+					
Clare			+											
Clinton									+					+
Crawford[1]														
Eaton						+								
Emmet			+		+		+	+					+	
Genesee		+	+	+	+				+	+	+			+
Gladwin[1]														
Grand Traverse[1]														
Gratiot									+					
Hillsdale				+			+							

	Acyrthosiphon pisum	Acyrthosiphon porosum	Amphorophora rubi	Amphoropfora sensoriata	Aphis forbesi	Aphis gossypii	Aphis rubifolii	Chaeosiphon fragaefolii	Chaetosiphon minor	Microsiphum euphorbiae	Microsiphum rosae	Masonaphis pepperi	Masonaphis rubicola	Myzus sammelli
Huron			+							+			+	
Ingham	+	+	+	+	+	+	+	+	+	+	+		+	+
Ionia		+	+											
Iosco[1]														
Isabella			+											
Jackson[1]														
Kalamazoo		+	+	+					+					
Kalkaska[1]														
Kent			+	+									+	
Lake[1]														
Lapeer														+
Leelanau			+						+					
Lenawee[1]														
Livingston							+							
Macomb[1]														
Manistee			+				+							
Mason			+										+	
Mecosta[1]														
Midland[1]														
Missaukee					+			+					+	
Monroe			+				+		+					
Montcalm			+	+	+							+		+
Montmorency[1]														
Muskegon			+		+		+					+		+
Newaygo			+	+									+	

	Acyrthosiphon pisum	Acyrthosiphon porosum	Amphorophora rubi	Amphorophora sensoriata	Aphis forbesi	Aphis gossypii	Aphis rubifolii	Chaetosiphon fragaefolii	Chaetosiphon minor	Macrosiphum euphorbiae	Macrosiphum rosae	Masonaphis pepperi	Masonaphis rubicola	Myzus scammelli
Oakland									+					
Oceana			+									+		
Ogemaw[1]														
Osceola			+										+	
Oscoda[1]														
Otsego[1]														
Ottawa		+	+		+				+	+		+		+
Presque Isle			+											
Roscommon[1]														
Saginaw			+				+		+					
Sanilac			+				+							
Shiawassee									+					
St. Clair[1]														
St. Joseph				+			+		+					
Tuscola				+					+					
Van Buren	+	+	+	+	+	+	+		+	+		+		+
Washtenaw				+			+							
Wayne			+	+			+							
Wexford													+	

[1]County not surveyed.

APPENDIX III

A list of predators collected from small fruit fields in the lower peninsula of Michigan

	Raspberry Fields	Blueberry Plantations	Strawberry Fields	Blackberry Fields
Neuroptera[1]				
Hemerobiidae				
Micromus posticus (Walk.)		+	+	
Micromus subanticus (Walk.)			+	
Micromus variolosus Hag.		+		
Psectra diptera (Burm.)	+			
Chrysopidae				
Chrysopa carnea Steph.	+	+		
Chrysopa oculata Say	+		+	+
Chrysopa rufilabris Burm.	+	+		
Chrysopa sp.	+			
Coleoptera[2]				
Coccinelidae				
Adalia bipunctata L.	+			
Ceratomegilla maculata DeGeer		+		
Coccinella novemnotata Herbst	+	+	+	
Coccinella trifasciata L.	+		+	
Cycloneda munda (Say)	+			
Hippodamia convergens Guérin	+	+	+	
Hippodamia parenthesis (Say)			+	
Hippodamia tredecimpunctata tibialis (Say)	+			
Psyllobora vigintimaculata (Say)		+		
Diptera				
Syrphidae	+	+		
Unidentified larvae				

[1]Determination by O. S. Flint, United States Department of Agriculture.

[2]Determination by Thomas Hlavac, Graduate Student, Department of Entomology, Michigan State University.

APPENDIX IV

A list of parasites reared from some small fruit aphids collected in the lower peninsula of Michigan

Acyrthosiphon porosum (Sand.)

Aphidius nigripes Ashm.[2]

Aphidius sp.[2]

Asaphes lucens (Prov.)[1]

Amphorophora sensoriata Mason

Unidentified dipterous endoparasite.

Aphis gossypii Glov.

Aphelinus semiflavus How.[1]

Aphis rubifolii (Thomas)

Lysiphlebus testaceipes (Cr.)[2]

Chaetosiphon minor (Forbes)

Asaphes lucens (Prov.)[1]

Charips sp.[1]

Lysaphidus rosaphidus Sm.[2]

Lysaphidus sp.[2]

Macrosiphum euphorbiae (Thomas) (Aphid host collected from cultivated tomato, Lycopersicon sp.)

Aphidencyrtus aphidivorus (Mayr)[1]

Aphidius nigripes Ashm.[2]

Aphidius sp. possibly nigripes Ashm.[2]

Asaphes lucens (Prov.)[1]

Charips sp.[1]

Pachyneuron siphonophorae (Ashm.)[1]

Pachyneuron sp.[1]

Unidentified dipterous endoparasite

Myzus scammelli Mason

Praon sp.[2]

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[1]Determination by B. D. Burks.

[2]Determination by P. M. Marsh.

APPENDIX V

A list of ants found in association with some small fruit aphids collected in the lower peninsula of Michigan

Aphis forbesi Weed

Crematogaster cerasi (Fitch)

Crematogaster lineolata (Say)

Lasius alienus (Foerster)

Myrmica (Myrmica) sabuleti americana Weber

Prenolepis imparis imparis (Say)

Aphis rubifolii (Thomas)

Crematogaster lineolata (Say)

Formica (Formica) sp.

Lasius alienus (Foerster)

Prenolepis imparis imparis (Say)

Myzus scammelli Mason

Prenolepis imparis imparis (Say)

Determinations of ants by D. R. Smith, United States Department of Agriculture.

APPENDIX VI

A description of the raspberry, blueberry and strawberry collecting sites sampled during the years 1961 to 1964

Raspberry Collecting Sites

Wild Red Raspberry

Ingham Co., Michigan State University campus, Farm Lane Road at the junction of the Grand Trunk Railroad tracks. This stand was approximately ninety feet long and eighteen feet wide. Plants were growing in a ditch in boggy soil. The water table was high and the lower areas of the plot frequently contained standing water. This plot was rarely disturbed and never treated with herbicides or pesticides.

Collecting dates:

1961. July 4 to November 21.

1962. May 25 to November 9.

1963. June 12 to November 6.

Cultivated Raspberry (Collecting from June 8 to September 28.)

Berrien Co., Mrs. P. Monte, 2 miles north of Benton Harbor, Monte and Koschke Roads. 5 year old black raspberry, variety Logan, planted in 30 rows each about 105 paces long. Applied 5-20-20 fertilizer in 1962 but no fertilizer was applied in 1963. Applied lime-sulfur in April and pruned the plants in March. These plants were about 24 inches high by May 18. No insecticides were used.

This was a poor stand of raspberry. The plants became unthrifty as the season progressed, possibly due to virus diseases and competition with weeds.

Van Buren Co., Mr. Mary Johnson, Sr., 2-1/2 miles southeast of Hartford, 64th St. and County Road 681. Fifteen acres of 1, 2 and 3 year old black raspberry, variety Logan. Only the 2 and 3 year old plantings were sampled. These were planted in 96 rows each about 90 paces long. Applied 12-12-12 fertilizer and lime sulfur the first week in April. Pruning was completed on April 13. Plants were about 27 inches high on April 14. No insecticides were applied.

Allegan Co., Mr. E. S. Maxwell, 1-1/2 miles south of Glenn, Spring Grove Road and U.S. 31. Eight year old black raspberry, variety Cumberland, planted in 10 rows about 122 paces long. Applied 12-12-12 fertilizer during the spring of 1963. Applied Ferbam June 24. Pruning was in process on April 14 and by May 18 plants were about 31 inches high. No insecticides were applied.

This stand of raspberry was in fairly good condition at the beginning of the season. As the season progressed the condition of the plants deteriorated, probably due to competition with weeds. By late August many of the raspberry plants were obscurred by the weeds growing among them.

Allegan Co., Mr. E. Wolle, two miles east of Pullman, 60th St. and 108th Ave. Five year old black raspberry, variety Logan, planted in 17 rows each about 120 paces long. Lime sulfur was applied during the first week of April but no fertilizer or insecticides were used.

Four-year old red raspberry, variety Latham, planted in 13 rows each about 80 paces long. Lime sulfur and liquid

Nitrogen were applied during the third week of April but no insecticides. Dead canes of both red and black raspberry were removed during the last two weeks of August. Pruning had been done in the fall of 1962.

The red and black raspberry plots were separated by a small creek. The water table in this field was very high, and during the summer the topsoil frequently showed patches of moisture.

Allegan Co., Mr. R. Vaughn. 2-1/2 miles southwest of Allegan 37th St. and 109th Ave. Seven year old black raspberry, variety Cumberland, planted in 9 rows each about 80 paces.

Nine year old red raspberry, variety Latham, planted in 5 rows each about 50 paces long. Both red and blacks had received organic fertilizer in the past but in the spring of 1963, 12-12-12 fertilizer had been applied. Lime sulfur was applied in April. Pruning was done during the Fall of 1962 and by May 18 the black raspberries were about 34 inches high and the red raspberries about 40 inches high. Between July 27 and August 10, a large portion of the black raspberry plot was plowed up, leaving only four rows measuring about 74 paces.

Blueberry Collecting Sites

Ingham Co., Michigan State University Horticulture Farm, E. Lansing. No chemical fertilizers or insecticides had been applied for at least three years. Good crops of berries were produced in 1964 and 1965. All plants were at least ten years old. This site

was sampled from June 1 to November 8.

Commercial Blueberry Plantations (These sites were sampled by Mr. T. Burger from May 7 until September 12.)

Berrien Co., Chickaming Plantation; Holoway Drive and highway U.S. 12. Two acres sampled. Aerial applications of Malathion dust were made on May 29, June 11, 21 and 25, July 11 and 22, and August 8.

Berrien Co., Hutchinson Plantation; Sawyer Road and highway U.S. 12. Two acres sampled. Malathion as a wettable powder was applied by means of ground equipment on May 6, 17 and 27, June 8, 19 and 30, July 10 and 20, and August 7 and 20.

Van Buren Co., Hartmann Plantation; Base Line Road and 60th Street. Twenty-five acres sampled. Aerial applications of Malathion dust were made on May 30, June 12 and 24 and July 2, 14 and 26.

Van Buren Co., Wakeman Plantation, 26th Avenue and County Road 681. Sixteen acres sampled. Malathion as a wettable powder was applied with ground equipment on May 6, 17 and 30, June 12 and 27, and July 8. An aerial application of Malathion dust was made on July 27.

Allegan Co., Double A Blueberry Farm; 140th Street and highway U.S. 31. Ten acres sampled. Aerial applications of Malathion dust were made on May 31, June 14 and 27, July 9 and 18, and August 3.

Allegan Co., Wadsworth Plantation; 58th Street and highway M-89. Twenty acres sampled. Aerial applications of Malathion dust were made on May 31, June 14 and 25, and July 5, 15 and 27.

Ottawa Co., DePree Plantation; Riley Road and 160th Street. Twenty acres sampled. Aerial applications of Malathion dust were made on May 30, June 16 and 27, July 10 and 19, and August 3.

Ottawa Co., Boohoot Plantation; New Holland Street and 160th Avenue. Thirty-five acres sampled. Aerial applications of Malathion dust were made on May 31, June 16 and 27, and July 10, 19 and 31.

Muskegon Co., Pauls Plantation; Mt. Garfield Road and Harvey Road. Forty acres sampled. Aerial applications of Malathion dust were made on May 27 and 30, June 20 and 29, and August 9. On June 4, Guthion as a wettable powder was applied with ground equipment.

Muskegon Co., Derkse Plantation; Farr Road and Stringer Road. Forty-five acres sampled. Aerial applications of Malathion dust were made on May 27 and 31, June 24, July 11 and 23, and August 9. Parathion dust was applied by air on June 4.

Strawberry Collecting Sites

Ingham Co., Michigan State University Horticulture Farm, E. Lansing. No fertilizers were applied. Plants were irrigated for frost control but no irrigation was carried out after May 30. No insecticides were to have been applied, but through an error, Methoxychlor was applied on June 4. The plants were in good

condition at the time of collecting and a good crop of berries was produced. Weeds became a problem and the test strips were weeded by hand on August 2 and September 13. This site was sampled from June 1 to November 8.

Berrien Co., Mr. O. Tidey, Sr., Brush Lake Road and Highway M-62. Second year strawberries; variety Tennessee Beauty, 2-1/2 acres; variety Earlidawn, 2-1/2 acres. Applied 14-14-14 fertilizer in 1963 but no fertilizer was applied in 1964. Applied Fixed Copper and Hydrated Lime plus Guthion as first cover and Captan and Guthion as a second cover. This field was irrigated once a week, but no irrigation was carried out after the crop was picked. The strawberry plants were a bit sparse and there were quite a few weeds growing in the field when collecting began. The problem of weeds became worse as the season progressed. Control had been attempted by means of geese but on July 19 the weeds had to be cut down to the level of the strawberry hills. The owner denied using any chemical weed control but on July 26 the weeds growing between the hills showed evidence of having been sprayed. By mid-August the strawberry plants were completely hidden by weeds. This farm was sampled from May 31 to November 14.

Van Buren Co., A. Wendzel Farm, County Road 352 and 62 Street. Second year strawberries, variety Midway, 5 acres. This field was irrigated daily until harvesting was completed. After this the field was irrigated approximately once a week for two hours. The plants were in excellent condition throughout the season.

By means of herbicides and mechanical cultivation weeds were kept to a minimum. Plants were cross rogued frequently and runner production was good. Guthion only was applied as first and second covers. This farm was sampled from June 7 to November 14.

APPENDIX VII

Actual numbers of raspberry aphids collected in quantitative samples made by hand

Michigan State University Campus, 1961

Wild Red Raspberry

Aphid Species	Sampling Dates																		
	7/4	7/12	7/19	7/25	8/2	8/9	8/14	8/21	8/30	9/7	9/14	9/22	9/27	10/6	10/18	10/24	10/31	11/7	11/14
Amphorophora rubi	-	-	-	-	-	17	53	55	42	7	-	-	12	-	1	-	-		1
Amphorophora sensoriata	-	-	-	-	-	6	17	8	-	1	-	-	-	-	-	-	-	-	-
Aphis rubifolii	24	-	24	6	-	21	60	29	22	9	31	30	11	3	13	14	8	-	2
Masonaphis rubicola	-	-	-	-	-	-	-	-	-	-	-	-	3	-	5	-	-		-

Michigan State University Campus, 1962

Wild Red Raspberry

Aphid Species	Sampling Dates																		
	5/25	6/1	6/12	6/22	6/29	7/6	7/13	7/27	8/10	8/17	8/24	9/7	9/14	9/21	10/12	10/19	10/26	11/2	11/9
Amphorophora rubi	-	-	-	-	1	-	5	-	7	15	7	-	-	-	1	2	-	-	-
Amphorophora sensoriata	-	-	-	-	-	-	2	-	-	4	-	-	-	-	-	-	-	-	-
Aphis rubifolii	6	14	-	41	18	-	3	-	-	4	1	23	6	8	14	12	14	9	2
Masonaphis rubicola	-	-	-	-	-	-	-	-	-	-	-	-	-	69	1	-	-	-	-

Michigan State University Campus, 1963

Wild Red Raspberry

Aphid Species	Sampling Dates																				
	6/12	6/19	6/26	7/3	7/10	7/17	7/24	8/7	8/14	8/21	8/28	9/4	9/11	9/18	9/25	10/2	10/9	10/16	10/23	10/30	11/6
Amphorophora rubi	-	-	-	2	-	-	1	4	11	6	13	7	1	1	4	1	17	20	24	8	-
Amphorophora sensoriata	-	-	-	-	-	-	-	4	5	1	4	8	1	3	5	-	8	-	-	-	-
Aphis rubifolii	36	6	9	31	12	23	14	47	452	328	396	-	-	-	1508	513	1249	1576	1184	624	16
Masonaphis rubicola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Commercial Raspberry Fields, 1963

Aphid Species	Sampling Dates															
	6/8	6/15	6/22	6/29	7/6	7/13	7/20	7/27	8/10	8/17	8/24	8/29	9/7	9/14	9/21	9/28
Johnson Farm																
Amphorophora rubi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Amphorophora sensoriata	1	-	-	-	-	-	46	43	298	572	279	44	109	20	15	-
Aphis rubifolii	2	-	-	18	7	13	12	11	7	96	-	5	7	-	6	1
Masonaphis rubicola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Monte Farm																
Amphorophora rubi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Amphorophora sensoriata	-		-	-	-	211	2	-	-	-	-	-	-	-	-	-
Aphis rubifolii	1	-	-	-	-	14	8	14	1	-	-	-	-	-	-	3
Masonaphis rubicola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Maxwell Farm																

Amphorophora rubi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Amphorophora sensoriata	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	
Aphis rubifolii	-	-	-	3	6	1	1	-	-	9	-	4	93	2	42	-	
Masonaphis rubicola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Walle Farm, Black Raspberry																	
Amphorophora rubi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Amphorophora sensoriata	-	-	-	-	-	-	2	-	10	-	-	5	-	-	-	-	
Aphis rubifolii	6	5	6	57	10	31	87	23	5	158	-	110	85	12	15	12	
Masonaphis rubicola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Walle Farm, Red Raspberry																	
Amphorophora rubi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Amphorophora sensoriata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Aphis rubifolii	-	-	-	-	17	1	-	-	-	-	-	1	-	-	-	-	

Commercial Raspberry Fields, 1963.--Continued

Aphid Species	Sampling Dates															
	6/8	6/15	6/22	6/29	7/6	7/13	7/20	7/27	8/10	8/17	8/24	8/29	9/7	9/14	9/21	9/28
Masonaphis rubicola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaughn Farm, Black Raspberry																
Amphorophora rubi	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Amphorophora sensoriata	-	-	-	-	-	-	13	-	16	30	-	20	-	-	-	11
Aphis rubifolii	3	17	27	20	-	2	6	1	-	22	-	1	2	7	13	25
Masonaphis rubicola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaughn Farm, Red Raspberry																
Amphorophora rubi	-	1	2	1	-	-	1	5	-	-	-	9	6	1	1	-
Amphorophora sensoriata	-	-	-	-	-	-	-	-	2	-	-	15	-	1	-	-
Aphis rubifolii	3	9	21	3	8	-	1	16	-	-	-	5	1	4	8	3
Masonaphis rubicola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

APPENDIX VIII

Actual numbers of blueberry aphids collected in quantitative samples made with a D-Vac sampler in 1964

Berrien County, 1964

Aphids Species	Sampling Dates 5/8	5/27	6/15	7/6	7/27	8/18	9/10
			Hutchinson				
Masonaphis pepperi	-	-	4	9	1	3	-
Myzus scammelli	-	-	-	-	-	-	-
			Chickaming				
Masonaphis pepperi	-	3	-	-	2	-	-
Myzus scammelli	-	-	-	-	-	-	-

Van Buren County, 1964

Aphids Species	Sampling Dates 5/7	5/25	6/16	7/8	7/28	8/19	9/11
			Wakeman				
Masonaphis pepperi	-	-	2	-	3	9	1
Myzus scammelli	-	-	-	2	1	1	1
			Hartmann				
Masonaphis pepperi	-	-	-	1	-	-	-
Myzus scammelli	-	-	-	-	-	-	-

Allegan County, 1964

Aphid Species	Sampling Dates 5/10	5/25	6/16	7/8	7/29	8/19	9/11
Double A							
Masonaphis pepperi	-	-	-	18	5	2	1
Myzus scammelli	-	-	-	1	5	-	-
Wadsworth							
Masonaphis pepperi	1	2	10	42	31	101	24
Myzus scammelli	-	1	2	-	-	-	-

Ottawa County, 1964

Aphid Species	Sampling Dates 5/11	5/26	6/17	7/9	7/29	8/20	9/12
DePree							
Masonaphis pepperi	-	-	2	48	59	40	-
Myzus scammelli	-	-	3	-	-	-	1
Boobot							
Masonaphis pepperi	-	-	11	11	-	6	2
Myzus scammelli	3	2	1	-	-	-	-

Muskegon County, 1964

Aphid Species	Sampling Dates						
	5/11	5/26	6/18	7/9	7/29	8/20	9/12
	Derkse						
Masonaphis pepperi	-	1	-	-	-	-	-
Myzus scammelli	-	-	2	2	-	-	-
	Pauls						
Masonaphis pepperi	1	-	-	2	2	2	1
Myzus scammelli	-	1	2	3	-	-	-

Ingham County, 1964

Aphid Species	Sampling Dates												
	6/1	6/8	6/22	7/5	6/18	8/2	8/16	8/20	9/13	9/28	10/11	10/25	11/8
Michigan State University Horticulture Farm													
Masonaphis pepperi	-	-	-	-	-	-	-	-	-	-	-	-	-
Myzus scammelli	53	224	39	10	13	36	2	8	-	3	5	1	5

APPENDIX IX

Actual numbers of strawberry aphids collected in quantitative samples made with a D-Vac sampler

Berrien County, 1964
Tidey Farm

Aphid Species	Sampling Dates													
	5/31	6/7	6/14	6/28	7/19	7/26	8/9	8/23	9/6	9/21	10/4	10/18	10/31	11/14
Acyrthosiphon pisum	-	-	-	-	6	-	2	-	-	-	-	-	2	-
Acyrthosiphon porosum	4	14	48	39	14	6	-	1	-	-	-	-	1	1
Aphis forbesi	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Aphis gossypii	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Chaetosiphon fragaefolii	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chaetosiphon minor	-	3	-	-	2	4	-	1	3	-	-	1	3	-
Macrosiphum euphorbiae	3	21	9	5	2	1	-	-	-	-	-	-	1	1
Macrosiphum rosae	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Van Buren County, 1964
Wendzel Farm

Aphid Species	Sampling Dates												
	6/7	6/14	6/28	7/19	6/26	8/9	8/23	9/6	9/21	10/4	10/18	10/31	11/14
Acyrthosiphon pisum	-	-	-	-	-	-	-	-	-	-	-	-	-
Acyrthosiphon porosum	-	-	1	-	-	-	1	-	5	3	3	9	2
Aphis forbesi	-	-	-	-	-	-	1	-	-	-	-	-	-
Aphis gossypii	-	-	-	-	-	-	-	3	2	-	-	10	-
Chaetosiphon fragaefolii	-	-	-	-	-	-	-	-	-	-	-	-	-
Chaetosiphon minor	-	-	-	-	-	-	-	-	-	-	-	-	-
Macrosiphum euphorbiae	-	-	-	-	-	-	-	-	-	-	1	-	-
Macrosiphum rosae	-	-	-	-	-	-	-	-	-	-	-	-	-

Ingham County, 1964
Michigan State University Horticulture Farm

Aphid Species	Sampling Dates												
	6/1	6/8	6/22	7/5	7/18	8/2	8/16	8/30	9/13	9/28	10/11	10/25	11/8
Acyrthosiphon pisum	-	-	-	-	15	2	-	-	1	1	-	-	1
Acyrthosiphon porosum	1	1	2	-	2	-	1	1	-	1	1	-	1
Aphis forbesi	-	-	-	-	-	-	-	-	-	2	1	-	-
Aphis gossypii	-	-	-	1	-	-	-	-	-	-	-	-	-
Chaetosiphon fragaefolii	-	-	-	-	-	-	-	-	-	23	1	-	3
Chaetosiphon minor	1	-	-	-	-	-	1	5	1	10	5	9	11
Macrosiphum euphorbiae	-	3	-	-	-	-	-	4	2	2	5	21	52
Macrosiphum rosae	-	-	-	-	-	-	-	-	-	-	-	-	-