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MORPHOLOGICAL DIFFERENTIATION BETWEEN
APHIS SPIRAECOLA AND *APHIS POMI*
(HOMOPTERA: APHIDIDAE)

Susan E. Halbert¹ and David J. Voegtlin²

ABSTRACT

Aphis pomi and *Aphis spiraeicola*, are both found on agriculturally important hosts such as apple and pear, and in trap collections. Their morphological similarity makes identification difficult. Examination of specimens of both species from a wide geographical range demonstrated that available keys, especially those based on European material, were not always accurate for North American specimens. Data taken from North American specimens is presented and a key is provided to aid in the identification of trapped alatae preserved in alcohol as well as slide mounted alatae and apterae of these two species.

Simultaneous flights of *Aphis spiraeicola* Patch and *A. pomi* DeGeer occurred near Prosser, Washington, in summer 1984. Pan traps in area wheat fields collected large numbers of alatae of both species that were very difficult to separate because of their close morphological similarity. A literature search revealed that there has been considerable confusion between these two species (Patch 1914, 1923, Palmer 1952, Cottier 1953). Biologically they are distinct. *Aphis pomi* has a relatively restricted host range within the woody Rosaceae and at times is considered a pest on *Malus* spp. and *Pyrus* spp. *A. spiraeicola* undergoes host alternation with *Spiraea*, its primary host, and a wide variety of secondary hosts. It is considered a pest of *Spiraea* spp. and citrus, and more recently its abundance on *Malus* spp. (Pfeiffer, Brown and Varn, 1989) suggests that it may be a pest on apple. The only forms of the two species that can be easily separated are the sexuales. *A. pomi* has apterous males and oviparae do not have swollen hind tibiae. Males of *A. spiraeicola* are alate, and oviparae have swollen hind tibiae (Palmer 1952, Blackman and Eastop 1984).

Patch (1923) discovered that *A. pomi* would feed and develop on *Spiraea* and *A. spiraeicola* would feed and develop on *Malus* which confirmed her suspicion that she was dealing with one highly variable species. Her colonies on apple were decimated by a fungus so all transfer attempts to secondary hosts, which would have demonstrated the limited host range of *A. pomi*, were made using *A. spiraeicola* from *Spiraea*! Later she suggested using the names *A. pomi* and *A. spiraeicola* on the basis of the plants on which they were found (Patch 1929). Host plants subsequently became the criteria on which identifications of ala-

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tae and apterae of these two species were based (Hottes and Frison 1931, Palmer 1952). This, combined with both species sharing the hosts of *A. pomi*, has resulted in misidentifications. An example of this is found in the material from apple, quince, *Crataegus* and pear identified as *A. pomi* by Hottes and Frison (1931). Approximately one-third of the specimens are *A. spiraecola* (determined by D.J.V.). Stroyan (1984) in his discussion of *A. spiraecola* (as *A. citricola*) noted, "Many of the hosts of *pomi* DeGeer may be infested, which may lead to confusion". Pfeiffer, Brown and Varn (1989) noted that *A. spiraecola* greatly outnumbered *A. pomi* in apple orchards in Virginia, West Virginia and Maryland during the 1986 season. Colonies containing both species have been observed on apple in Idaho by the senior author. Ronald Meyer (pers comm.) found large numbers of *A. spiraecola* on apple in Illinois in 1989.

Recent European publications have shown that the length of the ultimate rostral segment, the ratio of the length of the ultimate rostral segment to the length of hind tarsal segment II, the number of lateral tubercles on abdominal segments II-IV and the number of caudal setae are useful characters for distinguishing these two species (Blackman and Eastop 1984, Stroyan 1984, Heie 1986). We wanted to determine whether these characters hold for North American material and, because there seems to be a continual series of epidemiological projects involving trap collections of aphids, to see if there was a character or combination of characters that could be used to easily separate alcoholically preserved specimens of the two species.

MATERIALS AND METHODS

Alatae and apterae of both species were obtained through loans, gifts and our own cultures for morphological analysis. Specimens were obtained from Oregon, Washington, Idaho, Illinois, Virginia, West Virginia, British Columbia, Manitoba, Ontario and Quebec. Host plants represented were *Spiraea x Vanhouttei*, *Crataegus* sp., *Malus domestica*, *Malus scheiderkeri*, *Malus* spp., *Cydonia* sp. and *Cotoneaster* sp. Only specimens taken directly from host plants were used for measurements, i.e., no trap-collected alatae were measured.

The following measurements and counts were taken for each specimen: length of antennal segment III, base of antennal segment VI, process terminalis, siphunculi, cauda, ultimate rostral segment and hind tarsal II; number of setae on the cauda, and number of lateral abdominal tubercles on segment II-V. Specimens were measured using a drawing tube attached to a Zeiss® compound microscope. Measurements were effected using a Zidas® digitizing pad, calibrated for each microscope objective, connected to a Macintosh® computer where the data were stored for analysis.

The senior author sorted hundreds of trap-caught individuals of both species. In this process she observed that the veins in the forewing appeared dark in *A. pomi* and very pale in *A. spiraecola*. To test this observation, specimens were sorted into two groups with either dark or pale wing veins, mounted on slides and identified. All statistical analysis was done using the Systat® software package.

RESULTS

Although aphids were collected from variety of hosts, the majority were from either *Spiraea* or *Malus*. No within species host-related significant differences were found for any of the characters so all aphids were used for the

following analysis. The data were analyzed using an independent t-test with pooled variance to determine if there were significant differences between the means. For each comparison the significance levels are indicated in Table 1.

The range in number of caudal setae (Fig. 1A & B) shows considerable overlap between the two species. There is little difference in this character between alatae and apterae. The number of lateral abdominal tubercles on segments II-V shows overlap only in the apterae with less than 5% of both species having two (Fig. 1). The range of the length of the ultimate rostral segment (Fig. 2A & B) shows little overlap between the two species. There is considerable overlap in the value of the ratio of ultimate rostral segment to second hind tarsal segment (Fig 2C & D). The usefulness of wing vein pigmentation as a character for separating these two species in alcohol proved virtually 100% accurate. Fig. 3 shows a photograph of a slide mount of a forewing of each species. The wings were removed from the alcoholic specimens, rinsed in water and mounted into a gum based mountant. The dark wing venation pigmentation in *A. pomi* and lack thereof in *A. spiraeicola* is easily seen in this photograph.

DISCUSSION

The number of caudal setae is a character that has been used to separate the two species. Our data suggest that this is not a useful character for separating the apterae (Fig. 1A). Although there is considerably less overlap in alatae this character is not useful for discriminating between the two species (Fig. 1B).

Blackman and Eastop (1984) stated that there are no lateral tubercles on abdominal segments II-IV of *A. spiraeicola*. However, our data show the presence of tubercles in 21% of alatae and 14% of the apterae. Stroyan (1984) and Heie (1986) observed the presence of lateral abdominal tubercles but gave no indication of the frequency of specimens in which these occur. The small amount of overlap in number of abdominal tubercles in apterae and lack of overlap in alatae, (Figure 1C & D) makes this a useful character for separating the two species. Although small, these tubercles can often be seen using dissecting microscopes with magnification in the 40-60X range, making this a useful character for separating alcoholically preserved specimens of the two species.

The use of absolute lengths in taxonomy is often discouraged and given the variability of some aphid species can be risky, however, for these two species the length of the ultimate rostral segment is most useful for separating the two. There is some overlap in the apterae (Fig. 2A) but virtually no overlap in the alatae (Fig. 2B). The ratio of length of ultimate rostral segment to hind tarsal II has also been used to discriminate between these species (Stroyan 1984, Heie 1986). With our data this ratio works well with apterae (Fig. 2C) but clearly not with alatae where there is considerable overlap in the range of the ratios (Fig. 2D).

The difference in pigmentation of veins in the forewing is very useful especially for sorting trap catches in areas where both species occur. We have found it to be a reliable character for all specimens we have seen. This difference is clearly visible in photographs of these two species in Blackman and Eastop (1984).

Table 1. — Measurements of characters from *Aphis pomi* and *Aphis spiraecola* apterae and alatae. The top measurement in each set contains the mean and, in parentheses, standard deviation. The lower set of numbers is the range. Significance levels, based on an independent t-test, are indicated by asterisks between sets of data, ns = not significant,

species	number	ant III	ant VI base	ant VI pt	siphunculi	cauda	ult. rostral seg.	hind tarsal II
alatae								
<i>pomi</i>	40	0.286 (0.041)	0.118 (0.015)	0.299 (0.025)	0.308 (0.053)	0.175 (0.024)	0.140 (0.110)	0.111 (0.011)
		0.210-0.348	0.090-0.141	0.250-0.366	0.190-0.347	0.110-0.219	0.113-0.157	0.070-0.127
		****	****	****	****	****	****	****
<i>spiraecola</i>	90	0.179 (0.033)	0.087 (0.014)	0.250 (0.039)	0.178 (0.044)	0.139 (0.026)	0.097 (0.009)	0.086 (0.011)
		0.100-0.290	0.040-0.120	0.120-0.314	0.080-0.299	0.060-0.200	0.070-0.114	0.068-0.109
apterae								
<i>pomi</i>	47	0.204 (0.049)	0.095 (0.012)	0.253 (0.018)	0.292 (0.076)	0.177 (0.029)	0.129 (0.008)	0.096 (0.009)
		0.100-0.366	0.070-0.131	0.206-0.289	0.190-0.597	0.130-0.246	0.120-0.151	0.080-0.127
		ns	ns	****	*	***	****	**
<i>spiraecola</i>	82	0.194 (0.049)	0.091 (0.018)	0.232 (0.039)	0.263 (0.085)	0.197 (0.040)	0.102 (0.012)	0.090 (0.012)
		0.090-0.284	0.050-0.170	0.140-0.302	0.070-0.449	0.090-0.275	0.070-0.125	0.060-0.113

* = p < 0.05, ** = p < 0.01, *** = p < 0.005, **** = p < 0.001. Number of specimens measured is indicated under number.

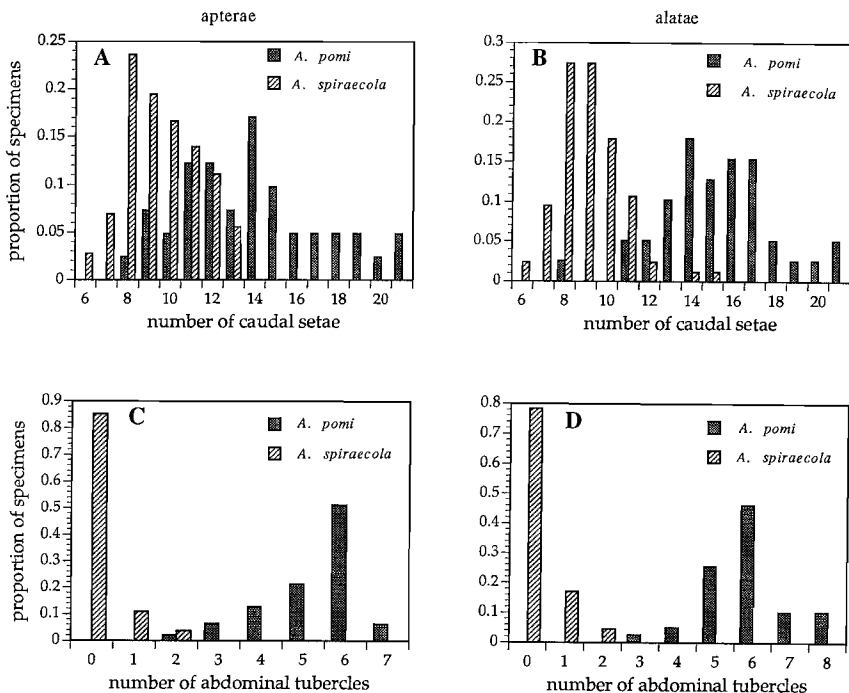


Figure 1. A & B, Histograms showing number of caudal setae for apterae and alatae, respectively, of *Aphis pomi* and *A. spiraeicola*; C & D, histograms showing number of lateral abdominal tubercles on segments II-V for apterae and alatae, respectively, of *A. pomi* and *A. spiraeicola*. For *A. pomi* apterae n=47, alatae n=40; for *A. spiraeicola* apterae n=82, alatae n=90.

KEY TO DISTINGUISH *A. POMI* AND *A. SPIRAECOLA*

The following couplets are provided to aid in separating alcoholically preserved alatae of these two species and alatae and apterae when mounted on microscope slides. Numbers in parentheses in the couplets are outside the range of the majority of the measurements or ratios. See Figs. 2C & D for relationship of these measurements to the rest of the distribution.

Alcoholically preserved alatae:

- 1a. Veins in forewing distinctly pigmented, much darker than the surrounding wing. A minimum of three lateral marginal tubercles present, most commonly 5 or more (count tubercles on both sides of abdominal segments II-V)..... *pomi* De Geer
- 1b. Veins in forewing, especially cubitus and media, not distinctly pigmented, not darker than surrounding wing. Usually without obvious lateral marginal tubercles but if present, only 1 or 2 (count tubercles on both sides of abdominal segments II-V)..... *spiraeicola* Patch

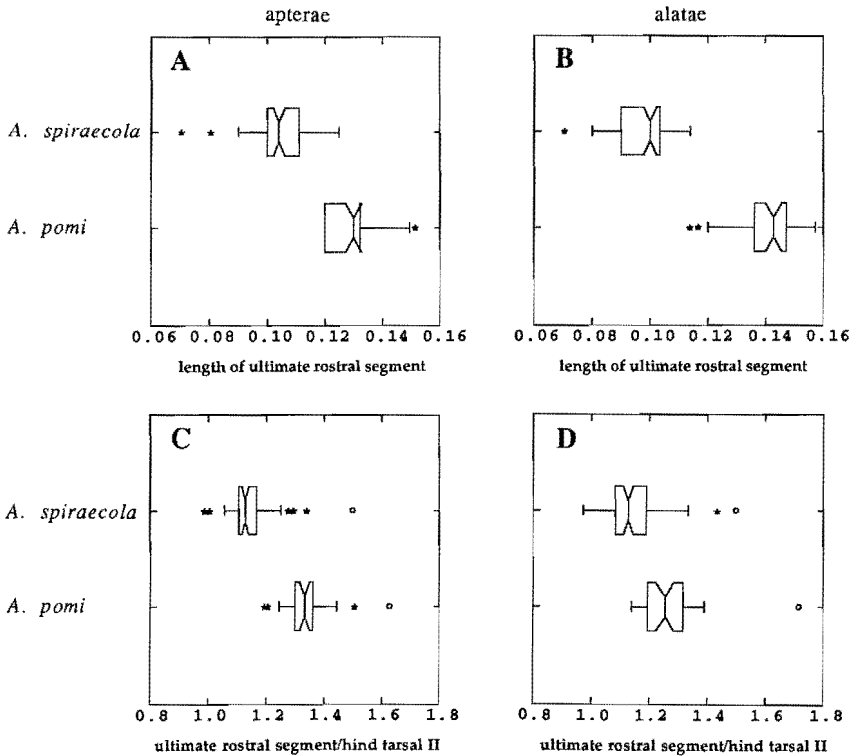


Figure 2. Notched box plots comparing length of ultimate rostral segment and the ratio, length of ultimate rostral segment/length of hind tarsal II, between alatae (2B, 2D) and apterae (2A, 2C) of *A. pomii* and *A. spiraecola*. The center line of each box is the median while the ends of the boxes are hinges and provide interquartile distances. The solid horizontal line indicates range within 1.5 times the spread between the two hinges (H), asterisks indicate values between 1.5 and 3H, and circles indicate outliers beyond 3H. The median of the box is notched, and the box returns to maximum width at the lower and upper confidence intervals. If the intervals around two medians do not overlap, the medians can be considered different at the 95% confidence level.

Slide mounted alatae and apterae:

- 1a. Length of ultimate rostral segment greater than 0.12 mm. Ratio of ultimate rostral segment/hind tarsal II 1.19–1.45 (1.63) in apterae and 1.14–1.39 (1.7) in alatae. Number of caudal setae ranging from 8 to 21 in apterae and (8) 11 to 18 (21) in alatae. A minimum of 2, usually 4 to 8 lateral tubercles on abdominal segments II–V. *pomii* DeGeer
- 1b. Length of ultimate rostral segment less than 0.12 mm, usually less than 0.11 mm. Ratio of ultimate rostral segment/hind tarsal II 0.98–1.25 (1.5) in apterae and 0.97–1.35 (1.43) in alatae. Number of caudal setae ranging from 6 to 13 in apterae and 6 to 12 (15) in alatae. Usually without

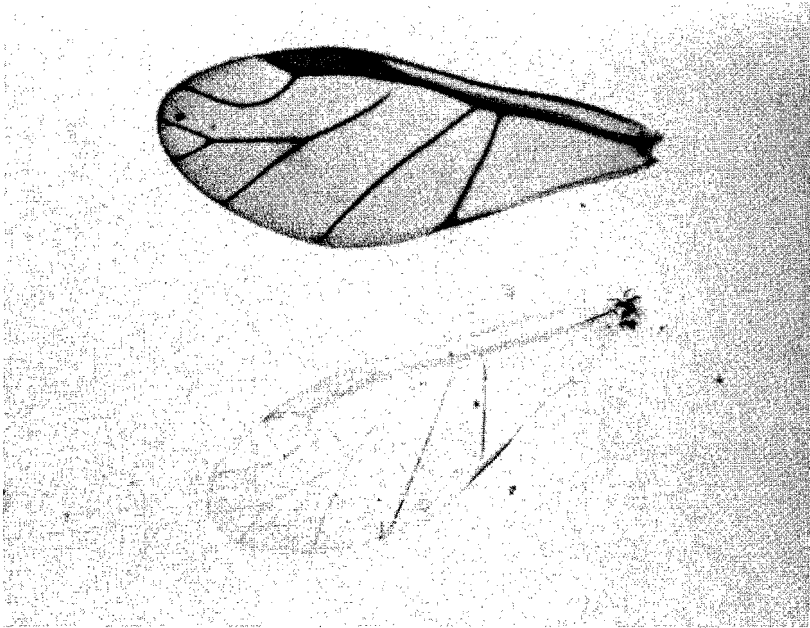


Figure 3. Photograph of forewing of *A. pomi* (top) and *A. spiraecola* (bottom). Note difference in darkness of veins, especially cubitus and media.

lateral tubercles on abdominal segments II-V, if present never more than 2. *spiraecola* Patch

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