

Relationship of the White Apple Leafhopper¹, *Typhlocyba pomaria* McAtee, and the Rose Leafhopper¹, *Edwardsiana rosae* (L.), on Apple in the Hudson Valley Region of New York²

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ABSTRACT For the last half-decade or longer, apple producers in the Hudson Valley region of NY perceived the white apple leafhopper, *Typhlocyba pomaria* McAtee, to be an increasingly damaging pest. We discovered that the rose leafhopper, *Edwardsiana rosae* (L.), was also prevalent in Hudson Valley apple orchards and that it contributed much to the observed damage. During 1992 and 1993, leafhopper adults and nymphs were monitored on 'Golden Delicious' apple and on florabunda rose, *Rosa multiflora* Thunb. We found that second generation nymphs of white apple leafhopper and rose leafhopper occur almost simultaneously on apple trees. Although not all Hudson Valley orchards are subject to rose leafhopper infestations, the occurrence of this pest in concert with white apple leafhopper, increases the likelihood that action thresholds will be exceeded. We feel that florabunda rose, the predominant rose leafhopper overwintering host that is widely distributed throughout the region, is integral to infestations of apple by this species. A vacuum device designed for the quantitative sampling of adult leafhoppers is described.

KEY WORDS Homoptera, Cicadellidae, apple, rose leafhopper, white apple leafhopper, florabunda rose, vacuum sampler, seasonal occurrence

Damage to apple caused by mesophyll-feeding leafhoppers may include stippling or chlorosis of leaves, and the spotting of fruit by the excrement of nymphs and adults. The white apple leafhopper (WALH), *Typhlocyba pomaria* McAtee, has been the primary indigenous leafhopper pest of apple, *Malus domestica* Borkh., grown in New York. Over the past few years, many Hudson Valley orchardists noted that leafhoppers have become more damaging throughout a greater portion of the growing season. Because such observations tend to promote additional applications of insecticides that are both costly and often disruptive to natural enemies in IPM

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programs, we initiated studies concerning possible changes in WALH habit or occurrence that would justify a revision of management strategies. Early in these investigations, we discovered that the rose leafhopper (RLH), *Edwardsiana rosae* (L.), was present and indeed a pest in some Hudson Valley orchards.

Although the early literature revealed some confusion by many workers regarding the identification and separation of RLH and other species affecting apple (Childs 1918, Lathrop 1918, Ball 1924), the situation was clarified when WALH was described by McAtee (1926). Shortly afterwards, DeLong (1931) provided keys and described several male morphological features of both species. Beirne (1956) later described the shape of the seventh abdominal segment providing a distinguishing female character for each species.

Even though RLH was found to be a pest of Northeast apple as early as the turn of the century, (Parrott 1909) and Ball (1924) noted it as a serious pest of apple throughout the Northeast apple-growing region, reports of its occurrence ceased after Lathrop (1927) first discovered damage by the then recently described WALH in the Hudson Valley of NY. A report from Connecticut (Garman & Townsend 1936) concerning WALH as a pest of apple did not mention RLH. Neither a report on leafhopper control in New York (Chapman et al. 1932), or the works on natural enemies of WALH in New York (Steiner 1936, 1938) hinted at the presence of any other species of leafhopper as an apple pest. This suggests that either RLH ceased to be present in the study areas, or that the differences between WALH and RLH were no longer being detected.

White apple leafhopper overwinters in the egg stage in the stems of apple, and it completes two generations exclusively on this host (Chapman et al. 1932, Garman & Townsend 1936). Although RLH may have three generations per year in some areas (Muller 1956, Elsner & Beers 1988b), it is generally bivoltine (Lathrop 1927, Balas 1966). RLH overwinters as eggs predominantly within the canes of rose (Childs 1918). Spring generation (hereafter called first generation) nymphs complete five stadia on rose, and subsequently the adults of this generation emigrate to other hosts including apple (Ball 1924, Saringer 1989). The RLH has more recently been reported as a pest of apple in Europe (Saringer 1989, Lehmann 1973), Washington (Elsner & Beers 1988a), West Virginia (Hogmire & Winfield 1992) and New York (Straub 1993). The purpose of the research reported herein was to assess the relative occurrence and importance of RLH and WALH in Hudson Valley orchards, with the primary objective being the assessment of current leafhopper management strategies.

Materials and Methods

The seasonal occurrences of WALH and RLH were monitored in a 12 acre orchard at Cornell's Hudson Valley Laboratory in Highland, NY. Twelve year-old, untreated 'Golden Delicious/EMII' were sampled twice-weekly starting in early April. Sampling ceased during early September. An extensive grove of florabunda rose, *Rosa multiflora* Thunb., located

approximately 100 m from the test orchard was monitored during the same time period. *Florabunda* rose is prevalent throughout the Hudson Valley and is presumed to be the primary overwintering and non-cultivated host of RLH.

Because WALH and RLH adults appear identical, being distinguished only by characters of the genitalia, quantitative assessment is difficult. The task is further hampered because mobile adults are difficult to capture from foliage, specimens are difficult to identify by genital characters once entrapped in the glue of sticky-cards, and a sex attractant for neither species has been isolated. During 1992, adults were collected by aspirator from infested leaves but adequate numbers of specimens could not be captured using this method. During 1993, a vacuum device was constructed, which allowed for the efficient collection of high numbers from within the tree canopy (Fig. 1). The complete apparatus was transported on an available All-Terrain Vehicle, but could just as easily be utilized from the rear of the van or pick-up truck. The power source is a 1.6 horsepower Honda EM650 generator (120 volts, 5.4 amps) (Honda Motor Company Inc., Moorestown, NJ) (Fig. 1, A). Vacuum is provided by a Dirt Devil Model 103 Hand Vac (2.0 amps) (Royal Appliances Manufacturing Company, Cleveland, OH) equipped with a 1 m length flexible suction hose (27 mm inside diameter) (Fig. 1, B). The dust bag serves no purpose and is removed. Attached to the distal end of the suction hose is a collector (Fig. 1, C), constructed as follows: (a) the bottom of a 473 ml Bel-Art polypropylene wide-mouth jar with screw-top lid (VWR Scientific, Piscataway, NJ) is removed using a band-saw; (b) the large opening of a 82.5 mm wide (3.5 in. diameter at top) Nalgene polypropylene funnel (VWR Scientific, Piscataway, NJ) with neck removed, is fitted with fine-mesh No-See-Um netting (Balson-Hercules Group Ltd., Providence, RI) and affixed by hot-melt glue (Parker Manufacturing Company, Northboro, MA); (c) a 473 ml (16 oz) clear-plastic soda bottle is cut in half (93 mm) using a band-saw, and the bottom half is discarded. The funnel with netting is inserted over the large opening of the soda bottle and hot-melt glued in place. The soda bottle/funnel, with the neck oriented to the outside, is inserted approximately 15 mm within the inside diameter of the Bel-Art jar and attached by a continuous bead of hot melt-glue. The entire collector is then joined to the vacuum apparatus by insertion of the 25 mm diameter soda bottle neck (d) into the suction hose. When sampling is completed, specimens are contained in the collector by affixing the jar lid (e). The collector can be removed for storage of specimens and another attached for continued sampling. The described generator provides sufficient power to facilitate the simultaneous operation of two vacuum collectors.

Adults were collected by walking around the perimeter of the apple-tree or rose-bush and vacuuming as much exterior and interior foliage as possible during a 3 min. period. Collections were removed to the laboratory, dated and frozen for later examination. Subsequently, specimens were thawed at room temperature, cleared for 24 hr. in 10% (wt/vol) KOH solution, dissected under low-power magnification and separated by sex and species according to genital characters (Elsner & Beers 1988a) (Fig. 2). Males of the two species differ in aedeagal structure, part of which may be released within the

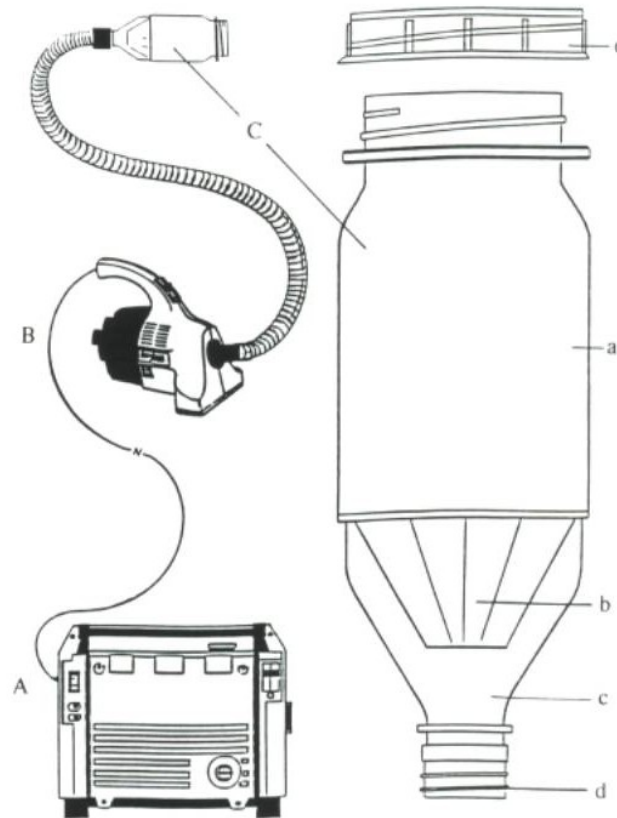


Fig. 1. Adult collecting apparatus. A, portable generator; B, hand-vac (extension cord may be added to increase range from generator); C, collector; a, Bel-Art jar; b, funnel with neck removed; c, one-half plastic soda-bottle, d, collector neck; e, screw-top lid.

abdomen. Females differ in structure of the second valvula of the ovipositor, which may be partially concealed by the first and third valvulae.

Nymphs were collected during 1992 and 1993 by excision of 50 or more infested leaves per sample date, and removal to the laboratory. Specimens were separated to species by examination of dorsal thoracic setae using a binocular microscope (Elsner & Beers 1988a) (Fig. 3). The dorsal thoracic setae of RLH are not prominent during the first and second stadia, making determinations imprecise; data were therefore taken only on stadia three through five. Specimens were segregated to instar as per the morphological descriptions of Childs (1918).

Results and Discussion

During 1993, first generation adults of both WALH and RLH became active within apple trees approximately the first week of June (Fig. 4). Although the occurrence of first generation RLH appeared to be slightly earlier than that of WALH, the second generation was more or less in synchrony. Because this research was directed toward leafhopper

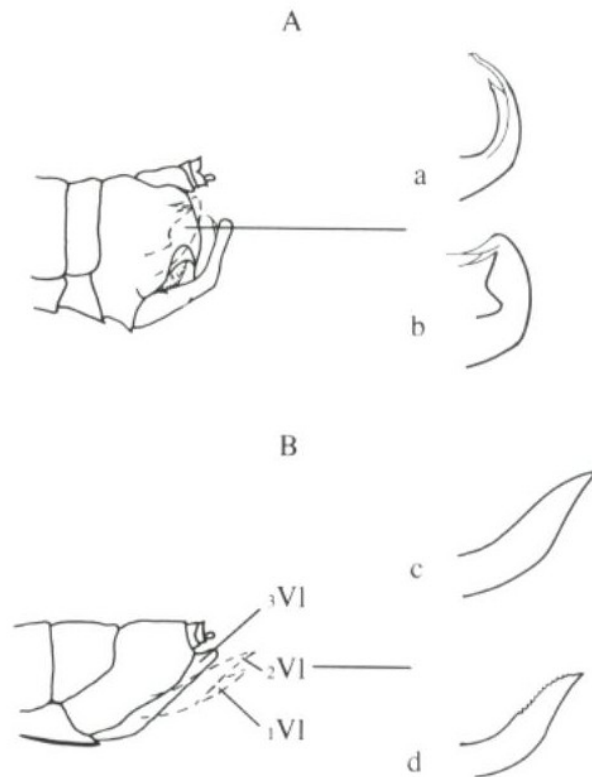


Fig. 2. Lateral views of terminal abdominal segments of the white apple leafhopper (WALH) and rose leafhopper (RLH) adult. Male (A): aedeagus of WALH (a) is pointed at the apex, aedeagus of RLH (b) has four leaf-like processes projecting anteriorly at apex. Female ovipositor (B) is composed of valvulae ($_1Vl$, $_2Vl$, $_3Vl$): tip of WALH (c) second valvula ($_2Vl$) is smooth, dorsal margin of tip of RLH (d) valvula ($_2Vl$) is serrated. (20X) (Revised after Elsner & Beers 1988a. Reprinted with permission of authors).

populations during our typical "spray season", i.e., the petal fall phenological period through the sixth-cover or seventh-cover periods, adult occurrence data after 20 August are incomplete. Insecticide applications in NY orchards are not recommended after 20 August (Cornell University 1993), at which time the threat of apple maggot, *Rhagoletis pomonella* (Walsh) has passed. Management of adult leafhoppers is not a general practice unless excrement on the fruit is perceived to be an economic problem.

Relative to adults, nymphs do the most feeding, cause the most damage and are generally easier to control with insecticides. First generation WALH nymphs were initially observed on trees on 19 May and 11 May during 1992 and 1993, respectively (Fig. 5). These dates coincided closely with the petal-fall phenological period of cultivars within the maturity range of 'McIntosh'. Because the RLH first generation is passed on the overwintering hosts, nymphs of this species were not present in the trees until the first week of July. Thereafter, second generation nymphs of both species coexisted on apple into September. Second generation RLH occurred in high numbers

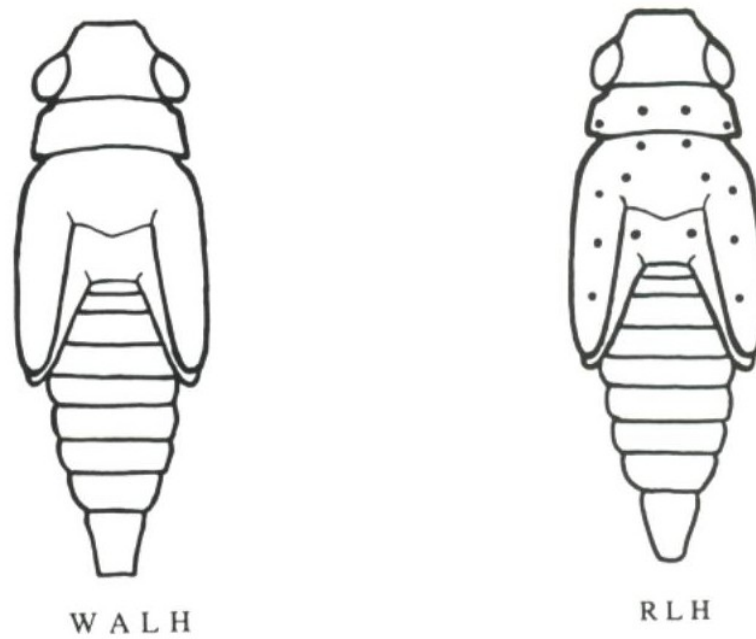


Fig. 3. Distinguishing characters of white apple leafhopper (WALH) and rose leafhopper (RLH) nymphs. Black dots on RLH represent prominent setae evident on stadia three to five. (20X) (Revised after Elsner & Beers 1988a. Reprinted with permission of authors.)

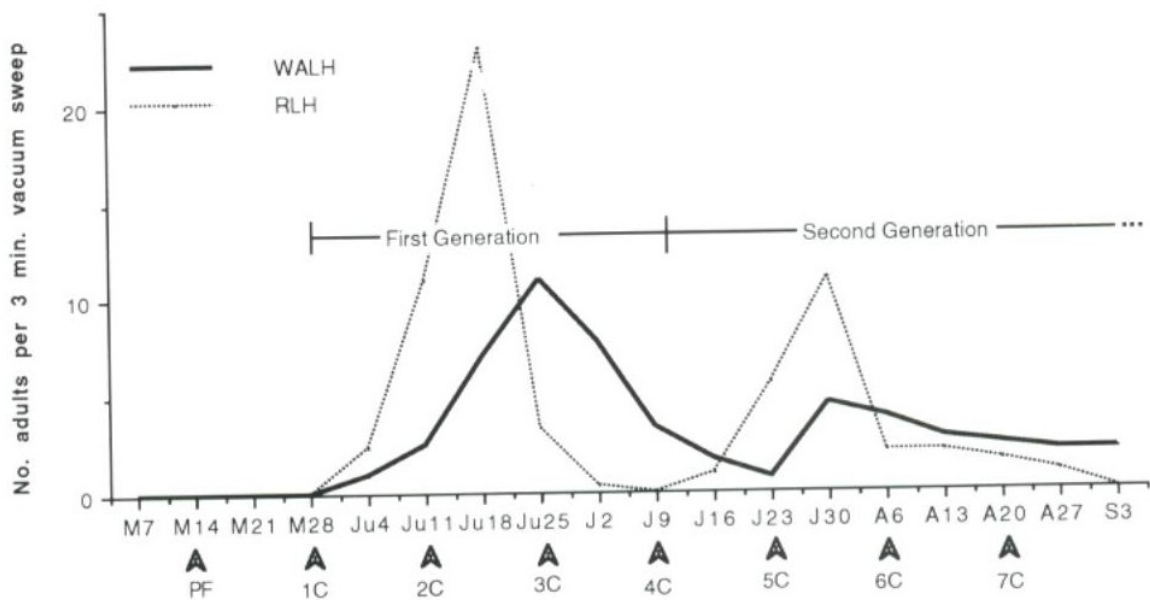


Fig. 4. Seasonal occurrence of white apple leafhopper (WALH) and rose leafhopper (RLH) adults on 'Golden Delicious' at the Hudson Valley Laboratory during 1993. Arrows on X-axis represent approximate spray periods (14 d interval starting at petal fall phenological period) where PF, petal fall; 1C, first cover; etc.

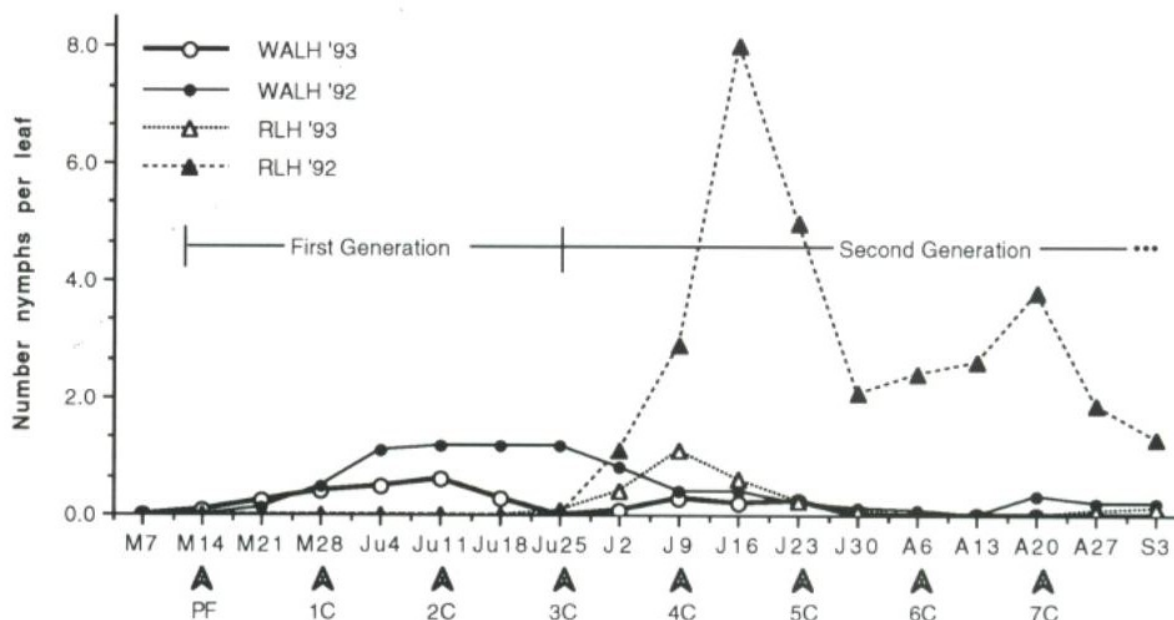


Fig. 5. Seasonal occurrence of white apple leafhopper (WALH) and rose leafhopper (RLH) nymphs on 'Golden Delicious' at the Hudson Valley Laboratory during 1992 and 1993. Arrows on X-axis represent approximate spray periods (14 d interval starting at petal fall phenological period) where PF, petal fall; 1C, first cover; etc.

during 1992, a season of average temperature and rainfall, in contrast to low numbers, during the 1993 season that was characterized by drought conditions from April until mid-August (Straub & Jentsch 1993). Schoene (1932) reported that leafhopper infestations are decreased during drought conditions. Although 1992 data suggest a third generation of nymphs during August, we unfortunately did not monitor adult occurrence by which to verify this.

These data from the Hudson Valley Laboratory orchard indicate that, from at least mid-summer onward, RLH is perhaps a greater pest than is WALH. Results from surveys in other Southeastern NY locations however, revealed that not all orchard sites are equally subject to RLH infestations. Of 17 sites sampled in mid-September during 1992 and 1993, six orchards had a predominant composition of WALH, while 11 had a predominance of RLH (Straub 1993). The causes for variability among orchards have not been thoroughly investigated, but we have preliminary evidence to suggest that infestations of RLH at a particular site are dependent upon the abundance and proximity of florabunda rose. Data from florabunda rose adjacent to the Hudson Valley Laboratory orchard revealed increasing numbers of RLH adults during August (Fig. 6), as they presumably emigrate from orchards. Such numbers suggest that the rose is integral to the life-cycle of RLH and is therefore relevant to the ultimate infestations of apple.

Immigrations of RLH have contributed to the perceptions by growers that WALH has become more damaging. The simultaneous occurrence of both

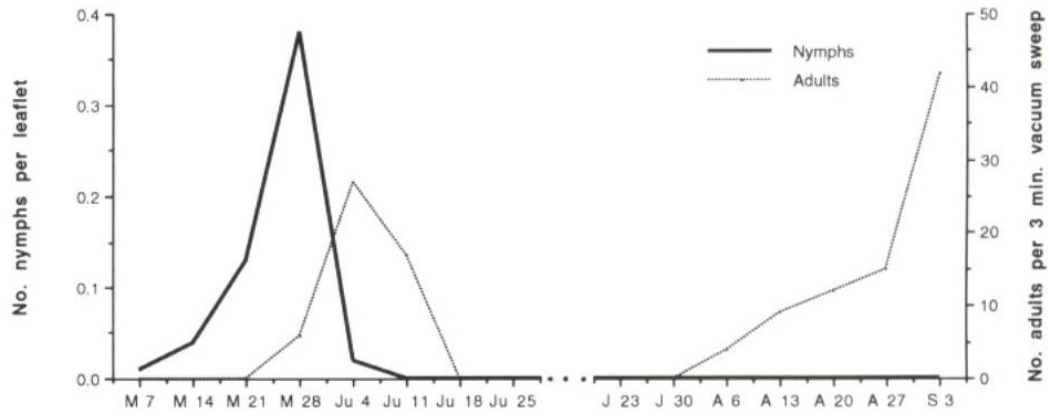


Fig. 6. Seasonal occurrence of rose leafhopper (RLH) nymphs and adults on florabunda rose at the Hudson Valley Laboratory during 1993.

WALH and RLH in an orchard increases the likelihood that established action thresholds will be exceeded. The major impact on current management strategies would be from mixed-species second generation nymphs. Because nymphs of both species are essentially synchronized during the period within which they are the most damaging, i.e. third-cover through sixth-cover, traditional summer leafhopper management programs should remain effective. At this time there is no evidence to suggest that WALH and RLH differ in their susceptibility to insecticides (unpublished data).

Acknowledgment

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