Establishment and Biocontrol Potential of Released *Typhlodromus pyri* Predator Mites in Massachusetts Apple Orchards: 2000-2003

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In the 2000 issue of *Fruit Notes*, we reported the results of a 3-year project (1997-1999) aimed at establishing the predator mite *Typhlodromus pyri* in Massachusetts apple orchard blocks of different tree sizes. Results showed that following release in 1997, *T. pyri* became established in all eight blocks by the following year, spreading fastest from tree to tree among cultivars on M.9 rootstock and slowest from tree to tree among cultivars on M.7 rootstock. Result also showed that even in blocks on M.7 rootstock, by 1999 *T. pyri* had spread to the most distant trees in the 49-tree blocks and provided effective block-wide suppression of European red mites.

Encouraged by results of this 1997-1999 project, in 2000 we launched a 4-year study to further characterize the establishment and spread of released *T. pyri* in commercial apple orchards in Massachusetts. We asked five questions. First, would the addition of pollen to trees in which *T. pyri* were released enhance the buildup of *T. pyri*? This predator is known to feed on pollen when prey mites are low in abundance and previous research has shown that supplementary pollen could elevate predator numbers. Second, in which direction is *T. pyri* likely to spread fastest following release from trees on row 4 of a block: toward row 1 (the perimeter) or toward row 7 (the interior)? Third, would the establishment of American hazel trees opposite plots in which *T. pyri* were released contribute to the buildup of *T. pyri* and/or *Amblyseius fallacis* as predator mites? American hazel trees have been found by others to harbor substantial populations of predatory mites. Fourth, what is the relationship between the abundance of *T. pyri* and the abundance of *Amblyseius fallacis* as predatory mites? Fifth, would the release of *T. pyri* in 2000 guarantee effective biocontrol of European red mites in subsequent years? Here, we present data that address each of these questions.

Materials & Methods

Our experiment was conducted in 12 blocks of apple trees in ten commercial orchards. Each block was about 140 meters long by seven rows deep and was divided into four equal-size plots. The perimeter row of each block was bordered by woods, hedgerow or open field. Trees were on M.9, M.26, or M.7 rootstock and were principally Mc Intosh, Cortland, Gala, Empire, Jonagold or Fuji.

There were four treatments at the outset in May of 2000 (one per plot): (1) *T. pyri* released in the presence of fresh cattail pollen, which was applied to the tree canopy by a commercial pollen applicator (E-Z Power Duster, Firman Pollen Co, Yakima, WA) at the rate of one-seventh ounce of pollen (about 100,000 pollen grains) per tree, (2) *T. pyri* released in the absence of pollen amendment; (3) no release of *T. pyri* but, as with the first and second treatments, no insecticide applied after mid-June (apple maggot flies were controlled by odor-baited red sphere traps), and (4) no release of *T. pyri* and organophosphate insecticide applied during July and August to control apple maggot. For the first and second treatments, *T. pyri* were released at bloom at the rate of about 100-200 individuals per tree on two trees in the fourth row of each plot, one tree to the right and one to the left of the center tree of the plot. Releases were made by wrapping a burlap band that contained *T. pyri* around the trunk of a release tree. In autumn of 1999, such bands had been placed around trunks of apple trees at Geneva, NY to collect *T. pyri* seeking overwintering sites.

In 2000, we sampled 25 leaves per tree on each of two trees in rows 1, 4 and 7 in each plot. We did this twice during July and twice during August. One of the sampled trees was immediately to the right and the other immediately to the left of the center tree of the row (for row 4, these were the same trees in which *T. pyri* were released). For 2001, 2002 and 2003, we no longer segregated samples according to plot and sampled five leaves on each of ten trees (50 in all) on each of rows 1, 4 and 7 in each block. We did this twice in 2001 (once in July and once in August), once in 2002 (in July) and twice in 2003 (once in July and once in August).

In 2000, in four of the blocks we planted 20 seedling trees of American hazel in hedgerows opposite and about 5 meters away from plots in which *T. pyri* were released. Our intent was to sample leaves from these seedlings for abundance of predatory mites as soon as the seedlings achieved reasonable growth (reached 1 meter height). Hence, in 2002 and 2003, we sampled five leaves from each of ten American hazel seedlings (50 leaves in all) once during August in each of the four blocks.

All sampled leaves were sent by overnight mail to Geneva, New York for the identification and counting of pest and predatory mites.

From 2000-2003, none of the sampled plots received pyrethroid or carbamate insecticide (except carbaryl as thinner), none received EBDC fungicide after mid-June, and none received miticide (except prebloom oil). The only exception was orchard F, which received a spot-treatment of Acramite in August of 2003 against European red mite.

Results

With respect to our first question, data for 2000 presented in Figure 1 show that addition of cattail pollen had no detectable effect on the buildup of *T. pyri* in trees in which these predators were released. Peak populations of *T. pyri* in 2000 were just as great in trees not receiving cattail pollen as in those that did receive pollen, and were roughly twice as great (on sampled center trees in row 4) in plots where *T. pyri* were released as in plots where no *T. pyri* were released. Conversely, peak populations of European red mites on sampled trees averaged about twice as great in plots where no *T. pyri* were released and which received insecticide during July and August as in plots where *T. pyri* were released and received no insecticide after mid-June. Peak populations of *A. fallacis* averaged roughly the same in all plots. For each of the four plot types, *A. fallacis* was less abundant than *T. pyri*.

In regard to our second question, there was no statistical evidence that spread of *T. pyri* differed among the rows of trees, although data for 2001 shown in Fig. 2 hint that *T. pyri* released in 2000 on trees in row 4 may have spread faster to trees in row 7 than to trees

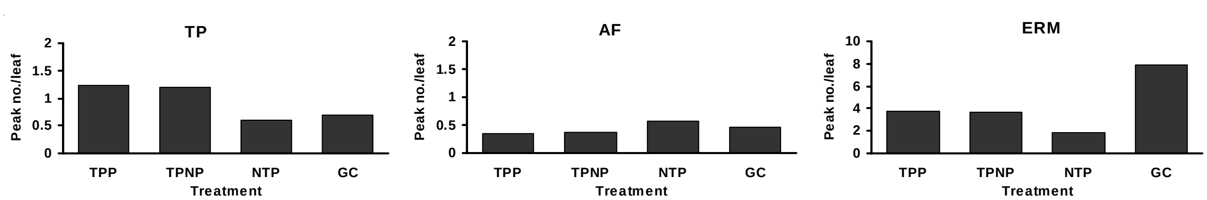

Figure 1. For 2000, peak abundance of *T. pyri* (TP), *A. fallacis* (AF) and European red mites (ERM) in two trees in row 4 of each of four plots in each of 12 orchard blocks: trees in which TP were released and cattail pollen was added (TPP), trees in which TP were released but no pollen was added (TPNP), trees in which no TP were released, no pollen was added and apple maggot was controlled by baited red sphere traps (NTP) and same as preceding except apple maggot was controlled by grower-applied insecticide (GC).

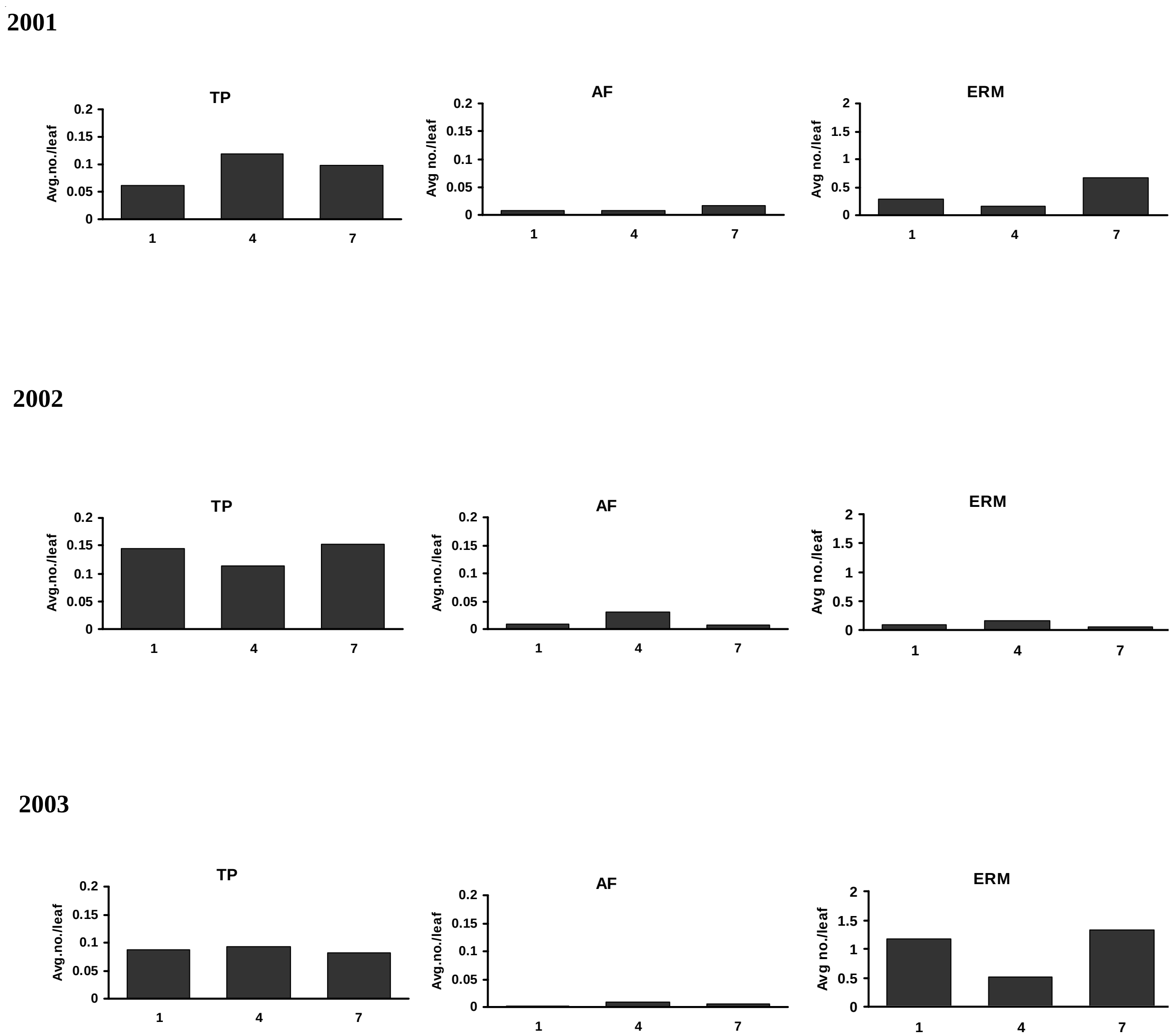

Figure 2. For 2001, 2002 and 2003, average abundance (across all sampling dates) of *T. pyri* (TP), *A. fallacis* (AF) and European red mites (ERM) in rows 1, 4 and 7 of 12 orchard blocks in which TP were released in row 4 in 2000.

in row 1. By 2002 and 2003, however, *T. pyri* were equally abundant in rows 1, 4 and 7. *A. fallacis* showed no clear pattern in abundance according to row across 2001, 2002 and 2003. The same was true for European red mites.

Our third question focused on the potential value of establishing American hazel trees in border areas as a way of promoting buildup of predatory mites and enhancing populations of predators in adjacent blocks of orchard trees. However, as shown in Fig. 3 for the four orchard blocks involved in this evaluation, the abundance of *T. pyri* and especially *A. fallacis* was low on leaves of American hazel trees in border areas. Moreover, neither of these predators was more abundant in row 1 trees than in row 4 or row 7 trees, which could have been expected if substantial numbers of predators were moving from American hazel trees toward orchard blocks.

Our fourth question concerned the relationship between *T. pyri* and *A. fallacis*. Data from our study of

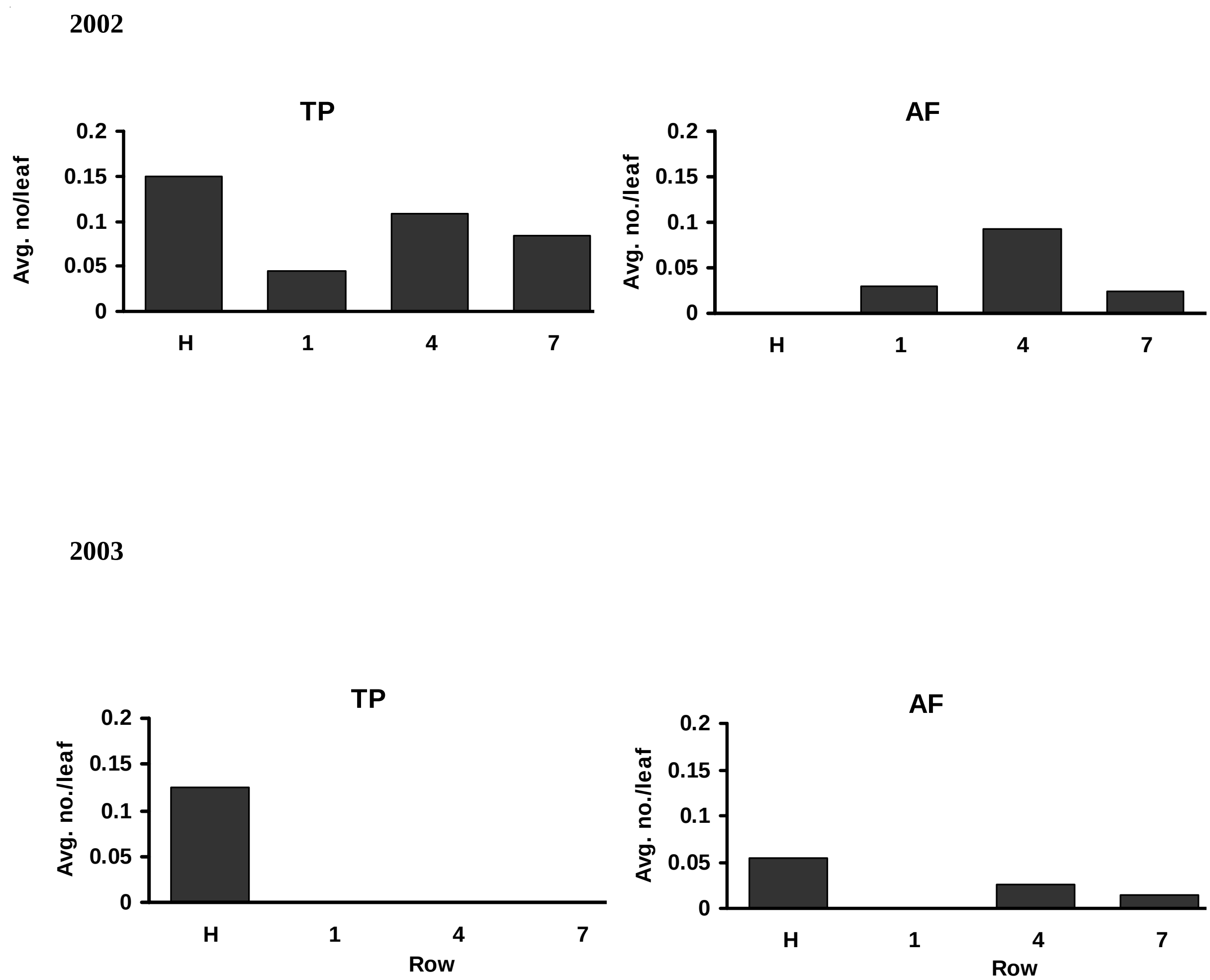

Figure 3. For 2002 and 2003, average abundance (across all sampling dates) of *T. pyri* (TP) and *A. fallacis* (AF) in American hazel trees (H) in border areas adjacent to four orchard blocks and in rows 1, 4, and 7 of these four blocks (in which TP were released in row 4 in 2000).

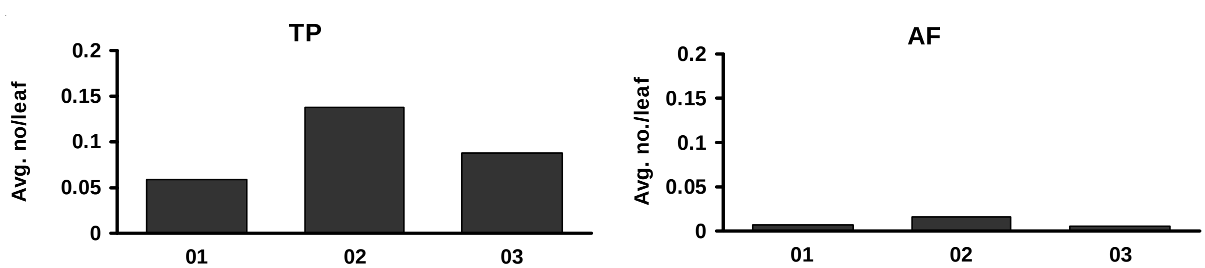

Figure 4. For 2001, 2002 and 2003, average abundance (across rows 1, 4 and 7 and across all sampling dates) of *T. pyri* (TP), and *A. fallacis* (AF) across 12 orchard blocks in which TP were released in 2000.

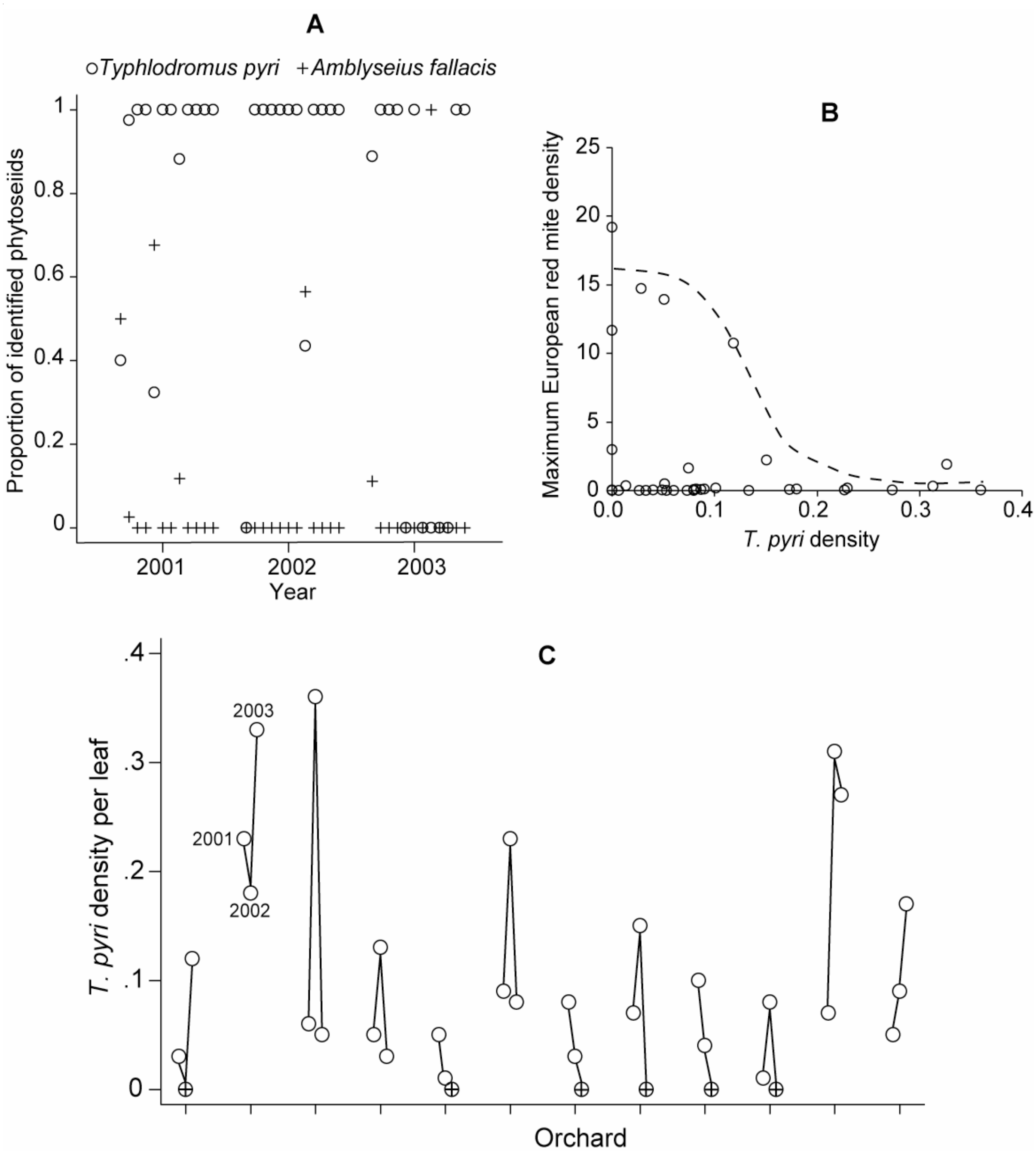

Figure 5. A) Proportions of phytoseiid mites identified as either *T. pyri* or *A. fallacis* in each of 12 orchard blocks over three years. Within a year there are 12 sets of circles denoting the *T. pyri* proportions and 12 + symbols denoting the *A. fallacis* proportions. At some sites, no phytoseiids were collected and these are denoted by a circle enclosing a + symbol. B) Maximum densities of European red mites in relation to the average density of *T. pyri*. Each circle represents data collected from a block in one of the years 2001, 2002 or 2003. The dashed line was fit by eye. C) Average densities of *T. pyri* in orchards over the years 2001, 2002 and 2003. Each set of three connected circles represents three years of data from an orchard block, arranged in sequence (left to right) for 2001, 2002 and 2003. Circles with a + symbol indicate no *T. pyri* were collected in the samples.

1997-1999 reported in the 2000 issue of Fruit Notes suggested that increasing abundance of *T. pyri* was correlated with decreasing abundance of *A. fallacis*. This pattern has been observed elsewhere and occurs because establishment of *T. pyri* usually leads to low levels of European red mites. *A. fallacis* are only abundant in apple trees when there is a ready supply of pest mites for food. In this study, nearly all the orchards had populations of *T. pyri* prior to their release in 2000. Therefore, we would expect low numbers of *A fallacis*. Our resuls are in accord with this expectation. As shown in Fig. 4, data for 2001, 2002 and 2003 averaged across all 12 orchard blocks indicate that overall, *T. pyri* was about ten times more abundant than *A. fallacis* on sampled leaves. Another way of looking at this relationship is to compare the proportions of *T. pyri* and *A. fallacis* found in each orchard (Fig. 5A). In 2001 *A. fallacis* were found in only four orchards and these were sites where some European red mites were also found. In 2002 there was but one orchard where *A. fallacis* was collected and in 2003 this number increased to two. Note that in 2003 there were four orchards where no phytoseiids were collected and five orchards where no *T. pyri* were collected. At present, we have no explanation for this.

Our final question asked whether establishment and conservation of *T. pyri* would assure effective biocontrol of European red mites. Previous research has shown that *T. pyri*, when sufficiently abundant, can keep European red mites at non-damaging densities. Recalll that *T. pyri* were present in most orchards prior to their release and by 2001, *T. pyri* were recoverd in all the orchards (Fig. 5A). Shown in Fig. 5B a is the relationship between the maximum density of European red mites observed and the average density of *T. pyri* . The dashed line was fitted by eye to the data points that reflect the highest European red mite numbers in relation to predator density. This graph shows that when *T. pyri* numbers are low (< 0.15 per leaf), there is a possibility that European red mite will become problematic. Note that even when *T. pyri* densities are low, pest mites do not always reach high densities, but the potential is there. On the other hand, when *T. pyri* were more numerous, European red mites never reached high numbers. It is also helpful to examine changes in the abundance of *T. pyri* over time because our experience has been that once established in an orchard, these predators usually persist in relatively high numbers. As shown in Fig. 5C, this was not the case, as in 2003 we did not collect any *T. pyri* in five of the 12 orchards studied. At present, we can offere no explanation for this decline in predator numbers

Conclusions

Across the four years of our study (2000-2003), we gained much useful information on the ecology and biocontrol potential of *T. pyri* in Massachusetts. Our findings lead us to the following conclusions. First, addition of a substantial amount of cattail pollen (as a food supplement) to trees in which *T. pyri* were released in 2000 had no detectable effect on buildup of *T. pyri*. Thus, there is sufficient alternate food to allow for establishment of *T. pyri* provided no pesticides harmful to this predator are used. Second, by 2002 *T. pyri* were equally abundant in plots where they were released or not released, with the exception of two sites where they were only found in plots where they were released, and they were equally abundant among the sampled rows (1, 4, 7). This likely reflects that *T. pyri* were present in most blocks prior to release. Third, establishment of American hazel trees (known to harbor mite predators) in border areas adjacent to plots of orchard trees did not substantially enhance populations of either *T. pyri* or *A. fallacis* in such plots. Fourth, commencing in 2001, *T. pyri* predominated in the study blocks, with *A. fallacis* absent or at very low levels in most blocks. Only where European red mites were moderately to very abundant were *A. fallacis* found. Finally, in a majority of orchard blocks *T. pyri* were sufficiently abundant by 2001 to provide what appeared to be consistently effective biocontrol of European red mites. In some orchard blocks, however, *T. pyri* did not build to appreciable levels or declined in abundance (for reasons unknown, but apparently not associated with use of offensive pesticides). In some of these blocks in some years, European red mites reached threatening levels.

Overall, as in our 1997-1999 study, *T. pyri* showed much promise as an effective biocontrol agent of European red mites in most of the blocks in which it is established and conserved.

Acknowledgments

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