BIOLOGY AND IMPACT OF *Thrips calcaratus* Uzel IN THE GREAT LAKES REGION

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Introduction

Basswood (*Tilia americana* L.) stands in the Lake States have been experiencing defoliation since around 1979. These symptoms were originally attributed to frost damage because they occur in early spring. However, the pattern of damaged trees was atypical of frost injury. Only basswood trees were affected, and there was no relationship to sites known to be frost pockets. By 1980 it was recognized that a thrips was associated with defoliation. The pest was originally identified as the basswood thrips, *Neohydatothrips* (then *Sericothrips*) *tiliae* (Hood) (Thripidae), a native species. Because this insect has no history of causing damage, the judgement was to let natural forces suppress the population. Outbreaks continued to expand, however, casting doubt on the role of a heretofore innocuous species as the causal agent. Further examination led to the identification of an introduced species, *Thrips calcaratus* Uzel (Thripidae) as the primary pest (Raffa & Hall 1988). This species was first recorded in North America in New York in 1925 (Hood 1927), and is now distributed throughout the Middle Atlantic States, Ontario, and Quebec, in addition to the Lake States.

The outbreak originated in northeastern Wisconsin, near the border with the upper peninsula of Michigan. The progression of infestation and the current outbreak area are shown in Figures 1 and 2. Defoliation shows no signs of abating. Currently, around 81,000 hectares (200,000 acres) are affected each year in Wisconsin (Table 1). There are about 40,470 hectares (100,000 acres) defoliated in Minnesota each year, and additional losses occur in Michigan (Wisconsin Department of Natural Resources 1980 - 1988, Minnesota Department of Natural Resources 1983 - 1987).

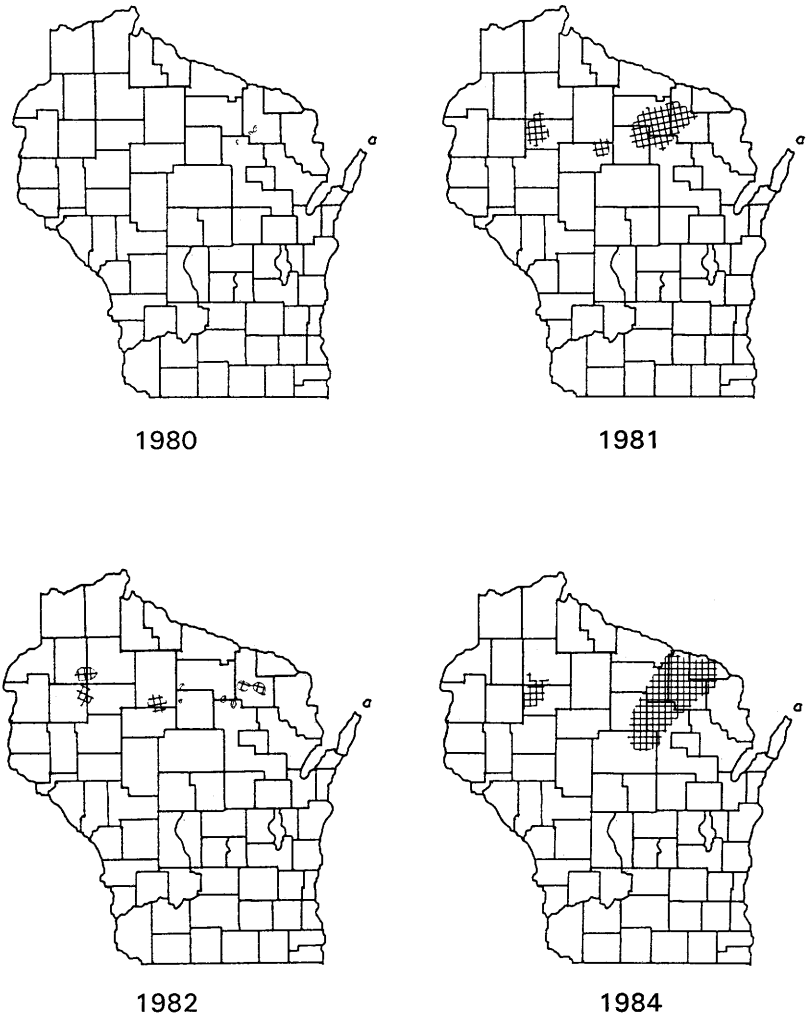

Figure 1. Areas (shaded) of moderate to severe defoliation by basswood thrips in Wisconsin from 1980 - 1984.

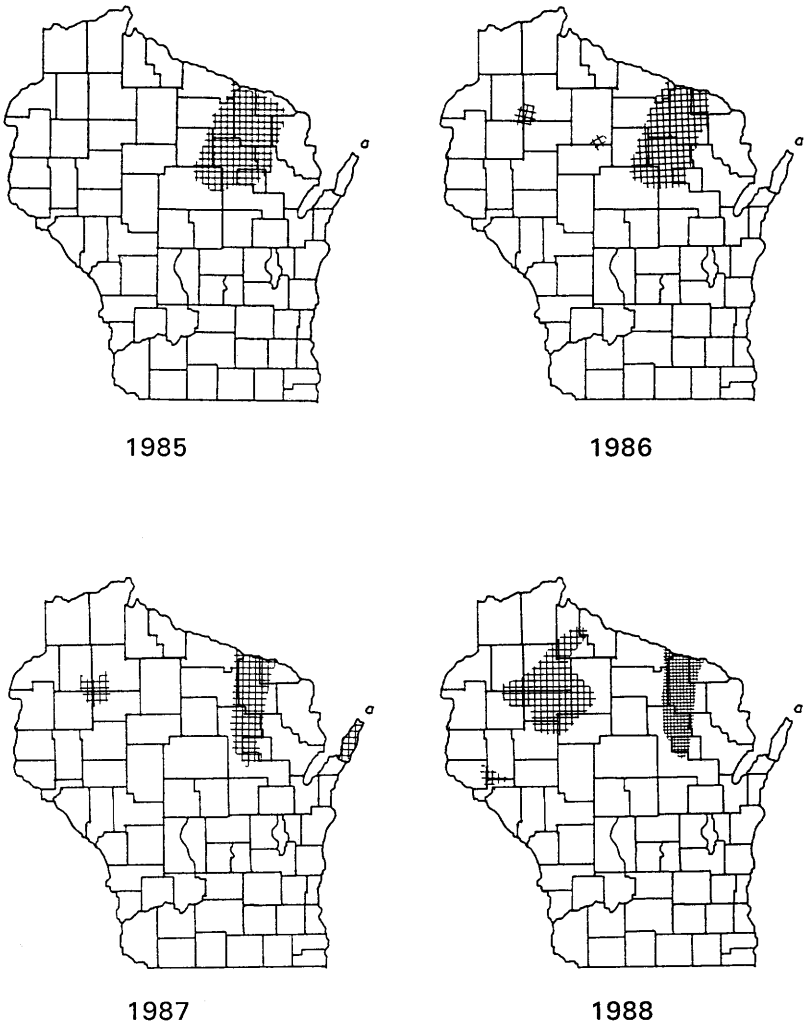

Figure 2. Areas (shaded) of severe defoliation by basswood thrips in Wisconsin from 1985 - 1988. Area shaded with small cross-hatching in the 1988 map represents regions of light to moderate thrips defoliation.

Table 1. Defoliation of *Tilia americana* by *Thrips calcaratus* in Wisconsin from 1980 - 1987[a]

Year	Hectares with moderate to severe defoliation
1980	809
1981	2,307
1982	20,000
1983	40,470
1984	105,222[b]
1985	101,175
1986	101,175
1987	80,940

[a] Data from Forest Pest Conditions in Wisconsin, WI Dep. of Natural Resources.

[b] Includes light defoliation.

Basswood is the third most common tree in the Lake States northern hardwood forest. This region has a large tourism economy, which could be adversely affected by thrips defoliation of this tree species. Basswood also has important commercial uses such as veneer, furniture, and particle board. This tree is also an important soil-improvement and wildlife habitat species (Fowells 1965, Panshin & de Zeeuw 1980, Beier 1985).

Basswood Thrips Bioecology

Very little is known about *T. calcaratus* biology. Because this species is not a pest in its native European range, it has not been studied beyond the taxonomic level (Gentile & Bailey 1968, Jacot-Guillarmod 1975). It has been recorded on nine tree genera, including some which occur in association with basswood in the North American range of *T. calcaratus*. The latter include maple, hickory, beech, ash, and oak. However, there are no rearing data available, and so these may be just casual associations. The European data suggest that *Tilia*

species are the only suitable breeding hosts (Jacot-Guillarmod 1975). The European hosts are *Tilia europa*, *T. platyphyllos*, and *T. vulgarus*. There are no data on developmental rates, fecundity, or behavior. The species is believed to consist entirely of females, as no males have been collected.

Thrips calcaratus appears to tolerate a wide range of climatic conditions. It is distributed throughout almost all of Europe, north to Denmark, south to Italy, west to Great Britain, and east to the Ukraine (Jacot-Guillarmod 1975). Thus, it seems that this species will ultimately colonize the entire range of basswood in North America.

In 1988 we initiated a two-year study on the life history and impact of *T. calcaratus*. Twelve permanent 0.10 hectare (0.25 acre) plots were established in April. Thirty basswood trees were randomly selected per plot. Tree data on each tree, including defoliation estimates in 1988 and 1989 and increment cores in 1989 were taken at scheduled times. Insect data were collected on eight plots, and include collections from two emergence traps and six soil/litter samples per plot per week. Soil samples were extracted using Berlese funnels. Direct observations of thrips adults and larvae in the field were also made.

T. calcaratus overwinters in the soil as an adult. Emergence begins during the first week of May in southern Wisconsin, and about a week later in the northern counties. Emergence is highly synchronous, being nearly complete by the end of the second week of May in the south, and late May in the north. Adult emergence coincides with basswood bud swelling. They feed in the opening buds, just as the leaves are starting to expand. The opening leaves show a shotgun effect, in which small feeding holes shred and further tissue degradation occurs. The leaves become chlorotic, and eventually drop off if feeding is extensive. Oviposition appears to occur in the main veins of the lower leaf surface. Larvae appear in early June, by which time very few adults can be found. Because a high degree of defoliation has already occurred by this time, adult feeding is probably the main source

of injury. Larvae complete development in June, drop to the ground, and burrow into the soil. Soil populations are much higher than litter populations. Development to the adult stage for most *T. calcaratus* is complete by mid-July, although some immatures are present into September. There is one generation per year.

Impact of Basswood Thrips

The impact of thrips feeding on basswood trees is largely unknown. We subsampled 77 trees in 1988, and based on these preliminary data, defoliation above 30% appears to reduce radial growth (Table 2). Branch dieback has also been observed. Defoliated trees do refoliate, but the new leaves appear small, chlorotic, and sometimes scorched at the edges. The actual source of injury remains a mystery. The amount of damage surely exceeds the actual consumption rates by these tiny insects. Feeding appears to induce necrosis around the site of puncture, but whether this is due entirely to mechanical damage is unknown. The chlorosis suggests that phytotoxic secretions may be involved, but we have no evidence for this.

Table 2. Effect of defoliation by *Thrips calcaratus* on radial growth of *Tilia americana* in northwestern Wisconsin in 1988

Defoliation (%)	*n*	Annual Radial Growth (% Increase)
0 - 30	10	0.81
40 - 60	20	0.49
70 - 100	47	0.42

Before we can develop intelligent management strategies, we need to answer some very basic questions about why this insect is so damaging here, but so innocuous in Europe. At least two biological features need to be considered. The first is natural enemies. Whenever an introduced species undergoes outbreak behavior in its new zone, the

possibility of escape from predators, parasites, and pathogens that regulate population densities in the native range must be considered. This may provide an opportunity for classical biological control through the introduction of natural enemies from Europe. In addition, the North American natural enemy complex should be characterized so that any control strategies against *T. calcaratus* do not negatively impact beneficial species.

A second consideration is that American basswood may be more sensitive to *T. calcaratus* feeding than European *Tilia* species. In Wisconsin, thrips injury has not been observed on ornamental linden, which is almost entirely of European stock. For example, 60% of ornamental *Tilia* are of the Greenspier cultivar, derived from European littleleaf linden, *T. cordata*, and in the Lake States most of the remainder are Redmond linden, a cross of the European *T. euchlora* with *T. americana*. Perhaps these species can support thrips populations, but are either less favorable for development or more tolerant to thrips feeding. However, an alternate explanation of why ornamental trees have not suffered damage is that site conditions may be unsuitable. Native basswood stands normally occur on relatively rich soils, with thick litter layers, certainly different conditions from most lawn trees. The host range, both of suspected suitable genera and other potential hosts within *Tilia* needs to be critically examined.

Acknowledgment

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Discussion Period

Question: Do you think the black plastic on your emergence cage effects your results? Do you have any data that suggests a change in soil temperature that might alter thrips phenology?

Raffa: Probably the black plastic warms up the soil to a certain amount. Our goal this spring was to get an indication about when to concentrate our research efforts. We now know there is about a 3-week period when they emerge. In the future, we are going to try different sampling methods within that time.

Question: You mentioned that thrips damage could result in growth loss. Have you had any examples of mortality or subsequent decline in those trees?

Raffa: The only examples we have of mortality has been landowner testimony. Based on these sources there does appear to be some mortality due to thrips damage. However, we have no direct evidence of this. I don't expect mortality to be very high considering the amount of damage that has occurred.

Question: Have you done any work on chemical control for basswood thrips?

Raffa: No control methods have yet been tried. At this point we wouldn't know how to go about doing it. There are also economic issues to consider. I have described to you the virtues of basswood, but not everybody would agree with me. The softwood industry predominates in the Lake States and many people do not consider the basswood to be of high value. In our state the Mongamy Indians are the principle hardwood managers and the impact of basswood thrips damage will probably be greatest on them. However, we don't have good data on the economic value of this tree.

Question: You mentioned that you plan to look at the predacious insects that attack basswood thrips. Have you found promising predators?

Raffa: No, not yet. All our specimens are in vials. We have finished the extractions and have separated the thrips, but the rest must still be analyzed. It is a very important question though. I disagree with the Governor, who said yesterday that it is better to act and make a mistake than to do nothing at all. Certainly our history and biological experience doesn't support that. It is critical to know how our control strategies may effect beneficial organisms and the overall environmental balance before they are implemented.

Question: Once you identify the predators in your samples, how are you going to make associations with basswood thrips?

Raffa: We're not. That would require elaborate biological studies. Our work on basswood thrips is a boot-leg effort; we have no formal research program in this area so any work on predators will have to be on a small scale.

Question: What do the thrips do in the ground?

Raffa: I think they are in an overwintering stage by that time, based on the population profiles we've seen in the emergence data and the soil data. We've found adults in the soil from early June to early July, and prior to that only larvae in the soil and after that no larvae in the soil. One thing we wondered about was could basswood thrips have alternate hosts that support it but don't show the same level of sensitivity to feeding. It is possible that there is an allergic reaction or something like that in basswood.