

Host Range and Geographic Distribution of *Chionaspis heterophyllae* Cooley and *C. pinifoliae* (Fitch) (Homoptera: Diaspididae)

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Introduction

Knowledge of the plants on which an insect pest is able to feed on better prepares plant protection personnel in anticipating the insect's occurrence on its hosts. Long-lived plants such as shrubs and trees are especially in need of monitoring closely since there are more opportunities for insects to develop into damaging populations on them. Various conifers used as ornamentals, Christmas trees and shelterbelts serve as hosts for two pernicious scale insects, *Chionaspis heterophyllae* and *C. pinifoliae* (Coulson and Witter, 1984; Miller, 1985). Maintaining an accurate host list for these two pests is essential to tree owners and arborists since they are able to quickly develop heavy infestations on their hosts (Stimmel, 1978).

Historically, the host list for *C. heterophyllae* has been abbreviated and limited to the genus *Pinus* (Merrill and Chaffin, 1923; Nakahara, 1982). This insect was originally described from *Pinus elliotii* (as *P. heterophylla*) by Cooley (1897). In contrast, *C. pinifoliae* has been reported feeding on several species of conifers, including members of the genera *Abies*, *Cedrus*, *Juniperus*, *Picea*, *Pinus*, *Pseudotsuga*, *Taxus*, *Torreya* and *Tsuga* (Dekle, 1976; McKenzie, 1956; Nakahara, 1982). Fitch (1856) originally described *C. pinifoliae* as feeding on "white pine".

Another valuable tool of plant protection personnel is knowing the geographical distribution of an insect pest. Both *C. heterophyllae* and *C. pinifoliae* are considered native to North America (Takagi and Kawai, 1967) but their natural distribution has been obscured due to movement of scale-infested hosts by nurserymen (Cumming, 1953; Furniss and Carolin, 1977; Peterson and DeBoo, 1969).

Fitch (1856) described specimens of *C. pinifoliae* from Illinois. (IL; hereafter all states will be abbreviated following the United States Postal Service method—see Nakahara, 1982). Ferris (1937) proposed a distribution "throughout Canada, the United States and at least northern Mexico". Nakahara (1982) concurred with Ferris (1937) and reported *C. pinifoliae* had also been collected in Cuba, El Salvador and Honduras in the New World and in England. Cooley (1897) described *C. heterophyllae* from FL and later reported it from RI (Cooley, 1899). Ferris (1942) proposed that this species was "characteristic of the southeastern United States and perhaps of the Caribbean region". Nakahara (1982) updated the distribution of this scale species as follows: AL, CT, DC, DE, FL, GA, LA, MA, MD, MO, MS, NC, NJ, NY, OH, PA, RI, SC, TN, TX, and VA in the United States as well as the Bahamas and Mexico.

There appears to be some interaction between the host range of *C. pinifoliae* and the geographic distribution and concentration of host trees, as reported by Peterson and DeBoo (1969). They observed that, in general, *Pinus* species were most frequently infested east of the Mississippi River in the United States whereas *Picea glauca* was a favored host in central Canada and *Pseudotsuga menziesii* was heavily infested in British Columbia. Edmunds (1973) stated that this host range and geographical distribution interaction illustrated "adaptation to specific conifer host species" by *C. pinifoliae*. He gave further evidence by reporting that this insect commonly developed outbreak populations in Spokane, WA, on *Pinus ponderosa* but did not utilize *Picea glauca*, *P. pungens* or

Pseudotsuga menziesii as regular hosts even though these potential hosts were present in the infested *Pinus ponderosa* stands.

The objective of this study was to record the observed host range and geographical distribution of *C. heterophyllae* and *C. pinifoliae* as in Indiana and from samples from other areas in the United States.

Methods

Host and geographical ranges for *C. heterophyllae* and *C. pinifoliae* were constructed from actual collections and from reliable literature accounts. Visits to several Christmas tree plantations throughout IN as well as examination of specimens received from nurserymen, foresters, entomologists and homeowners provided the basis for state distribution maps and host occurrences. National ranges were compiled from samples taken by the investigator or local collaborators and by careful literature searches.

All collections were verified to species based on adult female identifications (Koszta, 1963). Females were removed from host needles and either mounted in Hoyer's medium (Borror et al., 1981) or mounted permanently in euparal following the method of Wilkey (1977). A minimum of 5 slidemounted adult females for each collection site and host was used for these identifications.

Results and Discussion

Host Range. Host records for *Chionaspis heterophyllae* and *C. pinifoliae* observed for IN during this study are given in Table 1. *C. pinifoliae* was collected from several

TABLE 1. Host range observed in Indiana for *Chionaspis heterophyllae* (CH) and *C. pinifoliae* (CP) (1982-1986).

Conifer Species	CH Host*	CP Host
<i>Picea abies</i>	[X]	X
<i>P. pungens</i>		X
<i>Pinus cembra</i>		X
<i>P. mugo</i>	X	X
<i>P. nigra</i>		X
<i>P. resinosa</i>		X
<i>P. strobus</i>		X
<i>P. sylvestris</i>	X	X
<i>P. virginiana</i>	X	
<i>Pseudotsuga menziesii</i>		X
<i>Tsuga canadensis</i>	[X]	

* bracketed values from host-transfer studies — see Shour (1986)

different conifers but *C. heterophyllae* had a narrower host range. There were 4 hosts common to both scales: *Pinus mugo*; *P. sylvestris*; *Picea abies*; and *Tsuga canadensis*.

Previous host records within IN are few and abbreviated. Dietz (1912) mentioned *C. pinifoliae* fed on "various conifers" with *P. strobus* being the most common host encountered. Additional state collections have been made on *Picea pungens*, *Pinus mugo*, *P. nigra*, *P. resinosa*, *P. strobus* and *P. sylvestris* (Amos, 1933; Schuder, 1983). Our results supported all previous works done in this state, as well as provided a list of other hosts for *C. pinifoliae*. In addition, a host list for *C. heterophyllae* within IN has been initiated.

Both *C. heterophyllae* and *C. pinifoliae* were observed feeding only on the foliage of their coniferous hosts. Previous reports by Cooley (1897, 1899) that *C. heterophyllae*

fed also on the bark of new growth was not observed in this study nor has it been confirmed by other workers (ex. Dekle, 1976; Kosztarab, 1963).

National host records for *C. heterophyllae* and *C. pinifoliae* are given in Table 2. This is a compilation of the results of this study as well as data from selected literature accounts. This host list was not intended to be complete but serves to initiate a summary of specific hosts for both scale species in the United States. From this analysis, it was seen that there were 14 mutual hosts for *C. heterophyllae* and *C. pinifoliae*, the majority being *Pinus* species. It is expected that the host list for both scale species will increase as workers verify host and scale species present in their areas.

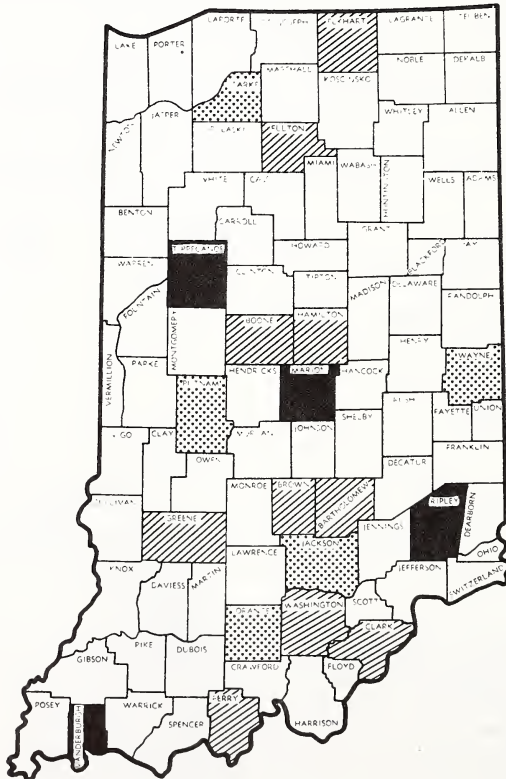
TABLE 2. National host range for *Chionaspis heterophyllae* (CH) and *C. pinifoliae* (CP) based upon several sources.**

Conifer Species	Documentation As	
	CH Host	CP Host
<i>Abies alba</i>		3
<i>A. balsamea</i>		4, 9
<i>Cedrus deodara</i>		8
<i>Cedrus</i> species		4
<i>Juniperus</i> species		4
<i>Picea abies</i>	9, 10	6, 9, 10
<i>P. mariana</i>		3
<i>P. orientalis</i>		6
<i>P. pungens</i>		4, 6, 9
<i>Pinus banksiana</i>		9
<i>P. canariensis</i>		9
<i>P. cembra</i>		10
<i>P. clausa</i>	9	4
<i>P. contorta</i>		5, 7
<i>P. densiflora</i>	9	
<i>P. echinata</i> (syn. <i>mitis</i>)	4, 9	
<i>P. elliotii</i>	4, 9	4
(syn. <i>caribaea</i> , <i>heterophylla</i>)		
<i>P. glabra</i>	9, 10	4
<i>P. halepensis</i>	4	
<i>P. jeffreyi</i>		7, 10
<i>Pinus monophylla</i>		2
<i>P. mugo</i>	9, 10	9, 10
<i>P. nigra</i>	4, 9, 10	6, 9, 10
<i>P. palustris</i>	4, 9	4
<i>P. ponderosa</i>		5, 10
<i>P. resinosa</i>	6, 9, 10	10
<i>P. rigida</i>	1, 6, 9	
<i>P. strobus</i>	9	6, 9, 10
<i>P. sylvestris</i>	4, 6, 9, 10	4, 6, 9, 10
<i>P. taeda</i>	4, 9, 10	4
<i>P. thunbergii</i>	4, 9, 10	4, 9
<i>P. virginiana</i>	9, 10	4, 9
<i>Pseudotsuga menziesii</i>		8, 10
(syn. <i>taxifolia</i>)		
<i>Taxus brevifolia</i>		8
<i>Torreya californica</i>		8
<i>Tsuga canadensis</i>	10	4, 6, 9, 10
<i>T. caroliniana</i>		9

** References: 1 = Andresen (1957); 2 = Brown (1965); 3 = Cooley (1899); 4 = Dekle (1976); 5 = Edmunds (1973); 6 = Kosztarab (1963); 7 = Luck and Dahlsten (1974); 8 = McKenzie (1956); 9 = Rhoades (1986); 10 = Current Study.

The presence of *C. heterophyllae* feeding on *Picea abies* and *Tsuga canadensis* was very notable. These observations indicated that *C. heterophyllae* was capable of feeding on conifers other than *Pinus*. The record of *C. heterophyllae* on *Picea abies* has been observed in the past in Georgia but only recently has a literature record been made (Rhoades, 1986). *Tsuga canadensis* may be a viable host for *C. heterophyllae* but this remains to be shown; this record and one of the *P. abies* references were the results of an artificial introduction to these conifers during separate experimentation (Shour, 1986). Previously, the host range distinction between *C. heterophyllae* and *C. pinifoliae* has been a major method of isolating these two scales as species in the field and, to some degree, systematically. Adaptation of *C. heterophyllae* to non-*Pinus* coniferous hosts tends to negate these major differences and will necessitate more careful species verification on non-*Pinus* hosts.

Geographic Distribution. The distribution of *C. heterophyllae* was widespread throughout the state of IN (Figure 1) and included the areas active in growing Christmas trees. This species was also collected from residential, commercial and institutional ornamental plantings. The occurrence of *C. pinifoliae* was scattered throughout the state (Figure 1) and was primarily associated with various ornamental and natural plantings, although the species was present in some Christmas tree plantations.



This state distribution for *C. heterophyllae* is considered the first verified report, whereas *C. pinifoliae* has already been observed in the state. About 1971, *C. heterophyllae* was first observed in IN at 3 sites (Rochester, Zionsville, and Columbus), but no formal record was made. Dietz and Morrison (1916) collected *C. pinifoliae* from central and southern Indiana and they proposed a statewide distribution for this species. We agree with Dietz and Morrison (1916) that *C. pinifoliae* is probably distributed throughout the entire state wherever suitable hosts exist. It is proposed that *C. heterophyllae* is more widespread in the state than Figure 1 indicates. A complete survey of IN is needed to better document the presence of both species and their hosts.

National collection records for *C. heterophyllae* and *C. pinifoliae* obtained in this study are presented in Figure 2. The presence of *C. heterophyllae* in IL, IN, KY and MI constituted new state records based on the distribution of Nakahara (1982). Although MacGillivray (1921) included *C. heterophyllae* in his treatise on coccids, there was no indication if this species was collected in IL or if it was included for completeness. Collections of *C. heterophyllae* from the other states in Figure 2 confirmed and verified the report of Nakahara (1982) for these specific states. Since *C. pinifoliae* has been known from all of the conterminous United States (Nakahara, 1982), these results served to verify some of these accounts and to show the scale's occurrence on both coasts. All records for both scale species were from biparental populations; an additional record was made of a parthenogenetic population in CA.

The United States distribution for *C. heterophyllae* is shown in Figure 3. This map



FIGURE 2. National collection records of *Chionaspis heterophyllae* (hatch lines) and *C. pinifoliae* (dots) during this study—1982-1986. The three states represented in black are where both scale species were collected. Collections and records were not available from unshaded states.

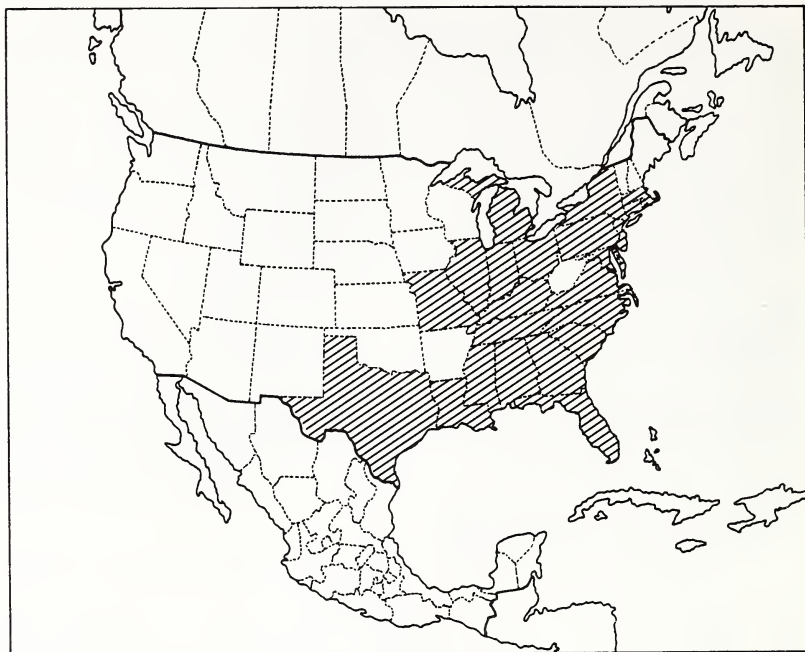


FIGURE 3. National distribution of *Chinoaspis heterophyllae*. Based upon actual collections during this study and records from coccidologists. Collections and records were not available from unshaded states.

was based on results from the current study as well as from reliable literature accounts (Andresen, 1957; Dekle, 1976; Kosztarab, 1963; Nakahara, 1982; Stimmel, 1978). The original Gulf States and Caribbean distribution proposed by Ferris (1937) has been expanded. This can be explained by: A) the movement of scale-infested stock via the nursery industry, Christmas tree growers (primarily with seedlings) and individual citizens transporting personal plants (Cumming, 1953; Furniss and Carolin, 1977; Peterson and DeBoo, 1969); B) the distribution of *C. heterophyllae* was broader than Ferris (1937) had imagined; and C) a growing awareness by entomologists of the presence of 2 scale species feeding on conifers.

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