

Balsam Woolly Adelgid

Adelges piceae (Ratzeburg)

Hemiptera: Adelgidae

Bryant, D. G. 1976a. Sampling populations of *Adelges piceae* (Homoptera: Phylloxeridae) on balsam fir, *Abies balsamea*. Canadian Entomologist 108: 1113-1124.

Objective: To describe methods of detecting, monitoring, and estimating populations of *A. piceae*.

Abstract: The balsam woolly adelgid, *Adelges piceae* (Ratzeburg), is an introduced species first recorded in North America in Maine in 1908. It has spread throughout the native range of balsam fir, *Abies balsamea* (L.) Mill., and Fraser fir, *A. fraseri* (Pursh) Poir., and is also found in the Pacific Northwest. Trees suffering from extensive stem attacks have characteristic white woolly masses on the stem and die quickly. Methods of detecting, monitoring and measuring population levels of *A. piceae* were developed on balsam fir sampled in Newfoundland, Canada.

The recommended sampling unit used to measure populations of sessile *A. piceae* is a second position node from a secondary branch axis, such as nodes 8, 12, 17, or 30 (Bryant 1972, 1976b). Sampling should be done at these positions on non-flowered, 3-yr-old branch tips of balsam fir. In addition, the author provides a thorough description of the morphology of the stem and crown of balsam fir, including surface features of the bark.

Sampling Procedure

Detection survey: Reference Table IV to determine the number of locations in a stand of balsam fir and number of nodes to sample at each location. Randomly select branches throughout the canopy of balsam fir. Use a 6 to 10X hand lens to examine underneath the bud scales of nodes 8, 12, 17, or 30 for the presence of sessile *A. piceae*. Refer to Fig. 2 for a diagram illustrating the node positions (Bryant 1976b). If no adelgids are present on any nodes in the sample, it is safe to classify the location as uninfested with 95% confidence. In Newfoundland, usually one location is sampled for every 10 ha of forest. This sampling intensity has not been verified statistically and would depend heavily on the distribution of *A. piceae* at the stand and forest level, which is not known.

Monitoring Populations: This method is used once an infestation is detected. Use a 6 to 10X hand lens to examine underneath the bud scales of nodes 8, 12, 17, or 30 for the presence of sessile *A. piceae*. Refer to Fig. 2 for a diagram illustrating the node positions (Bryant 1976b). Generally, if <33% of the examined nodes are infested, then *A. piceae* populations do not warrant control measures. However, if >33% of the nodes are infested then more detailed sampling is required to determine if control

measures are needed. Refer to Table IV to determine the appropriate sampling intensity.

Measuring Population Levels: Precise sampling methods are often needed to estimate *A. piceae* population levels annually, study its population dynamics, or to evaluate the success of treatments. The required number of sample units was estimated for low (Table V) and high (Table VI) populations at selected levels of precision, a range of allowable error, and a range of levels of assurance. Sample trees as described above, except examine nodes for *A. piceae* at 12 to 20X using a stereomicroscope.

Note: The sampling methods described here are only applicable to sessile adelgids and not eggs and crawlers. Evaluation of appropriate nodes might be difficult under certain circumstances. Interested users should refer to Bryant (1972, 1976b) for further details regarding the sample unit. Tables V and VI were developed from populations of *A. picea* on grand fir, *Abies grandis* (Dougl. ex D. Don) Lindl., in British Columbia. They should be used with caution for *A. picea* populations on different hosts in eastern North America. The author does not clarify the distinction between levels of confidence and levels of assurance; this might be clarified by consulting Steel and Torrie (1960).

References:

- Bryant, D. G. 1972. The measurement of population density of the balsam woolly adelgid, *Adelges piceae* (Ratz.) (Homoptera: Phylloxeridae) a highly aggregate species. PhD dissertation, Yale University. 169 p.
- Bryant, D. G. 1976b. Distribution, abundance, and survival of the balsam woolly aphid, *Adelges piceae* (Homoptera: Phylloxeridae), on branches of balsam fir, *Abies balsamea*. Canadian Entomologist 108: 1097-1111.
- Steel, R. G. D.; Torrie, J. H. 1960. Principles and procedures of statistics. McGraw-Hill, New York. 481 p.

Figure and Tables

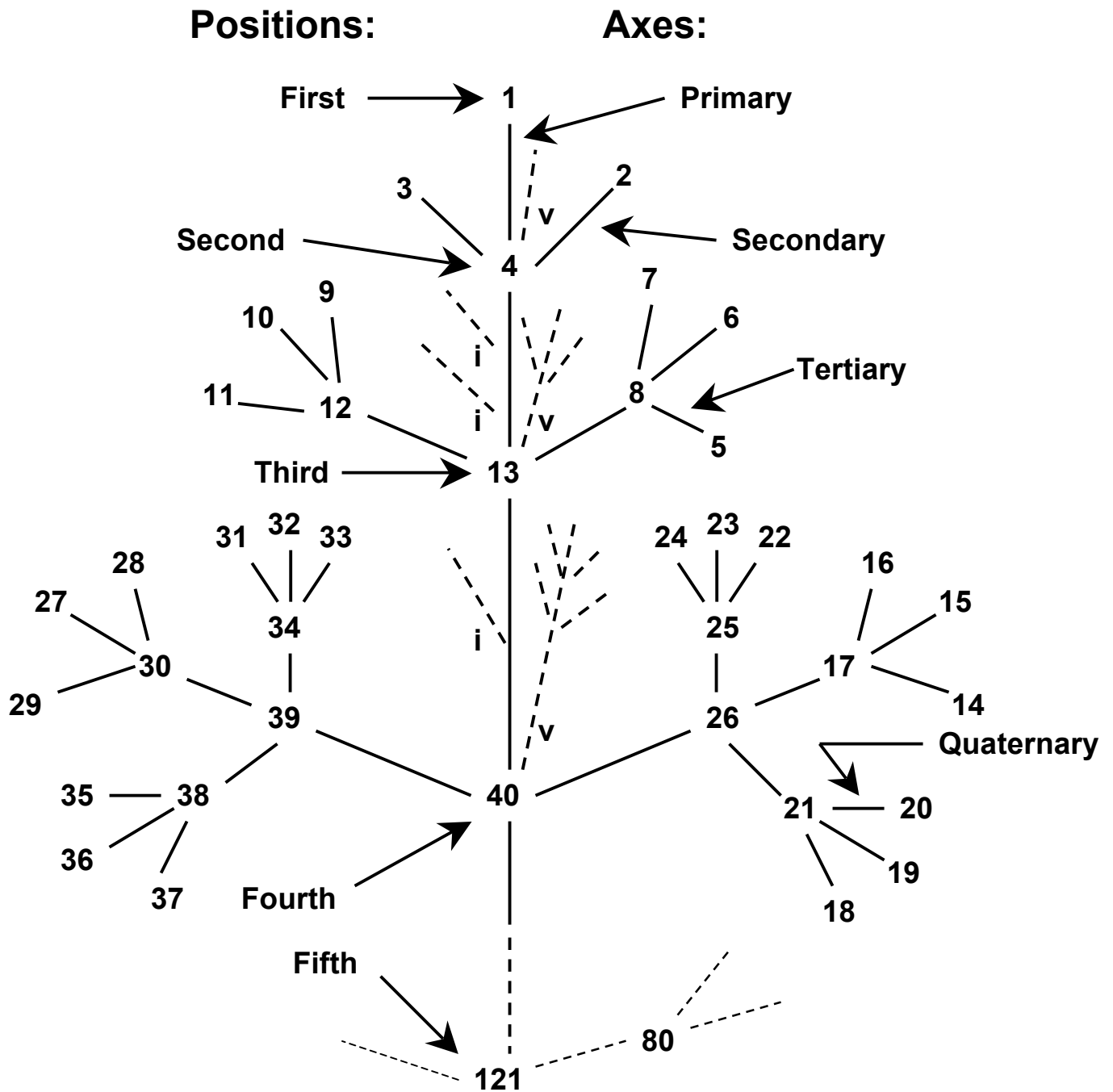


Fig. 2. Illustration of a 5-year-old branch showing four branching axes, five node positions, numbered nodes on the main branchings, and the ventral (v) and internodal (i) twigs.

Table IV. The number (n) of node 8 (or 12, 17, or 30) samples required per sample location (m) to state with over 95% confidence (α) that a balsam fir stand is uninfested by *A. piceae* where $\alpha = (1-q^n)^m$ and $q = 0.53$, probability of zero counts in an aphid population (Bryant 1972).

No. of sample locations in a stand	No. of nodes (one per tree) per location
1	5
2	6
3-5	7
6-10	8
11-16	9

Table V. Number of sample units (node 8 or its homologue 12, 17 or 30) required in a low population level of aphids to estimate each mean ($[\sum \log (X_i + 1)]N^{-1}$) with a confidence of 90 or 95% at an allowable error of 10 to 33% of the mean with an assurance of 0.75, 0.90, or 0.95. $s^2 = 0.042904$ at d.f. = 48.

Allowable error ^a	Estimate one mean			Compare two means			Estimate one mean			Compare two means		
	Level of assurance						Level of assurance					
	.75	.90	.95	.75	.90	.95	.75	.90	.95	.75	.90	.95
	90% confidence						95% confidence					
.03	166	187	199	313	378	410	228	265	283	457	500	546
.05	59	74	84	117	136	152	92	105	112	170	191	201
.07	31	38	41	60	71	86	44	54	57	72	84	113
.10	18	22	24	31	38	41	24	29	31	44	53	57

^a Nominally 10%, 15%, 25%, and 33% of the mean.

Table VI. Number of sample units (node 8 or its homologue 12, 17 or 30) required in a high population level of aphids to estimate each mean ($(\sum \log (X_i + 1)N^{-1})$) with a confidence of 90 or 95% at an allowable error of 10 to 33% of the mean with an assurance of 0.75, 0.90, or 0.95. $s^2 = 0.257971$ at d.f. = 40.

Allowable error ^a	Estimate one mean			Compare two means			Estimate one mean			Compare two means		
	Level of assurance						Level of assurance					
	.75	.90	.95	.75	.90	.95	.75	.90	.95	.75	.90	.95
	90% confidence						95% confidence					
.08	138	163	177	271	302	332	192	222	244	375	428	466
.11	79	94	102	148	172	184	109	119	131	199	237	258
.20	26	33	36	46	55	59	38	41	44	64	82	93
.26	18	20	21	32	37	39	23	29	32	39	47	52

^a Nominally 10%, 15%, 25%, and 33% of the mean.

Figure 2 and Tables IV, V, and VI are reprinted as fair use under 17 USC § 107.