# LIFE HISTORY OF THE WOOLLY PINE SCALE *PSEUDOPHILIPPIA QUAINTANCII* COCKERELL (HOMOPTERA: COCCIDAE) IN LOBLOLLY PINE SEED ORCHARDS

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## ABSTRACT

The woolly pine scale, *Pseudophilippia quaintancii* Cockerell, had 2 generations per year in the Georgia coastal plain. Crawler activity peaked in late March-early April and late May to mid-June. First-generation males were wingless and emergence began in late April. Second-generation males were alate and their emergence peaked in early July. Populations of *P. quaintancii* increased during the first generation and dispersal occurred during the second. Fecundity averaged about 500 offspring per female. Populations were significantly affected by tree clone and crown level, with higher average survival in the upper crown. Parasitism of the woolly pine scale was low.

Key Words: Coccidae, *Pseudophilippia quaintancii*, scale insects, loblolly pine, seed orchards, *Pinus taeda*.

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## INTRODUCTION

The woolly pine scale, *Pseudophilippia quaintancii* Cockerell, is an occasional pest of pines in the eastern and southeastern United States (Craighead 1950). This species is characterized by a white, cottony wax secretion on shoots and needles of infested pines. Recorded hosts are loblolly pine, *Pinus taeda* L.; mugho pine, *P. mugo* Turra; pitch pine, *P. rigida* Mill.; longleaf pine, *P. palustris* Mill.; Caribbean pine, *P. caribaea* Morelet; sand pine, *P. clausa* (Chapm.); shortleaf pine, *P. echinata* Cockerell; table mountain pine, *P. pungens* Lamb.; and slash pine, *P. elliottii* Engelm. var. *elliottii* (Hamon and Williams 1984).

Recent severe outbreaks[2] of the woolly pine scale in seed orchards have been associated with the aerial application of certain insecticides for cone and seed insect control (Nord et al. 1985). Heavy scale populations may cause stunted shoot growth (Ray and Williams 1980). As the biology of this pest was not well known, studies were initiated to determine its life history.

## MATERIALS AND METHODS

A 7.4-ha section of a loblolly pine seed orchard which had been established in 1978 in Bullock Co., GA was selected for study. Populations of the woolly pine

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[2] DeBarr, G. L., L. R. Barber, M. S. McClure, and J. C. Nord. 1982. An assessment of the problem of scale and mealybug outbreaks associated with the use of insecticides in southern pine seed orchards. Unpublished report on file at the USDA, Forest Service, Forestry Sciences Laboratory, Athens, GA.

scale, the striped pine scale, *Toumeyella pini* (King), and a loblolly mealybug, *Oracella acuta* (Lobdell), were present. Shoots were collected every 1 to 2 weeks from April to October 1984 and from March through November 1985, with monthly collections from November 1984 through February 1985. Nine clones with at least five ramets (individual trees of a clone) in the study area were selected as the sample population. Four ramets from each of four of these clones were selected each sampling date in 1984, with five ramets from each of two clones utilized each date in 1985. Four shoots per tree were clipped near midcrown, with one sample per quadrant. A sample shoot consisted of the most recent growth cycle (Greenwood 1980), plus ca. 10 cm of the previous growth cycle. This material was examined in the laboratory and the numbers of live, dead, and parasitized woolly pine scales were recorded. Females were also dissected to determine if they were producing eggs or crawlers. Only settled scales were counted. Mean numbers of female scales settling on shoots with and without ovipositing mother scales were analyzed by PROC TTEST (SAS 1982) each generation.

Gravid second-generation females were placed in gelatin capsules and the offspring per female were counted. Parasitized females were also placed in capsules to collect parasites for identification.

Microscope slides (7.5 cm × 2.5 cm) coated on both sides with silicon grease were used to monitor male activity. Slides were mounted in clips attached by flexible wire to 10 1-m high steel posts located throughout the infested orchard. There were two slides per post, positioned so that a slide surface faced each different cardinal direction. The slides were collected every 1 to 2 weeks, and numbers of captured woolly pine scale males were recorded.

Mating between first-generation males and females was observed in April 1985. Infested shoots were examined under a microscope and the behavior of males for up to 3 hours post-emergence was recorded.

Greased microscope slides from five posts in loblolly seed orchards in Blount County, TN and New Kent County, VA were also examined biweekly during 1985 to compare male emergence periods with those found in Georgia. Infested foliage from the orchards was also collected and examined to ascertain which generation was present at the time of slide collection.

Data collected 17 March 1983 from an infested loblolly pine seed orchard in Beaufort County, NC were used to determine if crown level influenced numbers of scales. This orchard was established in 1963, and a severe woolly pine scale outbreak occurred there in 1980-1982 during a 2 year pilot test of azinphosmethyl and fenvalerate to control other seed and cone insects.[3] One shoot was randomly collected from each quadrant in both the upper and lower crown of two ramets from each of five clones, and the numbers of live and dead females on the most recent growth cycle were counted.

## RESULTS AND DISCUSSION

The woolly pine scale had two generations per year (G1 and G2), with peak populations present in Georgia from April through July (Fig. 1). Overwintering G2 females, which had been inseminated the previous summer, became swollen with eggs in mid-February and oviposition commenced in late March when the first

[3] Barber, L. R., and D. S. Leonard. 1985 Final report: 1980-1981 Guthion-Pydrin aerial application pilot study. USDA, Forest Service, FPM-Region 8, Asheville, NC. Report 85-1-11.

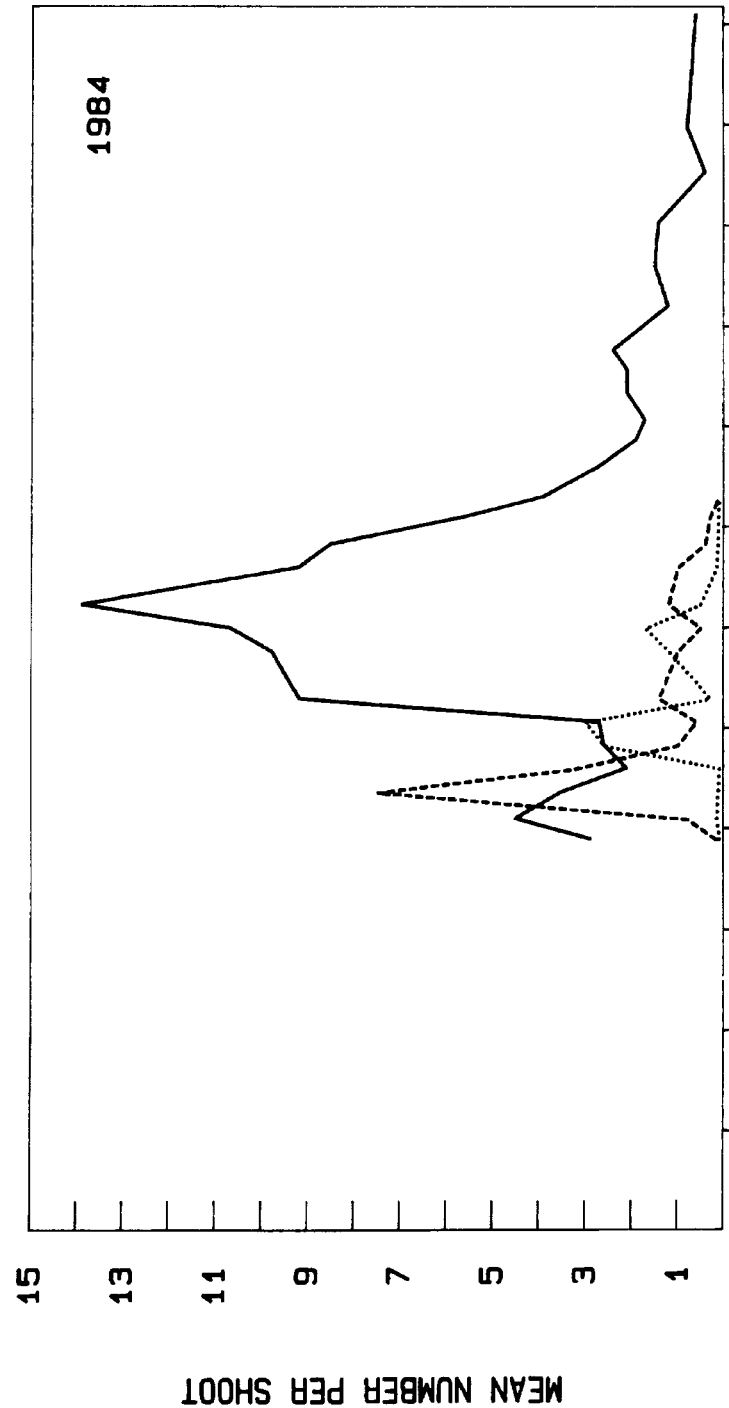
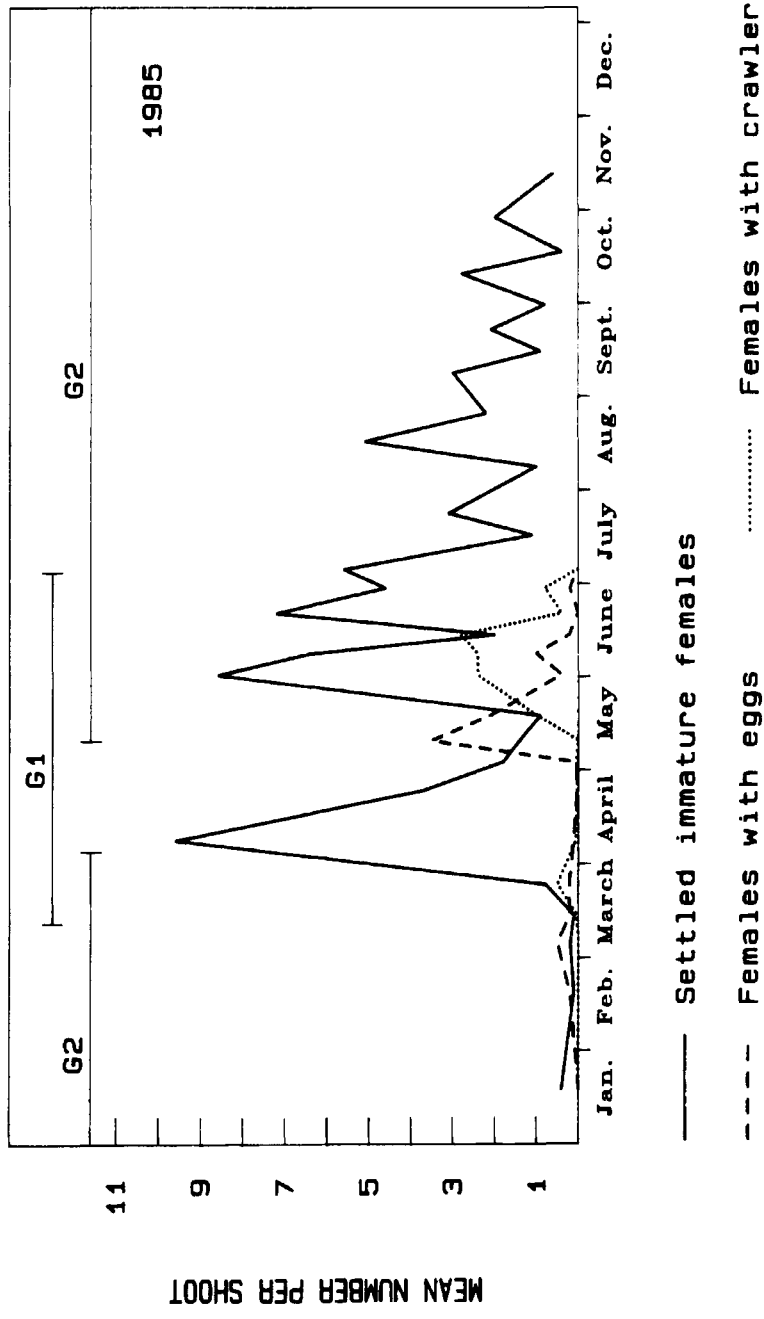



Fig. 1a. Mean numbers of live immature, egg-producing, and crawler-producing female *P. quaintancii* per shoot at the Bulloch County, Ga. seed orchard in 1984 and 1985. Generation time spans (G1 and G2) are indicated.

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cycle of shoot elongation began. Oviposition continued through early May (Fig. 1). Eggs hatched almost immediately after oviposition and the G1 crawlers quickly moved up to the new growth. Crawlers could not be distinguished morphologically by gender, but differences between the sexes were readily apparent among the settled second instars. Females predominated during this generation. Young female woolly pine scales were yellow and began producing white woolly wax immediately upon settling. Most G1 females settled on twigs that had G2 parent females. Adjacent shoots were often also covered with females. The few females observed on more distant shoots settled at the tip of the new growth. Significantly more females settled on shoots with an ovipositing female, $21.2 \pm 4.2$, than on those without, $4.5 \pm 0.26$ ($P = 0.05$). This distribution indicates that G1 female dispersal is limited.

All G1 males were apterous and they developed in the groove at the base of the fascicles on the new growth. Settled males were always much less numerous than settled females. Male development was rapid, and the sampling interval made determination of numbers per shoot difficult, but no more than 15 were found on a shoot. Disperal of G1 males was also limited, as only one was captured on a slide. Adult males emerged in late April-early May and crawled to the females. The settling behavior of females and the fact that males are apterous suggests that substantial mating between related individuals occurred in this generation. Males were polygamous and were observed mating with up to five females during a 3-hr period. Mating appeared to be facilitated when the honeydew secreted by females matted down the wax surrounding the anal opening. Male activity persisted for only 1-2 weeks after the first emergence was noted.

As they matured, females turned a reddish- or greenish-brown and became sclerotized. G1 females began egg production about a week after mating. Oviposition occurred from mid-May through June (Fig. 1). Mean fecundity was $477.5 \pm 28.7$ crawlers per female.

The predominance of females and the restricted dispersal in the first generation appeared to maximize survival and provide for population increases, while most dispersal occurred in the second generation. Similar numbers of G2 females were found on shoots with G1 females, $5.91 \pm 0.63$, as on shoots without G1 females, $5.72 \pm 0.31$. This indicated that many G2 females dispersed to uninfested new twigs to develop, as there were more shoots without G1 females. Shoot length did not appear to be a limiting factor, since females settled only at the shoot tip. These females must survive for about 10 months, so perhaps some advantage is gained by settling at the shoot tip. The lower average number of females per shoot following second generation dispersal could also reduce possible intraspecific competition during the overwintering period.

Most G2 males settled on the base of the needles of previous year's growth. Some settled on new needles of the current growth cycle, usually near the middle of a needle. A few developed at the shoot tip, especially males that dispersed to other shoots. G2 males secreted copious amounts of white wax, giving infested trees a flocculent appearance. An average of $23.0 \pm 3.8$ G2 males per old growth needle were found on shoots with G1 females, versus $3.2 \pm 0.28$ males on previously uninfested shoots, indicating differential dispersal of the sexes. The tendency of second-generation males to settle on old needles rather than the shoots may also reduce competition between the sexes for space and nutrients. Luck and Dahlsten (1974) found a similar behavior for males of the pine needle

scale, *Chionaspis pinifoliae* (Fitch), which settled on old needles while females settled on new needles.

G2 males outnumbered females, but because sex determination of crawlers is difficult, we were not able to ascertain whether a higher percentage of males was actually produced or if dispersal losses accounted for the shift in the sex ratio.

G2 males were alate and began emerging in late June in southern Georgia. Emergence peaked in early July, but up to 3.5 percent did not emerge until August or September. Males were again polygamous and many were found trapped in the thick wool of the females. Male emergence was 3 to 3 1/2 weeks later in Tennessee and Virginia (Fig. 2).

Mated females appeared to remain dormant until the following spring. They often lost their woolly covering during the fall and winter and survivors became difficult to detect. Female mortality increased from 39.8 percent at the start of the second generation to 87.5 percent by the end of the overwintering period.

Significantly higher numbers of live overwintering females per shoot were found in the upper crown in March 1983 at the Beaufort County, N.C. seed orchard (Table 1). Upper crown branches of loblolly pines are usually polycyclic (Greenwood 1980), so more uninfested shoot tips may have been available for the females than in the mono or bicyclic lower crown. Mortality may also have been lower in the upper crown. Clonal effects on population numbers were apparent, perhaps accounting for some of the variation in numbers of G2 females per shoot between sampling dates (Fig. 1), as clones were randomly selected from the sample population each date.

Parasitism never surpassed 5 percent. Two parasitoids were identified; an aphelinid, *Coccophagus lycimnia* Walker, and an encyrtid, *Metaphycus* sp. These species also parasitize the striped pine scale (unpublished data). Another encyrtid, *Cheiloneurus* sp., which has been reported as a hyperparasitoid of *Metaphycus* spp. (Smith 1933), was also collected. Predation by a pyralid moth larva, *Laetilia coccidivora* (Comstock) and green lacewings, *Chrysopa* spp., was observed but not quantified.

Peak scale insect populations are coincident with periods of routine aerial insecticide applications for cone and seed insect control, which could reduce the numbers of natural enemies. Though noticeable levels of parasitism of *P. quaintancii* have been reported, most parasitoid activity occurred in unsprayed areas.[2] This suggests that natural enemies may be responsible for maintaining *P. quaintancii* populations at low levels or for contributing to population declines in the absence of insecticide applications. Other factors such as dispersal losses or natural mortality during the overwintering period may be more important in regulating populations during insecticide-related outbreaks.

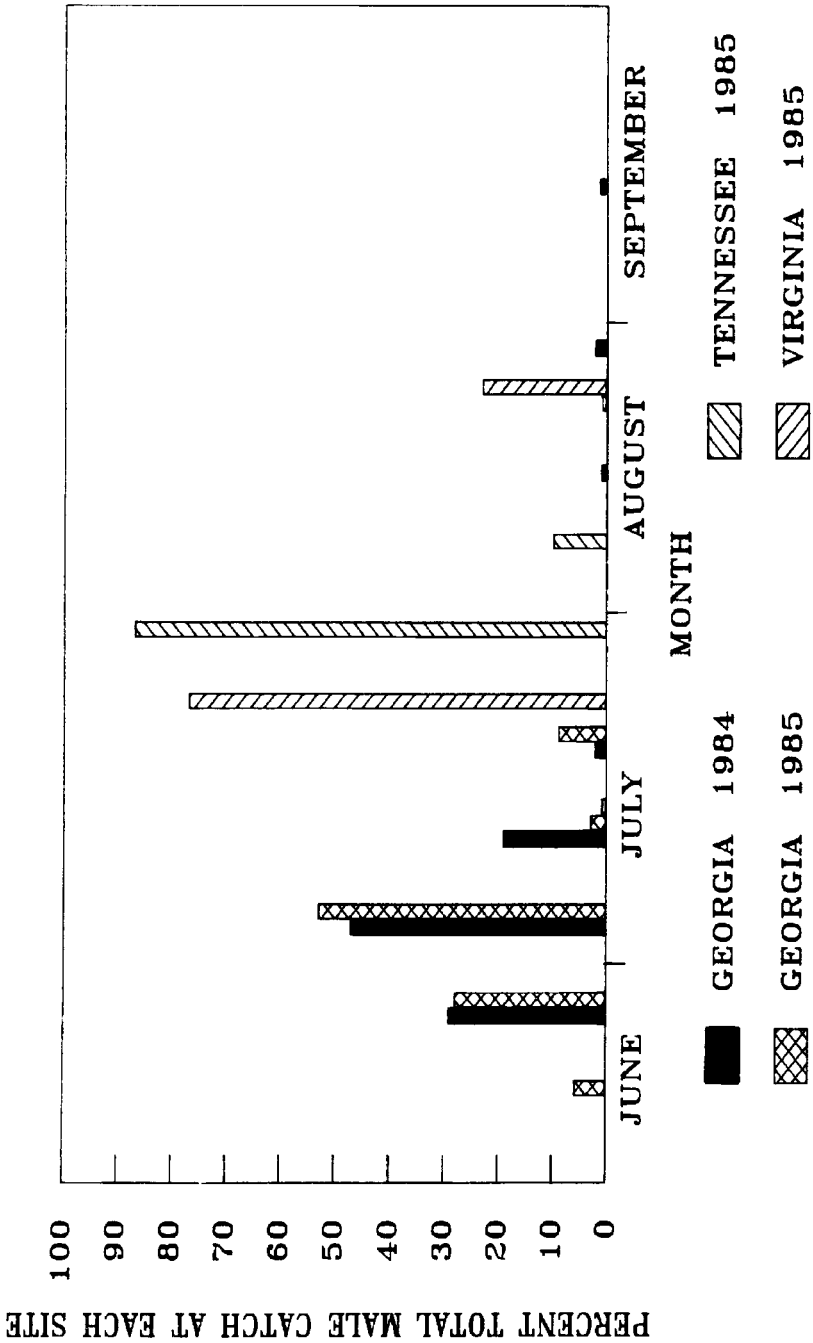


Fig. 2. Percentage of total G2 *P. quaintancii* males captured by date at three southern seed orchards in 1984 and 1985.

Table 1. Crown-level differences in numbers of overwintering woolly pine scale females per shoot in a loblolly pine seed orchard, Beaufort County, NC.

| Crown level | N | Mean live females per shoot* | Mean total females per shoot* |
|---|---|---|---|
| Upper | 40 | 1.9 ± 0.30 a | 2.2 ± 0.35 a |
| Lower | 40 | 0.9 ± 0.27 b | 1.2 ± 0.35 b |

* Means in a column followed by the same letter are not significantly different; ($P$ = 0.05; Duncan's [1955] multiple range test).

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