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Ceroplastes rubens Maskell Damage of Pinus caribaea Morelet with Notes on the Scale's Preference of Certain Clones as Host Material (Hemiptera: Coccidae)

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Introduction

The red wax scale, *Ceroplastes rubens* MASKELL (Hemiptera: Coccidae), a pest of citrus, *Pinus taeda* L. and *P. radiata* D. DON (BROWNE, 1968), is now causing damage to certain clones of *Pinus caribaea* MORELET in Papua New Guinea. Damage was first noted when an examination was carried out to determine factors causing various clones to have noticeably sparse and dark foliage. The greatest damage, as a result of scale attack, arises from the aggravation of the host by sooty-molds which live on honey dew secretions produced by the scale (BLUMBERG, 1935). TAUSMAN and HART, 1974, reported citrus leaves with sooty-mold fungus had less absorption of light than clean leaves.

First records of P. *caribaea* as *a* host of C. *rubens* are reported herein. The described investigations were carried out to determine the preference of the scale to different species of *Pinus* and various clones of *P. caribaea.* Of further interest was the extent of insect damage found on *P. caribaea.*

Materials and Methods

The study was carried out in the Bulolo and Watut River Valleys of the Morobe District, Papua New Guinea, from September 1974, to March 1975. Red wax scale damage was first noted in a *P. caribaea* seed orchard located 1.2 km S.E. of Bulolo at 700 m elevation. The seed orchard was established between June 1968, and July 1971, by randomly planting grafted ramets of clones taken from Bowenia, Queensland, Australia. In the orchard, no two ramets of the same clone were planted adjacent to one another.

The sampling of scale populations of trees within the seed orchard was carried out to determine relative attack frequencies on trees of 23 clones of *P. caribaea. A* count of scales was obtained on samples of thirty needles taken from the lower, middle and upper crown of all trees in the orchard.

Due to the uneven number of trees per clone, only 18 of the 23 clones could be analyzed statistically for attack frequencies. All clones with three or more trees were included in the test. Those clones with more than three trees were represented by a randomly selected sample of three trees. The statistical analysis included 57.5 percent of the sampled trees.

Tree heights were monitored in October 1975, and six months later, to determine height increment. Clones were rated according to their height increment for this period, as well as for a yearly period in 1969-70 (HOLESGROVE and HOWCROFT 1970).

Examination of stands of many species of *Pinus* was carried out to determine the scale's preference of various species.

Results and Discussion

Samples of attack frequencies on needles (*Table* 1) from different portions of the crown and from different clones revealed that the most heavily attacked portion of the tree was the upper crown (*Fig.* 1 *and 2)*. The mid-crown portion was more heavily infested than the lower portion. The samples also revealed a great difference (0.5 percent probability level) of attack frequencies among clones. When a Student-Newman-Keul's test was performed, the only significant difference (5 percent probabilitylevel) was between clones No. 21, 55 and 65, and the remainder. These three clones exhibited a greater amount of attacks than did the other clones (*Table* 2).

NO correlation was found between height of trees and amount of scales on samples within or among clones. This

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Table 1. — Scale attacks on the upper, middle and lower crowns of *P. caribaea* clones.

Clone No.	No. of trees Sampled	Average No. of Scales at three Levels (30 needles at each position)			Average No. of Scales (90 needles)	Mean Height of Trees
		Upper Crown	Mid Crown	Lower Crown		
1	4	7.75	2.75	2.00	12.50	8.93
21	6	72.00	80.83	27.83	180.67	9.93
29	9	6.78	5.44	4.67	16.89	9.89
40	1	8.00	0.00	1.00	9.00	11.99
41	3	6.33	1.67	3.67	11.67	8.04
43	5	5.00	5.40	7.00	17.40	8.26
44	6	7.67	4.67	1.67	14.00	7.77
49	9	6.00	3.56	2.44	12.00	9.60
54	5	2.20	2.80	3.00	8.00	9.46
55	5	55.80	26.40	14.60	96.80	8.05
56	7	4.71	3.00	1.00	8.71	9.89
57	4	8.00	6.75	8.25	23.00	10.07
59	2	2.50	1.50	3.00	7.00	8.07
61	5	5.20	5.60	3.80	14.60	9.67
62	3	7.00	5.67	2.33	15.00	9.61
63	6	4.17	3.33	4.00	11.50	9.12
65	3	78.00	46.33	7.33	131.67	9.64
66	2	5.00	2.00	.50	7.50	10.09
67	4	8.00	6.50	5.75	20.25	9.50
71	6	10.83	8.17	8.00	27.00	10.78
10x53	1	1.00	8.00	0.00	9.00	11.03
CL	4	2.50	1.75	1.50	5.75	7.82
NGGIA	1	9.40	5.40	4.80	19.60	7.80
Overall	439	14.60	11.22	5.75	31.57	9.32
Total	101	1475	1133	581	3189	941.32

Table 2. — Clones of *P. caribaea* arranged in increasing order of attack by *C. rubens*.

Clone No.	Mean
CL	4.67
54	8.33
1	10.00
61	11.00
41	11.67
71	11.67
43	12.33
44	12.67
56	13.00
62	15.00
49	15.33
67	17.00
63	17.33
29	25.00
57	30.33
65	131.67
55	137.33
21	172.00

Groups of means bracketed are significantly different at the 5 percent probability level as shown by Student-Newman-Keuls test.

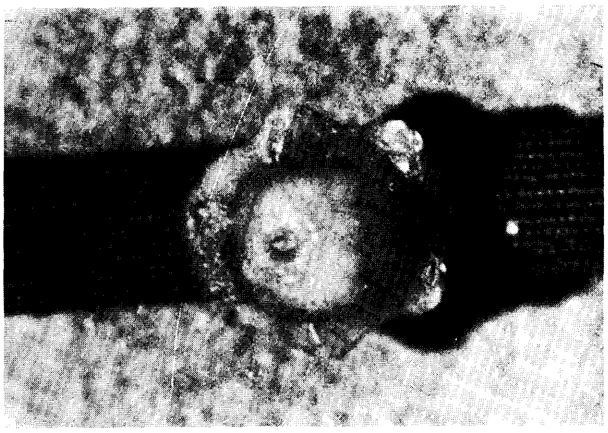

Figure 1. — *Ceroplastes rubens* on *P. caribaea* needle.

Figure 2. — Needles from a clone 21 tree exhibiting characteristic scale attack.

may have been due to the recent build up of *C. rubens* population. In comparison, when trees were rated according to their height growth increments for a period in 1969-70 and a period in 1974-75, a correlation was found between the number of scale attacks on clones and height increment ratings of clones. Clone 21 in the earlier assessment was the fastest growing clone. However, in the later assessment this clone exhibited the highest amount of scale attacks (180.67/90 needles) and was surpassed in height increment by clones 40 and 66, which were lower on the 1970-71 increment scale and were characterized by scale attacks of 9.00 and 7.50, respectively, per 90 needles.

The position of trees in the seed orchard appeared to have no effect on the intensity of scale attack *(Fig. 3)*.

Observations revealed no attacks on *P. merkusii* Jungh. and De Vriese, *P. taiwanensis* Hayata, *P. occidentalis* Swartz, *P. strobus* L., and *P. luchuensis* Mayr. In contrast, oc-

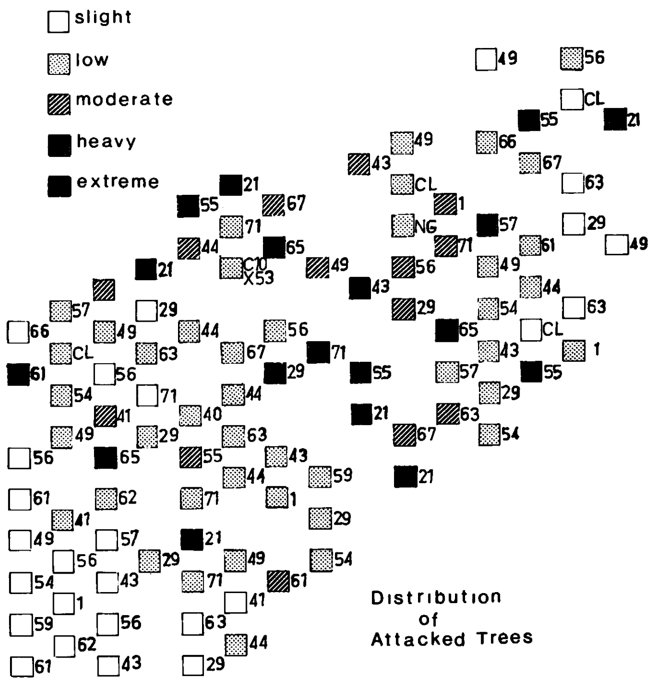

Figure 3. — Seed orchard layout of *P. caribaea* clones and the intensity of scale attack on each tree. Tress are identified by clone numbers. Slight intensity of attack represents zero to five attacks; low, six to 18 attacks; moderate, 20—32; heavy, 40—88; and extreme, 111 or more attacks.

casional attacks were found on *P. pseudostrobus* LINDL, *P. oocarpa* SCHIEDE, *P. patula* SCHIEDE and DEPPE, *P. cubensis* GRISEB., *P. radiata* D. DON, *P. keseya* ROYLE, and *P. michoacana* MARTINEZ. An occasional *P. taeda,* located in Eastern Highlands District plantings, was heavily attacked by *C. rubens*. *P. caribaea* was the only species currently undergoing very heavy insect attack and, subsequently, insect damage.

In all cases where *P. caribaea* was heavily attacked, two other conditions were found. These were:

1. Very sparse crowns, and
2. Considerable darkening of foliage by a dense covering of sooty-molds.

Entire identities of fungi growing on the honey dew secretions of *C. rubens* are unknown. However, there is at least one species present from each of the following genera:

Metacapnodium, Tripospermum and Capnophialophoro.

Due to the sparseness of crowns and the covering of fungal hyphae which cause reduced light absorption by needles *(Fig. 4),* the authors believe an epidemic population of scales would cause a reduction of tree height and girth development, an increase in tree stress, an increase in susceptibility to damage by other insects and, possibly, even death of trees.

The results of this study suggest clonal differences in severity of attack are influenced by the genetic make-up of individual clones. With this in mind, the authors suggest that clones 21, 55 and 65 should be excluded from the seed production programme.

Numerous examples of clonal resistance of trees to insect attack (for example, see LARSEN, 1953) show the advantages of selecting clones which are resistant to insect attack. Future trials testing the field tolerance of various progenies to red wax scale attack would be of value.

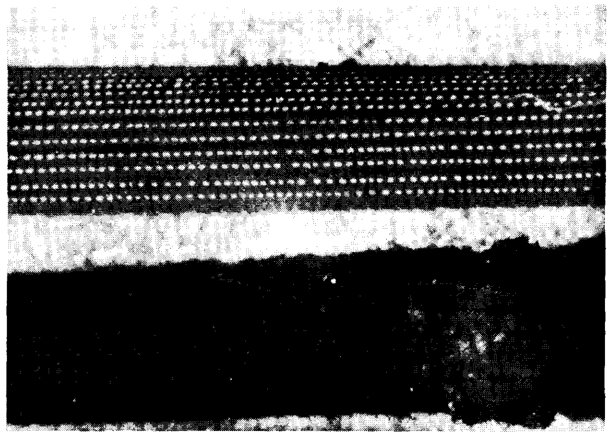

Figure 4. — *Pinus caribaea* needles demonstrating the intensity of sooty-mold on needle surface. The lower needle was taken from a tree heavily infested with scales; the other needle was taken from a tree with few scale attacks.

As staff becomes available, it may prove advantageous to investigate those factors which may be causing the differences in quantity of scale attacks on various clones. Tree resistance to insect attack may result from adverse morphological or anatomical characters, presence of chemical repellents, absence of chemical attractants, or detrimental nutritional status of trees (HANOVER, 1975). HANOVER, 1975, reports feeding habits of aphids make them prone to both anatomical and nutritional variation in their host. Inasmuch as scale feeding habits are similar to aphid's, the authors believe the most likely source of host resistance lies in either anatomical or nutritional variations.

One factor which could promote scale attack, may be differential response by clones to stress caused by improper nutrient balance or improper planting sites. BAULE and FRICKER, 1970, summarized that sucking insect attacks generally diminish as foliar potassium levels increase or nitrogen levels decrease. Foliar tests of *P. caribaea* have shown the phosphorus levels of grassland soils at Bulolo to be low and "field plantings are reported to suffer from a complex deficiency of boron, phosphorus and nitrogen"; potassium levels are reported to be marginal (SMITH, 1970). Accordingly, fertilizer treatment of *P. caribaea* plantings may possibly reduce scale damage.

Another factor, which may cause individual clones to be exceptionally attractive to scales, may be quantitative variation of chemical constituents of resin and foliage among different clones. Great quantitative variation of terpenes in *Pinus monticola* DOUGL. has been reported to be genetically controlled (HANOVER, 1966). It is, therefore, probable that the variation of terpenes among *P. caribaea* clones could also be considerable.

Acknowledgements

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Summary

Heavy infestation by the red wax scale, *Ceroplastes rubens* Maskell (Hemiptera: Coccidae), was first discovered in a seed orchard of *Pinus caribaea* Morelet near Bulolo in September, 1974. Within the orchard were 23 clones im-

ported from Queensland, Australia. Severe damage was found only on clones 21, 55 and 65.

Thirteen species of pine were checked for scale attack. *C. rubens* was found on six species; considerable damage was present only on *P. caribaea.*

C. rubens attacked the upper crown of *P. caribaea* more frequently than the middle crown. The lower crown portions were least heavily attacked. No correlation was found between height of trees and attack density.

Heavily infested trees were characterized by sparse crowns, considerable darkening of foliage by a dense covering of sooty-molds, and reduced height increment.

Key words: Ceroplastes rubens, Pinus caribaea, Clonal Resistance, Damage, Sooty-mold, Papua New Guinea.

Zusammenfassung

In einer Samenplantage von *Pinus caribaea* MORELET, in der Nähe von Bulolo, Neu Guinea, wurden im Herbst 1974 starke Schäden durch die rote Wachsschildlaus *Ceroplastes rubens* MASKELL festgestellt. Die Plantage enthält insgesamt 23 *Pinus caribaea*-Klone, von denen drei besonders stark geschädigt waren, insbesondere im oberen Kronenbereich der Pfropflinge. Die eingehende Untersuchung aller Klone der Plantage ergab, daß diese drei Klone, unabhängig vom jeweiligen Standort der randomisiert ausgepflanzten Pfropflinge, als besonders anfällig anzusehen sind und damit ein individualspezifisches Verhalten gegenüber *Ceroplastes rubens.*

Weitere Untersuchungen an 13 Kiefern-Arten ergaben einen mehr oder weniger starken Befall durch *Ceroplastes rubens* bei *Pinus pseudostrobus* LINDL., *Pinus oocarpa* SCHIEDE, *Pinus patula* SCHIEDE et DEPPE, *Pinus cubensis* GRISEB., *Pinus radiata* D. DON, *Pinus keseya* ROYLE und *Pinus michoacana* MARTINEZ, der jedoch in keinem Fall so stark war wie bei *Pinus caribaea.* Kein Befall konnte festgestellt werden bei *Pinus merkusii* JUNGH. et DE VRIESE, *Pinus taiwanensis* HAYATA, *Pinus occidentalis* SWARTZ, *Pinus strobus* L. und *Pinus luchuensis* MAYR.

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Effect of Seed Extracts on Radiosensitivity

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Introduction

It is known that soaking seeds in water immediately before treatment with ionizing radiations and chemical mutagens greatly increases the sensitivity of seeds to mutagenic treatment. The increased sensitivity of pre-soaked seeds was attributed to leaching out of radioprotective substances, KAMRA *et al.* 1960 a, b. The absence of oxygen has been reported to cause chromosomal aberrations in *Vicia faba* (MERZ, 1959) but an aerobiosis is not effective in barley (RIEGER and MICHAELIS, 1958). On the other hand, D'AMATO and HOFFMANN-OSTENHOF (1956) have postulated the production of automutagens inside the seeds after soaking in water which increases the frequency of spontaneous chromosomal aberrations (MICHAELIS and RIEGER, 1958) as well as spontaneous mutations.

Preliminary experiments have demonstrated the radiosensitivity of the 48 hours pre-soaked Douglas-fir seeds is maximum (EL-LAKANY and SZIKLAI, 1969). The present experiments were undertaken to investigate whether the extracts from soaked Douglas-fir and lodgepole pine seeds contain active substance(s) which would modify sensitivity to gamma-irradiation when it is used as a medium of pre-soaking other seed samples of the same species, or the radiosensitivity is affected by *in situ* systems.

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Materials and Methods

Seeds of Douglas-fir *(Pseudotsuga menziesii* (MIRB.) FRANCO) collected near Duncan, B.C. in 1968 and those of lodgepole pine *(Pinus contorta* DOUGL.) collected near Shuswap Lake, B.C. (Canada) in 1971 were cleaned, equilibrated for moisture content of 8 per cent, and stored at 0—4° C at George Allen's Tree Seed Laboratory, U.B.C., Vancouver. Seed samples were given the following treatments:

(A) Dry seeds were exposed to different doses of γ-radiation, soaked in tap water for 48 hrs. then germinated.

(B) Seeds were pre-soaked in tap water for 48 hrs., irradiated, then germinated,

(C) Seeds were pre-soaked in seed extracts for 48 hrs., irradiated then germinated. The seed extract was prepared from seeds of the same species that had been soaked for 48 hrs. in water, crushed in a mortar and a paste was made by adding 50 ml of water per 100 seeds. The paste was filtered through muslin cloth then used to soak the seeds immediately,

(D) Seeds were soaked in pre-irradiated extracts prepared by the same method mentioned above, then germinated without further irradiation.

At the end of the pre-soaking period, the seeds were washed thoroughly in running water for 2—3 min. The following doses of γ-radiation were given to the seeds of Douglas-fir and lodgepole pine respectively: 0 (Control), 1, 5 and 10 kR and 0, 1, 5 and 15 kR at 140 R/sec. A220