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AN OUTBREAK OF THE LEAF BAGWORM HYALARCTA HUEBNERI (WESTWOOD) (LEPIDOPTERA: PSYCHIDAE) IN FOREST PLANTATIONS OF PINUS RADIATA IN QUEENSLAND

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SUMMARY

The leaf bagworm, *Hyalarcta huebneri* (Westwood), is an endemic Australian species of Psychidae with numerous records of damage to the exotic reafforestation and ornamental species *Pinus radiata*. An outbreak in forest plantations in the Stanthorpe district of south-eastern Queensland resulting in extensive defoliation of trees is reported.

The history of this outbreak over an 11-year span showed a prodromal phase of 8 years and an eruptive phase of 3 years. Parasitism by *Spoggosia remota* Walker (Diptera:Tachinidae) and *Exeristes consimilis* Morley (Hymenoptera:Ichneumonidae) occurred each year but was not the mortality factor responsible for termination of the outbreak. Other natural influences on population are discussed.

I. INTRODUCTION

During the period 1953 to 1963, the leaf bagworm *Hyalarcta huebneri* (Westwood) caused extensive damage to forest plantations of *Pinus radiata* at Passchendaele in the elevated Stanthorpe district of south-eastern Queensland. The leaf bagworm (figure 1) is an endemic Australia species with a long history of damage to the exotic Monterey pine, *P. radiata.* The earliest record of *H. huebneri* as a pest of *P. radiata* was from New South Wales by Olliff (1891). Froggatt (1927) described damage by the species to trees in forestry plantations at Armidale, N.S.W. and Brimblecombe (1958) referred to its occurrence in the same way in Queensland. *H. huebneri* is polyphagous on a range of native and exotic hosts.

The South African species *Kotochalia junodi* (Heylaerts), described as a pest of wattle plantations by Sherry and Ossowski (1967), has many features in common with *H. huebneri.* Outbreaks of *K. junodi* were found to develop through two well defined phases, a 'prodromal' phase of 5 to 7 years and an 'eruptive' phase of about 2 years. These terms have been adopted for similar stages observed

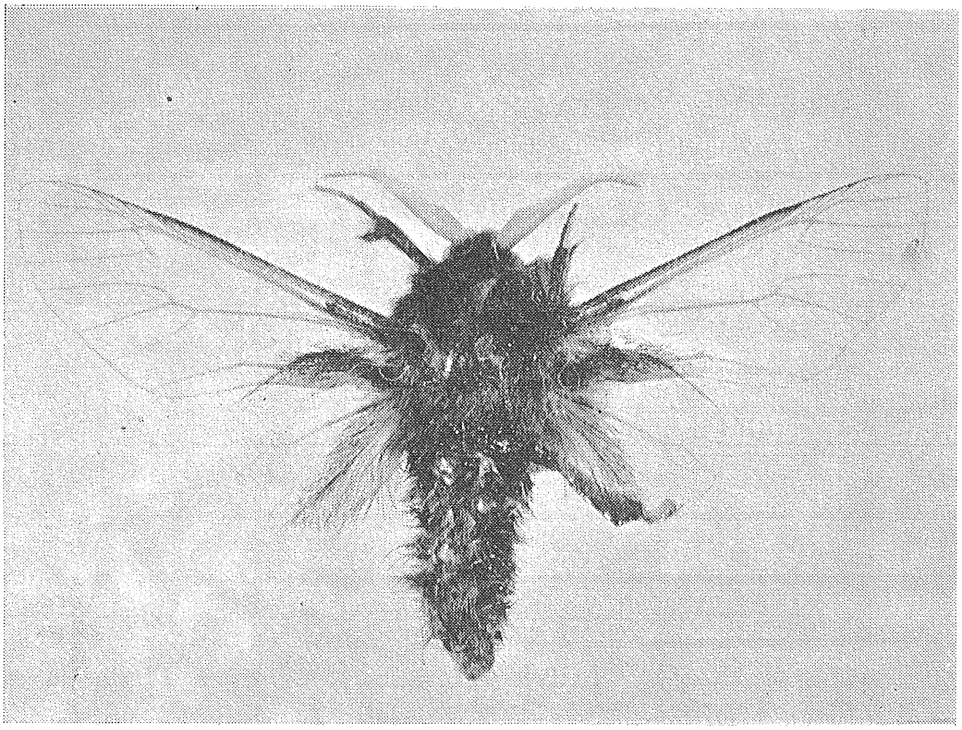

Figure 1a.—The adult of the leaf bagworm Hyalarcta huebneri *(Westwood).*

in the outbreaks of *H. huebneri* at Passchendaele. Brimblecombe (1958) named *H. huebneri* as the most common bagworm occurring in southern Queensland. in the Passchendaele area, native hosts were eucalypts and acacias. The life cycle occupied one year commencing with hatching in late summer and early autumn. Details of the life history and hosts have been described more fully in a paper to be published separately. (Heather 1976).

In Queensland, plantations of *P. radiata* are a small but significant part of reafforestation. The species has been planted commercially only in the southern highlands at elevations of 600 m to 900 m with uniform rainfall, where it is the most successful species. Plantations were commenced in the Stanthorpe district at Passchendaele in 1931 and to date *H. huebneri* has been the only insect pest to cause concern. At the inception of the outbreak in 1953 there were 167 ha of *P. radiata* of which 126 ha were less than 6 years old; by 1963 a further 422 ha had been planted. (Queensland Department of Forestry, personal communication 1970).

II. DEVELOPMENT OF THE OUTBREAK

Bagworm activity was first reported from Passchendaele in 1953 when trees were found to be infested in a 3 ha stand planted 6 years previously. Intensive localised damage had been caused to groups of trees at several foci and damage occurred in this way throughout plantation areas for the next 5 years until 1958.

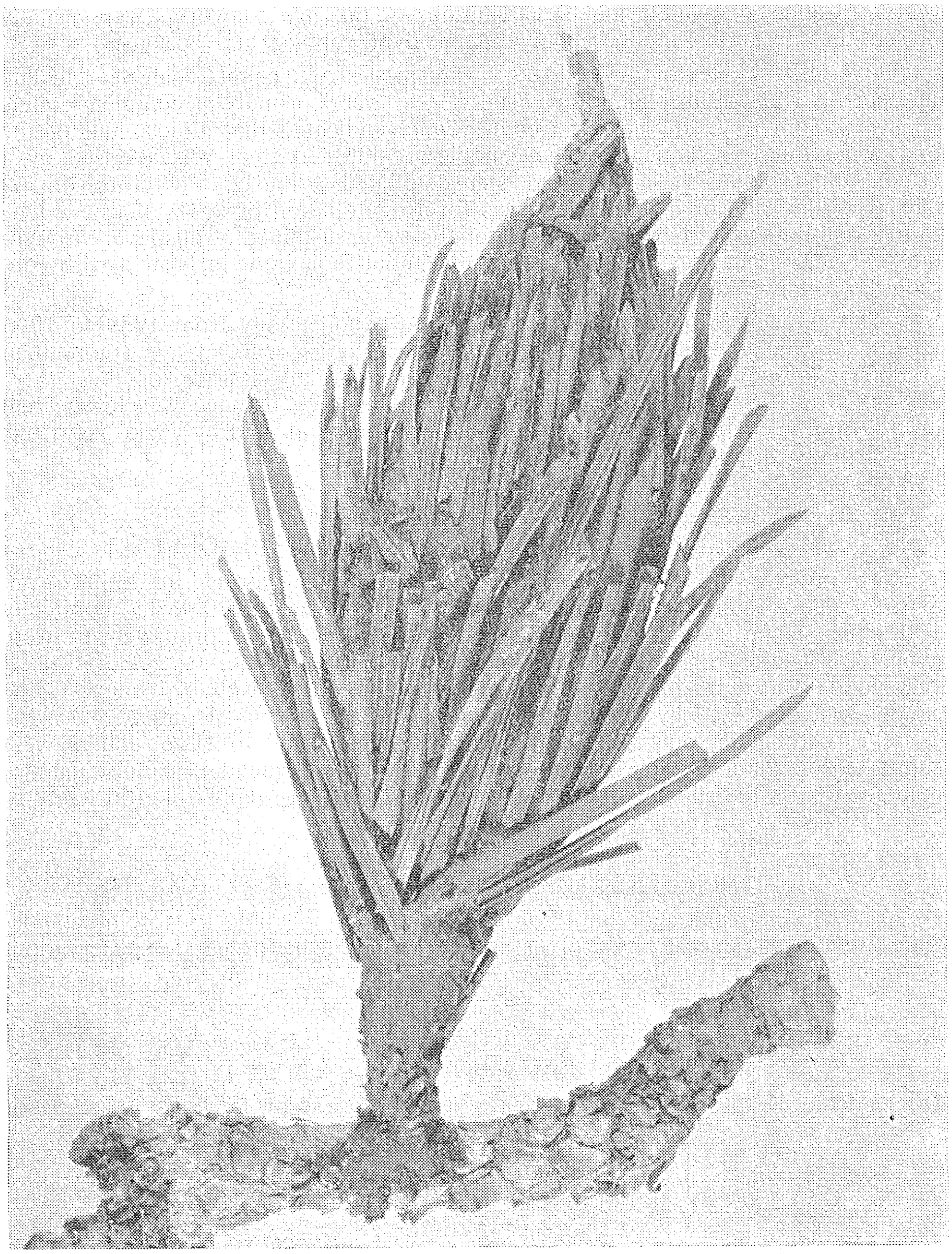

Figure 1b.—A late stage larval bag of the leaf bagworm Hyalarcta huebneri *(Westwood).*

In general, serious damage tended to cease as soon as canopy closure occurred, usually at from 8 to 12 years after planting. Only rarely were trees less than 4 years old affected severely and in plantations of this age bagworms were usually present in substantial numbers only on eucalypt coppice and acacias.

Overall estimates of trees affected were made from counts each year in late summer on 10% of all plantations, aged 4 to 10 years, usually as complete counts on every tenth row. In the 1963 count, which indicated that almost half of the trees were infested, damage to the canopies of infested trees was assessed by a visual rating and, of these, half had been defoliated seriously. Therefore, in 162 ha out of the total of 587 ha there was severe defoliation of 25% of trees. Due to the long life cycle of *H. huebneri,* defoliation was sustained at this level throughout that year as in previous years, and substantial reductions in growth with consequent loss in yield were to be expected.

The percentage of trees affected increased exponentially from 1959 to 1963 (figure 2) when overall, almost 50% of trees 4 to 12 years of age (more than 80 000), harboured bagworm infestations. In some areas 80% of trees were affected. In 1964, the percentage of trees with canopy damage was lower than in 1960 due to natural termination of the insect outbreak and by 1966 bagworms had virtually disappeared from plantation areas.

III. EFFECT OF H. HUEBNERI ON PINUS RADIATA

To observe the progress of trees affected by bagworms, in 1963, seven experimental observation plots were defined (table 1) each of 0.05 ha, nominally 100 trees, as far as possible in locations where records of prior growth were available. These had site indices (Pegg 1967) ranging from 64 (poor) to 94 very good) and in 1962 were aged from 2 to 11 years. Levels of damage to the canopy were assessed by a series of ratings (< 5%; 5-15% 16-30%; 31-50%; > 50% defoliated) on each tree during the period 1962 to 1966. These were supported by counts of larvae for one of the sites. Assessments of canopy damage made at five of the sites over the period 1962 to 1964 are represented in figure 3.

IV. FACTORS AFFECTING POPULATIONS OF H. HUEBNERI

GENERAL. Because of implications arising from possible use of insecticides for control, estimates of levels of parasitism formed a major part of observations on factors affecting survival of insects during each generation.

TABLE 1

DESCRIPTION OF DATUM PLOTS USED FOR ASSESSMENT OF DAMAGE BY THE LEAF BAGWORM *Hyalarcta Huebneri*, PASSCHENDAELE QUEENSLAND 1962–1967

Site	Date Outplanted	Planted size Rows x trees (2·44 m x 2·44 m)	No. Trees present	First Observation	Site Index
A	1951 ..	8 x 15	93	Sep 1962	64
B	1953–54 ..	10 x 10	61	Sep 1962	67
C	1955 ..	10 x 10	80	Sep 1962	90
D	1955 ..	10 x 10	72	Sep 1962	81
E	1956 ..	8 x 15	101	Sep 1962	61
F	1958 ..	10 x 10	71	Mar 1963	75
G	1960 ..	8 x 12	82	Mar 1963	94

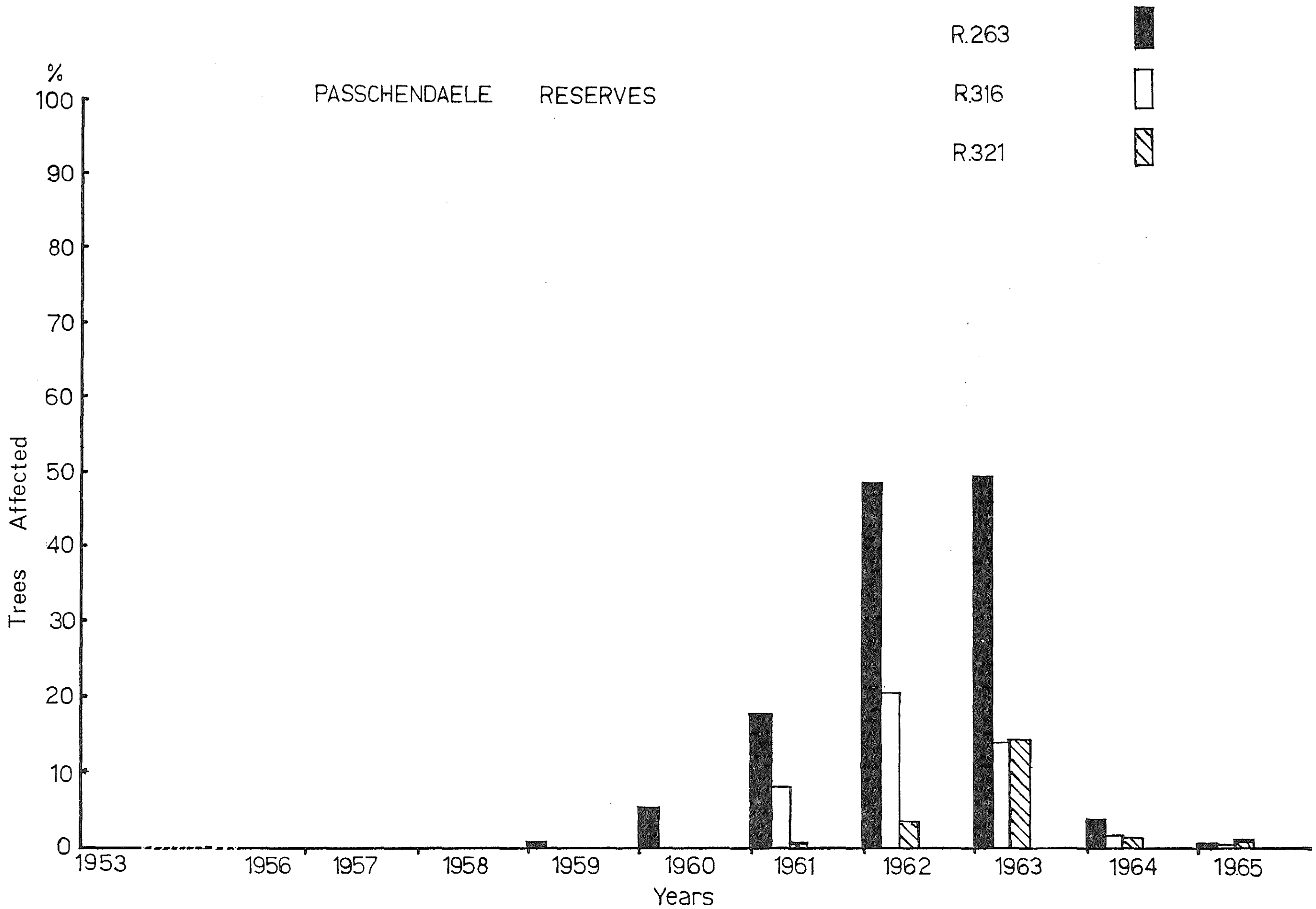

Figure 2.—Percentage of Pinus radiata *trees affected by the leaf bagworm* Hyalarcta huebneri *(Westwood) in Passchendaele (Q.) Forestry Plantations, 1953-1965.*

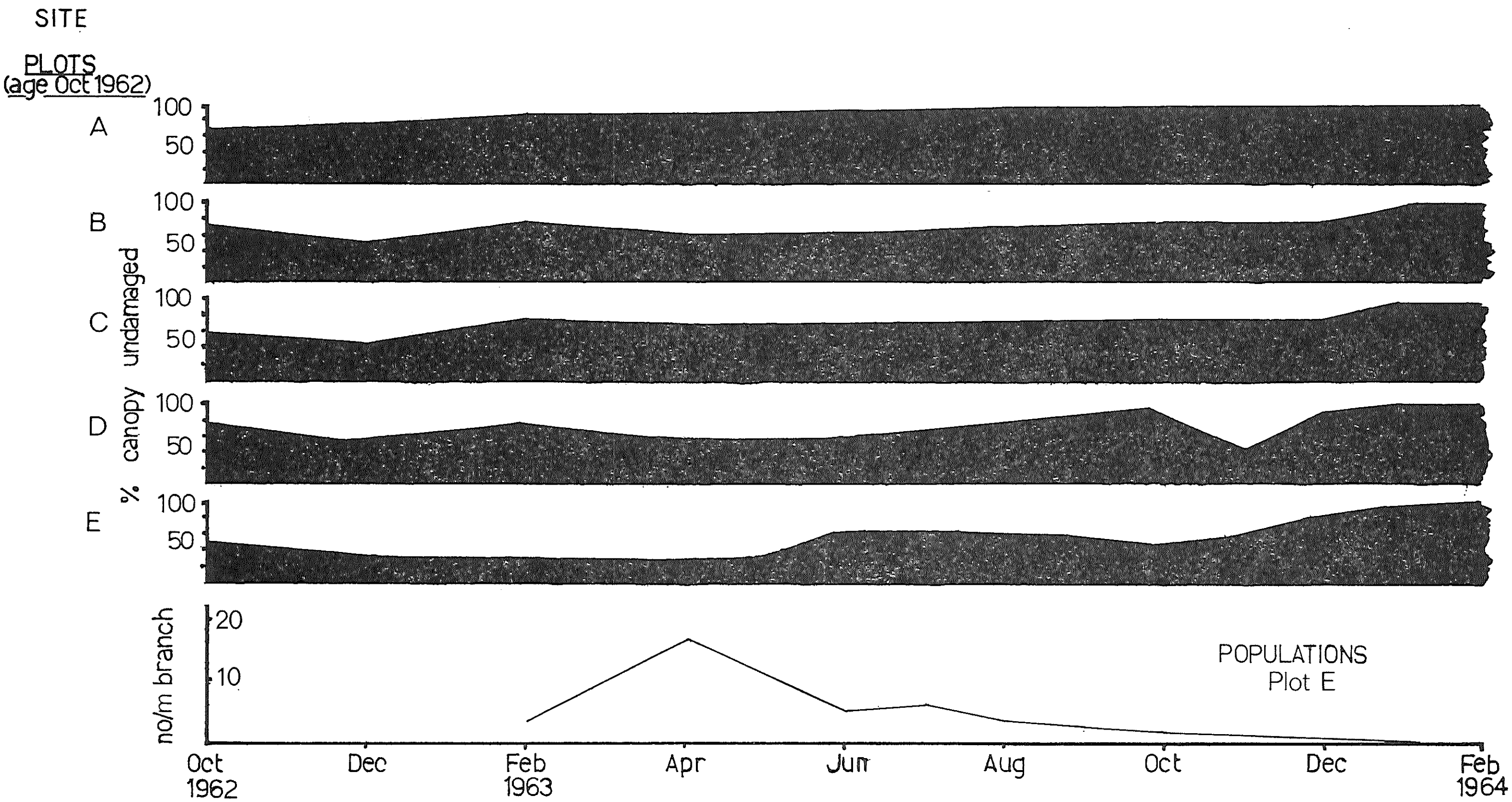

Figure 3.—Canopy depletion of Pinus radiata *trees by the leaf bagworm* Hyalarcta huebneri *(Westwood) at five datum sites with related bagworm populations for one site.*

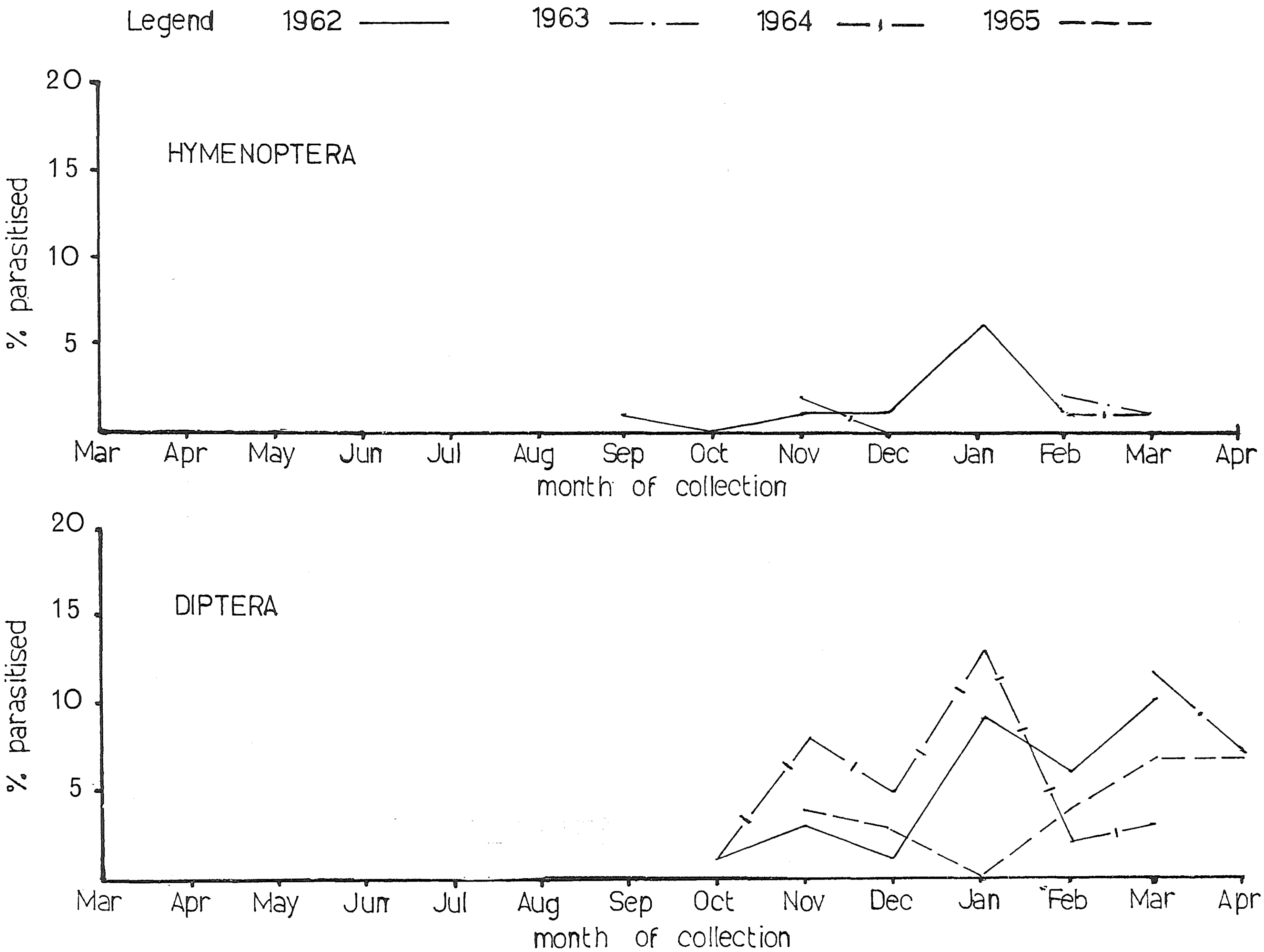

Figure 4.—Incidence of parasites in field populations of the leaf bagworm Hyalarcta huebneri *(Westwood) attacking plantation trees of* Pinus radiata *at Passchendaele (Q.), 1962-1965.*

In autumn of the year of the decline of the outbreak at Passchendaele, appearance of numerous dead larvae in field collections suggested the possibility that a viral pathogen might be active, but attempts to positively determine this proved unsuccessful. Mortality from other causes occurred earlier, during and shortly after the hatching period.

PARASITES. Species of parasites bred from material collected at Passchendaele were:—

1. *Exeristes consimilis* Morley (Hymenoptera: Ichneumonidae)
2. *Spoggosia remota* Walker (Diptera: Tachinidae)
3. An undetermined species of Tachinidae, probably undescribed

A further undetermined species of *Botanobia* (Diptera: Chloropidae) was also bred. It was not parasitic in habit and presumably was a scavenger. However, Froggatt (1927), Mingko (1962), and Moore (1963), recorded unnamed species of *Botanobia* as parasites of *H. huebneri.*

Parasite numbers recorded from the monthly field samples of larvae showed the seasonal incidence of parastism in bagworm populations at Passchendaele for the years 1962 to 1965 inclusive (figure 4). A substantial collection of bags (more than 700) of the 1962 generation, made in August 1963, showed that at pupation parasitism by Tachinidae (10%) had been more common than parasitism by Ichneumonidae (1·6%). Except in 1963, parasitism occurred during the latter part of each generation, from September to April; the average level recorded by dissection of larval samples was 3·8%. In 1963, parasites were not found in any monthly field sample until February (figure 4). Hymenopterous parasites were present in 0·5% and Dipterous parasites in 3·3% of larvae sampled, the proportions remaining uniform throughout.

DISPERSAL MORTALITY. As females of *H. huebneri* are apterous, dispersal occurs at the larval stage and mortality during dispersal of early larval instars appeared to be an important factor. Where foliage of host plants intermingled, all stages larvae were able to disperse but in young forestry plantations, spacing of trees almost eliminated dispersal of all but the first instar which made use of air movement while dropping on a silk thread. Here mortalities were high, reflected in population figures in table 2. Of other known hosts of *H. huebneri,* only eucalypt coppice and acacias occurred commonly in plantations of young pine trees. Distribution made these more important as foci of infestations in plantations than as an influence in the survival of first instar larvae during dispersal.

OTHER FACTORS. From the egg counts of 1 200 from females reared in the laboratory, a high potential increase factor was expected despite the male:female sex ratio which ranged from 2·0:1 to 1·5:1. However, counts of larvae showed an actual increase of about five times over the hatching period. Counts for 1963, the year in which the outbreak declined, are given for two sites in table 2.

V. DISCUSSION

The course of this outbreak was recognizable in retrospect as continuous over a period of 11 years. The pattern of development represented a prodromal phase of 8 years (1953–1960) and an eruptive phase of 3 years (1961–1963). Early records were insufficient to reveal all of the predisposing conditions, but it appears that these were not localized since the prodromal stages of an outbreak occurred at another plantation 130 km away at the same time. However, some factors were apparent.

TABLE 2

NUMBERS OF LARVAE OF THE LEAF BAGWORM *Hyalarcta Huebneri* (WESTWOOD) ON *P. Radiata* IN TWO DATUM PLOTS AT PASSCHENDAELE, 1963

Month	Numbers per metre of branch*	
	Site E	Site F
Feb	4·9	0·4
Apr	18·1	2·7
Jun	5·6	10·2
Aug	2·9	7·8
Oct	2·3	0·2
Dec	1·3	0·3
Feb	0·0	0·0

* From counts on four branches of the lowest whorl; branch lengths corrected for growth during the insect generation.

Firstly, *H. huebneri* occurred widely on natural vegetation, significant amounts of which remained distributed among the planted areas. In the establishment of each planted area, natural vegetation was felled and burned leading to coppicing of eucalypts and germination of acacias within a short period, often before planting of pine trees. These frequently supported bagworm populations during the first three years until pine trees carried sufficient foliage to support an entire generation. Obviously, these developing plantations of *P. radiata* were better suited to *H. huebneri* than the vegetation they replaced.

Secondly, a high reproductive potential and polyhagous feeding habits are outstanding characteristics of *H. huebneri*. These could be expected to facilitate the development and maintenance of outbreak populations over extended periods. Restricted mobility due to the apterous nature of the female is possibly offset by the male to female ratio exceeding 1·5:1 ensuring fertilization even in sparse populations, while dispersal by first instar larvae was effective despite high mortalities. However, factors which caused restriction of the outbreak populations to trees 4 to 8 years old, before canopy closure occurred, were not clear. Similarly, the influences which led to termination of the outbreak also were not clear; normal population levels of *H. huebneri* are extremely low.

The incidence of parasites in populations was low overall and, in addition, restricted to the latter half of the life cycle. It is of interest that the overall incidence of parasitism in larvae was constant over the period of observation with the exception of 1963. This was the year in which the outbreak declined. For the preceding year (1962), parasitism was 4·5% and for the succeeding year (1964) it was 4·5% but in 1963 it fell to 0·03% and occurred only in the last 3 months of the generation. Clearly, parasites played no direct role in the termination of the outbreak and their importance in general population regulation could well be relatively minor. Normally three generations of parasites appeared possible (figure 4).

In a discussion of the relationship of defoliation and loss of increment in *Eucalyptus grandis* following defoliation by Christmas beetles (Coleoptera: Scarabaeidae) Carne *et al.* (1974) expected little incremental loss below 40% defoliation if as suggested by Kulman (1971) the relationship between the extent of defoliation and increment loss is linear. Results obtained for defoliation by *H. huebneri* suggested agreement with these findings and those of Sherry and Ossowski (1967).

These results require further examination for elucidation of the growth-damage relationship and are expected to form the basis of a further paper.

VI. ACKNOWLEDGEMENTS

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