

NOTES ON THE BIONOMICS OF *DORYCTES PALLIDA* GOURLAY (HYMENOPTERA : BRACONIDAE)

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INTRODUCTION

Doryctes pallida Gourlay is a larval parasite of the Beech Buprestid, *Nascioides enysi* Sharp (Dumbleton, 1932; Morgan, 1966). The braconid was first collected in 1920 by G. V. Hudson and was described in 1928 (Gourlay, 1928). It occurs throughout the areas of New Zealand where *Nothofagus* spp. (Fagaceae) grow and where its host insect is established. Studies on this parasite were begun in 1956 with the prime purpose of determining whether it could be manipulated in biological control programmes against *N. enysi* which periodically causes outbreaks of tree mortality in the *Nothofagus* forests (Morgan, 1966). The work was begun with field observation and quantitative analyses of the density of parasites in infested bark removed from felled trees. In 1957, several rooms were converted to insectaries at Reefton, where rearing and behavioural studies were completed. While these rooms were not ideal and little equipment was available for ecological studies, certain experiments completed showed consistent and interesting results which together form the main points of this paper.

MATERIAL AND METHODS

The supply of insects for these studies was obtained from logs, selected in the field for the density of parasite cocoons in sections of bark removed from them. The braconids were allowed to emerge in the insectaries and were collected from windows or foliage placed near windows for this purpose. Host larvae were obtained from trees which, by similar examination, had very low levels of parasitism by *Doryctes*. The logs selected were cut into blocks about 8-12 inches long, then split so that equal sections of wood (with infested bark intact) were available for exposure to parasite attack. The logs selected were all thin-barked so that *Doryctes* could oviposit successfully in them (see Morgan, 1966) and as four sample blocks were usually produced for each 8-12 inch section of log, two were examined for previous parasitism and, if they were free of *Doryctes*, the other two were used in subsequent tests. As bark had to be firmly in contact with the wood to be suitable for *Nascioides*, the sample blocks used could not, themselves, be examined as this meant removal of the bark.

All test were carried out inside glass-topped rearing boxes about 14" x 8" x 5". The procedure followed was to collect parasites as they were pairing and to release pairs into containers. While females were ovipositing, the point of insertion of the ovipositor was marked. After specific periods of oviposition the bark was removed and parasitism assessed. In this way some general information on host and parasite relationships were obtained.

BIOLOGY AND BEHAVIOUR

The adult of *D. pallida* emerges from its cocoon by cutting a round hole at one end and bores directly through the infested bark. The exit gallery is almost at right angles to the vertical axis of the tree, the exit itself being 1.0 - 1.4 mm in diameter. Shortly after emergence the adult searches for a source of nectar in nearby foliage and it is probable that mating takes place during this time. Mating in the laboratory usually followed soon after feeding on a honey paste or sugar syrup. The period "in copula" varied from about 2-12 minutes and was usually less than 5 minutes. Oviposition was not recorded until 2 days after copulation and usually 4 or more days after emergence. Emergences occurred throughout the morning provided that the temperatures exceeded 55°F. Fewer emergences occurred in the afternoon. Emergences of *D. pallida* always begins before its host *N. enysi*, the former commencing in October about 10 days before the latter and often continuing into April. *N. enysi* usually completes its emergence period in February but in years with warm springs beetle activity in some localities may be over by December (Morgan, 1966).

The mean life spans of the sexes were determined from 38 males and 32 females, that for the former being 15.8 ± 3.8 and that for the latter being 19.4 ± 8.6 . The difference between the means (3.6 days) is significant ($P = 0.05$) so it can be concluded that females live longer than males. Adults fed on a honey/water paste lived about twice as long as starved insects (means 9 ± 3.6 and 17 ± 5.5 , the difference between is highly significant $P = 0.01$).

Mated females begin searching bark surfaces when the temperature reaches about 57°F, a temperature at which oviposition also occurs. On location of a suitable site the adult raises its abdomen and brings the tip of the ovipositor to a point midway between the tarsi of the prothoracic and mesothoracic legs. Insertion of the ovipositor takes about 4 hours at 61°F and 3.75 hours 72°. Females may thus seldom oviposit more than once or twice a day and, indeed, they were often observed to remain overnight with their ovipositors partially or wholly inserted into the bark. In the field, oviposition does not begin before 9.30 a.m.

The attraction of gravid *D. pallida* to host infested bark was studied by subjecting uninfested bark and "infested bark," with and without host larvae, to searching parasites. They did not attempt to oviposit in uninfested bark but did insert their ovipositors into "infested bark" both with host larvae present and with host larvae removed. The evidence from a series of replicated tests strongly indicated an olfactory attraction rather than an auditory or vibratory one (i.e., attraction did not appear to be due to the noise of larval feeding or to vibrations set up as a result of larval movement). The eggs of *D. pallida* are elongate, oval being about 5-7 times as long as they are wide. They are about .01 inch long, colourless to whitish,

and glabrous. They are attached to host larvae or rarely inserted within the host. They hatch in less than a week and probably in about 3 days, the host larva often being destroyed within 10 days of oviposition. The parasite grows rapidly within the larval gallery of *N. enysi*, constructs a silken cocoon over a period of about 4-5 days and may then diapause. The moult to the pupa takes about 48 hours and the teneral adult matures and develops pigmentation over about 10 days. The period from the beginning of pupation to emergence is about 4 weeks.

Host larvae of the 3rd to 6th instars only are parasitised, the great majority being 4th, 5th and 6th instars. In the laboratory emergence peaks appeared in November and February and three successive emergences of adults were obtained from successive selections of test blocks over spring, summer and autumn by gravid *Doryctes*. It would therefore appear that more than one generation occurs over the summer months and one generation of *D. pallida* occurs over the winter when later-stage larvae probably enter diapause, remaining inside their cocoons for about 4 months before pupating.

The density of female parasites appeared, from observations, to be correlated with numbers ovipositing in such a way that, after reaching a density of 5 or 6 per square foot of bark, the numbers of ovipositions per individual per day decreased. Experiments where densities of adults varied between 1 and 12 per square foot of bark were carried out. The first series of bark samples (all removed from the same log) was exposed for 4 days and a second series of similar bark samples was exposed to parasites for 10 days. The results (Table I) supported previous observations, the numbers of ovipositions per insect per day and the percentage parasitism per insect per day decreasing with increasing density of parasites.

The bark used in these experiments was heavily infested and parasites were fed and, to some extent, forced onto a small area of bark. It therefore represented a set of conditions that might seldom occur in the field. Indeed, field surveys indicated that parasitism by *D. pallida* was usually of a low order (less than 10%) and many trees infested by *Nascioides* had no parasites in them. This was particularly so where only one or two trees had died and no deaths had occurred in the previous year or two in that locality. Wherever the buprestid had been actively killing trees over a period of 2-3 years, infested trees were found with up to 70% of the larvae parasitised by *Doryctes*. In such areas it was usual to find one tree "parasitised" to this extent for every 3 or 4 with less than 30% of the *Nascioides* parasitised. There is, therefore, a great variation in the degree of attack by *D. pallida* on adjacent infested trees. The percentage of parasitism apparently increase with the duration of local outbreaks of the host, as would be expected.

TABLE I

The effect of density of mated female *Doryctes pallida* on its parasitism of *Nascioides enysi*.

Number Parasites per sq. ft.	Replication	Mean Number <i>N. enysi</i> per sample block.	Duration of Attack in Days	Percentage Parasitism	Percentage Parasitism per Parasite per Day	No. of Insertions of Ovipositor per Parasite per Day
1	2	16	4	31.8	7.9	1.7
1	2	18	10	62.0	6.2	1.4
4	2	20	4	58.9	3.7	1.6
6	2	27	10	90.5	1.5	1.0
10	2	18	4	51.9	1.3	0.7
12	2	20	10	72.5	0.6	0.4

DISCUSSION

Successful parasitism by this braconid therefore depends on the life stage of the host available at the time the parasite is active, probably upon the density of suitable hosts as well as upon bark of a satisfactory thickness for the ovipositor to penetrate the galleries of host larvae. In addition, warm sunny days are conducive to parasite activity, regular feeding increases their mean life span and successive years of infestation in any locality contributes to increases in parasite numbers. The ease with which it can be reared and manipulated in laboratory experiments suggests that *D. pallida* could be bred in the laboratory for release in biological control programmes against *Nascioides enysi* if such project becomes necessary. The data from these studies give sufficient information upon which successful field releases could be made.

The oviposition tests indicate that the number of insertions of the ovipositor per insect per day decreases both with time and with increasing density of insects. The decrease in time appears to be related to rest and feeding periods which were more frequent and longer with increasing time. The fall-off of the oviposition rate with density of the insects appears to be due to the interruption of searching caused by random contacts between individuals.

No predation or hyperparasitism of *Doryctes* has been recorded.

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