THE POPULATION DYNAMICS OF THE BORER, *SESAMIA GRISESCENS* WALKER (LEPIDOPTERA: NOCTUIDAE), ON SUGARCANE IN THE RAMU VALLEY OF PAPUA NEW GUINEA.

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ABSTRACT

*The top borer, **Sesamia grisescens**, is a serious pest of sugarcane at Ramu, Papua New Guinea. Borer populations were sampled at the Ramu Sugar plantation for 147 weeks, from 1986 to 1989. Populations increased during the North West monsoon and declined during the drier part of the year. Life stages were strongly synchronized during the period of study and this was attributed to nitrogen boost to the population at the start of the North West Monsoon. Additionally, a field trial showed a strong correlation between rates of nitrogen applied and percent stalks bored by **S. grisescens**. From the available evidence, natural enemies exerted little control over borer populations, however discrete life stages provide scope for augmentative releases of natural enemies in the future.*

Key Words: *Sesamia, Sugarcane, Nitrogen, Natural enemies, Life stages.*

INTRODUCTION

The sugarcane borer, *Sesamia grisescens* Walker (Lepidoptera: Noctuidae), is known from mainland Papua New Guinea (PNG) and offshore islands (Szent-Ivany and Ardley 1962; Bourke 1968; Anon 1969; Bourke *et al.* 1973). Adult females lay their eggs beneath the sheaths of younger leaves of the sugarcane stalk, after hatching the larvae bore into the terminal internodes of the stalk where they feed gregariously. Larval feeding eventually results in the death of the apical meristem causing a characteristic deadheart. *S. grisescens* will attack sugarcane at any stage of growth. There are 7 larval instars and the final instar pupates within the sugarcane stalk. The mean time from egg to adult is 60 days (Young and Kuniata 1992).

Sugarcane, *Saccharum officinarum*, is the main host plant, although the wild pit pits *Saccharum robustum* and *S. spontaneum* are also attacked and destroyed by Ramu Stunt disease (Eastwood 1990). As a result 4,700 hectares had to be planted with disease resistant varieties in the last half of 1986. Over 4,000 hectares were planted to variety Cadmus. This plant crop was severely damaged by *S. grisescens* between January and June 1987 (Kuniata and Sweet 1991; Young and Kuniata 1992). Studies on the population dynamics of the borer were started in order to predict future outbreaks and formulate control measures.

Sugar grown at Ramu is rainfed with the growing season extending from November to May during the North West monsoon. Fields are planted to a plant crop followed by 2 ratoon crops. Harvesting, planting and ratooning is carried out continuously between June and November. The time from planting or ratooning to harvest is 11 to 13 months.

MATERIALS AND METHODS

Ninety fields were sampled for borer life stages each month. The estate was divided into 9 sections with 10 fields being selected at random from each section. Individual fields were sampled by selecting 20 rows at random and then cutting 9 stalks systematically from each row, making a total of 180 stalks per field (Elliott 1977). The sugarcane sampled ranged

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in age from 6 weeks to 48 weeks.

Stalks were cut longitudinally with a knife and the numbers of larvae and pupae recorded, additionally the terminal leaves were examined for the presence of egg masses (Young and Kuniata 1992). A sub-sample of each life stage was returned to the laboratory for parasite emergence. Numbers of adult borers were estimated by means of 3 light traps, each consisting of a fluorescent black light and 2 m X 2 m calico sheet. The traps were separated by a distance of 2 kms. The work was carried out between July 1986 and May 1989.

A trial was established on a plant crop during 1988 to determine the response of *S. grisescens* populations to varying rates of nitrogen fertiliser. There were 6 treatments, with urea applied at 0, 30, 60, 90, 120 and 150 Kg N/ha and 3 replicates of each treatment. At harvest 50 stalks were cut at random from each plot. Stalks were split open with a knife and scored for *S. grisescens* damage. Leaf 4 was sampled from 5 stalks per plot, taking the spindle as leaf 1. The leaf samples were analysed for total nitrogen using the Kjeldahl method.

RESULTS

Over the 147 weeks of the study populations of *S. grisescens* started to increase with the onset of the North West monsoon and declined during the drier part of the year (Figs. 1 & 2). Numbers of larvae peaked during May 1987, August 1988 and May 1989, while pupal numbers peaked during April 1987, July 1988 and June 1989. The populations showed strongly synchronized or discrete life stages (Fig. 3). The exception was the period between late October 1987 and mid March 1988, where populations were too low to detect any changes. This period was preceded by the worst drought on record at Ramu when only 13 mm of rain fell between mid May 1987 and the first week of October 1987. The period between population peaks ranged from 7 to 10 weeks for larvae and 5 to 11 weeks for pupae. This is in broad agreement with Young and Kuniata (1992), who reported a generation time of 7 to 11 weeks in the field. Egg masses ranged from 0 to 5.2 per 100 stalks and zero counts were recorded for 80 of the 147 weeks. The light traps were ineffective in estimating the adult population recording zeros in most of the 147 weeks.

Two species of parasitoids, *Cotesia flavipes* (Cameron) (Hymenoptera: Braconidae) and *Enicospilus* sp. (Hymenoptera: Ichneumonidae), as well as an entomogenous fungus *Beauveria* sp., were recorded from *S. grisescens* larvae. Parasitism by *C. flavipes* ranged from 0 to 68 percent and a mean parasitism of 12 percent per month with larval numbers and percent parasitism being statistically unrelated (Fig. 4). During June 1988 parasitism by *Enicospilus* sp. reached 10 percent but the mean monthly parastism was less than 1 percent, with zero parasitism recorded for 16 months. Up to 2 percent of larvae were attacked by *Beauveria* sp. No parasites were recorded from either eggs or pupae, although there was evidence of egg predation.

The earwig, *Chelisoches morio* Fabricius (Dermaptera: Chelisochidae), was recorded feeding

Table 1. **Effect of nitrogen on stalk damage by *S. grisescens*.**

Kg N per Hectare	Percent foliar N	Percent stalks bored by *S. grisescens*
0	2.08	61.4
30	2.13	62.5
60	2.44	65.2
90	2.43	73.0
120	2.53	76.1
150	2.50	80.4

on early instar larvae. The nitrogen fertiliser trial showed that the proportion of stalks bored increased with increasing rates of nitrogen applied per hectare (Table 1). There was a highly significant positive correlation between percent stalks bored by *S. grisescens* and rates of nitrogen applied ($r = 0.98$, $p < 0.001$. $df = 4$, $Y = 59.5 + 0.14X$). Additionally, there was a significant correlation between percent foliar nitrogen and rate of nitrogen ($r = 0.90$, $p < 0.05$, $df = 4$, $Y = 2.1 + .003X$), however the correlation between percent stalks bored and percent foliar nitrogen was not significant correlation between percent foliar nitrogen was not significant.

DISCUSSION

The synchronized life stages of *S. grisescens* as well as the relationship between high populations and rainfall point to fluctuations in the nutrition of the borer. Phytophagous insects have a high protein content yet the host is predominantly composed of carbohydrate (Norris 1991). Spectacular increases in populations of phytophagous insects are often associated with increased levels of available nitrogen (McNeill and Southwood 1978; White 1969 and 1978). McNeill and Southwood (1978) view this nitrogen boost to phytophagous populations as a rise in the rate of increase due to higher growth rates, survial or reproduction or a combination of all three. Setamou *et al.* (1993), working with *Sesamia calamistis* Hampson (Lepidoptera: Noctuidae) on maize, found that the intrinsic rate of increase and net reproductive rate were positively related to leaf and stem nitrogen. Our data on increasing rates of nitrogen suggests a similar response for *S. grisescens* on sugarcane, although the lack of a significant correlation between leaf nitrogen and *Sesamia* damage suggests that leaf nitrogen might be a poor indication of stalk nitrogen in sugarcane.

Rapidly multiplying meristematic tissues are usually high in soluble nitrogen, that is amides and amino acids (McNeil and Southwood 1978). *S. grisescens* larvae feed predominantly in the soft internode tissue of the sugarcane stalk, just below the meristem (Young and Kuniata 1992). When the sugarcane stalk is growing rapidly the nitrogen content of the meristematic and surrounding tissue would be higher than at times of slow or no growth. It is reasonable to conclude that *S. grisescens* populations would be sensitive to changes in the nitrogen content of this tissue.

The start of the North West monsoon would initiate an increase in cane growth and the nitrogen content of stalk tops. Eggs laid at this stage would produce a generation of larvae with a high rate of growth and survival by comparison with larvae born during the preceding dry months. It is probable that the generation of larvae which fed on enchanced levels of nitrogen was the start of a series of discrete generations which continued throughout the growing season (Figs. 1 & 2).

It could be argued that harvesting the crop was the reason for the population crashes during the dry season, by removing the borer's food source. This is an unlikely explanation, since *S. grisescens* can attack cane at any age and harvesting removes the crop over 5 months as well as overlapping with planting and ratooning (Young and Kuniata 1992). Therefore borer populations would not have run short of food.

From the available evidence natural enemies made little impression on borer populations over the period of study. The most important parasite was *C. flavipes*, however the level of sampling was not sufficient to allow an accurate assessment of its contribution to larval martality. *C. morio* has been recorded feeding on eggs and larvae of *S. grisescens* in the laboratory but its importance in the field is not known (unpublished data).

The data points to a nitrogen induced increase in population growth allowing borer populations to escape the controlling effects of natural enemies (McNeill & Southwood 1978). Additionally, discrete generations present problems for parasites in as much as the relevant host stage may not be available when the female parasite is ready to oviposit. Discrete generations do however allow scope for augmentative releases of laboratory reared parasites when the target host stage is abundant.

Further research is required on the influence of natural enemies on borer populations at Ramu, in particular the construction of life tables.

Prior to 1986, 90% of the estate was planted to variety Ragnar and, while *S. grisescens* was always present populations never reached the levels found on variety Cadmus during the first half of 1987. It may be that Cadmus is a more favourable host to the borer than Ragnar. The susceptibility of different varieties of sugarcane to attack by *S. grisescens* requires further investigation.

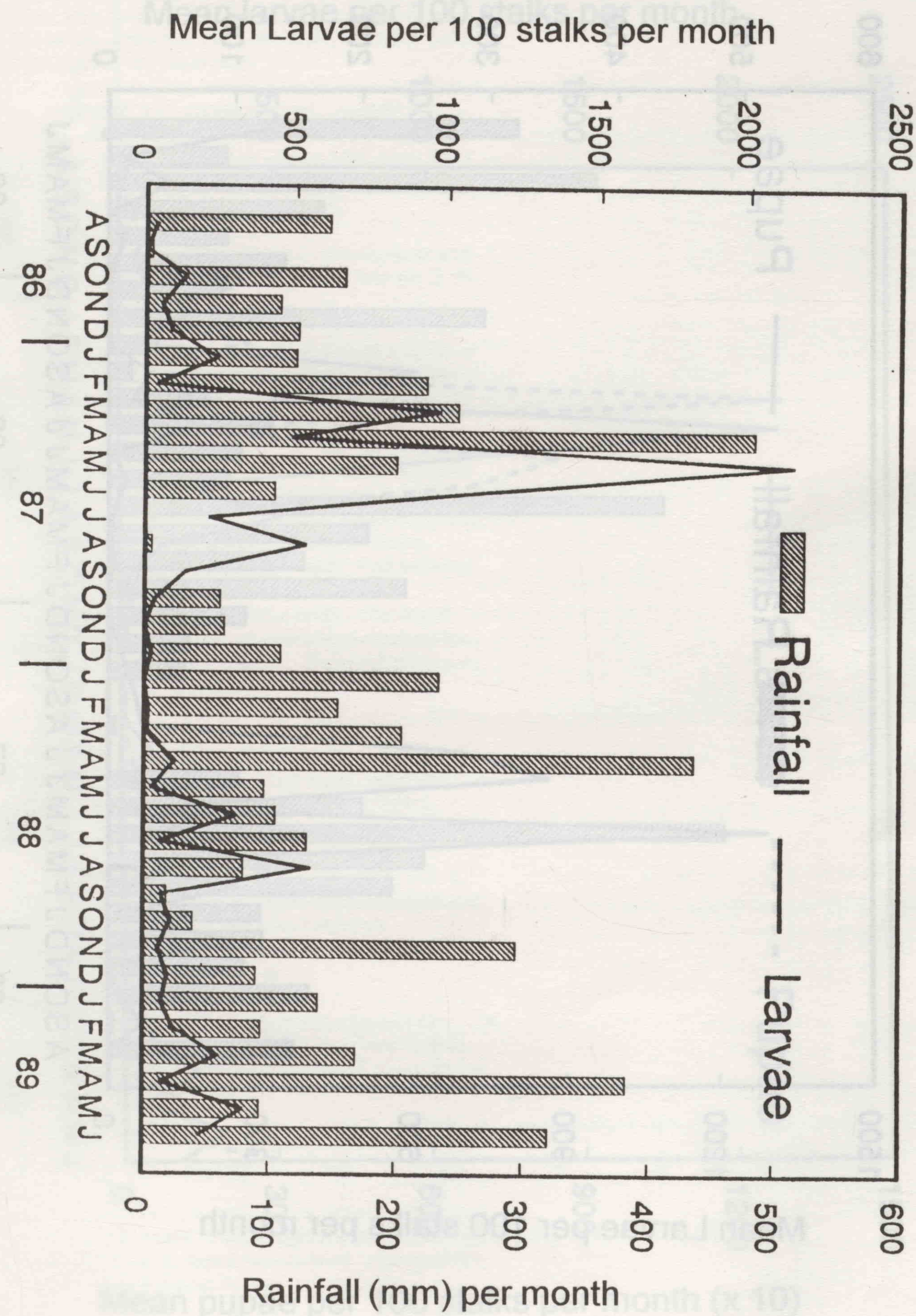


Figure 1. **Numbers of *S. grisescens* larvae and monthly rainfall, August 1986 to June 1989.**

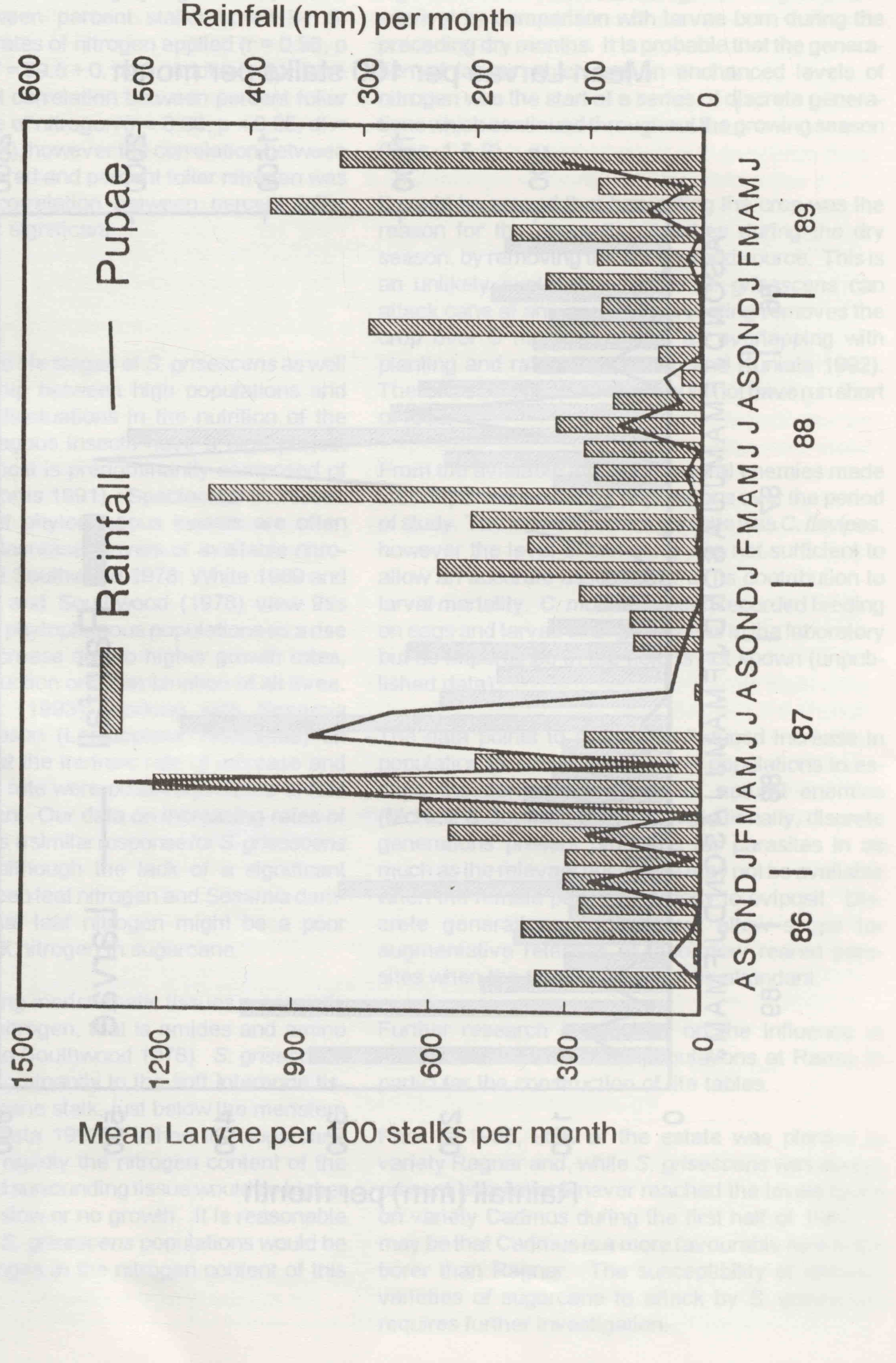


Figure 2. Numbers of *S. grisescens* pupae and monthly rainfall, August 1986 to June 1989.

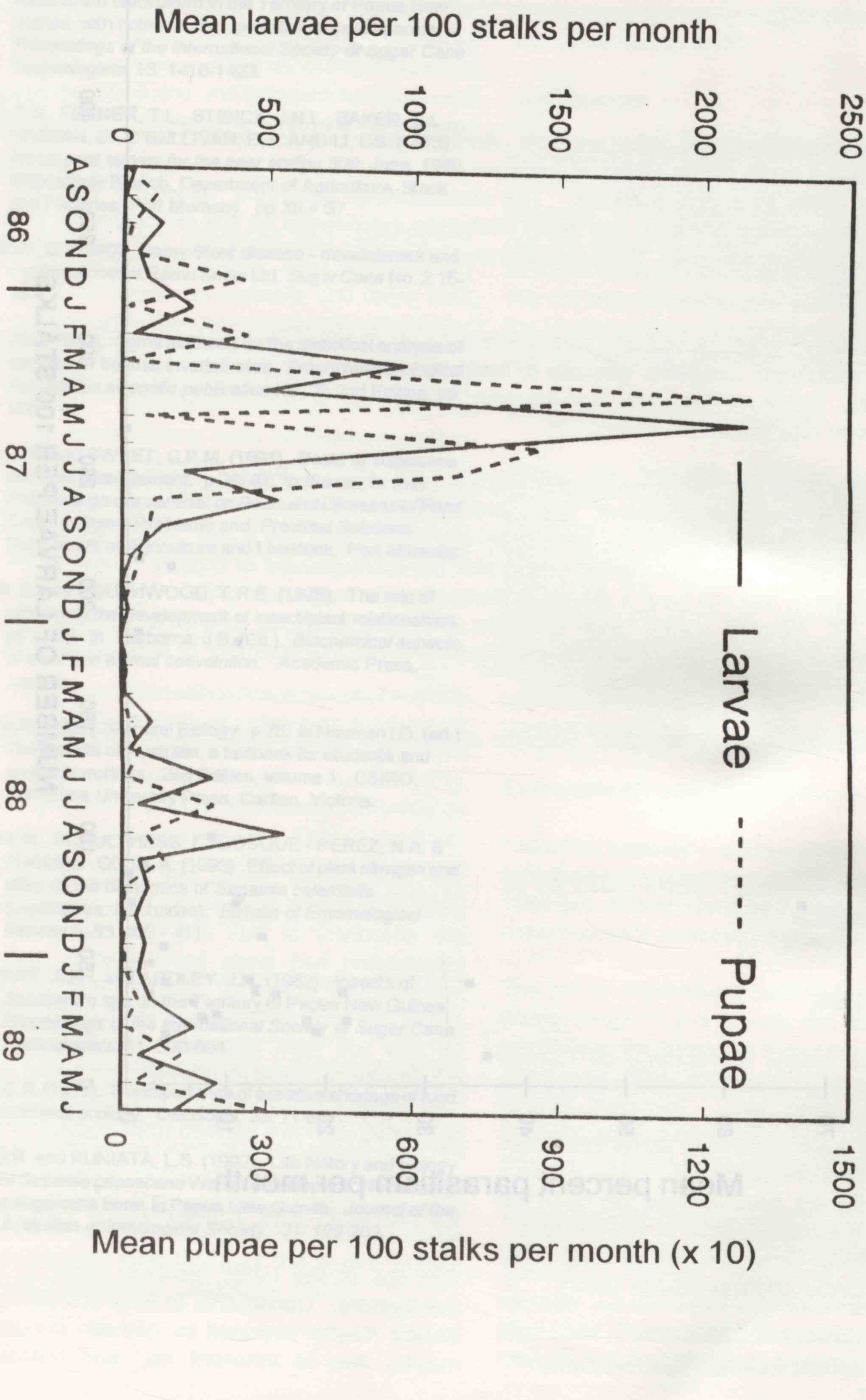
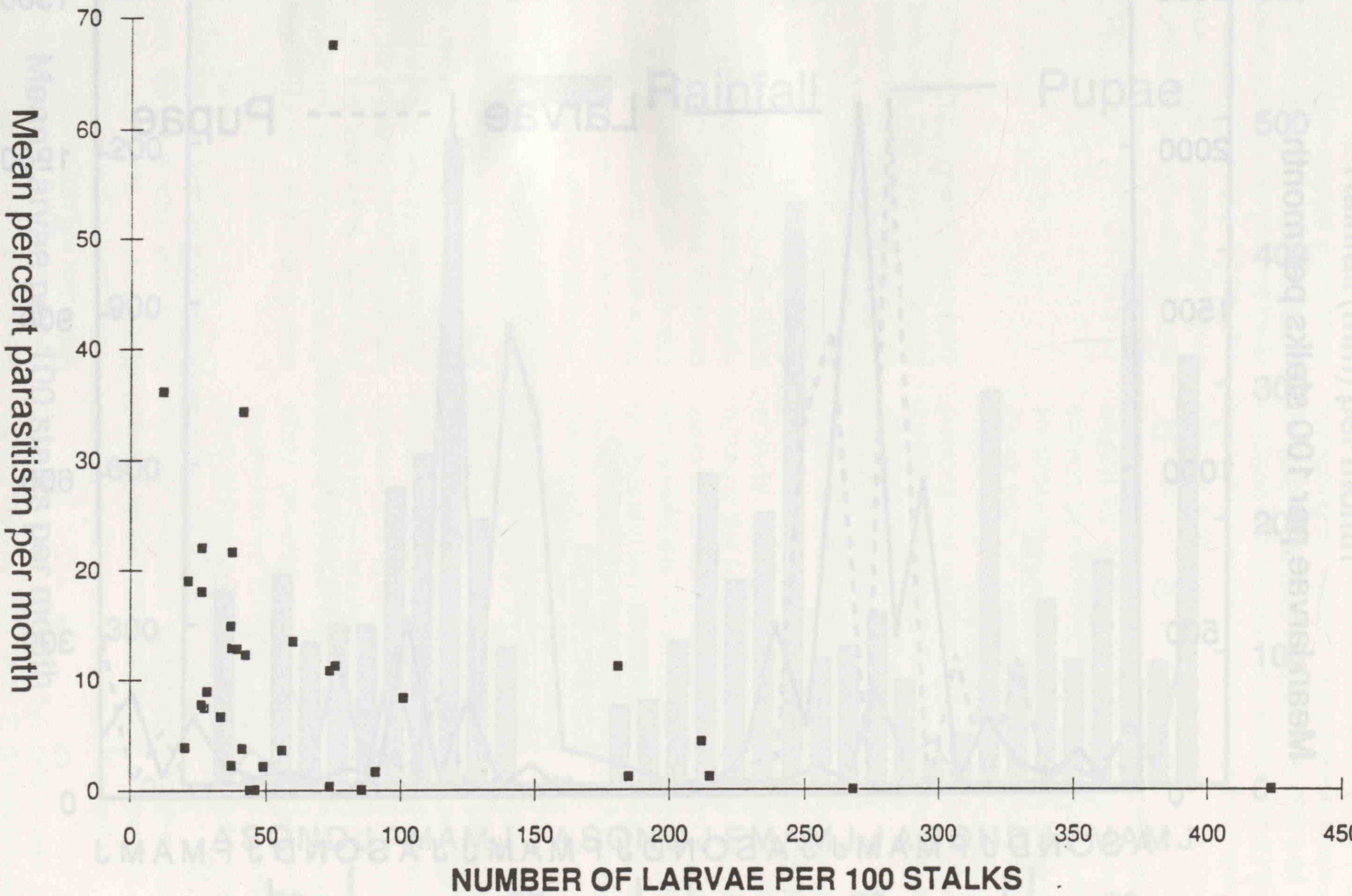


Figure 3. Numbers of *S. grisescens* larvae and pupae, August 1986 to June 1989.

Figure 4. **The relationship between the density of *S. grisescens* larvae and parasitism by *C. flavipes.***



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