

OVERVIEW OF NATURAL ENEMIES OF SUGARCANE MOTH STEM BORERS AT RAMU SUGAR ESTATE, PAPUA NEW GUINEA, FROM 1991-2004

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Abstract

Larvae of moth stem borers of sugarcane are a major constraint to sugar production at Ramu Sugar estate, Papua New Guinea (PNG). All the moth borers are indigenous, with the most important pest species being *Sesamia grisescens* Warren (Lepidoptera: Noctuidae), *Chilo terenellus* Pagenstar (Lepidoptera: Pyralidae) and *Scirpophaga excerptalis* Walker (Lepidoptera: Pyralidae). The braconid wasp, *Cotesia flavipes* (Cameron), is a very important parasite that provides up to 80% parasitism of *S. grisescens* larvae in the field. The ichneumonid wasp, *Enicospilus terebrus* Gauld, can provide up to 16% parasitism of *S. grisescens* larvae. Parasitism of *C. terenellus* larvae by both of these parasites in the field was low and ranged between 0-20%. Another braconid wasp, *Stenobracon* sp., is a very important parasite of *S. excerptalis* larvae in *Saccharum spontaneum* (wild cane), but this parasite is rarely found in commercial crops. The introduced eulophid wasp, *Pediobius furvus* Gahan, has established in PNG and is responsible for up to 50% parasitism of *S. grisescens* pupae in the field. There was no parasitism observed in *C. terenellus*.

Keywords: sugarcane, *Sesamia grisescens*, *Chilo terenellus*, *Cotesia flavipes*, *Pediobius furvus*

INTRODUCTION

A number of moth stalk borers of sugarcane are endemic to New Guinea, with *Sesamia grisescens* Warren (Lepidoptera: Noctuidae), *Chilo terenellus* Pag. (Lep.: Pyralidae) and *Scirpophaga excerptalis* Walker (Lep.: Pyralidae) being economically important at Ramu Sugar estate, Papua New Guinea (PNG). The pink sugarcane stalk borer, *S. grisescens*, is indigenous to New Guinea (Warren, 1911; Holloway, 1989), and occurs from sea level to 2000 m above sea level (Szent-Ivany and Ardley, 1962; Li, 1985). This stem borer has become a serious pest of sugarcane (*Saccharum* hybrids) at the Ramu Sugar estate, with cane losses as high as 31 t/ha (Kuniata, 1998). Bored cane not only depresses cane yields, but also interferes with efficient extraction of sugar in the factory (Kuniata, 1998; Eastwood *et al*, 1998). *S. grisescens* is considered one of the major constraints to sugar production in PNG.

Information on the natural enemies of graminaceous stalk borers and their manipulation in the control of these pests, have become available (such as Mohyuddin and Greathead, 1970; Kfir, 1990). Attempts have been made to import various exotic parasitoids to deal with specific pest problems in a number of industries, with varying degrees of success (Overholt and Smith, 1990; Conlong, 1994). A review by Mohyuddin (1991) of work carried out by CAB International Institute of Biological Control (IIBC) described how the braconid wasp, *Apanteles flavipes* (Cameron), has given spectacular classical biological control of graminaceous stalk borers in a number of countries. In 1982, an Indian strain of *A. flavipes* was introduced by IIBC into Ramu Sugar estate to establish a breeding colony (unpublished

data¹). Over the following two years, more than 5000 parasites were bred and released on the plantation. However, data showed that only the indigenous strain of *Cotesia* (= *Apanteles*) *flavipes* was obtained from recovery surveys. It is possible that the Indian strain may not have established in the field. Kuniata and Sweet (1994) reported up to 43% parasitism in fields where parasitoids were not released and, where parasitoids had been released, this increased to more than 74%. Significant reductions in bored stalks were observed. This resulted in higher cane yields obtained in fields where the parasite was released, indicating the potential of this parasite to control *S. griseascens*.

A pupal parasitoid, *Pediobius furrus* Gahan (Hym.: Eulophidae) is indigenous to Africa and widely distributed south of the Sahara from latitude 17°N to 17°S (Mohyuddin, 1968). It has been recorded from all major graminaceous crops, where it parasitises pupae of pyralid and noctuid moths. In 1991, this parasite was imported from Kenya via IIBC (UK) for evaluation against *S. griseascens* at Ramu Sugar estate. Recovery surveys indicate that this parasitoid has established, and field parasitism, where releases have been made, was about 16% compared with 5% in fields without releases (Kuniata and Sweet, 1994).

The utilisation of these two parasitoids (*C. flavipes* and *P. furrus*) in augmentative release programmes has been explored at Ramu Sugar estate, with the aim of integrating biological control with cultural and insecticidal methods to manage *S. griseascens* in sugarcane. The rationale for augmentative release is that, if the phenology of the parasitoid is not well synchronised with that of the host, the activity of the natural enemy will lag behind that of its host. Augmentative release, as soon as the host resumes activity, may suppress the pest population to non-damaging levels. Alternatively, these releases could be made following insecticide spraying. The use of an insecticide spray is likely to synchronise the population by reducing the peaks of young larvae (usually unsuitable for *C. flavipes*), so that the release of parasitoids 2-3 weeks later will have maximum effect on the residual host larvae and pupae.

Materials and Methods

All the field studies were done at Ramu Sugar estate, Gusap, PNG, between 1991 and 2004. The *C. flavipes* and *P. furrus* parasitoids were reared in the laboratory on *S. griseascens* larvae and pupae, respectively. The host larvae were raised on an artificial diet developed specifically for *S. griseascens*. The parasitoids were fed via honey-water swabs before being released in the field.

After 2-3 weeks, the field larvae and pupae were sampled at random to estimate parasitism in the blocks where the parasitoids had been released. Adjacent blocks without parasite releases were also sampled to estimate natural parasitism levels. The field-collected larvae and pupae were returned to the laboratory and kept individually in glass tubes until the emergence of the parasitoids. Rate of parasitism was determined by the percentage of total number of larvae or pupae producing parasitoids. Dead larvae were also dissected and those showing parasitoids were included in the calculation of parasitism.

During the field collection, *S. griseascens* larvae and pupae were collected, as were larvae and pupae of *C. terenellus* and *S. exceptalis*. These samplings were done on a monthly basis. The larvae and pupae collected were returned to the laboratory and kept until parasite emergence.

¹ Unpublished reports, Ramu Sugar

Results

The production of parasitoids in the laboratory increased from <500 000 in 1993 to 2.5 million *P. furvus* parasitoids in 2004 (Figure 1). Similarly, the number of *C. flavipes* parasitoids increased from negligibly small numbers in 1993 to around 500 000 in 2004. The increases in numbers were due mainly to improved efficiencies in the mass rearing of parasitoids in the laboratory.

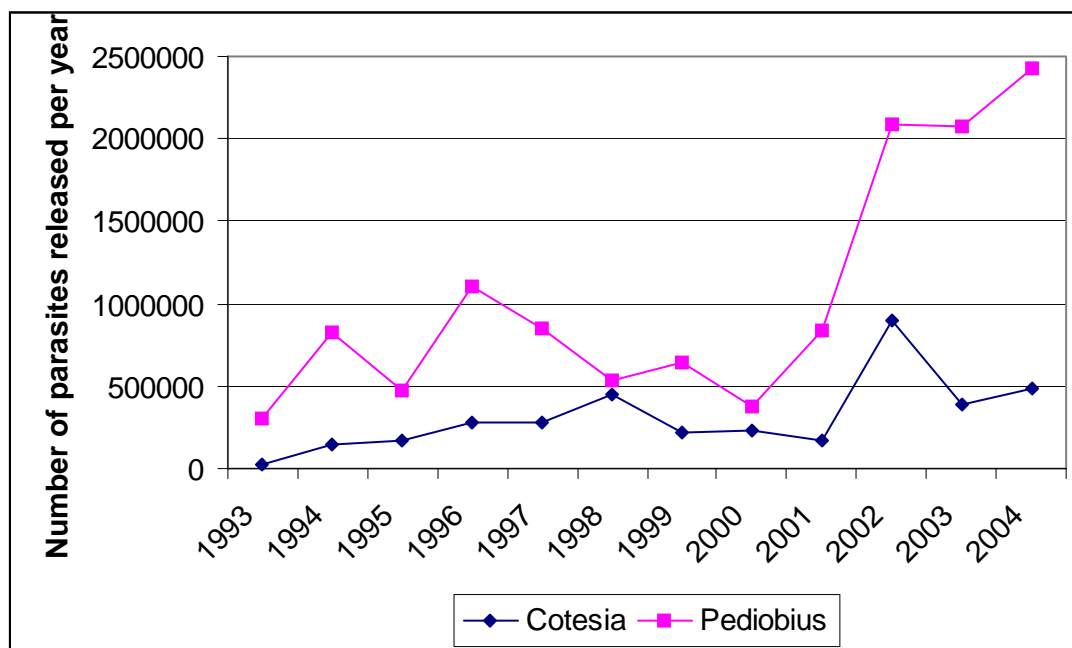


Figure 1. Total number of *Cotesia flavipes* and *Pediobius furvus* parasites released in the field since 1993.

Eggs

A number of parasite species have been recorded on sugarcane moth borers at Ramu Sugar estate, with varying impacts on the borer populations (Table 1). The eggs of both *S. excerptalis* and *C. terenellus* are usually exposed on leaf surfaces, and are often heavily parasitised by the egg parasitoids *Telenomus* sp. and *Trichogramma* spp. Parasitism levels as high as 95% have been observed in the eggs of both moths. The eggs of *S. grisescens* are parasitised by *Telenomus* sp. but, due to the cryptic nature of the eggs, parasitism levels are usually low at <10%.

Important egg predators of *S. grisescens* are an anthocorid bug, *Blaptodtethoides* sp., and an earwig, *Chelisoche morio* (F.) (Table 1). These predators account for up to 20% mortality in *S. grisescens* eggs. The important egg predator of *C. terenellus* is *Corphurus* sp. near *rubroannulatus* Motsch. (Col.: Melyridae). Entire egg masses of *C. terenellus* have been predated by *Corphurus* sp. in the field.

Table 1. Important natural enemies associated with moth borers at Ramu Sugar estate, Papua New Guinea. Except for *P. furvus*, all the other natural enemies are indigenous.

Family	Species	Life stage of borer attacked	Natural enemy species
Noctuidae	<i>Sesamia grisescens</i> ; <i>S. inferens</i>	Eggs	Parasitoids: <i>Telenomus</i> sp. near <i>basseolae</i> Gah. (Hym.: Scelionidae); <i>Trichogramma</i> sp. near <i>plasseyensis</i> Nag. (Hym.: Trichogrammatidae) Predators: <i>Blaptostethoides</i> sp. (Hem.: Anthocoridae); <i>Chelisoches morio</i> F. (Derm. Chelisoichidae)
		Larvae	Parasitoids: <i>Cotesia flavipes</i> (Cam.) (Hym.: Braconidae); <i>Enicospilus terebrus</i> Gauld (Hym.: Ichneumoidae) Predators: <i>Chelisoches morio</i> F. (Derm.: Chelisoichidae); <i>Pheidole megacephala</i> (Hym.: Formicidae)
		Pupae	<i>Pediobius furvus</i> Gahan (Hym.: Eulophidae)
Pyralidae	<i>Chilo terenellus</i> ; <i>C. infuscatellus</i>	Eggs	Parasitoids: <i>Trichogramma</i> sp. near <i>plasseyensis</i> Nag.; <i>T. chilotraeae</i> Nag. & Nagar. (both Hym.: Trichogrammatidae); <i>Telenomus</i> sp (Hym.: Scelionidae) Predators: <i>Corphurus</i> sp. near <i>rubroannulatus</i> Motsch. (Col.: Melyridae)
		Larvae	<i>Cotesia flavipes</i> (Cam.) (Hym.: Braconidae)
Pyralidae	<i>Scirpophaga excerptalis</i>	Eggs	<i>Telenomus</i> sp. <i>dignus</i> Nixon (Hym.: Scelionidae)
		Larvae	<i>Stenobracon</i> sp. (Hym.: Braconidae)

Larvae

Average field parasitism in *S. grisescens* larvae ranged from 10 to 40% (Figure 2). From 1991 to 2001 the highest average *C. flavipes* parasitism was 25%. In 1998 to 2001, a high proportion of the estate was sprayed with insecticides to control the larvae of *S. grisescens*. It was possible that the decline in average parasitism during this period may have been due to

the indirect effect of spraying. In 2002 to 2003, the average field parasitism was 33-40%, and well above the previously observed parasitism levels. This increase in parasitism may be due to smaller areas sprayed with insecticides and increased parasite numbers released in the field.

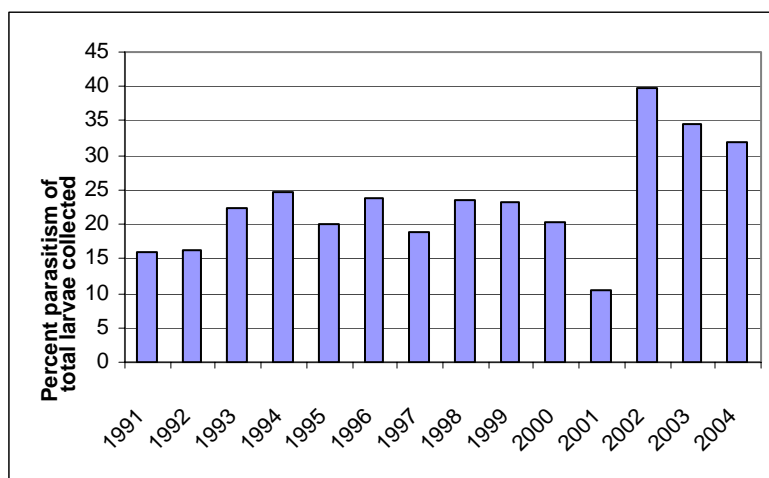


Figure 2. Annual average parasitism of *S. griseocens* larvae observed since 1991.

Parasitism levels observed for *C. flavipes* on larvae of *S. griseocens* were usually highest between November and July (Figure 3). Since 2002, parasitism levels have been well above 30%, and field parasitism of over 80% was observed in 2003. From July to September, the dry season is usually severe and this can affect parasite establishment and host abundance in the field, thus resulting in lower parasitism levels.

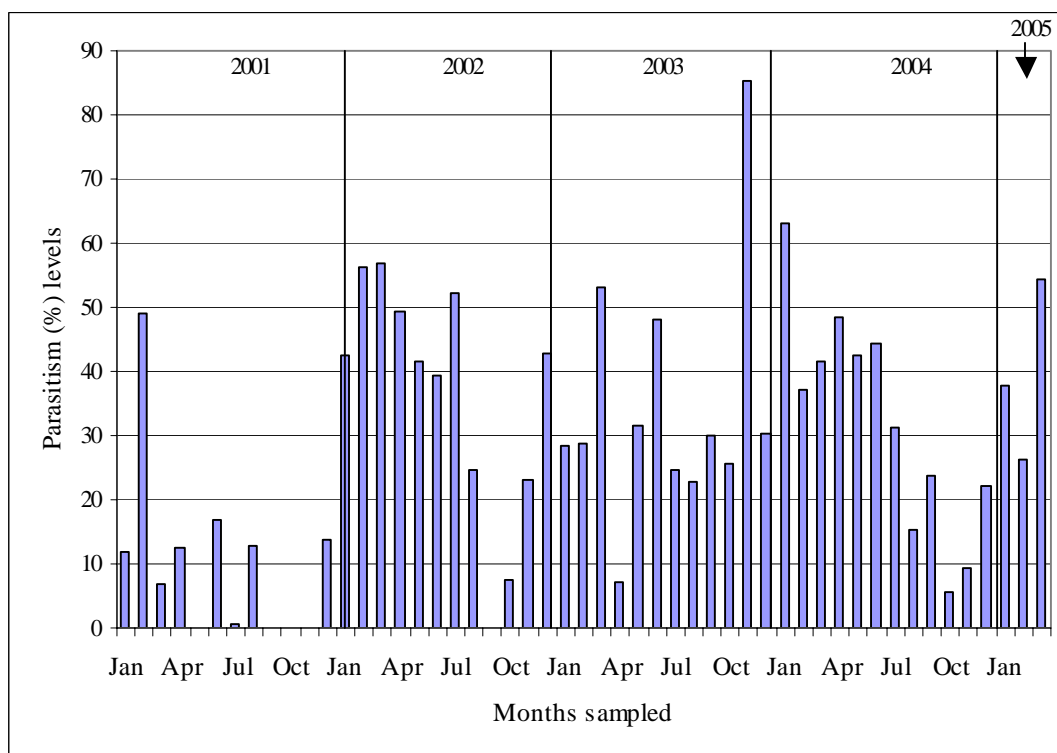


Figure 3. Parasitism by *C. flavipes* of *S. griseocens* larvae in sugarcane.

An ichneumonid wasp, *Encospilus terebrus* Gauld, is an indigenous parasite which has also been recorded on *S. grisescens* larvae at Ramu Sugar estate. This parasite attacks full grown larvae. In the past four years parasitism levels have ranged from 0-16%, with the highest levels observed between January and June (Figure 4). Parasitism levels were generally lower during the dry season from June to October, and re-colonisation by the parasite did not occur until after December each year. Although *E. terebrus* has been reared from *Chilo terenellus* Pag. (Lepidoptera: Pyralidae) larvae, levels of parasitism were usually very low.

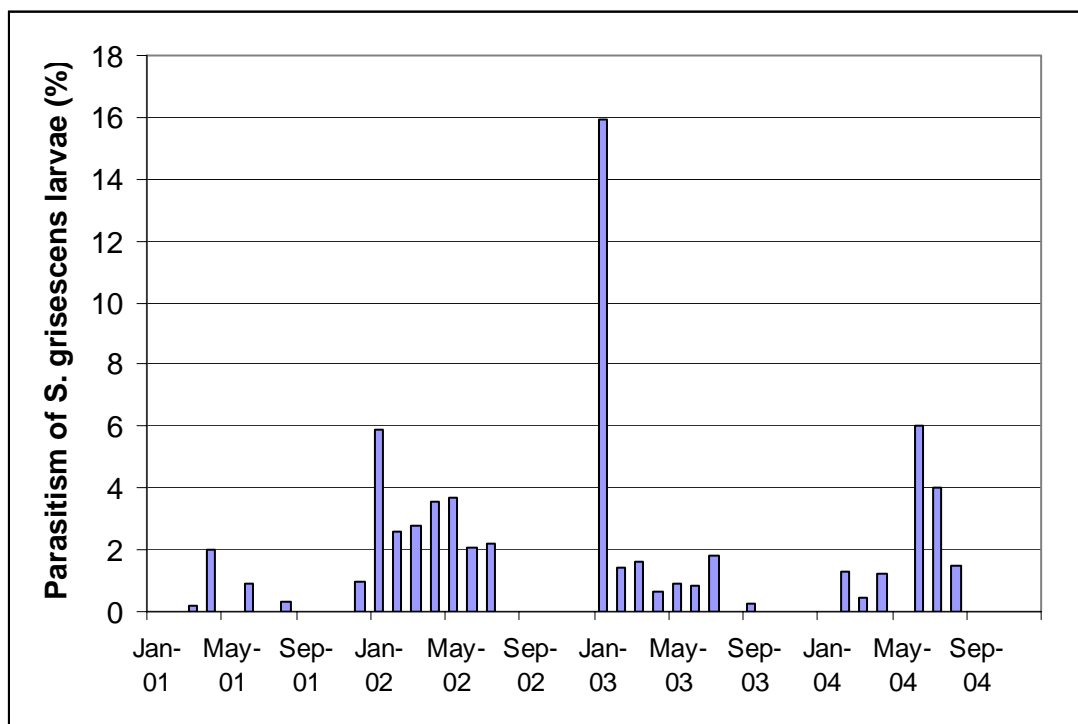


Figure 4. Parasitism levels from *Encospilus terebrus* in *S. grisescens* larvae.

Apart from *S. grisescens*, the larvae of *C. terenellus* were also parasitised by *C. flavipes*. Field parasitism levels were very variable and ranged from 0 to 36%. The highest levels were usually observed from January to May.

Scirpophaga excerptalis Walker (Lep.: Noctuidae) is a pest of sugarcane, with the larvae causing up to 30% damage to shoots/stalks in certain varieties. This borer is also common in wild cane, especially *Saccharum spontaneum*. Parasitism levels of the braconid wasp, *Stenobracon* sp., were high and provided up to 90% parasitism in larvae collected in *S. spontaneum*. Parasitism levels in larvae collected in commercial cane were very low.

Pupae

The annual average parasitism from *P. furvus* on *S. grisescens* between 1991 and 2001 was generally less than 5% (Figure 5). From 1998 to 2001 the very low levels observed could be attributed to insecticide spraying. From 2002 to 2004 the average field parasitism levels were 15-20%. This increase in parasitism from *P. furvus* was probably due to the same reasons presented above for *C. flavipes*. Since 2002, the field parasitism levels have been well above 10% and, for a number of months in 2003, these were between 40 and 55% (Figure 6).

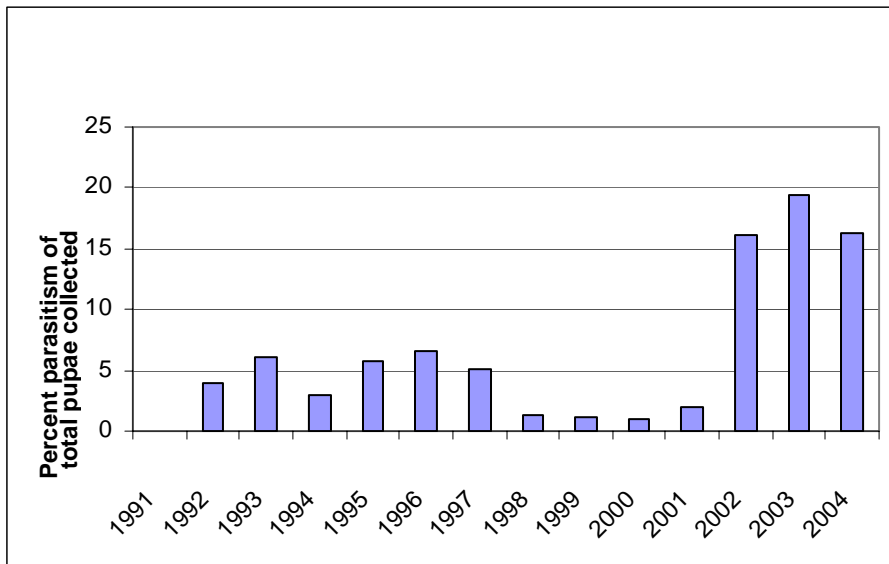


Figure 5. Annual average parasitism by *P. furvus* of *S. griseocens* pupae observed at Ramu Sugar estate since 1991.

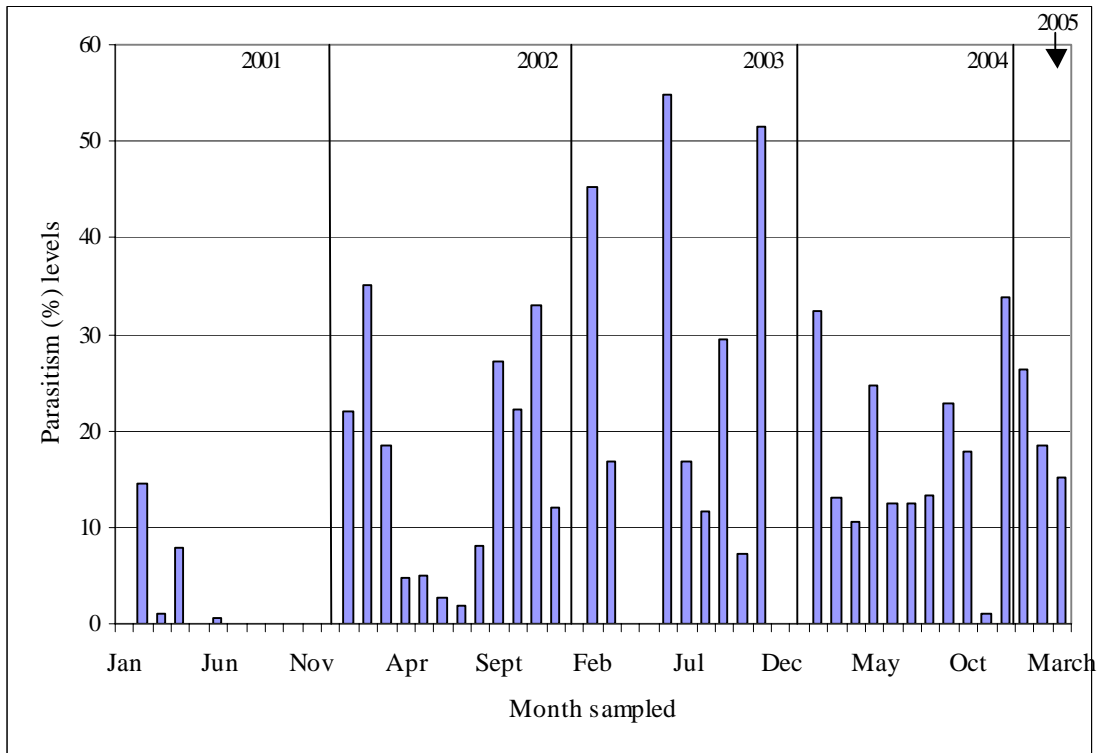


Figure 6. Field parasitism of *S. griseocens* pupae by *P. furvus* in sugarcane.

Discussion

The use of both *C. flavipes* and *P. furvus* provides sustainable control of *S. griseocens* in sugarcane in PNG. Parasitism levels discussed above were as high as 85 and 55% after augmentative releases of *C. flavipes* and *P. furvus*, respectively. Kuniata (1999) demonstrated in small plot trials that the parasitism level from combined parasitism of *C. flavipes* (2500/ha) and *P. furvus* (5000/ha) was as high as 82% following augmentative release.

The low parasitism levels observed for *P. furvus* showed this species to be unsuitable due to the high synchrony observed in *S. griseascens* pupal stages (Young and Kuniata, 1992; Young and Kuniata, 1995). Although the pupae of *C. terenellus* were readily parasitised by *P. furvus* in the laboratory, there was no parasitism observed in the field-collected material. Its inability to utilise this species as an alternate host will continue to minimise the carry-over effect of the parasite in subsequent borer populations. In contrast, Kuniata (1999) observed that, although parasitism levels of *C. flavipes* were low initially following parasite releases, parasitism by *C. flavipes* in the release plots continued to be high and was more than 60% two months after releases were made. It is possible that apart from *S. griseascens* larvae, *C. flavipes* may have utilised *C. terenellus* larvae as alternate hosts, thus maintaining a carry-over effect on populations of the borer.

Since the effects of natural enemies are greatly influenced by insecticide spraying and various cultural control methods, it is important to identify those factors that have the most effect on the borer and the least impact on natural enemies. Selective spraying in highly infested fields, especially in the egg-laying to 2nd instar stages of *S. griseascens* larvae, may control the peaks and reduce host density. If this can be followed up with augmentative releases of parasitoids from the 4th instar stage to pupation, this may provide an effective strategy for managing this borer. Another possibility is to use certain cultural methods, such as resistant varieties and time of planting/ratooning, to reduce the multiplication rate of the borer, keeping population densities sufficiently low for natural enemies to keep them in check. This strategy has been adopted for Ramu Sugar estate and is proving very successful in keeping borer populations and damage low.

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