PARASITOIDS OF THE SUGARCANE SPOTTED BORER, *CHILO SACCHARIPHAGUS* (LEPIDOPTERA: PYRALIDAE), IN MAURITIUS

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Introduction

The sugarcane spotted borer, *Chilo sacchariphagus* Bojer (Lepidoptera: Pyralidae), was probably introduced into Mauritius from Java in 1850, together with sugarcane setts. Its presence has been reported in Réunion, Madagascar, South East Asia, China, Indonesia, Philippines, Taiwan (Williams, 1983) and Mozambique (Leslie, 1994). Severe damage has been observed recently in cane fields located in the sub-humid region of Mauritius.

Insecticides are not used against this pest, and control measures have been only through the importation and release of exotic parasitoids. Several parasitoid species have been introduced from Sri Lanka, India, Java, Trinidad, Uganda and South Africa. Of the 31 species introduced and released (Greathead, 1971; Williams, 1983; Rajabalee, 1990) eight have been reported to have become established (Moutia and Courtois, 1952; Williams, 1961; Rajabalee and Banymadhub, 1986). Of those established, only the egg parasitoid, *Trichogramma australicum* Girault (Hymenoptera: Trichogrammatidae) and the larval parasitoid *Cotesia flavipes* Cameron (Hymenoptera: Braconidae) are of common occurrence. The larval parasitoid *Alabagrus stigma* (Brullé) (=*Agathis stigmatera* Cresson) (Hymenoptera: Braconidae) and the pupal parasitoids, *Xanthopimpla stemmator* (Thunberg) (Hymenoptera: Ichneumonidae) and *Tetrastichus atriclavus* Waterston (Hymenoptera: Eulophidae) appeared less abundant. Studies over a four year period from 1993 showed that an average of 64,8% of eggs, 2,6% of first and second instar larvae, 8,6% of third and later stage larvae and 4,7% of pupae of *C. sacchariphagus* were parasitised.

T. australicum is distributed worldwide. It attacks the eggs of stem borers of many Lepidopterans. In Mauritius, it has been reared from *Achaea trapezoides* Guenée, *Tetramoera* (=*Argyroploce*) *schistaceana* Snellen, *Melanitis leda* L., *Plusia orichalcea* F., *Sesamia calamistis* Hampson (Moutia and Courtois, 1952) and *Helicoverpa armigera* Hübner (Williams, 1980).

C. flavipes (aboriginal to the Indo-Australian region) is a gregarious larval endoparasitoid of *C. sacchariphagus* as well as of other pyralid and noctuid stem borers of various graminaceous crops (Mohyuddin, 1971; Nagarkati and Nair, 1973; Mohyuddin *et al.*, 1981). *C. flavipes* is presently widespread in the Indo-Australian region, and has been introduced with varying success into more than 40 countries in the tropics and sub-tropics against members of the genera *Chilo* and *Diatraea* (Cochereau, 1991; Smith *et al.*, 1993; Kfir, 1994; Overholt *et al.*, 1994; Omwega *et al.*, 1995; Potting, 1996). It was probably introduced into Mauritius with its host, *C. sacchariphagus*, in the mid-nineteenth century (Rajabalee and Govendasamy, 1988), and various studies have been carried out to determine its effectiveness as a biocontrol agent of *C. sacchariphagus*. While Jepson (1939) reported 50% parasitism, Moutia and Courtois (1952) and Rajabalee and Govendasamy (1988) mention only 7,5 and 9,9% parasitism respectively. No mention is made of parasitism of the larval stages.

This paper assesses the importance of the established exotic parasitoids on the different life stages of *C. sacchariphagus* over a four year period from 1993.

Materials and Methods

The study site was in sugarcane (variety M 1557/70) at Belle Vue in the northern sub-humid part of the island (annual rainfall 1 375 mm).

Egg parasitoids

In 1993 and early 1994, cane leaves were examined fortnightly for one hour in the morning over an area of approximately 0,1 hectare. Portions of leaves with batches of *C. sacchariphagus* eggs were clipped off and taken to the laboratory, where they were placed in 9 cm diameter petri dishes containing water. Numbers of egg batches and numbers of eggs per batch were counted. Eggs were monitored daily to record the number parasitised, which was indicated by their dark colouration. Numbers of parasitoids emerging and the number of *C. sacchariphagus* larvae hatching from all the eggs were recorded.

Larval and pupal parasitoids

In 1994 and 1995, larvae and pupae were collected fortnightly for approximately one hour by splitting open sugarcane stalks. Young larvae found on the leaf blade and in the midrib were also collected. All the larvae and pupae were taken to the laboratory and placed singly in plastic pill boxes 50 mm in diameter and 25 mm in height (Watkins and Doncaster, UK), in which a 30 mm diameter aeration hole had been made and sealed with 80 grade bronze mesh. Single-ply tissue paper (Kleenex, 100 x 100 mm) was folded into four, moistened and placed in the pill box to prevent dehydration. Sugarcane tops (40 mm long) were provided as food for the larvae, and were replaced every two or three days.

Based on head capsule width, the larval stages were aged and grouped as small (first and second instars), medium (third and fourth instars) or large (fifth and sixth instars). The larvae and pupae were examined every two days for the presence of parasitoids. Dead individuals were dissected to determine whether they were parasitised.

In 1995-96 *C. sacchariphagus* larvae and pupae were surveyed at irregular intervals. Incidental collections were made in various localities to assess parasitism. Only medium and large larvae were collected in 1995, but all stages were collected in 1996.

All laboratory observations were carried out at a mean ambient temperature of 20,5°C (minimum 15,0°C, maximum 27,0°C) and relative humidity of 72% (minimum 60%, maximum 92%).

Table 1
Parasitism of *Chilo sacchariphagus* eggs by *Trichogramma australicum*, February 1993 to February 1994.

Month	No. of eggs collected	No. of eggs parasitised	% parasitism	Ratio of parasitoids to eggs
February 1993	404	–	–	–
March	328	–	–	–
April	144	40	27,8	1,3
May	770	676	87,8	1,7
June	702	698	99,4	not recorded
July	83	83	100,0	1,6
August	31	31	100,0	2,5
September	83	66	79,5	1,7
October	–	–	–	–
November	no collections			
December	221	197	89,1	2,0
January 1994	14	14	100,0	2,5
February	12	3	25,0	1,7
Total/average	2 792	1 808	64,8	–

Results and Discussion

Egg parasitoids

T. australicum was the only egg parasitoid collected (Table 1). Egg parasitism was found to be high (average 64,8%), with peaks of 99-100% during the months of June, July, August and December. The ratio of number of adult parasitoids emerging from host eggs to the number of parasitised eggs was found to be greater than one, implying multiple egg laying by the parasitoid. Of the unparasitised eggs, only four did not emerge as *C. sacchariphagus* moths.

Larval parasitoids

Results of the studies conducted at Belle Vue in 1994 and 1995 are given in Tables 2 and 3. None of the 425 small larvae collected in both years was parasitised. Ninety-one of the 1 123 larvae (8,1%) and 56 of the 1 569 larvae (3,6%) collected in 1994 and 1995 respectively, were parasitised. The level of parasitism was higher in the fifth and sixth instars (20,7% in 1994 and 7,7% in 1995) compared with the third and fourth instars (4,8% in 1994 and 2,7% in 1995). *C. flavipes* was the predominant species. *A. stigma* was collected in 1994 from two medium and one large larvae, and in 1995 only *C. flavipes* was collected.

In the other localities 652 medium and large larvae were collected in 1995 and the average parasitism was 8,8%. A single *A. stigma* was collected, and 57 *C. flavipes*.

Contrary to what was observed in 1994 and 1995 at Belle Vue, 5,4% of the small larvae collected during 1996 were parasitised by *C. flavipes*. The percentage parasitism was 9,4% of the medium and 19,8% of the large larvae. Overall parasitism was 11,1%. *Alabagrus stigma* was reared from three medium sized larvae (Table 4).

Table 2
Number of small, medium and large *Chilo sacchariphagus* larvae collected from February to December 1994, and percentage parasitised.

Month	No. small larvae collected	% parasitised	No. medium larvae collected	% parasitised	No. large larvae collected	% parasitised	Total collected	% parasitised
February	18		64	8,1	20	30,0	102	11,0
March	35		35	11,4	18	55,6	88	15,9
April	62		172	5,2	77	23,4	311	8,7
May	10		56	3,2	23	13,2	89	5,4
June	24		73	3,8	44	9,5	141	5,0
July	12		86	2,4	30	30,2	128	8,7
August	1		65	6,5	20	15,2	86	8,4
September	2		45	4,4	31	12,8	78	7,7
October	1		4	–	1	100,0	6	15,0
November	1		31	3,2	18	5,6	50	4,0
December	10		31	–	3	–	44	–
Total	176	Nil	662	4,8	285	20,7	1 123	8,1

Table 3
Number of small, medium and large *Chilo sacchariphagus* larvae collected from January to October 1995, and percentage parasitised.

Month	No. small larvae collected	% parasitised	No. medium larvae collected	% parasitised	No. large larvae collected	% parasitised	Total collected	% parasitised
January	7		41	2,4	10	–	58	1,7
February	5		41	2,4	34	8,8	80	5,0
March	33		90	3,3	103	8,7	226	5,3
April	46		145	2,8	45	6,7	236	3,0
May	37		169	1,8	121	5,0	327	2,8
June	19		105	2,9	20	20,0	144	4,9
July	35		92	–	26	8,0	153	1,3
August	40		72	2,8	32	12,5	144	4,2
September	20		116	2,6	20	5,0	156	2,8
October	7		32	9,4	6	–	45	6,7
Total	249	Nil	903	2,7	417	7,7	1 569	3,6

Table 4
Parasitism of *Chilo sacchariphagus* larvae at various localities in 1996.

Locality	Climatic zone	No. of small larvae collected	% parasitised	No. of medium larvae collected	% parasitised	No. of large larvae collected	% parasitised
Belle Vue	Sub-humid	92	8,7	105	1,9	81	9,9
Mon Loisir Rouillard	Sub-humid	10	10,0	9	33,3	10	20,0
Tamarin	Sub-humid	48	2,1	12	–	8	25,0
St Antoine	Sub-humid	51	2,0	52	11,5	83	14,5
Riviere du Rempart	Sub-humid	62	–	60	5,0	74	20,3
Savannah	Humid	34	5,9	40	10,0	45	11,1
New Grove	Humid	35	14,3	29	13,8	4	–
Solitude	Humid	35	2,9	19	5,3	20	20,0
Britannia	Humid	17	11,8	8	25,0	26	34,6
FUEL	Humid	–	–	2	–	1	–
Joli Bois	Super-humid	7	–	9	11,1	5	50,0
Valetta	Super-humid	15	6,7	69	17,4	25	52,0
Total		406	5,4	414	9,4	383	19,8

In 1994, 21 pupae were collected at Belle Vue. Two were parasitised by *Tetrastichus* sp. None of the 22 collected in 1995 was parasitised. Six pupae were obtained from the other localities in 1995 and 36 in 1996. *Xanthopimpla stemmator* was reared from only one pupa in 1995 and one in 1996. However, the number of *X. stemmator* wasps that can be observed flying about in cane fields is an indication that this parasitoid is not negligible.

Parasitism of the eggs appears high (Table 1). Spiders, ants and earwigs are probably responsible for mortality of the early instars of *C. sacchariphagus*.

The predominant larval parasitoid of *C. sacchariphagus* was *C. flavipes*. Although the level of parasitism is generally low, this has been found to increase on occasion, implying that the parasitoid can become an important mortality factor in the host population. The existence of different geographic, host specific and host-plant specific strains of *C. flavipes* has been postulated (Moyhuddin *et al.*, 1981; Potting, 1996). The low levels of larval parasitism prompt consideration of the introduction of other strains of *C. flavipes*. However, a method for differentiating the strains should be developed prior to introduction and field release of any strain.

REFERENCES

Cochereau, P (1991). Installation en Guadeloupe de *Cotesia flavipes* Cameron (Hymenoptera: Braconidae), un parasite larvaire du foreur de la canne à sucre *Diatraea saccharalis* L. (Lepidoptera: Crambidae). In: C Parvis and A Kermarec (eds) *Rencontres Caraïbes en lutte biologique*. Institut National de la Recherche Agronomique, Paris. pp 443-450.

Greathead, DJ (1971). A review of biological control in the Ethiopian region. Technical Communication No. 5, Commonwealth Institute of Biological Control. 162 pp.

Jepson, WF (1939). Annual Report, Dept of Agriculture, Mauritius, 1938: 40-51.

Kfir, R (1994). Attempts at biological control of the stem borer *Chilo partellus* (Swinhoe) (Lepidoptera: Pyralidae) in South Africa. *African Entomology* Vol 2(1): 67-68.

Leslie, GW (1994). Pest status, biology, and effective control measures of sugarcane stalk borers in Africa and surrounding islands. pp 61-73 In: AJM Carnegie and DE Conlong (eds) Proceedings of the Second ISSCT Sugarcane Entomology Workshop, Mount Edgecombe, South Africa.

Mohyuddin, AI (1971). Comparative biology and ecology of *Apanteles flavipes* (Cam.) and *A. sesamiae* Cam. as parasites of graminaceous borers. *Bull ent Res* 61: 33-39.

Mohyuddin, AI, Inayatullah, C and King, EG (1981). Host selection and strain occurrence *in Apanteles flavipes* (Cameron) (Hymenoptera: Braconidae) and its bearing on biological control of graminaceous stem-borers (Lepidoptera: Pyralidae). *Bull ent Res* 71: 575-581.

Moutia, LA and Courtois, CM (1952). Parasites of the moth-borers of sugarcane in Mauritius. *Bull ent Res* 43: 325-359.

Nagarkatti, S and Nair, KR (1973). The influence of wild and cultivated Graminae and Cyperaceae on populations of sugarcane borers and their parasites in north India. *Entomophaga* 18: 419-430.

Omwega, CO, Kimani, SW, Overholt, WA and Ogol, CKPO (1995). Evidence of the establishment of *Cotesia flavipes* (Hymenoptera: Braconidae) in continental Africa. *Bull ent Res* 85: 525-530.

Overholt, WA, Ngi-Song, AJ, Kimani, SK, Mbapila, J, Lammers, P and Kioko, E (1994). Ecological considerations of the introduction of *Cotesia flavipes* Cameron (Hymenoptera: Braconidae) for the biological control of *Chilo partellus* (Swinhoe) (Lepidoptera: Pyralidae), in Africa. *Biocontrol News and Information* 15: 19-24.

Potting, RPJ (1996). Hunting for hiding hosts - the behavioural ecology of the stemborer parasioid *Cotesia flavipes*. PhD thesis, University of Wageningen. 125 pp.

Rajabalee, MA and Banymadhub, N (1986). Elevage et tentative d'implantation *d'Allorhogas pyralophagus* Marsh, un braconid ectoparasitaire de *Chilo sacchariphagus* Boj., le foreur ponctué de la canne à sucre à Maurice avec quelques notes sur sa biologie. *Rev agric Sucr Ile Maurice* 65: 67-72.

Rajabalee, MA and Govendasamy, M (1988). Host specificity and efficacy of *Apanteles flavipes* (Cam.) and *A. sesamiae* (Cam.) (Hymenoptera: Braconidae) parasites of sugarcane moth borers in Mauritius. *Rev agric Sucr Ile Maurice* 67: 78-80.

Rajabalee, MA (1990). Management of *Chilo* spp. on sugarcane with notes on mating disruption studies with the synthetic sex pheromone of *C. sacchariphagus* in Mauritius. *Insect Sci Applic* 11(4/5): 825-836.

Smith, JW Jr., Wiedenmann, RN and Overholt, WA (1993). Parasites of Lepidopteran stem borers of tropical graminaceous plants. ICIPE Science Press, Nairobi. 89 pp.

Williams, JR (1961). Cane pests. Annual Report, Mauritius Sugar Industry Research Institute, 1960: 68.

Williams, JR (1980). Entomological parasite-host records from Mauritius. Occasional Paper No. 32. Mauritius Sugar Industry Research Institute, Reduit. 39 pp.

Williams, JR (1983). The sugarcane stem borer (*Chilo sacchariphagus*) in Mauritius. *Revue Agricole et Sucr de l'Ile Maurice* 62: 5-23.