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# Arrowroot Leaf-Roller - a serious pest of Arrowroot in St. Vincent

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In St. Vincent, arrowroot leaf-roller *Calpodes ethlius* (Cramer) is the major pest of arrowroot (*Maranta arundinacea*), and causes a reduction in the starch yield of the rhizomes. During the period 1982 - 1984, it was found that the pest was more numerous between July and November, the infestation was slightly lower in the North of Dry River and the two varieties "Banana" and "Creole" grown in the island were equally susceptible to the pest. The two larval parasites, *Ardalus* (= *Elachertus*) sp. and *Bracon* sp., (despite their secondary parasites) are the most important biocontrol agents which keep the pest under reasonable control. The "Jack Spaniard" *Polistes cinctus cinctus*, *Polybia occidentalis grenadensis*, *Anoplius* sp. and *Prionyx thomae* play a significant role in the reduction of the pest populations, particularly during outbreaks and should be encouraged.

Keywords: *Calpodes ethlius*; Arrowroot; Biocontrol; St. Vincent

## Introduction

In the Lesser Antilles, arrowroot (*Maranta arundinacea* L.) is grown on a large scale only in St. Vincent, where a high quality starch is extracted from the rhizomes. The most important pest of the crop is the "arrowroot leaf-roller" *Calpodes ethlius* Cramer. The larvae feed on the leaves, eating all but the mid-ribs. During severe outbreaks, the crop is completely defoliated and such damage reduces the starch reserves in the rhizomes. Heavy infestations necessitate the use of pesticides, which apart from killing a large number of natural enemies also increase the cost of production.

The female lays milky-white eggs, singly, on the upper surface of the leaves, which hatch in 5 to 6 days. The dull-green larvae, with head distinctly marked off from the body, feed for a short time on the leaf-surface and then fold over the edge of the leaf to form a shelter under which they continue to feed. As the larvae grow in size, they enlarge the leaf-folds. The larvae become fully grown in 15 to 20 days. Pupation occurs in the leaf-fold or in litter. The pupal stage lasts for 9 to 12 days.

The pest is found in the Greater and Lesser Antilles and also feeds on Indian shoot (*Canna coccinea*) and other *Canna* spp.

## Background

At the start of the *C. ethlius* project in St. Vincent, a search for its natural enemies was made in the Eastern Caribbean islands (Table I). Generally, it was found that the pest preferred to lay more eggs on *Canna* spp., even when arrowroot was growing close by. Also parasitism both on eggs and larvae was higher on *Canna* than on arrowroot. It might therefore be concluded that if *Canna* is a preferred host plant for arrowroot leaf-roller, and if levels of parasitism are also higher, it is worth planting *Canna* round arrowroot fields, to encourage high parasitism and also to keep the parasite populations fairly high during the arrowroot crop time.

**Table 1** List of natural enemies of *Calpodex ethlius* recorded in Trinidad, Barbados, Guyana, Puerto Rico, St. Vincent and Cuba.

	Parasite	Stage Attacked	Host Plant
<b>Trinidad</b>			
Trichogrammatidae	<i>Xenofens ruskini</i> Girault	Eggs	Canna spp.
Encyrtidae	<i>Ooencyrtus</i> spp. (2)	Eggs	Canna spp.
Eulophidae	<i>Ascrysocharis</i> sp.	Eggs	Canna spp.
	<i>Ardalus</i> (=Zlachertus) sp.	Young larvae	
	<i>Borismenus</i> sp.	Secondary parasite of <i>Ardalus</i> sp.	
Scelionidae	<i>Telenomus</i> sp.	Eggs	Canna spp.
Braconidae	<i>Alphomelon</i> (=Apanteles) sp.	Young to medium stage larvae (solitary para.)	Canna spp.
	<i>Apanteles marginiventris</i> Cresson	Young to medium stage larvae (solitary para.)	Canna spp.
	<i>Apanteles talidicida</i> Wilkinson	Young to medium stage larvae (gregarious para.) Also attacks <i>Quinte</i> sp. (Resperidae)	Canna spp.
	<i>Apanteles ruficollis</i> (Cameron)	Young to medium stage larvae (gregarious para.)	Canna spp.
	<i>Microbracon</i> sp.	Medium to full-grown larvae	Arrowroot
Elasidae	<i>Elasmus maculatus</i> Howard	Secondary parasite of <i>A. ruficollis</i>	
Eupelmidae	<i>Anastatus</i> sp.	Eggs	Canna spp.
Chalcididae	<i>Brachymeria annulata</i> (F.)	Pupae	Arrowroot
Tachinidae	<i>Achaetoneura nigripalpis</i> Ald.	Pupae	Arrowroot
	<i>Exoristoides urichi</i> Ald.	Pupae	Arrowroot
<b>Barbados</b>			
Encyrtidae	<i>Ooencyrtus</i> sp.	Eggs	Canna spp.
Aphelinidae	<i>Marietta</i> sp.	Secondary parasite of <i>Ooencyrtus</i> sp.	
Eulophidae	* <i>Ardalus</i> (=Zlachertus) sp.	Young larvae (introduced from St. Vincent). Well established against <i>C. ethlius</i> .	Canna spp.
<b>Guyana</b>			
Trichogrammatidae	<i>Trichogramma</i> sp.	Eggs of a Hesperid	Canna spp.
<b>Dominica</b>			
Encyrtidae	<i>Ooencyrtus</i> sp.	Eggs	Canna spp.
Eulophidae	<i>Borismenus</i> sp.	Young larvae. Probably a primary parasite	Canna spp.
<b>Puerto Rico</b>			
Chalcididae	<i>Brachymeria incerta</i> Cresson	Pupae	Canna spp.
Eulophidae	<i>Euplectrus</i> sp.	Young larvae	Canna spp.
Trichogrammatidae	<i>Xenofens ruskini</i> Girault	Eggs	Canna spp.

Table 1 (ctd.)

	Parasite	Stage Attacked	Host Plant
St. Vincent			
Trichogrammatidae	<i>Trichogramma</i> sp.	Eggs	Arrowroot
Scelionidae	<i>Telenomus</i> sp.	Eggs	Arrowroot
Eulophidae	<i>Ardalus</i> (=Elachertus) sp.	Young larvae	Arrowroot
	<i>Horismenus</i> sp. nr. <i>fraterculus</i> (Pitch)	Secondary parasite of <i>Ardalus</i> sp.	
Braconidae	<i>Alphacelon</i> (=Apanteles) sp.	Young to redivm stage larvae (solitary para.)	Arrowroot
	<i>Bracon</i> sp.	Medium to full-grown larvae (solitary para.)	Arrowroot
Ceraphronidae	<i>Aphanogmus</i> (=Ceraphron) sp. prob. <i>fijiensis</i> (Ferriere)	Secondary parasite of <i>Alphacelon</i> and <i>Bracon</i>	
Chalcididae	<i>Erachymeria annulata</i> (Fab.)	Pupae	Arrowroot
	<i>Spilochalcis</i> sp.	Secondary parasite of <i>Alphacelon</i> , Tachinids and Sarcophagids	
Tachinidae	<i>Eucelatoria</i> sp. (araigera group)	Larval-pupal parasite	Arrowroot
	<i>Spoggosia</i> (=Phorocera) <i>floridensis</i> (Townsend)	Larval-pupal parasite	Arrowroot
Sarcophagidae	<i>Sarcodexia innotata</i> (Walk.)	Larval-pupal parasite	Arrowroot
	<i>Sarcophaga lakbers</i> Wiedemann	Larval-pupal parasite	Arrowroot
Vespidae	<i>Polistes</i> (=Aphanilopterus) <i>cinctus cinctus</i> (Lepeletier)	Larvae (predator)	Arrowroot
	<i>Polybia</i> (=Myraptera) <i>occidentalis grenadensis</i> Richards	Larvae (predator)	Arrowroot
Pompilidae	<i>Anoplius</i> sp.	Larvae (predator)	Arrowroot
Sphecidae	<i>Prionyx thomae</i> (Fab.)	Larvae (predator)	Arrowroot
Reduviidae	<i>Ariulus gallus</i> (Stal)	Eggs (predator)	Arrowroot
	<i>Zelus longipes</i> (L.)	Eggs (predator)	Arrowroot
Formicidae	Unidentified ants	Eggs (predator)	Arrowroot
Virus	Polyhedral virus	Puparia of Tachinids and Sarcophagids	Arrowroot
Cuba			
Eulophidae	<i>Euplectrus</i> sp.	Larval parasite	Arrowroot
Trichogrammatidae	<i>Xenotenus ruskini</i> Girault	Egg parasite	Arrowroot

In St. Vincent, egg-parasitism by *Telenomus* sp. and *Trichogramma* sp. is moderate. In Barbados, Trinidad and Dominica, *Ooencyrtus* spp. are quite common, attacking a high percentage of eggs, and are therefore good candidates for introduction into St. Vincent. Amongst the larval parasites, *Ardalus* (=Elachertus) sp. and *Bracon* sp. play a significant role in the control of *Calpodes* in St. Vincent. These are sometimes attacked by secondary parasites, the population of which may be fairly high in individual fields, and so restrict the populations of the primary parasites. To overcome this problem, the primary parasites were bred in the laboratory, and releases were made in heavily infested fields, with satisfactory results.

A number of *Apanteles* spp. recorded in Trinidad were considered for introduction into St. Vincent, but due to very low populations of these parasites in Trinidad and also due to the presence of secondary/hyperparasites in St. Vincent, these were not found suitable.

The populations of Tachinids (*Eucelatoria* sp. [armigera group] and *Spoggosia floridensis*); and Sarcophagids (*Sarcodexia innotata* and *Sarcophaga lambens*), were not high in St. Vincent. This was probably due to the high incidence of a Polyhedral virus infecting the puparia of these insects. In Trinidad also, the parasitism levels of Tachinid flies, *Achaetoneura nigripalpis* and *Exoristoides urichi*, were not encouraging.

### Survey Findings

Levels of infestation recorded during the year 1983 are given in Table 2. From January to November, the monthly range of leaf infestations was 4 to 29 percent, (average 14 percent). The time of highest infestation was between July and November. Individual field plant infestation ranged from 1 to 29 percent, the lowest being in February and the highest in November. Observations in different arrowroot growing areas were also taken. Details are given in Table 3, which shows that the lowest level of infestation was in the area north of Dry River, while there was no significant difference in the other three areas.

**Table 2** Percentage leaves damaged by *Calpodes ethlius* during 1983 in St. Vincent

Month	No. fields examined	No. plants examined	Percent leaf infestation
January	1	50	6
February	12	600	4
March	17	850	10
April	7	350	10
May	20	1,000	11
June	12	600	9
July	7	350	17
August	7	350	10
September	22	1,100	19
October	16	800	29
November	11	550	28
Total	132	6,600	14

**Table 3** Percent leaf infestation in different arrowroot growing areas in St. Vincent

Area	No. fields examined	No. plants examined	Average % leaf damage/field
North of Dry River	23	1,150	7
Mt. Grennon to Dry River	67	3,350	18
Windward up to Mt. Grennon	38	1,900	17
Leeward	4	200	14

## Varietal susceptibility

There are only two arrowroot varieties - "Banana" and "Creole" - grown in St. Vincent. Of these, "Creole" produces some 1,500 lbs. tubers per acre and "Banana" 2,000 lbs. per acre. The higher weight of Banana is due mainly to the higher water content of the tubers, but they are equal in starch content. The levels of leaf infestation by *C. ethlius* on "Creole" and "Banana" varieties in St. Vincent during 1983 is given in Table 4. The data shows that there was no significant difference in the levels of infestation on these two varieties.

## Biological control

Simmonds (1950, unpublished report) listed a number of parasites and predators attacking eggs, larvae and pupae of *C. ethlius* in St. Vincent. He also reported some natural enemies from other Caribbean territories.

**Table 4** Percent leaf infestation by *C. ethlius* on variety "Creole" and "Banana", in St. Vincent

Variety	No. fields examined	No. plants examined	Average No. leaves/plant	Percent leaf infestation
Creole	82	4,100	5.5	13
Banana	17	850	5.9	19

During the studies carried out between August 1982 and February 1984, a large number of parasites and predators were recorded in St. Vincent. Observations were taken on their abundance, levels of parasitism during different times of the year and their impact on the pest populations. Records of secondary parasites attacking these natural enemies were also kept. Collections of egg and larval parasites in other Caribbean islands were also made. (Table 1). The natural enemies recorded in St. Vincent, and their level of parasitism are discussed below.

### Egg parasites

*Telenomus* sp. and *Trichogramma* sp. were the two egg-parasites recorded. Between January and December 1983, out of 1,935 eggs collected, 146 (7.5 percent) were parasitised. The former species was more consistent and the parasitism was relatively higher than by *Trichogramma* sp.

### Larval parasites

The larvae of *C. ethlius* are parasitised by *Alphomelon* (= *Apanteles*) sp., *Ardalus* (= *Elachertus*) sp. and *Bracon* sp.; and the pupae by *Brachymeria annulata* Fab., *Eucelatoria* sp. (*armigera* group) *Spoggosia* (= *Phorocera*) *floridensis* (Townsend), *Sarcodexia innotata* (Walk.) and *Sarcophaga lambens* Wiedemann. *Alphomelon* (= *Apanteles*) sp. - a solitary larval parasite - attacked 2 to 5 percent larvae in individual fields. Some 5 percent cocoons of *Alphomelon* sp. were parasitised by *Aphanogmus* sp. prob. *fijiensis* and *Spilochalcis* sp. *Ardalus* (= *Elachertus*) sp. - a gregarious ecto-larval parasite -

attacks first and second instar larvae of *C. ethlius*. During 1983, out of 1,770 larvae collected from different parts of the island, 661 or 37.3 percent, were parasitised. The range of parasitism was 0 - 40 percent. Some 13 percent pupae of *Ardalus* sp. were attacked by a secondary parasite, *Horismenus* sp. nr. *fraternus*.

*Bracon* sp. - a solitary larval parasite - attacks medium sized *Calpodus* larvae. Out of 1,770 larvae collected, 1,062 or 60 percent, were parasitised by *Bracon* sp. Some 15 percent of cocoons of *Bracon* sp. were attacked by *Aphanogmus* (= *Ceraphron*) sp. prob. *fijiensis* (Ferriere). *Brachymeria annulata* Fab. - a pupal parasite - was not very common in the field. Occasionally one to two percent of pupae were found parasitised. *E.* sp. (armigera group) and *S.* (= *P.*) *floridensis* - The parasitism by these two Tachinids was erratic. Between August 1982 and February 1984, from 272 pupae collected, 7 were parasitised by the two species. *S. innotata* and *S. lambens*: of 272 field-collected pupae 25, or 9.2 percent were parasitised.

One percent pupariae of the Tachinids and Sarcophagids were attacked by a secondary parasite *Spilochalcis* sp. During August and September 1983, 7 percent pupariae of Sarcophagids and 35 percent of Tachinids were infected by a Polyhedral virus. From August to December 1982, the total parasitism by Hymenoptera and Diptera ranged from 11.8 - 57.5 percent, averaging 33.7; from January to December 1983, 6.7 - 60.1 percent, averaging 23.4, and during January and February 1984, 23.7 - 60 percent, averaging 34.

## Predators

The Jack Spaniard wasp *Polistes* (= *Aphanilopterus*) *cinctus cinctus* (Lepeletier), and *Polybia* (= *Myraptera*) *occidentalis grenadensis* Richards become very active during heavy attacks of *C. ethlius*. The wasps attack the larger larvae in their leaf-rolls, biting their heads off after a struggle and gnawing off only a small part to take away. The wasps tend to congregate where infestations are highest and are more efficient as control agents under these circumstances than when the larval population is low. Thus, although they help in diminishing an attack once started, they do little to prevent its occurrence. However, it would certainly be an advantage to encourage the wasps by providing nest-building sites. This has been done in the past, but is offset by the stings sustained by field workers who destroy the nests. The other predatory wasps recorded in the fields were *Anoplius* sp. and *Prionyx thomae* (Fab.). In the field, some of the eggs were eaten by ants, probably also by some predaceous bugs, viz. *Arilus gallus* (Stal) and *Zelus longipes* (L.) (Reduviidae).

*Brachymeria ovata* Say, a pupal parasite of cabbage white butterfly *Ascia monuste* L. was bred in the laboratory in Barbados on the pupae of arrowroot leaf-roller, and releases were made in arrowroot fields in St. Vincent, but the parasite was not recovered. During heavy attack the farmers were advised to spray the crop with Decis (R) 1 tsp/41 (US gal.) or Ambush (R) 1 tsp/41 (US gal.).

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