
Gall Former as a Biological Control for Strawberry Guava - *Psidium cattleianum*

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Abstract

A seed gall of *Psidium cattleianum* that destroys the embryos and cements the seeds together is described and its potential as a biological control agent evaluated. All seeds in infested fruit fail to germinate. It would be useful, therefore, in areas where management wishes to decrease the seed bank only. The causative agent is a species of *Sycophila* (Hymenoptera: Eurytomidae). Preliminary host range testing indicates that it attacks the fruit of this species only. There is only one known parasitoid, a species of *Torymus* (Hymenoptera: Torymidae). Transportation to other parts of the world is simple. The main difficulty will be timing the production of flower buds at the correct stage of development.

Introduction

Technological progress in transportation and expansion of European interests over the last two centuries have dramatically increased global interactions in all regions of the world. Those interactions have encouraged trade, tourism, and the exploitation of new crops and ornamental plants. The increasing speed of transportation has resulted in successful transport of perishable materials previously impossible due to spoilage. This capability has resulted in the introduction of many species that now threaten the indigenous biodiversity of many areas of the world as well as causing enormous economic losses.

An excellent example of a plant once confined to a small region but now a widespread problem throughout the tropics and subtropics is araçá or strawberry guava, *Psidium cattleianum* Sabine (Myrtaceae). Introduced to Hawaii about 1825, it quickly escaped from cultivation. Initially, seeds were disseminated by birds. Feral pigs, a relatively recent invader of the Hawaiian ecosystem have become the most important dispersal agent of strawberry guava seeds (Diong, 1982). Strawberry guava has become the most important forest weed in Hawaii (Smith, 1985) due to suitable soil and climatic factors, the absence of natural enemies, and effective dispersal by several different agents resulted in its uncontrolled dispersion.

Unable to control strawberry guava by mechanical and chemical means, the U.S. National Park Service initiated efforts to find biological control agents against this weed. A cooperative program between the Cooperative National Park Resources Studies Unit, University of Hawaii at Manoa, and the Federal University of Paraná was established in March 1991.

Initially, a general survey identified a number of potential biological control agents, all gall-forming insects (Wikler *et al.* this volume). This paper describes the biology of one of these species, a eurytomid wasp in the genus *Eurytoma* that forms [seed-galls](#).

Material and Methods

Most studies were conducted on First Plateau of Paraná State, Brazil (latitude 25° 27' - 25° 34'S, longitude 48° 25' - 49° 15'W). Altitude in this region varied from 650-1.100 m. Annual mean temperature varied from 15-19°C (min 10°, max 35°C). The climate was sub-montane, hot, humid with an annual medium precipitation between 1,250 - 2,500 mm distributed uniformly throughout the year (179 days of rain) (Maack, 1968). Vegetation was a cloud forest of broad-leaved trees and *Araucaria angustifolia* interspersed with agricultural fields in various states of exploitation (Carpanezzi *et al.*, 1986). Additional collections and general observations were made on trees in coastal restinga and Atlantic forest areas east of Curitiba.

Weekly systematic collections of galls were made at Betânia Farm and Mananciais da Serra. Sampling was intensified, every third or fourth day during Spring. Collections were made for two years from March 1995 and ended in February 1997. Adult insects and galls in different stages of development were obtained. At every collection site, galls and fruits were collected manually from the soil or off the tree.

One-meter square trays filled with wood chips were used to sample fruit that had fallen from trees. All fruit was collected from the surface and in the littler just under the canopy.

Adult gall formers were obtained by placing galls in Petri dishes containing a layer of slightly moistened, fine soil. Adults of the gall former and associated insects emerged inside the dishes. Mating behaviour and oviposition was studied by placing adults in transparent plastic flasks (4 cm diameter x 7,5 cm tall) with moist filter paper at the bottom and covered with a fine mesh screen. Insects were maintained in a controlled temperature cabinet at 22°C ± 2°C, under a 12 h day/night photoperiod at RH 70±10%. Dead adult insects were removed from flasks and mounted. Observations were made on the size and external morphology of galls, content of galls, exit holes, marks left by parasitism, etc. Galls were also split open to make observations on larvae. Dissections, measurements, and counts of galls per fruit were made using a Wild stereoscopic microscope with an ocular micrometer and an electronic digital caliper. Macroscopic observations were made using a Ramsor II-20 dissecting microscope. Measurements were conducted at the Forest Protection Laboratory, Federal University of Paraná, Curitiba and the Entomology Laboratory, International Institute of Biological Control, Ascot, England.

Results and Discussion

Galls

Galls are present on plants from sea level to 1,100 m. They can be found in both red and yellow-fruited forms. Infested trees of both forms can have up to 60% of the fruit infected by the gall-formers. Adjacent trees may be completely free of galls. Fruit containing seed galls have a lumpy, deformed exterior and are generally larger than smooth, normal fruit. Seeds are cemented together in a large mass or one or two smaller masses with considerably less pulp than normal fruit. Normal looking seeds may be found in the galls. Seed masses or the individual seeds in galls, however, fail to germinate. All ungalled seeds and seed masses in 100 fruits of *P. cattleianum* failed to germinate over a 60 day period.

The number of galls per fruit varied from site to site. The highest average was 6.4 galls/fruit (n=70) at Mananciais da Serra Betânia Farm averaged only 3.56 galls/fruit(n=45). Gall number was positively correlated with the number of seeds; fruits

with high number of seeds also had high number of galls.

The average diameter of the gall varied between 1.2 and 1.3 cm in Mananciais da Serra and between 0.8 and 1.5 cm at Betânia Farm.

Other species of fleshy fruited members of the Myrtaceae sympatric with strawberry guava are not galled by *Eurytoma* sp., inferring that this gall-former is host specific. Fruits of Myrtaceae plants species searched in Brazil for seed galls included *Psidium guajava* (commercial guava, both white and red pulp varieties) *Campomanesia xanthocarpa* (gabirobeira) and *Eugenia uniflora* (pitangueira). No gall formation of any kind was observed in fruits of these species. The fruit fly, *Anastrepha fraterculus* (Diptera: Tephritidae), was the only insect consistently emerging from fruits of all collected Myrtaceous species.

The gall forming insect was readily obtained from galled fruit held in covered flasks. The gall former was an unidentified species of *Eurytoma* (Hymenoptera: Eurytomidae). An unidentified species of *Torymus* (Hymenoptera: Torymidae) was also collected in the flasks and determined to be a larval parasitoid of *Eurytoma* sp. Viable larvae have been found still within galls 2 years after collection.

Gall former

Description

Adult females were larger than males. Females were predominantly pale brownish yellow with a large black stripe from the middle of the pronotum to the posterior end. The stripe on the abdomen had triangular lateral patterns of black. Males were predominantly black. There was a small carina running down the whole length of the gena. Antennae were located on the ventral margin between the eyes, with 5 funicular segments. The first segment was elongated, the remainder almost square. Apex of the scape reached the level of the lateral ocellus. Anterior margin of the pronotum was ecarinate and the posterior curved downward. Petiole was longer than wide and longer than the anterior coxa. The head is as wide as high. Height of the compound eyes was twice as large as the malar. Margin of the clypeus was bilobed. Claws had three clearly separate segments. Dorsal thorax was smooth and shiny with a relatively large, triangular prepectus. Sub-marginal vein was extremely long, and the wing was generally darker behind the marginal vein. Propodeum was sunken and its surface smooth and shiny, occasionally with some small, irregular lateral carinae. Metasoma was strongly compressed, flat and shiny. Ovipositor was slightly raised dorsally. Males and females were readily distinguished from one another not only by the presence/absence of the ovipositor but also differences in the antennae. The scape of the female antenna was approximately one third the size of the rest of the antenna which contained seven segments slightly longer than wide. Female flagellae were filiform. Male antenna were more robust. Number of sensorial hairs was significantly higher in males but decreased in length distally.

Biology

Mating was observed among seven couples of *Eurytoma* sp. in small laboratory dishes. Copulation generally occurred within the first day after emergence and lasted between 10-30 minutes.

Oviposition was never observed in the laboratory. It only occurred on living trees where insects were confined within net bags. Eggs were laid in either mature floral buds or, more frequently, in recently opened flowers, even after most of the pollen had been

removed in a pollination event. It was not possible to make detailed observations on the exact site of oviposition.

Females produced an average of 32 eggs per adult (max 85, min 13, n=18). Eggs were opaque, elliptical, and light brown with a stem at one end and a filament at the other.

Larvae were typical of Eurytomidae; white, without legs, and curved in later instars. Mouth parts were a pair of brown, chitinized, sharp jaws. Larvae had an average of 13 segments. All attempts to rear larvae removed from galls failed. Length of the larval phase was not determined. Some larvae matured in a relatively short time, others, however, were obtained from galls two years after oviposition.

Pupae were initially whitish but gradually darkened. Sex of the insect was distinguished early in development; Genitalia were apparent and males were smaller than females. Pupa body was differentiated into head, thorax and abdomen, even though the segments of the abdomen were indistinguishable. The insect had a short pupal phase, transforming to adults within a few days. Of 112 offspring examined a sex ratio of 0.69 was observed from 34 males and 78 females.

Parasitoid of Gall Former

Description

Only one parasitoid of *Eurytoma* sp. was recovered from strawberry guava galls; an unidentified species of *Torymus*, present in more than 50% of the galled fruits.

Body length of female *Torymus* sp., excluding the ovipositor, was small (1.22 mm, min 0.2, max 4.1 mm, n=38). Ovipositor length was over half the length of the body (0.83 mm, min 0.2, max 3.1 mm, n=38). Adults were light brown with a striking metallic green mesosoma, metasoma, and half of the posterior coxa.

Antenna had 13 segments. The wing had a long submarginal and marginal vein but a short stigmal and post-marginal vein. Uncus almost reached the postmarginal vein. Tarsi had five segments. Mesosoma was punctuate but smooth. Prepectus was quite large. Metasoma was not totally inserted in the propodeum and was occasionally petiolate. The ovipositor had a distinctly exerted sheath. Cerci were peg-like. The main character separating the sexes was the presence of the enormous ovipositor on female. Males had a more oval abdomen than females.

Biology

Oviposition was only observed in the field on fruits in the early stages of development. Females were observed ovipositing in fruits previously galled (galled fruits were already characteristically deformed) strongly suggesting that this species does not induce gall formation. The presence of a long ovipositor enabled deposition of eggs close to larval *Eurytoma* sp. Eggs were translucent, light yellow to almost white, oval, approximately 0.5 mm long, and with a small, beak-like projection at one end.

Larvae were straight, approximately 0.4 mm long, and their body, including the head, had 14 segments. The head was almost spherical with brown chitinized mandibles. None of the larvae survived after removal from galls. Pupae were 3-4 mm long. Initially, they were white, but turned brown then dark green as they matured. Female were larger than males and the ovipositor became apparent late in development.

Potential of *Eurytoma* sp. as a biological control agent

The prospects of *Eurytoma* sp. as a biological control agent against strawberry guava

are high. All seeds in a galled fruit are non-viable, normal seeds may be found in the fruits but they also fail to germinate (Wikler, 1999). The major impact would be an immediate and significant effect reducing dissemination of the weed in areas where range expansion is still occurring. The potential for reducing established populations is low which may not be suitable for managers looking for more immediate reductions in population levels of the weed. The population levels of the insects should rise rapidly in the absence of the parasitoid unless some predator or parasitoid in the control area attacks the insect. The ability of this insect to attack plants throughout its native range is a considerable advantage. This gall former was also found in *Psidium longipetiolatum*, plant that according to Klein (1990) is a mutation originated from *P. cattleianum*, which is intimately connected by the macromorphologic aspects, but it is a much larger tree.

It will be difficult but not necessarily impossible to coordinate the emergence of insects with floral bud production in some areas. There is a potential conflict of interest with horticulturalists who grow the plant for its fruit. Galled fruit are somewhat unsightly and the rough texture of the seed masses somewhat unpalatable.

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