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Strawberry Guava (*Psidium cattleianum*) – Prospects for Biological Control

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Abstract

The impacts of seven species of insects that have significant deleterious effects on *Psidium cattleianum* (Strawberry guava) are presented. A leaf gall produced by *Tectococcus ovatus* (Homoptera, Eriococcidae) is the most promising potential agent due to the damage caused and its ease of handling. Bud galls formed in response to *Dasineura gigantea* (Diptera, Cecidomyiidae) are precocious developments of the bud that terminate shoot growth. A shoot gall produced by *Eurytoma* sp. (Hymenoptera, Eurytomidae) terminates further growth of the shoot. A seed gall induced by *Eurytoma* sp. (Hymenoptera, Eurytomidae) cements groups of seeds together and prevents germination of all seeds in the fruit. Another leaf gall formed in response to an unknown species of Psyllidae though species specific has little impact on the plants. The sawfly, *Haplostegus epimelas* (Hymenoptera, Pergidae) is unsuitable for biological control because it attacks commercial guava occasionally. The chrysomelid *Lamprosoma azureum* (Coleoptera, Chrysomelidae) is not recommended because it attacks a number of myrtaceous species.

Introduction

Psidium cattleianum Sabine (Myrtaceae) known as araçá in Brazil and strawberry guava in many other parts of the world was introduced in Hawaii about 1825. It is the highest priority weed for control in forests. Conventional mechanical and chemical control methods are only feasible in small areas leaving an enormous pool of trees to reinfest conserved areas and do not reach the seed bank in the soil. The potential for biological control was considered to be low because any agent must have a significant impact on *P. cattleianum* but not the closely related, commercially important *P. guajava*.

Early exploratory work was not encouraging. In March 1991 the U.S. National Park Service through its cooperative program at the University of Hawaii at Manoa entered into an agreement with the Paraná Forestry Foundation (FUPEF), Federal University of Paraná, Brazil, to study the insects that attacked *P. cattleianum* in subtropical Brazil. It had earlier been decided that there were no pathogens that were suitable. This paper presents

a summary of the insects for consideration for use as biological control agents plus two that were initially promising but later found to attack *P. guajava*. They might be used as control agents in areas where guava is not an important crop but only under certain very special circumstances.

Material and Methods

Psidium cattleianum is distributed in the Atlantic Forest of Brazil from Espirito Santo south to northern Uruguay. All of the research presented in this paper was conducted in the State of Paraná, Brazil, the center of the range. Exploratory research was conducted from the coastal restinga to the First Plateau of Paraná State but the detailed ecological studies were restricted to areas of the First Plateau (Balsa Nova, Centro Politécnico, Estância Bethânia, Guaraguaçú, Juruqui, Mananciais da Serra, Taboão, Nursery of the Forestry Course and São Fernando Farm). The laboratory and garden experiments were conducted at the Forest Protection Laboratory, Federal University of Paraná, Curitiba.

Results

POTENTIAL BIOLOGICAL CONTROL AGENTS.

BUD GALL - *Dasineura gigantea* (Diptera, Cecidomyiidae)

The bud galls form small rosettes up to 3 cm diameter somewhat like a double flower due to precocious production and development of the leaves that probably outpaces the ability of the meristem to produce embryonic tissue. The rosettes are initially green but then turn yellow as they age and finally turn a deep purple before drying out and turning brown. The arrangement of the leaves in the rosette is irregular on a very compressed shoot in contrast to another recently discovered bud gall in which the leaves are regularly arranged around a short stem up to 1.5 cm long. The galls can be found on trees throughout the range of the weed. It attacks both the red and yellow-fruited forms (Angelo, 1997).

Brief Description of Insect

Two parasitoids that attack *D. gigantea* are known. *Leptacis* sp. (Hymenoptera, Platygasteridae) is very small (1,5-2,0 mm) with previous wings reaching of length. The geniculated antennae is inserted in the inferior portion of the head with 10 articles (males with the fourth specialized segment), gaster moderately chitinous, with six or less visible tergites and the ovipositor hidden at rest. This parasitoid is found throughout the range of *D. gigantea*. The other parasitoid is an unidentified species in the Braconidae, Alysiinae. It is small yellow-orange being winged with previous wings reaching of 3 to 5 length mm. There are more than 16 segments in the antennae, which are not geniculated and not club. The jaws are exodonts with 3-7 teeth, gaster with tergites 2 and 3 usually melted.

The insect forms galls in terminal and lateral buds of flush shoots occasionally producing diminutive galls in flowers and more rarely fruits. The production of the gall ceases the activity of the apical meristem of the affected shoot killing it. Heavily infested shoots do not grow any further. Any future activity of that branch results from the growth of a lower bud released from the apical dominance of the terminal parts.

This agent is a very promising agent because it will not kill the trees. The death of a large number of trees in monotypic stands, as in Hawaii, is a concern of forest managers due to the increased potential for erosion. How effective this insect will be when exposed

to species of braconid and platygasterid parasitoids which are less species specific is not known. The wide ecological range of the species makes it a generally useful agent. There is a potential cultural use of the galls in Hawaii where they could be substituted for green roses which are frequently used in leis.

***Lamprosoma azureum* (Coleoptera, Chrysomelidae)**

Both the larvae and adults damage the plants by feeding on the young, unsclerified bark of the shoots frequently girdling it. Even if the girdling is incomplete the shoot is severely stunted and very susceptible to attack by pathogens. The beetles attack young trees only and have never been observed on plants above 1.8-m height. The highest number of insects on one plant was 8 where they cause extensive damage.

This chrysomelid is confined to the upper elevations of the distribution of the boost plant above 650 m.

The adult is a brilliant metallic blue beetle with a flat body approximately 4 mm in length. The larvae in their scatoshell are usually found in the axils of branches but are also found occasionally on young branches.

Natural enemies include some unidentified Hymenoptera. They attack the larvae in the scatoshell.

The activity of the beetles and their larvae stresses the strawberry guava plants considerably. Chrysomelids are generally favoured in biological control because of the damage they cause and their specificity (Julien, 1993). Unfortunately, this species is not specific to strawberry guava. It has been found feeding on the following species of Myrtaceae: *Eugenia uniflora* L., *Campomanesia xanthocarpa* Berg, *Psidium guajava* L., *P. spathulatum* Mattos and *Acca sellowiana* Berg. The scatoshell were also observed on two species of Melastomataceae: *Tibouchina sellowiana* (Cham.) Cogniaux and *Tibouchina urvilleana* (DC.) Cogniaux. This is thought to be the first record of a chrysomelid beetle on Melastomataceae (Caxambú, 1998).

LEAF GALL (Hemiptera, Psyllidae)

The insect produces large, round green galls on the leaves. The insect is found throughout the range of *P. cattleianum*. Emergency of the psyllids occurs from October to November and they copulate 5-10 minutes after the emergency. The posture occurs mainly in the margin of the limbo, with the eggs attached in the pedicel. The adults live around 5 days and feed the sap in the leaves. The nymphs hatch and after short displacement they fix in the in the adaxial surface and start feeding.

After intense hiperplasy, these cells hypertrofy and start the gall formation with growth and projection in the inferior part of the leaf. The gall has round shape with 5 mm diameter in average. The amount of galls are variable, sometimes more than 70 by leaf. The nymphs can have 4-5 ecdysis inside the gall and become adults inside of the gall. The gall tissues only break up with the adults formation when they are released to the exterior.

The adults are predated by wasps, ants, flies, spiders and birds. The nymphs are protected inside the galls but also can be attacked by parasitoids.

This species, though apparently confined to *P. cattleianum*, will probably not be an effective biological control agent. The damage that it causes does not result in premature leaf drop or any reduction in flowering or growth of the plants.

LEAF GALL - *Tectococcus ovatus* (Homoptera, Eriococcidae)

The gall is convex oval on one side of the leaf, and acuminate oval on the other. The acuminate portion is generally on the upper side of the leaf whether or not that is the abaxial surface. Occasionally galls may have acuminate or convex forms on both sides of the leaf. The size of the galls is very variable, depending on the developmental stage and the sex of the insect, those containing adult males are narrower and more acuminate than females. The maximum diameter of the gall varies from 0,95 - 7.9 mm on the acuminate side and 1,55-7,0 mm on the convex side. The depth of the galls from the acuminate tip to the top of the convex portion varied from 1,80-8,5 mm. The galls are the same colour as the leaf though the tips are frequently red (Vitorino, 1998).

Tectococcus ovatus is distributed throughout the range of *P. cattleianum* in Brazil but it much more frequent on the red-fruited form on the First Plateau.

The adult female is oval (1,1-3,7 by 0.8-2.0 mm), translucent rosy-white, turgid, fragile, and wingless with black eyes. The legs are legs but apparently do not function. The anal ring is hairless. The rostrum is small in comparison to the body. The length of the insects is varied. The males are smaller, yellow-gold with a pair of wings, long legs, and an atrophied buccal apparatus.

There is one parasitoid, *Metaphycus flavus* (Hymenoptera, Encyrtidae). The percentage parasitism in Brazil is 49%. There is also an ectoparasite *Aprostocetus* sp. Westwood, 1883 (Hymenoptera, Eulophidae) but the percentage parasitism is only 1%. There is also a predator, *Hyperaspis delicata* Massuti and Vitorino (Coleoptera, Coccinellidae) (Almeida & Vitorino, 1997). The percentage parasitism of galls is 5%.

SAWFLY – *Haplostegus epimelas* (Hymenoptera, Pergidae)

The sawfly can cause extensive damage to young shoots and mature leaves of *P. cattleianum*. The eggs are laid subepidermally along the length of one side of the shoot which slows the growth of that side considerably. Further damage and fungal growth can result in death of the twig. The young nymphs feed on the undersurface of the leaves which in conjunction with oviposition kills a larger percentage of shoots. The later instars consume large quantities of the mature leaves defoliating shoots (Pedrosa-Macedo, 1998). The sawflies can be found throughout the range of *P. cattleianum*.

The caterpillars are the most obvious phase of the life cycle of this insect and the one that creates the damage of the plants. It is yellowish to occasionally. There are no spots along the body though the dark intestine is visible. The mature caterpillars are about 2 cm long. The aggregated caterpillars feed voraciously on the leaves stripping them within one or two hours.

The eggs are damaged by a species of mites which suck out the contents of the eggs. There is a Pentatomid that attacks the larvae. The percentage parasitismm by these predators is less than 1%. A *Vibrissina* sp. (Diptera: Tachinidae) parasitoid results in the death of 4% of the insects. The greatest loss in populations (up to 50%) are in the prepupal and pupal stages in the soil where they are susceptible to fungal diseases.

The potential of the sawfly as a biological control agent is poor. Previous reports had indicated that the sawfly also attacks *P. guajava* but during 4 years study we have had only 2 observations out of a minimum of over 300 comparative studies. The sawfly obviously has a high preference for *P. cattleianum*. The low number of events where the sawfly attacks *P. guajava* may indicate that only certain varieties or perhaps plants weakened by other factors are attacked. The problem needs further study because we have not yet confirmed that the sawfly completes its life cycle on this plant.

SEED GALL - *Sycophila* sp. (Hymenoptera, Eurytomidae)

The insect lays its eggs in young buds and open flowers up until pollination but not those where the floral organs are beginning to deteriorate. Fruit containing seed galls have a lumpy, deformed appearance and are generally larger than the smooth, normal fruit. The seeds are cemented together in large masses or a few smaller masses and contain considerably less pulp than in normal fruit. Apparently normal seeds may be found in the galls but they and the seed masses fail to germinate (Wikler, 1999; Wikler, this volume).

The insect is found throughout the range of *Psidium cattleianum*. It does not demonstrate any preference for any type of fruit or ecological situation. It 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.

The adult female is yellowish to light brown with a large black stripe from the middle of the pronotum to the posterior end. The males are predominantly black. There is a small carina running down the whole length of the gena. Males and females can be readily distinguished from one another not only by the presence/absence of the ovipositor. The female is larger, predominantly brownish yellow pale In the abdomen the stripe has triangular lateral branches.

There is one natural enemy, the parasitoid *Torymus* sp. (Hymenoptera, Torymidae). These insects are readily distinguishable from the gall former by their general light brown with a striking metallic green mesosoma, metasoma, and half of the posterior coxa. The females have a very long ovipositor with which they lay their eggs in young fruit including those showing early signs of deformation due to the activity of the gall former.

Fruit with gall fall to the ground at the same time as normal fruit. None of the seeds in galled fruit germinate. Galls can be found in the leaf litter of trees for at least two years after fruit drop. Laboratory studies showed that the bulk of the insects emerge from 4-10 weeks later but the presence of live larvae in the galls.

The prospects of this insect as a biological control agent are high. It will be difficult but not necessarily impossible to coordinate the emergence of insects with floral bud production in some areas. The ability of this insect to attack plants throughout its range is a considerable advantage. An insect that reduces seed viability, however, is a long-term control agent that may not be suitable for managers looking for more immediate reductions in population levels of the weed. It will, however, have a strong effect in controlling dissemination of the weed in areas where range expansion is still occurring. There is a potential conflict of interest with horticulturalists who grow the plant for its fruit. Galled fruit are somewhat unsightful and the rough texture of the seed masses somewhat unpalatable.

STEM GALL - *Eurytoma* sp. (Hymenoptera, Eurytomidae)

The stem galls are predominantly lightly dilated to round, 2-3 times the diameter of the stem at the base of a short shoot. The gall is the same colour as the stem, initially green but slowly turning brown with age. The size of the galls varied from 0.6-2.1 cm long by 0.3-0.9 cm wide (Wikler, 1995; Wikler *et al*., 1996).

The species is confined to the First Plateau (800-1100m). The adult insects are black in both sexes. The main characteristics are the roughly punctate thorax and the large, square pronotum which when seen from above is as wide as the mesonotum.

There are no known natural enemies while the insect is inside the gall. After emergence, it is attacked by several insects and birds.

The insect attacks emerging shoots, the gall developing at the base of the shoot which is generally somewhat stunted. Leaf development is normal but no flower buds are formed as on uninfested adjacent shoots. At the end of the growing season the shoot distal to the gall dies terminating growth of that branch. Heavily infested plants, therefore, are somewhat stunted when compared with adjacent uninfested plants.

The insect appears to be species specific attacking both the yellow and red-fruited forms but shows a marked preference for the red-fruited form. It does not attack the commercial guava or other representative myrtaceous species. Nor does it attack common species adjacent to plants in native forests, e.g., *Baccharis* spp. (Asteraceae), *Rapanea ferruginea* (Myrsinaceae), *Schinus terebinthifolius* (Anacardiaceae), *Tibouchina* spp. (Melastomataceae), *Vernonia* spp. (Asteraceae). Its restricted occurrence to the higher elevations of the distribution of *P. cattleianum* means that it has limited potential as a universal agent against this plant. Hawaiian forest managers, however, are interested because the critical areas for conservation of Hawaiian native forests are all at higher elevations where potential conflicts of interest with fruit fanciers and horticulturists are minimal.

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