COOPERATIVE NATIONAL PARK RESOURCES STUDIES UNIT
UNIVERSITY OF HAWAII AT MANOA

Department of Botany
3190 Maile Way
Honolulu, Hawaii 96822

(808) 948-8218
551-1247 (FTS)

Technical Report 66

PRELIMINARY EXPLORATION FOR POTENTIAL BIOLOGICAL CONTROL AGENTS FOR *PSIDIUM CATTLEIANUM*

Charles S. Hodges

Charles S. Hodges
Department of Plant Pathology
North Carolina State University
Raleigh, North Carolina 27695-7616

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ABSTRACT

Psidium cattleianum is a weedy tree introduced to Hawaii from Brazil. Two forms of the species are known in Hawaii, a red-fruited form commonly known as strawberry guava, and a yellow-fruited form commonly known as waiwai. The red-fruited form is usually considered the more common, troublesome of the two in Hawaii. Strawberry guava aggressively invades and forms dense thickets in native forests from about 2500 to 4000 feet elevation, replacing native vegetation.

As part of the National Park Service's biocontrol program, an exploratory trip was made to Brazil during April, 1988, in search of potential biocontrol agents, both insects and diseases. Except for limited plantings of the red-fruited form, the yellow-fruited form was the form found throughout the trip and was the form associated with the name P. cattleianum in the areas of Brazil visited (Parana and Santa Catarina states). The red-fruited form was largely unknown even to botanical scientists in this region. Although no diseases which appeared to be of significance in control were found, several insects, causing a variety of types of damage were found.

In addition to P. cattleianum, some observations were made on lantana (Lantana camara) and Christmasberry (Schinus terebinthifolius), also troublesome weedy species introduced to Hawaii from Brazil.

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INTRODUCTION

Psidium cattleianum Sabine was introduced into Hawaii from Brazil about 1825, mainly for its edible fruit. Since then it has become thoroughly naturalized and established on the major Hawaiian islands. It forms thickets in moist areas from about 2500 to 4000 feet elevation, where it competes with native vegetation. It is an especially serious problem on the island of Hawaii, where it is invading areas affected by ohia decline (6), and in the Kipahulu Valley on Maui. It apparently has no serious insect or disease problems in Hawaii and no previous attempts at biological control have been made.

In Hawaii, P. cattleianum occurs in two forms, one with red fruits, commonly called strawberry guava; and one with yellow fruits, commonly called waiawi. The yellow-fruited form has been described as a separate variety, P. c. var. lucidum Deg. Fosberg (2) used the name P. littorale Raddi instead of P. cattleianum. He transferred P. c. var. lucidum to this species and also transferred P. coriaceum Mart. ex Berg var. longipes Berg to P. littorale to accommodate the red fruited form. However, Fosberg (personal communication) now believes that P. cattleianum is the correct name.

The red-fruited form appears to be the most common, but no definitive information on this is available. Nor is there any information on the relative aggressiveness of the two forms.

As part of an on-going program of biological control of certain introduced noxious weeds in Hawaii (3), a trip was made to Brazil during the period April 7-22, 1988 to make a preliminary survey for potential biocontrol agents of P. cattleianum. The objectives of the trip were to:

1. Determine the distribution of P. cattleianum in Brazil.

2. Determine the locales where P. cattleianum could be found.

3. Make contacts with local scientists who might be willing to cooperate in collecting and testing in Brazil potential biocontrol agents for P. cattleianum.

4. Determine the kinds and relative impact of diseases and insects on P. cattleianum in its native

environment.

In addition to P. cattleianum, observations were also made on Lantana camara L. and Schinus terebinthifolius Raddi, two additional noxious weeds in Hawaii which are native to Brazil.

This report describes observations and conclusions based on the trip and makes recommendations for further work.

PSIDIUM CATTLEIANUM IN BRAZIL

The Myrtaceae in Brazil is a very large and variable family, and still somewhat little studied. There are no definitive national or regional floras on the family and statewide floras have been completed for only two states - Santa Catarina (7) and Rio Grande do Sul (8), the two southernmost states in Brazil. As an example of the diversity of the family, the Myrtaceae in Santa Catarina encompasses 191 species in 20 genera. Eugenia with 48 species is the largest genus. Psidium is represented by 9 species, including P. cattleianum. All but one species, P. guajava L. are considerd native, and P. guajava is widely naturalized. Eight species of Psidium are known in Rio Grande do Sul, four of which also occur in Santa Catarina. In Rio Grande do Sul, two varieties of P. cattleianum are recognized, P. c. var. cattleianum and P. c. var. littorale (Raddi) Mattos (8), the former with globose fruits and the latter with pyriform fruits. Even in recent papers no mention could be found of the variety lucidum.

According to Legrand and Klein (7), P. cattleianum occurs from the state of Espirito Santo south to Uruguay, roughly between latitudes 20° and 32° S, a distance of more than 1400 miles (Fig. 1). Throughout this range, P. cattleianum is strictly a coastal species where it is found most commonly as a component of a vegetation type known as "restinga" which occurs in low areas near the coast (Fig. 2) or in the valleys of the Atlantic Tropical Forest vegetation type further inland. Soils in restingas are extremely sandy with little organic matter, and although generally well-drained, the water table at times may be high. Height of the dominant trees varies from 4-5 to 12-15 meters, depending on soil characteristics (Fig. 3). Species makeup can be quite diverse depending on location and drainage. Other Myrtaceae, especially Eugenia spp., are common components.

Psidium cattleianum can sometimes be found in "capoeiras" (Fig. 2), which are essentially brush fields

resulting from cutting the native forests. The species does not occur as a component of intact native forests.

Psidium cattleianum can usually be found at elevations from 5 to 100 meters. Between Paranagua, Parana and Florianopolis, Santa Catarina, the area surveyed during the current trip (Fig. 4), P. cattleianum was found in almost every restinga visited. The species usually occurred as scattered individuals or in small groups, never in extensive thickets. However, it often occurs in small clumps (Fig. 5), giving the impression of the plants resulting from several seeds of one fruit. Although the leaves of P. cattleianum are similar to those of some associated species, trees could be distinguished easily by their characteristic bark. Trees occurring on the edges of restingas had dense, spreading crowns (Fig. 6). Within the stand, crowns were usually small and stems often slender and twisted (Fig. 7), almost like large vines. Most trees observed were 3-10 cm in diameter and 2-5 meters tall. The largest tree seen was 20 cm diameter and approximately 10 meters tall.

Once the restinga vegetative type is recognized, there is no problem in finding trees of P. cattleianum. The species is more difficult to find in capoeiras.

In Parana and Santa Catarina, only one other species of Psidium might be confused with P. cattleianum. Psidium logipetiolatum Legrand occurs as a component of the Atlantic Coastal Forest. It is a large tree up to 30 meters tall (Fig. 8). However, small trees occurring on the edge of the forest or in capoeiras look very much like P. cattleianum. Fruits are similar in size and color (Fig. 9), but seeds are fewer; 8-10 per fruit compared to 40-50 for P. cattleianum.

Except for P. guajava, for which the common name is "goiaba", the common name for Psidium spp. in Brazil is "araca". Individual species of Psidium are called "araca-vermelha", "araca-goiaba", "araca-azedo", etc. but may have numerous common names depending on the locale. Twelve common names are recorded for P. cattleianum (7). In the coastal area, asking for "araca" will usually lead one to P. cattleianum. The species is well known for its edible fruit and is commonly planted as an ornamental. The wood is widely used for fuel (Fig. 10).

Both red- and yellow-fruited varieties of P. cattleianum are common in Hawaii. Unfortunately the time of my visit to Brazil was at the end of the fruiting season (February to April). However, a few mature fruits could be found in most

of the areas visited. Without exception the fruits seen in native stands were yellow (Fig. 11). According to Corrêa (1), Legrand and Klein (7), and Reitz, et al. (9), fruits of P. cattleianum may be either red or yellow. Legrand and Klein cite several collections with fruits of either color. Mattos (8) did not mention fruit color in his description of the species. I had an opportunity to talk with Klein in Florianopolis, and he informed me that he had personally seen the red-fruited form only once. Professor Ademir Reis, botanist at the Federal University of Santa Catarina, and who accompanied me for two days in the field, has traveled widely in Santa Catarina and Rio Grande do Sul. He has never seen P. cattleianum with red fruits. Yoshiko Kuniyoshi, dendrologist at the Federal University of Parana, also had no personal knowledge of the occurrence in native stands of the red-fruited form. However, she took me to a small country estate near Curitiba where six trees of the red-fruited form had been planted. The fruits were identical to the red-fruited variety found in Hawaii (Fig. 12). Unfortunately, no one knew of the origin of the seed.

I also discussed the problem with Paulo Ernani Carvalho of the National Center for Forestry Research near Curitiba. He had collected seeds of the red-fruited form in the vicinity of Curitiba but did not remember the exact location. Plants of both the red and yellow fruited forms are planted in the arboretum at the center.

I also visited the Botanical Garden of Rio de Janeiro and talked with botanists Marcos Peron and Cristina Pereira. Neither knew of the red-fruited variety. Miss Pereira is working on the flora of restingas along the coast of Rio de Janeiro state. She informed me that P. cattleianum was present in these areas but not particularly abundant. She had seen only the yellow-fruited type.

Eight specimens of P. cattleianum were present in the Botanical Garden Herbarium. Two of these had notations that the fruits were red. Both were collected in the mountains behind the Botanical Garden (Horto Florestal) at about 800 meters elevation. I made a visit to the area but could not find any Psidium.

From personal observation, discussions with botanists and foresters, and from available Brazilian literature, the dominant form P. cattleianum in Brazil is the one with yellow fruits. It may be the only one that occurs along the coast. The skimpy evidence available indicates that the red-fruited form may occur in forests at elevations above 700-800 meters.

It is obviously poorly known and probably rare.

Few plants of Psidium were seen in the vicinity of Vicosa, M.G. None of the botanists or foresters I talked to knew much about the genus or the species that occurred in the area. The few plants I saw looked similar to P. cattleianum and Corrêa (1) reported the species to occur in Minas Gerais. However, Minas Gerais is not a coastal state and the report is probably in error.

The climate of the coastal area of Parana and Santa Catarina is tropical. Mean annual temperature is 17-23° C, with 1200-2000 mm annual rainfall. In the more northern limits of the species, mean annual temperature is slightly higher, but rainfall is within the same range.

OBSERVATIONS ON DISEASES AND INSECTS

Diseases

Few pathogenic fungi were found on P. cattleianum in the areas visited. The only common disease was a leaf spot (Fig. 13) found in the vicinity of Paranagua on the yellow-fruited form, and on planted trees of the red-fruited form at the Forestry Center Arboretum and at the small estate near Curitiba. The disease appeared to be more severe on the red-fruited form. It also occurred on P. longipetiolatum.

The pathogen associated with the leaf spot has not yet been identified. Efforts to culture the fungus were not successful. No similar disease has been reported previously on P. cattleianum.

A tarspot fungus, tentatively identified as Phyllachora subcircinans Speg. was found on leaves of a few trees, also near Paranagua. The fungus produces small black fruiting bodies on living leaves but generally causes little, if any, damage. The same fungus was also collected on a Psidium sp. near Vicosa, M.G. This is the only fungus previously reported from P. cattleianum (10).

Of interest, but probably of little importance from the standpoint of biological control, was finding the eucalyptus canker fungus Cryphonectria cubensis (Bruner) Hodges on P. cattleianum near Florianopolis, S.C. The fungus apparently entered the cut end of stems girdled by adult cerambycid beetles, locally known as "erradors" or sawyers. These insects will be discussed later. After infection, the fungus moved downward and produced small cankers in the live stem

beneath the girdle (Fig. 14). No cankers were seen in the absence of insect damage.

The canker fungus already occurs in Hawaii but only on the island of Kauai. It is a very serious problem on Eucalyptus spp. in Brazil, but until now had never been reported on a species native to that country. The fungus is believed to have been introduced to Brazil, and to other tropical areas including Hawaii, on clove [Syzygium aromaticum (L.) Merr. & Perry] (5).

The timing of the trip corresponded to early fall in Brazil, too late to find many insects actively feeding on P. cattleianum. Since the main purpose of the trip was to make observations on insect damage rather than to collect live insects, this did not present a major problem.

In contrast to the observations made on Myrica faya Ait. in the Azores, Madeira and Canary Islands, where the appearance of M. faya was of generally good health (4), the foliage of P. cattleianum showed evidence of substantial insect damage. Few trees were observed that had not been attacked by at least one kind of insect; often four or five types of insect damage could be identified on the same tree. Even published drawings of herbarium specimens often show evidence of insect damage (Fig. 15).

The types of insects and insect damage include:

- scales (on leaves) - at least four species
- leaf rollers - at least four species
- leaf miner
- leaf galls - at least three types. One type affected the buds which caused them to proliferate and later die (Fig. 17). Another produced symptoms similar to the ohia psyllid in Hawaii (Fig. 18).
- leaf feeders
    - margin feeders - Larvae of two different species of lepidopterous insects were observed feeding gregariously at two locations (Figs. 19, 20). One group placed in a plastic bag overnight completely consumed several leaves. One type (Fig. 19)

fed only on the lower epidermis and mesophyll in the early instars, leaving brown areas up to 2-3 cm in diameter. Since general foliage feeding is not characteristic of any one species, feeding damage where no insect was present could have been caused by additional species.

- The larva of another lepidopterous insect cut a circular flap about 2 cm diameter from the leaf, folded it over itself and attached it with silk. The larva then periodically left this protective covering to feed along the margin of the leaf. This insect was seen in several locations.

- Two, perhaps more, types of damage were seen that apparently were caused by small beetles feeding on the lower or upper leaf surface. The feeding often left characteristic patterns in the leaf surface. Little damage could be detected on the opposite leaf surface, but the feeding damage itself was often extensive. Feeding on the lower leaf surface by one insect was so extensive that the lower part of the leaves appeared black when looking upward into the crown (Fig. 22).

- fruit feeders - Most of the ripe fruit seen were full of insect larvae. Many young fruits were mishapen due to insect attack.

- sawyers - Adults (not seen) of a beetle, probably a cerambycid, girdle a branch or small stem well into the xylem, and then oviposit in the distal portion. Wind causes the branch or stem to break at the girdle and the larvae develop in the part that falls to the ground. Most of the branches or stems attacked are 2-5 cm in diameter. Near Florianopolis, however, several trees up to 8 cm in diameter were found girdled at the base (Fig. 23), and although the tree did not break, the tops died (Fig. 24), and the larvae apparently matured in the dead portion. This type of insect attacks other tree species as well, but in the areas visited, only P. cattleianum was affected. Sprouts usually develop beneath the girdle.

No trees were seen which appeared to have been killed by insect attack. However, insect damage was common in the areas visited and foliar damage was often extensive. In general, damage was heavier in the area around Paranagua, Parana than further south along the coast of Santa Catarina. For this reason, it may be profitable to explore northward along the coasts of the states of Sao Paulo, Rio de Janeiro and Espirito Santo.

In restingas that had been partially cleared for crops or pasture and then abandoned, P. guajava was often common. In areas where that species and P. cattleianum occurred together, the latter was often more heavily attacked by insects. The occurrence of these two species together will expedite the collection of insects which might be specific to P. cattleianum.

The only fungus collected on P. guajava was the rust Puccinia psidii Wint., which was not observed on P. cattleianum. The leaf spot collected on P. cattleianum was not seen on P. guajava.

OBSERVATIONS ON OTHER PLANTS

Lantana camara L.

Lantana camara was commonly seen in the vicinity of Vicosa, M. G., along the highway from Rio de Janeiro to Vicosa, and throughout the area visited in Parana and Santa Catarina. The form present in Hawaii with purplish flowers and thorns was common in all areas, as were thornless plants with similar or different colored flowers. Lantana lilacina Desf. also was commonly seen.

Most plants observed seemed to be heavily attacked by insects. The most common and noticeable were a gall-forming mite (Fig. 25) and a leaf miner which mined out the central and major lateral veins leaving an interesting damage pattern (Fig. 26).

One leaf fungus was collected, but has not yet been identified.

From 1972-1982 the Australians had a lantana project headquartered in what is now the National Center for Forestry Research near Curitiba, Parana. One of the local entomologists, Edson Iede, that worked on the Australian project now works for the Forestry Center. He would be an

excellent contact for anyone wanting to collect lantana insects in southern Brazil.

Two rusts, Puccinia lantanae Farl. and Prospodium tuberculatum (Speg.) Arth. occur on lantana in Brazil. I was hoping to find these around Vicosa but was unsuccessful. I previously had collected Puccinia lantanae in the state of Espirito Santo where it appeared to be doing some damage to the plant. Both rusts should be tested as potential biocontrol agents. Prof. Francisco Ferreira, forest pathologist at the Federal University of Vicosa, is willing to grow lantana plants from Hawaii in Vicosa and do preliminary testing of the rust fungi.

Schinus terebinthifolius Raddi

This plant was commonly observed in the vicinity of Vicosa, M. G. and in Parana and Santa Catarina growing in a variety of habitats from the mountains to the seacoast. It is often found in pastures and cut-over areas and was common along the coastal restingas, sometimes in close association with P. cattleianum. It is also commonly used as an ornamental. If someone wanted to search for biocontrol agents, there would be no problem in finding the plant. Unfortunately, the plants I saw appeared very healthy with little indication of fungus or insect attack. Thrips were observed attacking new foliage near Vicosa, M. G. and a leaf miner was generally present everywhere.

CONCLUSIONS AND RECOMMENDATIONS

1. Psidium cattleianum in Brazil occurs along the coast from the state of Espirito Santo south to Uruguay. It is a major or minor component of vegetative types known as restingas and capoeiras. It usually occurs singly or in small groups, never in pure thickets. It is relatively common in most areas, especially in restingas, and easy to find and identify.

2. The form most commonly seen during the trip, reported in local literature, and most familiar to local botanists and foresters, has yellow fruits. The red-fruited form common in Hawaii appears to be rare in the areas of Brazil visited. Naturally-occurring plants were not seen, nor could any of the local botanists tell me where specimens could be found.

3. Few disease problems were seen and none appear to be particularly promising as biocontrol agents.

4. Numerous kinds of insect damage were noted on foliage and stems of P. cattleianum. Damage was sometimes extensive but mortality due to insect attack was not seen. There appears to be sufficient potential, especially with two species of lepidopterous defoliators, to warrant additional work.

5. Less than one-fourth of the range of P. cattleianum was explored during this visit. Exploration of the remaining range, especially to the north of Parana, seems warranted.

6. Because of the wide distribution of P. cattleianum in Brazil, and the apparently large number of insects associated with the species, it will be difficult to do meaningful exploration in short visits. For these reasons, it is recommended that a local entomologist be contracted to do a preliminary survey of the most likely candidates for biological control. To this end, preliminary discussions were held with Dr. Jose Pedrosa-Macedo, professor of entomology at the School of Forestry of the Federal University of Parana In Curitiba. Dr. Pedrosa-Macedo holds a Ph.D. from the University of Freiburg in Germany. He is willing to direct a graduate student to work on insects of P. cattleianum providing the stipend and travel expenses are furnished. Costs of such a program would be about $10,000 per year.

7. Seeds of the Hawaiian form(s) of Lantana camara should be sent to Vicosa, M.G. so that Dr. Francisco Ferreira can use the plants for inoculation with the two local rust fungi. Contacts were made with entomologists in Vicosa and Curitiba who would be willing to help with collection of lantana insects should anyone be interested.

8. Schinus terebinthifolius has a very wide distribution in central and southern Brazil, and is locally very abundant. Unfortunately it appears exceptionally healthy. Limited observations did not turn up any promising insects or fungi.

LITERATURE CITED

1. Corrêa, M.P. 1984. Dicionario das plantas uteis do Brasil e das exoticas cultivadas. Ministerio da Agricultura, Instituto Brasileiro de Desenvolvimento Floresta, Brasilia. p. 140.

2. Fosberg, F.R. 1941. Varieties of the strawberry guava. Proc. Biol. Soc. Washington 54: 179-180.

3. Gardner, Donald E. and Clifton J. Davis. 1982. The prospects for biological control of nonnative plants in Hawaiian national parks. Technical Report 45. Cooperative National Park Resources Studies Unit, Dept. Botany, University of Hawaii, Honolulu. 55 pp.

4. Hodges, C.S., Jr., and Donald E. Gardner. 1985. Myrica faya: Potential biological control agents. Technical Report 54. Cooperative National Park Resources Studies Unit, Dept. of Botany, University of Hawaii, Honolulu. 42 pp.

5. Hodges, C.S., Jr., A.C. Alfenas, and F.A. Ferreira. 1986. The conspecificity of Cryphonectria cubensis and Endothia eugeniae. Mycologia 78:343-350.

6. Hodges, Charles S., et al. 1986. Decline of ohia (Metrosideros polymorpha) in Hawaii: a review. General Technical Report PSW-86. USDA-Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, CA. 22 pp.

7. Legrand, C. Diego and Roberto M. Klein. 1977. Myrtaceae. In: Flora Illustrada Catarinense. Herbario Barbosa Rodrigues, Itajai, SC, Brazil.

8. Mattos, J.R. 1984. Myrtaceae do Rio Grande do Sul. Roessleria 6:3-394.

9. Reitz, P.R., R.M. Klein, and A. Reis. 1983. Madeira do Rio Grande do Sul. Sellowia 55: 65.

10. Viegas, A.P. 1961. Indice de Fungos da America do Sul. Instituto Agronomico, Campinas, SP, Brazil.

ACKNOWLEDGEMENTS

The successful conclusion of this exploratory trip was due in no small part to the efforts of several local scientists. They were especially helpful in furnishing information on the distribution and ecology of Psidium cattleianum. They also exhibited keen interest in the biological control program and agreed to cooperate on future aspects of the program should it continue. Special thanks are due the following:

Federal University of Vicosa, Vicosa, M. G.
Professor Francisco Ferreira, Pathologist
Professor Acelino Alfenas, Pathologist
Professor Jose Cola Zanuncio, Entomologist

Federal University of Parana, Curitiba, PR
Professor Jose Pedrosa-Macedo, Entomologist
Professor Yoshiko Kuniyoshi, Dendrologist

National Center for Forestry Research, Curitiba, PR
Dr. Arnaldo Bianchetti, Seed Specialist
Paulo Ernani Carvalho, Forester
Edson Iede, Entomologist

Federal University of Santa Catarina, Florianopolis, SC
Professor Ademir Reis, Botanist

Bosbosa Rodrigues Herbarium, Itajai, SC
Roberto M. Klein, Botanist

Rio de Janeiro Botanical Garden Herbarium,
Rio de Janeiro, RJ
Marcos Peron, Botanist
Cristina Pereira, Botanist

I am especially indebted to Arnaldo Bianchetti and Ademis Reis, who not only gave up a Sunday to travel with me to the field, but a holiday as well.

ITINERARY

Thursday, April 7, 5:20 pm - Left Raleigh, NC

Friday, April 8, 8:50 am - Arrived Rio de Janeiro

Friday, April 8, 10:30 am - Left for Vicosa, M.G.

Friday, April 8, 7:00 pm - Arrived Vicosa.

Saturday, April 9. Looked for Psidium, Lantana and Schinus terebinthifolius in vicinity of Vicosa.

Sunday, April 10. Off.

Monday, April 11. In morning searched for Psidium in vicinity of Vicosa. In afternoon discussed possible cooperation with pathologists Fancisco Ferreira and Acelino Alfenas and entomologist Jose Cola Zanuncio of the Federal University of Vicosa.

Tuesday, April 12. 8:30 am - Left for Rio de Janeiro. Made observations on Lantana and Schinus along the way. 5:30 pm - Arrived Rio de Janeiro.

Wednesday, April 13, noon - Left for Curitiba, Parana.

Wednesday, April 13, 2:30 p.m. - Arrived Curitiba.

Thursday, April 14, am - Visited National Center for Forestry Research. Discussed distribution of P. cattleianum with Arnoldo Bianchetti; seed specialist working on native plants, and Paulo Carvalho, and forester specializing in native plants. Also met with Edson Iede, entomologist, about insects reported from P. cattleianum (there were none in the Brazilian host list).

In pm, talked with Dr. Jose Pedrosa Macedo, entomologist at the School of Forestry at the Federal University of Parana about possible cooperation in collecting and preliminary testing of insects on P. cattleianum.

Friday, April 15 - Accompanied by Arnaldo Bianchetti and Yoshiko Kuniyoshi, dendrologist at the school of Forestry, Federal University of Parana, made observations on P. cattleianum on coast in the vicinity of Paranagua.

Saturday, April 16 - Returned to coast near Guaratuba

accompanied by Bianchetti.

Sunday, April 17, am - Made observations on P. cattleianum along coast of Parana and Santa Catarina on way to Florianopolis, accompanied by Bianchetti. In pm, made observations in vicinity of Florianopolis accompanied by Ademir Reis, botanist at Federal University of Santa Catarina.

Monday, April 18. Worked with Bianchetti and Reis in vicinity of Florianopolis.

Tuesday, April 19 am - Met with Roberto Klein of the Barbosa Rodriques Herbarium in Itajai to discuss distribution of P. cattleianum in Brazil. He was one of the authors of the Myrtaceae chapter in Flora Illustrata Catarinense. Left for Curitiba along more inland route making observations on P. cattleianum. Arrived Curitiba 8:00 pm.

Wednesday, April 20 - Prepared specimens for return to U.S. Discussed again possible cooperative program with Jose Pedrosa-Macedo.

Thursday, April 21. 8:30 am - Left for Rio de Janeiro. 10:30 am. Arrived Botanical Garden in Rio de Janeiro. Discussed P. cattleianum with Marcos Peron and Cristina Pereira at Botanical Garden Herbarium. Looked for red-fruited P. cattleianum in mountains behind Botanical Garden: 10:30 pm - Left for U.S.

Friday, April 22. 2:30 pm - Arrived Raleigh.

Fig. 1. Approximate distribution of Psidium cattleianum in Brazil (shaded).

Fig. 2. Low areas near the coast contain a vegetation type known as "restinga". A vegetation type known as "capoeira" is found on cut-over forest areas on the hills (background).

Fig. 3. Typical "restinga" vegetation.

Fig. 4. Area (shaded) explored in Parana and Santa Catarina for potential biocontrol agents of Psidium cattleianum.

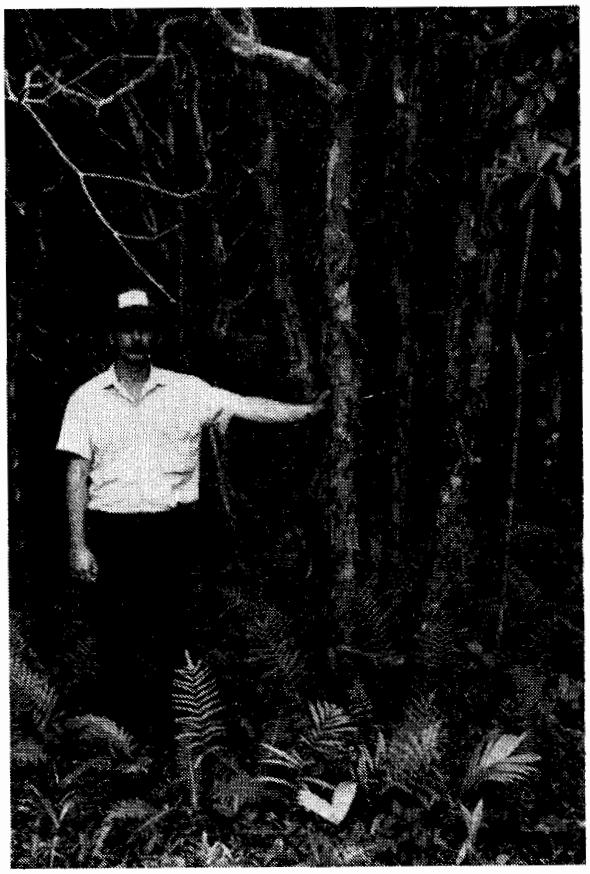

Fig. 5. Clump of Psidium cattleianum with several stems.

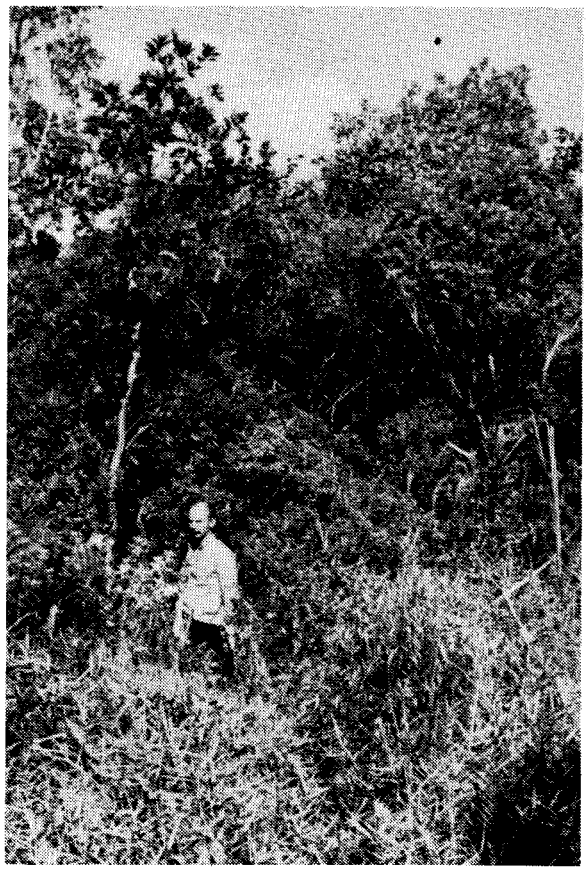

Fig. 6. Single plant of Psidium cattleianum on edge of "restinga".

Fig. 7. Slender, contorted stems of Psidium cattleianum within dense "restinga".

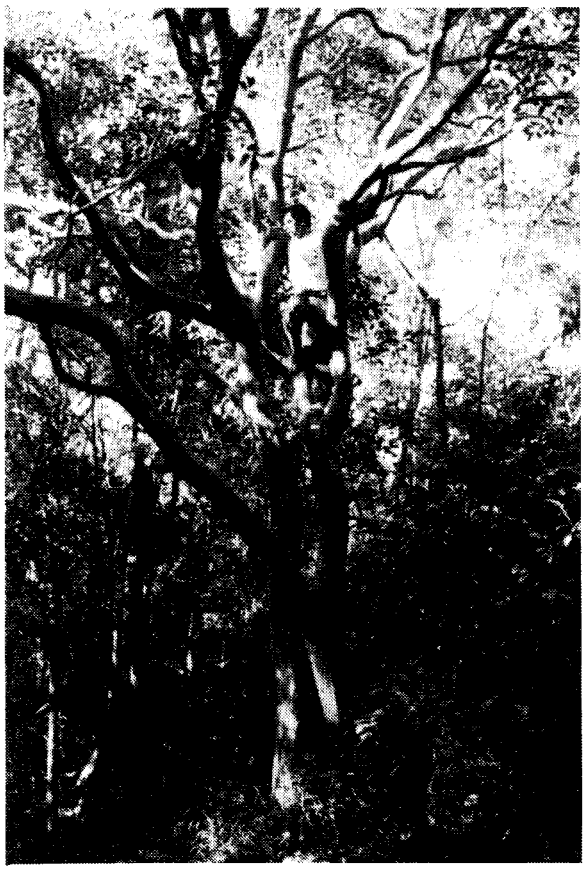

Fig. 8. Tree of Psidium longipetiolatum within native forest.

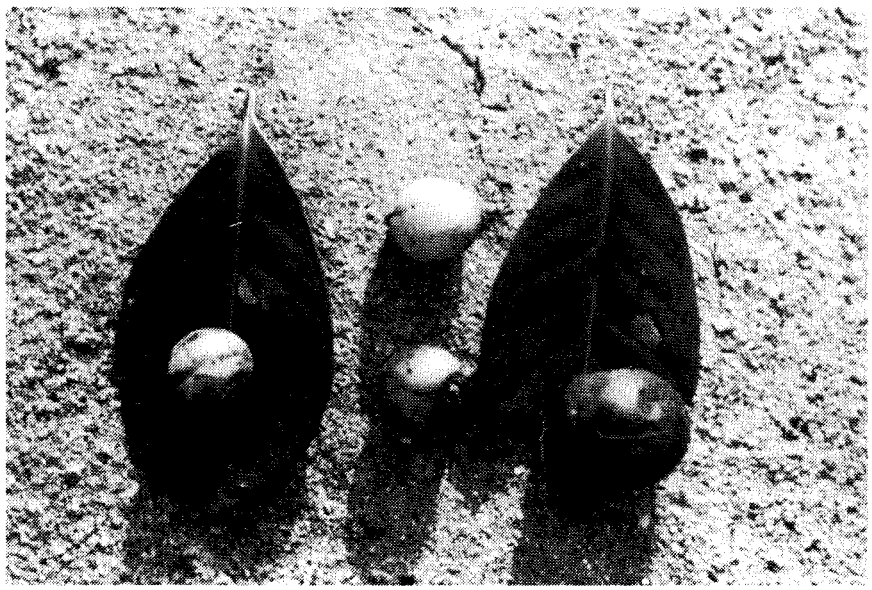

Fig. 9. Fruit and leaves of Psidium longipetiolatum.

Fig. 10. Psidium cattleianum firewood.

Fig. 11. Yellow-fruited form of Psidium cattleianum.

Fig. 12. Red-fruited form of Psidium cattleianum.

Fig. 13. Leafspot of Psidium cattleianum caused by an as yet unidentified fungus.

Fig. 14. Canker on Psidium cattleianum caused by Cryphonectria cubensis. Note "sawn" top due to insect attack by "serrador" and sprouting below-canker.

Fig. 207 — PSIDIUM CATTLEIANUM Sabine. A — Reitz & Klein 10,870.
B — A. Cevieski 46 x ½.

Fig. 15. Drawing of herbarium specimen of Psidium cattleianum showing insect feeding.

Fig. 16. Damage on Psidium cattleianum caused by leafrolling insect.

Fig. 17. Dead deformed buds caused by gall-type insect on Psidium cattleianum.

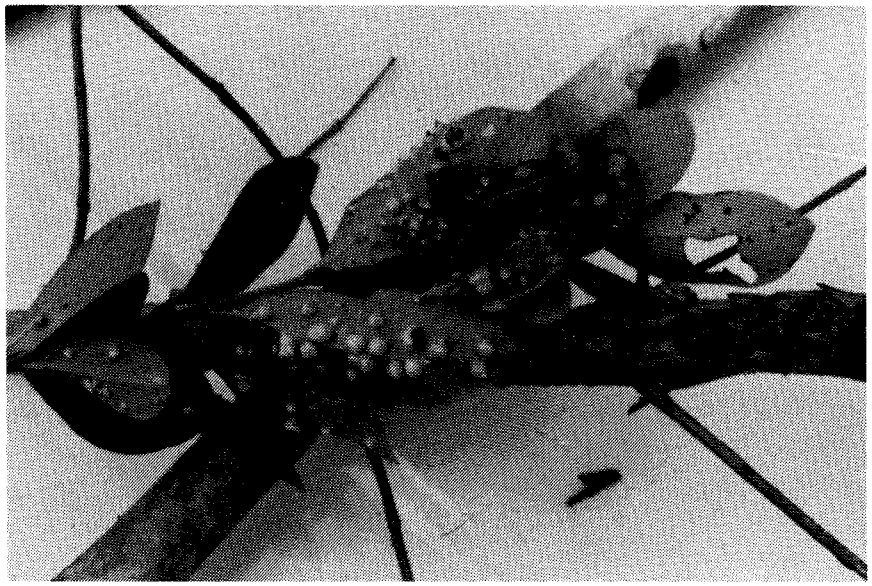

Fig. 18. Psyllid-like galls on leaves of Psidium cattleianum.

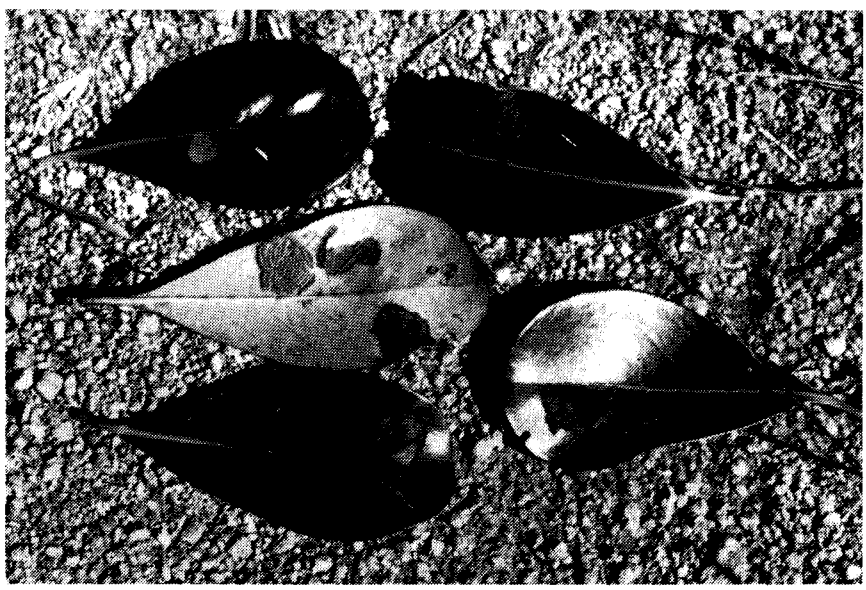

Fig. 19. Group of small insect larvae (center leaf) and the damage they cause on leaves of Psidium cattleianum.

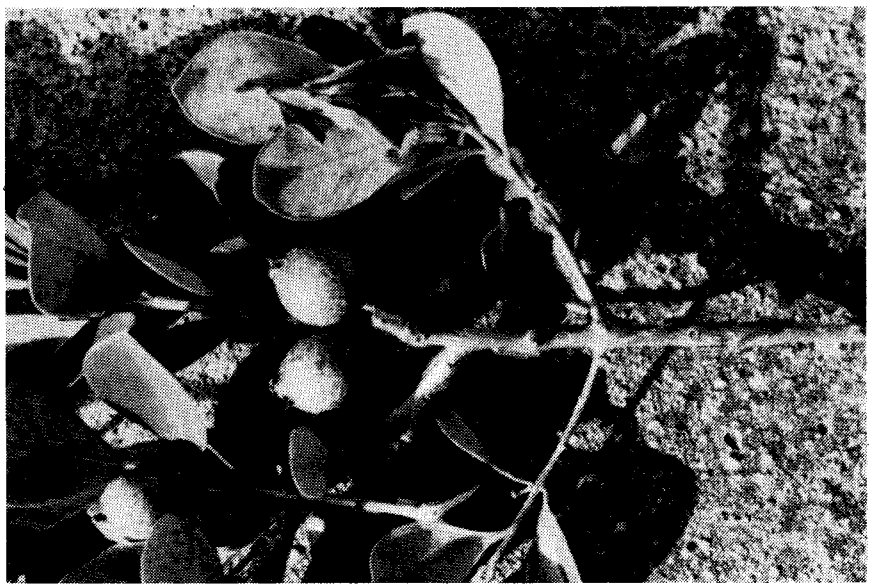

Fig. 20. Insect larvae feeding on leaves of Psidium cattleianum. Many larvae can be seen along branchlets.

Fig. 21. Insect larvae feeding on leaves of Psidium cattleianum.

Fig. 22. Lower surface of leaves of Psidium cattleianum showing symptoms of attack by small insect, probably a beetle or weevil. Note unaffected upper surface of leaf.

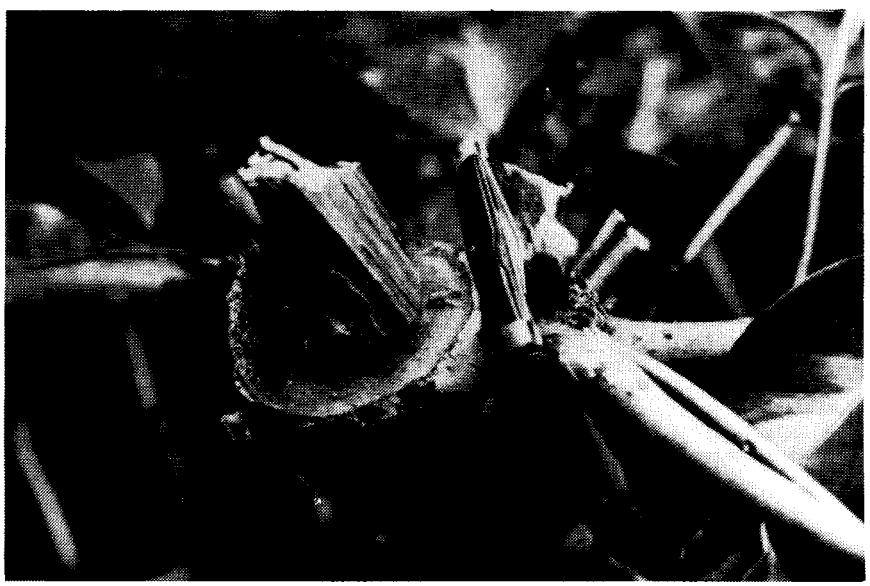

Fig. 23. Stem of Psidium cattleianum girdled by adult cerambycid beetle ("serrador").

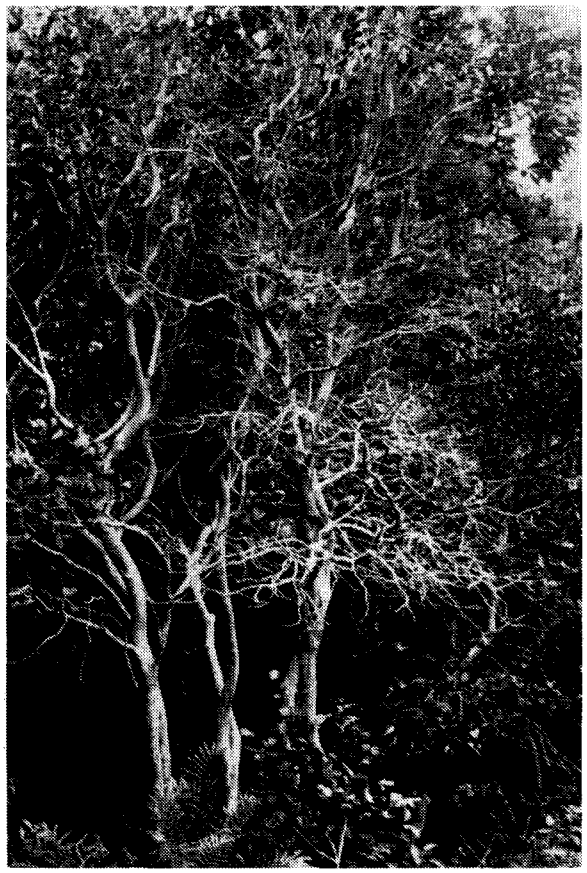

Fig. 24. Dead tops of trees of Psidium cattleianum girdled near base by adult cerambycid beetle.

Fig. 25. Leaves of Lantana camara attacked by mites.

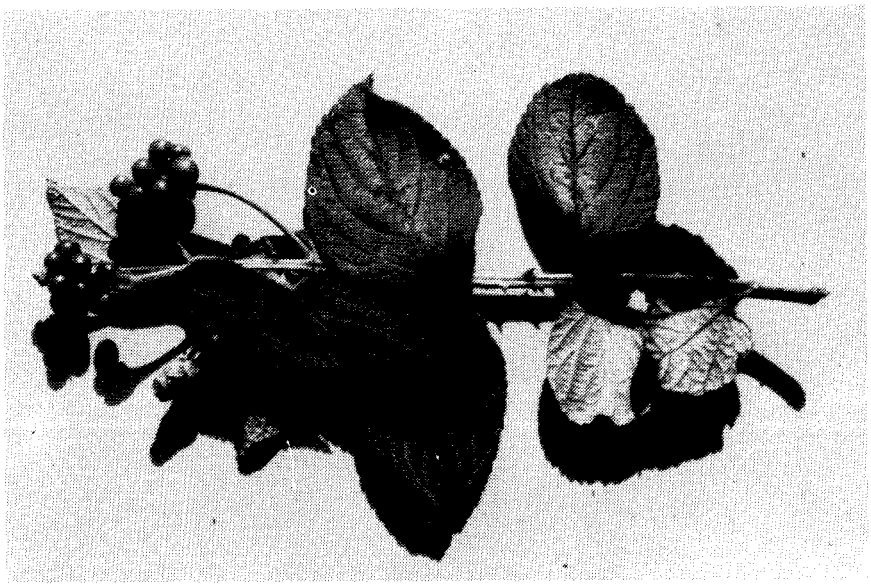

Fig. 26. Leaves of Lantana camara attacked by miner which tunnels through midvein and major lateral veins leaving characteristic symptoms.