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RESPONSES OF THE COMMON BIRDWING, *TROIDES RHADAMANTUS* LUCAS (PAPILIONIDAE, LEPIDOPTERA), TO *ARISTOLOCHIA TAGALA* CHAM. AND *A. ELEGANS* MAST.

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ABSTRACT

The life history, development and survival rate of the common birdwing, *Troides rhadamantus* Lucas, on *Aristolochia tagala* Cham., its natural host plant, and *A. elegans* Mast., an introduced ornamental, were compared. Larval, pupal and adult abnormalities in external morphology were observed when the insects were reared on *A. elegans*. Likewise, larval and pupal periods were longer on *A. elegans*. On the contrary, adult size and longevity were reduced.

Key Words: Common birdwing, *Troides rhadamantus, Aristolochia tagala, Aristolochia elegans,* Papilionidae.

INTRODUCTION

Aristolochia tagala Cham. and *A. elegans* Mast. have been studied for their antifeedant and other insecticidal properties against the Asian corn borer, *Ostrinia furnacalis* (Guenee) (Caasi-Lit & Morallo-Rejesus, 1989), and the common cutworm, *Spodoptera litura* (Fabr.) (Caasi-Lit & Morallo-Rejesus, 1990). *A. tagala* (timbangan or mala-ubi,) is a twining suffrutescent and glabrous perennial vine that grows heavily in thickets and flowers abundantly from March to December. This vine is widely distributed in the Philippines, India and Malaya and can be found in open thickets at low and medium altitudes on Mount Makiling (Pancho, 1983). In the Philippines, this plant is known to have medicinal value (Jumalon, 1968; Quisumbing, 1951). On the other hand, *A. elegans* (itik-itik, Dutchman's pipe or calico flower), originally from South America, is also a vine that flowers from January to October. Its reniform or heart-shaped leaves contain waxy materials in the under surfaces. It is mainly used as an ornamental plant (Merrill, 1912) because of its attractive purplish and beautifully shaped flower which resembles a Dutchman's pipe and hence the English common name.

It is assumed that all species of Aristolochiaceae contain aristolochic acid. However, each species will probably differ in the relative content of this toxic substance. Coutts *et al.* (1957) and Straatman (1962) confirmed the presence of aristolochic acid in *Aristolochia reticulata* and *A. indica*. Morallo-Rejesus *et al.* (1988) isolated and identified by spectrophotometric methods this same toxic substance from the leaves and seeds of local populations of *A. elegans*. This was

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also confirmed in the non-preference and antifeedant properties observed by Caasi-Lit & Morallo-Rejesus (1989 & 1990) using ethanolic extracts of *A. elegans* and *A. tagala* against the Asian corn borer *(Ostrinia furnacalis* (Guenee)) and the common cutworm *(Spodoptera litura* (Fabricius)).

Under natural conditions, however, *Aristolochia* species and other plants in the family Aristolochiaceae are hosts to a number of beautiful papilionid butterflies (Jumalon, 1968). In the Philippines, *A. tagala* is the common host plant of several endemic butterflies like the Palawan birdwing, *Trogonoptera trojana* (Honrath); the Magellan birdwing, *Troides magellanus magellanus* (C. & R. Felder); and the Common birdwing, *Troides rhadamantus* Lucas.

Jumalon *f.* (1978) studied the comparative life history and feeding habits of the two aforementioned *Troides* species on *A. tagala* and two other native species, *A. ramosi* Merr. and *A. philippinensis* Warb. as well as the introduced *A. elegans*. She found that the most preferred host of both butterflies is *A. tagala* and the least desired food plant was *A. elegans* with only the later instars observed to feed on it. Jumalon f. (1978), however, presented no detailed quantitative and comparative data and photographic documentation to support her observations. She also failed to take note of developmental abnormalities which Caasi-Lit & Morallo-Rejesus (1989 & 1990) later observed with other lepidopterous insects grown on *A. elegans*. This study aims to compare the life history, development and survival of *Troides rhadamantus* Lucas when fed with *A. tagala* and *A. elegans* and present new evidence of the inhibitory and toxic effects of the introduced *A. elegans* to native *Aristolochia*-feeding butterfly fauna.

MATERIALS AND METHODS

Mass rearing of *T. rhadamantus* on *A. tagala*

Host plants were planted and mass-produced from seeds obtained from Professor Julian N. Jumalon of Cebu City. Old plants established at the back of the Department of Entomology, UPLB were also used as sources of food plants for the insects. Both new and old plants were maintained using standard agronomic practices.

The existing old vines of *A. tagala* which were grown in open spaces served as the oviposition sites of the wild *Troides*. Additional planting sites were established and maintained to attract as many butterflies as possible using the surrounding trees as trellises. Once eggs were observed and allowed to hatch, the newly emerged first instar larvae were either reared continuously on the vines or in acrylic pans inside the laboratory where larvae were given fresh leaves. Larvae were grown up to the last (fifth) instar and allowed to pupate inside a cage with twigs and branches which served as pupating and molting anchors. This became the source of test insects.

Effect of *A. tagala* and *A. elegans* on *Troides rhadamantus*

Eggs of *T. rhadamantus* were placed in a petri dish for hatching and reared in acrylic pans. Fifteen larvae were fed separately with fresh leaves of *Aristolochia* species and the leaves were replaced when necessary. Mortality of the different instars was recorded as well as the number of normal pupae and adults. For the purpose of measurements and other observations, the contracted (as contrasted with normal, expanded, full-grown) fifth instar larva which has ceased to feed and positioned itself on twigs preparatory to pupation was called "pre-pupa". The normal female adults were allowed to lay eggs inside a screened cage (0.3 x 0.45 x 0.45 m) provided with fresh leaves of the plants. The number of eggs laid, hatchability (number of fertile eggs) and longevity of the adults were determined.

These experiments were conducted in the Insectary of the Department of Entomology at a temperature range of 27-34°C and 70-80% relative humidity.

RESULTS AND DISCUSSION

The life history of *Troides rhadamantus* was shorter when reared on *A. tagala* than on *A. elegans* (Table 1; Figure 1). The larvae reared on *A. tagala,* especially the fourth and fifth instars, were bigger than those reared on *A. elegans* (Table 2, Figure 2). Normal pre-pupae and pupae of *T. rhadamantus* reared on its natural host, *A. tagala,* were also bigger as shown in Figure 3. Pupae and pre-pupae of those reared on *A. elegans* were relatively smaller (photograph not available). The observation was also true in the case of emerging adults which had shorter wing expanse if their larvae were fed with *A. elegans* (Table 3). Dwarf adults had emerged from those reared on *A. elegans.* The prolonged larval period and smaller larval and pupal sizes were characteristics of those insects reared on *A. elegans*. This probably indicates that *A. elegans* contains a greater amount of the toxic compound that inhibits the growth and development of *T. rhadamantus.*

In terms of body coloration, later larval instars that fed with *A. elegans* were darker and brighter than the normal dull plum-colored ones on *A. tagala,* sometimes almost blackish except for the white markings. There were no noticeable color differences among adults of both sexes from both treatments.

In general, the stadia are longer with *A. elegans* than with *A. tagala,* except in the adult stage where longevity is reduced. These findings agree with the report of Jumalon *f.* (1978) that *A. elegans* was toxic to the larvae of *T. rhadamantus,* some failing to complete their life cycle. In her study, however, no numerical data were provided for this butterfly species when reared on *A. elegans* under natural conditions. Also, she apparently was unable to record developmental abnormalities.

To investigate further the effect of *A. elegans,* survival rate was determined for each stage. In general, survival was lower on *A. elegans,* becoming as low as 20% after the fourth instar. Twelve out of the 15 eggs hatched and completed the first stadium but only 41.66% survived after the second larval instar (Table 4). This may be due to the feeding behavior of the second instar larvae, the latter being more ravenous than the former. This clearly indicates that the amount of *A. elegans* consumed by the larvae was already toxic thus causing larval mortality. The larvae that survived may not have consumed enough toxic material from the leaves to cause death but their growth and development were retarded.

The last instars of *T. rhadamantus* were observed to feed on *A. elegans.* However, the excreta of the larvae were watery compared to the dry feces of those that fed on *A. tagala.* After feeding, the larvae started to weaken, their body softened and became unable to pupate normally. Difficulty in spinning the thread-like structure for pupation was also observed. Most of the time, failure to form the thread-like structure would affect their normal (upright) pupal position, thus

Table 1. Comparative life history of *T. rhadamantus* reared on *A. tagala* and *A. elegans*.

Stages		Life History (days)	
		A. tagala	*A. elegans*
Egg		7-8	7-8
Larva:	First Instar	2-3	3-4
	Second Instar	3-4	5-6
	Third Instar	3-4	4-5
	Fourth Instar	4-5	6-7
	Fifth Instar	5-6	7-9
Pre-pupa		2-3	3-5
Pupa		23-25	28-30
Adult longevity:	Male	12-15	7-9
	Female	14-18	9-11
	Total	61-76	69-84

Table 2. Body length of *T. rhadamantus* larvae and pupae reared on *A. tagala* and *A. elegans*.

Stages		Body Length (cm)	
		A. tagala	*A. elegans*
Larva:	First Instar	0.3 - 0.5	0.2 - 0.3
	Second Instar	1.2 - 1.5	0.7 - 0.9
	Third Instar	1.8 - 2.0	1.1 - 1.3
	Fourth Instar	4.0 - 5.0	1.8 - 2.0
	Fifth Instar	6.0 - 8.0	3.5 - 4.0
Pre-pupa (contracted 5^{th})		4.0 - 5.0	3.5 - 4.0
Pupa		4.5 - 6.0	2.4 - 4.0

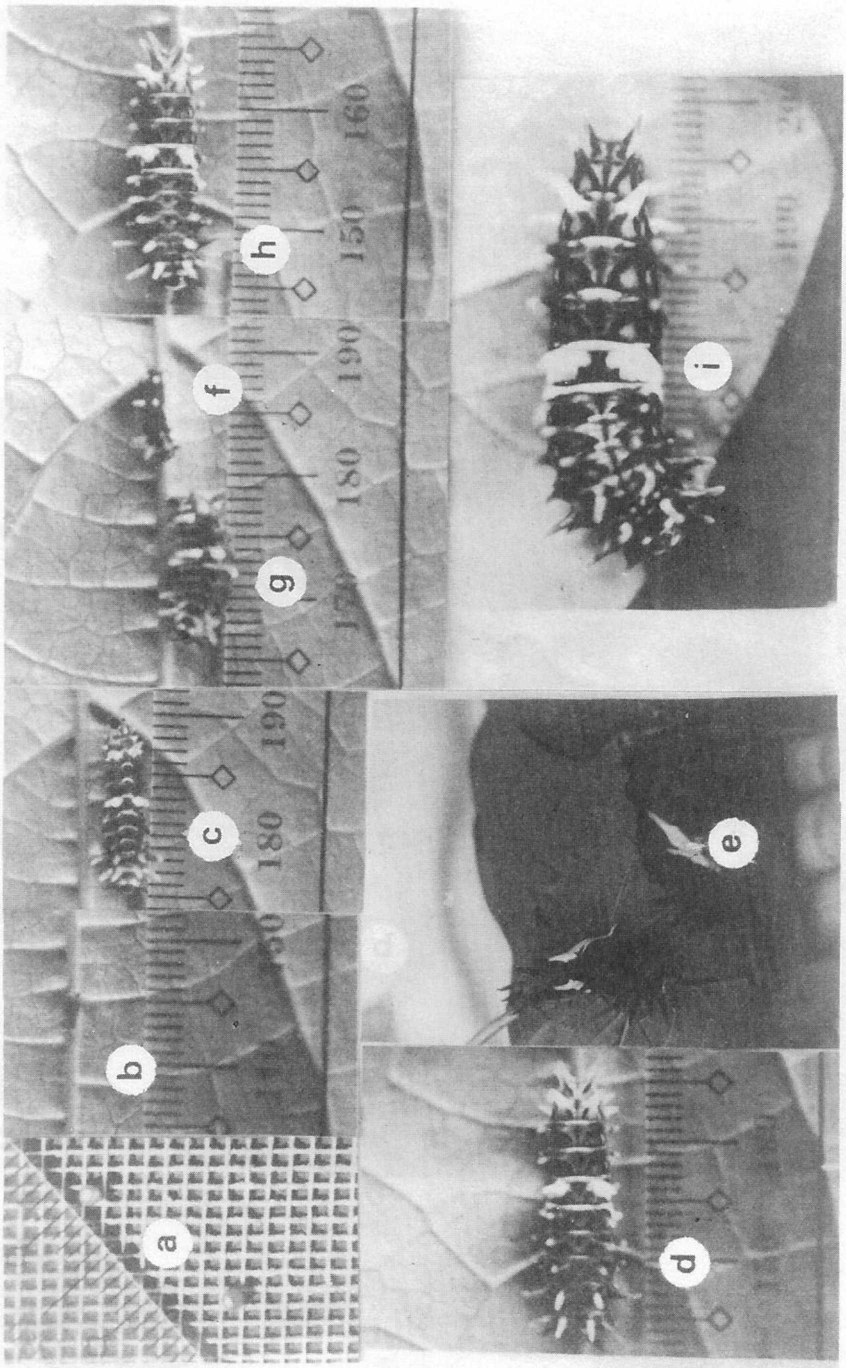

Figure 1. Comparative life stages of *T. rhadamantus* reared on *A. tagala* (a. egg; b-e. larval instars: b. first; c. second; d. third; e. fourth) and on *A. elegans* (f-i, larval instars: f. second; g. third; h. fourth; i. fifth).

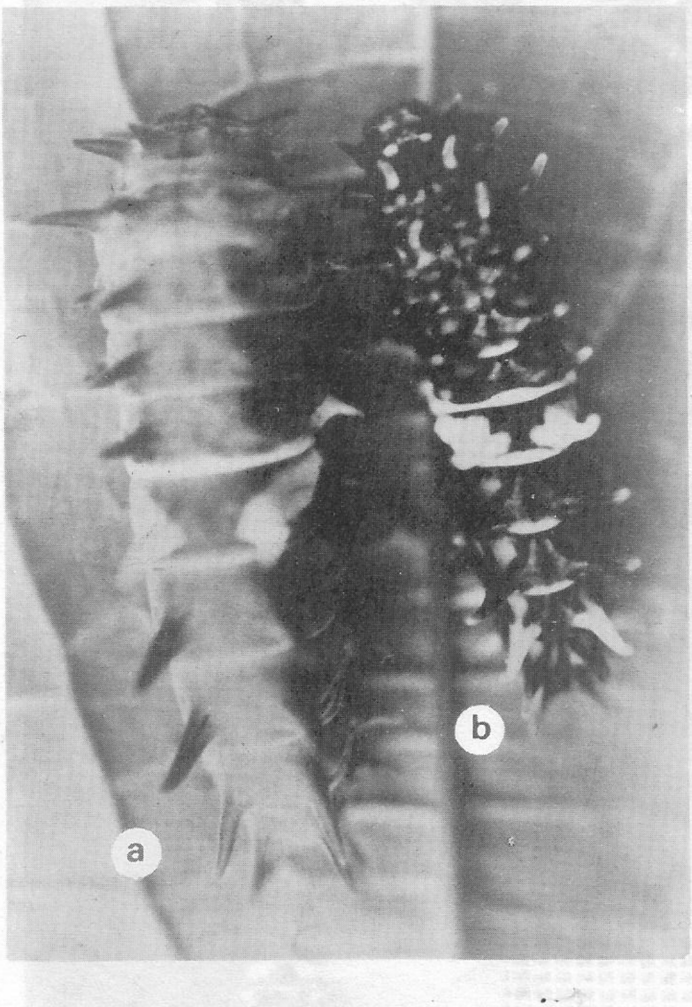

Figure 2. Fifth instar larvae of *T. rhadamantus* reared on (a) *A. tagala* and (b) *A. elegans*.

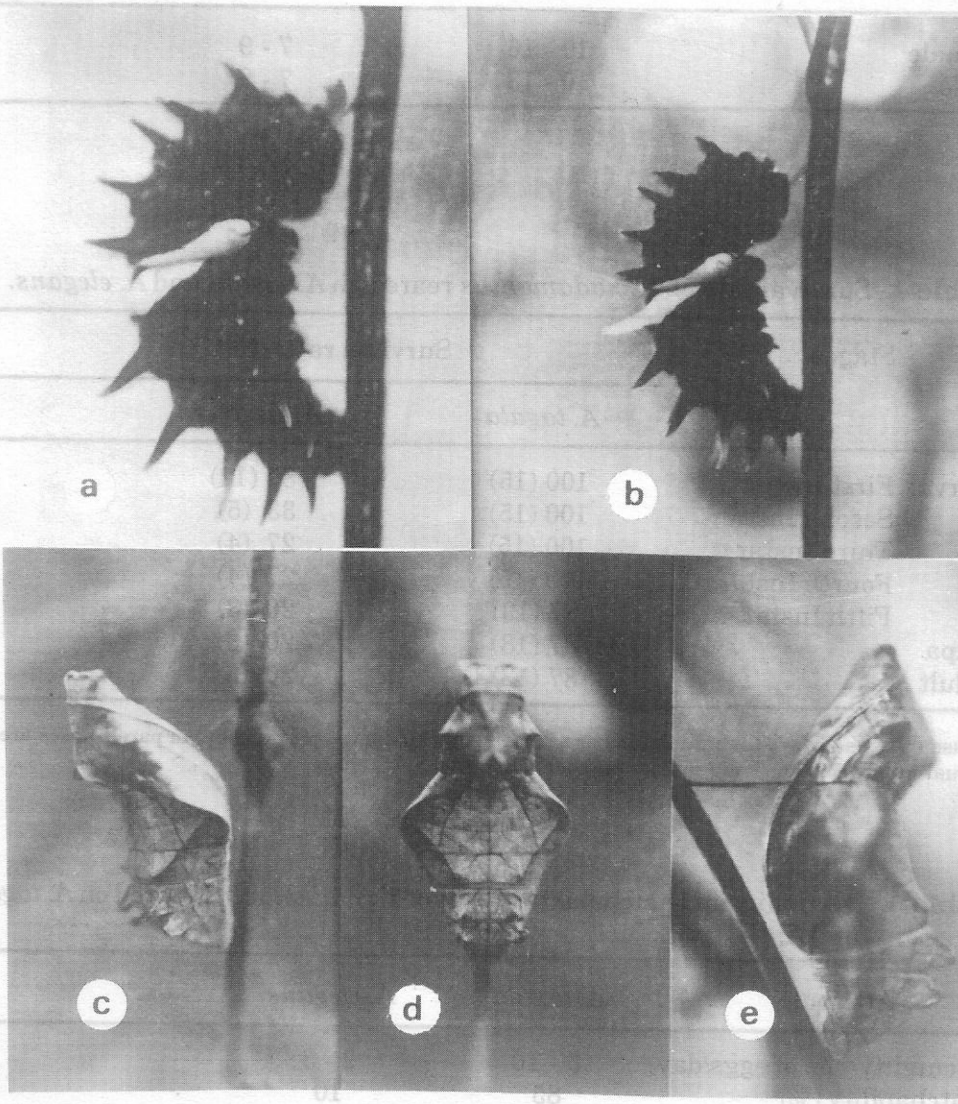

Figure 3. Pre-pupae (a, b) (a) early prepupa when disturbed; (b) prepupa about to molt; and pupae (c-e) of *T. rhadamantus* reared on *A. tagala:* (c) dorso-lateral view; (d) dorsal view, (e) ventro-lateral view.

Table 3. Wing expanse of *T. rhadamantus* reared on *A. tagala* and *A. elegans.*

Sex	Wing expanse (cm)	
	A. tagala	*A. elegans*
Female	10 - 16	7 - 9
Male	10 - 13	7 - 9

Table 4. Survival rate of *T. rhadamantus* reared on *A. tagala* and *A. elegans.*

Stages		Survival rate (%) [a]	
		A. tagala	*A. elegans*
Larva:	First Instar	100 (15)	80 (12)
	Second Instar	100 (15)	33 (5)
	Third Instar	100 (15)	27 (4)
	Fourth Instar	100 (15)	27 (4)
	Fifth Instar	87 (13)	20 (3)
Pupa		87 (13)	20 (3)
Adult		87 (13)	20 (3)

[a] base value is always the initial number of first instar larvae i.e. 15; numbers in parentheses are the actual number of surviving insects for each stage.

Table 5. Fecundity and hatchability of eggs of *T. rhadamantus* reared on *A. tagala* and *A. elegans.*

Attribute	*A. tagala*	*A. elegans*
Fecundity (no. of eggs/day)[a]	5 - 10	2 - 3
Hatchability (%)[b]	85	10

[a]based on 15 individuals; [b]based on 30 eggs

resulting to abnormal pupae. Consequently, abnormal pupae either failed to emerge into adults or if ever they did, the emerging butterflies were deformed, many of them with twisted wings (Figure 4). *A. elegans* also reduced fecundity, hatchability and longevity of *T. rhadamantus* as shown in Table 5.

As expected, larvae fed with *A. tagala,* the natural host plant, underwent normal growth and development. Adults emerging from the pupae were normal and there were no twisted-winged ones (Figure 5). In general, the growth inhibitory and toxic effects of *A. elegans* can be attributed to the presumed greater amount of aristolochic acid in this introduced *Aristolochia* species. Therefore, only the native plant species, *A. tagala,* should be used if ever mass rearing or captive breeding of this beautiful butterfly would be done for experimental, aesthetic and/or possibly conservation purposes. As an insight, the decimation of the populations of the Richmond butterfly, *Ornithoptera richmondi,* in Australia, has been attributed not only to the destruction of its forest habitat but also to the presence of the introduced *A. elegans* (Sands & Scott, 1997). The butterfly is lured by the strong odor of the latter and are stimulated to lay eggs on its leaves. However, when the larvae hatch and start to feed, they are poisoned by the plant's toxic compound. Sands & Scott (1997) added further that "the Dutchman's Pipe is also responsible for poisoning the caterpillars of the Cairns birdwing *(Ornithoptera euphorion)* as well as other aristolochia-feeding butterflies in northern Queensland."

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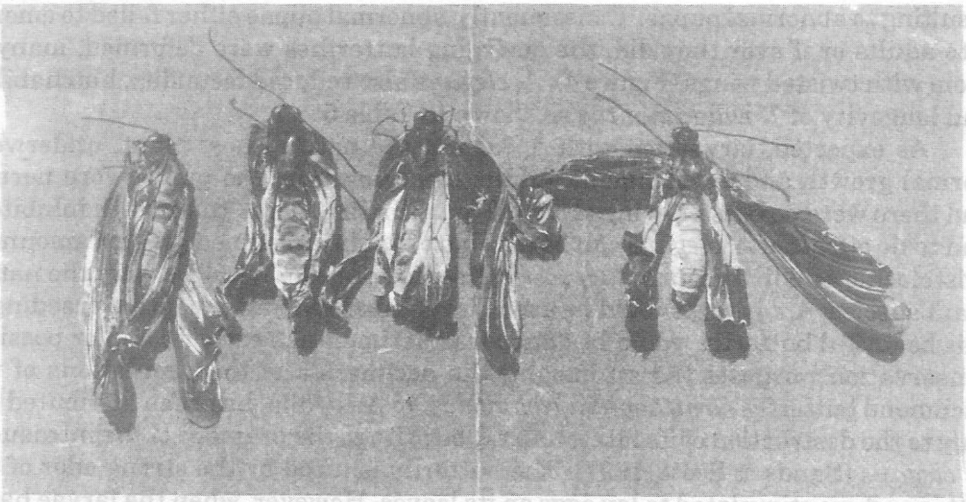

Figure 4. Abnormal adults of *T. rhadamantus* emerging from pupae reared on *A. elegans.*

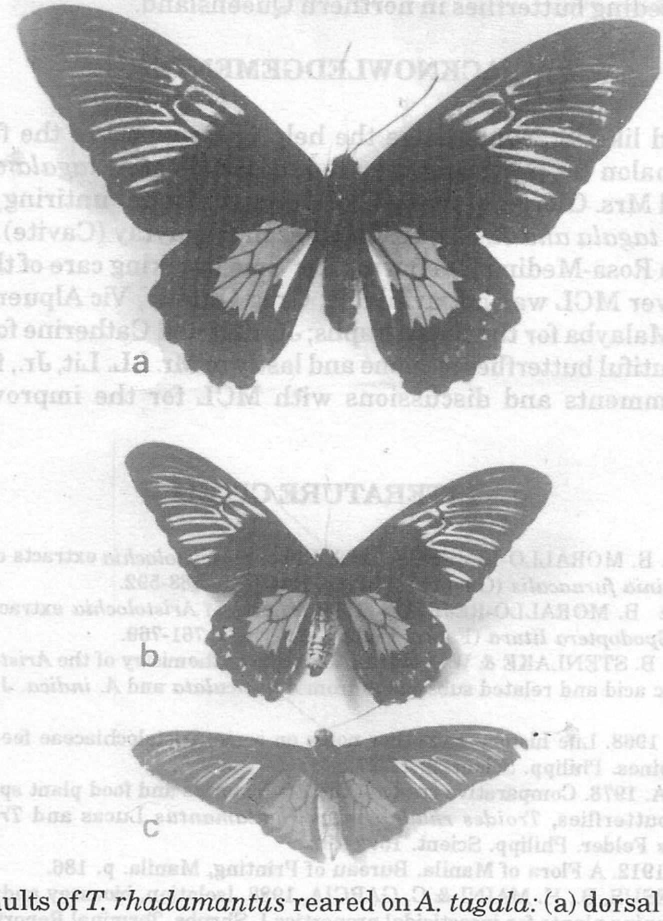

Figure 5. Adults of *T. rhadamantus* reared on *A. tagala:* (a) dorsal view of female, (b) ventral view of female, (c) ventral view of male.

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