

Habits, Palatability and Mimicry in Thirteen Ctenuchid Moth Species from Trinidad, B.W.I.¹

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(Plates I & II)

[This paper is one of a series emanating from the tropical Field Station of the New York Zoological Society, at Simla, Arima Valley, Trinidad, British West Indies. The Station was founded in 1950 by the Zoological Society's Department of Tropical Research, under the direction of Dr. William Beebe. It comprises 200 acres in the middle of the Northern Range, which includes large stretches of undisturbed government forest reserves. The laboratory of the Station is intended for research in tropical ecology and in animal behavior. The altitude of the research area is 500 to 1,800 feet, with an annual rainfall of more than 100 inches.

[For further ecological details of meteorology and biotic zones see "Introduction to the Ecology of the Arima Valley, Trinidad, B. W. I.," William Beebe. (Zoologica, 1952, Vol. 37, No. 13, pp. 157-184.)]

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I. INTRODUCTION

THE highly specialized moths of the family known as the Ctenuchidae (Syntomidae, Amatidae, Euchromiidae) are among the most interesting and colorful of the Lepidoptera. In general, they are medium to small in size; many are brightly colored, some with metallic luster on wings and abdomen. More than 2,000 species are known, the great majority being restricted to the American tropics. Although they are commonly referred to as "day-flying" moths, many species fly also, or even exclusively, at night. Some species "mimic" other insects, and the larvae of some show remarkable adaptations (see especially Beebe, 1953).

The taxonomy of this group in Trinidad has been discussed by Kaye & Lamont (1927) and Fleming (1957), but relatively few observations have been reported on these moths in life: flight pattern, position at rest, frequency, time of flight and seasonal occurrence. Also, although it is well known that this family includes species which are obvious wasp and beetle "mimics," little experimental work has been done on the palatability of these moths to possible predators.

For this paper field observations and palatability tests were limited to 13 of the more than 80 species so far recorded in Trinidad. The choice of species was based on the following criteria: most are relatively common, therefore more readily available for observation and collection; they include both day- and night-flying species; they include genera from the most high-

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ly specialized (*Pseudosphex*) to the most generalized (*Eucereon*, *Ctenucha*); they include species which show great differences in wing scaling, i.e., completely hyaline (*Pseudosphex*), completely scaled and having bright patches of color (*Histiaria*), cryptic fuscous (*Episcepsis*) and metallic lustrous (*Macrocneme*); some species which are obvious "mimics" are included, and some which are drawn to *Heliotropium indicum* and others which apparently are not attracted to it.

This attractant is reported in detail by Beebe (1955 and refs.) but a brief summary is pertinent here. *Heliotropium indicum* Linnaeus is a common weed which, when uprooted and allowed to shrivel, exercises a remarkable selective attraction for several lepidopteran families including the Ctenuchidae. For some unknown reason, however, only certain species appear to be attracted to it, while other species common in the same locality ignore it completely.

The authors are indebted to Mr. Henry Fleming for identification and range of the ctenuchid species used in this study.

II. MATERIAL AND METHODS

Nearly all observations and collections were made within a radius of approximately a quarter of a mile from the Simla field station, the majority within 100 yards of the laboratory. At night they were made at several incandescent electric light bulbs outdoors and at a spotlighted sheet, by day along trails, roadside or in the laboratory itself where a large screened window trapped many of the day-flyers which entered at an open end of the room. *H. indicum* was used both night and day as a collecting and observing site. The best results were had with this attractant when a clump of the weed was suspended from a low tree branch along a shaded trace.

Abundance records used in this paper were kept during the three-year period 1953-1955 but cover only the months of December to June, the extreme limits of our stay at the field station.

Rest position was usually observed on a captured uninjured moth placed in a large glass jar or terrarium. Most flight observations were made on free-flying moths at night lights or at *H. indicum*, or inside a screened insectary measuring 12 × 18 feet.

As shown in Table 1, the relative acceptability of moths to various vertebrates and invertebrates was tested. In experiments with ants, the ctenuchids were either freshly dead or completely incapacitated. No chemicals were used for killing. With all the other testers, living active specimens

were used. There is an occasional record of a mantid or a spider capturing a ctenuchid in the field, but all experiments with bird, lizards, frog, tarantula and with most mantids were done with the testers in captivity. The *Polychrus* lizard and the bird, a Moriche Oriole, were tamed specimens which readily accepted food held by forceps in the hand.

In each test, with the exceptions just mentioned, an active moth was placed in the terrarium or cage with the tester and the response of the latter was noted. Each test was controlled, i.e., a negative result was listed only if another lepidopteran specimen, usually a pyralid moth or a riodinid butterfly of comparable size, was accepted immediately afterwards.

The results of the tests were classified as follows:

A—Moth eaten entirely (with occasionally the obvious exception of wings or genitalia).

B—Moth eaten partially or with apparent distaste, i.e., mouthed (by bird or mantid), sucked for short time (spider), partially eaten only (ants, mantid, bird), or eaten with apparent distaste (frog).

C—Moth originally noticed (antennae or dragged by ants, seized by mantid, spider, frog, lizard or bird) but eventually released without being injured.

D—Moth ignored completely or fled from.

The numeral following each of the above classifications in Table 1 indicates the number of tests performed with that result.

III. OBSERVATION AND RESULTS

Pseudosphex kenedyae Fleming
(Plate I, Figure 1; Plate II, Figure 14)

Range.—Trinidad.

Field Name.—Dusky-winged Wasp-mimic.

Field Characters.—Thorax yellow with dark brown markings; abdomen yellow banded with brown, constricted at base; wings hyaline with fuscous streak along costal margin of forewing. In flight, cannot be distinguished from another Trinidad ctenuchid, *Sphecosoma trinitatis* Rothschild, nor from its vespid wasp "models" (see below). Sexes differ by presence of ventral valve in ♂.

Frequency.—This species was not seen by us until dead *Heliotropium indicum* was used as an attractant. Since then it has been very common on the weed. The attraction is almost limited to ♂♂, as out of 114 individuals seen or taken, only one was ♀.

Active Period.—One of the most decidedly

TABLE 1. PALATABILITY OF CTENUCHID MOTHS

Explanation: A—eaten completely
B—eaten partially or with distaste
C—uneaten, but originally noticed
D—ignored

The numeral following each of the above categories indicates the number of tests performed.
For further details, see "Material and Methods."

Palatability Testers		Species of Ctenuchid Moth												
		<i>Pseudosphex kenedyae</i>	<i>Saurita clusia</i>	<i>Histiace cepheus</i>	<i>Macrocneme thyra intacta</i>	<i>Calonotos craneae</i>	<i>Aethria carnicauda</i>	<i>Episcepsis hypoleuca</i>	<i>Napata walkeri</i>	<i>Agyrta dux</i>	<i>Eucereon maia</i>	<i>Eucereon obscurum</i>	<i>Correbidia assimilis</i>	<i>Ctenucha andrei</i>
Ants	<i>Monomorium floricola</i>	C1, D2	B1, D3	D1	D11	B2, D2	A1, B4, D3 C1	B2, D1		A2	B5	B1	B1, D2	A1, D2
	<i>Eciton vagans</i>	C1, D2	A2	C2, D1	D1		D7	A1, B1, D5	A1	B1	A2, D5		B1, D1	B1, D1
	<i>Dolichoderus bispinosus</i>	D5		B2, C4, D2	D2								A1	A2, B2, D1
Mantids	<i>Stagmatoptera septentrionalis</i>			B1, D2	C2, D2			A1					D1	
	<i>Vates lobata</i>		A2	B1	A1, B1, C1	A1						A1	A1	A1
	<i>Acanthops falcata</i>		A2		A1								A1, B1	
	<i>Oryopsis rubicunda</i>		A1	B1	A4, B2	A2		A1				A1	A1	
	<i>Stagmomantis carolina</i>				B1							B1		
Spiders	<i>Thesprotia filum</i>													
	<i>Tarantula Epeirid</i>		B1, C1	C2, D2	B1, C4 D2	C1					A1 A2		A1	A2
Frog	<i>Hyla maxima</i>		A1, B2	A1, D1	A2, C1, D3	C1, D1		A1, C1			A2, B1, C4, D1	A1	A1	A1
Lizards	<i>Polychrus marmoratus</i>	D1		A1, C5, D4	A2, D1 D2			D1					A4, D1	A4
Bird	<i>Thecadactylus rapicaudus</i>													
	<i>Icterus chrysoccephalus</i>	C5, D5	D2	B1	D5	D1	D1	C1, D2		C2	A1, B2	B1, C4	C1, D3	C2, D4
Totals, Degree of Palatability		C7, D15	A8, B4 C1, D5	A2, B6 C13, D13	A10, B5 C8, D29	A3, B2 C2, D4	A1, B4 C1, D11	A4, B3 C2, D9	A1	A2, B1 C2	A8, B8 C4, D6	A3, B3 C4	A10, B3 C1, D7	A11, B3 C2, D8
Total Tests Made		22	18	34	52	11	17	18	1	5	26	10	21	24

diurnal of the ctenuchids, flying, often with its model, from early morning (6:00 to 6:15 A.M.) to nearly dusk. In a terrarium it is invariably positively phototropic. Observed every month from December to June.

Rest Position.—Wings 75° back, at times vertical. When walking, wings 45° back, 45° up. Antennae in constant motion, often alternately. When pausing between steps, the abdomen is frequently twitched up and down several times.

Flight.—Quick, jerky darts, wholly wasplike; sometimes remains suspended before landing, motionless except for the wings, the hindlegs extended downward and slightly backward. It has been seen to alight directly on the underside of a leaf without any hesitation and without alighting on the upperside first.

Palatability.—(Table 1). In every one of the 22 tests made, this species proved to be unacceptable to lizard, bird and three species of ants. In 15 tests the moth was ignored completely; in only seven cases was it approached or noticed. Army ants dragged a living moth by one leg for a few seconds before releasing it, uninjured. In another instance, ants approached a freshly dead specimen, touched it with their antennae for a short time but ignored it thereafter. In five tests the tame Moriche Oriole started to approach a living moth but backed away almost immediately; in one case it pecked at the forceps but not at the insect held by it. In five other tests with the same bird the moth was ignored completely.

Mimicry.—There exists a remarkably exact resemblance between this day-flying moth and several of the common Simla wasps. In our first search for this mimicry we captured seven of the wasps and a single ctenuchid. The latter was resting head down on a dry leaf of *Heliotropium indicum*, while the former were either flying or resting on leaves or inside the laboratory. This particular hymenopteran was *Stelopolybia pallipes* var. *anceps* (Saussure).

The two field characters by which the "model" and "mimic" may best be distinguished are the head, that of the wasp being wider and bearing a pair of jaws rather than a proboscis, and secondly, the antennae. The solidity of the antennae in the case of the wasp or the pectination in the case of the moth is made more difficult for differentiation by the fact that in the moth the pectination comes to an abrupt ending about two-thirds from the base, the distal end being reduced to a slender, easily overlooked filament.

Other insects bearing a close resemblance to this moth are *Oriodes* in Syrphidae and one of the Stratiomyidae, both dipterans.

The force of the mimicry is enhanced by the following characters: *Size*: In total length the wasp is 12 mm., the moth 10 mm. *Shape*: The abdomen of the moth is proximally constricted to a most unmothlike degree. *Color and Pattern*: Basic amber color the same, also the thoracic and abdominal pattern. *Antennae*: Nervous twiddling. *Walk and Flight*: Character, speed and details of manoeuvrability similar in moth and wasp. When the moth is feeding, its abdomen is lifted into a curve and occasionally raised and lowered, emphasizing the wasplike shape and pattern. *Wings*: As in the wasp, the wings are held 45° up and out, and the costal area is darker than the remainder of the forewing. Another remarkable wing character was noted by Kaye (1913) in *Pseudosphex* spp. He observed that they "curve the forewing while the hindwing is folded up, so that the wings appear to be as narrow as the completely folded wings of the Vespidae and Eumenidae." This character applies also to the Trinidad species, and is shown to some extent in Plate II, figure 14.

On the whole, the present species of ctenuchid appears to offer an almost perfect example of Müllerian mimicry: the moth is definitely distasteful, and its extremely close hymenopteran counterpart possesses an efficient sting.

Saurita clusia (Druce)

(Plate I, Figure 2)

Range.—French Guiana and the Amazon Region.

Field Name.—Black-tipped Whitewing.

Field Characters.—Wings yellowish-white, dusky at base with large apical spot. Five red spots, paired on shoulders and collar and one at base of dorsal abdomen. Hindwings short and rounded. ♀♀ with more extensive black scaling at apex and base of forewing and antennae less heavily pectinated, almost threadlike.

Frequency.—One of the most common species at Simla, but of the 156 individuals seen or taken, only five have been ♀♀.

Active Period.—Strictly nocturnal. Taken every month, December to June.

Rest Position.—Wings 60° back, flat, tips clear of surface. When walking the wings are raised 45° and held well apart. Thorax and narrow anterior segment of abdomen exposed, revealing the five scarlet spots. Antennae 45° apart.

Flight.—At first, forewings are waved slowly, then all four are whirled, before taking off. Flight is flylike, usually more or less straight upward, the insect finally alighting and walking at once. When liberated from a hand-held con-

tainer in an insectary, the moth seeks shelter beneath fingers or in a dark crevice in the rafters, as if to avoid the light. Twice found resting beneath a leaf.

Palatability.—(Table 1). This species appears to be acceptable to mantids, moderately so to spider and frog. A specimen was seized by a tarantula but immediately released; later the same specimen was captured and the abdomen sucked for several minutes, but it was eventually released alive and able to walk. Two specimens were eaten by frog with apparent distaste. Two were refused by Moriche Oriole. But as the moth is strictly nocturnal, these negative results with the bird appear to have little or no survival value.

Mimicry.—No definite models have been observed in association with this species. It is flylike in many respects but is strictly nocturnal.

Histiaceae cepheus (Cramer)

(Plate I, Figure 3)

Range.—Venezuela to Surinam.

Field Name.—Large Red-and-yellow-spotted Brown.

Field Characters.—Large (expanse $2\frac{1}{2}$ inches), dark brown; forewings with three buffy yellow spots, hindwings with two large, irregular, scarlet spots; basal segments of dorsum with three incomplete yellow bands. Sexes very similar; abdomen of ♀ slightly broader.

Frequency.—Common. Of 81 moths seen or taken, two-thirds were ♂♂.

Active Period.—Strictly nocturnal, usually taken at lights before 10 P. M. Twelve imagoes, reared from larvae (Kenedy, unpub.), were placed in an insectary for observation. They were inactive during the day, usually resting, singly, beneath a large leaf. From 6:00 to 6:30 P.M. they began to be active, flying and walking on the screening of the roof. Seen or taken all months, December to June.

Rest Position.—Wings 50° back, tips not touching surface. Abdominal bands exposed. The moth has often been observed to wave its wings up and down, through a rather large arc, when standing still or walking, or to whirr its wings rapidly.

Flight.—In an insectary, it took off with moth-like flight, the slow beat of the wings rendering them visible. Liberated in the open, it rose swiftly and smoothly, circled twice in mid-air, then flew straight over the valley.

Palatability.—(Table 1). Thirty-four tests were completed, 26 of which demonstrated that this species could be considered unpalatable. A rather unique phenomenon has been observed

in this species. When a specimen is immobilized suddenly, whether captured by a caged tester such as a mantid or held by observer, it has been seen in many cases to exude droplets of thick yellow fluid from the thorax. Sometimes the droplets are bubbly and almost completely cover the dorsal thorax. This seems to serve as an effective defense against at least some predators. In two cases mantids bit into the dorsum but dropped the moth when the yellow froth came in contact with their eyes and mouthparts; a lizard five times threw a captured but uninjured insect from its mouth with violent shaking of its head. In the single test with the Moriche Oriole it ate the interior of the thorax and abdomen, leaving the head, genitalia and entire exoskeleton. In this case, no drops of fluid were observed on the insect's thorax. A tarantula ignored two specimens, and captured but immediately released two others undamaged.

Macrocneme thyra intacta Draudt

(Plate I, Figure 4; Plate II, Figure 15)

Range.—Trinidad and Colombia.

Field Name.—White-bellied Greenwing.

Field Characters.—Wings black, basal half with metallic blue-green sheen; dorsal base of abdomen with four white spots; hind tarsi white tipped; ♂ white below on thorax and abdomen, ♀ venter with white spots.

Frequency.—Abundant. ♂♂ dominate in number: of 326 seen or taken, only 10 were ♀♀.

Active Period.—Chiefly night flyers. Of 326 individuals, 14 (nine ♂♂, five ♀♀) were netted by day. Seen or taken every month, December to June.

Rest Position.—Wings 20° back, flat, the forewings overlapping the hindwings so that the latter are invisible. Antennae 45° apart. When walking, movements are nervous and jerky, wasplike; wings held up and back 30° to 45° ; antennae in motion.

Flight.—Wasplike, direct. The long hindlegs are held down and backward in flight. When several captured ♂♂ were released they spiralled upward fairly slowly or circled several times before flying away. Half of the total ♀♀ collected were netted while they were flying slowly along roadside or near stream, in bright sunshine.

Palatability.—(Table 1). Fifty-two tests were made with this species. In 29 the moths were ignored completely and in eight they were originally noticed but uneaten. In five tests with the Moriche Oriole, the bird would not approach the insect; in one case the bird appeared to jump agitatedly around its cage during the several

minutes the moth was crawling inside. Ants ignored freshly dead specimens in all 14 tests. Mantids, however, ate 75 per cent. of the specimens offered to them, and frog and *Polychrus* lizard occasionally accepted the moths.

Mimicry.—As noted by Kaye (1913), members of the genus *Macrocneme* seem to be excellent mimics of fossorial or pompilid wasps, especially the genera *Salius* and *Pepsis*. *M. thyra intacta* is wasplike both in facies and in behavior. The wings and abdomen possess a metallic blue-green sheen; the long hindlegs, more heavily scaled than is usual in ctenuchids, are extended downward and backward in flight. Kaye also noted that they wave their antennae and vibrate their wings rapidly when alighted, and that they settle usually, like fossorial wasps, on ground, bank or leaf.

Calonotos craneae Fleming
(Plate I, Figure 5)

Range.—Trinidad.

Field Name.—White-spotted Green-stripe.

Field Characters.—Wings black, with two or three white spots on forewing (♂♂ have two and sometimes a smaller third; ♀♀ have three); a single spot on hindwing; abdomen black with three longitudinal, iridescent, pale green stripes.

Frequency.—Common, 78 having been recorded or collected, with ♀♀ slightly outnumbering ♂♂.

Active Period.—This species has been taken at Simla only at night lights, chiefly before 10 P.M. However, one specimen was captured by Fleming in central Trinidad in daytime, in palm and immortelle forest. Have been taken December to June, with March, April and May the time of heaviest flight.

Rest Position.—Wings 50° back, 30° raised. Hindwings concealed. Black abdomen exposed, showing conspicuous streaking of iridescent green. Antennae 45° up and out.

Flight.—Relatively slow, direct. On one occasion at night light a moth was seen to "play dead" when taken.

Palatability.—(Table 1). Specimens refused or rejected by bird, frog and tarantula. Ants ate interior of two moths, ignored two others. Eaten by mantids.

Aethria carnicauda (Butler)
(Plate I, Figure 6)

Range.—Venezuela and Brazil.

Field Name.—Red-tailed Clearwing.

Field Characters.—Black with red-tipped abdomen; wings hyaline with margins and veins

black. ♂♂ with palpi, shoulder spot, forecoxae and ventral base of abdomen white; ♀♀ lack white. This species may be mistaken for *Dinia mena* (Hübner) but the latter has the scarlet abdominal fringe extended well up the sides.

Frequency.—A common species; 66 were observed or collected; ♀♀ slightly outnumbered ♂♂.

Active Period.—Confined to daylight, from 8:30 A.M. to 4:30 P.M. Observed from December to June. The moths are more numerous at the end of the dry season, in March and April.

Rest Position.—Wings 60° back, flat, inner edges not quite touching. In walking the wings are raised 40°, spread so that the hindwings are exposed; wings in slight but constant motion. When the moth is walking about on the attractant *H. indicum* the antennae are constantly in play, tapping the surface.

Flight.—Apparently more swift and direct than is usual in the group. A moth liberated five times in an insectary flew straight upward toward the light.

Palatability.—(Table 1). This species was tested with ants and bird only. Refused in single test with Moriche Oriole; ants ate five of 16 specimens.

Episcepsis hypoleuca Hampson
(Plate I, Figure 7)

Range.—Central America.

Field Name.—Red-collared Brownwing.

Field Characters.—Wings unicolored snuff brown; forecoxae red; dorsal abdomen metallic blue. ♂♂ with white at base of ventral abdomen.

Frequency.—Common. Total recorded 128, of which 82 were ♂♂, 34 ♀♀ and 12 undetermined.

Active Period.—Chiefly nocturnal, both at lights and *H. indicum*. Approximately 20 per cent. were taken in the daytime; the sex ratio remained constant. Seen December to May, with heaviest flight in December and January.

Rest Position.—Wings 70° back, not touching surface, overlapping at anal angle, meeting medially.

Flight.—Slow, slightly wavering until full speed is attained, then direct, not very rapid. Fairly sluggish on *H. indicum*, crawling slowly in and out of dried branches, sometimes dropping instead of flying off when approached.

Palatability.—(Table 1). Refused or rejected by bird in three tests, by house gecko in a single test; frog ate one, rejected another; eaten by mantids; ants ate four, ignored six.

Napata walkeri (Druce)
(Plate I, Figure 8; Plate II, Figure 16)

Range.—Mexico, Central America.

Field Name.—Barred-tip Yellow.

Field Characters.—Wings orange-yellow; apex of forewings white barred with black; palpi, legs and ventral surface black and white. Sexes indistinguishable in the field.

Frequency.—Taken occasionally at Simla. Of a total of 25 specimens, 22 were ♂♂, three ♀♀.

Active Period.—Nocturnal. Taken from December to June, with the exception of May.

Rest Position.—Wings 70° back, just meeting at midline over dorsum; tips not touching surface.

Flight.—Wavering and not rapid. At end of flight may seek shelter under leaf.

Palatability.—Because of the comparative rarity of this species, only one specimen was tested, and that inadvertently. It was a rare ♀ which was being kept in captivity in the hope of obtaining eggs. When freshly dead, ants swarmed over it and ate it before it could be salvaged for the collection.

Mimicry.—This orange-yellow ctenuchid is quite unlike other members of its family, but there are several species of other families which in color and pattern might be considered as models. Among these are the riodinid butterfly, *Mesene semiradiata*, and the zygaenid moth, *Malthaca radialis*. A pyralid moth, *Mapeta xanthomelas*, fulfills all the demands in numbers and appearance of a model, although it is a day-flying species. At rest the ctenuchid and the pyralid are remarkably similar, and not until one is close enough to see the backward angle of the antennae and the prominent palpi of the pyralid can they be distinguished (see Plate II, fig. 17). In flight, however, the barred hindwings of the pyralid are quite visible; the ctenuchid lacks these markings.

Two of the pyralids were tested for palatability with ants and were eaten except for the shell of the thorax. However, two specimens were ignored by the Moriche Oriole.

Agyrta dux (Walker)

(Plate I, Figure 9)

Range.—Central America to Venezuela and Brazil; St. Lucia.

Field Name.—Six-windowed Black.

Field Characters.—Relatively large moth, black shot with blue; wings with six large, irregular hyaline areas, two in forewing, one in hindwing, crossed by black veins; wing bases, thorax and abdomen iridescent blue; palpal base and tongue scarlet; narrow dorsal abdominal

streak and venter white. Sexes similar except for slightly shorter antennal pectinations in ♀. Differs from closely related *A. micilia* by hyaline forewing area arising near base.

Frequency.—Occasionally recorded at Simla. A total of 23 consisted of 19 ♂♂, three ♀♀ and one undetermined.

Active Period.—Exclusively diurnal, taken from early morning to late afternoon, with the majority seen in late afternoon. December and January have been the best months for recording this species, but they have also been taken in March, April and May.

Rest Position.—Wings 20° to 40° back, meeting over back. When walking, wings are waved through a 45° arc; antennae in constant motion, moving in unison.

Flight.—Fairly rapid, darting, low, circling before alighting. It was seen to alight on dead *H. indicum* three times at the same spot. At once it began to search eagerly with its tongue, within a small area. After feeding on a panicle it literally ran through the dense, dry foliage, its wings rubbing against the leaves in the narrow places. Its speed was remarkable in the deeper interstices. The wing iridescence and the deep red collar and tongue could be plainly seen when the rest of the insect was invisible.

Palatability.—(Table 1). This species is apparently palatable to ants. A small ponerine ant was once seen carrying off a ♀ specimen, holding it at the tip of the abdomen. The insect was rescued, but died. The Moriche Oriole twice picked up a specimen hesitantly, but dropped it without injury.

Mimicry.—An unidentified geometrid moth is a close model for the species except for its smaller size, spreading only 28 mm. whereas *A. dux* extends 40 mm. between wingtips. The rest position of the geometrid is similar to that of the ctenuchid and it also is a day-flyer. Both in facies and flight, *A. dux* appears more butterfly-like than is usual in the group.

Eucereon maia Druce

(Plate I, Figure 10)

Range.—Mexico, Central America, Venezuela, British Guiana.

Field Name.—Red-bodied Brown.

Field Characters.—Thorax and forewings light brown, mottled with darker; hindwings pale; abdomen red above, dotted with black, whitish below. Forewings of ♀ paler.

Frequency.—♂♂ of this species are abundant. Total of 260 seen or taken consisted of 196 ♂♂, 12 ♀♀ and 52 undetermined.

Active Period.—Nocturnal, flying throughout the night, appearing at dusk and seen also at dawn with records every hour to 3 A.M. The peak of the flight seems to be 10:30 to 11:30 P.M. In an insectary the moth is negatively phototropic. Recorded every month from December to June, with December and January the months of heaviest flight.

Rest Position.—Wings 70° back, overlapping, completely covering abdomen.

Flight.—Rapid and direct, occasionally circling once or twice. When disturbed, the moth often drops to the ground, beetlelike, before taking flight. Or it may crawl along the ground instead of flying, sometimes hiding under a low-growing leaf. The habit of dropping is so usual that a specimen can almost always be collected merely by placing the open end of a vial beneath it.

Palatability.—(Table 1). Ants ate seven specimens, ignored five; spiders sucked three; one was captured and eaten by a centipede on *H. indicum*. In majority of tests the frog captured but spit out this species. The Moriche Oriole ate one, ran two others through its bill, then flicked them away, injured.

Eucereon obscurum (Möschler)

(Plate I, Figure 11)

Range.—Mexico and Central America south to the Amazon.

Field Name.—Blue-spangled Bronzewing.

Field Characters.—Abdomen black, the terminal segments shot with blue; forewings bronze-black, faintly spangled and lined with bluish-white; hindwings semi-hyaline, pale brown. Sexes indistinguishable in the field.

Frequency.—A common species. Of 87 specimens 58 were ♂♂, 10 ♀♀ and 19 undetermined.

Active Period.—Exclusively nocturnal, like others of the genus. It first appears in early evening and has been found as late as 3:30 A.M. Has been taken from December to June, with the heaviest flight in December and February.

Rest Position.—Wings 80° back, almost parallel; inner edges overlapping, concealing body; tips resting on surface.

Flight.—A rapid fluttering, but rather slow flight. The moth circles slowly, hovers before alighting. When released in insectary, it invariably flew to the ground and hid among grass.

Palatability.—(Table 1). Eaten by ants, mantids and frog; Moriche Oriole ate head and thorax of one, seized four others but dropped them immediately.

Correbidia assimilis (Rothschild)

(Plate I, Figure 12; Plate II, Figures 18, 19)

Range.—Venezuela, British Guiana, Surinam, Brazil.

Field Name.—Yellow-banded Beetle Mimic.

Field Characters.—Small moth. Wings black, crossed in center by a wide, pale yellow band. Sexes indistinguishable in the field except by slightly shorter antennal pectinations in ♀.

Frequency.—The most abundant ctenuchid at Simla. Total recorded 337, of which 205 were ♂♂, 30 ♀♀ and 102 undetermined.

Active Period.—More than 95 per cent. were seen or taken at night, being drawn chiefly to lights but also to uprooted *H. indicum*. Occasionally taken during the day and then usually in the early morning or late afternoon, within two hours of dawn and dusk. Seen from December to May. The numbers drop off in April and May.

Rest Position.—Wings 80° back, outline curved, overlapping medially, only thorax exposed. In this position the light yellow midwing markings form a continuous transverse band. Antennae 45° forward and out, tips slightly curved. When walking the moth waves its antennae alternately up and down. This species appears to be unusually lethargic and slow to take flight.

Flight.—Slow and fluttering.

Palatability.—(Table 1). Ants ate three specimens, ignored two; eaten by mantids, spider, frog and lizard; Moriche Oriole ignored three, approached one hesitantly but would not take it.

Mimicry.—Several authors, especially Kaye (1913), have commented on the remarkable resemblance that exists between members of this genus and lycid beetles, such as the genus *Lycomorpha* in North America. Lycid beetles are general in the Neotropics and are known to be protected (Forbes, 1930, p. 27). There are three Simla insects which might be considered as models for *C. assimilis*: a small arctiid moth, *Lycomorphodes aracia*, and two lycid beetles, a smaller and a larger species (Plate II, figs. 18, 19). The arctiid and the smaller beetle are nocturnal, the larger beetle is a day-flyer.

The smaller lycid is common and frequently found associated with the ctenuchid. The larger beetle and *C. assimilis* are similar in color and pattern and in their slow, lethargic movements. They also resemble one another in appearance and movements of the antennae, and in the mutual habit of slowly lifting and lowering the forewings (elytra in the case of the beetle) as

they walk. The average in both is seven waves in five seconds.

During the same length of time 54 arctiids, 37 lycids and 130 specimens of the ctenuchid were recorded.

Kaye (1913) made several interesting observations on mimicry in *Correbidia* which we have also noted in *C. assimilis* in Trinidad: they are sluggish in the early morning and, beetlelike, drop to the ground when disturbed, drawing their legs in; the shape and color of wings are like a lycid beetle. To heighten the deception, the abdomen of the moth is slightly flattened, the legs are short and the heavy pectinations of the antennae are carried to the tip.

To check palatability, the two beetles and the arctiid were tested with ants. Three specimens of the arctiid were eaten; one large and two small beetles were untouched.

Ctenucha andrei Rothschild

(Plate I, Figure 13)

Range.—Has been recorded also from British Guiana.

Field Name.—Large White-banded Black.

Field Characters.—A good-sized moth; forewings blue-black with broad, oblique, white band; hindwings steel blue. ♂♂ with white on venter, ♀♀ black.

Frequency.—♂♂ common, ♀♀ rare. Of 89 specimens, 63 were ♂♂, 2 ♀♀ and 24 undetermined.

Active Period.—A diurnal species, flying at any hour of the day from dawn to dusk. A single exception was a ♂ taken at the night light in early evening. Observed from December to June.

Rest Position.—Wings 60° back, meeting over dorsum; white bands on forewings not meeting. When walking the moth waves its wings slowly through a 45° arc. Antennae 70° forward, 20° apart.

Flight.—Rather slow and fluttering. In flight the wings become a black haze, with curved ring of white above and below. Wings move through an arc of 130°.

Palatability.—(Table 1). This species was eaten by mantid, tarantula, frog and lizard. In 60 per cent. of the tests with ants the moth was eaten. Army ants ignored one specimen, killed but did not eat another. In two tests the Moriche Oriole took the moth but dropped it immediately; it ignored four others.

Mimicry.—The most reasonable "model" for this species is *Cecropterus bipunctatus* (Hesperiidae). In abundance, pattern and color, general motions and habitat this approximates the

ctenuchid. However, this skipper was found to be acceptable to the Moriche Oriole.

IV. DISCUSSION

Table 2 is a recapitulation of data, most of which are already given in the text under individual species, with the addition of positive or negative results with the use of *Heliotropium indicum* as an attractant. These results bring out several interesting problems: although the attraction of the weed is highly selective, being almost exclusively limited in the Heterocera to the family Ctenuchidae, yet some of the most common Trinidad ctenuchids, such as *Macrocne thyra intacta*, have never been found on it. *Pseudosphex kenedyae* is a common visitor to *H. indicum*, but it has not been seen elsewhere nor had we ever seen a specimen before using the attractant. Other ctenuchids are common both at lights and on the weed, such as *Correbidia assimilis* and *Eucereon maia*; however, another member of the same genus, *E. obscurum*, is fairly common at lights but extremely rare on *H. indicum*.

Frequency.—The species are listed in order of abundance in Table 2. The sex ratio of 11 species shows a predominance of males. However, females slightly outnumber males in *Calonotos craneae* and *Aethria carnicauda*. As the latter flies by day and as the larval foodplant is a low-growing sedge (see Beebe, 1953) and as eggs are laid singly (Kenedy, unpub.), it is perhaps reasonable to suppose that ovipositing females would be seen and netted more often than males. But in the case of *C. craneae* all the females seen or taken at Simla were attracted to night lights.

Active Period.—Six species were found to be exclusively nocturnal and four exclusively diurnal; three species were active both by day and at night, although chiefly nocturnal.

Rest Position.—The backward angle of forewings at rest ranges among the 13 species from 20° in *Macrocne thyra intacta* to an almost parallel 80° in *Eucereon obscurum* and *Correbidia assimilis*. The wasp "mimics," *M. thyra intacta* and *Pseudosphex kenedyae*, hold their wings at a slightly upward angle when walking; the other species hold them either parallel to the surface or angled slightly downward so that the apex is almost touching the surface.

Flight.—There is great variation in habits of flight, from slow and wavering (*Correbidia assimilis*, *Episcepsis hypoleuca*) to rapid and direct (*Aethria carnicauda*, *Eucereon maia*).

Palatability and Mimicry.—In Table 1 the results of palatability tests show that the only

TABLE 2. FREQUENCY, ACTIVE PERIOD AND ATTRACTION TO *Heliotropium indicum*

Species are listed in order of abundance. Totals are for three-year period 1953-1955, principally during January to April. Extreme limits of observation and collection were December to June.

Species	Frequency				Active Period		Attraction to <i>H. indicum</i>
	Total Seen or Taken	Sex Ratio			%	%	
		% ♂ ♂	% ♀ ♀	% Un- determined			
					Diurnal	Nocturnal	
<i>Correbidia assimilis</i>	337	61	9	30	5	95	+
<i>Macrocneme thyra intacta</i>	326	97	3		4	96	—
<i>Eucereon maia</i>	260	75	5	20		100	+
<i>Saurita clusia</i>	156	97	3			100	—
<i>Episcepsis hypoleuca</i>	128	64	27	9	20	80	+
<i>Pseudosphex kenedyae</i>	114	> 99	< 1		100		+
<i>Ctenucha andrei</i>	89	71	2	27	100		+
<i>Eucereon obscurum</i>	87	67	11	22		100	+ (rare)
<i>Histiaea cepheus</i>	81	68	22	10		100	—
<i>Calonotos cranaeae</i>	78	45	49	6		100	—
<i>Aethria carnicauda</i>	66	45	55		100		+
<i>Napata walkeri</i>	25	88	12			100	+ (rare)
<i>Agyrta dux</i>	23	83	13	4	100		+

species which appears to be well protected from potential enemies is the vespid wasp "mimic" *Pseudosphex kenedyae* and therefore is an excellent example of Müllerian mimicry. Although tests with the other species are inconclusive, it seems that they are at least partially protected against possible predators.

V. SUMMARY

Field characters, sex differences, frequency, active period, rest position and flight are recorded in 13 of the more common species of ctenuchid moths in Trinidad.

Interesting habits include extremely wasplike flight as well as facies in two species, and in two others a beetlelike dropping to the ground when disturbed.

In two species only, more females were seen or taken than males; in the others, males far outnumbered females.

There is great variation in habits of flight and in rest position among the 13 species.

Their palatability to various vertebrates and invertebrates was tested under controlled conditions. They appear to be at least partially unacceptable to possible predators.

It is suggested that a fluid exuded from the thorax of *Histiaea cepheus* serves as an effective defense.

Mimicry in several species is discussed. *Pseudosphex kenedyae* appears to be an almost perfect example of Müllerian mimicry.

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EXPLANATION OF THE PLATES

PLATE I

- FIG. 1. *Pseudosphex kenedyae*.
FIG. 2. *Saurita clusia*.
FIG. 3. *Histiaea cepheus*.
FIG. 4. *Macrocneme thyra intacta*.
FIG. 5. *Calonotos craneae*.
FIG. 6. *Aethria carnicauda*.
FIG. 7. *Episcepsis hypoleuca*.
FIG. 8. *Napata walkeri*.
FIG. 9. *Agyrta dux*.
FIG. 10. *Eucereon maia*.
FIG. 11. *Eucereon obscurum*.
FIG. 12. *Correbidia assimilis*.
FIG. 13. *Ctenucha andrei*.

PLATE II

All photographs are of living specimens in natural rest position, taken in a confined area.

- FIG. 14. *Pseudosphex kenedyae* feeding on *Heliotropium indicum* seed panicle. Note wasp-like pattern, constriction of abdomen and curve of forewings; also reduction of pectinations on distal third of antennae.
FIG. 15. *Macrocneme thyra intacta*, showing long, heavily scaled hindlegs and white tarsi.
FIG. 16. *Napata walkeri*.
FIG. 17. *Mapeta xanthomelas* (Pyralidae).
FIG. 18. *Correbidia assimilis* and small lycid beetle.
FIG. 19. Same, with large lycid beetle.



FIG. 1



FIG. 2

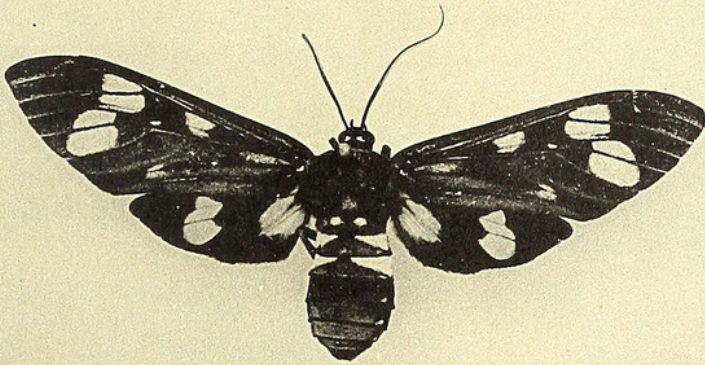


FIG. 3

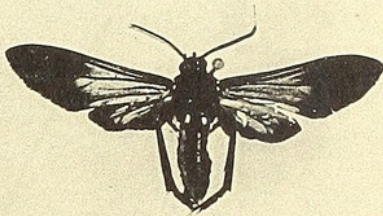


FIG. 4



FIG. 5



FIG. 6

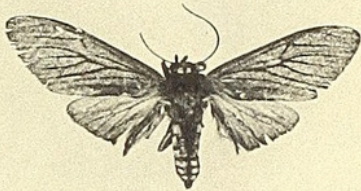


FIG. 7



FIG. 8

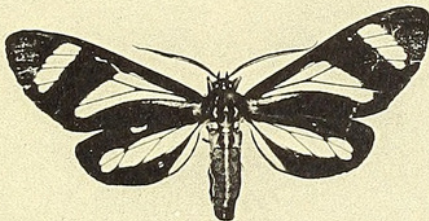


FIG. 9

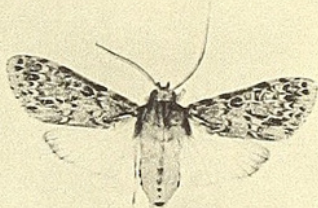


FIG. 10



FIG. 11



FIG. 12

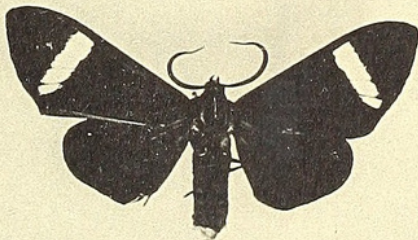


FIG. 13

HABITS, PALATABILITY AND MIMICRY IN THIRTEEN CTENUCHID MOTH SPECIES FROM TRINIDAD, B.W.I.

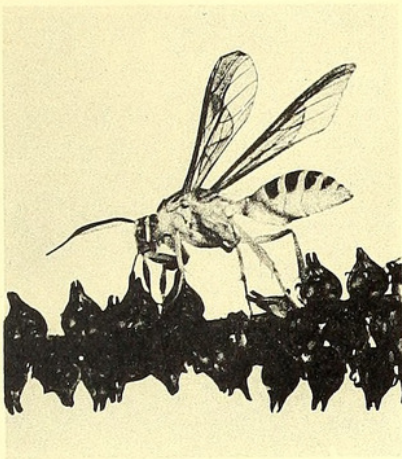


FIG. 14

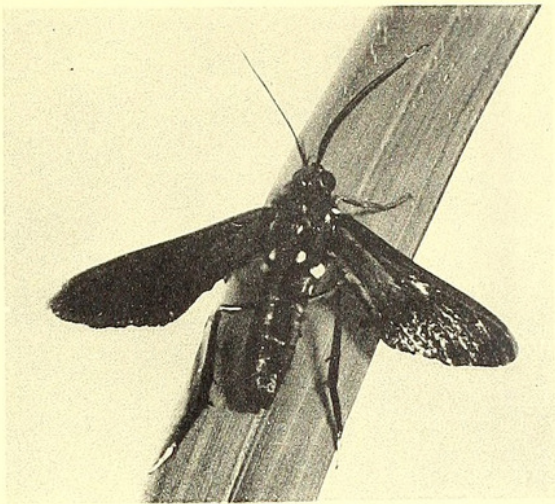


FIG. 15

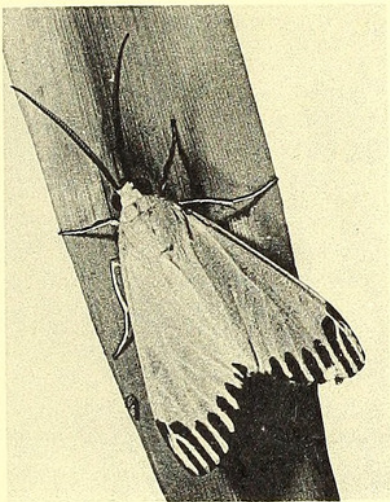


FIG. 16



FIG. 17

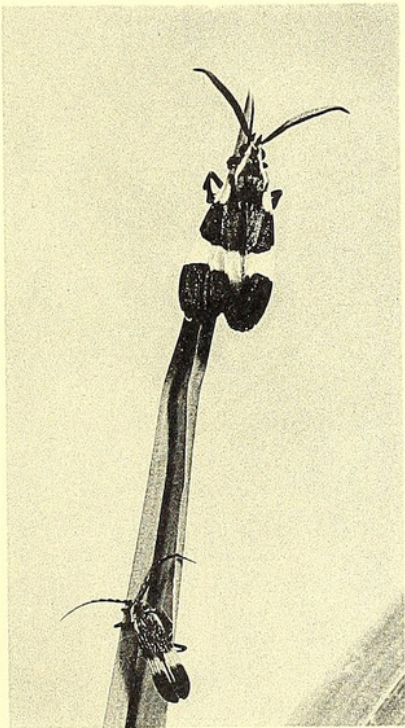


FIG. 18

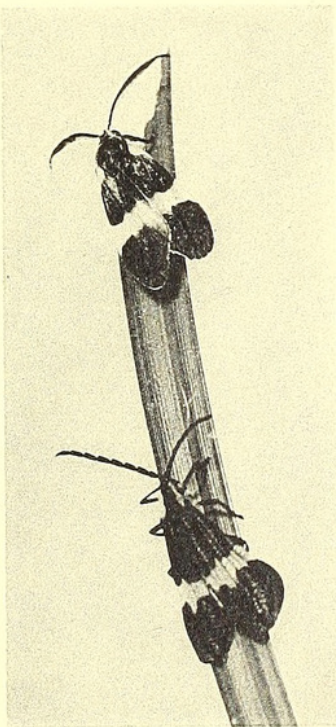


FIG. 19

HABITS, PALATABILITY AND MIMICRY IN THIRTEEN CTENUCHID MOTH SPECIES FROM TRINIDAD, B.W.I.



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