

A REVISION OF THE NEOTROPICAL GENUS ERILOPHODES
WARREN (LEPIDOPTERA, GEOMETRIDAE)

by

Charles VanOrden Covell Jr.

Thesis submitted to the Graduate Faculty of the
Virginia Polytechnic Institute
in candidacy for the degree of

MASTER OF SCIENCE

in

Entomology

May, 1962

Blacksburg, Virginia

4D
565E

V855

1962

C683

c.2

TABLE OF CONTENTS

	Page
I. INTRODUCTION	5
II. MATERIALS AND METHODS	8
III. REVIEW OF LITERATURE	11
IV. GENUS <u>ERILOPHODES</u> WARREN	14
A. <u>Erilophodes colorata</u> Warren	19
B. <u>Erilophodes spinosa</u> , new species	22
C. <u>Erilophodes toddi</u> , new species	25
V. KEY TO THE SPECIES OF <u>ERILOPHODES</u> (MALES)	28
VI. DISCUSSION	29
A. Zoogeography	29
B. Phylogenetic Considerations	32
VII. SPECIES ERRONEOUSLY REFERRED TO <u>ERILOPHODES</u>	39
A. <u>Erilophodes indistincta</u> Warren	39
B. <u>Erilophodes marmorinata</u> Bastelberger	40
C. <u>Erilophodes arana</u> (Dognin)	42
VIII. ACKNOWLEDGMENTS	43
IX. LITERATURE CITED	44
X. VITA	47
XI. FIGURES	48

LIST OF FIGURES

- Fig. 1. Wing venation of Erilophodes colorata Warren.
- Fig. 2. Male genitalia of Erilophodes colorata Warren, without aedeagus.
- Fig. 3. Labial palp of Erilophodes colorata Warren, without scales.
- Fig. 4. Hind tibia of Erilophodes colorata Warren, without scales or hair pencil.
- Fig. 5. Hind tibia of Erilophodes spinosa, new species, without scales or hair pencil.
- Fig. 6. Hind tibia of Erilophodes toddi, new species, without scales.
- Fig. 7. Uncus of Erilophodes colorata Warren.
- Fig. 8. Uncus of Erilophodes spinosa, new species.
- Fig. 9. Uncus of Erilophodes toddi, new species.
- Fig. 10. Juxta of Erilophodes colorata Warren.
- Fig. 11. Juxta of Erilophodes spinosa, new species.
- Fig. 12. Juxta of Erilophodes toddi, new species.
- Fig. 13. Left arm of gnathos of Erilophodes colorata Warren.
- Fig. 14. Left arm of gnathos of Erilophodes spinosa, new species.
- Fig. 15. Left arm of gnathos of Erilophodes toddi, new species.

- Fig. 16. Costal process of left valve of Erilophodes colorata Warren.
- Fig. 17. Costal process of left valve of Erilophodes toddi, new species.
- Fig. 18. Costal process of left valve of Erilophodes spinosa, new species.
- Fig. 19. Aedeagus of Erilophodes colorata Warren.
- Fig. 20. Aedeagus of Erilophodes spinosa, new species.
- Fig. 21. Aedeagus of Erilophodes toddi, new species.
- Fig. 22. Female genitalia of Erilophodes colorata Warren.
- Fig. 23. Map showing distribution of Erilophodes species.
- Fig. 24. Habitus of Erilophodes colorata Warren, male.
- Fig. 25. Habitus of Erilophodes colorata Warren, female.
- Fig. 26. Habitus of Erilophodes spinosa, new species, holotype male.
- Fig. 27. Habitus of Erilophodes toddi, new species, holotype male.

I. INTRODUCTION

In the past few decades the area of animal taxonomy has undergone a change as far as bases of distinction of species, genera and higher categories are concerned. According to Simpson (1945), taxonomy earlier in this century was disreputable, "a pursuit for hack workers only." Today it is realized that taxonomy is one of the most basic areas of biological research. Simpson states that "one of the most fundamental goals of modern biological research is comprehension of the way in which species arise." Thus taxonomists work alongside ecologists, geneticists, and workers in other disciplines to achieve this goal. New tools for the taxonomist have been developed with the help of these workers in other disciplines. Whereas earlier species were separated on the basis of superficial morphological differences, today the taxonomist attempts to find every way in which one species differs from another. In addition to morphological differences, each species may show genetic, physiological, and behavioristic differences from other closely related species. As the modern taxonomist utilizes these new approaches, he also has the experience of the earlier workers to aid him in his efforts.

Because many genera and species were established before the taxonomic methods used today were developed, many changes in classification have been effected by revisions of taxonomic groups. Many new species, overlooked by the earlier workers, have recently been discovered. Thus revisionary work is bringing the classification of animals nearer to the "natural classification" we wish to parallel.

The order Lepidoptera is the second largest order in the animal kingdom as far as number of species is concerned, there being over 120,000 described species (Metcalf, Flint and Metcalf, 1951). Of this order, one of the largest moth families is the Geometridae, the larvae of which are the well-known "inchworms" or "measuringworms." McDunnough (1938) lists 245 genera and 1198 species of Geometridae in the United States and Canada. Forbes (1948) treats 129 genera which occur in New York and neighboring states. Other genera and species are to be found in tropical America. There are presently very few taxonomists investigating Neotropical Geometridae although a great deal of material is available in large collections for study. Although much of this material is poorly preserved and labeled, it provides a basis for revisionary studies. More

collecting, plus biological studies of live material in their natural environments, will further aid in the understanding of Geometrid genera and species and their phylogeny.

The genus Eriophodes Warren was chosen for revisionary study because of its need for further investigation, and because of the availability of specimens. Except for the addition of three species since it was first proposed, Eriophodes has undergone no critical examination. The objective of this work has been to redescribe this genus. The genitalia of specimens have been examined in search of distinguishing characteristics. Also, using what data are available, zoogeographic information has been assembled in an attempt to define the habitat range of the species. By comparing and contrasting the external morphological characters with other genera in the Geometridae (especially in the subfamily Ennominae, in which Eriophodes is placed) an effort has been made also to understand the phylogeny of the genus.

Since few workers are presently studying Neotropical Geometridae, the author hopes that this work is the beginning of a lifelong interest and association with tropical American Geometrid moths.

II. MATERIALS AND METHODS

The choice of the genus Eriophodes Warren as the subject of this revisionary study was made at the suggestion of Dr. E. L. Todd, Agricultural Research Service, United States Department of Agriculture. Specimens of Eriophodes and related genera in the United States National Museum (USNM) provided the basis for the work. Additional material was borrowed from the following institutions:

American Museum of Natural History (AMNH)

Carnegie Museum (CM)

California Academy of Science (CA)

Cornell University (CU)

British Museum (Natural History) (BM)

In all 359 specimens were available to the author.

In the case of type material, photographs of specimens and drawings of genitalic structures were obtained, except in the case of the United States National Museum, where type material was studied by the author.

Dissections and observations were made using a Spencer binocular dissecting microscope. The author prepared over 135 genitalic slides. The abdomens were

removed from specimens, and notes made regarding their vestiture, especially the tufting on the dorsum. The abdomens were then treated with concentrated potassium hydroxide solution. The genitalia were removed from the rest of the abdomens, and the aedeagus separated from the other genitalic structures (males). The genitalia and abdominal skins were rinsed, stained with 2% aqueous mercurochrome, dehydrated, and mounted on microscope slides in Canada balsam. Additional genitalic slides made by other workers were also available. Slides of wings were also made. The right pair of wings was removed from each specimen to be thus treated, and bleached in concentrated Clorox solution so that the veins could be easily seen. The two wings were placed between two microscope slides, which were then taped together. Also, a slide of one set of legs and one antenna were made of several specimens. These were bleached, then mounted on a microscope slide in Canada balsam.

Measurements were made using an eyepiece micrometer (Whipple disc) mounted in the binocular microscope and calibrated with a stage micrometer. The width between the eyes was measured just above the clypeus; the labial palpi were measured in a straight line from

the base to the tip; the hind tibiae were measured at their widest point; alar expanse was measured from the base to the apex of each forewing. Dimensions are expressed either as comparisons with other structures, or in millimeters.

Drawings of genitalia, legs, palpi and wing venation were prepared by the author. Analogous structures of the three species were drawn to the same scale. Photographs of specimens were made to the same scale using an Exacta 35 mm. camera and Kodak Plus-X Pan film.

III. REVIEW OF LITERATURE

William Warren (1894) established the monotypic genus Erilophodes, designating E. colorata as type species. A description of E. colorata appeared in the same paper, following the generic description. The genus was described on the basis of wing shape and venation, with brief discussion given to abdominal tufts, antennae, labial palpi, tongue and hind tibiae.

E. colorata was described wholly on the basis of maculation and coloration of body and wings; alar expanse was given as "32 to 34 mm.," and the sexes were distinguished by the statement that "The rosy suffusion is more pronounced in the ♀ than the ♂." No other information was given regarding the species; no genitalic features were mentioned, and no figures accompanied the description. The type locality was not given, although the holotype is labeled "Sao Paulo."

Warren (1904) described E. indistincta on the basis of a single male from Onaca, Sta. Marta, Colombia, collected "June - August" by Engelke. Again only characters of body and wing maculation and coloration were treated.

H. Bastelburger (1908) described E. marmorinata on the basis of one female from Agualani, Peru. No seasonal data appeared in the description, or are there any on the type specimen label. As with Warren's descriptions, only characters of maculation and coloration were utilized.

Paul Dognin (1895) described Caripeta arana from two specimens: "Un ♂, El Monje, 1893; une ♀, San Francisco près Loja (Ecuador), août 1886." Coloration and maculation of body and wings comprised the bulk of the description, with remarks concerning the nature of antennae in males and females and of the palpi. In examining a series of specimens from Agualani, Warren (1909) found a pair which he felt represented a dark form of arana; this he named E. arana aberration fumipennis. Thus Warren transferred arana to the genus Erilophodes.

Apparently unaware of the work of Warren (1894) in describing E. colorata, E. Le Mout (1911) described Ischnopterix wagneri on the basis of six males and seven females from San Ignacio (Missions), Argentina. Males and females were described as to maculation and coloration. Examination of a cotype male reveals that wagneri is identical with colorata, and thus the

former name must be treated as a junior subjective synonym. The cotype male of wagneri is in the United States National Museum.

Hambleton and Forbes (1935) listed E. colorata as having been collected at "Estado de Minas Geraes (Sao Paulo)" in January and February, 1918, by Zikan. Forbes (1948) mentioned Erilophodes as belonging to the tribe Nacophorini in the subfamily Ennominae of the Geometridae. Biezanko, Ruffinelli and Carbonell (1957) listed E. colorata from Montevideo, Uruguay, with the statement: "Adultos capturados en setiembre."

As was the case in the original description of Erilophodes and E. colorata, none of the subsequent descriptions included detailed morphological, biological and zoogeographic information; nor did they include figures.

IV. GENUS ERILOPHODES WARREN

Nov. Zool., 1: 465

Front of head smooth, slightly swollen, vested with dense mat of narrow, flat scales; width between eyes from 0.55 to 1.05 mm.; eyes globoid, naked, varying in diameter from 0.83 to 1.35 mm.; ocelli wanting. Antennae bipectinate in males, simple in females; length from 7.7 to 13.2 mm. (males) and 9.4 to 12.0 mm. (females); male antennae pectinated for from two-thirds to three-fourths of length; pectinations setaceous; scape urceolate, bearing short, flat scales. Tongue about 7.5 mm. long. Labial palpi (Fig. 3) curved downward then upward and densely vested; loosely appressed to front and attaining about one-half height of eye; 1.35 to 2.10 mm. long; basal and basal half of median segment blackhaired, the rest white or ochre-white. Front and rest of head white or ochre-white, except for black row of scales caudad of eyes and small black patch sometimes on venter of scape.

Thorax with pronotum white or ochre-white, often with rosy suffusion; patagia, tegulae, mesonotum and metanotum mostly black-scaled, with varying degrees of white sprinkling; central, erect white tuft on

mesothorax; scales of patagia long, caudally-directed, hairlike; small white tuft centrally located on metathorax. Pectus clothed with white, ochre-white, or rose-white hairs. Foretibia with epiphysis. Hind tibia dilated or not so, bearing two pairs of spines; groove and hair pencil present or absent (males). Legs vested with appressed, flat scales, white or ochre-white, with scattering of black scales.

Abdomen narrow, vested with appressed, flat, white or ochre-white scales, with black scales sprinkled throughout; dorsal tufts of erect, flat, white-tipped black scales on segments one to five, those on segments two and three largest; ventral surface of segment three with row of bristles in males of one species.

Forewings 13.88 to 17.70 mm. long (males) and 14.60 to 18.00 long (females); elongate, apex rounded, outer margin slightly convex, regular; 12 veins, 11 from cell; one areole; Sc entirely free; R₂₊₃ joined to R₁ to well past end of cell; R₄ anastomosing with R₂₊₃ just beyond departure of former from R₅ and departure of former from R₁, forming a long, narrow areole; R₁₊₂₊₃ from just before upper angle; R₄₊₅ and M₁ from upper angle; M₂ closer to M₁ than to M₃; M₃ and Cu₁ from outer angle; Cu₂ from well before outer angle; cell roughly .55 of

wing length; discocellulars poorly developed; fovea absent.

Hindwings elongate, apex produced; frenulum well developed in both sexes; Sc approximate and parallel to Rs for about .43 length of Sc, but not touching; Rs departing from M₁ at or just before upper angle of cell; M₂ obsolete; Cu₁ departing just before outer angle; Cu₂ from well before outer angle; 2d A well developed, and 3d A poorly developed.

Maculation of species very similar (Figs. 24 - 27). Forewings and hindwings above and beneath concolorous white or ochre-white in ground-color. Forewing with curved basal streak black, outer extremity not attaining C; postbasal area white, with varying amount of brown or red-brown suffusion, concentrated most toward inner margin; t.a. line black, broken, with white basal border; median area well suffused with black, brown or red-brown, especially toward inner margin; black reniform spot shadowed distally by white patch, in which may be smaller black spot; t.p. line black, broken (especially just below M₃), with white distal border; postmedian area dark brown or gray-black from C to Cu₁, where it becomes reduced or lighter (either gray or rose-brown in varying shades) and narrower, perhaps reaching inner margin; submarginal area

white or ochre-white, darkening with ochre, brown or rose-brown suffusion to outer margin; fringe checkered black and white or ochre-white. Hindwings above with gray median line becoming broken and reduced toward anal margin, strongest to about Cu₁; long, white hairs on surface toward anal margin; sprinkling of gray scales concentrated toward outer margin, especially in region between Cu₁ and Cu₂ at margin, forming a loose patch; gray or black scales sprinkled throughout light areas of hindwings and forewings to varying degree. Forewings and hindwings slightly paler beneath than above, with gray markings corresponding to the black lines and areas above on forewings, and corresponding to median line and sometimes to marginal patch in hindwings; black sprinkling on both forewings and hindwings beneath as above; ochraceous and rose-brown suffusions absent on underside.

Male genitalia (Fig. 2) with uncus (un) from broad base, terminating in two lobes, the dorsal lobe being reduced in one species (Figs. 7 - 9); gnathos (gn) separated into two separate, strongly sclerotized arms, terminating ventrally in two to 16 various sized teeth; valves (va) broadly truncate at base, symmetrical, densely pubescent on dorsal inner surface for distal

two-thirds, narrowing to blunt point; basal costal processes (co. pr) variable among species; juxta (jx) semi-cylindrical, strongly sclerotized, terminating dorsally in a single central spine flanked by several smaller teeth, or in two long, dorsally-directed lateral spines; furcae wanting; vinculum (vin) narrow; saccus absent; aedeagus sharply curved, longer than juxta, without cornuti (Figs. 19 - 21).

Female genitalia (Fig. 22) with genital plate made up of rounded, sclerotized lamella antevaginalis (lla) and broad, sclerotized lamella postvaginalis (llp), tending to be bilobed cephalad; ductus bursae (du. bu) membranous, with sclerotized collar just cephalad of ostium bursae (o. b); ductus seminalis (du. sml) ventrally from ductus bursae near ostium; ductus bursae fairly constant in length, being just under one-third of total length of genitalia, but merging gradually cephalad into corpus bursae (crp. bu); corpus bursae globoid, with shield-shaped signum (sig) heavily sclerotized; apophyses posteriores (apo. po) and apophyses anteriores (apo. ant) narrow, heavily sclerotized; total length of genitalia in dissected and mounted condition from 4.3 to 6.6 mm.

Type Species: Erilophodes colorata Warren, 1894.

A. Erilophodes colorata Warren

(Figs. 24, 25)

Erilophodes colorata Warren, 1894, Nov. Zool. 1: 466.

Ischnopterix wagneri Le Mout, 1911, Bull. Sec. Entomol.
France, Annee 1911: 74 - 75.

Male: Front light ochre-white; 0.55 - 0.68 mm.
between eyes; antennae from 7.7 to 8.3 mm. long; palpi
1.35 - 1.86 mm. long; diameter of eye 0.90 - 1.16 mm.;
white vestiture of thorax and abdomen only slightly
tinged with ochre; erect abdominal tufts black; row of
bristles on venter of third abdominal segment wanting;
hind tibiae slightly swollen (greatest width - 0.50 to
0.68 mm.) and grooved on inner surface, the groove
containing pencil of white hairs.

Wings with white ground color above and below in both
forewings and hindwings; brown-black suffusion in lower
postbasal and median areas of forewings lack reddish tint;
other suffusions of forewings pure light ochre; hindwings
pure, shining white, the median gray line almost absent
in some individuals, being reduced to two or three light
gray spots; black patch at outer margin small but well
defined; brown-black and gray of forewings and hindwings

above a uniform dark gray below; irregular dusting with gray scales on all surfaces.

Alar expanse: 13.9 to 15.2 mm.

Male genitalia: Uncus ending with short, pointed nub at point where ventral lobe departs (Fig. 7); arms of gnathos with five to 14 teeth (Fig. 13); valves narrowing rapidly to rounded point; costa of valves well sclerotized; costal processes of valves broadly based, erect, rising to point, but curving toward tips of valves (Fig. 16); juxta long and narrow, rising to central, heavily sclerotized, dorsally-directed spine, with smaller dorsally-directed teeth on either side and below (Fig. 10); aedeagus bent downward at midpoint (Fig. 19).

Female: Similar to male, but larger in most cases; width between eyes 0.60 to 0.86 mm.; palpi 1.50 to 2.10 mm. long; hind tibia not dilated as in males, and not having groove and hair pencil. Wings essentially maculated the same as males, but with less ochre suffusion, and more complete gray median line on hindwings above; much more dusting with gray scales than in male on all wing surfaces.

Alar expanse: 14.6 to 18.0 mm.

Female genitalia: All specimens before the author appear as described earlier, and are indistinguishable as to species.

Early stages: Nothing is known about the immature forms, or of their food plants.

Types: Holotype male of colorata, BM; cotype male of Ischnopterix wagneri, USNM.

Type localities: Of colorata, "Sao Paulo" (Brazil) (on label); of wagneri, "San Ignacio (Missions), République-Argentine."

Range: Southern Brazil from coast west to south-central Paraguay.

Season: Probably throughout the year. Records are for February, March, August, September, October and December.

Specimens examined: BRAZIL: Nova Friburgo (?) ("N. F."), 11.2.'13, J. Arp, 1 male (USNM): Rio de Janeiro ("Rio Janiero"), 1 male, (USNM): Campobello, 9.3.'31, 1 female (colorata ?), (USNM); Castro Parana, 3 males, 2 females (1 male labeled "98"), (USNM); Guarani, Rio Grande de Sul, C. A. de Biezanko, 2 males ("III or VIII"), 1 female ("26.VIII.'33"), (CU); "Brazil, Hoffman" (second label cannot be read except for "600 m."), 1 female, (CU). PARAGUAY: Paso-Yobal,

Caaguazu, Dec. '51, Foerster, 1 male, (AMNH). ARGENTINA:
San Ignacio (Missions), September, E. Wagner, 1 male
(cotype I. wagneri), (USNM).

B. Erilophodes spinosa, new species

(Fig. 26)

Diagnosis: (Males only) Generally larger than colorata. More deep ochre and rose-brown suffusion than colorata on body and wings. Hindwings with more complete median line than colorata, usually with vague gray submedian dash. Row of spines present on venter of third abdominal segment. Hind tibia with groove and hair pencil. Uncus of genitalia developed well beyond departure of ventral lobe; arms of gnathos longer than those of colorata, with fewer terminal spines; costal processes of valves longer than those of colorata; juxta with two lateral, dorsally-directed arms, the right arising at a point higher than the left; aedeagus more abruptly bent than that of colorata.

Male: Generally larger than colorata; width between eyes from 0.75 to 0.99 mm. (0.99 in holotype); antennae from 10.5 to 13.2 mm. in length (about 10.5 in holotype); palpi from 1.8 to 2.1 mm. long (2.1 in holotype);

diameter of eye from 1.1 to 1.9 mm. (1.2 in holotype); hind tibia (Fig. 5) more obviously broadened, from 0.83 to 0.92 mm. wide (0.83 in holotype), and having groove and hair pencil on inner surface. Abdomen with row of spines on venter of third segment. Maculation essentially as in colorata, except as follows: more rose-brown tint to white of front, thorax and abdomen; lighter suffusions of forewings more rose-brown to rose-ochre than in colorata; submarginal areas of forewings more completely suffused with rose-brown, usually with very little white showing; hindwings more ochre-white above, especially toward outer and anal margins; median gray line more complete and usually quite wide and well defined from C to Cu₁, with some traces carrying on to anal margin in some individuals; often an obscure gray longitudinal dash in submedian area between M₁ and M₂; more gray dusting on hindwing above than in colorata, especially toward outer margin; dark pattern of forewings and hindwings above repeated on underside as in colorata.

Alar expanse: 16.4 to 17.7 mm.

Male genitalia: Uncus produced well beyond departure of ventral lobe (Fig. 8); arms of gnathos terminating in two to six long spines (Fig. 14) (four terminal spines on each arm in holotype); valves as in colorata, but basal

costal process longer (Fig. 18); juxta terminating in two long, dorsally-directed lateral spines, the right spine arising consistently higher than the left (Fig. 11); aedeagus more abruptly bent than in colorata (Fig. 20).

Female: Apparently indistinguishable from female of colorata.

Early stages: Nothing is known of the early stages, feeding habits or ecology of spinosa.

Holotype: Male, CU. (Collected 26.VIII.1933 by Biezanko).

Type locality: Guarani, Rio Grande de Sul, Brazil.

Range: Southeastern Brazil from Espirito Santo to Guarani.

Season: Probably throughout the year. Records are for August and September (males); and May, September, October and November (females).

Paratypes: BRAZIL: Same locality as holotype, 29.VIII.'38, Biezanko, 1 male, (CU); same locality and date as holotype, Biezanko, 1 female (spinosa ?), (CU); Espirito Santo, 1 male and 1 female (spinosa ?), (USNM); "Santa Catarina," Pohl, 1 male, (USNM), 1 male, (CM); Nova Teutonia, "27° 11' B. 52° 23' L.," Sept. 20, 1938, Fritz Plaumann, 1 male, (USNM), Aug. 17, 1952, Plaumann, 1 male, (Sperry Collection, USNM), 26.IX.51, 1 female,

(Sperry Collection, USNM), 13.X.52, 1 female, (Sperry Collection, USNM), 12.XI.52, 1 female, (Sperry Collection, USNM), May, 1953, 1 female, (Sperry Collection, AMNH).

C. Erilophodes toddi, new species

(Fig. 27)

Diagnosis: (Males only) Resembling spinosa in size, maculation and coloration. Submedian dash on hindwing of spinosa replaced by submedian gray spot in toddi. As in colorata, row of spines lacking on venter of third abdominal segment. Hind tibia lacking groove and hair pencil. Uncus of genitalia resembling that of spinosa, sometimes a little less developed than spinosa beyond departure of ventral lobe; arms of gnathos intermediate in length between colorata and spinosa, but having largest number of terminal spines; basal costal process of valve broad and blunt, not pointed as in the other two species; juxta terminating in two lateral, dorsally-directed spines as in spinosa, but both arise consistently at the same height; aedeagus least bent of the three species.

Male: Essentially like spinosa in size, maculation and coloration. Width between eyes from 0.75 to 1.05 mm. (0.75 in holotype); antennae from 10.5 to 12.0 mm. (about 10.5 in holotype); palpi from 1.8 to 2.3 mm. in length (1.95 in holotype); diameter of eye from 1.2 to 1.6 mm. (1.24 in holotype). Hind tibia (Fig. 6) not broadened or grooved, lacking hair pencil, 0.53 to 0.60 in width (0.60 in holotype). Abdomen without row of spines on venter of third abdominal segment. Forewings above with varying degrees of rose-brown and rose-ochre suffusion as in spinosa. Hindwings above resembling spinosa, but median gray line more complete below Cu₁, usually almost complete to anal margin; small submedian spot usually present, centered on M₂. Forewings and hindwings generously dusted with gray scales.

Alar expanse: 15.0 to 17.7 mm.

Male genitalia: Uncus as in spinosa (Fig. 9); arms of gnathos (Fig. 15) intermediate in length between colorata and spinosa, terminating in nine to 16 spines (at least 10 on each arm in holotype); valves similar in shape to other species, costal process broad and blunt (Fig. 17); juxta as in spinosa, but terminal arms arise at same height consistently (Fig. 12); aedeagus least abruptly bent of the three species (Fig. 21).

Female: The female is yet indistinguishable from other species of Erilophodes.

Early stages: Nothing is known of the biology of toddi.

Holotype: Male, AMNH. (Collected Feb. 10, 1924).

Type locality: Alto da Serra, Sao Paulo, Brazil.

Range: Known only from Alto da Serra, Sao Paulo; Baracea; and Nova Teutonia; Brazil.

Season: Probably throughout the year. Records are for February, March, May, August and October (males only).

Paratypes: BRAZIL: Alto da Serra, Sao Paulo, "20.V", Pohl, 1 male, (AMNH), "X.23", Pohl, 1 male, (USNM), "10.3.'29," "Pohl, Leg.," 1 male, (CM); Baracea, "24.3.'49," Pearson, 1 male, (AMNH); Nova Teutonia, Aug. 17, 1952, "Plaumann, Coll.," 1 male, (USNM).

Dedication: This species is gratefully dedicated to Dr. E. L. Todd, Agricultural Research Service, United States Department of Agriculture.

V. KEY TO THE SPECIES OF ERILOPHODES (MALES)

1. Hindwings shiny white above; uncus not produced beyond departure of ventral lobe except for short, pointed nub; apex of juxta terminating in a single, central spine, with much smaller teeth on either side E. colorata War.
Hindwings ochre-white above; uncus produced well beyond departure of ventral lobe; apex of juxta with two long, pointed, dorsally-directed lateral arms 2
2. Hind tibia dilated, with groove containing hair pencil on inner surface; row of spines on venter of third abdominal segment; gnathos with two to six long terminal spines on each arm; apex of juxta with right lateral arm arising at point higher than left; costal process of valve slender and pointed E. spinosa, n. sp.
Hind tibia not dilated, lacking groove and hair pencil; row of spines wanting on venter of third abdominal segment; gnathos with nine to 16 terminal spines on each arm; apex of juxta with both lateral arms arising at same height, costal process of valve broad and blunt E. toddi, n. sp.

VI. DISCUSSION

Certain aspects of this problem need more attention than has been given them in the descriptions. They are discussed as follows:

A. Zoogeography

As mentioned data labels on the specimens and references to geographical localities in the literature were found to be inadequate. When names such as "Espirito Santo" and "Santa Catarina" appeared, it was impossible to decide whether the collector meant the state or the city. One label read "N. F.," which the present author could only deduce meant Nova Friburgo. The names Nova Teutonia and Baracea could not be located, although the approximate location of the former was found to be in western Santa Catarina state when the latitude and longitude data on one label for Nova Teutonia was applied to a map. Thus some of the localities marked in Fig. 23 are only approximate.

Additional data as to the habitats of the three species were almost entirely lacking. In one case "600 m." was on a label, but the locality could not be

read. On the basis of the data available, the genus Erilophodes as a whole can be said to occupy a range from Espirito Santo, Brazil, in the north to Montevideo, Uruguay, in the south (Biezanko, Ruffinelli and Carbonell, 1957), along the coast. The range extends inland for roughly 450 miles, through northeastern Argentina into southeastern Paraguay.

Of the three species, E. toddi seems most limited in distribution, the localities known being Alta da Serra, Sao Paulo; Baracea; and Nova Teutonia - all in Brazil. Excluding Baracea, the range of toddi is roughly 500 miles long.

E. spinosa has the farthest northern limit (Espirito Santo), if the label means the city or its environs. This species shares with E. colorata the most southward limit (Guarani, Rio Grande de Sul, Brazil), excepting that Montevideo, Uruguay, is probably a correct locality for one of the three species, it not being known which (for this reason Montevideo is omitted from Fig. 23).

E. colorata is known from the most different localities, and is the only species found so far from Argentine and Paraguay as well as Brazil. Thus its range contains the greatest amount of territory.

The pattern of occurrence is not easily established for these three species. More collecting is necessary. There is some overlap of exact localities. Both E. colorata and E. spinosa are from Guarani and both E. spinosa and E. toddi have been collected at Nova Teutonia. In both these cases there are females as well as males. As the females cannot be distinguished, it is a problem to place these specimens as to species.

The three species are at least partly sympatric (Fig. 23). Whether they differ in altitudinal preference or some other geographical peculiarity cannot be known from the available data. Seasonal data does not indicate different periods of the year for each species. Males of all three have been collected in August, and both E. colorata and E. toddi have been taken in February, March and October. No biological data being available, it is impossible to suggest differences in this area. As the range of Erilophodes is over mountainous terrain, the author feels that perhaps isolated local colonies exist within the overall ranges, depending for survival on some aspect of their local environment.

B. Phylogenetic Considerations

Because of the similarity in maculation among the males of the three species of Erilophodes, the similarity of the females to the males, and because of the overlap in ranges, it seems that the three species form a closely related group. The fact that the females of the species cannot be differentiated also supports this supposition.

The males of the three species can be separated easily on the basis of morphological characters cited in the key. It seems that these structures are evolving at different rates and in different directions. Rindge (1954) in his revision of the Geometrid genus Tornos states that the presence of the row of spines on the third abdominal sternite and the hair pencil on the hind tibia represent the primitive condition. If this is the case in Erilophodes, the most primitive species with regard to these features is E. spinosa, with both, and the most advanced is E. toddi with neither. However, as these structures must have been derived at some point, it is possible that the situation is reversed, with E. toddi not having derived the structures in the first place.

With respect to genitalic structures in the males and their evolution one from the other, it is difficult to decide whether the shortened uncus of colorata is

more or less advanced than those of spinosa and toddi. The part of the uncus beyond the departure of the ventral lobe seems a bit larger and longer in spinosa than in toddi, while in colorata it is reduced drastically. Perhaps the uncus of toddi is the most primitive of the three, that of spinosa lengthening and broadening beyond the departure of the ventral lobe, and that of colorata becoming reduced to the point where the ventral lobe essentially becomes the terminal portion of the uncus proper (Figs. 7, 8, 9).

In a large number of Geometrid species the gnathos is a single structure, with a medially located and variable group of ventrally-directed spines or teeth. If this is the less specialized situation than the gnathos consisting of two separate arms, perhaps the longer arms of spinosa represent the least degree of evolution from the single structure, the arms of the other two species having shortened and developed more teeth (Figs. 13, 14, 15).

As bilateral symmetry is generally the case with less specialized animals, the juxta in toddi is perhaps the most primitive in Eriolophodes. That of spinosa is slightly assymetrical, and that of colorata, lacking the two lateral, dorsally-directed arms, is the most

specialized, being radically different from the juxtas of the other two species (Figs. 10, 11, 12).

The valves of all three species are very similar, especially in outline; but dissimilarity can be seen in the basal costal processes in each species. These processes are simplest, and perhaps least specialized, in colorata. Those in toddi are the widest and bluntest, perhaps representing the most specialized condition (Figs. 16, 17, 18).

In all three species the aedeagus is more or less bent, lacking cornuti. However, they differ in degree of curvature, that of toddi being least curved, and that of spinosa having the most abrupt bend (Figs. 19, 20, 21). It is difficult to decide which direction evolution is taking in the change among these species with regard to the aedeagus.

Erilophodes was placed in the subfamily Ennominae by Forbes (1948). While the forewing vein R₁ does not anastomose with Sc as is stated by Forbes to be commonly the case in the Ennominae, Erilophodes seems to be properly placed in this subfamily with regard to other morphological characters. In dividing the Ennominae into tribes, Forbes places Erilophodes in the tribe Nacophorini with Phaeoura, Gabriola, Thyrinteina and

Nacophora, plus "some other South American genera."

However, Erilophodes seems to differ from this tribe in several characters by which Forbes describes it.

They are as follows:

1. " ... the apices of pectinations (of the male antennae) ... bearing two well separated setae."

(Erilophodes antennae bear a large number of setae.)

2. "male genitalia with a complex spiked or dentate outgrowth from 'tendon' of valve, sometimes fused with transtilla but separate from juxta, with small free projections from apical margin."

(Although this "outgrowth" is probably the basal costal process of Erilophodes, no transtilla seems to be present in the genus.)

3. "gnathos with simple hook, sometimes shagreened."

(This does not describe the separated, spined nature of the gnathos in Erilophodes.)

4. "They resemble the Bistonini in the heavy body and short tongue, but differ wholly in the early stages (egg and pupa particularly)."

(The body of Eriophodes does not seem particularly heavy in comparison with other genera observed by the author, and the tongue is certainly not short, being about 7.5 mm. As the early stages are as yet unknown, they cannot be used in classification.)

Eriophodes does, however, fit into Forbes's description of the Nacophorini in having the abdomen dorsally tufted. The descriptions of other tribes do not seem to define them clearly; Forbes admits that this classification is weak. Characters are mentioned in some instances that might possibly be referable to Eriophodes, but in each case except one only a single character of the genus seems to fit a given tribe. The exception is the Ennomini, in which Forbes includes only the genus Ennomos. Characters which might fit Eriophodes are as follows:

"Male genitalia variable in detail; uncus sometimes modified; gnathos very heavy, heavily spinose; valve lightly chitinized, but more or less spinose on inner face, not modified; juxta heavy, emarginate or with the apex continued into two spines (not a furca)."

It is not clear, however, whether in saying that the valve is "not modified" Forbes means the absence of the

basal costal process. Forbes also states that the arms of the juxta are "free."

With some knowledge of the immature stages of Erilophodes the genus can perhaps be better placed at the tribal level. None of the tribes as described by Forbes seem to be capable of including it without some change in the tribal characteristics. On the basis of the abdominal tufting and the costal process of the valve, the author feels that it should be left in the Nacophorini, although the subject of its tribal relationship should be investigated further.

As far as relation to other genera is concerned, Dr. J. G. Franclemont (in correspondence) feels that Erilophodes may be an "outlying element" of the "large Pero complex," although he really does not know to what it is related. (Forbes includes Pero in the tribe Azelinini.) The author feels that in maculation Erilophodes is similar to some species of Leucolithodes, Pseudobrephos, Gabriola, Cidariophanes, and Neodesmodes. These are all included in the Ennominae, but have not been placed in tribes to the knowledge of the author. Genitally none have been found to have analogous male structures in the gnathos, juxta or valves. The

author is presently revising the genus Neodesmodes, the female genitalia of which have a signum identical to that in Erilophodes females.

In order to understand more fully the genus Erilophodes as a generic entity, it is necessary not only to collect more material of the species and study their biology, but also to become familiar with other genera which have not yet been revised. Our knowledge of Neotropical Ennominae is incomplete; the author hopes that he will be able to contribute much toward their understanding in future work.

VII. SPECIES ERRONEOUSLY REFERRED
TO ERILOPHODES

Three species of moths are attributed to Erilophodes which the author believes should not be included in the genus. Their disposition is treated below.

A. Erilophodes indistincta Warren

A photograph of the holotype male of Erilophodes indistincta Warren (1904) from the British Museum and the description of maculation and coloration by Warren indicate that this species resembles closely certain species in the large genus Ischnopterix Hubner. It has an almost uniform maculation of olive-gray scales on the forewings above, and lacks the distinct markings of the basal, median, postmedian and submarginal areas which characterize Erilophodes species. This species is based on a single specimen from Onaca, Santa Marta, Colombia. It may be that indistincta is identical with Ischnopterix nigralbata Dognin, the holotype female of which bears a very close resemblance to indistincta. If these two species are the same, nigralbata, described in 1913, will be a junior subjective synonym of indistincta.

On the evidence above, indistincta is transferred as follows:

Ischnopterix indistincta (Warren), new combination
Erilophodes indistincta Warren, 1904, Nov. Zool., 11: 173.

B. Erilophodes marmorinata Bastelberger

Comparison of photographs of Erilophodes marmorinata holotype female from Senckenbergische Naturforschende Gesellschaft in Frankfurt am Main, Germany, and of the holotype female of Neodesmodes semialbata Warren from the British Museum, show these two species to be identical in maculation. The holotype of semialbata is from Limbani, Peru, and that of marmorinata from Agualani, Peru. The author has before him 12 females from Cochabamba, Bolivia, and one male from Cuzco, Peru, which seem to be semialbata - the type species for the genus Neodesmodes. In maculation semialbata resembles Erilophodes species, but differs markedly in some respects. The forewing has a white vertical dash in the apical region and another in the tornus; and the t.a. and t.p. lines are shaped differently from those in Erilophodes. The hindwing above has a wide dark gray border along the outer

margin, extending in for about one-fourth of the wing's length.

The female genitalia of semialbata has a signum similar to that of Eriophodes females, but the ductus bursae is much longer in the former, and widens for a distance approximately the same as the length of the corpus bursae, and is striated in the widened part. The formation of the genital plate also differs between the two species. In the male, no genitalic resemblances are found between semialbata and the Eriophodes males. The uncus is simple; the gnathos is a single process; the juxta is a flat, irregular sclerite with lateral attachments (furcae); the valves are shaped differently from those in Eriophodes; and the aedeagus is short, straight, and contains several cornuti.

On the basis of these dissimilarities, E. marmorinata is considered a junior subjective synonym of N. semialbata, as follows:

Neodesmodes semialbata Warren

Neodesmodes semialbata Warren, 1905, Nov. Zool., 12: 361.

Eriophodes marmorinata Bastelberger, 1908, Jahrb. Nassau.

Ver. Naturkunde, 61: 79 - 80, new synonymy.

C. Erilophodes arana (Dognin)

Examination of the male and female cotypes of Caripeta arana Dognin, transferred to Erilophodes by Warren in his description of arana aberration fumipennis (1909), in the United States National Museum, show this species to be closely related to N. semialbata in both maculation and male and female genitalia. The male genitalia generally follows the description given for that of semialbata given above. A photograph of Warren's holotype male for aberration fumipennis in the British Museum indicates that it is probably a species distinct from arana. Dognin's cotype male is from El Monje and his cotype female from San Francisco, near Loja, both localities in Peru. The holotype male of aberration fumipennis is from Agualani, Peru. Since arana is felt by the author to be closely related to Neodesmodes semialbata, it is transferred as follows:

Neodesmodes arana (Dognin), new combination
Caripeta arana Dognin, 1895, Ann. Soc. Entomol. Belg.,
39: 117.

Erilophodes arana ab. fumipennis Warren, 1909, Nov. Zool., 16: 109.

VIII. ACKNOWLEDGMENTS

The author wishes to express his gratitude to Dr. E. L. Todd, Agricultural Research Service, United States Department of Agriculture, and to Dr. S. E. Neff, Department of Biology, Virginia Polytechnic Institute, for giving generously of their time, advice and facilities during the course of this work. Also, the author is grateful to Dr. J. McD. Grayson, Head, Department of Entomology, Virginia Polytechnic Institute, and to Dr. R. L. Hoffman, Department of Biology, Radford College, for their help.

The author also wishes to thank the following for the loan of specimens and the contribution of photographs and data concerning species of Erilophodes in their care: Dr. J. F. G. Clarke, United States National Museum; Dr. F. H. Rindge, American Museum of Natural History; Dr. H. K. Clench, Carnegie Museum; Dr. C. D. MacNeill, California Academy of Science; Dr. J. G. Franclemont, Department of Entomology, Cornell University, Mr. D. S. Fletcher, British Museum (Natural History); and Dr. H. Schroeder, Senckenbergische Naturforschende Gesellschaft, Frankfurt am Main, Germany.

The author is also grateful to Dr. J. L. Bishop,
Department of Entomology, Virginia Polytechnic Institute,
for making the photographs of Erilophodes specimens which
appear in this work.

IX. LITERATURE CITED

- Bastelberger, H., 1908. Weitere neubeschreibungen
exotischer Geometriden in meiner sammlung.
Jahrb. Nassau. Ver. fur Naturkunde, 61: 79 - 80.
- Biezanko, C. M. de, A. Ruffinelli, & C. S. Carbonell,
1957. Lepidoptera of Uruguay. Rev. Fac. Agr.,
46: 39.
- Dognin, P., 1895. Lepidopteres de Loja et environs.
Ann. Soc. Entomol. Belg., 39: 117.
- Forbes, W. T. M., 1948. Lepidoptera of New York and
Neighboring States, Part II. Cornell Univ.
Agr. Expt. Sta. Mem. 274.
- Hambleton, E. J. & W. T. M. Forbes, 1935. Uma lista
de Lepidoptera (Heterocera) do estado de
Minas Geraes (Sao Paulo). Arch. Inst. Biol.,
6, Suppl 2: 223.
- Le Moults, E., 1911. Description d'une espece nouvelle
du genre Ischnopterix Enderl. (Lep., Phalaenidae).
Bull. Soc. Entomol. France, Annee 1911: 74 - 75.
- McDunnough, J., 1938. Check List of the Lepidoptera of
Canada and the United States of America, Part 1:
139 - 174.

- Metcalf, C. L., W. P. Flint & R. L. Metcalf, 1951.
Destructive and Useful Insects, 3rd Ed.
- Rindge, F. H., 1954. A revision of the genus Tornos
Morrison (Lepidoptera, Geometridae). Bull.
Am. Museum Nat. Hist., 104, Art. 2: 183 - 184.
- Warren, W., 1894. New genera and species of Geometridae.
Nov. Zool., 1: 465 - 466.
- _____, 1904. New American Thyrididae, Uraniidae
and Geometridae. Nov. Zool., 11: 173.
- _____, 1905. New American Thyrididae, Uraniidae
and Geometridae. Nov. Zool., 12: 360 - 361.
- _____, 1909. New American Uraniidae and
Geometridae in the Tring Museum. Nov. Zool.,
16: 109.

X. VITA

Charles VanOrden Covell Jr. - born December 10, 1935, in Washington, D. C., the son of Rev. Charles VanOrden Covell and Katherine Shaw Covell. Graduated in 1954 from the Episcopal High School in Alexandria, Virginia. Received the B. A. degree from the University of North Carolina in January, 1958. Taught at Norfolk Academy, School for Boys, in Norfolk, Virginia, from February, 1958, to June, 1960. Was married in 1958 to Elizabeth Gore Barnes. Was employed as a graduate research assistant in entomology with the Virginia Agricultural Experiment Station (1960 - 1961) and as a graduate teaching assistant in entomology (1961 - 1962) while studying in the Department of Entomology, Virginia Polytechnic Institute. Is a member of the following honorary and professional societies: Phi Sigma Society, Entomological Society of America, Brooklyn Entomological Society, The Lepidopterists' Society, and the Virginia Academy of Science.

Charles Van Orden Covell Jr.

XI. FIGURES

Fig. 1. Wing venation of Erilophodes colorata Warren.

Fig. 2. Male genitalia of Erilophodes colorata
Warren, without aedeagus.

Explanation of symbols:

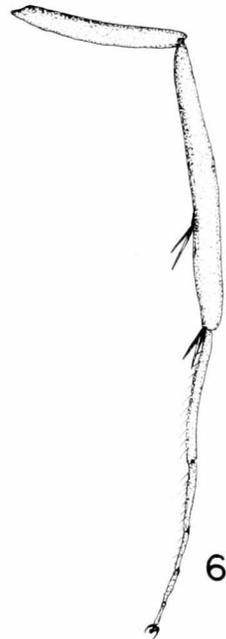
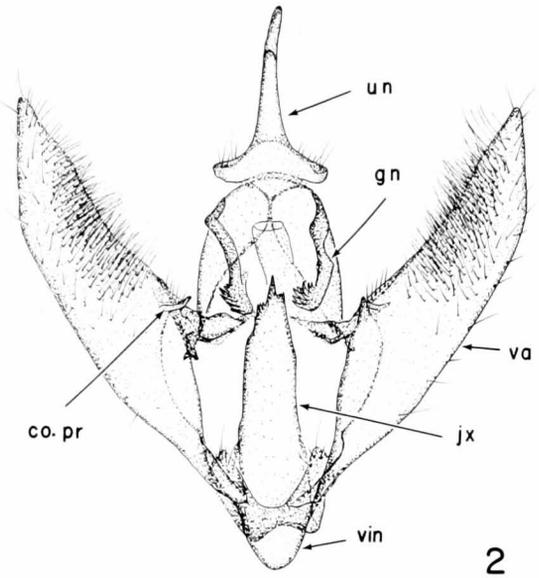
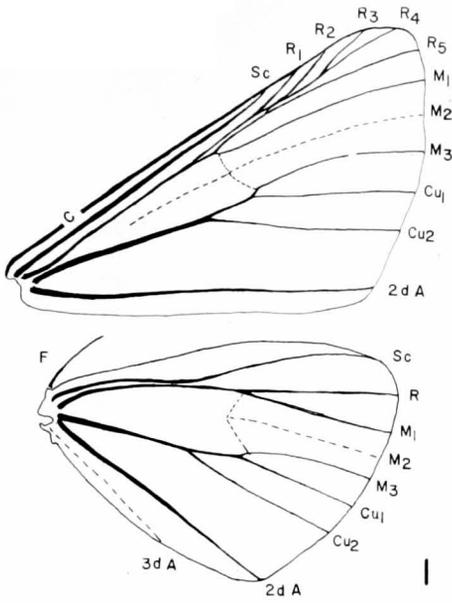
un - uncus
gn - gnathos (arm)
va - valve
jx - juxta
vin - vinculum
co. pr - costal process

Fig. 3. Labial palp of Erilophodes colorata Warren,
without scales.

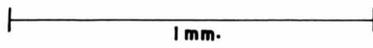
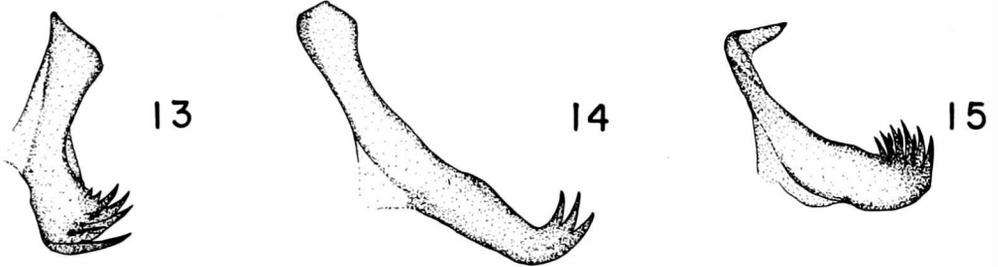
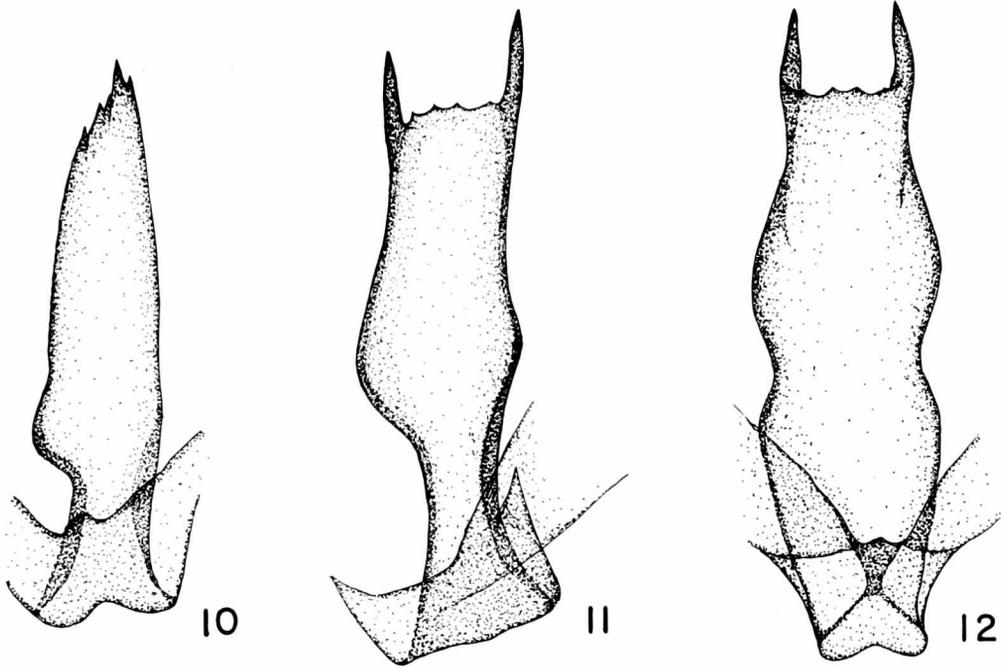
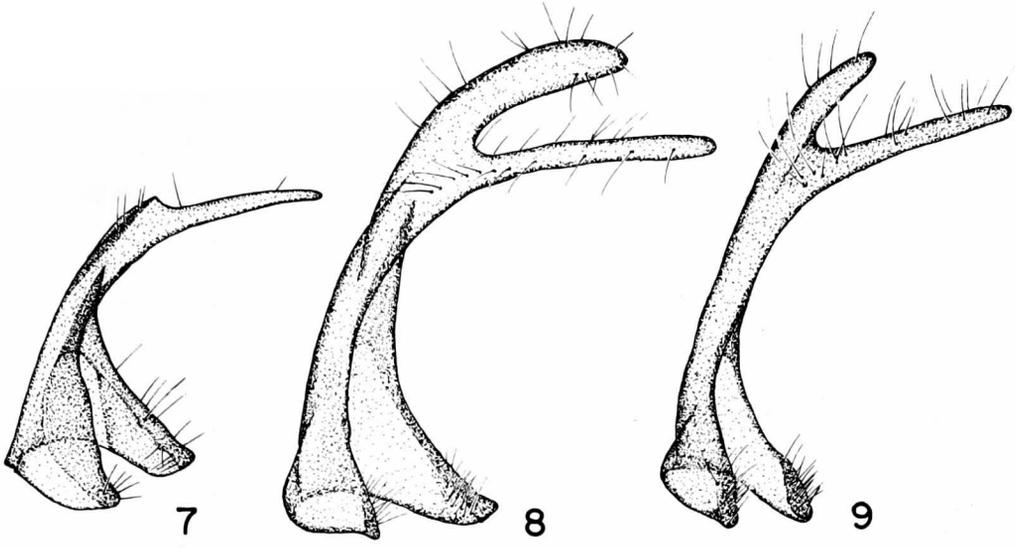
Fig. 4. Hind tibia of Erilophodes colorata Warren,
without scales or hair pencil.

Fig. 5. Hind tibia of Erilophodes spinosa, new
species, without scales or hair pencil.

Fig. 6. Hind tibia of Erilophodes toddi, new
species, without scales.



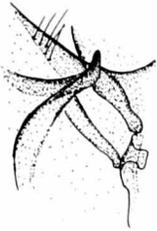
- Fig. 7. Uncus of Erilophodes colorata Warren
- Fig. 8. Uncus of Erilophodes spinosa, new species
- Fig. 9. Uncus of Erilophodes toddi, new species
- Fig. 10. Juxta of Erilophodes colorata Warren
- Fig. 11. Juxta of Erilophodes spinosa, new species
- Fig. 12. Juxta of Erilophodes toddi, new species
- Fig. 13. Left arm of gnathos of Erilophodes colorata Warren
- Fig. 14. Left arm of gnathos of Erilophodes spinosa, new species
- Fig. 15. Left arm of gnathos of Erilophodes toddi, new species



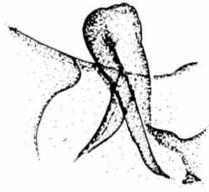
- Fig. 16. Left costal process of valve of
Erilophodes colorata Warren
- Fig. 17. Left costal process of valve of
Erilophodes toddi, new species
- Fig. 18. Left costal process of valve of
Erilophodes spinosa, new species
- Fig. 19. Aedeagus of Erilophodes colorata Warren
- Fig. 20. Aedeagus of Erilophodes spinosa, new species
- Fig. 21. Aedeagus of Erilophodes toddi, new species
- Fig. 22. Female genitalia of Erilophodes colorata
Warren

Explanation of symbols:

pap. a - papillae anales
apo. po - apophyse posterior
o. b - ostium bursae
apo. ant - apophyse anterior
du. sml - ductus seminalis
du. bu - ductus bursae
sig - signum
crp. bu - corpus bursae
lla - lamella antevaginalis
llp - lamella postvaginalis



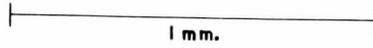
16



17



18



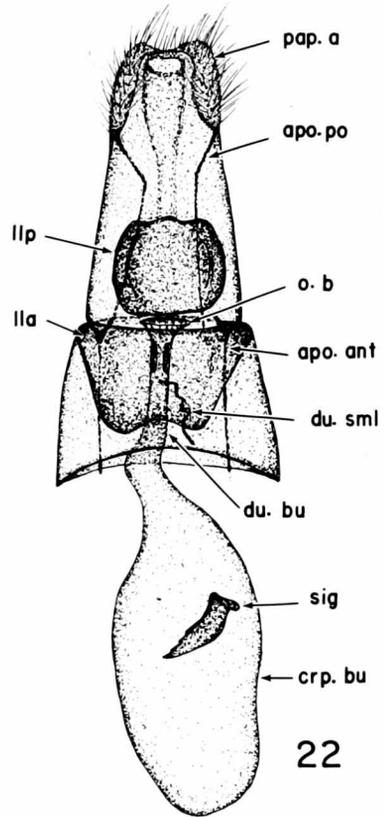
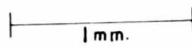
19



20



21



22

Fig. 23. Map showing distribution of
Eriophodes species



Fig. 24. Habitus of Erilophodes colorata
Warren, male

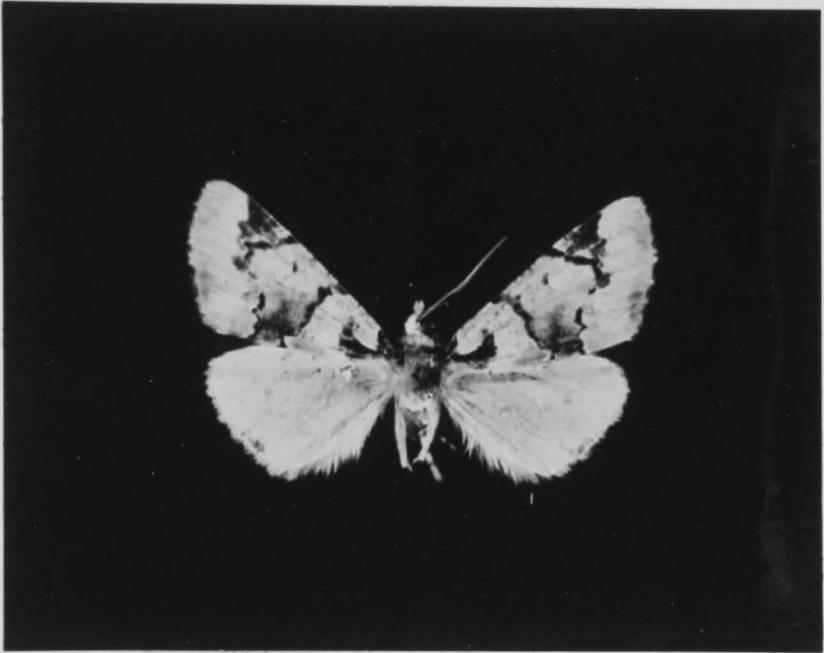


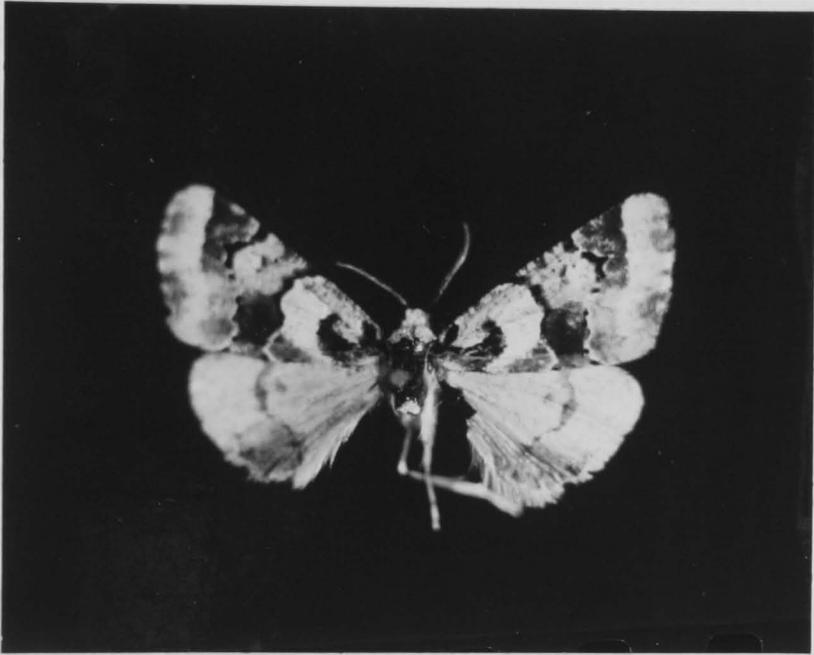
Fig. 25. Habitus of Erilophodes colorata
Warren, female



Fig. 26. Habitus of Erilophodes spinosa,
new species, holotype male



Fig. 27. Habitus of Erilophodes toddi, new
species, holotype male



ABSTRACT

The Geometrid moth genus Erilophodes Warren was redefined, using morphological characters of the wings, abdomen, hind tibiae and genitalia. Two new species, E. spinosa and E. toddi, were described on the basis of male characteristics. Females of these species are indistinguishable from each other and from those of E. colorata Warren, the type species. Ischnopterix wagneri Le Moult was treated as a junior subjective synonym of E. colorata Warren.

Three species referred to Erilophodes Warren were removed from the genus. E. indistincta Warren was transferred to the genus Ischnopterix Hubner. E. marmorinata Bastelberger was placed as a junior subjective synonym of Neodesmodes semialbata Warren. E. arana (Dognin) was transferred to the genus Neodesmodes Warren.

Erilophodes Warren was found to occupy an area from Espirito Santo on the southern coast of Brazil to Montevideo, Uruguay, westward through the northeastern tip of Argentina into southeastern Paraguay. There seems to be considerable overlap in the ranges of the three species.

Placement of Erilophodes Warren in the subfamily Ennominae was verified. With some reservations the genus was retained in the tribe Nacophorini.