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Two new species of *Rhodochlora* Warren, 1894 of the Neotropics (Lepidoptera: Geometridae, Geometrinae)

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Abstract

Rhodochlora Warren, 1894 is a Neotropical genus of the largest and most attractive species of their kind. This article aims to characterize two additional species. *Rhodochlora rufaria* Warren, 1909 is a well-characterized species ranging from Peru to Venezuela. *Rhodochlora elias* Viidalepp, sp. nov. has similar wing markings to *R. rufaria* but differs in the shape of the lateral appendages of the uncus and has an eastern distribution in South America. Another new species, *Rhodochlora ylle* Lindt, sp. nov. from Costa Rica, resembles the western Neotropical *Rhodochlora brunneipalpis* Warren, 1894 in its wing markings, but again, it is morphologically different, and confined to the fauna of Mesoamerica.
Keywords: Lepidoptera, Geometridae, Geometrinae, *Rhodochlora*, vicariant distributions, new species, French Guiana, Costa Rica.

Dos nuevas especies de *Rhodochlora* Warren, 1894 del Neotrópico (Lepidoptera: Geometridae, Geometrinae)

Resumen

Rhodochlora Warren, 1894 es un género Neotropical de las especies más grandes y atractivas de su género. Este artículo pretende caracterizar dos especies adicionales. *Rhodochlora rufaria* Warren, 1909 es una especie bien caracterizada que se extiende desde Perú hasta Venezuela. *Rhodochlora elias* Viidalepp, sp. nov. tiene marcas alares similares a *R. rufaria* pero difiere en la forma de los apéndices laterales del uncus y tiene una distribución oriental en Sudamérica. Otra especie nueva, *Rhodochlora ylle* Lindt, sp. nov. de Costa Rica, se parece a la Neotropical occidental *Rhodochlora brunneipalpis* Warren, 1894 en las marcas alares, pero de nuevo es morfológicamente diferente y está confinada a la fauna de Mesoamérica.
Palabras clave: Lepidoptera, Geometridae, Geometrinae, *Rhodochlora,* distribuciones vicariantes, nueva especie, Guayana Francesa, Costa Rica.

Introduction

Warren (1894) described the genus *Rhodochlora* for a beautiful Neotropical looper moth *Achlora roseipalpis* Felder & Rogenhofer, 1875. Warren (1909) later added descriptions of several other Neotropical species, among them *Rhodochlora brunneipalpis* Warren, 1894 with two forms, f. *minor* Warren, 1909 and f. *rufaria* Warren, 1909. Prout (1932) raised the status of *R. rufaria* to species (based on its reddish tinged wing colour), and Pitkin (1996) showed the morphological differences between *R. rufaria* and other species of the genus but retained this species in the same genus as *Rhodochlora*

rufaria. Here we propose descriptions of two new species related to *Rhodostrophia brunneipalpis* and *R. rufaria*.

Hausmann (2017) added descriptions of more species of *Rhodochlora* and divided the species into five species groups (the *exquisita* species group, the *trifasciata* species group, the *basicostalis* species group, the *albipunctata* species group, and the *roseipalpis* species group) based on DNA analysis and morphological data. *R. rufaria* is grouped with *R. exquisita* Warren, 1905, *R. claushippi* Hausmann, 2017, *R. gaujoniaria* (Dognin, 1892), *R. sordida* Hausmann, 2017 and *R. brechlini* Hausmann, 2017 in the *Rhodochlora exquisita* species group. The species included in this group share a dirty green ground colour on the wings, and some red hue medially on the hindwing. The genitalia of a male *R. rufaria* specimen from Peru is illustrated and one Ecuadorian specimen (EC BOLD:ACL1812) is also used in the analysis by Hausmann (2017). *R. rufaria* seems rare in collections.

Warren (1894) described the "forms" of *Rhodochlora brunneipalpis* as follows: "… ab. *Rufaria* demands a more detailed description. To a certain extent it resembles *R. exquisita* Warren, 1905, but it is not marked so brightly red. The outer line of forewing is redder and thicker than in the type [of *brunneipalpis*], and is followed by red spots between the veins, the lower of which forms a red blotch at anal angle. In the grey-green central band beyond the yellow base is followed by a broad space of dull rufous, which extends to beyond the postmedian line and leaves only a comparatively narrow marginal border of green. On the underside the red-brown blotch at apex of hindwing, which is well developed and conspicuous, and red on forewing shows in several places. In many respects it answers the description of *gaujoniaria* (Dognin). But the face and head are bright red and not deep black…"

Prout (1932) characterized the wing markings of the genus and divided it into two groups: a) twelve species that have a hair pencil, and two pairs of spurs close together on the hindlegs, including *R. rufaria* and *R. brunneipalpis*, and b) two species without a hair pencil and with reduced proximal spurs of the hindtibia (*R. exquisita* Warren, 1905 and *R. trifasciata* Warren, 1909). Hausmann (2017) does not accept such a division, as he has found sister species differing in the build of the male hindlegs.

Pitkin (1996) stressed the different shape of the socii in *R. rufaria* and larger lobes at the distal edge of the eighth abdominal sternite in the male. She found that the number of hindtibial spurs, the presence of a hair pencil, and the apical extension of male hindtibia vary across species of *Rhodochlora*.

Rhodochlora rufaria Warren, 1909 (Figures 1, 7, 8)
Rhodochlora rufaria Warren, 1909. *Novit. zool., 15*, 87
Type locality: Peru.

Material studied: Ecuador, Napo prov., Archidora, 1 ♂, 02-X-1999, T. Kesküla leg.; Loreto, 400 m, 1 ♂, 13-II-2008, 00º36'49"S, 77º18'10"W, gen. prep. 8151, A. Lindt leg., IZBE0121419. Peru, Lagunas, 120 m, 1 ♂, 30-XI-2003, 05º14'14"S, 75º35'44"W, A. Lindt leg., IZBE0122450.

Diagnosis: *Rhodochlora rufaria* Warren belongs to the *Rhipignophos gaujoniaria* species group (Hausmann, 2017). It differs from all described *Rhodochlora* species, except the species *R. elias* sp. n. described below, in having large, broad, flat socii arising from the uncus base beside of uncus process. This character is combined with the specific uncus shape (filiform) and vinculum shape (almost rectangular) in the male genitalia. The specimens of *R. rufaria* from Peru and Ecuador and *R. elias* from French Guiana do not differ in their wing markings.

Characteristics: *Rhodochlora rufaria* has been well characterized previously and we need only to make some additions to this (Figure 1). Male genitalia (Figure 7) relatively large with vinculum almost rectangular shape, shorter than tegumen (see also Pitkin 1996, fig. 124). Uncus long, thin, filiform, about 0.8 mm long in the western Ecuadorian specimen, about 0.6 mm long in the Peruvian specimen. Valva rounded, broad in middle and rounded at apex. Socii flat (Figure 8), saccular part broadly rounded, medially constricted and downcurved at apex; socii provided with a broad, ventrally tooth-edged black sclerite. This sclerite is broader in its distal 2/5 part in the French Guiana than in the Peruvian specimen. Last sternite of male bidentate at posterior edge. Aedeagus thin, tubular, 3 mm

long, distally thicker, dorsally split and provided with two fine dentate ridges differing from those in the Peruvian (Lagunas) specimen: about five denticles on both sides, longer and sharper, and wider apart. In the specimen from Peru, these structures are close to one another and provided with about seven triangular denticles each. The tegumen + vinculum ring is solid, thicker than in the *R. furcata* of the Peruvian specimen, rectangular ventrally. The valvae are simple oval flaps, with the distal fourth of its dorsal edge darker.

Female genitalia with antrum broad and ostium cup-shaped, differing slightly in edge sclerotization.

***Rhodochlora elias* Viidalepp, sp. nov.** (Figures 2, 4, 5, 9, 10)

Material studied: Holotype: 1 ♂, French Guiana, Kaw Mts., Amazone Nature Lodge, 18-X-2006, J. & V. Viidalepp leg., IZBE0120930, (gen. prep. 9127). Paratypes: 21 ♂, 8 ♂, French Guiana, Kaw Mts., Amazone Nature Lodge, 13-20-X-2006, J. & V. Viidalepp leg., IZBE0120928, IZBE0120931, IZBE0120932, IZBE0120933; Camp Caiman, Kaw Mts., 5 ♂, 1-2-II-2005, 04º34'N, 52º11'W, S. Põlme leg., IZBE0120934, IZBE0120935; Belizon Road, 2 ♂, 1 ♀, 4-I-2003, V. Soon leg., IZBE0120936, IZBE0120937; the same locality and collector, 3 ♂, 8-I-2003, IZBE0120938, IZBE0120940, IZBE0120943; Belizon Road, 3 ♂, 6-XI-2002, 4-I-2003, 26-XI-2002, V. Soon leg., IZBE0120945, IZBE0120944, IZBE0120942, (gen. prep. 7038); Amazone Nature Lodge, 300 m, 1 ♂, 2 ♂, 12-16-I-2023, 04º33'35"N, 52º12'25"W, TAMZ0242535, TAMZ0242536; Rd. Roura - Kaw, 235 m, 1 ♂, 1 ♀, 23-I-2023, 04º38'38"N, 52º18'00"W, TAMZ0242537; Amazone Nature Lodge, 300 m, 3 ♂, 1 ♀, 24-28-I-2023, 04º33'35"N, 52º12'25"W, TAMZ0242538, TAMZ0242539 A. Lindt leg.; Rd. Roura - Kaw, 285 m, 1 ♂, 25-I-2023, 04º33'47"N, 52º11'32"W; Rd. Roura - Kaw, 285 m, 1 ♂, 26-I-2023, 04º33'47"N, 52º11'32"W; Rd. Roura - Kaw, 285 m, 1 ♂, 27-I-2023, 04º33'47"N, 52º11'32"W Tasane leg.; Kaw Mts., Camp Caiman, 300 m, 2 ♂, 05-II-2008, 04º34'N, 52º12'W; 30 km E St. Laurent du Maroni, 100 m, 1 ♂, 10-II-2008, 05º27'N, 53º47'W; Mt. Singes 15 km S Kourou, 30 m, 1 ♀, 11-II-2008, 05º03'N, 52º41.6'W Renge leg. The holotype is deposited in the IZBE collection of the Estonian University of Life Sciences (Tartu, Estonia). The paratypes are in the IZBE insect collection (Tartu) and the TAMZ insect collection of the Estonian Museum of Natural History (Tallinn) and in the private collections of A. Lindt, T. Tasane, and I. Renge.

Description: Wing markings grey and suffused on dull light green ground colour (Figure 2), as in the sister species *Rhodochlora rufaria* (Figure 1), differing so from other congeners. Wingspan 31-34 mm (Figure 2) in males, 36-41 mm (Figure 4) in females. Male hind tibia with two pairs of long spurs (Figure 5), which are close together, hind tibia provided with a hair pencil. Male antennae thinly bipectinate in basal half (Figure 5), filiform in female. Male with frenulum present.

Male genitalia (Figure 9) are well chitinized, except the uncus, which is thin filiform, about 0.8 mm long. The tegumen + vinculum ring is solid, thicker than in Peruvian *R. rufaria*, rectangular ventrally. The valvae are simple oval flaps, with a darker distal fourth of the dorsal edge. Socii (Figure 10) are almost parallel-sided flaps, about three times as long as wide, apices downcurved, with a medial ridge reaching the edge of the downcurved apex. In French Guiana moths, the ridge is broader in its distal 2/5 compared to the Peruvian specimen. Aedeagus 3 mm long, filiform, distally thicker, dorsally split and provided with two fine dentate ridges that differ from those in the Peruvian (Lagunas) specimen: about five denticles on both sides longer and sharper, and wider apart. These ridges are close to one another in the specimen from Peru and provided with about seven triangular denticles each.

Female genitalia with antrum broad and ostium cup-shaped, differing slightly from *R. rufaria* female in edge sclerotization.

Diagnosis: *Rhodochlora elias* Viidalepp, sp. nov. belongs to the *Rhipignophos gaujoniaria* species group (Hausmann, 2017). The new species differs from the Western Neotropical sister species *R. rufaria* in the shape of the socii of the male genitalia. The ground colour of the wings is not bright green, but a dull pale green as for *R. brunneipalpis* and *R. rufaria*, and it shares the reddish hue on the wings of *R. rufaria*.

Derivatio nominis. Elias was an internationally recognized prophet in the Kingdom of Judah, about thirty centuries ago. Masculine name in nominative case.

***Rhodochlora ylle* Lindt, sp. nov.** (Figures 3, 6, 11, 12)

Material studied: Holotype: 1 ♂, Costa Rica, Golfito, 50 m, 14-II-2007, 10º38'58"N, 84º01'12"W, A. Lindt leg. TAMZ0131838. Paratypes: Costa Rica, Golfito, 50 m, 2 ♂, 14-II-2007, 10º8'58"N, 84º01'12"W, A. Lindt leg. TAMZ0131839, gen. prep. 749. The holotype is deposited in the TAMZ insect collection of the Estonian Museum of Natural History (Tallinn). The paratypes are in the Estonian Museum of Natural History and in the private collection of A. Lindt.

Description: Wingspan of males 36-38 mm (Figure 3). Male antennae (Figure 6) bipectinate. Frons colour yellowish brown, palpi brown, vertex whitish. Male hind tibia slender, with two pairs of spurs, the distal proximal spur the longest. Wings dull light green without rusty hue. Forewing discal spot dark grey, postmedial line thin, blackish and suffused, ending in lunar white spot at hind margin of wing. Hindwing base shiny yellow, a little blackish shading distally and in the postmedial area. A small black spot at the forewing apex and a thin black line at the hindwing apex.

Male genitalia (Figure 11): Uncus thin, almost linear, shorter than socii; socii (Figure 12) flat, wide at base, elbowed and tapering to a point. Gnathos a broad loop with long, strong, pointed cochlear. Valva about 2 mm long, slender with dorsal edge thicker and apex rounded; juxta a small oval plate behind bases of sacculi. Transtilla a large bicornute plate. Saccus smooth-edged, rounded, aedeagus long (3 mm), with some black spicules on its split apex. The last abdominal sternite of the male is bidentate posteriorly, as in *R. rufaria*.

Female unknown.

Diagnosis: *Rhodochlora ylle* Lindt, sp. nov. belongs to the *Rhodochlora roseipalpis* species group according to Hausmann (2017). The new species has flat socii flaps which are similar to those in *R. brunneipalpis* Warren which was described from Guyana (Warren, 1894) and was mentioned as *R. brunneipalpis minor* Warren from nearby Nicaragua (Viidalepp et al. 2010). The ribbon-like flat socii of the new species are much slenderer than those in *R. rufaria* and *R. elias* described above. The socii are elbowed and tapered towards the apex as in *R. brunneipalpis,* much broader than the filiform socii in other congeneric species. Valva of the new species *R. ylle* is provided with ball shaped basal process while this process is long thumb shaped in R. *brunneipalpis*.

Discussion: The vegetation history of the huge territory of the Amazon tributary is variously interpreted. Barke & Lamb (2006) proposed that the Andean uplift in the Late Cenozoic blocked the path of the ancient Amazon to the Pacific coast. This caused flooding, and the Amazon, at that time, became a lake (Val et al. 2022; Albert et al. 2018). Mega-wetland conditions persisted over millions of years until the river broke through to the Atlantic Ocean. Since then, populations of an ancient fauna have diversified not only between the Guiana region and the Andes, but also between the eastern and western elevated areas of the South American continent. Only some elements of the former fauna have been able to recolonize the tributary.

Derivatio nominis: The species is dedicated to the prematurely deceased wife of A. Lindt, Ülle Jaanimäe.

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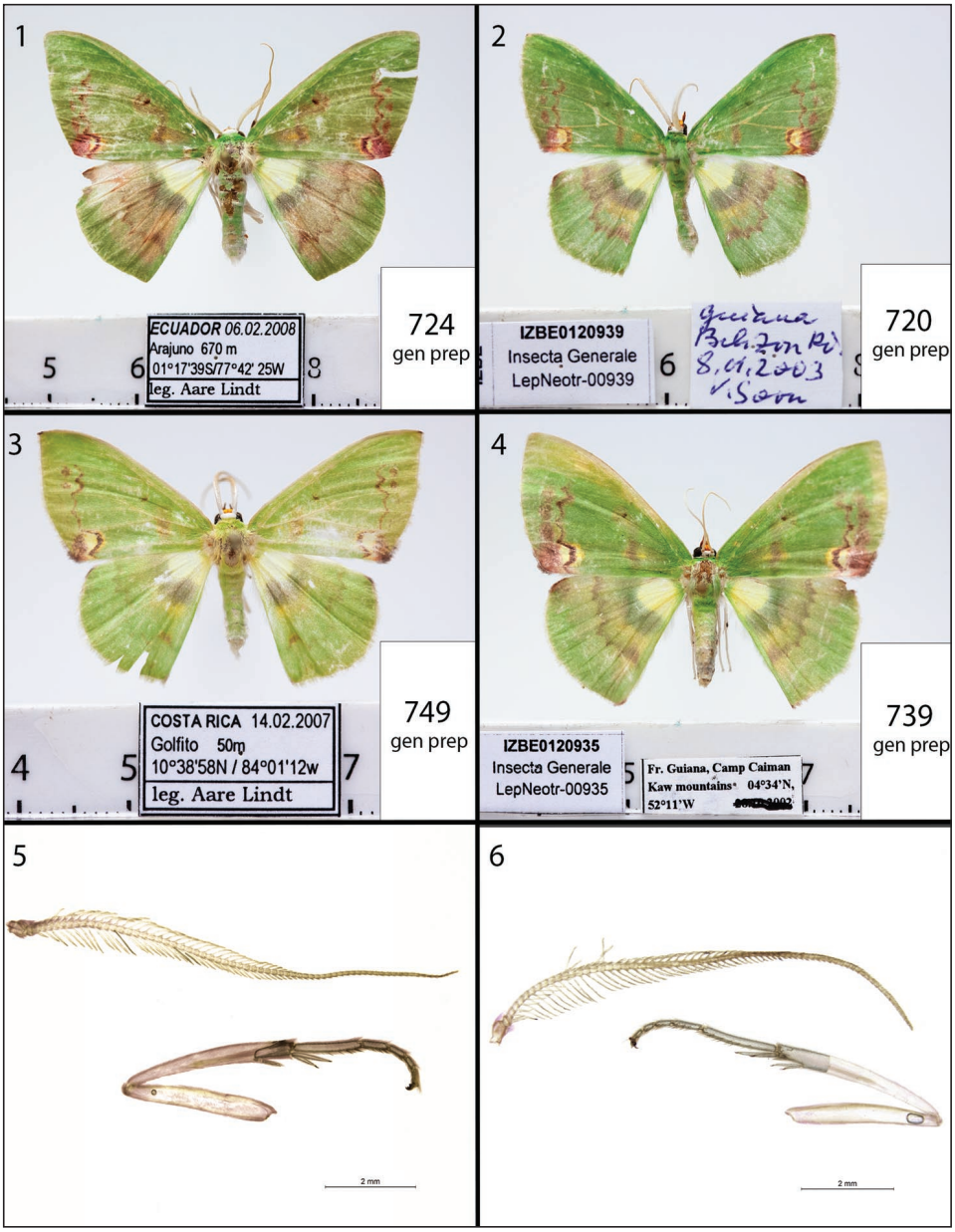
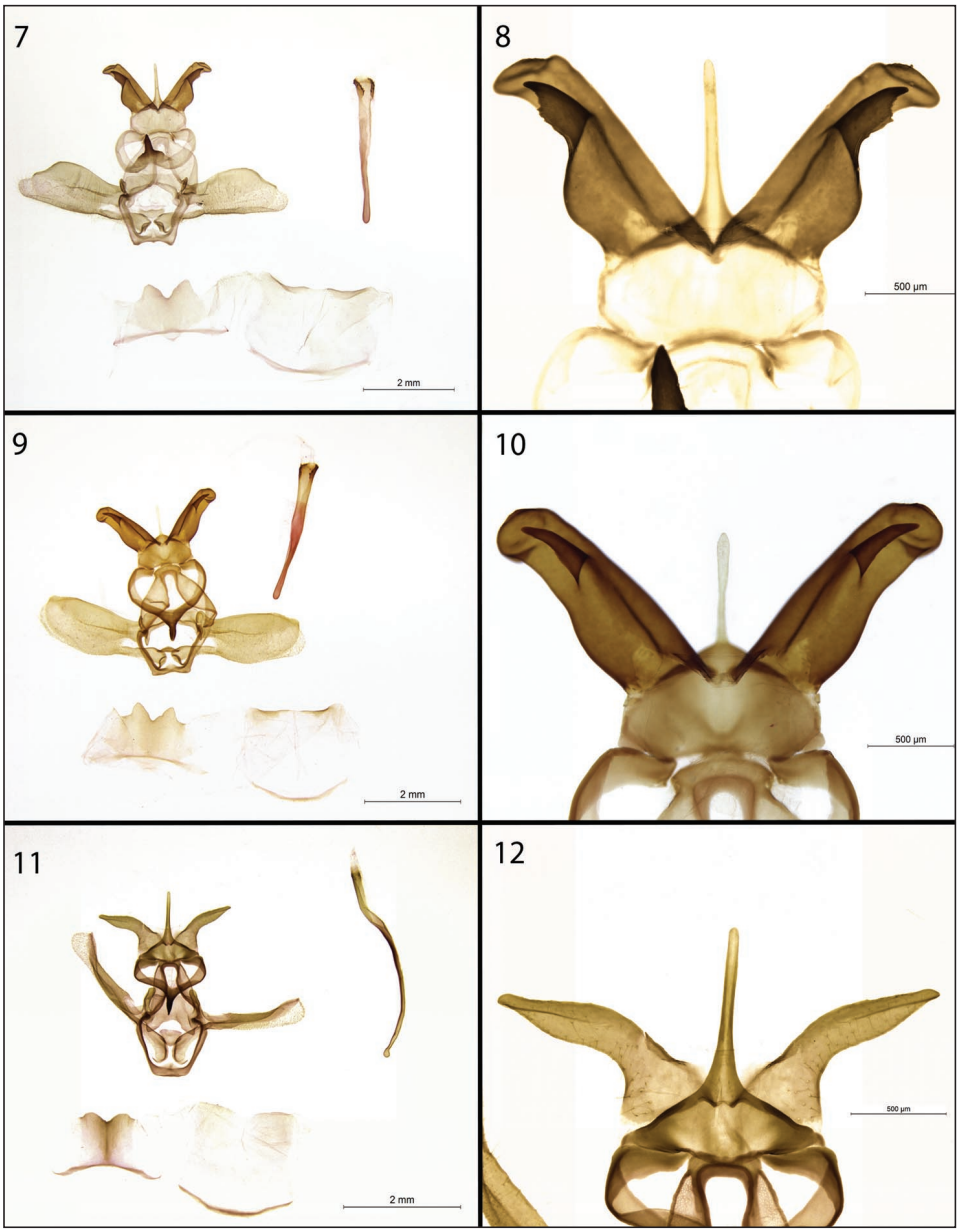


Figures 1-6. *Rhodochlora rufaria* Warren and *Rhodochlora elias* Viidalepp, sp. nov. and *Rhodochlora ylle* Lindt, sp. nov. **1.** *Rhodochlora rufaria* Warren (male, Ecuador). **2.** *R. elias* Viidalepp, sp. nov. (holotype male, Fr. Guiana). **3.** *R. ylle* Lindt, sp. nov. (holotype male, Costa Rica). **4.** *R. elias* Viidalepp, sp. nov. (holotype female, French Guiana). **5.** *R. elias* Viidalepp, sp. nov., male antenna and hindleg. **6.** *R. ylle* Lindt, sp. nov., male antenna and hindleg.



Figures 7-12. *Rhodochlora rufaria* Warren and *Rhodochlora elias* Viidalepp, sp. nov. and *Rhodochlora ylle* Lindt, sp. nov. **7.** *R. rufaria* male genital armature, aedeagus and the last sternite. **8.** *R. rufaria*, socii (enlarged). **9.** *R. elias* Viidalepp, sp. nov., male genital armature, aedeagus and the last sternite. **10.** *R. elisa* Viidalepp, sp. nov., socii (enlarged). **11.** *R. ylle* Lindt, sp. nov., male genital armature, aedeagus and the last sternite. 12. *R. ylle* Lindt, sp. nov., socii (enlarged).