



## **Description of a New *Lucillella* Species (Riodinidae: Symmachiini) Discovered in the Eastern Andes of Ecuador Using the Single Rope Canopy Access Technique**

Authors: Hall, Jason P. W., and Willmott, Keith R.

Source: The Journal of the Lepidopterists' Society, 64(3) : 139-146

Published By: The Lepidopterists' Society

URL: <https://doi.org/10.18473/lepi.v64i3.a2>

---

BioOne Complete ([complete.BioOne.org](https://complete.BioOne.org)) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at [www.bioone.org/terms-of-use](https://www.bioone.org/terms-of-use).

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

---

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

DESCRIPTION OF A NEW *LUCILLELLA* SPECIES (RIODINIDAE: SYMMACHIINI) DISCOVERED IN THE EASTERN ANDES OF ECUADOR USING THE SINGLE ROPE CANOPY ACCESS TECHNIQUE

JASON P. W. HALL

Department of Entomology, National Museum of Natural History, Smithsonian Institution, Washington, DC 20560-0127, USA

AND

KEITH R. WILLMOTT

McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History, University of Florida, Gainesville, FL 32611, USA

**ABSTRACT.** A new rioidinid species in the tribe Symmachiini, *Lucillella arcoirisa* Hall & Willmott n. sp., is described from the eastern Andes of Ecuador. All five true members of the genus *Lucillella* Strand, 1932, are figured, and their known geographic ranges are mapped. *Lucillella* is hypothesized to be monophyletic with the exclusion of *suberra* Hewitson, 1877, and the sister genus is hypothesized to be *Esthemopsis* C. & R. Felder, 1865. The new *Lucillella* species was discovered in the forest canopy using the single rope technique. The equipment and procedures used in this canopy access method are described and illustrated.

**Additional key words:** canopy diversity, canopy sampling methods, montane forest, South America

Vertical stratification within tropical forest butterfly communities is now a well-known phenomenon (e.g., Papageorgis 1975; Burd 1994; Beccaloni 1997; DeVries *et al.* 1997). However, studying butterflies that fly in the upper-most levels of the forest, beyond the reach of even the most long-handled nets, is physically problematic. Fogging techniques, involving the use of portable machines to spray insecticide into the canopy of targeted trees, have been a boon to the study of some of the more sessile insect taxa, such as Coleoptera, Hemiptera, and Hymenoptera (e.g., Adis *et al.* 1998), but adult butterflies are far too mobile to be sampled in this way. The most commonly used method to sample midstory and canopy butterfly species is bait trapping. Such trapping methods have made a significant contribution to our knowledge of subtropical and tropical butterfly faunas, including the discovery of new species (e.g., Hall & Willmott 1998) and the improvement of species distribution data. Without the use of traps, a large proportion of any given butterfly community is likely to remain completely unseen, even after hundreds of man-hours of sampling (Hardy & Dennis 2005). Nevertheless, bait traps have two major disadvantages. Firstly, no bait attracts all species of interest. For example, although rotting carrion is the most effective known bait for Riodinidae, there are still many genera and species that have never been found on any bait, or indeed observed feeding at all during the adult stage (Hall & Willmott 2000). Secondly, the relative abundance of species in bait traps may be strongly dependent on differences in bait preference and mobility, thus providing a poor estimate of true abundance.

By making direct observations from within the midstory and canopy, species may be recorded that are unlikely to be sampled by any other method, and the true abundance and behavior of species that are otherwise never seen in their natural habitat may be studied. Canopy rafts (e.g., Lowman *et al.* 1993), canopy towers (e.g., Burd 1994), and canopy cranes (e.g., Parker *et al.* 1992; Basset *et al.* 2003) all provide a means of directly observing midstory and canopy species, but the usual goals of such canopy sampling projects are to study herbivory or total arthropod diversity, and we do not know of any Neotropical butterfly inventories that have widely employed canopy access techniques. For the majority of tropical Lepidoptera researchers, mobility, flexibility, and/or cost are the major factors that limit the practical use of all these methods. An alternative that is cost effective and applicable to any forest site is the use of rope techniques to access the midstory and canopy. There are a bewildering variety of such techniques available, developed mainly by cave explorers, professional arborists, and recreational tree climbers (e.g., Dial & Tobin 1994; Smith & Padgett 1996; Jepson 2000). Perry (1978) provided one of the first descriptions of a method suitable for tropical ecologists, which is now generally known as the single rope technique. This method enables the researcher to quickly place ropes and then make relatively easy ascents and descents, with a minimum of equipment that can be carried along rough trails by a single person. During the last few years, we have increasingly used this method to aid our long-term study of the butterflies of Ecuador (see [www.butterfliesofecuador.com](http://www.butterfliesofecuador.com)). We have successfully



FIG. 1. One of the authors (KRW) using the single rope climbing equipment in Ecuador.

used the single rope technique in both lowland and montane forest in Ecuador to collect specimens and make observations at heights varying from 5 to 30 meters above the ground (see Fig. 1).

During recent fieldwork at the Fundación Arcoiris montane forest reserve in the upper Zamora valley of southeastern Ecuador, the single rope technique was used to survey butterflies in several different microhabitats at elevations between 1900 and 2200 meters. During a rope survey conducted approximately 20 meters above a stream gully, to investigate a diverse array of butterflies seen flying above a dense midcanopy layer of *Cecropia* Loeffl. trees, one of the species captured was a new species of *Lucillella* Strand, 1932, which to our knowledge has never previously been seen or collected. *Lucillella* is a small genus of rare, aposematically brightly colored rioidinid butterflies in the tribe Symmachiini that is confined to elevations between about 900 and 2200 meters in the northern and central Andes of South America. The members of this sizeable tribe are among the rarest in the family, and they are only very infrequently attracted to baited traps (Hall & Willmott 2000), meaning that they have to be sampled by traditional hand-netting techniques. The Symmachiini is exactly the kind of butterfly group in which innovative canopy sampling methods would be expected to uncover new taxa. In this paper, we first describe and illustrate the equipment and specific procedures that we have used to conduct canopy surveys of butterflies in Ecuador, and then we describe

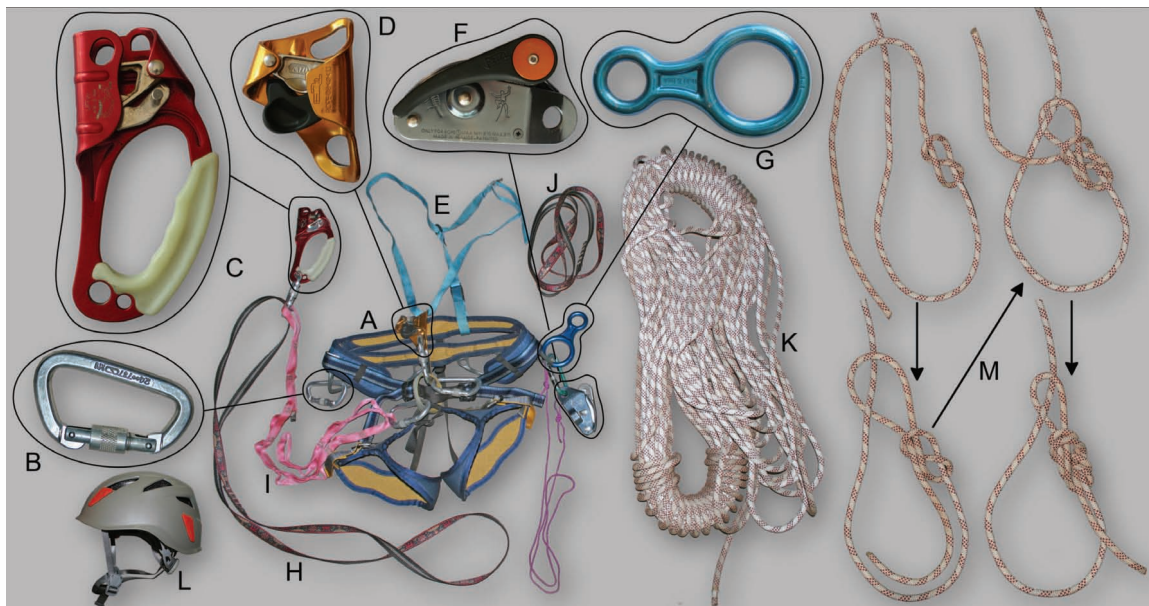


FIG. 2. Single rope climbing equipment. **A.** Petzl Calidris climbing harness. **B.** Screw-lock carabiner, 24 kN (x 5). **C.** Ascender (jummar). **D.** Croll. **E.** Croll harness (torse). **F.** Petzl Grigri descending device. **G.** Figure-8 descender. **H.** Sling (120 cm). **I.** "Daisy-chain" sling. **J.** Spare sling (120 cm) for attaching harness to tree limb. **K.** Static climbing rope (11 mm) x 80 m. **L.** Petzl Altios climbing helmet. **M.** Steps in tying a figure-8 knot.

the new species of *Lucillella* in the context of a taxonomic overview of the genus.

## METHODS

### Single Rope Canopy Access Technique

*Basic equipment:* Most of the equipment we use is illustrated in Fig. 2. It weighs approximately 8 kg. Other essential items include a lead fishing weight, a thin throwing line, and a 5 mm line for raising the rope. Close-focusing binoculars (< 2 meters) are valuable for recording species that are out of reach of the net. We use “static” rope (Fig. 2K) rather than the more elastic rock-climbing rope, but since “static” rope will break after a much shorter fall, it is important to maintain tension on the rope attaching the climber to the tree at all times. We carry 80 meters of rope, giving access up to 40 meters, but in practice 50 meters will suffice for most sites. Rope is most easily stored in a canvas sack or old rucksack, into which it is placed as it is hauled in from a tree.

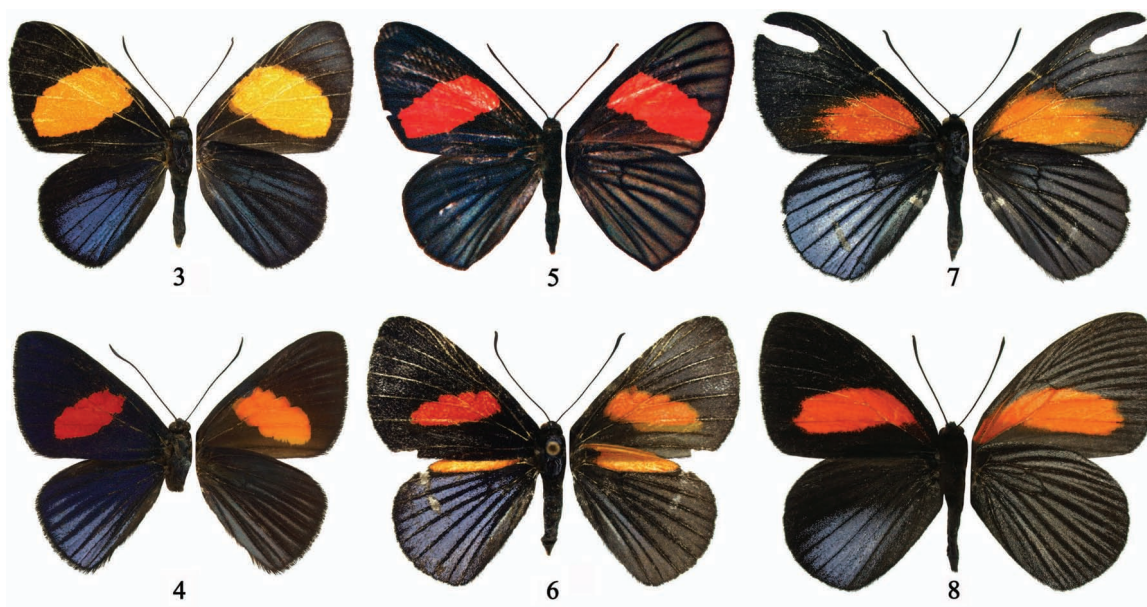
*Choosing a rope site:* Rope sites can be random or designed to sample areas where butterflies congregate, such as perching or feeding sites. In our experience, the most productive sites are hilltop and streamside lightgaps, and flowering trees. Leaning, dead, or dying trees should obviously be avoided, and Hymenoptera nests are a further concern, so a thorough preliminary inspection of a targeted supporting tree is necessary (e.g., see Jepson 2000). The rope should pass over a crotch between branches rather than over a single branch, and ideally should pass over at least one other branch or crotch to provide a back up. The rope should ideally be placed to provide access to an additional limb, as it is considerably easier to net butterflies, as well as use binoculars, while sitting or standing on a limb.

*Placing the rope:* We use a 5 oz (c. 150 g) lead fishing weight attached to light polyethylene builder’s line to initially pass a line over the rope site. The underarm throwing method is physically the easiest, although considerable practice may be necessary to achieve accuracy. The string is held approximately 50 cm above the weight (a slip knot may be useful to help grip the string), and the weight is swung slowly back and forth in a pendular motion through an arc of approximately 90 degrees, with the arm remaining parallel to the string. The momentum of the weight is used to launch it upwards, and remarkably little effort is required to reach the canopy of even the tallest trees. An alternative method is to use an overarm throw. It is more precise at shorter distances, but is physically more demanding and cannot attain the same heights as the underarm method. Devices such as modified crossbows and shotguns are also in use, but they suffer from the disadvantages of

being expensive, bulky to carry, potentially difficult to transport across international borders, and vulnerable to mechanical failure in the field. One possible low-tech alternative is a robust slingshot. Once the initial line is in place, a thicker 5 mm line, which is readily available in any hardware store throughout the tropics, is attached and pulled over the tree limb, then used to pull the climbing rope into place. This thicker line can be left in place after climbing to permit the site to be easily revisited. With the climbing rope in place over the tree limb, one end needs to be firmly attached at ground level. We tie the rope around the base of the climbing tree using a figure-8 knot as a slip knot (see Fig. 2L). Although rather cumbersome, the figure-8 knot has the advantages of being secure, easy to learn and remember, and easy to check.

*Ascending:* The method of ascent relies on two mechanical devices, the croll (Fig. 2D) and the ascender (Fig. 2C), one of which is moved up the rope and then locked in place, providing the leverage to advance the other device. Hanging from the croll, which is anchored to the harness (Fig. 2A), the climber moves the ascender up the rope, places a foot in the sling (Fig. 2H) attached to the ascender, and “stands up”. This movement advances the croll up the rope. The climb continues with alternating sitting and standing movements until the desired height is reached. If a branch is available on which to stand or sit, a sling (Fig. 2J) may be used to provide extra security by looping it around the trunk or another branch and fastening to a carabiner attached to the harness. The rope attachments (croll and ascender) should not be removed until the grigri descending device is attached and checked. If a mid-air position is unavoidable, we have found that surveys of up to 2 hours are possible, but a simple wooden swing attached to an additional ascender can greatly reduce any discomfort.

*Descending:* The transition from ascending to descending is one of the most difficult and potentially dangerous stages of any climb. We use a grigri descending device (Fig. 2F), which locks automatically when the handle is released, but we also suggest carrying a figure-8 descender as a back up (Fig. 2G). The grigri is first attached to the rope immediately below the croll, paying close attention to the rope direction, and then clipped into a third harness carabiner. Once the grigri is attached to both rope and carabiner, the climber stands up on the sling attached to the ascender to release the tension on the croll, and detaches the croll from the rope. At this point, the climber will be supported entirely by the grigri, and can reach up and detach the ascender. Cranking the handle of the grigri allows a controlled descent.



FIGS. 3–8. *Lucillella* and *Hades* adult males (dorsal surface on left, ventral surface on right). **3.** *Lucillella camissa* (Hewitson, 1870), Río Pindo Grande, Shell, E. Ecuador (JHKW). **4.** *Lucillella aterra* (Grose-Smith, 1898), Valdevia, C.W. Colombia (MNHN). **5.** *Lucillella pomposa* (Stichel, 1910), holotype, Marcapata, S.E. Peru (ZMHU). **6.** *Lucillella splendida* Hall & Harvey, 2007, holotype, Arcabuco, C. Colombia (USNM). **7.** *Lucillella arcoirisa* Hall & Willmott n. sp., holotype, Río San Francisco, Loja-Zamora rd., E. Ecuador (FLMNH). **8.** *Hades hecamede* Hewitson, 1870, Río San Francisco, Loja-Zamora rd., E. Ecuador (JHKW), a hypothesized co-mimic of *Lucillella arcoirisa*.

**Safety issues:** It must be remembered that rope climbing is a potentially dangerous activity, and it is highly advisable not to climb alone. Before attempting to climb, we highly recommend reading widely on the subject of canopy access in general and the single rope technique in particular. It is absolutely necessary to receive prior training from a local climbing club and/or an experienced rope-climbing colleague.

### Taxonomy

The terminology for male genital and abdominal structures largely follows Klots (1956), Eliot (1973), and Harvey (1987a), and nomenclature for venation follows Comstock & Needham (1918), with cells named for the vein above. The dissection methods used followed those outlined in Hall (2005). The following collection acronyms are used throughout the text: BMNH - The Natural History Museum, London, England; FLMNH - Florida Museum of Natural History, Gainesville, FL; JHKW - Collection of Jason P. W. Hall and Keith R. Willmott, Washington, DC, USA; MNHN - Muséum National d'Histoire Naturelle, Paris, France; USNM - National Museum of Natural History, Smithsonian Institution, Washington, DC, USA; ZMHU - Zoologisches Museum, Humboldt Universität, Berlin, Germany.

### Description of New *Lucillella* Species

#### *Lucillella arcoirisa* Hall & Willmott, new species (Figs. 7; 9; 10)

**Description:** MALE: Forewing length 24 mm. *Wing shape:* Both wings slightly elongate; base of forewing costa very slightly convex, anal margin very slightly convex basally, and distal margin convex; hindwing rounded, with a rounded tornus and apex. *Dorsal surface:* Forewing pale black, with a subtle dark blue iridescence across distal half of wing; a large, somewhat oval, dark orange patch extends from near wing base two-thirds distance towards distal margin, is bounded by upper margin of discal cell and vein 2A, and has an uneven, streaky distal margin; forewing fringe pale black; hindwing predominantly chalky pale blue overlaid with a subtle dark blue iridescence, except for some whitish-blue scales through middle of cells  $Cu_2$  to  $M_2$ , grayish-black costal and anal margins, a proximally black discal cell, a narrow black area along distal margin of apex, a very narrow line of black scaling along remainder of distal margin, and black scaling outlining all veins, a wing crease through middle of cell  $Cu_{2+3}$ , and a short diagonal line just inside lower half of discal cell end; hindwing fringe black. *Ventral surface:* Forewing brown with some orange scaling along anal margin below vein 2A, orange in approximately basal half of wing, with orange patch occupying nearly all of discal cell, very base of cell  $M_3$ , basal half of cell  $Cu_1$ , and all but very base of cell  $Cu_2$ , and metallic bluish gray overlaid with a subtle dark blue iridescence in distal half of wing, with black scaling outlining distal veins and along entire distal margin; hindwing predominantly metallic bluish gray overlaid with a subtle dark blue iridescence, except for an uneven area of black scaling along costal margin, a very narrow line of black scaling along distal margin, and black scaling outlining all veins, a wing crease through middle of cell  $Cu_{2+3}$ , and a short diagonal line just inside lower half of discal cell end.

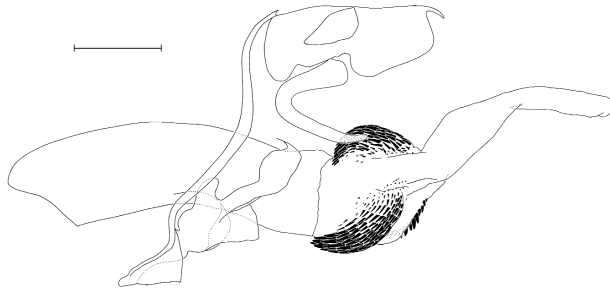


FIG. 9. Male genitalia of *Lucillella arcoirisa* in lateral view. Scale bar = 0.5 mm.

**Head:** Eyes brown and bare, with black marginal scaling; frons black; labial palpi black; antennal length approximately 60% of forewing length, segments black with a small section of whitish scaling at base, nudum along inner ventral margin discontinuous, clubs black.

**Body:** Dorsal and ventral surfaces of thorax and abdomen black; a narrow, medially divided band of concealed androconial scales along anterodorsal margin of tergites four, five, and six; all legs black.

**Genitalia** (Fig. 9): Uncus approximately rectangular in lateral view, with a long, downwardly curved posterior projection from middle of dorsal posterior margin; tegumen with a broad ventral lobe; falces large, with a slightly broader base, a rounded "elbow", and a slightly upturned tip; vinculum an evenly narrow and moderately sinuous ribbon that is fused to dorsal portion of anterior margin of tegumen, saccus in lateral view broadly triangular and of medium length, with a slightly downwardly directed anterior tip; valvae in lateral view somewhat dorsally elongate and positioned at a 45° angle, with a small, narrow, and slightly posteriorly curved anterodorsal portion, a broadly rectangular posteroventral portion, and a narrowly elongate medial portion that slightly broadens and angles dorsally at middle, valves fused at base; aedeagus somewhat short, evenly very broad, and weakly convex, with an upturned and angular posterior tip that is slightly posteriorly projecting along dorsal margin, anterior end opens anteroventrally and posterior tip opens posteriorly, everted vesica very bulbous at base before abruptly narrowing to become an evenly narrow tube, with three evenly spaced, approximately parallel cornutal bands, consisting of two bulbous dorsolateral to lateral bands of small, densely packed, anteriorly flattened spines, and a single ventrolateral line of slightly larger and more erect anteriorly directed spines, and numerous very tiny spines sparsely distributed between these cornutal bands (too small to be illustrated); pedicel short, broad, and strap-like, ventrally joining aedeagus at its middle; eighth abdominal tergite and sternite approximately square.

FEMALE: Unknown.

**Types:** *Holotype male*, ECUADOR: *Zamora-Chinchipe*, Río San Francisco, km 24 Loja-Zamora rd., Reserva Arcoiris, 3°59.30'S 79°50.58'W, 2050 meters, 3 Dec 2006 (K. R. Willmott) (FLMNH).

No additional specimens have been located in the major museums of Europe, North America, and South America (as listed in Hall 1999, 2005; Willmott 2003).

**Etymology:** This species is named after the Fundación Arcoiris, which promotes conservation in southern Ecuador and owns the reserve where the species was discovered. The Spanish word "arcoiris", meaning rainbow, is also an appropriate descriptor for such a beautifully patterned species.

**Systematic placement and diagnosis:** The genus *Lucillella* Strand, 1932, first proposed by Hewitson

(1870) under the preoccupied name *Lucilla*, was treated by Stichel (1910-11, 1930-31) in what is now the tribe Riodinini, but was correctly moved to the tribe Symmachiini by Harvey (1987a) on the basis of its males possessing concealed androconial scales along the anterodorsal margin of certain abdominal tergites. Throughout the twentieth century, *Lucillella* was treated by most authors as containing three species, *L. camissa* (Hewitson, 1870), *L. aterra* (Grose-Smith, 1898), and *L. suberra* (Hewitson, 1877) (e.g., Stichel 1910-11; Seitz 1916-20; d'Abreu 1994). With the elevation of *L. pomposa* (Stichel, 1910) to species status from a subspecies of *L. aterra* (Hall & Harvey 2002), and the recent description of the new species *L. splendida* Hall & Harvey, 2007 (Hall & Harvey 2007), *Lucillella* is currently recognized as containing five species. However, the wing pattern and morphology of *suberra* are highly divergent, and the species does not appear to form a monophyletic group with the remaining four described members of *Lucillella* (Hall & Harvey 2002 [see Table 3], 2007). These four species, *L. camissa*, *L. aterra*, *L. pomposa*, and *L. splendida*, along with the new species *L. arcoirisa* described here, do however form a rather homogeneous group that seems to be monophyletic.

All five of these *Lucillella* species, illustrated in Figs. 3-7, are medium to large sized riodinids, with a relatively compact wing shape. The dorsal forewing is black with a broad orange to red band across its middle to base, the dorsal hindwing is predominantly pale to medium blue with variably broad black margins and all veins outlined with black scaling, and both dorsal wings have a variably prominent dark blue iridescence when viewed at an angle. The ventral surface is rather similar to the dorsal surface, but the hindwing and distal half of the forewing are a dully-iridescent blue or green with the veins outlined in black. Also outlined in black on the ventral (and sometimes dorsal) hindwing is a wing crease through the middle of cell  $Cu_2$  and a short diagonal line just inside the lower half of the discal cell end, which forms one side of a small black triangle. Although the former character occurs in certain other genera, the latter character appears to be unique to *Lucillella*. In a few species of *Xenandra* C. & R. Felder, 1865, a similar black triangle occurs in the discal cell of the forewing. In contrast, *suberra* is a slightly smaller species, with narrow and elongate wings, no blue on the dorsal hindwing, no dark blue iridescence on both dorsal wings, a pale brown instead of dully-iridescent blue or green ventral surface, and no black scaling along a line through cell  $Cu_2$  or inside the discal cell end on the ventral hindwing.

The male genitalia of the five true *Lucillella* species

are characterized by a long, rectangular uncus bearing a prominent, downwardly curved projection from the middle of the dorsal posterior margin, and relatively large falces. The typically tripartite valvae are positioned at a roughly 45° angle in lateral view, and consist of a small, variably narrow, and slightly posteriorly curved anterodorsal portion, a generally rectangular posteroventral portion, and a dorsally elongate medial portion that is often posteriorly pointed at its tip. The aedeagus is somewhat short, very broad, and slightly medially convex, and the everted vesica is variably bulbous basally and bears three evenly spaced, approximately parallel, basal bands of small, anteriorly directed spine-like cornuti, two of which are large, oval, and dorsolaterally to laterally positioned, and one of which consists of a single row of slightly larger, ventrolaterally positioned spines. As *L. camissa* is the only true *Lucillella* species whose female appears to be known, no generalizations can yet be made about the female genitalia of the genus. In contrast, *suberra* has a short, square uncus bearing a tiny dorsal posterior projection, relatively small falces, a prominently convex aedeagus, and, most critically, a very different valve complex and everted vesica. The valvae consist of a long, dorsally, and slightly outwardly directed, narrowly rectangular, and very slightly medially convex main section, with a small, inwardly directed oval process attached anterodorsally by membranous tissue. The everted vesica is a uniformly narrow tube, with a pair of rather small, anteriorly directed, “hand”-like cornutal patches situated laterally at its very base, and a cluster of approximately eight very long and narrow, anterolaterally directed spines originating from the middle of its right side. As the wing pattern and morphology of *suberra* do not match those of any species in *Lucillella*, as defined here, or any other genus, it seems likely that *suberra* will eventually need to be placed in its own monotypic genus. Until such time as a more exhaustive generic-level study of the tribe can be completed (Hall in prep.), we prefer to retain *suberra* in *Lucillella* as a misplaced species rather than transfer it temporarily to another probably more distantly related genus (see below).

The sister genus to *Lucillella* is probably *Esthemopsis* C. & R. Felder, 1865 (Hall & Harvey 2002 [see Table 3]), based on similarities in the male genitalia, particularly the arrangement of cornuti on the everted vesica and the basic underlying structure of the valvae, and to a lesser extent certain ventral wing pattern elements, as well as the fact that both genera share the same distribution pattern of concealed male abdominal androconia. The males of all true *Lucillella* and *Esthemopsis* species have a narrow, medially divided

band of androconial scales along the anterodorsal margin of tergites four, five, and six (Harvey 1987a; Hall & Willmott 1996; Hall & Harvey 2002). The only other symmachiine species with this androconial arrangement is *suberra*, suggesting that this species probably does have a close phylogenetic relationship with *Lucillella* and *Esthemopsis*, perhaps as their sister taxon.

Based on similarities in size, wing shape, wing pattern, and male genitalia, *L. arcoirisa* seems to be most closely related to the Colombian species *L. splendida*. Externally, *L. arcoirisa* differs from *L. splendida* by having a slightly more elongate wing shape, with a slightly less prominently convex forewing distal margin, and a forewing band that is twice as broad, dark orange instead of red, basally instead of discally positioned, and more elongate on the ventral surface, reaching the tornus, and by lacking a yellow bar along the costal margin of both hindwing surfaces. The male genitalia of the two species are similar, but differ slightly in the shape of the valvae, the male genital structure that exhibits the most interspecific variation in *Lucillella*. In the valvae of *L. arcoirisa*, the posterior margin of the rectangular posteroventral section curves anteriorly towards the medial section of the valvae instead of continuing in a straight line, and the posterior margin of the medial section of the valvae is approximately straight in its dorsal half instead of medially indented, leaving the posterior valve tip rounded instead of slightly posteriorly projecting.

**Biology:** This very rare species was found in wet montane forest at 2050 meters. Based on the type locality of the close relative *L. splendida*, which lies near the upper elevational limit for the family Riodinidae, the upper elevational limit for *L. arcoirisa* is likely to be close to 2200 meters. Based on the elevational ranges of other riodinids that occur with *L. arcoirisa* at 2050 meters, the lower elevational limit for *L. arcoirisa* is likely to be around 1500–1600 meters. Males of *L. arcoirisa* were discovered perching high above a small, vegetation-choked stream from about 1245 to 1315 hrs. From ground level, in the relatively gloomy understory, the butterfly activity above was barely discernible. However, by using the single rope technique to ascend above the dense midstory layer of streamside *Cecropia* trees, it became apparent that several riodinid species, among others, were perching in the sunny subcanopy, about 12 to 15 meters above the ground. The *Lucillella* males flew with a slow fluttering flight and landed beneath the tips of *Cecropia* leaves with their wings outspread. Although several *Lucillella* males were seen, given the difficult collecting conditions, only a single individual could be captured.

Another riodinid species found flying in this same

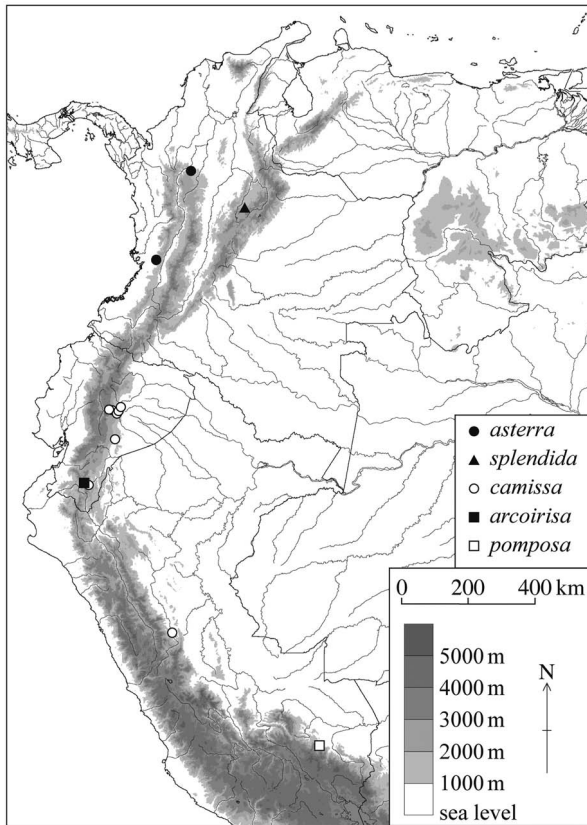


FIG. 10. Map of the northern and central Andes showing the known geographic ranges of the five true *Lucillella* species. The data points are based on the following locality data gleaned from the BMNH, ZMHU, MNHN, USNM, FLMNH, and JHKW: *L. camissa* (ECUADOR: Tungurahua: Mapoto; Pastaza: Cashurco, Shell, Puyo, Río Llandia [Puyo-Tena rd.]; Morona-Santiago: Macas; Zamora-Chinchipe: Quebrada de Chorrillos [above Zamora]. PERU: Huánuco: Tingo Maria); *L. asterra* (COLOMBIA: Antioquia: Valdivia; Valle del Cauca: upper Calima valley); *L. pomposa* (PERU: Cuzco: Marcapata); *L. splendida* (COLOMBIA: Boyacá: Arcabuco); *L. arcoirisa* (ECUADOR: Zamora-Chinchipe: Río San Francisco [above Zamora]).

subcanopy lightgap was *Hades hecamede* Hewitson, 1870, a large member of the subfamily Euselasiinae (see Fig. 8). The males of *L. arcoirisa* and *H. hecamede* have such similar wing patterns and flight behaviors, it was not until a *Lucillella* male was actually netted that its true identity was realized. At a distance, the two species could only be readily separated when they landed, with *L. arcoirisa* resting with its wings open and *H. hecamede* resting with its wings closed. The remarkable similarity in the wing patterns of these two unrelated species, which fly in the same montane streamside habitats, suggests that there may be a mimetic relationship. It is certainly notable that the only other member of *Hades*, the white-rayed *H. noctula* Westwood, 1851, from the Transandean region, and most, if not all, of the other,

aposematically brightly colored, *Lucillella* species appear to be involved in their own mimetic relationships. Given that the caterpillars of *H. noctula* are known to feed on plants in the Anacardiaceae, the caterpillars and pupae are gregarious (Harvey 1987b; Janzen & Hallwachs 2009), and fresh adults will exude drops of an oily brown fluid from the thorax when handled, in a manner similar to many arctiid moths (DeVries 1997), *H. hecamede* would seem to be a possible model in this mimicry system. With no good evidence to suggest that any members of the Symmachiini are unpalatable to predators, *L. arcoirisa* is probably a Batesian mimic. Other members of this mimicry ring might include the similarly patterned, although larger, members of the pierid genus *Pereute* Herrich-Schäffer, 1867, which fly with a slow gliding flight in the same streamside habitats.

**Distribution:** *Lucillella arcoirisa* is currently known only from the type locality in the southeastern Andes of Ecuador. However, given that no two *Lucillella* species are known to be sympatric (see Fig. 10 for the known distributions of all five true *Lucillella* species), with the most closely related species apparently geographically allo- or parapatrically distributed (e.g., *L. asterra* and *L. camissa*) and the more distantly related species elevationally allo- or parapatrically distributed (e.g., *L. arcoirisa* and *L. camissa*), the true distribution of *L. arcoirisa* can be estimated. We suggest that *L. arcoirisa* probably ranges from eastern Colombia to at least central eastern Peru, whereas the close relative *L. splendida* is probably confined to central Colombia and perhaps the Chocó.

#### ACKNOWLEDGEMENTS

We thank the National Science Foundation (DEB #0103746 and #0639977) for financial support of museum and field research; Fundación Arcoiris for providing accommodation and research support while conducting fieldwork in the upper Zamora valley; Julia Robinson Willmott for assistance and companionship during canopy ascents in the field; Chris Lear for invaluable advice on rope climbing techniques; the Ministerio del Ambiente and the Museo Ecuatoriano de Ciencias Naturales, in Quito, for arranging the necessary permits for research in Ecuador; and two anonymous reviewers for helpful comments on the manuscript.

#### LITERATURE CITED

- ADIS, J. A., Y. BASSET, A. FLOREN, P. M. HAMMOND, & K. E. LINSENAIR. 1998. Canopy fogging of an overstory tree—recommendations for standardization. *Ecotropica* 4: 93–97.
- BASSET, Y., V. HORLYCK, & S. J. WRIGHT (ed.). 2003. Studying Forest Canopies from Above: The International Canopy Crane Network. Smithsonian Tropical Research Institute and UNEP, Panama City, Panama. 196 pp.
- BECCALONI, G. W. 1997. Vertical stratification of ithomiine butterfly (Nymphalidae: Ithomiinae) mimicry complexes: the relationship between adult flight height and larval host-plant height. *Biol. J. Linn. Soc.* 62: 313–341.



- BURD, M. 1994. Butterfly wing colour patterns and flying heights in the seasonally wet forest of Barro Colorado Island, Panama. *J. Trop. Ecol.* 10: 601–610.
- COMSTOCK, J. H., & J. G. NEEDHAM. 1918. The wings of insects. *Amer. Nat.* 32: 231–257.
- D'ARRERA, B. 1994. Butterflies of the neotropical region, Part VI. Riodinidae. Hill House, Victoria, Australia. Pp. 880–1096.
- DEVRIES, P. J. 1997. The butterflies of Costa Rica and their natural history. Volume II: Riodinidae. Princeton University Press, Princeton, NJ. 288 pp.
- DEVRIES, P. J., D. MURRAY, & R. LANDE. 1997. Species diversity in vertical, horizontal, and temporal dimensions of a fruit-feeding butterfly community in an Ecuadorian rainforest. *Biol. J. Linn. Soc.* 62: 343–364.
- DIAL, R., & S. C. TOBIN. 1994. Description of arborist methods for forest canopy access and movement. *Selbyana* 15: 24–37.
- ELIOT, J. N. 1973. The higher classification of the Lycaenidae (Lepidoptera): a tentative arrangement. *Bull. Brit. Mus. Nat. Hist. (Ent.)* 28: 373–506.
- HALL, J. P. W. 1999. A revision of the genus *Theope*: its systematics and biology (Lepidoptera: Riodinidae: Nymphidiini). Scientific Publishers, Gainesville, FL. 127 pp.
- . 2005. A phylogenetic revision of the Napaeina (Lepidoptera: Riodinidae: Mesosemiini). The Entomological Society of Washington, Washington, DC. 235 pp.
- HALL, J. P. W., & D. J. HARVEY. 2002. A survey of androconial organs in the Riodinidae (Lepidoptera). *Zool. J. Linn. Soc.* 136: 171–197.
- . 2007. Three new species of Symmachiini from Panama and Colombia (Lepidoptera: Riodinidae). *Trop. Lepid.* 16: 7–10.
- HALL, J. P. W., & K. R. WILLMOTT. 1996. Systematics of the riodinid tribe Symmachiini, with the description of a new genus and five new species from Ecuador, Venezuela and Brazil (Lepidoptera: Riodinidae). *Lambillionea* 96: 637–660.
- . 1998. Three new species of Riodinini from the cloud forests of Ecuador (Lepidoptera: Riodinidae). *Trop. Lepid.* 9(suppl. 1): 22–26.
- . 2000. Patterns of feeding behaviour in adult male riodinid butterflies and their relationship to morphology and ecology. *Biol. J. Linn. Soc.* 69(1): 1–23.
- HARDY, P. B., & R. L. H. DENNIS. 2005. Is richness of local tropical butterfly faunas underestimated? Perspectives gained from biases in transect observations. *Acta Zool. Sin.* 51(2): 237–250.
- HARVEY, D. J. 1987a. The higher classification of the Riodinidae (Lepidoptera). Ph.D. Dissertation. University of Texas, Austin, TX. 216 pp.
- . 1987b. Riodinidae (Papilionoidea), pp. 446–447. *In*: Stehr, F. W. (ed.), *Immature insects*. Marshall/Hunt Publishing Company, Dubuque, IA.
- HEWITSON, W. C. 1870. Remarks on and descriptions of new species of butterflies collected by Mr. Buckley in Ecuador. *John Van Voorst*, London, UK. 4: 49–79.
- JANZEN, D. H., & W. HALLWACHS. 2009. Philosophy, navigation and use of a dynamic database ("ACG Caterpillars SRNP") for an inventory of the macrocaterpillar fauna, and its food plants and parasitoids, of the Area de Conservacion Guanacaste (ACG), north-western Costa Rica (<http://www.janzen.sas.upenn.edu>).
- JEPSON, J. 2000. The tree climber's companion. Beaver Tree Publishing, Longville, MN. 104 pp.
- KLOTS, A. B. 1956. Lepidoptera, pp. 97–110. *In*: Tuxen, S. L. (ed.), *Taxonomists' glossary of genitalia in insects*. Munksgaard, Copenhagen, Denmark.
- LOWMAN, M., M. MOFFETT, & H. B. RINKER. 1993. A new technique for taxonomic and ecological sampling in rain forest canopies. *Selbyana* 14: 75–79.
- PAPAGEORGIS, C. 1975. Mimicry in neotropical butterflies. *Am. Sci.* 63: 522–532.
- PARKER, G., A. P. SMITH, & K. P. HOGAN. 1992. Access to the upper canopy with a large tower crane. *Bioscience* 42: 664–671.
- PERRY, D. R. 1978. A method of access into the crowns of emergent and canopy trees. *Biotropica* 10(2): 155–157.
- SEITZ, A. 1916–20. 8. Familie Erycinidae, Volume 5, pp. 617–728. *In*: Seitz, A. (ed.), *Die Gross-Schmetterlinge der Erde*. A. Kernen, Stuttgart, Germany.
- SMITH, B., & A. PADGETT. 1996. On rope: North American vertical rope techniques. National Speleological Society, Huntsville, AL. 382 pp.
- STICHEL, H. F. E. J. 1910–11. Lepidoptera Rhopalocera. Fam. Riodinidae. *Genera Insectorum* 112: 1–452.
- . 1930–31. Riodinidae. *In*: Strand, E., *Lepidopterorum catalogus*, 38–41: 1–795. W. Junk, Berlin, Germany.
- WILLMOTT, K. R. 2003. The genus *Adelpha*: its systematics, biology and biogeography (Lepidoptera: Nymphalidae: Limenitidini). Scientific Publishers, Gainesville, FL. 322 pp.

*Received for publication 21 October 2008; revised and accepted 6 October 2009.*