

A new genus and three new species of Neotropical sawflies (Hymenoptera, Tenthredinidae) from Costa Rica, with host plants and life history notes

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Academic editor: Marko Prous | Received 8 August 2019 | Accepted 30 September 2019 | Published 31 October 2019

<http://zoobank.org/CA13DAAB-A1DA-4057-ACF8-CAC7495BAEE6>

Citation: Smith DR, Nishida K (2019) A new genus and three new species of Neotropical sawflies (Hymenoptera, Tenthredinidae) from Costa Rica, with host plants and life history notes. Journal of Hymenoptera Research 72: 45–65. <https://doi.org/10.3897/jhr.72.38908>

Abstract

Descriptions, host plants, and biological notes are given for three species of Tenthredinidae from Costa Rica. *Waldheimia saurauia* Smith & Nishida, **sp. nov.** (Blennocampinae) feeds on *Saurauia montana* Seem. (Actinidiaceae). *Leseha* Smith, **gen. nov.** (Selandriinae), includes two species that feed on ferns: *Leseha vespa* Smith & Nishida, **sp. nov.**, feeds on *Phlebodium pseudoaureum* (Cav.) Lellinger (Polypodiaceae) and *L. carranzae* Smith & Nishida, **sp. nov.**, feeds on *Elaphoglossum bellermannianum* (Klozsch) T. Moore, and *E. lingua* (C. Presl) Brack. (Dryopteridaceae). *Stromboceros cruralis* Konow, 1899 from Peru, *Dochmioglène cubitalis* Malaise, 1954 from southern Brazil, *Siobla joergenseni* Schrottky, 1913 from northern Argentina, *Selandria limbata* Kirby, 1882 from Brazil, and *Strongylogaster strigatus* Enderlein, 1920 from southern Brazil, are all transferred to *Leseha* (**combs. nov.**).

Keywords

Blechnum, Blennocampinae, *Elaphoglossum*, *Phlebodium*, *Saurauia*, Selandriinae, taxonomy, *Waldheimia*

Introduction

A number of host plants and life histories of Central American sawflies were given in the publications by Kimsey and Smith (1985), Smith and Janzen (2003a, b), and Smith et al. (2013); however, there remains much to be discovered. Field work in Costa Rica by KN has provided the host plants and life histories of three additional species. All three species were previously undescribed, and two belong to a new genus. Two species belonging to the subfamily Selandriinae were reared from larvae feeding on ferns, *Elaphoglossum* sp. (Dryopteridaceae) and *Phlebodium pseudoaureum* (Cav.) Lellinger (Polypodiaceae). The other, a new species of *Waldheimia* of the subfamily Blennocampinae, was feeding on the tropical tree *Saurauia montana* Seem. (Actinidiaceae). Such discoveries are significant, and here we describe these sawflies and give notes and illustrations on their biology.

Materials and methods

The hosts and biology of the three species treated were studied in the field and under rearing conditions in area of the main building of Estación Biológica Monteverde (EBM), Puntarenas Province, Costa Rica, in between May and October in 2008, 2017 and 2018. EBM is a private biological research station with ca. 120 hectares of secondary and primary cloud forest preserve (Fig. 9), located on the Pacific slope of Tilarian Mountain Range. The coordinates of the study site are 10°19'07"N, 084°48'29"W, and the elevation approximately 1530 m. The climatic conditions of the area, according to Herrera Soto and Gómez Pignataro (1993), are tropical temperate humid with 3 to 4 months of dry season. The life zone ecology is considered lower mountain wet forest, with a mean annual rainfall of ca. 4000 mm and mean annual temperature of 17 °C (Bolaños and Watson 1993). The rainy season with typical afternoon thunder showers lasts from mid-May to November. December through February is a transition to the dry season with strong trade winds carrying drizzle rain and mist. Late February to mid-April becomes very dry (A. Pounds, pers. comm. 2014; KN personal observations 2013–2018). The general vegetation type is 'perpetually dripping cloud forest,' characterized by diverse and abundant epiphytes and epiphylls, dense understory shrubs, tree saplings, and large herbs (Haber et al. 2000; KN personal observations 2013–2018). The habitat of the study site is open with a gradient of rich native vegetation (man-modified native plant garden) with a few exotic plant species, surrounded by protected secondary forests.

Studied host plants are: *Saurauia montana*, *Phlebodium pseudoaureum* [syn. *P. areolatum* (Humb. & Bonpl. Ex Willd.) J. Sm.], *Elaphoglossum bellermannianum* (Klotzsch) T. Moore, *Elaphoglossum hammelianum* A. Rojas, and *E. lingua* (C. Presl) Brack. (Dryopteridaceae).

Eggs, larvae, and adults were collected and placed in translucent plastic bags (655 mm long by 430 mm wide) with their host plants. To rear, the plastic bags were brought inside the laboratory of KN at EBM. The tops of the plastic bags were tied in a twisted fold, clamped with a clothespin and hanged from a rope clamped with another

clothespin. Larvae were supplied with fresh leaves attached to stems and with or without roots and soil. To provide pupation sites for the larvae, dioramic aquarium chambers were prepared by putting a layer of soil (2–3 cm deep), pieces of rocks, and fallen dry tree branches and leaves. Host plants with mature last instar larvae were transferred to the dioramic aquariums. The dioramic aquariums were covered/enclosed with fine mesh fabric to provide airflow, control humidity, and to minimize entering and escaping of insects and other arthropods, and placed outside in ambient temperature under the roof. The soil inside the aquariums was kept relatively moist by spraying water. The plastic bags and aquariums were reviewed at least once a day. Emerged adults were kept alive for some days refrigerated in vials and then preserved in 95% ethanol. Some mature, last feeding instar larvae were preserved in 75% ethanol. Measurements of immature stages were made by digital caliper.

Life histories of each species (Figures 1, 9–16, 24–38, and 45–50) were recorded with the following digital cameras: Olympus Tough TG-5, OM-D E-M1 Mark II with 60 mm macro lens, Canon EOS 7D Mark II with 100 mm macro lens, and Sony DSC-RX100IV. Images were processed and edited by Adobe Lightroom Classic and Photoshop software.

Figures 2–8, 17–23, 39–44, and 51–55 were acquired by DRS through an EntoVision micro-imaging system. This system included a Leica M16 with and JVC KY-75U 3-CCD digital video camera or a GT-Vision Lw11057C-SC1 digital camera attached that fed image data to a notebook or desktop computer. The program Cartograph 6.6.0 was then used to merge an image series into a single in-focus image.

Morphological terminology follows Huber and Sharkey (1993).

Depositories for specimens are as follows. Ciencias Naturales y Museo, Universidad Nacional de La Plata, La Plata, Argentina (**LP**); The Natural History Museum, London, England, UK (**BMNH**); Museo de Zoología, Universidad de Costa Rica, San José, Costa Rica (**MZUCR**); National Museum of Natural History, Smithsonian Institution, Washington, DC (**USNM**); Naturhistoriska Riksmuseet, Stockholm, Sweden (**NHRS**); Polska Akademia Nauk, Instytut Zoologii, Warszawa, Poland (**PAN**); Senckenberg Deutsche Entomologische Institut, Müncheberg, Germany (**SDEI**); Museo Nacional de Costa Rica, Sede e Santo Domingo de Heredia (former collection of INBio (INBio = **MNCRA**)). Most of the larvae and parasitoid flies and wasps reared are deposited at MZUCR.

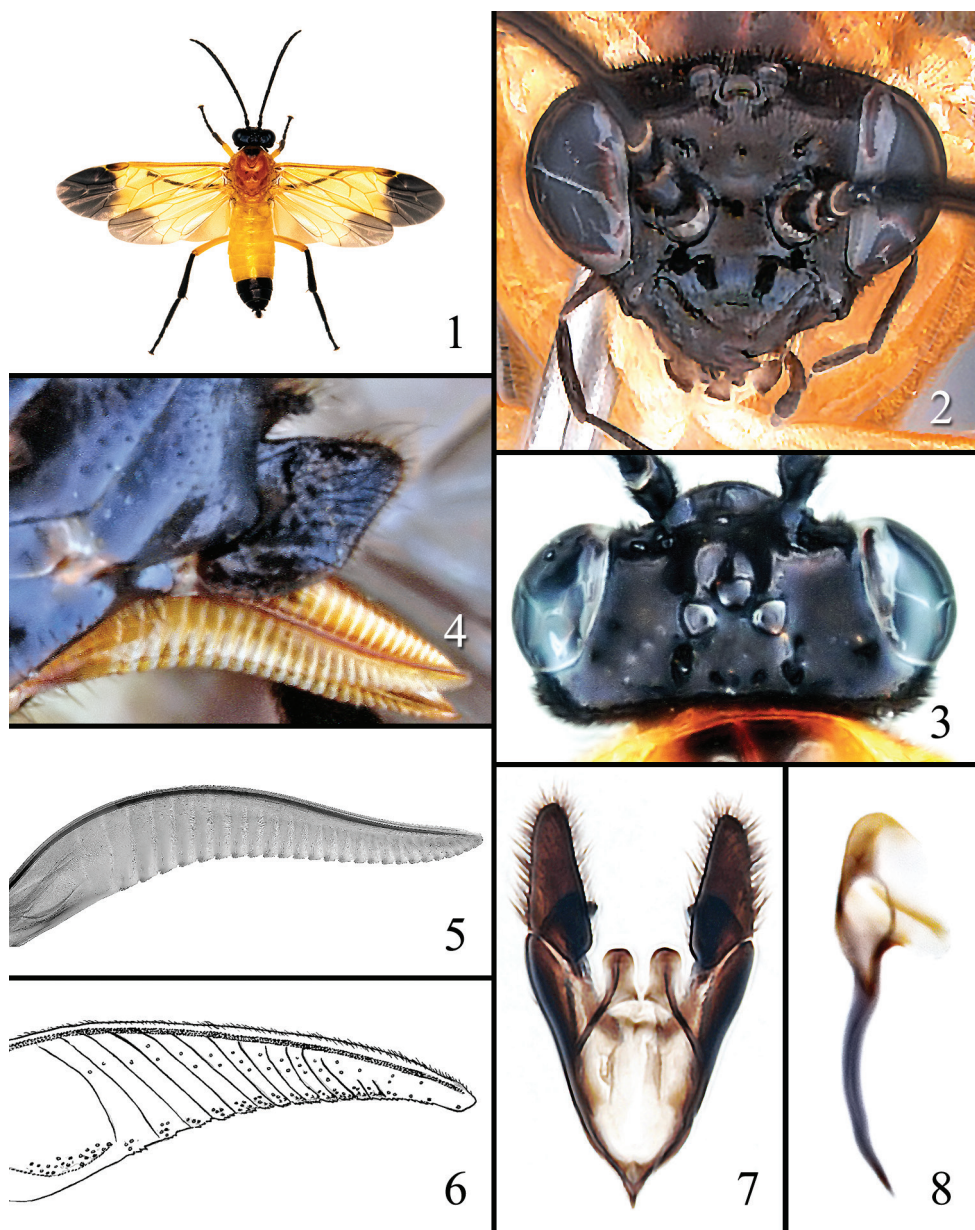
Results

Waldheimia saurauia Smith & Nishida, sp. nov

<http://zoobank.org/F8C3251E-EDF8-4EDC-86F8-D0B45E54B29A>

Figs 1–15

Diagnosis. Head black; legs with coxae, trochanters, and femora orange, tibiae and tarsi black; wings yellow with apex from stigma black; abdomen orange with apex black; lancet (Fig. 5) elongate, gradually tapering from base to apex; annuli straight.



Figures 1–8. *Waldheimia saurauia* (except 6) **1** dorsal view, female **2** head, front **3** head, dorsal **4** female sheath, lateral **5** female lancet **6** female lancet of *W. laeta* **7** male genital capsule **8** male penis valve.

Description. Female (Fig. 1): Length 8.5 mm. Antenna, head, and mouthparts black. Thorax orange with large black spot on mesoscutal middle lobe. Legs with coxae, trochanters, and femora orange, tibiae and tarsi black. Abdomen orange with apical three segments and sheath black. Forewing yellow infuscated with apex from base of stigma black; veins yellow in yellow part, black in black part; stigma mostly black with

extreme base orange. Hindwing yellow with apex from about apex of stigma black; veins yellow in yellow part, black in black part; stigma mostly yellow. *Head* (Figs 1–3): Antenna long, slender, $2.4\times$ head width; 1st and 2nd antennomeres each longer than broad; 3rd antennomere subequal in length to 4th; 5th antennomere $0.7\times$ length of 4th; apical 4 antennomeres about subequal in length, together about $1.3\times$ length of 3rd; apical 4 antennomeres with elongate, pale sensory pits the length of each antennomere except for the basal quarter of the 6th. Malar space about as broad as diameter of front ocellus. Lower interocular distance $1.1\times$ eye height. Distances between eye and lateral ocellus, between lateral ocelli, and between lateral ocellus and hind margin of head as 1.0:0.7:0.8; postocellar area $1.6\times$ broader than long. *Thorax*: Hind basitarsus $1.3\times$ longer than remaining tarsomeres combined; inner hind tibial spur $0.3\times$ length of hind basitarsus. *Abdomen*: Sheath uniformly slender in dorsal view, with short, stiff hairs; in lateral view (Fig. 4) straight above, rounded below. Lancet (Fig. 5) long, gradually tapering from base to apex, annuli parallel and straight; with about 25 serrulae, serrulae flat with 4 or 5 small subbasal teeth.

Male: Length, 8.0 mm. Color and structure similar to holotype. Genitalia in Figs 7, 8; harpe elongate, about $2.3\times$ longer than broad; valvices of penis valve rounded at apex, with dorsal lobe.

Larva (Figs 12–15): Last feeding instar 15–25 mm long. Head black, width ca. 2.5 mm. Body white, second thoracic segment to abdominal segment 7 greenish internally; thoracic legs white, apically yellowish, claws black. Abdominal segments 1–7 with yellow tint more visible along spiracular to proleg area; anal plate white ($n = 20$).

Type material. Holotype female, labeled “COSTA RICA, Puntarenas Province, Monteverde, Estación Biológica Monteverde, 1530 m, $10^{\circ}19'08.5''\text{N}$, $84^{\circ}48'32.0''\text{W}$, larvae coll. 26.ix.2017, adult 14.i.2018, Kenji Nishida (USNM). Paratypes: Same data as for holotype (1 ♀ MZUCR); same data as for holotype except middle to late instar larvae collected 8.vii.2018, cocoons spun ± 20 .vii.2018, adult emergence 9–12. ix.2018, on *Saurauia montana*, Kenji Nishida (3 ♀, MZUCR, USNM); same except adult emergence 3.ix.2018 (2 ♂, USNM MZUCR); Est. Biol. Las Alturas, 1500m, Coto Brus, Prov. Punt., COSTA RICA, M. Ramirez, Set 1991, L-S-822500, 591800; Costa Rica, INBIO CR1000, 619428 (1 ♀, INBio); Est. La Casona Res. Biol., Monteverde, 1520m, Prov. Punt., COSTA RICA, N. Obando, Dic 1990, L-N-253250, 449700; Costa Rica, INBIO, CRI000, 664810 (1 ♀, INBio); Quebrada Segunda Ref. Nac. Fuana Silv. Tapanti, 1150m, Prov. Cartago, Costa Rica, G. Mora, Abr 1992, L-N 194000, 560000; Costa Rica, INBIO, CR1000, 727881 (1 ♀, INBio).

Variation. One paratype is about 8.5 mm long, the others are about 10.0 mm long. One paratype has the mesoscutal middle lobe, spot on the posterior corner of the mesoscutal lateral lobes, center of mesoscutellum, upper two-thirds of mesepisternum and mesepimeron blackish. Another paratype has similar black marks on the mesonotum, but the underthorax is completely orange.

Etymology. The name is the generic name of the host plant.

Host, life history. Larvae feed on *Saurauia montana* (Actinidiaceae). First to last feeding instar larvae were found on 45 cm to ca. 3 m tall trees growing along open trails contiguous to valley or stream (Fig. 10) ($n = 10$ trees, 8 cohorts/groups). Eggs



Figures 9–15. *Waldheimia saurauia* **9** general habitat of Estación Biológica Monteverde **10** habitat at open trail along valley, arrow pointing at young *Saurauia montana* tree where young larvae were found **11** oviposition scar-swellings on secondary veins with larva-exited holes **12** middle stage first instar larvae, ca. 4 mm long, on underside leaf near oviposition site; some oviposition swellings are visible **13** early to middle instar larvae intermingled and resting **14** last feeding instar larva, lateral **15** last feeding instar larva, dorsolateral.

are unknown, but remains of eggs (egg shells) were found. Swellings from oviposition were noticed along the primary and secondary veins of young and soft leaves near apical shoots ($n = 7$) (Fig. 11). Each swelling was ca. 2.5×1.5 mm. By dissecting the swelling, a single egg shell (or a dead larva) was found in each. Apparent oviposition scar as old hole of ca. 0.5 mm was observed on the side of the secondary veins on underside leaf (abaxial) ($n = 30$). The first instar larva in the egg apparently made an exit orifice of ca. 0.5 mm on upperside leaf (adaxial) ($n = 30$). Early to late stage first instar were feeding gregariously, skeletonizing leaf along or near the oviposition site on abaxial (Fig. 12). Thirty and 33 first instar larvae were counted in each single cohort ($n = 2$). Also under natural conditions in the field, early to middle instar larvae were intermingled and resting together ($n = 1$ group) (Fig. 13). Middle to late instars were also found together resting and feeding on abaxial of relatively young leaves located at apical growth of the plant ($n = 4$ groups). The larvae did not feed on the secondary veins of mature, hard leaves, but readily fed on the secondary veins of relatively young leaves. Under natural and rearing conditions, last feeding instars were scattered along different leaves, found either solitary or in groups of two to four larvae ($n = 30$ larvae). Neither early nor late instar larvae fed on leaf buds or mature old leaves. The last feeding instar larvae molted and went under soil. Soil-covered ovoid cocoons ($11\text{--}13 \times 6\text{--}7$ mm, $n = 7$) were located at the bottom surface of the dioramic aquarium. A parasitoid, an unidentified fly ($n = 1$) (Diptera: Tachinidae), emerged from a cocoon of *W. saurauia*.

Summary of collecting and rearing records is as follows: Middle to large instar larvae 26.xi.2017, most went into soil 4.xii.2017, adult emergence 4.i.2018; middle to late instar 8.vii.2018, cocoon spun 20.vii.2018, adult emergence 9–12.ix.2018; first instar 6.viii.2018, late to last feeding instar 20.ix.2018, went into soil 25.ix–6.x.2018. First instar larvae 25.ix.2018, middle instar larvae 15.x.2018. Early instar larvae 10.x.2018.

Remarks. At adult stage, this species is almost identical in color to *Waldheimia laeta* (Cameron) known from Central America and northern South America, but *W. laeta* usually has the clypeus white, areas around the antennal insertions orange, the mesonotum entirely orange, the apical four antennomeres shorter with the 6th and 7th only about as broad as long, the sheath shorter and rounded at its apex and by the lancet. The lancet of *W. laeta* (Fig. 6) is elongate but abruptly tapering to a rounded apex and has slanted annuli.

The host plant, *Saurauia montana*, is a relatively small tree 3–10 m high, leaves become up to ca. 8 by 30 cm, and distributed between Honduras and Panama. In Costa Rica, it has been recorded from 200–2600 m elevations on both Pacific and Atlantic (Caribbean) slopes, and in Monteverde area it is found commonly up to 1550 m in open habitat (Haber et al. 2000, Missouri Botanical Garden 2018).

Hosts for other *Waldheimia* are *Cissus pseudosicyoidea* Croat (Vitaceae) for *W. fascipennis* (Norton) (Smith and Janzen 2003b); *Cissus rhombifolia* Vahl (Vitaceae) for *W. suturalis* (Cameron) (Smith and Janzen 2003b); *Cissus alata* Jacq (Vitaceae) for *W. laeta* (Cameron (Smith et al. 2013)), *Davilla nitida* (Vahl) Kubitzki (Dilleniaceae) for *W. lucianocapellii* Smith (Smith et al. 2013); *Hamelia patens* Jacq. (Rubiaceae) for *W. interstitialis* (Cameron) (Kimsey and Smith 1985, Smith and Janzen 2003b).

***Leseha* Smith, gen. nov.**

<http://zoobank.org/F8C3251E-EDF8-4EDC-86F8-D0B45E54B29A>

Type-species. *Leseha vespa* Smith & Nishida

Description. Antenna with scape and pedicel each longer than broad. Mandibles evenly curved, each with one subapical tooth. Clypeus truncate to very shallowly emarginate. Malar space less than half diameter of an ocellus. Genal carina absent. Eyes large, converging below, lower interocular distance subequal to or slightly less than eye height. Head from above narrowing behind eyes; distance behind eyes half or less eye length. Epicnemeum elongate, flat, on same level as mesepisternum and separated by a fine suture. Anal cross vein of forewing absent. Anal cell of hindwing sessile. Tarsal claws with one inner tooth about as long and broad as outer tooth and located near outer tooth; basal lobe absent.

Etymology. The genus name is an arbitrary combination of letters; the gender is feminine.

Remarks. *Leseha* is separated from other genera of Selandriinae by the bifid tarsal claw without a basal lobe (Fig. 53), mandibles each with one inner tooth, absence of a genal carina, and elongate, flat epicnemeum. It is similar to *Adiaclema*, but *Adiaclema* has simple mandibles. The claws and epicnemeum are similar to *Liliacina*, but *Liliacina* has a deeply circularly emarginated clypeus and mandibles are long and bent at almost a right angle. In existing keys (Smith 2006) it will key to *Andeana* in couplet 22; however, the following will separate *Leseha* from *Andeana* (characters in parentheses): tarsal claws (Fig. 53) with long inner tooth, about as long and broad as outer tooth and situated next to outer tooth (inner tooth small, less than half length of outer tooth and situated near center of claw, as in Fig. 54); eyes large (Figs 17, 39), lower interocular distance subequal to or slightly less than eye height (small, lower interocular distance greater than eye height, as in Fig. 51); head in dorsal view (Figs 18, 40) narrowing behind eyes with distance behind eyes less than half eye length (head in dorsal view straight behind eyes, distance behind eyes more than half eye length, as in fig. 52); anal cell of hindwing sessile, as in Fig. 1 (anal cell of hindwing with short petiole, as in Fig. 55).

Hosts recorded for other Selandriinae are *Entodontopsis leucostega* (Brid.) W.R. Buck and Irel. (Stereophyllaceae) for *Adiaclema chigiyae* Smith (Smith and Janzen 2003b); *Blechnum occidentale* L. (Blechnaceae) for *Dochmioglene* sp., and *Lomariopsis vastita* E. Fourn. (Lomariopsidaceae) for *Dochmioglene crassa* (Cameron) (Smith et al. 2013).

Species included. In addition to the two new species described here, the following four South American species also belong in this new genus.

***Leseha cruralis* (Konow), comb. nov.**

Stromboceros cruralis Konow 1899: 296. ♀. “Peru (Callanga, Cuzco)”; Konow 1905: 98; Oehlke and Wudowenz 1984: 376 (holotype); Taeger et al. 2010: 532.

Material. Bolivia, Ecuador, Peru.

Notes. Two females at SDEI are labeled as types: the one labeled “Callanga, Cuzco, Peru,” “Coll. Konow,” “TYPE,” “*Stromboceros cruralis* Knw., Peru” is here designated lectotype. The other specimen from “Pachitea Peru” is not part of the type series since the locality was not mentioned by Konow.

***Leseha cubitalis* (Malaise), comb. nov.**

Dochmioglene cubitalis Malaise 1954: 283. ♀, ♂. no locality in original description; Taeger et al. 2010: 487.

Material. Brazil (Santa Catarina).

Notes. Malaise (1954) did not designate a holotype; he stated “(10 ♀♀, numerous ♂♂)”, so the exact number of specimens he had is unknown. The lectotype, here designated, is labeled “Brasilien, Nova Teutonia, 27°11'B., 52°23'L, Fritz Plaumann,” “11 Mar. 1942,” “TYPUS,” “*Dochmioglene cubitalis* sp. nov., R. Malaise det. 1952,” “31 71,” “Riksmuseum Stockholm” (NHRS).

***Leseha joergenseni* (Schrottky), comb. nov.**

Stromboceros joergenseni Jörgensen 1913: 274. ♀, ♂. nomen nudum.

Siobla joergenseni Schrottky 1913: 702. ♀, “♂”? “Bompland”; Taeger et al. 2010: 540; Abrahamovich et al. 2010: 67 (two syntypes, male and female, at LP).

Material. Argentina, Brazil.

Notes. Jörgensen’s mention of this species predates Schrottky’s description, but Jörgensen gave no description, only “Junto con la especie anterior, pero acaso no tan comun.” Schrottky stated “♀♂,” “22-IX-09, Bompland (Jorgensen Nr. 3).” DRS saw three females from La Plata (LP), no males. There are two females on the same pin with a label “Argentina, Bonpland, 22-IX-1909, P. Jorgensen,” “*Siobla joergenseni* Schrottky, C. Schrottky det. 1012.” The lectotype, here designated, is the top specimen on this pin. The other female DRS saw has a different date, 20-IX-1910, and even though labeled as *joergenseni*, it belongs to the genus *Plaumanniana*.

***Leseha limbata* (Kirby). comb. nov.**

Selandria limbata Kirby 1889: 141. ♀, ♂. “Theresopolis, Brazil”; Dalla Torre 1894: 143; Taeger et al. 2010: 540.

Stromboceros limbatus: Konow 1905: 98.

Material. Brazil (Rio de Janeiro, Santa Catarina).

Notes. The holotype, at BMNH, is a male labeled “Type H.T.,” “B.M. Type Hym. 1.303,” “B. M. Type Hym., *Selandria limbata* (Kirby 1889),” “limbata type,” “27/987,” “Theresopolis, 88–137.” DRS could not find the female.

***Leseha strigata* (Enderlein), comb. nov.**

Strongylogaster strigatus Enderlein 1920: 363. ♀. “Südbrasilien, Santa Catarina; Brasilien, Espiritu-Santo”; Taeger et al. 2010: 537.

Material. Brazil (Santa Catarina).

Notes. Enderlein saw two females, one from each of the localities, but DRS saw only one female from Santa Catarina. It is labeled “S. Catarina, Lüderwaldt,” “Type,” “*Stromboceros strigatus* Endl., type F, Dr. Enderlein det 1918,” Muz. Zool. PAN Warszawa 12/75” and is here designated the lectotype.

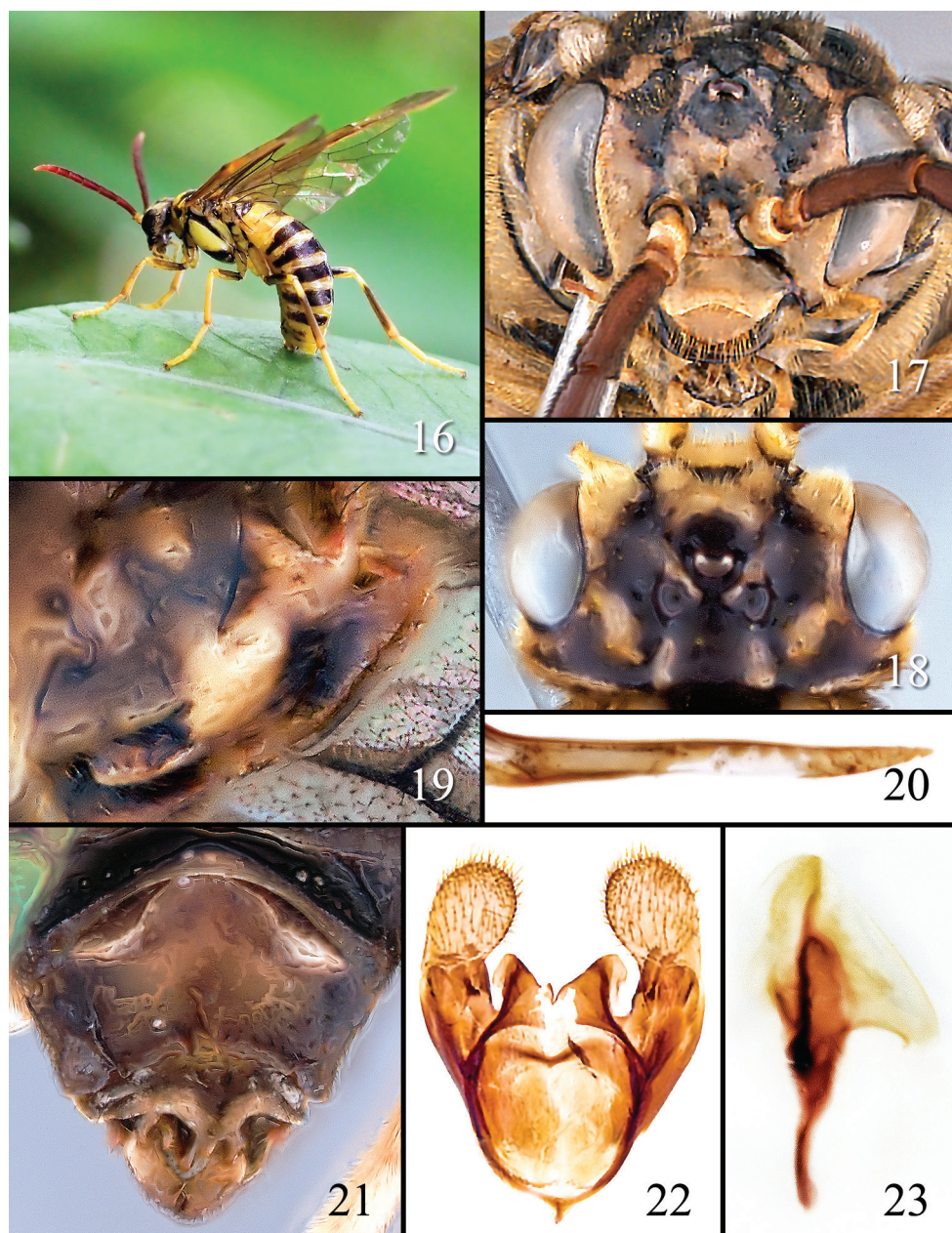
***Leseha vespa* Smith & Nishida, sp. nov.**

<http://zoobank.org/9475C9CD-04F9-4F14-AB49-4273FA8F885E>

Figs 16–37, 53

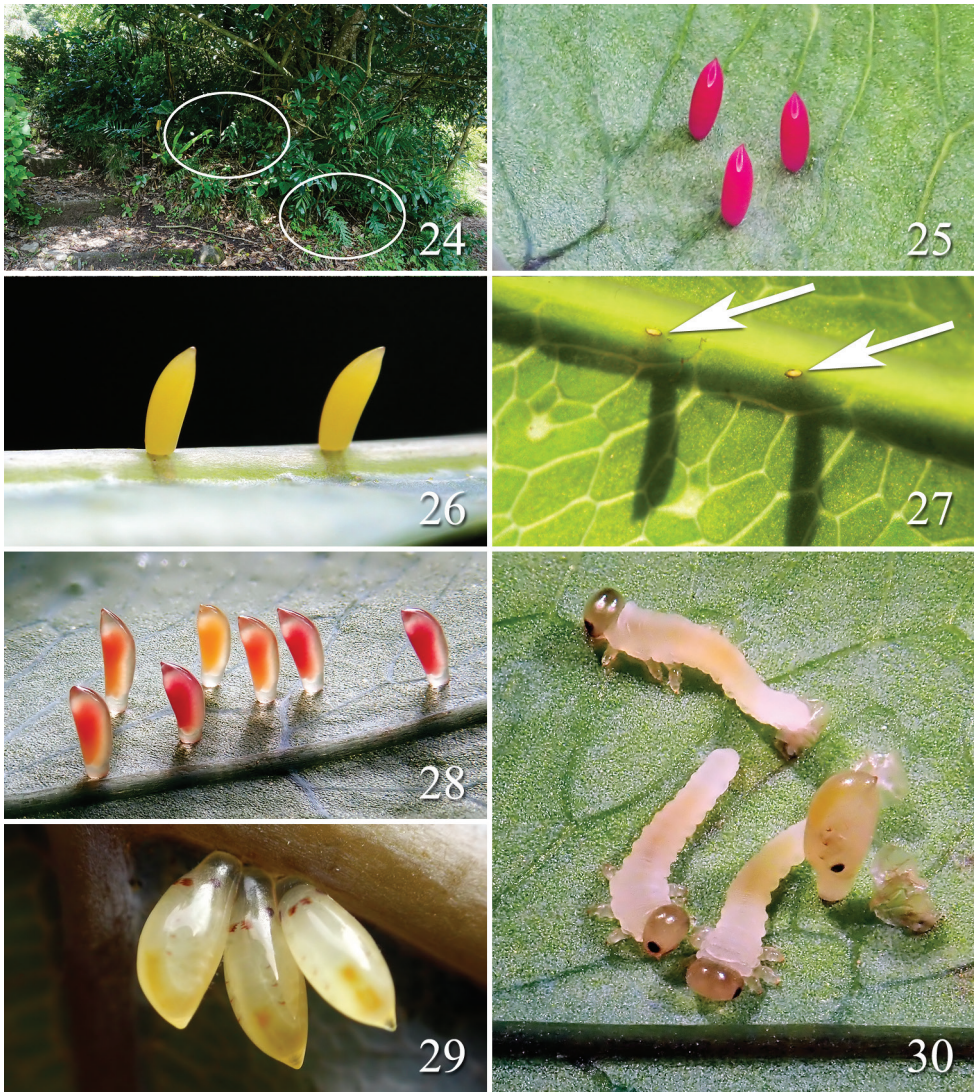
Diagnosis. Largely black with reddish-brown to yellow spots on head, thorax, and transverse stripes on abdomen (Fig. 16). Lancet (Fig. 20) very short, without distinct serrulae or annuli. Male with concave area on apical tergite.

Description. Female (Fig. 16): Length 9.5 mm. Antenna with scape yellow, pedicel and flagellum reddish brown, 4th antennomere to apex sometimes darker brown than pedicel and 3rd antennomere. Head mostly yellow with black marks; black on postocellar area, broad stripes from lateral ocelli almost to antennal insertions, area surrounding front ocellus, spot on occiput above each eye, spot above interantennal area, narrow bands surrounding antennal sockets. Thorax mostly yellow with black marks on center of mesoscutal middle lobe, lateral lobes except sides, downturned lateral sides of lateral lobes, mesoscutellar appendage, area between cenchri, mesosternum, line separating epicnemium, and spot on lower margin of propleuron. Legs yellow with black stripe on outer surface of hind femur. Abdomen with first 2 segments mostly yellow, segments 3 to apex mostly black above, apical 3 or 4 segments black. Sheath reddish brown at apex, black at base. Wings lightly, uniformly hyaline, costa and stigma yellow, other veins black. Head and thorax shiny, without sculpture, abdomen dull densely microsculptured. *Head* (Figs 17, 18): Antennal length 2.0× head width; scape and pedicel about as long as broad, 3rd antennomere slightly longer than 4th, as 1.0:0.8; antennomeres 4 to apex slightly decreasing in length, slightly thickened at antennomeres 5–7. Clypeus with shallow, circular emargination. Malar space less than half diameter of front ocellus. Lower interocular distance slightly longer than eye height, as 1.0:0.9. Distances between eye and lateral ocellus, between lateral ocelli, and between



Figures 16–23. *Leseha vespa* **16** adult female, ovipositing **17** head, front **18** head, dorsal **19** sheath, lateral **20** female lancet **21** apical tergite of male **22** male genital capsule **23** male penis valve.

lateral ocellus and hind margin of head as 1.0: 0.6:1.0; postocellar area about 1.6× broader than long. *Thorax*: Hindbasitarsus subequal in length to remaining tarsomeres combined; hind tibial spurs subequal in length, about as long as width of hind tibia at apex. *Abdomen*: Sheath (Fig. 19) in lateral view narrow, slightly turned up at apex,



Figures 24–30. *Leseha vespa* **24** habitat where host plants occur (circles) **25** three freshly laid purple eggs on abaxial of mature old frond **26** freshly laid yellow eggs on abaxial of young frond of soft primary vein (note: frond was flipped upside-down for photography) **27** adaxial of Fig. 26 showing pierced holes of oviposition (arrows), ca. 0.2 mm **28** middle stage (3-day old) purple orange and yellow eggs **29** clustered mature yellow eggs showing developing larva in each (note: mandibles stemmata, and thoracic legs are seen in reddish brown **30** just hatched first instar larvae (2.6–2.7 mm long, n=30), an egg with developed larva inside (black stemmata), and remaining shrunk egg shells.

dorsal margin slightly concave, ventral margin rounded, tapering to narrowly rounded apex; in dorsal view broad at base, tapering to narrow rounded apex, with long, fine hairs. Lancet (Fig. 20) very short; serrulae and annuli barely discernable.



Figures 31–37. *Leseha vespa* **31** early stage first instar larva on abaxial blade and feeding scar as hole(s) on young frond (note green internal color of larva) **32** early stage first instar larvae scrape-feeding on abaxial blade of mature frond **33** middle instar larva feeding on sorus on mature tough frond (note brown internal color of larva) **34** last feeding instar larva, lateral view **35** last feeding instar larvae, dorsal view **36** cocoon (ca. 12 mm long) spun on surface of dry, mossy branch (enclosed in oval circle) **37** pupa in situ (cocoon is cut to show pupa).

Male: Length, 8.0 mm. Color similar to female. Apex of abdomen (Fig. 21) with deep, oval concavity dorsally; 7th tergite emarginate and with ridge at apex, 8th tergite deeply concave. Genitalia in Figs 22, 23; harpe rounded; parapenis rounded at apex, slanted laterally; valvices of penis valve with long, narrow apical lobe and long narrow dorsal lobe.

Larva: Last feeding instar (Figs 34, 35): Length 18–24 mm. Head black, width ca. 2.2 mm. Body pale green with yellowish tint, yellowish tint more visible on thoracic segments 2 and 3, and abdominal segments 7–10 and abdominal tergum 1 yellow, lateral lobes of thoracic segments 2–3 yellow, thoracic legs black, spiracular to proleg area of abdominal segments 1–10 creamy white ($n = 7$).

Type material. Holotype female, labeled “COSTA RICA, Puntarenas Province, Monteverde, Estación Biológica Monteverde, 1530 m, 10°19'08.5"N, 84°48'32.0"W, larvae 15.v.2017, adults 22–25.vi.2017, *Phlebodium pseudoaureum*, Kenji Nishida (USNM). Paratypes: Same data as for holotype (2 ♀, 2 ♂, MZUCR, USNM); same data as for holotype except mid-May 2018, in flight and perched on leaves (1 ♀, MZUCR); adult emerged 26.viii.2018, *Phlebodium areolatum* (5 ♀, 2 ♂, USNM, MZUCR); larvae 15.viii.2018, emerged 17.viii.2018, *Phlebodium areolatum* (1 ♀, MZUCR); collected on *Phlebodium areolatum*, 14.vi.2018 (1 ♀, MZUCR); adult emerged 10.viii.2018, *Phlebodium areolatum* (3 ♀, USNM, MZUCR); adult emerged 21.viii.2018, *Phlebodium areolatum* (1 ♀, USNM); Costa Rica, S. J., San Antonio de Escazu, 1325 m, W. G. Eberhard, 12.VIII.2018, vouchers study of W. Eberhard (1 ♀, 2 ♂, USNM).

Etymology. The name *vespa* is Latin for wasp. This species resembles a commonly seen yellow and black striped paper wasp, an *Agelaia* sp. (Vespidae), at the same habitat of the study site in Monteverde.

Host, life history. The larvae feed on *Phlebodium pseudoaureum* (Polypodiaceae). In the native plant garden of EBM, *P. pseudoaureum* ferns were growing in patches (Fig. 24). Between May and June of 2017 and 2018, vigorous growths of new shoots and young fronds were observed. In May 2017 and 2018, some yellow and black striped paper wasp-looking sawfly females were observed walking on the host fern. Between 10:12 AM and 10:55 AM, the females laid ca. 1.5 mm long purple or yellow eggs (Figs 25, 26, 28, 29) on the abaxial of the blade ovipositing from the adaxial, i.e., oviposited piercing the ovipositor through blade tissue ($n = 3$) (Figs 16, 25–29). On young, soft and succulent fronds, eggs were laid mostly on leaf veins ($n = 12$ fronds) and on old and tough fronds, were laid on the blade ($n = 10$ fronds). Pierced holes of oviposition were visible from adaxial. The females oviposited in small clusters of 2–7 eggs ($n = 7$ clusters). In a few cases singly laid eggs and eggs positioned on adaxial blade were observed. Under captive conditions, a female laid up to 58 eggs in 10 days. Regarding the color variation of the eggs, in the first days of oviposition the eggs were yellow and then became orangish, and last days became purple. The eggs became translucent and enlarged in 2–3 days, and formation of the larvae was visible inside (Figs 28, 29). A commonly seen earwig (*Ancistrogaster spinax* or *A. scabiosa*: Dermaptera) placed in a petri dish quickly devoured 3 recently laid *L. vespa* eggs. Very recently hatched larvae were creamy-colored with light brown head and black stemmata (Fig. 30). The light brown head became black and as the larvae fed on the blade tissue the body became greenish internally. The early instar larvae fed on soft and succulent blades making small holes (Fig. 31) and grazed on tough blades (Fig. 32). Early instar larvae on very old and tough fronds fed on sori, and the body color was pale brown (Fig. 33) ($n = 3$). Late instar larvae fed on the entire blade leaving tough vein areas. In the

dioramic chamber, pupation occurred under rocks and branches spinning dark brown ovoid cocoons ($n = 18$) (Figs 36, 37). Relatively mature pupae were greenish ($n = 2$) (Fig. 37). Some of the dissected cocoons contained prepupal larvae which apparently were in diapause ($n = 3$).

A summary of collecting and rearing records is as follows: Eggs, early to late instar larvae on maturing fronds 12–16.vi.2008. Middle to late instar larvae on young fronds 15.v.2017, all went under soil 8–10.vi.2017, adult emergence 22–25.vi.2017; a female laid eggs 14.vi.2018, first instar hatched 22.vi.2018, last feeding instar 15–30.vii.2018, adult emergence 21.viii.2018; recently laid eggs 26–27.vii.2018, first instar hatched 4.viii.2018, middle to late instar larvae 27.viii.2018, adult emergence 22–30.ix.2018.

Remarks. *Phlebodium pseudoaureum* is an epiphytic or terrestrial fern with up to ca. 30 pinnae or 2 cm width growing to ca. 1 m tall. Fronds are soft and succulent when young, when mature it becomes tough (crunchy). Abaxial of frond is thinly covered with a white, waxy substance. It is distributed between Mexico (vicinity of Topic of Cancer) to northern Argentina, including the Caribbean (Dominican Republic and Jamaica). In Costa Rica it has been recorded from near sea level to 2500 m elevations on both slopes (Moran 2009; Missouri Botanical Garden 2018; KN personal observation 2017 – 2018). The species of the genus *Phlebodium* are closely related to *Polypodium* (Tejero'Díez et al. 2009).

Eggs ($n = 7$) and some late-instar larvae were also found at 14°2'4"N, 87°4'29"W, ca. 1625 m elevation, in Reserva Biológica Monte Uyuca in Zamorano, Honduras (KN personal observation 2019). Although adults were not reared, these are most likely those of *L. vespa* based on the observation and the host plant.

The morphology, enlargement, and plant tissue association of the egg of this species are currently being studied by KN and Kondo Laboratory of Pattern Formation, Graduate School of Frontier Biosciences, Osaka University.

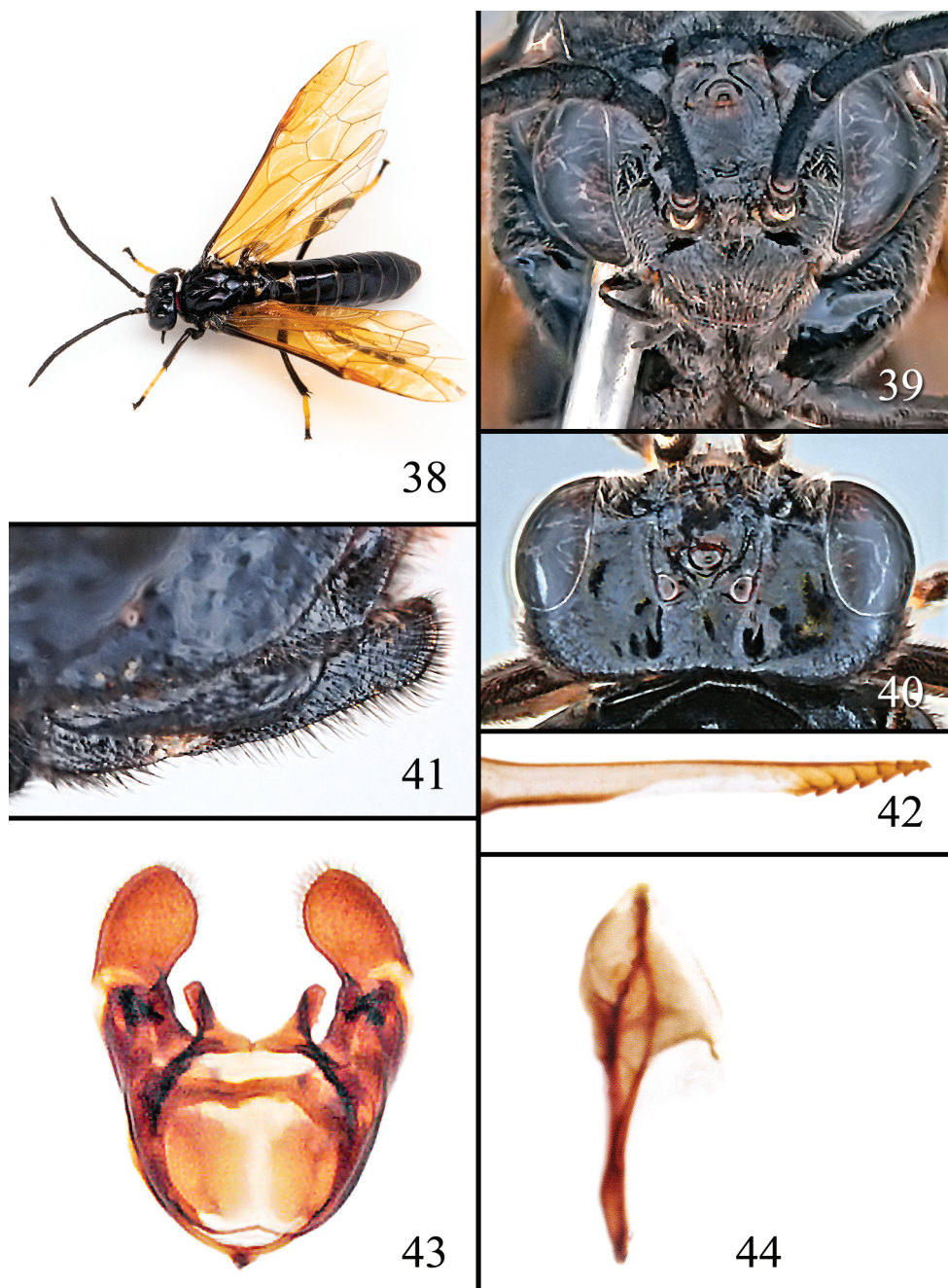
***Leseha carranzae* Smith & Nishida, sp. nov.**

<http://zoobank.org/AFC92EC4-0D39-4D78-B776-11FDD9477395>

Figs 38–50

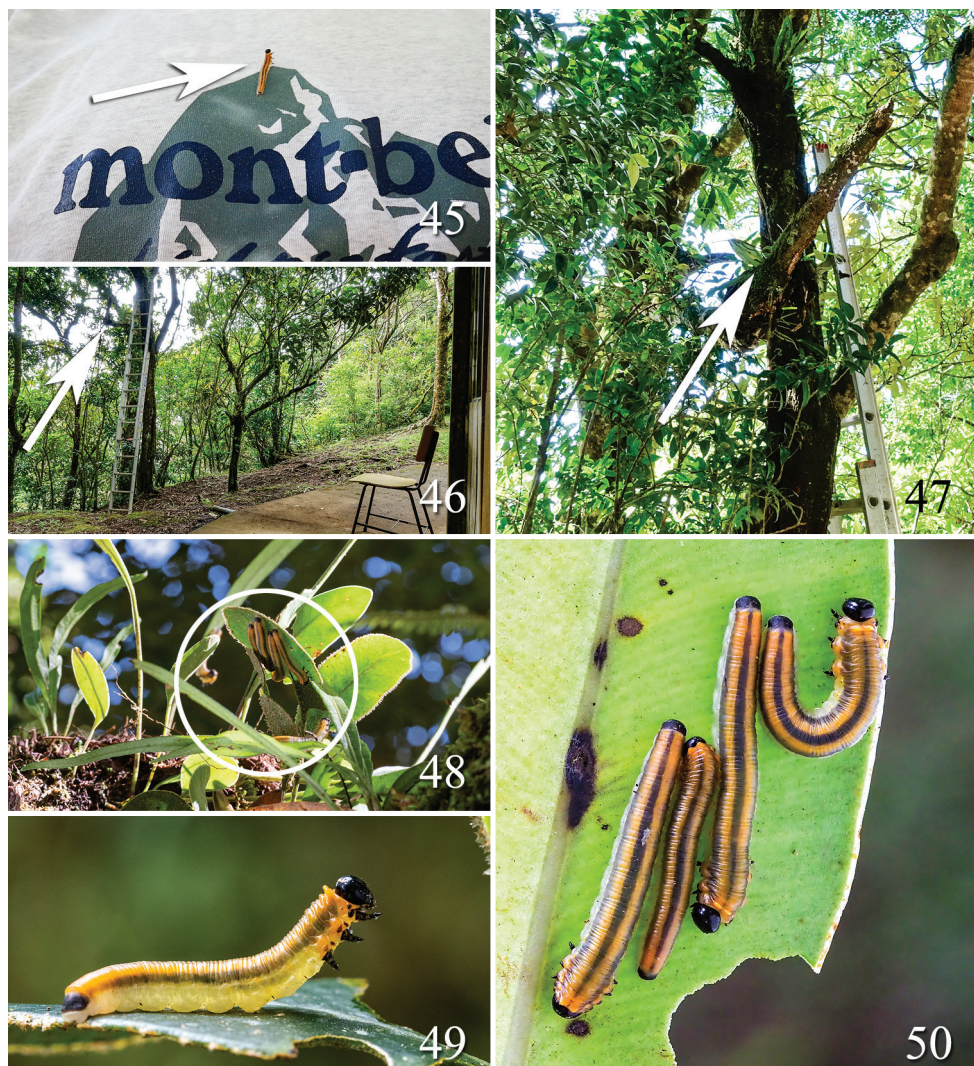
Diagnosis. Black with contrasting white basal 3 tarsomeres. Wings a contrasting bright yellow. Female lancet (Fig. 42) short, but with distinct serrulae and annuli at apex.

Description. Female (Fig. 38): Length, 10.0 mm. Black, small mark on outer surface of scape and basal 3 tarsomeres white. Wings, with veins and stigma, completely golden yellow. Head and thorax shiny, without sculpture, abdomen dull and densely microsculptured. *Head* (Figs 39, 40): Antenna 2.1× head width; scape and pedicel each slightly longer than broad; 3rd antennomere slightly longer than 4th, 4th to 9th antennomeres gradually decreasing in length. Malar space less than half diameter of front ocellus; clypeus with shallow, circular emargination. Lower interocular distance subequal to eye height. Distances between eye and lateral ocellus, between lateral ocelli, and between lateral ocellus and hind margin of head as 1.0: 0.5:1.2;



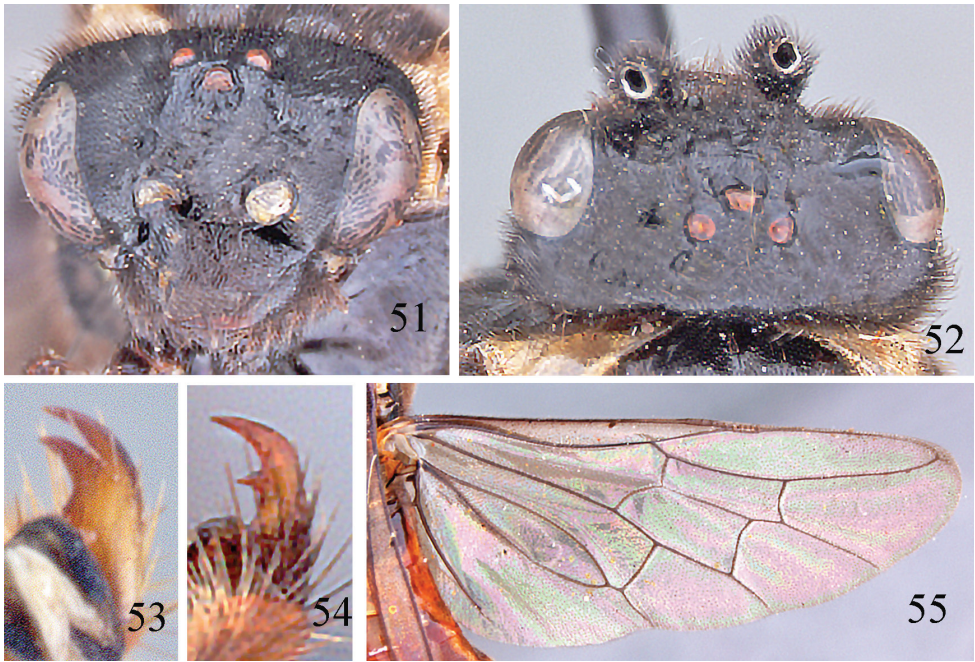
Figures 38–44. *Leseha carranzae* 38 female, dorsolateral view 39 head, front 40 head, top 41 female sheath, lateral 42 female lancet 43 male genital capsule 44 male penis valve.

postocellar area almost quadrate, very slightly broader than long, with deep lateral grooves. *Thorax*: Hind basitarsus slightly longer than length of remaining tarsomeres combined, as 1.0:0.8; apical hind tibial spurs sub equal in length, length slightly less



Figures 45–50. *Leseha carranzae* **45** wandering last feeding instar larva (arrow) on shirt of KN **46** habitat with chair where wandering larva appeared (arrow pointing at location of host plants with larvae) **47** closer view of habitat (arrow pointing at host plants where larvae were present) **48** six last feeding instar larvae shown in indicated white circle, four last feeding instar larvae resting on abaxil of *Elaphoglossum bellermannianum* and two other larvae ‘in search of food plant’ **49** last feeding instar (lateral view) reaching for next frond **50** three last feeding instar and one penultimate feeding instar (dorsal view) resting abaxial of *Elaphoglossum lingua*, fed area shown on lower right.

than width of hind tibia at apex. Hind tibia and hind basitarsus slightly flattened, each with longitudinal groove. Tarsal claw with long inner tooth, very slightly shorter than outer tooth. *Abdomen*: Sheath (Fig. 41) short and rounded at apex in lateral view; in dorsal view, uniformly wide with stiff, straight hairs at apex. Lancet (Fig. 42) short, with few annuli and serrulae.



Figures 51–55. 51, 52, 54, 55 *Andeana* sp. 53 *Leseha vespa* 51 head front 52 head dorsal 53 trsal claw 54 tarsal claw 55 hindwing.

Male: Length 8.5–9.5 mm. Color and structure as for female. Genitalia in Figs 43, 44; harpes oval, slightly longer than broad; parapenis very narrow, elongate, apex slanted laterally; valviceps of penis valve rounded at apex, with narrow dorsal lobe directed posteriorly.

Larva: Last feeding instar (Figs 45, 48–50): Ca. 20 mm long. Head black; width ca. 2.5 mm. Body reddish yellow with longitudinal 3 dark green to dark gray stripes (one mesially on dorsum, other two above lateral lobes). Thorax laterally reddish yellow with black spots, thoracic legs black, spiracular to proleg area of abdominal segments 1–10 creamy white. Abdominal segment 10 and anal plate black ($n = 7$).

Type material. Holotype female, labeled “COSTA RICA, Puntarenas Province, Monteverde, Estación Biológica Monteverde, 1530 m, 10°19'08.5"N, 84°48'32.0"W, larvae collected 4.xii.2017, adults 1.i.2018 to 27.i.2018, *Elaphoglossum* spp., Kenji Nishida” (USNM). Paratypes: Same data as for holotype (4 ♀, 2 ♂, MZUCR, USNM), on leaf, 6.viii.2018 (1 ♀, MZUCR); Costa Rica, San José, Zurquí Moravia, 1600 m, iii.1999, P. Hanson (1 ♀, MZUCR), same except iv.1995 (1 ♀, MZUCR), same except viii.1995 (1 ♀, USNM).

Etymology. Named after Melanie Carranza who started to have a passion for insects and helped with the rearing of this species and getting the adults.

Host, life history. Larvae were feeding on *Elaphoglossum hellermannianum*, *E. lingua* (under natural conditions) and *E. hammelianum* (under rearing conditions)

(Dryopteridaceae). On a windy afternoon of 4.xii.2017, while KN was sitting on a chair outside in front of the laboratory of EBM, a sawfly larva climbed on to his shirt (Fig. 45). KN had not seen this larva before and started to search for the host plant in the surrounding environment. The larva was placed in a translucent plastic bag with leaves of ca. 10 plant species, e.g., *Myrsine coriacea* (Myrsinaceae), *Myrcia splendens* (Myrtaceae), *Cormus disciflora* (Cornaceae), *Quercus insignis* and *Q. cortesii* (Fagaceae); however, the larva did not feed on any of these plants. The larva under captive conditions appeared to walk/move upwards to a higher position, and KN searched for other plants that grow on the higher part of trees, such as epiphytic ferns. KN collected *Elaphoglossum hammelianum* that was growing 4–5 m from the ground and placed in the plastic bag. The larva readily fed on the fern. KN searched for more larvae on *Elaphoglossum* ferns growing on trees in front of the laboratory, and found eight more larvae in a patch of *Elaphoglossum* species growing on a dead branch (Figs 46, 47). The larvae were feeding on thick and tough blades of *E. lingua* (Fig. 48). When finished devouring a blade the larvae walked around and settled on abaxial of *E. bellermannianum* and started to feed on it eventually. The larvae were collected and placed in the plastic rearing bag along with the *Elaphoglossum* spp. patch attached to the soil. Additionally, a small patch of *E. lingua* was added for rearing. The larvae fed on all three species of *Elaphoglossum* under rearing conditions. From 9.xii.2017 the larvae started to disappear from fronds little by little until 17.xii.2017. The larvae probably spun cocoons within the attached soil, rhizome, and roots, and pupated. Adult emergence occurred between 1.i.2018 and 27.i.2018. Part of the life history data and additional information were published online (Nishida 2017). See Type Material section and above for collecting and rearing records.

Remarks. *Elaphoglossum bellermannianum* is a scaly blade (leather like) epiphytic fern, with elongate oval shaped blade of 6–17 cm long by 1.5–4 cm wide, relatively thick and dark green on adaxial. The species has been recorded from Dominican Republic, Costa Rica, Panama, Colombia, Venezuela, Ecuador, Peru, and Bolivia (Vasco 2011, Missouri Botanical Garden 2018), In Costa Rica it is distributed between 1500 and 3100 m elevations. *Elaphoglossum hammelianum* is epiphytic, having relatively thin, narrow and long blade (up to 20–30 cm) with wavy margin. Pale brown scales are present scattered along the blade (KN personal observation 2017, 2018). It has been recorded from elevations between 900 and 3100 m from Costa Rica through western Panama (Missouri Botanical Garden 2018). *Elaphoglossum lingua* is an epiphytic or terrestrial fern with thick and crunchy tongue-shaped blades. The blade grows up to ca. 24 by 7 cm. It is found from Costa Rica, Antilles to Brazil at Tropic of Capricorn and recorded along the mountain ranges of Costa Rica between 1100 and 2700 m (Mickel 2009, Missouri Botanical Garden 2018, KN personal observation 2017, 2018).

Two other species of Selandriinae were reared from ferns at the same study site: a single specimen of a black and pink ‘firefly-mimicking’ species from *Elaphoglossum lingua* and more than 30 adults of another species from *Blechnum appendiculatum* (Blechnaceae). Also, unidentified sawfly larvae ($n = 2$) were collected feeding on *Serpo-caulon ptilorhizon* (Polypodiaceae); however, adults were not obtained.

Acknowledgments

We thank Robbin Moran, Klaus Mehlreter, and Emily Holenbeck for identifications of the fern species, William A. Haber and Willow Zuchowski for identification of *Saurauia* species, Paul. E. Hanson for identification of the vespid wasp, Daniel Briceño Lobo for identification of the earwig, Museo de Zoología-Escuela de Biología, P. E. Hanson, Eddy Camacho, and Michael Gates for making sawfly specimens reach the hands of DRS, Melanie Carranza for assisting in the field work and rearing of sawflies, Elizabeth Heffington for reviewing of the draft, and EBM and Willow Zuchowski for letting KN study in the garden. William Eberhard, Smithsonian Tropical Research Institute and Escuela de Biología, Uiversidad de Costa Rica, also provided some specimens. E. Hollenbeck also provided literature. KN gives thanks also to F. Castañeda and N. Estrada for the field trip to Reserva Biológica Monte Uyuca. KN obtained research/collecting permit from Lourdes Vargas Fallas of MINAET-SINAC in San José. Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the USDA. USDA is an equal opportunity provider and employer.

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