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Lissomus cacique, a Remarkable New Species of Click Beetle (Coleoptera: Elateridae) from Cloud Forests in Costa Rica and Panama, with Notes on *Lissomus flavipennis* Guérin-Méneville

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Abstract

Lissomus cacique Johnson, **new species** from Costa Rica and Panama is described and discriminated from its morphologically most similar and geographically disjunct congener, *Lissomus flavipennis* Guérin-Méneville from Guatemala and southern Mexico. These two species form a unique pair in *Lissomus* Dalman distinguished by their relatively large and robust body form, yellow-brown to orange-red elytra not concolorous with the body, and the presence of a complete arcuate postcoxal carina partially delimiting the meso-metaventral crural impression. This new species is the largest of the genus and is only known from premontane cloud forests in Costa Rica and adjacent Panama. *Lissomus flavipennis* is known only from comparable premontane cloud forests in Guatemala and Mexico. The habitats of both species are now remnants of formerly more extensive forests and are threatened by anthropogenic activities.

Keywords: taxonomy, click beetle, cloud forest, Neotropical, climate warming, endangered habitat

Resumen

Lissomus cacique Johnson, **nueva especie** de Costa Rica y Panamá se describe por primera vez y se discrimina de su congénere morfológicamente similar y geográficamente disyunto, *Lissomus flavipennis* Guérin-Méneville de Guatemala y sur de México. Estas dos especies forman un grupo hermano distintivo en *Lissomus* Dalman que se distingue por su forma corporal relativamente grande y robusta, élitros de color amarillo anaranjado a rojo anaranjado, y la presencia de una carina arqueada completa que delimita una depresión crural mesoventral. Esta nueva especie es la especie más grande conocida del género y solo se conoce en bosques húmedos premontanos en Costa Rica. *Lissomus flavipennis* también se conoce solo en los bosques húmedos premontanos de Guatemala y México. Los bosques donde habitan son ahora remanentes de bosques anteriormente más extensos y actualmente están amenazados por actividades antropogénicas.

Palabras Clave: taxonomía, elaterídos, bosque nuboso, neotropical, calentamiento climático, hábitat en peligro de extinción

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Introduction

Lissomus Dalman, 1824 (Elateridae: Lissominae: Lissomini) presently includes 27 valid species recorded from the tropical Americas. Another seven species are recorded from mesic tropical forests from southern India and Sri Lanka, and mesic-forest tropical Africa. The genus was established based on two species from "Brasilia", *Lissomus foveolatus* Dalman and *Lissomus punctulatus* Dalman, with both species collected by George Wilhelm Freyreiss somewhere during his travels in Bahia, Espírito Santo, Minas Gerais and Rio de Janeiro (Papavero 1971). Species formerly in *Lissomus* from Australia were transferred to *Osslimus* Calder (1996). The first classification to explicitly include *Lissomus* in the traditional sense of Elateridae was from Schiödte (1866), with the modern context from Lawrence and Newton (1995).

The *Lissomus* species of tropical North America were first treated faunistically by Bonvouloir (1859), who included *Lissomus bicolor* Chevrolat, *Lissomus flavipennis* Guérin-Méneville, and his own *Lissomus impressifrons* Bonvouloir from Guatemala and Mexico. Gerstäcker (1860) described *Lissomus episcopalis* Gerstäcker from Costa Rica, and Horn (1890) added to the regional fauna *Lissomus inopinatus* Horn from Nicaragua and Panama, *Lissomus pilarius* Horn from Mexico and Nicaragua, and *Lissomus trapezoideus* Horn from Guatemala. Both Bonvouloir and Gerstäcker provided keys to the species known to them, but Horn did not provide an updated key or other methods sufficient for separation and determination of all species treated by him.

Gemminger and Harold (1869) first cataloged the then known species. Since Horn (1890), there is only a world catalog by Schenkling (1928) as part of the Throscidae, and a checklist of the American taxa by Blackwelder (1944). Unfortunately, all the above authors variously interpreted, usually in error, the presence of the South American *Lissomus discedens* Bonvouloir, *L. foveolatus*, *Lissomus gagatinus* Bonvouloir, *L. punctulatus*, and *Lissomus ustulatus* Bonvouloir in tropical North America.

Here, a distinctive and remarkable new species from Costa Rica and Panama is described; the first new Mesoamerican *Lissomus* since 1890. The species is compared with *L. flavipennis*, from Guatemala and Mexico. A more complete early nomenclatural history of the genus is given than previously published, and a revised morphological description of the genus is provided to encompass the diversity of species included, including a number of undescribed forms, and to better compare with other click beetle genera.

Materials and Methods

Primary types were examined for pertinent taxa here and associated studies. All specimens and images examined of the new species described or discussed below are from the following collections: Instituto Nacional de Biodiversidad, Santo Domingo, Costa Rica (INBIO) [presently this collection is managed by the Museo Nacional de Costa Rica, San Jose, Costa Rica (MNCR)]; Museo de Insectos, Universidad de Costa Rica, San José, Costa Rica (MUCR); Florida State Collection of Arthropods, Gainesville, Florida (FSCA); Museum für Naturkunde, Berlin, Germany (MFNB); Senckenberg Deutsche Entomologische Institut, Müncheberg, Germany (SDEI); Museum national d'Histoire naturelle, Paris (MNHN); Natural History Museum, London, UK (NHMUK); Nebraska State Museum, University of Nebraska, Lincoln, Nebraska (UNLC); Texas A&M University, College Station, Texas (TAMU); and Kenji Nishida, Tokyo, Japan and Monte Verde, Costa Rica.

Morphological terms and concepts generally follow Calder (1996) and Lawrence *et al*. (2010). Colors are discussed in English terms for ease of interpretation, rather than more precise but sometimes cumbersome traditional terms used in the description; as for many elaterids lighter colors can be affected by collecting, preservation, and relaxation methods. Measurements were made with an ocular micrometer at 0.1 mm and 0.01 mm increments between 10–50 magnifications. Body length was measured from the anterior margin of the frons to the elytral apices, and width was measured across the elytral midlength. Antennomere length ratios were calculated for antennomeres 2–11 as measured along the lateral midline from antennomere base to apex, values rounded to one decimal place, and given as a ratio string. Pronotal length is along the midline from anterior margin to the posterior margin at the antescutellar emargination, and width across the base of the hind angles. Tarsomere lengths were measured from base to apex, values rounded to two decimal places, and given as a ratio string. Aedeagus portion lengths were measured from the median lobe (penis) apex to the anterior margin of the basal piece (phallobase); paramere length from apex to the anterior-most point; paramere tip along midline from apex to lateral spine; and basal piece length from basal lateral angle to apex of shoulder junction with paramere. Aedeagal proportional dimensions of taxonomic value measured were calculated to two decimal places are basal piece length/total length, paramere length/total length, paramere apex/paramere length, and paramere apex length/paramere length.

Label data are presented verbatim. Information from separate labels is separated by a slash (/) bracketed by single spaces. Interpolated information is given within brackets as needed for clarity or supplementation. Literature citations demonstrate the historical sequence of name use which is essential for accurately tracking taxonomic use in faunas, checklists, catalogs, and other documents. Generally, recent references for name use other than for taxonomic purposes are not included.

Taxonomy

Lissominae Laporte, 1835
Lissomini Laporte, 1835
Lissomus Dalman, 1824

Lissomus Dalman 1824: 13.

Type species: *Lissomus punctulatus* Dalman 1824: 14, designation of Fleutiaux 1947: 138.

Lissomus; Eschscholtz 1829: 31, 1836: table; Latreille 1829a: 452, 1829b: 452, 1831: 342, 1832: 317, 1834a: 135, 1834b: 426, 1849: 510; Dejean 1833: 84, 1836: 95; Lacordaire 1830: 242, 1857: 135; Laporte de Castelnau 1835: 178, 1836: 260, 1840: 229; Chevrolat 1835: 194, 1849: 404, 1868: 147; Brullé 1837: 247; Germar 1839: 195; Voigt 1839: 89; Drapiez 1839: 432, 1853: 452; Guérin-Méneville 1838: 260, 1844b: 41; Blanchard 1846: 145; Bonvouloir 1859: 97, 1860: 366; Jacquelin du Val 1859: 110; LeConte 1859: 614; Schiödte 1866: 333; Gemminger and Harold 1869: 1459; Fleutiaux and Sallé 1889: 405; Heyne and Taschenberg 1905: 147; Fleutiaux 1911: 237; Schenkling 1928: 12; Blackwelder 1944: 304; Yensen 1975: 126; Costa *et al*. 1988: 154, 2010: 91; Aguirre-Tapiero 2009: 31; Aguirre-Tapiero *et al.* 2010: 20; Aguirre-Tapiero

and Johnson 2014: 6; Johnson and Chaboo 2015: 271; Johnson *et al*. 2018: 82; Kundrata *et al*. 2019a: 124, 2019b: 5; Kirmse and Johnson 2020: 5.

Lissode Eschscholtz 1829: 31 (as synonym, not available, ICZN Art 11.6).

Lissodes Latreille 1829a: 452 (as synonym, not available, ICZN Art 11.6), 1829b: 452, 1831: 342, 1832: 317, 1834a: 135, 1834b: 426, 1849: 510; Laporte de Castelnau 1835: 178, 1840: 229; Voigt 1839: 89; Lacordaire 1857: 93; Bonvouloir 1859: 97; Gemminger and Harold 1869: 1459.

Cymbium Gerstäcker 1860: 136 (not *Cymbium* Röding 1798: 151; Gastropoda) (as synonym, not available, ICZN Art. 11.6).

Pseudelater Fleutiaux 1899: 161 (as synonym, not available, ICZN 1999: Art. 11.6) (not *Pseudelater* Miwa 1934: 20; type species *Elater habunensis* Miwa 1934: 20, original designation).

Lissernus Fleutiaux 1911: 263 (misspelling).

Diagnosis [Adapted after Bonvouloir (1859) and Gerstäcker (1860)]. Body moderate in length, about 6–16 mm; dorsum shallowly to strongly convex, venter shallowly convex. Integument smooth, shining, finely to moderately punctured; each puncture with either a minute fine seta and surface appearing glabrous, or seta long, thin, hair-like. Head depressed to shallowly impressed on frons, frontal margin a thick medial intra-antennal pad and a strong subantennal carina each side. Mandibles stout, acutely bidentate apically. Antennal insertion fossa deep, transverse; antenna with antennomere 1 robust, subcylindrical to subangular, coarsely punctate, slightly arched; antennomere 2 subcylindrical to subserrate; antennomeres 3–10 moderately to strongly serrate, antennomere 11 ovoid to lachrymiform. Pronotum trapezoidal, shallowly to moderately convex, sparsely to moderately densely punctured; anterior angles often slightly reflexed; hind angles with dorsal carina extended anterad and forming a longitudinal bulge before anterior angle. Prosternum longitudinally convex anterad of procoxal cavities, shallowly to moderately transversely arched at midlength, with anterior lobe not to shallowly deflexed; intercoxal process with apex broadly to narrowly rounded, postcoxal portion slightly expanded laterally, and with strong dorsal extension; lateral margins simple to shallowly sulcate. Hypomeron deeply excavate posteriorly to receive front legs, posterior margin a thin perpendicular lamelliform wall; pronotosternal margin deeply excavate to receive antenna. Scutellar shield transverse, ovoid to subpentagonal with obtuse angles; dorsum flat to shallowly convex, sparsely punctured, shining. Elytra moderately to strongly convex, occasionally depressed discally, often gibbous; striae 1–8 of fine to moderately-sized serial punctures; intervals flat to weakly convex; stria 9 coarsely punctured to sulcate; apices conjointly rounded, often deplanate. Mesoventrite with deep median fossa, broadly U- to V-shaped, walls planar with metaventrite to below or slightly elevated; anterior angles formed as crural impressions to receive mesothoracic legs, usually with an arcuate post-coxal carina from mesocoxal margin directed laterally, reaching partly or completely to lateral margin. Tarsomeres 1–4 with progressively enlarging ventral membranous lobes, rarely with tarsomere one with densely setose ventral pad. Pretarsal claw asetose. Abdomen with 5 ventrites, ventrite 1 with elytral locking flange laterally, ventrite 5 broadly rounded apically. Male with sternite 8 rounded apically, V-shaped basally; sternite 9 membranous discally, truncate to shallowly emarginate apically; tergite 9 with deep V-shaped emargination; tergite 10 subtruncate apically; aedeagus trilobed with median lobe and parameres articulating against basal piece; median lobe variably attenuate; parameres sagittate, hooked or truncate at apex. Female with sternite 8 narrowly rounded apically, broadly U-shaped basally, with long, narrow strut; ovipositor with long, flattened, darkly sclerotized paraprocts; gonocoxites narrowly subtriangular, usually with short subapical dorsolateral stylus bearing a long apical seta. Internal genital tract with bursa bulbous, with corrugated surface, 4 darkly sclerotized internal armatures, tubular colleterial glands from vaginal-bursal juncture, and spermatheca lateral, thin, corrugated, twisted.

Notes. The names Lissode (Latreille 1825: 248), and Lissome and Lissomes (Brullé 1837: 427; Latreille 1829a: xxiii, 452, 1829b: xxiii, 452, 1834a: 135), are French vernacular and are not available genus names. Eschscholtz (1829) appears to have treated "*Lissode*" as a genus and synonym of *Lissomus* in the same manner as other names for other taxa; this treatment is accepted here. As such, *Lissode* Eschscholtz is not an available name (ICZN 1999: Art. 11.6). Earlier, *Lissodes* Berthold (1827: 335) was presented as a genus name, but there were no assigned or indicated species, hence this is not an available name (ICZN 1999: Art. 12.2.5) for purposes involving *Lissomus* nomenclature. Treatment of *Lissodes* as a synonym of *Drapetes* Megerle by Smetana (2007) is a nomenclatural issue best treated elsewhere.

Lissomus cacique Johnson, new species

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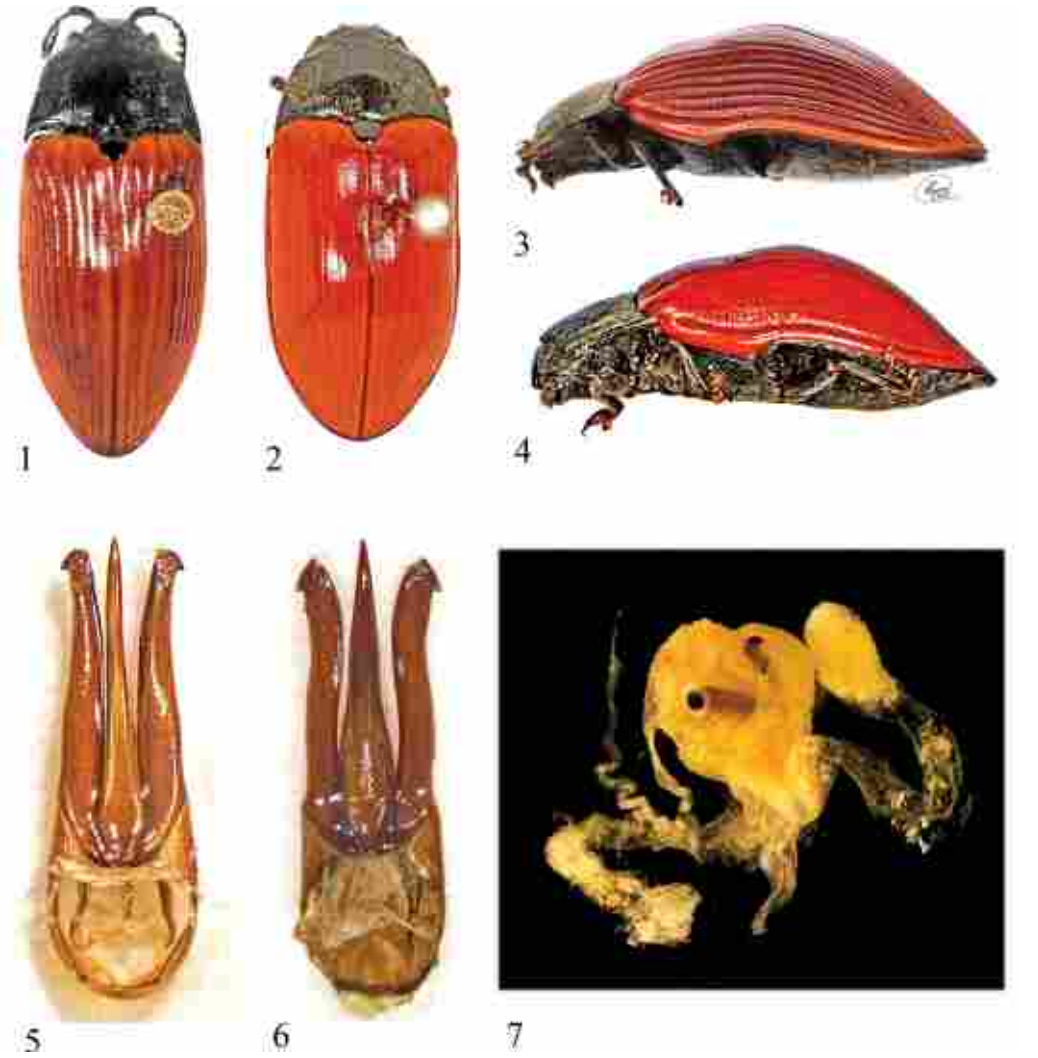
(Figs. 1, 3, 5, 7–9)

Diagnosis. *Lissomus cacique* is immediately recognized by the combination of larger size, subparallel dorsal silhouette at midlength, strongly convex



Figs. 1–7. *Lissomus* species. Adult male, dorsal aspect: **1)** *L. cacique*, **new species**; **2)** *L. flavipennis*. Adult male, lateral aspect: **3)** *L. cacique*, **new species** (photo by H. Lezama, used with permission); **4)** *L. flavipennis*. Aedeagus, dorsal aspect: **5)** *L. cacique*, **new species**; **6)** *L. flavipennis*. **7)** *L. cacique*, **new species**, female internal genital tract.

dorsum (Fig. 3), shallowly subsulcate elytral striae, and orange-red elytra contrasting with black body. This species is superficially similar to *L. flavipennis* from Mexico, and will key to this species in Bonvouloir (1859) and Gerstäcker (1860). Both species share the traits of an arcuate post-coxal carina (Fig. 8) delimiting the posterior margin of the crural impression for the mesothoracic leg; the anterior pronotal angles appearing constricted at a smooth bulging termination of a carina; and the elytra predominately of a translucent yellow-brown to orange-red color (post-mortem vs. alive) with narrow black margin at apices, strikingly different from the remainder of the body, with visible trabeculae, and with a deep stria 9 sulcus usually separated from humeral sulcus by a trans-sulcal bridge; elytral margin carinate only at base, generally rounded, smooth, polished, contiguous with epipleuron. In contrast, *L. flavipennis* is proportionately shorter, more oval in outline, and the elytral striae and intervals form a continuous smooth surface.

Description. Body length 13.9–14.8 mm, width 6.0–6.1 mm across humeri, 6.6–6.9 mm across elytral midlength, oblong, subparallel to elliptical in dorsal silhouette (Fig. 1), dorsum strongly convex (Fig. 3). Integument black thoughout, except

elytra rufotestaceous to testaceous, with black margins and suture near apices (Figs. 1, 3). Pubescence fine, pale flavous, moderately long, minute on elytra. **Head** coarsely punctured, punctures large, deep, umbilicate, approximate; frons shallowly impressed. Antennomeres 2–3 subserrate, subequal in length, 4–10 strongly serrate, 11 lachrymiform, 2–11 length ratio 1.0:1.0:1.7:1.6:1.6:1.6:1.7:1.7:1.7:2.6. **Pronotum** broadly trapezoidal, coarsely punctured as on head, punctures approximate discally to subrugose laterally; median line polished, with irregular margins; posterolateral area shallowly impressed. Anterior margin bisinuate; anterior angles rounded, slightly reflexed. Lateral margin sinuate, joining medial hypomeral margin before anterior angle; pronotum appearing constricted at anterior quarter. Hind angle dorsal carina long, reaching two-thirds the distance from hind angle apex to anterior margin, close to lateral margin, terminating on lateral dilation of pronotum. Scutellar shield shallowly convex, nearly flat, sparsely punctured. **Elytra** appearing glabrous, setae fine, minute, pale. Dorsal color translucent dull orange-red, revealing narrow and transverse linearly arranged trabeculae beneath striae. Humerus a shallowly to moderately domed boss, extended to fit over pronotal margin, subtended by deep groove. Striae 1–8 finely, shallowly impressed to subsulcate; stria 9 deeply sulcate basally from near humerus, separated from subhumeral groove by a smooth bridge, sulcus becoming shallower apically. Intervals shallowly convex, finely, sparsely, serially punctured. Costal margin smooth, rounded and confluent with epipleuron; lateral carina short, at base only. **Prosternum** with intercoxal process attenuate posteriorly, evenly convex, midline smooth and polished. Mesoventrite with arcuate carina delimiting crural impression for mesothoracic leg (Fig. 8). Ventral sclerites moderately to coarsely punctured, slightly denser on abdominal ventrite 5. Metatarsomere length ratio 1.0:0.3:0.3:0.3:1.1. **Aedeagus** (Fig. 5) with basal piece 0.42–0.43 of total length; median lobe narrow, evenly attenuate, apex acute, 0.72–0.74 of total length; parameres gradually narrowing apically, 0.76 of total length; apices obtuse, with acute subapical lateral spine, 0.06 of paramere length. **Females** not distinguishable from males without examination of terminal sclerites or genitalia. Gonocoxites and internal genital tract (Fig. 7) as per genus diagnosis.

Type Material. Holotype, female: "Buen Amigo, San Luis, Monteverde, Pr. Punta., COSTA RICA, 1000–1350m, 20 MAR-14ABR 1995, M. Segura, L N 250850 449250 #4410/INBIOCR002191821". This specimen will be returned to the INBio collection, presently managed by the Museum Nacional de Costa Rica, San José, Costa Rica.

Paratypes (28; 5 females, 5 males available for dissection). **COSTA RICA: Cartago Province:** Parque Nacional Tapanti, Orosi, 1,500 m, 23-AUG-1991, R. Coto (1, INBIO/MNCR). **Guanacaste Province:** Estac. Cacao, 1000–1400m, SW side Volcan Cacao, Guanac. Pr., Mar 1988, GNP Biod. Sur., 32300, 375700/INBIO CRI00050623 (1, INBIO/MNCR); same, Mar 1988, GNP Biod. Sur., 32300, 375700/CRI000050620 (1, INBIO/MNCR); same/CRI000050626 (1, INBIO/MNCR); same, Apr 1988/INBIO CR000035273 (1, INBIO/MNCR), same/CRI000127682 (1, INBIO/MNCR); same, M. Espinoza/CRI000036398 (1, INBIO/MNCR); same/CRI000036130 (1, INBIO/MNCR); Malaise Tp, 1988–1989, GNP Biodiv. Survey 323300, 375700/CRI000071599 (1, INBIO/MNCR); A.C.G. Liberia, Pque Nal Gte. Est Cacao. 1000–1150m, 9 MAR 1988, Espinoza Manual, L_N_323150_375500 #52583/INB0003354495 (1, INBIO/MNCR); Estac. Menog, 1100m, SW side Volcan Cacao, Guanac. Pr., Feb 1989, GNP Biodiversity Survey, W85 28′10″, N10 55′43″/CRI001038133 (1, INBIO/MNCR). **Puntarenas Province:** Buen Amigo, San Luis Monteverde, A.C. Arenal, Prov. Punta, 1000–1350 m, May 1994, Grace Fuentes, L N 250850_449250 #2927/CRI001870832 (1 INBIO/MNCR); same, ABR 1995, Z. Fuentes, L N 250820 449250 #4801/CRI002202986 (1, INBIO/MNCR); Cerro Amapola, San Luis, Monteverde, Prov. Punta, 1000–1350m, 23 Feb 1994, Z. Fuentes, L N 250850_449250 #2620/CRI001981686 (1, INBIO/MNCR); Monte Verde, Pens[ion] Quetzal, v-18-1988, 1380 m, B. Ratcliffe & M. Jameson (1, UNLC); Monteverde de Puntarenas 1959, has. Palmer/M. Robinson collection 1959 (1, FSCA), 1-3.vi.1978, E. Giesbert Coll. (1, FSCA), 11-14.iv.1981, E. Giesbert Coll. (1, FSCA), 23-27.v.1987, E. Giesbert Coll. (1, FSCA); San Luis, 1040 m, R. B. Monteverde, Prov. Punt., Abr 1993, Z. Fuentes, L-N250820,449250/INBIO CR001325792 (1, MUCR); Monteverde, v.26–vi.3.84, E. Riley, D. Rider, D. Ledoux (2, TAMU); C. R. Punt. ACLA. R.P.Z.P.T., Send. al Salto a 4.5 km, NE de Progreso, 1600m, 18-enero-1998, A. Picado Col. en Tronco podsido, LS-320150/599000E/CRI002607764 (1, INBIO/MNCR); C. R. Prov. Punt. Est. Pittier Send. a Río Canasta, 1.4 Km NNO. de la Estación 1750-1800m, 26–27 MAR 1998, M. M. Morago, Red Mariposera, LS_332100_576800 #50835/INB0003014982 (1, INBIO/MNCR); Est. Biol. Las Alturas, 1500m, Coto Brus, Prov. Punt, M. Zumbado, Ene 1992, L-S-322500, 591300/CRI000339475 (1, INBIO/MNCR). **PANAMA:** [**Chiriquí Province:**] Hartmann's Finca, 19.v.1996, R. Turnbow (1, FSCA).

Additional Specimen as Image. COSTA RICA, [Puntarenas Province] Monteverde, April 2013,

Fig. 8. *Lissomus cacique*, **new species**, ventral oblique aspect, arrow pointing to the arcuate postcoxal carina.

Kenji Nishida (1 image); specimen in Nishida collection for deposition in MUCR.

Etymology. The species epithet "*cacique*" is treated as a noun in apposition and is taken from the Taino as a term for a societal leader. The term was applied by Spanish colonizers more generally to leaders of indigenous groups throughout much of modern Latin America. The term is familiar to field biologists and Ticos in Costa Rica as Guaro Cacique, a popular and inexpensive rum.

Distribution (Fig. 9). Costa Rica (Cartago, Guanacaste, and Puntarenas); Panama (Chiriquí).

Notes. All examined specimens were collected from premontane wet forest habitats at approximately 1,000–1,800 m elevations. Collector labels indicate adult activity from January through late August, with most dates from mid-April through early June. Some adults were reported as collected on the abaxial surfaces of leaves along trails as is often for other *Lissomus* species. Immature life stages remain unknown. Larvae may be subcortical in senescent and decaying wood as is known for other American *Lissomus* species (Costa *et al*. 1988; personal observation).

Lissomus flavipennis Guérin-Méneville, 1844
(Figs. 2, 4, 6, 10)

Lissomus flavipennis Guérin-Méneville 1844a: 257; Lacordaire 1857: 94; Bonvouloir 1859: 121, 1860: 366; Gerstäcker 1860: 151; Gemminger and Harold 1869: 1459; Horn 1890: 198; Fleutiaux 1894: 690; Schenkling 1928: 12; Blackwelder 1944: 304.

Diagnosis. *Lissomus flavipennis* (Fig. 2) is slightly smaller than the preceding species, length 10.0–13.6 mm, width 5.0–5.8 mm; has the sides shallowly arcuate at midlength in dorsal silhouette (Fig. 2); antennomeres 2–11 with length ratio of 1.0:1.0:1.5:1.5:1.5:1.5:1.3:1.3:1.3:2.5; a strongly convex dorsum (Fig. 4); the elytral striae not or vaguely impressed (Fig. 2); the dorsal color translucent dull yellow to orange-red, revealing narrow and transverse linearly arranged trabeculae; metatarsomeres with length ratio 1.0:0.3:0.3:03:1.2. Aedeagus (Fig. 6) with basal piece 0.41 of total length; median lobe narrow, evenly attenuate in apical two-third of length, apex acute, 0.67 of total length; paramere sinuate laterally, 0.64 of total length; apices angulate, with acute subapical lateral hook, 0.13 of paramere length.

This species superficially resembles *L. cacique* as described above. Both species share the traits of a complete arcuate carina delimiting the crural impression of the mesothoracic leg (Fig. 8); the anterior pronotal angles appearing constricted at the termination of the carina; and the elytra predominately of a red-yellow to yellow-orange color, strikingly different from the remainder of the body. In contrast, *L. cacique* is proportionately longer, more elongate-oval in outline, the elytral striae are sulciform and intervals shallowly convex, coloration a darker red, and the aedeagi differ as described and illustrated (Figs. 5, 6).

Specimens Examined (22; 3 females, 3 males available for dissection). Type/Mexique/Flavipennis Guerin./ex Museo Mniszech (4, MNHN [3 lacking "type" label]. **GUATEMALA:** Guatemala/coll Schwarz (1, SDEI), Guatemal. Tumbador Reidel S. [I 1912 on reverse]/Lissomus spec. (1, MFNB); [possible syntype]. **MEXICO:** Mirador, Mexico, Sallé coll./Lissomus flavipennis, Guerin., Sallé coll 1382 (1, NHMUK); same data, 1380 (1, NHMUK) [these last two specimens may be syntypes]; Mexico (5, MFNB); Jalapa 6/Mexico, J. Flohr G. (1, MFNB); Mexico, J. Flohr G./flavipennis Guer. (2, MFNB); Mexico, J. Flohr G. (1, MFNB); no label [prob. provenance as previous] (1, MFNB); San Antonio, Chiapas, v. Türckheim (3, MFNB); 1185, Mexico, Tapachula, v. Türckheim (1, MFBN); 892 (1, MFNB).

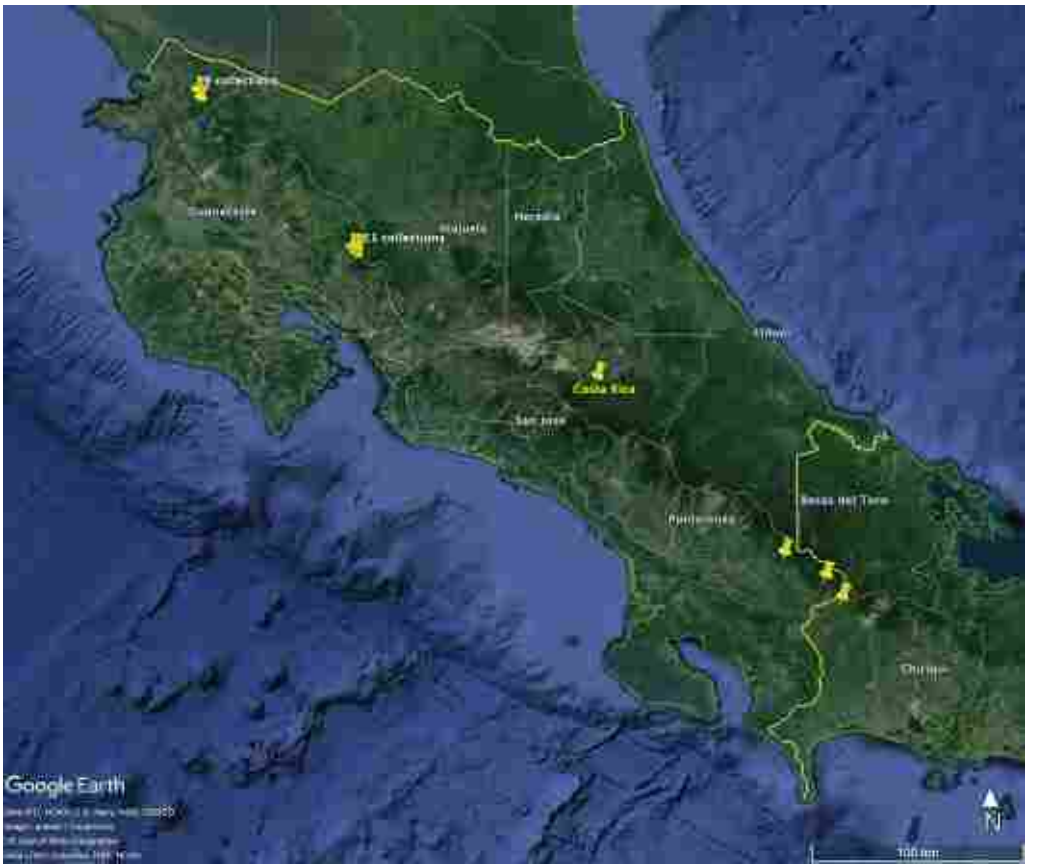


Fig. 9. Satellite image of Costa Rica and Panama with five *Lissomus cacique*, **new species** sites pinned. Two sites have multiple nearby collections as indicated.

Distribution (Fig. 10). Guatemala (Baja Verapaz, Quezaltenango); Mexico (Chiapas, Veracruz).

Notes. Bonvouloir (1859) examined an unspecified number of specimens from the collections of Guérin-Méneville and Mniszech, all from unspecified localities in Mexico. At least the originally described specimen(s) was or were obtained by the naturalist José Apolinario Nieto from "l'intérieur du Mexique" (Guérin-Méneville 1844a). Nieto lived in Cordoba, explored and collected there, as well as Orizaba, Xalapa, and in surrounding regions, and sent specimens to Guérin-Méneville for description (Sallé 1874). Horn (1890) also cited specimens in the *Biologia Centrali-Americana* (BCA) collection from "Jalapa" (= Xalapa) and "Cerro de Plumas" in Mexico (see below), and "Sinanja" (= Sinamjá, Baja Verapaz), "Purula" (= Purulhá, Baja Verapaz) and "Cerro Zunil" (= Volcán Zunil, Quezaltenango) in Guatemala (Selander and Vaurie 1962). No direct or original habitat information is available for *L. flavipennis*, and immature life stages remain unknown.

The "Jalapa" labeling for specimens collected by C. T. Höge may be questioned as some of his specimens from the Oaxaca area were mislabeled (Selander and Vaurie 1962). The "Cerro de Plumas" locality in Horn (1890) is "Cerro de Palmas", but apparently remains an unknown site supposedly in Veracruz (Selander and Vaurie 1962). However, Papavero (1973) and Flores-Villela *et al*. (2004) noted that Höge and Mateo Trujillo, both cited as collectors of *L. flavipennis* by Horn (1890), accompanied Frederick Godman to Xalapa (Godman 1915), and collected in that area and others to the east; this suggests that the original locality records are valid for this species. Less than 35 air kilometers south of Xalapa and approximately 12 air kilometers northeast of Huatusco, is the Hacienda El Mirador from where at least one specimen in Auguste Sallé's collection derived. Hacienda El Mirador was

Fig. 10. Satellite image of the Guatemala and southern Mexico region with 10 *Lissomus flavipennis* sites pinned.

established and operated by Christian William "Carlos" Sartorius, and later by his son Florentín Sartorius, both of whom hosted visits and collaborated extensively with numerous naturalists over many years and the finca became a famous collecting area (Goldman 1951). Schätti and Kucharzewski (2018) gave the coordinates of El Mirador as 19°12′46″N and 97°52′49″W, which differs from the coordinates given by Selander and Vaurie (1962). The first set of coordinates better fits for altitude, ecozone, and general environmental setting. The property was the first privately owned and protected natural area in Mexico (Ochoa-Ochoa *et al*. 2009).

Discussion

Lissomus cacique and *L. flavipennis* are the only *Lissomus* species with the elytra markedly contrasting with the ground color of the body, and the mesoventral crural impression delimited posteriorly by a complete arcuate post-coxal carina extending from the coxal cavity to the anterolateral margin of the mesoventrite. Interestingly, the complete arcuate carina on the mesoventrite is otherwise shared within *Lissomus* only with five Afrotropical species and *Lissomus mastrucatus* Gerstäcker from southwestern India and Sri Lanka. In contrast, other American species have no or an abbreviated carina that extends at most to about one-third the distance from the mesocoxal margin to the metaventral lateral margin. There are no available recent phylogenetic hypotheses for the composition of *Lissomus*, or its affinities to other genera in Lissominae. Kundrata *et al.* (2019b) tested only the position of the genus in relation to morphologically similar Indo-Australian taxa based on molecular and adult morphology. Despite a wealth of phylogenetic value from larvae, the use of such morphological information was apparently last incorporated into assessments of lissomine taxa by Costa *et al.* (2010). The genus and species taxonomic composition of Lissominae remains confounded as few studies (see above) have addressed the diversity within *Lissomus* and other genera that are represented by numerous poorly delimited and undescribed taxa. Recent study by this author of lissomine diversity indicates definable species groups within *Lissomus*, such that *L. cacique* and *L. flavipennis* are here provisionally considered

putative sister species based on the shared morphological features given above and their similar habitats, apart from other known *Lissomus* species.

Ecological attributes of lissomines are poorly documented. Adults of *Drapetes* and *Lissomus* are often found on abaxial surfaces of leaves along trails and in forest openings and edges (*e.g.*, Lacordaire 1857; personal observations), but activity details such as mating (Lacordaire 1830) are not well documented. Kirmse and Chaboo (2019) and Kirmse and Johnson (2020) reported *Lissomus obconicus* Bonvouloir feeding nocturnally at flowers and extrafloral nectaries in tree canopies, and on immature leaves of *Senna* cf. *silvestris* (Vell.) H.S. Irwin & Barneby (Fabaceae) in the laboratory. Such behaviors and activities are likely habits for *L. cacique* and *L. flavipennis*, but this needs investigation. A number of lowland-forest shining black or brown *Lissomus* species are collected at light traps or at light sheets, supporting the observations of *L. obconicus* for nocturnal activity. However, *L. cacique* and *L. flavipennis* from cloud forest elevations appear to be diurnal aposematic species.

As indicated above, there is little direct or original habitat information available in the taxonomic literature. However, from the published collecting areas and specimen locality labels generalized habitat information may be inferred. The known localities for *L. cacique* in Costa Rica and Panama are within premontane cloud forest ecozones between 1,000 and 1,800 m elevations on Volcan Cacao in the Guanacaste mountains, the Monteverde area in the Tilarán mountain range, and along the Talamanca mountain range into adjacent Chiriquí, Panama. These collection sites fall within the vegetational characteristics of premontane wet forests of the Holdridge Life Zone classification (Kohlmann 2011) and termed the Talamancan montane forests (*e.g.*, Corrales *et al*. 2015). The elevation range of this forest zone includes cloud forest. Deforestation and conversion of the landscape below and above the 1,000 m elevation to agricultural and urban uses has created large areas inimical to mesic forest insects such as *L. cacique*. Ángel Solis (personal communication) noted that the Hartman Farm area of western Chiriquí is presently mostly coffee plantation. These landscape conversions are readily seen and easy to distinguish from intact forest in aerial and satellite images, and are becoming disjunct montane islands that are threatened due to both anthropogenic and stochastic climate warming impacts.

Similar patterns of premontane wet forest habitats exist for *L. flavipennis* in Guatemala and southern Mexico. Goldman (1951) provided good general descriptions of the habitats at and surrounding Hacienda El Mirador. This site is on the windward side and lower slopes of the Pico de Orizaba area of the Mexican Plateau and receives extensive rainfall. Following Ricketts *et al*. (1999) and Corrales *et al*. (2015), the mesic broadleaf or mixed forests of eastern Mexico, the Sierra Madre de Chiapas Moist Forest ecozone of southern Mexico and southwestern Guatemala, and the Central American Montane Forest ecozone of the Sierra las Minas of central Guatemala are the ecoregions in which *L. flavipennis* was collected. The distribution pattern and habitat associations of *L. flavipennis* are the same as cloud forest scarabaeoid beetle patterns in Guatemala and adjacent Mexico discussed by Schuster and Cano (2006) and Ratcliffe *et al.* (2013). All of these areas can also be visualized on satellite images as isolated habitats surrounded and invaded by anthropogenic destruction of critical habitats for *L. flavipennis*. Should these forests further degrade this beetle species is also likely subject to extinction as a result of anthropogenic and climate warming impacts.

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