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A new species of *Leucochrysa* and a redescription of *Leucochrysa* (*Nodita*) *clepsydra* Banks (Neuroptera: Chrysopidae)

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ABSTRACT

A new species, *Leucochrysa* (*Nodita*) *digitiformis,* is described from an agricultural area in the coastal region of southeastern Brazil. In accordance with the most recent key to some agriculturally-associated lacewings in Brazil (Freitas and Penny 2001), this species would have been identified as *Leucochrysa* (*Nodita*) *clepsydra* Banks, which was described from the Andean region of Colombia (1,000–1,340 m). However, a comparison of our Brazilian specimens with Banks's syntypes of *L.* (*N.*) *clepsydra* showed that Freitas and Penny's redescription of *L.* (*N.*) *clepsydra* differs markedly from Banks's types in body size, wing shape, and male genitalia. To facilitate reliable identification of natural enemies in South American agroecosystems, we redescribe *L.* (*N.*) *clepsydra* (male and female) from the type specimens, describe a similar species from Brazil, and modify the existing key.

Key words*:* Leucochrysini, South America, agriculturally important predators

Resumo—Uma nova espécie, *Leucochrysa* (*Nodita*) *digitiformis*, encontrada em área agrícola na região costeira do sudeste do Brasil, é descrita. De acordo com a chave mais recente para crisopídeos associados com agroecossistemas do Brasil (Freitas e Penny 2001), esta espécie seria identificada como *Leucochrysa* (*Nodita*) *clepsydra* Banks, originalmente descrita com base em espécimes coletados na região andina da Colômbia (1000–1340 metros de altitude). Entretanto, comparando os espécimes brasileiros aqui estudados com os síntipos de *L.* (*N.*) *clepsydra* de Banks, observa-se que a redescrição desta espécie realizada por Freitas e Penny difere significativamente dos tipos de Banks quanto ao tamanho do corpo, forma das asas e genitália do macho. Para facilitar a identificação segura dos inimigos naturais de agroecossistemas sul-americanos, macho e fêmea de *L.* (*N.*) *clepsydra* são redescritos a partir dos espécimes tipos, uma espécie semelhante do Brasil é descrita e a chave existente é modificada.

INTRODUCTION

The New World genus *Leucochrysa* (Neuroptera: Chrysopidae: Chrysopinae: Leucochrysini) includes many species that are associated with agricultural crops, especially in the Neotropical region (Núñez 1988; Freitas and Penny 2001, Freitas 2007). These species are potentially useful as natural enemies of plant pests, but identifying them is difficult; in fact, misidentifications commonly occur in the literature and also on specimen labels.

The systematic problems with *Leucochrysa* arise from several causes. First, the genus is relatively large (~ 190 species in two subgenera, *Leucochrysa* and *Nodita*), and the external differences between species are often subtle. Second, the genus has received little modern systematic attention. For example, the systematically important adult genital structures were not included in descriptions until the late 1960s (males) and late 1970s (females) (Alayo 1968, Adams 1977); since then, only a very small fraction of *Leucochrysa* species has

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received such "modern" treatment (Adams 1979, 1987, Freitas and Penny 2001, Tauber 2004, Freitas 2007, Tauber *et al.* 2008). Third, many *Leucochrysa* species express large intraspecific variation in their adult coloration and markings; this variation has led to numerous synonymies (see examples and discussion in Tauber 2004, Mantoanelli *et al.* 2006).

Given the above, there are virtually no means to identify *Leucochrysa* species with accuracy and confidence. Such a weak taxonomic base presents a significant hurdle for evaluating or realizing the value of this group of predators as biological control agents of plant pests.

During a recent (2005–2007) survey of green lacewings in guava orchards, a substantial number of *Leucochrysa* (*Nodita*) were collected in the Campos dos Goytacazes region of Rio de Janeiro state (survey conducted by J.S. Multani and G.S. Albuquerque, UENF). Using the recent systematic treatment of agriculturally important chrysopids in Brazil (Freitas and Penny, 2001), we provisionally identified the most abundant species in the samples as *Leucochrysa* (*Nodita*) *clepsydra* (Banks). However, a comparison (by CAT) of our specimens with Banks's syntypes of *L.* (*N.*) *clepsydra* revealed significant differences—in the male and female genitalia, body size, and wing shape. The comparison also showed that the illustrations and description attributed to *L.* (*N.*) *clepsydra* by Freitas and Penny (2001) did not apply to that species, but probably to the new species described here. To help avoid further confusion, herein we (a) redescribe and illustrate the adults (male and female) of *L.* (*N.*) *clepsydra* based on the type specimens from Colombia and (b) describe the specimens collected in Rio de Janeiro state as a new species. We also modify the key of Freitas and Penny (2001) so that it will differentiate *L.* (*N.*) *clepsydra* from the new species.

Two CAVEATS: (1) Because *Leucochrysa* species are difficult to identify, our descriptions contain considerable morphological detail. It is hoped that the detail will help researchers identify specimens with a higher degree of confidence than is possible currently. (2) Also, given the current poor state of *Leucochrysa* systematics**,** it is possible that the new species described here, may, when comprehensive studies of this genus become available, turn out to be synonymous with a currently named species. Nevertheless, we believe that the occurrence of this species in agricultural situations and the potential for its confusion with *L.* (*N.*) *clepsydra* justify the risk of creating a potential synonym now, while more extensive systematics studies of *Leucochrysa* are underway.

MATERIALS AND METHODS

Our redescription of *L.* (*N.*) *clepsydra* is based on Banks's syntypes (two males, two females), which are held in the Museum of Comparative Zoology, Cambridge, MA (MCZ). Our description of the new species is based on 117 specimens (59 males, 58 females, pinned and preserved in alcohol). Unless stated otherwise, the procedures for clearing, mounting and describing the specimens follow those used previously (Tauber 2007).

All measurements were made with a Nikon Stereo Microscope Model SMZ 1550 (magnification margin of error ± 2%) and NIH ImageJ software (http://rsb.info.nih.gov/ij/). Head measurements were made according to Tauber (2007); scape width was measured at the widest position; genal length was the shortest distance from the base of the eye to the tip of the gena. Prothoracic length was measured along the dorsal midline, and the width was the straight-line distance across the posterior margin (widest position). Callus cerci were measured along the narrowest and widest diameters; the range was reported. Abdominal sclerites were measured in relation to the longitudinal axis (length: along the axis; height: perpendicular to the axis). To correct for the lateral curvature of the abdomen, "height" was measured on cleared specimens mounted in glycerin on a slide, and flattened with a glass cover-slip; thus, the reported values represent the height of one side, plus one-half of the width of the abdominal sclerite.

Consistent with our previous publications (e.g., Tauber 2007), we rely primarily on the terminology of Tillyard (1916), and somewhat on Adams (1996), for the wing venation; e.g., we use the terms "second intra-

median" cell (im2), "upper Banksian" cells (b1, b2, etc.), and "lower Banksian" cells (b'1, etc.). We retained Tillyard's terms in these cases because the structures that they signify are clearly identified and labeled on his figures and they provide useful and brief designations for the cells above and below the pseudomedia and also because subsequent authors did not state explicit reasons for rejecting the terms. Similarly, we use the term third intracubital cell (icu3), rather than the more recent term, distal cubital cell, because it provides more information. For example, in some chrysopids (e.g., *Vieira* spp., Tauber 2007) the forewing has a fourth cell in the distal position; in all cases the homology of the cells is not known. And, in all cases the features that we mention in the text are labeled on the figures.

Wing width was measured at four positions (midwing, 1/4th and 3/4th the distance from the base, and at the widest position); each is reported in the text. Measurements of wing cells were width (along the longitudinal axis) and height (perpendicular to the longitudinal axis). The height of the tallest costal cell was measured along the longest costal veinlet; the width of that cell was the width (mid-cell) of the cell distal to that veinlet. The width of the first intramedian cell (im1) was measured from the middle of the median arculus (ma) to the tip of the cell on the pseudomedia (Psm). The width of the third medial cell (m3) was taken from the most proximal margin of the cell (in the middle of the second m-cu crossvein, m-cu2) to the midline of the most distal vein (adjoining im2). The longest radial (R-Rs) crossvein was identified and measured; we then measured the width of each cell adjacent to that crossvein**.** The height of the b cells (= cells beneath Rs, not including an inner gradate vein) was measured from the apex (at the intersection of the radial crossvein) to the pseudomedia; the height of cells beneath the radial sector (& free of the pseudomedia) was taken from the apex (at the intersection of the radial crossvein or mid-cell) to the middle of the inner gradate posteriorly; the width of the above cells was the shortest distance mid-cell. The height and width of the cells bounded by the inner and outer gradates were taken midway along the bounding veins. The height of b' cells (=cells beneath the Psm after the second intramedian cell) was the distance from the Psm to the most distant posterior intersection of veins. The length of the basal intracubital cells was the straight-line distance along the upper longitudinal margin of the cells; in the case of the distal cubital cell we included both the upper longitudinal margin and the distal margin in the measurement.

To facilitate our long-distance collaboration, we used the MorphoBank website (O'Leary and Kaufman 2007). Images of both *L.* (*N.*) *clepsydra* and the new species are available on the website (http://morphobank.geongrid.org/permalink/?F15).

Type material.—The primary type of the new species and a series of paratypes (males and females) will be deposited in the Coleção Entomológica Pe. Jesus Santiago Moure (Universidade Federal do Paraná, Curitiba, PR, Brazil; DZUP). Additional paratypes will be deposited in the Essig Museum (University of California, Berkeley, CA; UCB), the insect collection at the Universidade Estadual do Norte Fluminense (UENF).

NOTE: Herein, we correct an error in the designation of the depository for the types of two species that we previously described from Brazil [*Leucochrysa riodoce* Tauber 2007, now *Santocellus riodoce* (Tauber) and *Santocellus atlanticis* Tauber & Albuquerque 2008]. The original descriptions stated that the holotypes (males in both cases) and the allotypes were to be held in the collection at the California Academy of Sciences (Tauber 2007, Tauber *et al*. 2008). In accordance with Brazilian federal law, these types will be deposited in a Brazilian museum—the Coleção Entomológica Pe. Jesus Santiago Moure (Universidade Federal do Paraná, Curitiba, PR, Brazil; DZUP). For each species, the depository for the paratypes is as mentioned in the original descriptions, with the exception that those designated for the CAS will be deposited in the Essig Museum, UCB.

***Leucochrysa* (*Nodita) clepsydra* Banks**
(Figs. 1–5; additional images: http://morphobank.geongrid.org/permalink/?F15)

Leucochrysa clepsydra Banks 1918: 14 [description].

Nodita clepsydra. Banks 1944: 20 [species listing, combination]; Penny 1977: 25 [species listing].
Leucochrysa (*Nodita) clepsydra.* Brooks and Barnard 1990: 277 [species listing]; Freitas and Penny 2001: 288, 359.

Type Material.—**Lectotype**. Male; abdomen cleared. Labels as follows—(1): "Inmbo, Cauca, Colombia, So. Am. 1,000 m., Jan"; (2): "Collection N. Banks"; (3) (red): "Type 10062_{2}"; (4): "Gen. prep. P. Adams '90"; (5): "Lectotype, *Leucochrysa clepsydra* Banks, desig. C. A. Tauber & G. S. Albuquerque, 2008" (red).

Paralectotypes (two females, one male) are also designated; each bears labels with the following data: (1): "Caldras, Colombia, 4,400 ft."; (2): "May". (3): "Type $10062_{1, 3, or 4}$"; Lowest: "Paralectotype, *Leucochrysa clepsydra* Banks, desig. Tauber & Albuquerque, 2008". "$Type_{1}$" (a mature female) bears a fourth label, "type" (small, red), and a fifth label, "*Leucochrysa clepsydra* Bks, type" (large, in Banks handwriting). Banks' "$Type_{3}$" (a teneral female) and "$Type_{4}$" (a teneral male) bear a fourth label: "N. Banks".

We could not locate an "Inmbo" in Colombia; we suspect that it is a misspelling of Yumbo, a town on the outskirts of Cali, in the Valle del Cauca Department. Banks (1918) indicates that the specimen (the lectotype) was taken by A. H. Fassl. The locality "Caldras" on the paralectotypes is probably a misspelling of "Caldas", which could refer either to an unspecified location at 4,400 feet elevation in the Caldas Department or to the Andean town of Caldas in Antioquia Department. The town of Caldas is higher than that indicated on the label [around 1,750 m (5,750 ft.) versus 1,341 m (= 4,400 ft)]. Banks (1918) states that the specimens were collected by H. S. Parish.

Diagnosis.—*Leucochrysa* (*N.*) *clepsydra* can be distinguished from other *Nodita* species by the following set of traits: head unmarked except vertex with pair of longitudinal, maroon marks; genae with reddish or maroon stripe; palpi and antennae pale throughout, except scape with reddish, longitudinal, mid-dorsal stripe (absent on some specimens); body probably green; pronotum with two pairs of reddish lateral spots (not continuous); mesoscutum with pair of reddish spots anteriorly; male with heavily sclerotized mediuncus separated from gonarcus by enlarged membrane; mediuncus with bifurcated dorsal horn, prongs of dorsal horn separated by U-shaped trough; female with subgenitale enlarged and heavily sclerotized, reproductive tract simple, spermatheca small, bursal duct straight or twisted (not coiled), spermathecal duct short, slender throughout (not enlarged basally).

Adult description.—[Measurements: head, thorax, abdomen (n=3–4), wings (n=4), genitalia (n=1 mature male, 1 mature female)]. *Head:* Width (including eyes) = 1.25–1.35 mm (male), 1.65–1.82 mm (female); ratio of head width to eye width = 2.06–2.73:1. Vertex raised, flat anteriorly, with flat folds posteriorly, smooth surface, no setae. Scape longer than broad (female: 0.25–0.29 mm long, 0.21–0.26 mm wide; male: 0.19 mm long, 0.15 mm wide); ratio of width of scape : distance between scapes = 0.36–0.39:1 (female), 0.25:1 (male); no long setae; lateral margin fairly straight. Flagellum (broken on all specimens) with proximal three flagellomeres short (length = 1.2–1.4 times width), with ~3 concentric rings of setae; subsequent flagellomeres longer [2.1–3.0 times width (middle), 3.1–4.5 times width (distal)], with four concentric rings of setae. Distance between scapes = 0.06–0.08 mm; distance between tentorial pits = 0.39–0.48 mm; length of frons (midway between scapes – midway between tentorial pits) = 0.32–0.38 mm. Frons slightly raised mesally; surface relatively smooth. Clypeus convex basally. Labrum with distal margin indented mesally, dorsal surface smooth, rounded; sides rounded. Gena short; ratio of genal length to distance between tentorial pits = 0.35–0.36:1.

Head coloration (based on the faded specimens and on Banks's 1918 description): Antenna pale, unmarked, except dorsum of scape with strong, red to dark maroon, longitudinal stripe mesally (absent, probably faded, on two of the types). Vertex pale, with pair of reddish longitudinal stripes. Frons, clypeus, toruli, labrum pale; genae with distal 3/4 reddish to dark maroon dorsally and ventrally, pale mesally and basally. Palpi, labium, mentum pale.

Thorax: Cervix pale with maroon to black marks laterally, with numerous short, dark setae. Prothorax 0.62–0.65 mm long; 0.77–0.82 mm wide; ratio of length:width = 0.79–0.82:1; setae thin, long (longest 0.25–

0.33 mm), pale to golden; pronotum pale with two red to dark maroon lateral spots on each side. Mesothorax, metathorax pale with pair of dark maroon to black spots on anteromesal edge of mesoscutum. Claws simple, with large quadrate base.

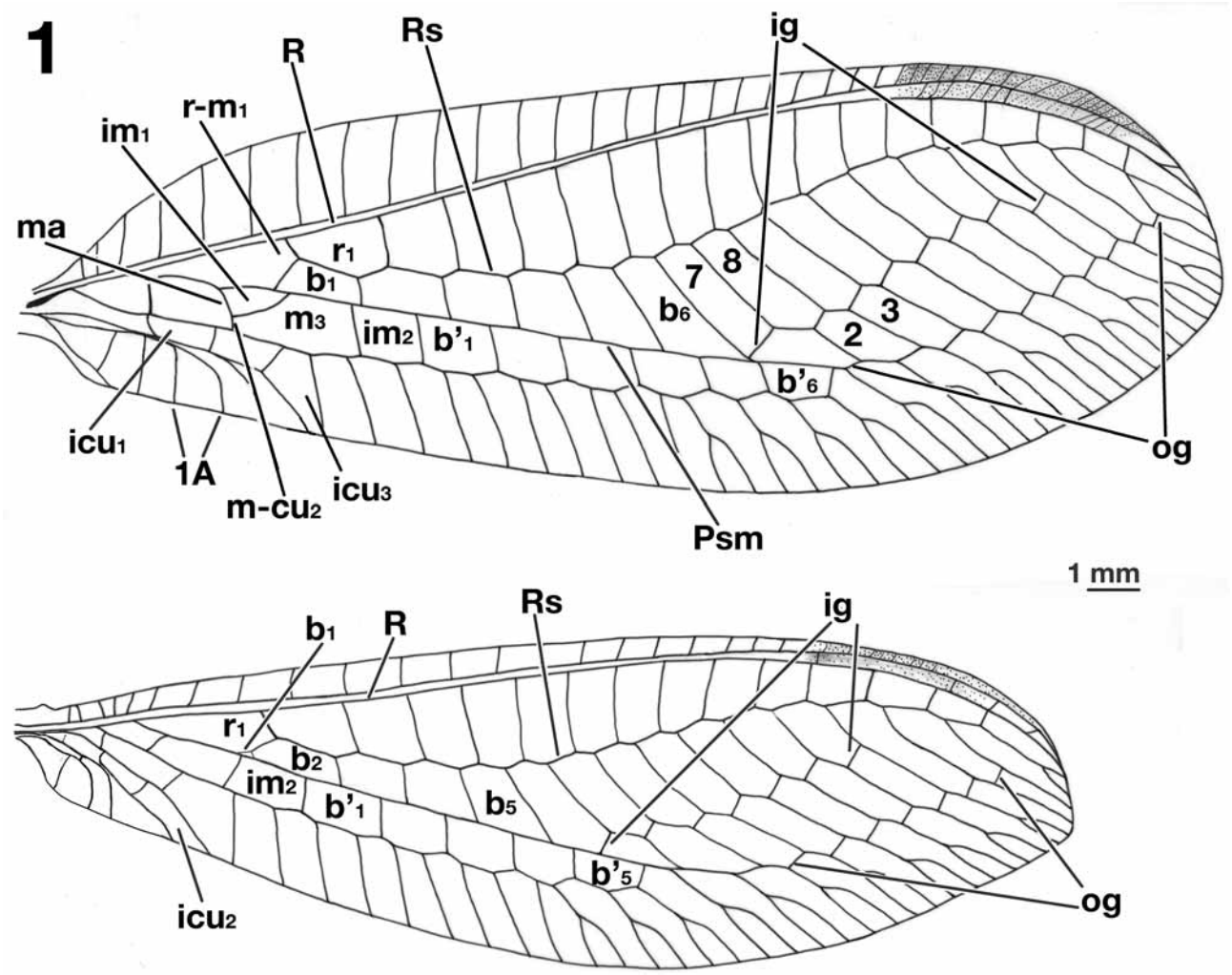

FIGURE 1. *Leucochrysa* (*Nodita*) *clepsydra*, forewing (top), hindwing (bottom). Abbreviations: b#, upper Banksian cells; b'#, lower Banksian cells; icu#, intracubital cells; ig, inner gradate veins**;** im#, intramedian cells; ma, median arculus; m-cu2, second m-cu crossvein (between the Media and Cubitus); m3, third medial cell; og, outer gradate veins; Psm, pseudomedia; R, Radius; Rs, radial sector; r1, first radial cell; r-m1, first crossvein between Rs and Media; 1A, first anal vein; 2, 3, second and third cells bounded by gradates; 7, 8, seventh and eighth cells beneath Rs (= first two cells beneath Rs, free of Psm).

Wings (Fig. 1): Forewing 16.7–19.6 mm long, 5.7–6.6 mm wide (midwing); ratio of length:maximum width = 2.8–3.1. Costal area relatively narrow, longest costal veinlet (#7, #8) 1.4–1.5 mm long, 1.0–1.4 times width of distal adjacent cell, 0.23–0.24 times width of wing (midwing). First intramedian cell ovate, 0.5–0.6 width of third median cell (m3). First radial crossvein (r–m1) distal to origin of radial sector (Rs); radial area (between Radius and Rs) with single row of 15–16 closed cells; tallest cell (#7, #8) 1.9–2.3 times taller than wide. No veins crassate except slight swelling at furcation of Cu (male and female); 5–6 b cells; distal b cell 0.4–0.7 times wider than tall. First two cells beneath Rs, free of pseudomedia (= seventh, eighth, and ninth cells beneath Rs) 2.9–3.4 times taller than wide. Two series of gradate veins; 7–8 inner gradates, 9 outer gradates; second to fourth cells bounded by gradates 3.0–4.1 times taller than wide. Six b' cells; last b' cell 0.5 times taller than wide. Three intracubital cells (two closed); first cubital crossvein located basal to second mediocubital crossvein; first and second intracubital cells of similar lengths; both shorter than third. Vein 1A

forked. Membrane clear; stigma slightly opaque. Veins largely discolored, originally described as green, marked with black on gradates, marginal forks, parts of costals, radials, branches of Rs, and origin of Rs.

Hindwing 14.9–17.1 mm long, 4.6–5.3 mm wide. Two series of gradate veins; 6–7 inner, 8 outer; 13–14 radial cells (counted from origin of Radius, not false origin). Five b cells (including small b1 cell); five b' cells beyond second intramedian cell; two intracubital cells (one closed). Membrane clear, with stigma slightly opaque to light brown (originally described as distinct). Veins discolored, originally described as green, with gradates not dark, marginal forks partly dark, marginal vein dark distally.

Abdomen: Color largely faded. Sternites (cleared specimens) slightly taller than long (lateral view), with setae medium length, slender; microsetae sparse. Tergites rounded anteriorly and posteriorly, with slightly heavier, denser setae than on sternites. Spiracles oval externally, simple, unilobed; atria not enlarged.

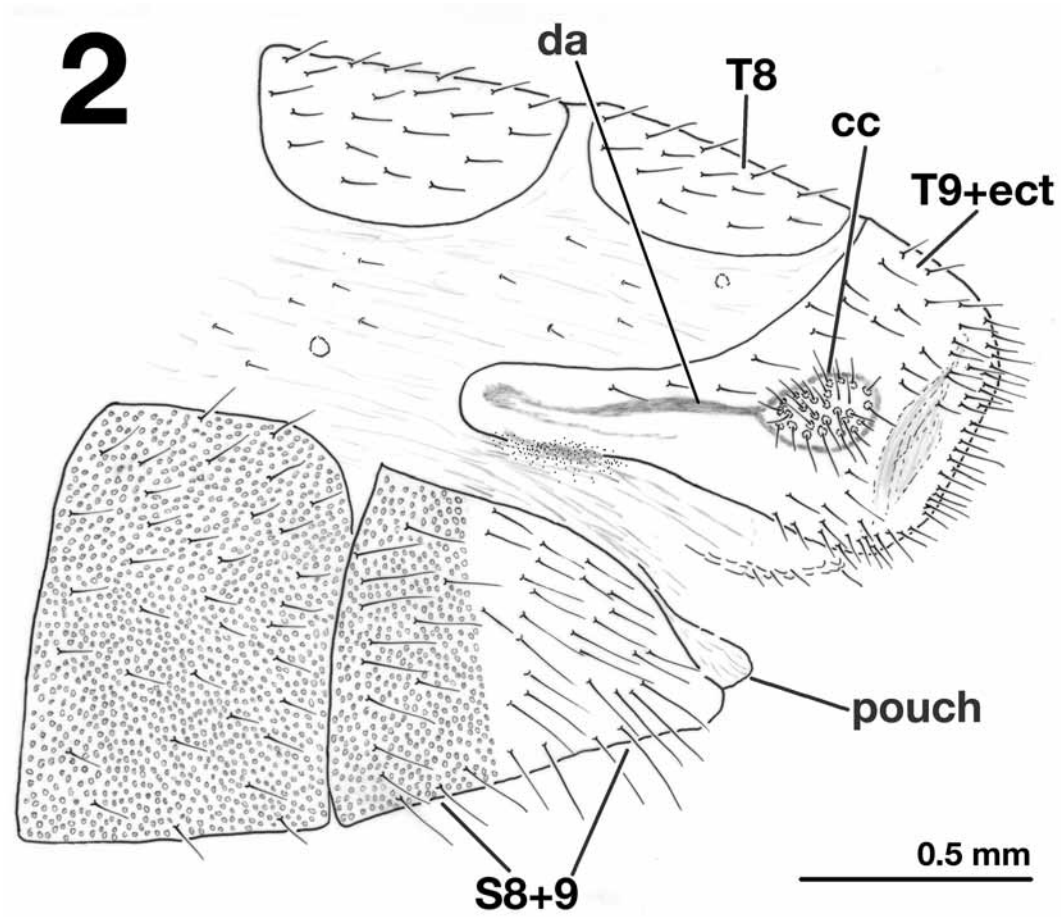

FIGURE 2. *Leucochrysa* (*Nodita*) *clepsydra*, male terminal abdominal segments, lateral. Abbreviations: cc, callus cerci; da, dorsal apodeme; pouch, membranous pouch above tip of S8+9; S8+9, fused eighth and ninth sternites; T8, eighth tergite; T9+ect, fused ninth tergite and ectoproct. Hypandrium internum missing from both male specimens that we studied.

Male (Figs. 2, 3): Callus cerci oval, 0.16–0.29 mm diameter (range), with 33 thin trichobothria (0.04–0.15 mm long). Sternites 3–8 with dense microtholi (none on S1 or S2). Dorsum of T9+ectoproct truncate distally, fused mesally, without deep cleft at midline, with distal setae slightly more dense than elsewhere; ventral section of T9+ectoproct with rounded proximal extension reaching full length of T8, proximal margin well sclerotized. Dorsal apodeme heavy, extending distally from base of segment, forming a loop around callus cerci. S8 and S9 fused, although clearly distinct, without suture; S9 about 5/8 length of S8, without microtholi; S8+9 (lateral view) triangular in shape, with dorsal surface slightly convex. Setae on S9 longer, more robust, stemming from slightly heavier bases than those on S8; terminus of S9 with small invaginated, membranous

pouch, no gonocristae. Gonarcus arcuate; gonarcal apodemes greatly expanded, with sculptured appearance; gonarcal bridge broad, with elongate gonocornua. Gonocornua stout basally, tapering distally, terminating in acute apex curved inward; apex of each with dorsal patch of microsetae. Mediuncus well sclerotized, attached to gonarcus via large, bulbous membrane; base of mediuncus shield-like, with broad, neck-like dorsal extension terminating in pair of fork-like projections; with pair of cylindrical extensions and gonosaccus below; ventral surface of gonosaccus with ~18 short setae arising from chalazae; gonosaccus large, delicate posteriorly. Entoprocessus, tignum, gonapsis, pseudopenis, spinellae, gonocristae absent. Hypandrium internum apparently lost or undiscernable on both male specimens.

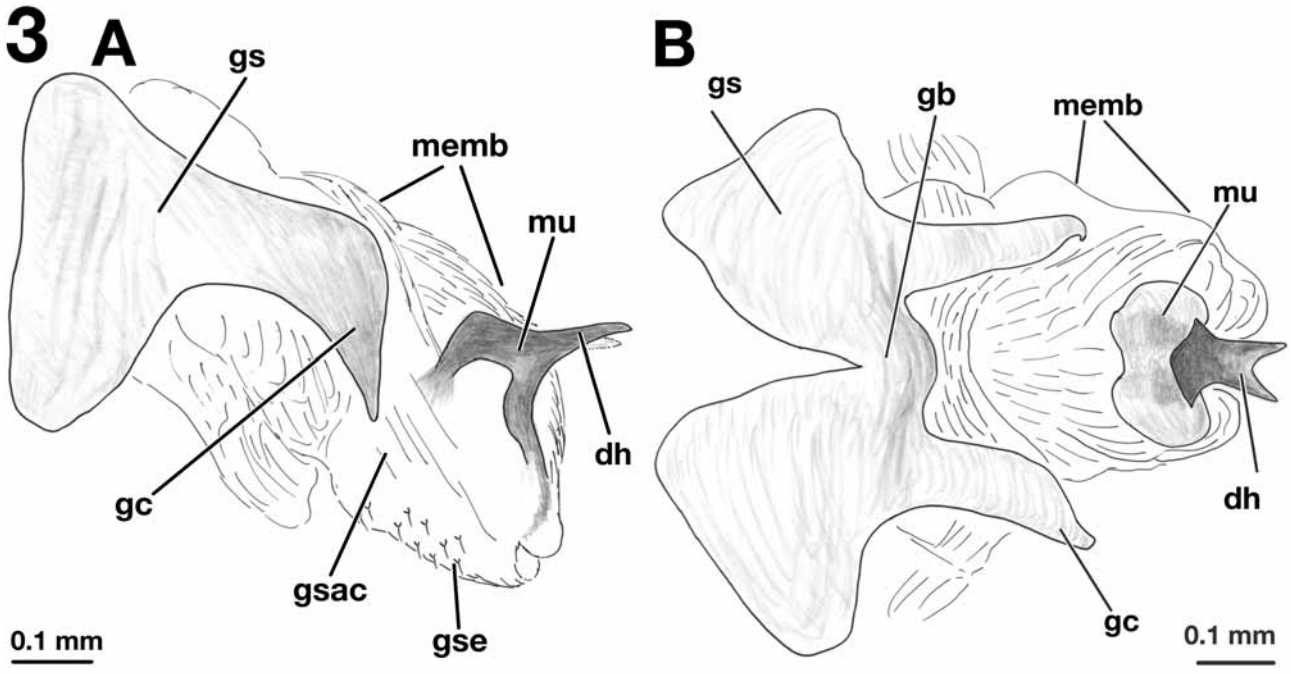

FIGURE 3. *Leucochrysa* (*Nodita*) *clepsydra*, gonarcal complex. A, lateral; B, dorsal. Abbreviations: dh, dorsal horn; gb, gonarcal bridge; gc, gonocornu; gs, gonarcus (lateral apodeme); gsac, gonosaccus; gse, gonosetae; memb, membrane between gonarcus and mediuncus; mu, mediuncus.

Female (Figs. 4, 5): Callus cerci almost circular, 0.14–0.17 mm diameter, with 28 thin trichobothria of variable size (0.05–0.18 mm long). Tergite 8 cap-like (lateral view), similar in depth to T7, T6. Tergite 9+ectoproct elongate, distal (dorsal) margin slightly convex, acute distoventrally, extending slightly below gonapophyses laterales. Sternite 7 roughly quadrate, acute distally; terminus unmodified, with long setae. Gonapophysis lateralis elongate, rounded dorsally, quadrate ventrally, with relatively dense, long, regularly spaced setae; inner membranous surface expandable, with two to three rows of setae. Colleterial gland large, extending well into A6, with bulbous reservoir entirely within T9+ectoproct; duct between gland and reservoir relatively narrow. Transverse sclerification well hardened, flat, platform-like (lateral view), tapering laterally, with long, fine longitudinal striations. Bursa copulatrix membranous, with loose longitudinal folds, triangular with apex of triangle extending anteriorly into A7, distal (anterior) end tapering to membranous duct that recurves and meanders posteriorly to spermatheca within subgenitale, opening to spermatheca via long slit along dorsal surface of spermathecal velum. Pair of large, bulbous bursal glands extending laterally

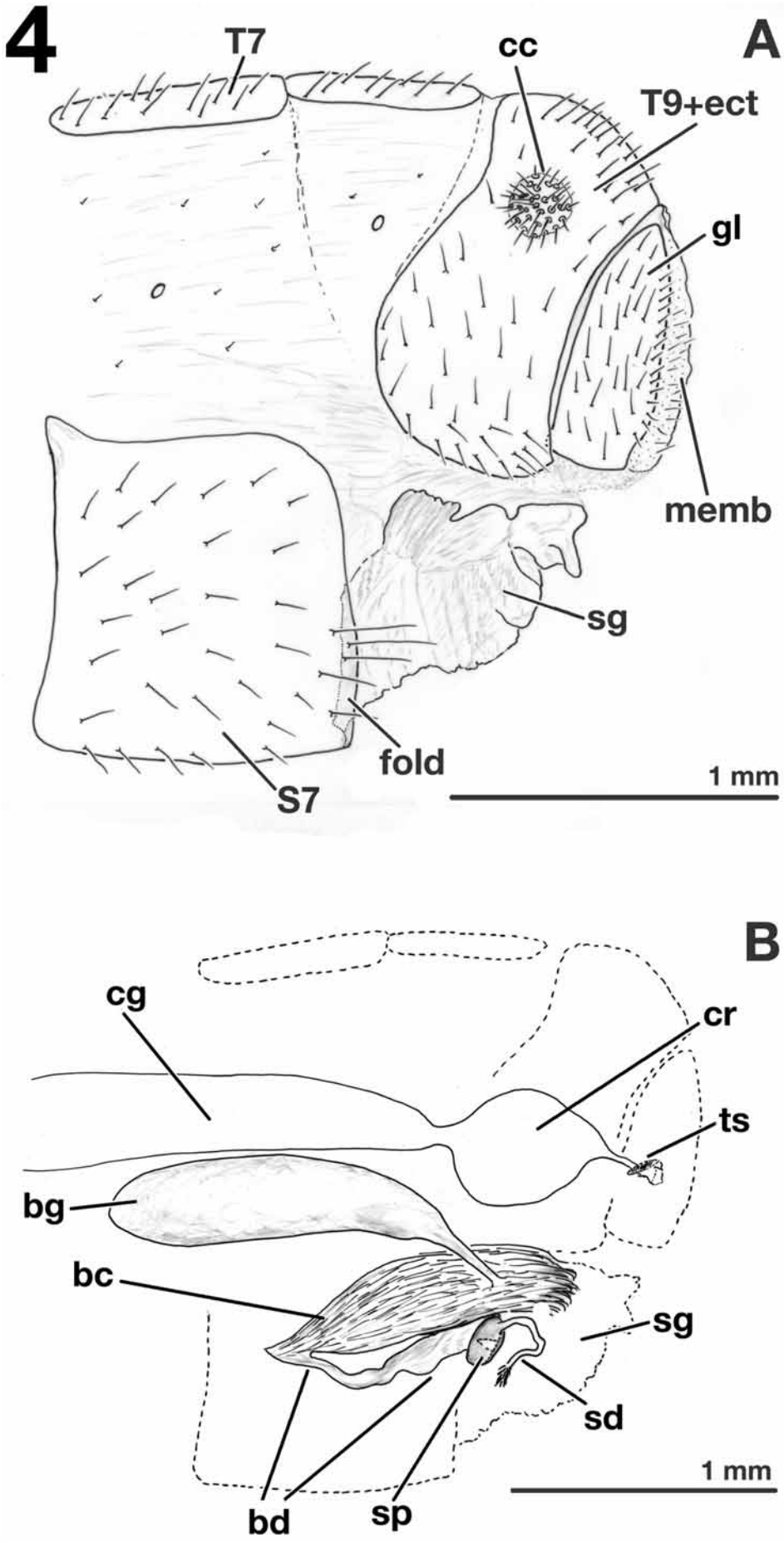
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FIGURE 4. *Leucochrysa* (*Nodita*) *clepsydra,* female. A, terminal abdominal segments, external, lateral; B, same, internal, lateral. Abbreviations: bc, bursa copulatrix; bd, bursal duct; bg, bursal gland; cc, callus cerci; cg, colleterial gland; cr, colleterial reservoir; fold, small fold at terminus of S7 and point of insertion of subgenitale; gl, gonapophysis lateralis; memb, expandable, setose membrane lining inner surface of gonapophysis lateralis; sd, spermathecal duct; sg, subgenitale; sp, spermatheca; S7, seventh sternite; ts, transverse sclerification; T7, seventh tergite; T9+ect, fused ninth tergite and ectoproct.

from base (posterodorsal surface) of bursa. Spermatheca small, round, doughnut shaped (~7% length of T9+ect), with mesal invagination extending entire depth. Spermathecal velum tubular basally, broadly folded, melding with bursal duct distally, smooth-walled, clear throughout. Spermathecal duct short, ~ 2x diameter of spermatheca (hidden within subgenitale), slender throughout, attached to dorsal margin of spermatheca, with U-shaped curve and two distal bends before terminus; terminus near spermatheca; glandular setae on terminal section extending ca. one-fifth length of entire duct. Subgenitale large, extending well beyond lower margin of T9+ectoproct; base heavy, well sclerotized, with dense transverse folding throughout, ventrally with small membranous fold into S7; without setae. Distal section of subgenitale elongate; terminus with small, shallow sclerotized lobes and shallow depression; elongate, cylindrical protuberance extending ventrally; membrane above lobes with small, crescent-shaped, very lightly sclerotized lamellae.

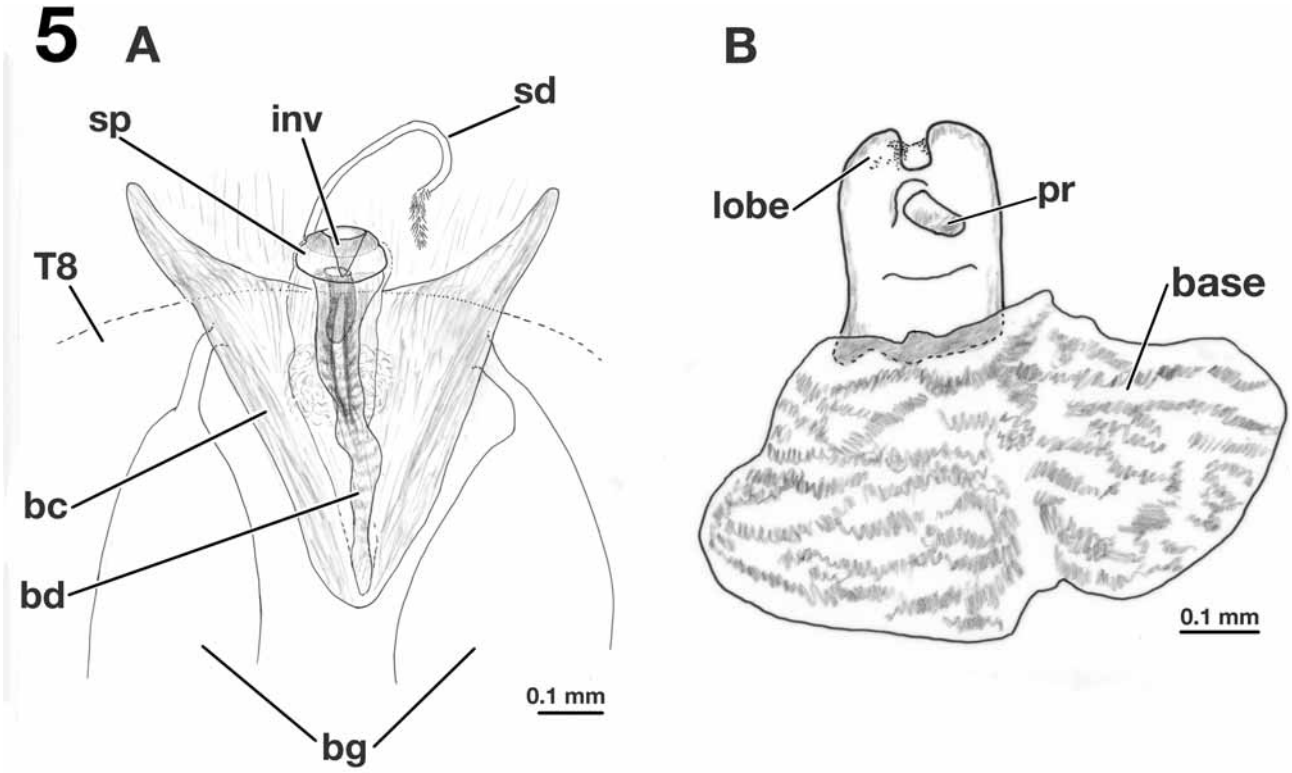


FIGURE 5. *Leucochrysa* (*Nodita*) *clepsydra,* female. A, spermathecal complex, ventral; B, subgenitale, ventro-lateroventral. Abbreviations: base, base of subgenitale; bc, bursa copulatrix; bd, bursal duct; bg, bursal gland; inv, spermathecal invagination; lobe, lobe of subgenitale; pr, ventrally projecting process on neck of subgenitale; sd, spermathecal duct; sp, spermatheca; T8, ventral surface of eighth tergite.

Larvae and biology.—Unknown.

Distribution.—This species is known only from the Andean region of Colombia, 1,000–1,341 m elevation.

Variation.—It is noteworthy that the four adult specimens of this species, including the three from one locality, show considerable variation in size (e.g., wing length among the four specimens varies by 3 mm, ~12% of the wing length).

Adult specimens examined.—Type material only.

***Leucochrysa* (*Nodita*) *digitiformis* Tauber and Albuquerque, new species**
(Figs. 6–10; additional images: http://morphobank.geongrid.org/permalink/?F15)

Type Material. **Holotype.** Male; abdomen not cleared. Labels read as follows [material in square brackets added]: (1) "Brazil: R[io de] J[aneiro], Campos dos Goytacazes, Est. Exp. PESAGRO [Estação Experimental da Empresa de Pesquisa Agropecuária do Estado do Rio de Janeiro, 21°44'55"S, 41°18'30"W, 14m altitude], IV–19–2005"; (2) "G. S. Albuquerque, J. S. Multani, Collectors"; (3) "HOLOTYPE *Leucochrysa* (*Nodita*) *digitiformis* Tauber and Albuquerque, desig. 2008." In the collection of the Coleção Entomológica Pe. Jesus Santiago Moure (Universidade Federal do Paraná, Curitiba, PR, Brazil; DZUP).

Paratypes. Data as above, except the collection dates on Label (1) for some "IV–19–2005 to I–31–2006"**,** and Label (3) reads: "PARATYPE *Leucochrysa* (*Nodita*) *digitiformis* Tauber and Albuquerque, desig. 2008." Two males, 2 females (pinned), DZUP; 2 males, 2 females (pinned), UENF; 2 males, 2 females (pinned), Tauber Research Collection; 2 males, 2 females (pinned), Essig Museum, University of California, Berkeley (UCB).

Diagnosis.—Externally, *L.* (*N.*) *digitiformis* closely resembles *L.* (*N.*) *clepsydra* in that it has a green body, with brownish-red marks on the genae, dorsolateral surfaces of the scapes, sides of the pronotum (two discontinuous pairs of spots), and prescutal-scutal margin of the mesonotum (one distinct pair of spots). *Leucochrysa* (*N.*) *digitiformis* can be distinguished from *L.* (*N.*) *clepsydra* and other *Leuchochrysa* (*Nodita*) species by the following combination of traits: dorsum of head without marks; genal mark located dorsally on the gena, extending dorsally along margin of frons; longitudinal mark on scape located dorsolaterally, not mesally; distal palpomeres marked with brown; a brownish-red mark at the base of the costal region of the forewing; a relatively long prothorax; male with mediuncus attached directly to gonarcal bridge, dorsal horn extending from below gonarcal bridge (not from above); dorsal horn deeply bifurcate, prongs of horn elongate, digitiform, separated by V-shaped trough; female with subgenitale bearing an elongate, flat ventral projection that extends into the seventh abdominal segment, spermatheca with large, coiled bursal duct, and a relatively long spermathecal duct (> 2x diameter of spermatheca) that is thick basally, tightly looped mesally and with long distal section of glandular setae.

Adult description.—[Measurements: head, thorax, abdomen, wings (n=4), genitalia (n=2 mature males, 2 mature females)]. *Head:* 1.2–1.8 mm wide (including eyes); ratio of head width to eye width = 1.96–2.35:1. Vertex approximately oval, raised slightly, with smooth to slightly textured surface, with transverse patch of short setae, without posterior fold. Antenna 21.1–24.5 mm (~1.5 times length of forewing); scape longer than broad, (~0.27 mm long, ~0.21 mm wide), width = 0.2x distance between scapes, with three to four long setae distally on dorsal surface, shorter setae laterally; lateral margin fairly straight, mesal margin straight basally, curved outward distally; pedicel ~0.16 mm long, ~0.11 mm wide (at widest point); proximal flagellomeres short (segments 1, 2, 3: length = 1.3–1.7 times width), with three to four concentric rings of setae; middle and distal segments becoming longer (segments 6–8: length = 1.8–2.0 times width; distal segments: length = 3.0–3.9 times width), with four concentric rings of setae. Distance between scapes 0.12–0.15 mm; distance between tentorial pits 0.46–0.67 mm; length of frons (midway between scapes – midway between tentorial pits) 0.40–0.59 mm. Torulus large (below scape, 0.12–0.15 mm deep). Frons relatively flat mesally, with slightly scalloped fold below toruli; surface smooth to slightly textured, with short setae. Clypeus straight basally; surface slightly textured, not horizontally striated. Labrum with distal margin slightly indented

mesally; dorsal surface smooth, rounded, setose; sides rounded. Gena short; ratio of genal length to distance between tentorial pits = 0.24–0.32:1.

Head coloration: Antennae with scape greenish-yellow and bearing brownish-red distolateral stripe; pedicel greenish yellow with amber ring distally; flagellum white with greenish tinge, setae dark amber. Eyes purplish-grey to black. Vertex yellowish-green, unmarked. Frons yellowish-green, with brownish-red stripe anteromesal to eyes extending onto upper margin of gena and posterior margin of clypeus. Otherwise, genal area light green; clypeus, labrum yellowish-green throughout. Torulus cream. Maxilla with basal two palpomeres cream; mesal palpomere brown distally and laterally, penultimate palpomere brown throughout; distal palpomere brown basally, cream distally**.** Labium and labial palpi cream.

Thorax: Cervix collar-like, quadrate, slightly concave anteriorly, yellowish-green, with dorsolateral-lateral patches of very short setae, dorsomesal section punctate. Prothorax 0.90–0.93 mm long; 1.10–1.20 mm wide; ratio of length : width = ~0.8:1; setae thin, long (longest 0.23 mm), light golden; pronotum yellowish-green, with two pairs of brownish-red markings: narrow, darker pair anterolaterally, larger pair posterolaterally; posterior marks widest mesally, tapering posteriorly; sometimes a yellow mesal stripe; pleuron, venter light green. Mesothorax, metathorax yellowish-green dorsally, sometimes with a yellow mesal stripe, light green laterally and ventrally; mesoscutum with pair of bold dark brownish-red spots mesally (size variable); metascutum unmarked or with pair of small, diffuse brown spots mesally. Legs light green, unmarked, with golden to dark amber setae. Tarsal claws simple, elongate, narrow, with quadrate base.

Wings (Fig. 6): Forewing 14.4–16.5 mm long, 5.1– 6.0 mm wide (at widest point); ratio of length : maximum width = 2.7–2.8:1. Costal area not exceptionally broad; longest costal veinlet (#7, #9) 1.1 mm long, 1.6–2.1 times width of distal adjacent cell, 0.23 times width of wing (midwing). First intramedian cell triangular, 0.5–0.6 width of third median cell (m3). First radial crossvein distal to origin of radial sector (Rs); radial area (between Radius and Rs) with single row of 12–14 closed cells; tallest cell (# 5, #6) 2.0–2.3 times taller than wide. No veins crassate except slight swelling at furcation of Cu (male and female); 5–6 b cells; distal b cell 0.3–0.5 times wider than tall. First two cells beneath Rs, free of pseudomedia (= eighth, ninth or tenth cells beneath Rs) 2.5–3.1 times taller than wide. Two series of gradate veins; 6–7 inner gradates, 8 outer gradates; second to fourth cells bounded by gradates 3.2–4.3 times taller than wide. Five to six b’ cells; last b’ cell 0.5–0.6 times taller than wide. Three intracubital cells (two closed); first cubital crossvein located basal to second mediocubital crossvein; first, second, third intracubital cells of similar lengths. Vein 1A forked. Membrane clear**;** stigma slightly opaque. Veins green, with black on gradates, some marginal forks, ends of costals, basal and distal radials, origin of Rs, median arculus, branches of pseudomedia and pseudocubitus, anal veins; base of forewings (between the bases of the costal and subcostal veins) with small, dark brown spot.

Hindwing 12.5–13.2 mm long, 3.9–4.3 mm wide. Two series of gradate veins; 6 inner, 6–7 outer; 13–14 radial cells (counted from origin of Radius, not false origin). Five b cells (including small b1 cell); five b’ cells beyond second intramedian cell; two intracubital cells (one closed). Membrane clear, with stigma pronounced, brown. Veins mostly light green, but dark on parts of Rs (base, distal regions, and branches), gradates, middle costals, and marginal forks.

Abdomen: Distal segments (beyond A4) expanded; pleural region ca. twice height of sternites. Sternites, tergites with microsetae relatively sparse; male: S6 approx. 1.1–1.2 times longer than tall, S7 approx. 0.95–0.97 times longer than tall (lateral view); female: S6 approx 1.4 times longer than tall, S7 approx. 1.7 times longer than tall. Tergites narrow, roughly rectangular, with lighter setae and longer microsetae than on sternites. Spiracles oval externally; atria not enlarged. Integument mostly yellowish-green, with mesal yellow stripe dorsally; T2–T6 with pair of irregularly shaped, brownish-red, pigmented spots submesally (small or sometimes missing on T2–T5, large on T6); gonapophyses laterales, callus cerci light green; setae pale.

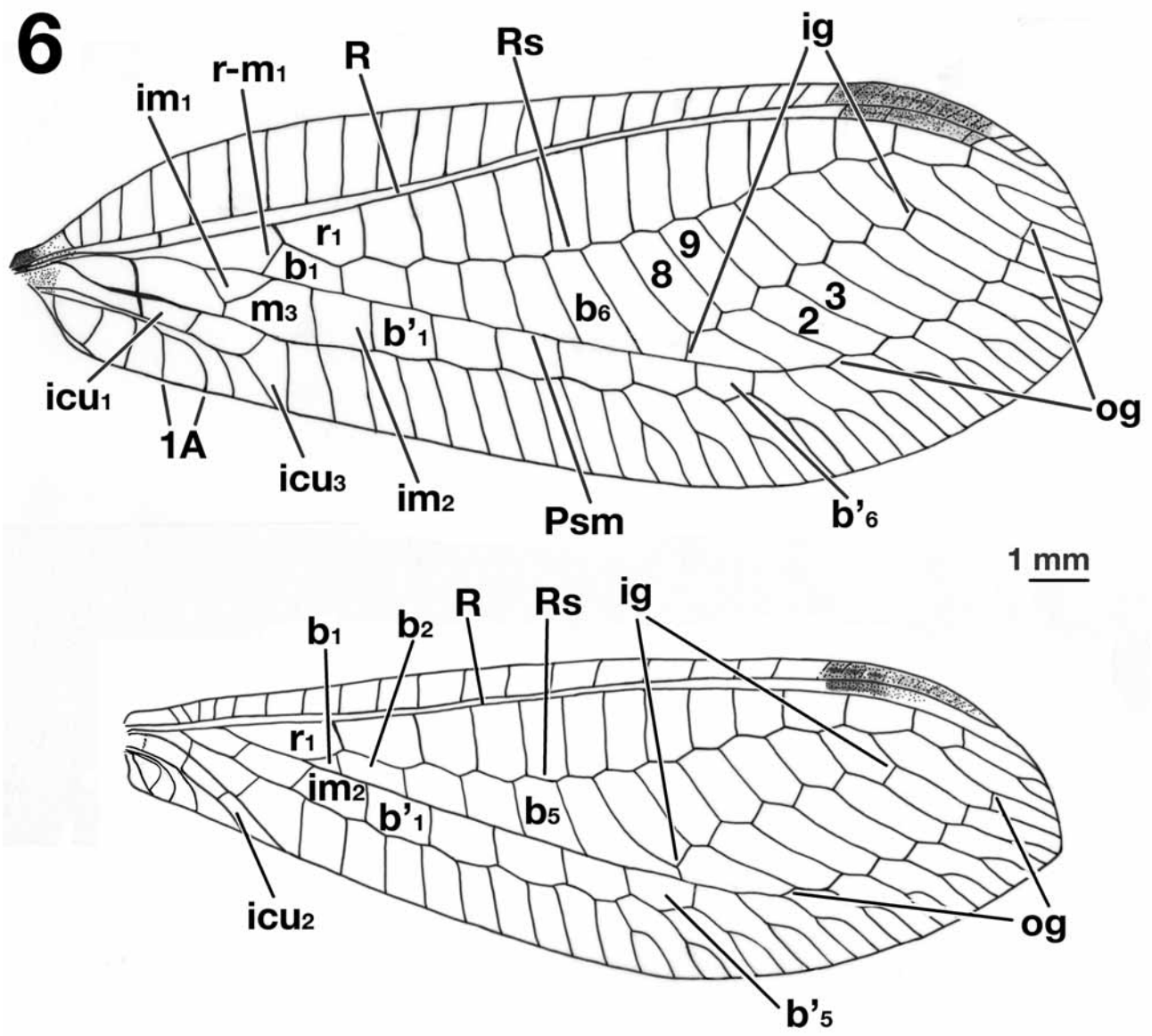


FIGURE 6. *Leucochrysa* (*Nodita*) *digitiformis*, forewing (top), hindwing (bottom). Abbreviations: b#, upper Banksian cells; b'#, lower Banksian cells; icu#, intracubital cells; ig, inner gradate veins; im#, intramedian cells; m3, third medial cell; og, outer gradate veins; Psm, pseudomedia; R, Radius; Rs, radial sector; r1, first radial cell; r-m1, first crossvein between Rs and Media; 1A, first anal vein; 2, 3, second and third cells bounded by gradates; 8, 9, eighth and ninth cells beneath Rs (= first two cells beneath Rs, free of Psm).

Male (Figs. 7, 8): Callus cerci oval to round, 0.20–0.26 mm diameter (range), with 38–40 relatively thin trichobothria of various lengths (0.04–0.24 mm long). Sternites 5–8 (possibly proximal segments as well) with microtholi. Dorsum of T9+ectoproct truncate distally, fused mesally, midline without deep cleft, setae robust throughout; ventral section of T9+ectoproct with elongate proximal extension reaching almost full length of A8; proximal section well sclerotized, with ventral apodeme heavy, extending along ventral margin below callus cerci; dorsal apodeme lighter, extending almost to callus cerci. S8+9 fused, without suture; S9 without microtholi; S8 much shorter, slightly taller than S9; S8+9 (lateral view) with proximal margin straight, acute dorsally and ventrally; distal margin straight, with rounded apices, approximately ½ height of proximal margin. Setae on S9 slightly heavier than those on S5–S8; terminus of S9 without gonocristae. Subanal region membranous, with small pouch below anus, no setae. Gonarcal complex large, almost as wide as T9+ect; gonarcal apodemes extending proximally to region of callus cerci; distal section (including dorsal

horns) extending out from heavy membranous cuff within T9+ect; dorsal structures (gonocornua, mediuncus; not dorsal horns) covered with tight-fitting, thorny membrane that extends to gonosaccus. Gonarcus U-shaped, heavy, with lateral apodemes greatly expanded, rounded throughout, attached laterally on gonarcal bridge, but not extending laterally much beyond bridge. Gonocornu large, elongate, extending forward from gonarcal bridge, rounded basally, acute, curved inward apically at tip of mediuncus. Mediuncus with pair of dorsoventrally flattened internal rods that extend upward and outward; terminus truncate, with small rounded, beak-like tip, pair of rounded distal lobes beneath heavy membrane; membranous lateral surface with 9–10 short gonosetae; ventral surface with heavy, rugose membranous flange and hollow pouch beneath. Dorsum of mediuncus with pair of elongate, digitiform horns that extend well above dorsal surface of gonarcal complex (visible externally on uncleared specimens). Area below gonarcal complex with large, delicate membrane bearing hypandrium internum internally, near proximal margin of S8 and no gonosetae. Entoprocessus, tignum, gonapsis, pseudopenis, spinellae and gonocristae absent. Hypandrium internum with apex rounded, large but very delicate, lightly sclerotized; comes elongate, thin.

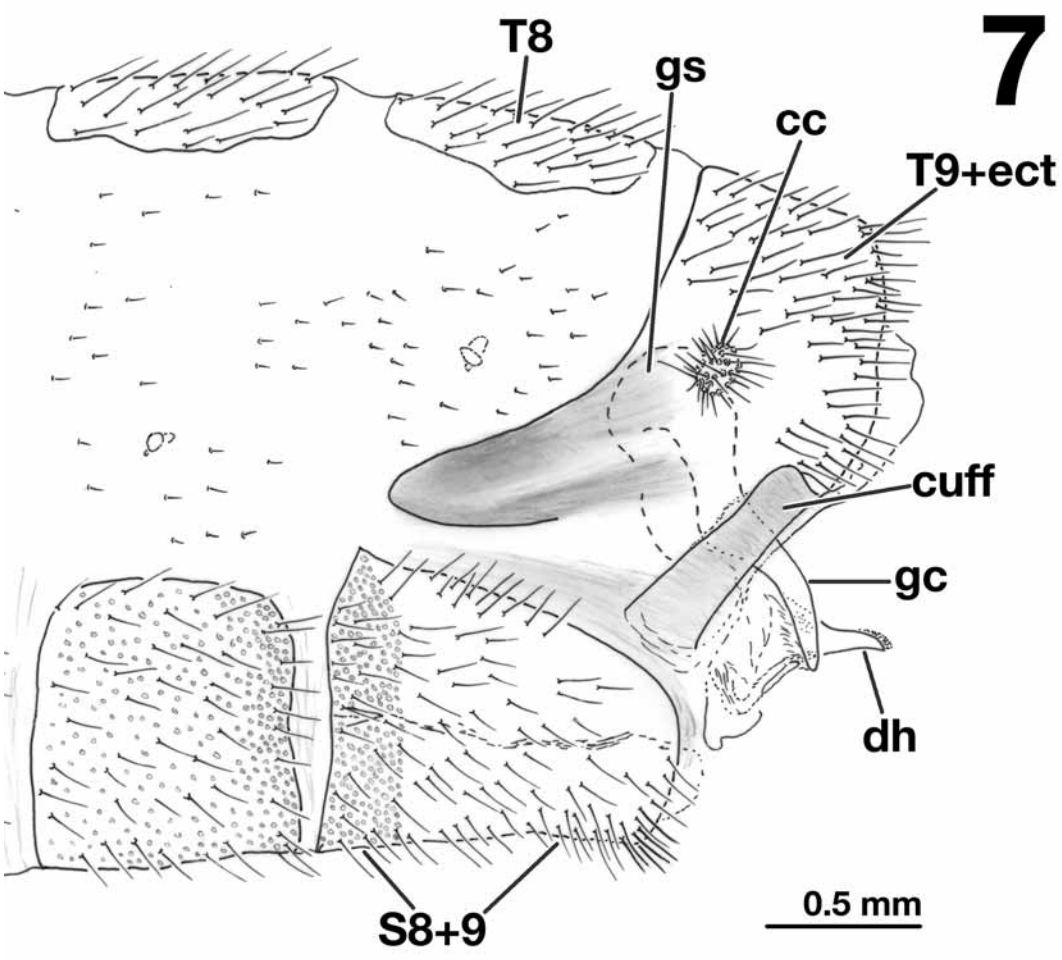


FIGURE 7. *Leucochrysa* (*Nodita*) *digitiformis*, male terminal abdominal segments, lateral. Abbreviations: cc, callus cerci; cuff, heavy membranous cuff surrounding genital opening; dh, dorsal horn; gc, gonocornu; gs, gonarcus (lateral apodeme); S8+9, fused eighth and ninth sternites; T8, eighth tergite; T9+ect, fused ninth tergite and ectoproct (dorsal apodeme diffuse).

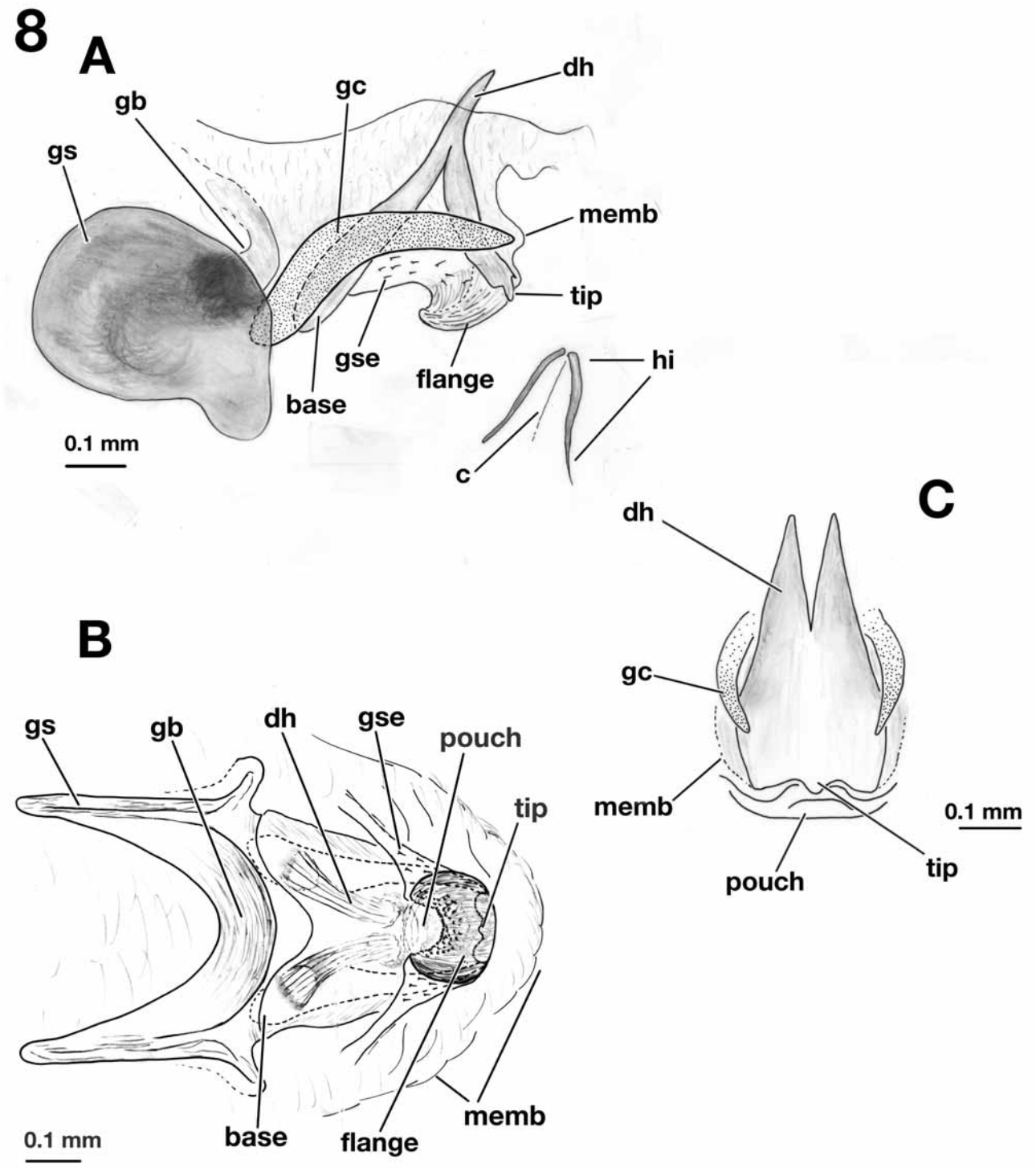
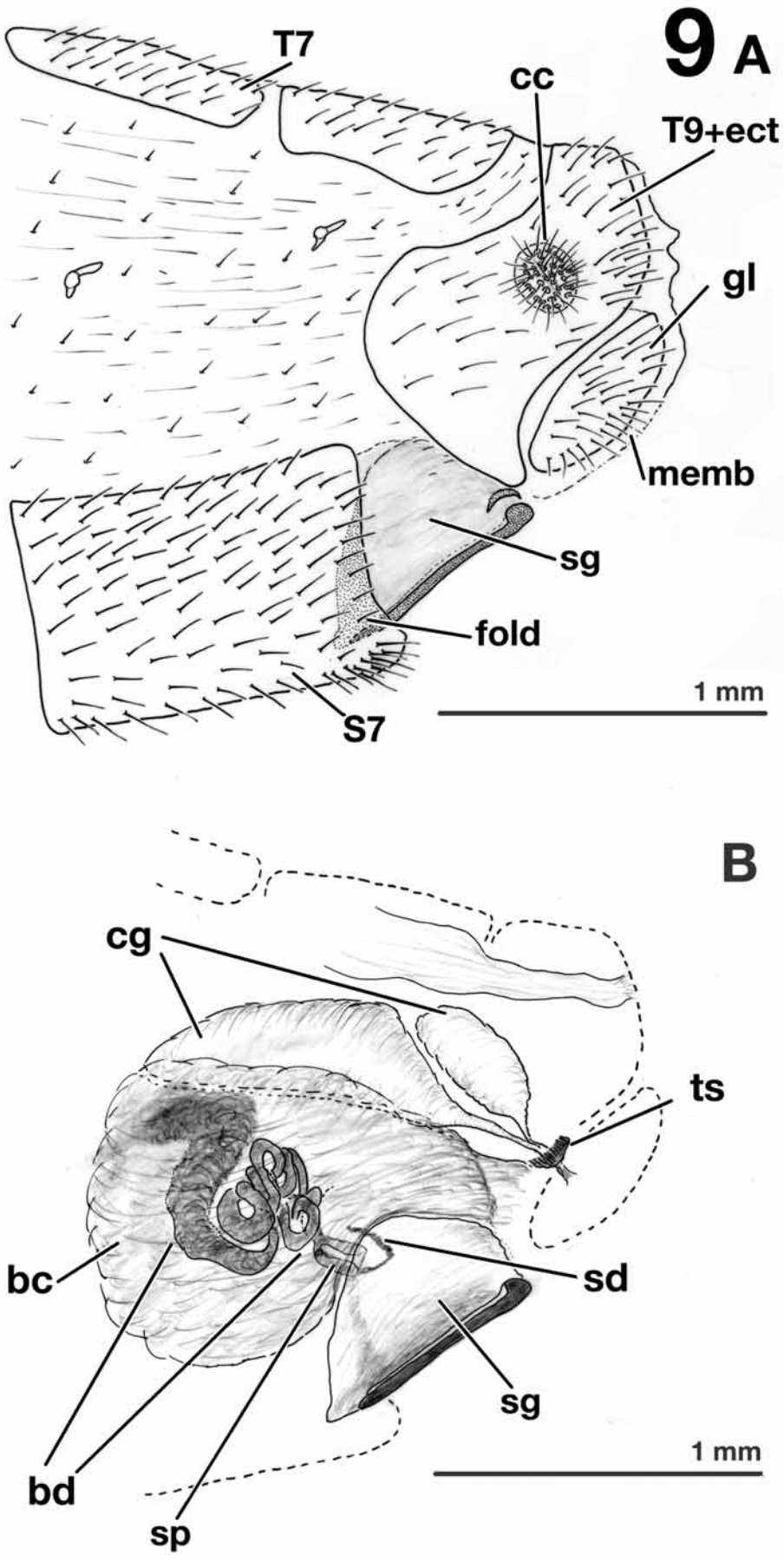


FIGURE 8. *Leucochrysa* (*Nodita*) *digitiformis*, male. A, gonarcal complex, lateral; B, same, ventral; C, mediuncus, frontal. Abbreviations: base, base of mediuncus; c, comes; dh, dorsal horn; flange, heavy membranous flange below tip of gonarcus; gb, gonarcal bridge; gc, gonocornu; gs, gonarcus (lateral apodeme); gse, gonosetae; hi, hypandrium internum; memb, membrane surrounding mediuncus; pouch, pouch below mediuncus; tip, tip of mediuncus.

FIGURE 9. *Leucochrysa* (*Nodita*) *digitiformis*, female. A, terminal abdominal segments, external, lateral; B, same, internal, lateral. Abbreviations: bc, bursa copulatrix; bd, bursal duct; cc, callus cerci; cg, colleterial gland complex; fold, small fold at terminus of S7 and point of insertion of subgenitale; gl, gonapophysis lateralis; memb, membrane lining inner surface of gonapophysis lateralis; sd, spermathecal duct; sg, subgenitale; sp, spermatheca; S7, seventh sternite; ts, transverse sclerification; T7, seventh tergite; T9+ect, fused ninth tergite and ectoproct.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Female (Figs. 9, 10): Callus cerci oval, 0.15–0.17 mm maximum diameter, with 34 relatively short trichobothria (0.02–0.03 mm long). Tergite 8 roughly quadrate (lateral view), similar in depth to T6. Tergite 9+ectoproct elongate; posterior margin vertical, quadrate; ventral margin extending slightly below gonapophyses laterales. Sternite 7 with dorsal margin straight, not tapering distally; terminus unmodified, with terminal (posteroventral) setae slightly more dense, robust, and longer than other setae. Gonapophysis lateralis rounded, small (~0.63 length of T9+ect); inner membranous surface slightly expandable, with two vertical rows of short setae. Colleterial gland very delicate (difficult to see), bifurcate at transverse sclerification, each section with short, narrow constriction at junction, upper section smaller than lower section, lower section extending well into A7, resting in trough above bursal copulatrix, reservoir not identified. Transverse sclerification robust, relatively flat, platform-like, with long, fine longitudinal ridges. Bursa copulatrix bulbous, consisting of robust, loosely folded membrane, extending anteriorly over spermatheca and bursal duct, well beyond midpoint of S7. No bursal glands found. Spermatheca small, tubular, approx. 0.1 mm diameter, 0.2 mm length, with deep (0.14 mm), mesal invagination; connected to bursa via elongate, coiled and looped, sclerotized bursal duct extending directly from base of spermatheca; bursal duct becoming membranous distally (anteriorly), opening to bursa on left distoventral surface. Spermathecal glands not identified. Spermathecal duct attached to right distal side of spermatheca, broad basally, then tapering before mesal bend; mesal bend heavily sclerotized, with tight coil on either side; duct recurving anteriorly after mesal bend; glandular setae on distal ca. one-half of entire duct. Subgenitale broad, rounded, with sparse transverse folds, terminus broad, bilobed, with shallow, flat depression between lobes, with flat, oblong, elongate, distal process that recurves anteriorly along ventral surface of subgenitale and extends into fold at tip of S7; membrane above lobes with crescent-shaped, lightly sclerotized lamellae; small ventral fold on S7 without setae.

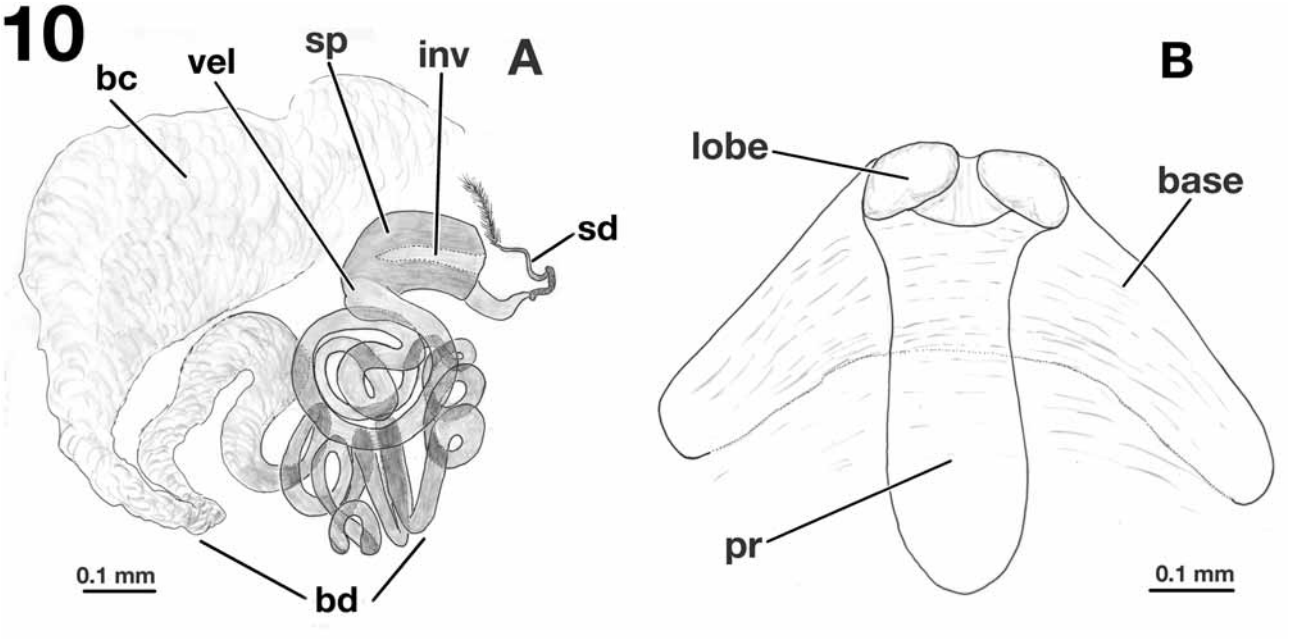

FIGURE 10. *Leucochrysa* (*Nodita*) *digitiformis*, female. A, spermathecal complex, lateral; B, subgenitale, ventral. Abbreviations: base, base of subgenitale; bc, bursa copulatrix; bd, bursal duct; inv, invagination; lobe, lobe of subgenitale; pr, ventrally projecting process on neck of subgenitale; sp, spermatheca; sd, spermathecal duct; vel, spermathecal velum.

Larvae and biology.—Larval descriptions and an analysis of the seasonal occurrence are the topics of two PhD dissertations scheduled for completion in 2008 (E. Mantoanelli, J. S. Multani).

Distribution.—Currently known only from Brazil: the type locality in the state of Rio de Janeiro, and Fazenda São Nicolau, Cachoeira do Sul, state of Rio Grande do Sul, 30º07'32"S, 52º49'20"W, 30 m altitude, XII–28–2005, G. S. Albuquerque, collector.

Variation.—The female specimen from Cachoeira do Sul in the state of RS is slightly larger than those from Campos dos Goytacazes in the state of RJ. The wings are about 2 mm longer than the average specimen from Campos; however all other features correspond to the description.

Although our adult specimens showed the full range of post-emergence maturation and sclerotization, most were teneral. On teneral males, the gonarcal bridge was acute mesally (not rounded, as shown for a mature male in Fig. 8), and the mediuncus and dorsal horns tended to evert, thus distorting the shape of the gonocornua. The variation shown by teneral males is visible on images on our project website at http://morphobank.geongrid.org/permalink/?F15. Teneral females had delicate bursa, and many of their internal membranous structures were difficult to identify. Among our specimens, there was considerable variation in the size and darkness of the brownish-red markings on the thorax and abdomen. It is possible that this variation reflects both individual variation and the degree of maturation.

Adult specimens examined.—Types listed above and an additional 50 M and 50 F with same data as types except collection dates range from VII to X–2007 (alcohol), maintained at UENF.

Etymology.—The specific name *digitiformis* (adjective) refers to the finger-like shape of the prongs on the dorsal horn of the mediuncus.

Ammended Key

To distinguish *L.* (*N.*) *clepsydra*, *Leucochrysa* (*N.*) *cornuta* (Freitas and Penny), and *L.* (*N.*) *digitiformis*, we offer the following expansion of the key by Freitas and Penny (2001, p. 285, as F&P below) to *Leucochrysa* (*Nodita*) found in Brazilian agroecosystems.

16. Vertex green, with pair of longitudinal, red marks dorsally; scape also with longitudinal, red mark dorsally (sometimes faded); male with dorsal horn of arcessus (= mediuncus here) bifurcate, its two prongs separated by a broad, U-shaped trough (Fig. 3); lateral surface of gonarcal apodemes flat, expanded laterally, surface with sculpted appearance; female with spermatheca small, curved once; spermathecal duct relatively short (length = ~2x diameter of spermatheca) (Fig. 9) ..... *L.* (*N.*) *clepsydra*

16'. Vertex green, unmarked; scape either unmarked or with short dorsolateral mark; male with dorsal horn of arcessus (= mediuncus) bifurcate, its prongs separated by a V-shaped trough (Fig. 8C; F&P, fig. 62F); lateral surface of gonarcal apodemes concave at the connection with the gonarcus (Fig. 8A; F&P fig. 62F); female otherwise or unknown 16a

16a. Maxillary palpi pale (F&P, fig. 62C); spots on mesoscutum barely visible; prothorax short (approximate length of vertex); male with distal margins of gonarcal apodemes flared slightly (dorsal view); gonocornua arising from top of gonarcal bridge (F&P, fig. 62F); female unknown .....*L.* (*N.*) *cornuta*

16a'. Maxillary palpi dark apically; spots on mesoscutum dark brownish-red; prothorax long (considerably longer than vertex); male with gonarcal apodemes parallel throughout (dorsal view); gonocornua arising from below gonarcal bridge (Fig. 8A); female with oblong, elongate, flat, ventral process on exterior surface of subgenitale; very long, coiled bursal duct; spermathecal duct longer than 2x diameter of spermatheca, thick basally ..... *L.* (*N.*) *digitiformis*

DISCUSSION

Although *L.* (*N.*) *clepsydra, L.* (*N.*) *cornuta* and *L.* (*N.*) *digitiformis* resemble each other in a number of ways, it is not clear that they are closely related phylogenetically. On the one hand, they show similarity in some body and head markings, wing venation, presence of large dorsal horns on the mediuncus, etc. On the other hand, there are a number of distinct differences that may indicate the lack of a close relationship. For example, the basal structure of the mediuncus and gonocornua, as well as the shape and flaring of the gonarcal apodemes differ among the males of the three species. Also the *L.* (*N.*) *digitiformis* female reproductive system is much more complex than that of *L.* (*N.*) *clepsydra* [*L.* (*N.*) *cornuta*'s female is unknown]. Because of these differences, and the lack of sufficient other comparative data, we believe it is prudent to refrain from speculating on relationships among *Leucochrysa* (*Nodita*) species at this time in the development of information on the group.

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