



New species and color forms of *Empoasca* (Hemiptera: Cicadellidae: Typhlocybinae: Empoascini) from South America

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Abstract

Three new Neotropical species in the genus *Empoasca* are described and illustrated (*Empoasca bartletti* n. sp., *Empoasca concava* n. sp., *Empoasca coofa* n. sp.). The species are placed in a previously published key and relationships to other species of the genus are described. Two informal species groups, the *E. dolonis* group and the *E. papae* group are described and included species are listed. Evidence for the occurrence of dimorphic color forms in the genus is discussed.

Key words: leafhopper, *Empoasca*, *dolonis* group, *papae* group, color forms, distribution

Introduction

The genus *Empoasca* and the tribe Empoascini are very species rich taxa. To date, over 1,000 species names have been described in or combined with *Empoasca*. Although some of these species have subsequently been treated as junior synonyms or moved to other related genera, the number of valid species names currently placed within *Empoasca* exceeds 880. Over 380 additional species have been described in other genera of Empoascini. Although the majority of species occurring in the temperate zones of the Northern Hemisphere have probably been described, this is not the case for tropical species. In my experience, examination of any general collection (at light, sweeping, etc.) from a location in the American tropics is likely to yield numerous empoasine species, the majority of which are undescribed. Although 149 species of *Empoasca* (and 8 species currently placed in *Solanasca*) have been described from South America, undoubtedly many more are yet to be described. Three such species are treated here. Southern (1982, 2006) reviewed the literature relative to Neotropical *Empoasca*.

Material and methods

Except as described here, the methods and terminology used in this work are those presented by Southern (1982, 2006). Several additional body measurements are given in this paper in the hope that they will prove useful in future revisions. These include head length (measured from the anterior margin of the crown to a line joining the posterior-most margin of the compound eyes), head width (measured between the outer margins of the compound eyes), hind tibia length, hind tarsus length, hind tarsomere I length, and the ratio of the hind tarsomere I length to the total hind tarsus length.

Terms used for venation and cells of the forewing follow those of Dietrich and Dmitriev (2006). Consequently, the “apical cell 3” used in my previous work is herein called “apical cell 2” (this is the cell that is

often triangular and petiolate in *Empoasca*).

All labels found on the pin of the holotype are quoted. A single forward slash (/) indicates a new line of the label; a double forward slash (//) indicates a new label. The following abbreviations are used in referring to the collections in which specimens are deposited.

NCSU	North Carolina State University Insect Museum, Raleigh, N.C. USA
UDEL	University of Delaware Insect Reference Collection, Newark, Del.
USNM	United States National Museum of Natural History, Washington, D.C. USA



FIGURE 1. *Empoasca* spp. dorsal aspect (abdomen removed). a: *Empoasca bartletti* n. sp. b: *Empoasca concava* n. sp. c: *Empoasca coofa* n. sp. d: *Empoasca longibrachiata* Southern—common color pattern. e: *Empoasca longibrachiata* Southern—variant color pattern.

***Empoasca bartletti* n. sp.**

(Figs. 1a, 2)

Body (male): Length: 3.6 mm; crown length: 0.28–0.29 mm; crown projection: 0.13 mm; crown projection ratio: 0.45–0.46; head length (including eyes): 0.65–0.66 mm; interocular width: 0.48–0.49 mm; head width (including eyes): 1.00–1.04 mm; face length: 1.25 mm; interantennal width: 0.49–0.50 mm; pronotum width: 0.90–0.95 mm; pronotum length: 0.50–0.55 mm; hind tibia length: 1.80–1.85 mm; hind tarsus length: 0.50–0.59 mm; hind tarsomere I length: 0.33–0.40 mm; hind tarsomere I/hind tarsus ratio: 0.66–0.68. Crown (Fig. 1a) yellow to yellow-green with darker green spots just laterad of midline on anterior margin. Coronal suture distinct, reaching or nearly reaching anterior margin. Face yellow-green without distinctive markings but more yellow on central portion of upper face; frontal sutures end just below ocelli which are on crown/face margin, slightly nearer eye than mid-line. Pronotum opaque along anterior margin, yellow-green at midline, green laterally; elsewhere subhyaline. Scutellum yellow-green with thin paler lines just laterad of midline. Forewing faintly striped with yellow-gold and green in basal 2/3; apical veins R_2 and RM confluent basally (apical cell 2 triangular, petiolate), arising from cell R. Hind wing similar to that of *Empoasca fabae* (Harris).

Pygofer in lateral view with rounded apex (Fig. 2a); 8–11 macrosetae along posterior margin at and below apex and 5–7 macrosetae in posterodorsal – anteroventral line on inner face; filamentous setae on outer face near dorsal margin; 8–10 setae (slightly less stout than those at posterior margin) in diagonal line just above

base of plate; spicules on inner and outer face of pygofer. **Plate** in lateral aspect apically curving gradually dorsad and tapering to rounded apex (Fig. 2a); A-group setae absent; B-group setae (29–30) uniseriate, continuing basally into usual location of A-group setae, slightly more closely spaced apically; C-group setae (19–23) generally biseriate basally, thence uniseriate, gradually declining in length to shortest at apex; D-group setae (32–34) roughly biseriate. **Style** short, body beyond connective less than 1/2 length of pygofer process; in ventral view (Fig. 2g) with sharp lateral bend near base, thence bowed strongly mediad, dentifer slightly recurved, not strongly demarked from body; teeth (5–7) ridge-like; setae (10–11) on ventro/lateral surface in basal half of style; apex truncate at slight angle in some aspects. **Pygofer process** in lateral aspect (Figs. 2a, h) with obvious basal brace directed dorsad, nearly reaching sclerotized extension of dorsal structure; long, extending beyond pygofer to near apex of plate; curved upward from near base, thence relatively straight to apical portion slightly decurved; thin, relatively parallel-margined to slight ventromedial expansion at apical 1/4, thence gradually tapered to sharp apex. In ventral view (Figs. 2b, i), thin, directed caudad, abruptly bowed slightly laterad in apical 1/4, apex sharp; medial surface bearing aculeae from near base to near point at which process bows laterad. **Anal hook** in lateral view (Fig. 2a), a long unbranched process over 3/4 depth of pygofer, reaching nearly to dorsal margin of plate; thin throughout, tapering very gradually to sharp apex, slightly sinuate; in caudoventral view (Fig. 2d), apical half curved strongly mediad. **Aedeagus** in lateral aspect (Fig. 2c1, c2) with preatrium broadest at base, tapered slightly distad, sinuate (bowed first caudad then cephalad); pair of processes arising from atrium near base of shaft appear at their bases to wrap collarlike around anterior side of atrium – but they actually do not, each process bifurcated at about midlength with ventral process shorter (1/4 to 1/2 length of more dorsal process); shaft relatively thin and parallel margined through most of length, curved dorsad in apical half, apex rounded. In caudoventral aspect (Fig. 2d), preatrium broadened abruptly to wide atrium (atrium 3X or more average width of preatrium); processes appear to arise from side of atrium, directed laterad at base, thence dorsocaudad, ventral ramus directed caudad, dorsal ramus curved mediad in apical half; shaft parallel-margined, slightly broader than average width of preatrium, rounded at apex; gonopore terminal or just ventrad of terminus. **Connective** (Fig. 2e) slightly longer than broad; anterior margin heavily sclerotized; well defined dorsal keel on midline which in lateral view is much deeper apically than basally (wedge-shaped); lateral margins obscure. **Dorsum of genital capsule** (Fig. 2k) with anterior margin sclerotized; no obvious bridge; transverse bar sclerotized laterally but obscure near midline; horns very weakly differentiated but appear as lightly sclerotized triangles well separated basally.

First sternal complex (Fig. 2m) with well sclerotized sternal bar; dorsal apodemes reduced to low tubercles which bend sharply caudad; lateral apodemes well separated at midline. **Second sternal apodemes** (Fig. 2n) broad (0.54–0.58 mm) and long (0.68–0.71 mm, reaching 6.0); apices relatively square, extended caudad slightly more on medial side; not widely separated medially through most of length. **Third sternal complex** a cradle in which lie second sternal apodemes; small triangular apodemes just laterad of outer margins of second apodemes directed dorsad. **Second tergal apodeme** a very low wall continuing across midline with slight expansion ventrad at lateral ends. **Third tergal apodeme** (Fig. 2q) a very low wall reduced medially, not crossing midline, a distinct ventral projection—a rounded triangle—near lateral end of apodeme. **Abdominal sternum VIII** with posterior margin broadly and deeply concave.

Holotype male: ECUADOR: Provincia de / Francisco de Orellana / Yasuni National Park/ S00° 40.478 W76° 23.866 // 27.IV.2005, CRBartlett / N Nazdrowicz, D Chang / ex: Sweeping / Night // PSS RESEARCH/ 07-316-2 // HOLOTYPE / *Empoasca bartletti* n. sp. / P.S. Southern 2008 (NCSU). Paratype: 1 male, same collection data as holotype (UDEL).

This specific name, *bartletti*, is a masculine noun in the genitive case. The species is named in honor of the collector, Dr. Charles Bartlett, who provided the specimens for study.

Of New World species of *Empoasca*, only *E. tepona* DeLong and Guevara (1954) has a bifurcate aedeagal process. However, *E. tepona* does not have the aedeagal processes massive and bowed well away from the

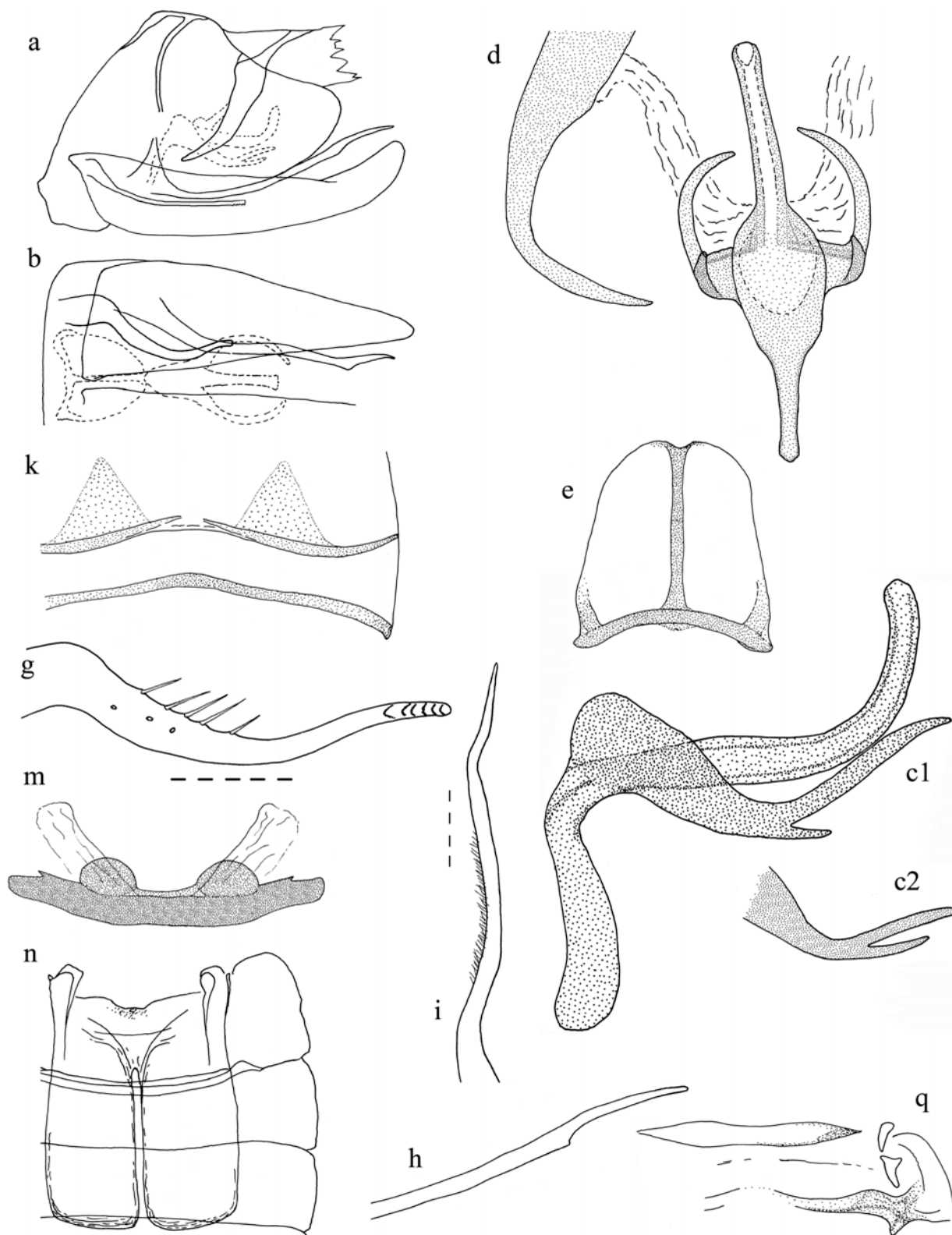


FIGURE 2. *Empoasca bartletti* n. sp. a. genital capsule, lateral view (broken line = outline of aedeagus); b. genital capsule, ventral view (broken line = outline of aedeagus); c1. aedeagus, lateral view; c2. aedeagus, variation in processes, lateral view; d. aedeagus, left anal hook and dorsal aedeagal support, posteroventral view; e. connective, ventral view; g. style, ventral view; h. pygofer process, lateral view of apical portion; i. pygofer process, ventral view; k. pattern of sclerotization of dorsal surface of genital capsule, dorsal view; m. first sternal complex, anterior view; n. base of abdomen and second sternal apodemes, ventral view; q. base of abdomen, dorsal view.

shaft in ventral view; the shaft in lateral view is angled upward from the base, not directed caudad for at least half its length; the styles are not very short as in *E. bartletti*. The external coloration of *E. tepona* as described differs greatly from that of *E. bartletti*, and *E. tepona* is smaller (3.0 mm vs. 3.6 mm). In the key to *Empoasca* of eastern Peru (Southern, 1982), *E. bartletti* keys to couplet 31 and *E. norcasta*. *E. bartletti* differs from that species in several aspects, including: bifurcate aedeagal processes, apex of style not bent abruptly laterad, and pygofer process bearing aculeae.

***Empoasca concava* n. sp.**

(Figs. 1b, 3)

Body (male): Length: 4.3–4.5 mm; crown length: 0.24–0.28 mm; crown production: 0.10–0.13 mm; crown projection ratio: 0.39–0.46; head length (including eyes): 0.50–0.56 mm; interocular width: 0.58–0.64 mm; head width (including eyes): 0.99–1.13 mm; face length: 1.25–1.38 mm; pronotal width: 0.93–1.03 mm; pronotal length: 0.61–0.69 mm; hind tibia length: 2.10–2.43 mm; hind tarsus length: 0.99–1.06 mm; hind tarsomere I: 0.60–0.78 mm; hind tarsomere I/hind tarsus ratio: 0.63–0.77. Crown blue-green laterally, with medial yellow-gold spot broad posteriorly narrowed anteriorly (Fig. 1b); eyes brown with network of lighter brown lines; coronal suture reaching anterior margin. Face blue-green laterally, yellow-gold along midline dorsally and along margins of frontoclypeus, blue-green in center of frontoclypeus. Ocelli on or just below anterior margin of crown, nearer midline than eye. Frontal suture evident to below ocelli, faint to near midline. Rostrum long, reaching hind coxae. Pronotum yellow-gold, with blue-green spot on each side of midline and blue-green along lateral and posterior margins. Scutellum yellow-gold, with faint blue-green medially in some specimens. Forewing with basal 2/3 yellow-gold marked with blue-green spots, punctations along or paralleling obscure veins R and M; apical 1/3 hyaline, brown with center of cells lighter, pale blue-green along apical veins; apical veins R₂, RM and MCu confluent basally, arising from cell R, in most specimens, MCu separating first (Fig. 3r1), R₂ and RM separate for only short distance; in one specimen R₂ separating first with RM and MCu confluent beyond this point (Fig. 3r2). Hind wing venation characteristic of *Empoasca fabae* (Harris). Abdomen and lateral and sternal structures of thorax greenish-yellow with some blue-green markings; pleural and tergal surfaces of genital capsule blue-green. Legs generally greenish yellow; tibiae of all legs becoming darker green distally and dark brown at apex. **Body (female):** Length: 4.4–4.8 mm. Coloration as in male, except sternum of abdominal segment VIII powdery white.

Pygofer of male in lateral view (Fig. 3a) with dorsal margin slightly concave in apical half, tapering on both dorsal and ventral margins to apex; macrosetae (20–30) along dorsal and caudal margins, most on outer face but few on inner face at apex; long filamentous setae (4–8) on outer face, in some specimens these forming rough line from anteroventral corner toward apex. **Plate** in lateral view (Fig. 3a) expanded dorsolaterally near base, thence nearly parallel-margined to rounded apex, curving very gradually dorsad in apical half; A-group setae (3–7, most 4–5) only slightly longer than B-group and distinct primarily by location; B-group setae (15–49) highly variable in number, in some specimens uniseriate and very sparse in mid-range, in other specimens roughly biseriate and more evenly spaced, distributed along dorsolateral margin of plate apically but continuing onto dorsomedial face of plate basally; C-group setae (14–20) narrowly biseriate in mid-range, otherwise uniseriate; D-group setae (17–21) roughly biseriate and sparse; also with ca. 20 structures that may be sensory pits or bases of missing D-group setae. **Style** in lateral view (Fig. 3f) long and thin, nearly reaching apex of pygofer process, relatively straight or bowed slightly ventrad, apex narrowly truncate; in ventral view (Fig. 3g) nearly straight through most of length or bowed slightly mediad, tapering very gradually and evenly from near articulation with connective, dentifer not well demarcated from body; teeth (6–13) more peglike than ridgelike, distributed evenly along dentifer; setae (8–12) short and stout, distributed along ventromedial face from near articulation with connective (where 3–4 setae may be bunched) to or exceeding basal-most

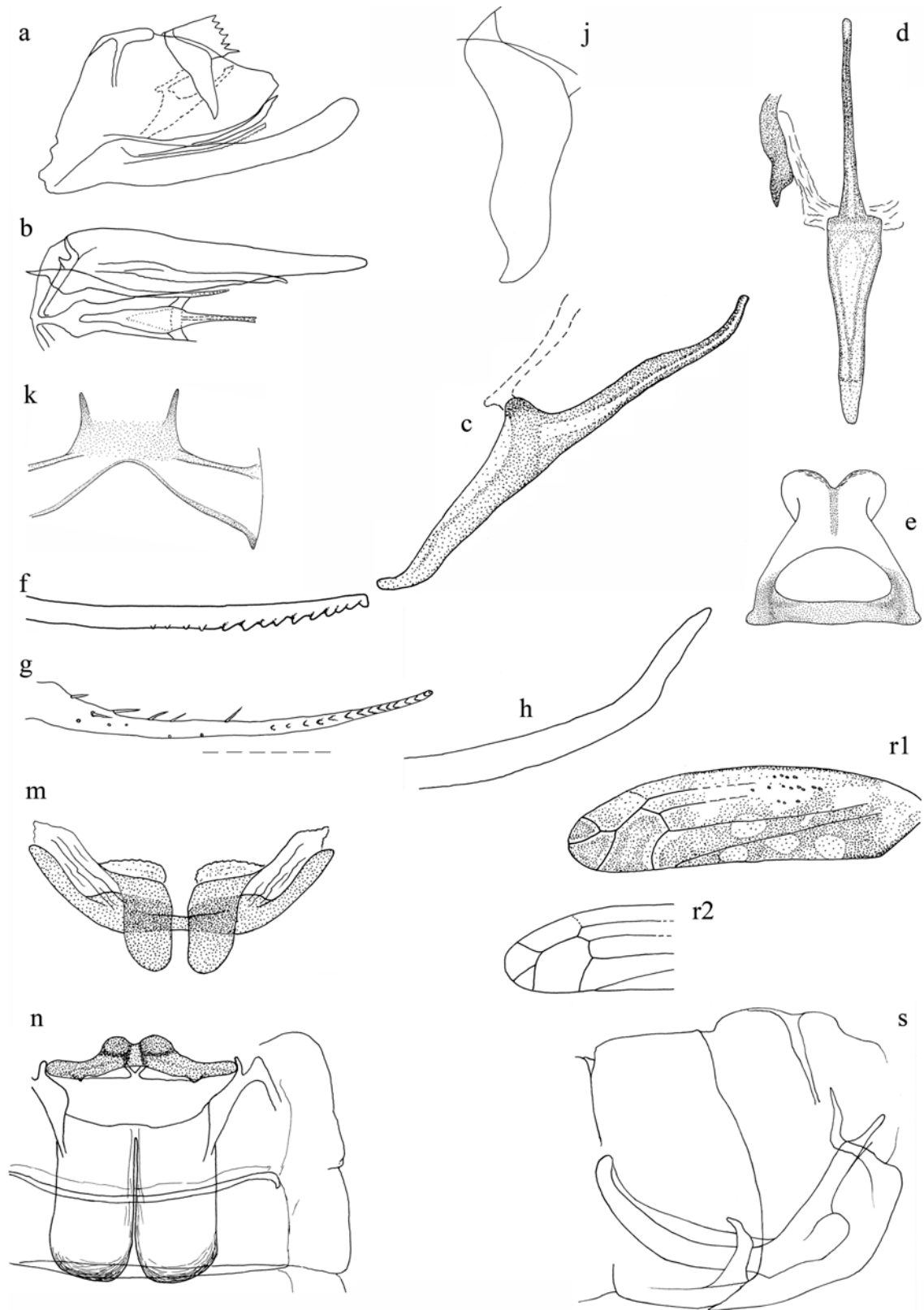


FIGURE 3. *Empoasca concava* n. sp. a. genital capsule, lateral view (broken line = outline of aedeagus); b. genital capsule, ventral view; c. aedeagus, lateral view; d. aedeagus, left anal hook & dorsal aedeagal support, posteroventral view; e. connective, ventral view; f. style, lateral view; g. style, ventral view; h. pygofer process, lateral view of apical portion; j. anal hook, lateral view; k. pattern of sclerotization of dorsal surface of genital capsule, dorsal view; m. first sternal complex, anterior view; n. base of abdomen and second sternal apodemes, ventral view; r1. forewing—common form; r2. apex of forewing—variant; s. base of abdomen, lateral view.

tooth. **Pygofer process** in lateral view angled slightly upward from near base to follow ventral margin of pygofer, relatively straight and parallel-margined to near apex, thence angled more abruptly upward and tapered to a narrow apex (Fig. 3h). In ventral view, relatively straight and parallel-margined to near apex, apically bowed laterad on medial margin to form shallow cup. **Anal hook** in lateral view (Figs. 3a, j) large, nearly reaching ventral margin of pygofer, tapered to narrow apex, slightly sinuate, collar connecting hooks around dorsum of anal tube is well sclerotized. **Aedeagus** in lateral view (Fig. 3c) with shaft continuing line of preatrium, shaft narrow, tapering slightly from atrium through about ½ its length, thence more rapidly to a narrowly rounded apex, apically curved slightly upward, shaft longer than preatrium/atrial complex; in ventral view (Fig. 3d) pratrium expands gradually to a relatively narrow atrium, shaft tapered rapidly in the basal fourth, thence narrow and nearly parallel-margined to narrowly rounded apex, gonopore terminal. **Connective** (Fig. 3e) with well sclerotized anterior bar, roughly trapezoidal but narrowed distally, thence expanded into lateral lobes, apical notch deep, V-shaped. **Dorsum of genital capsule** (Fig. 3k) with horns narrow and widely spaced, in some specimens medial margins of horns distinct only apically; anterior margin nearly reaching transverse bar; bridge may or may not be distinct.

First sternal complex (Fig. 3m) with sternal bar reduced medially; dorsal apodemes large, appearing folded anteroventrad to lie cephalad of sternal bar, apodemes sometimes joined loosely at apex by transverse structure and apparently articulating with small Y-shaped structure extending from second sternite. **Second sternal apodemes** (Figs. 3n, s) extending to 4.5–5.0 (length: 0.45 mm), narrowly separated medially, apically curved strongly dorsad, each apodeme also curved dorsad on lateral and medial margins to varying degrees to form cuplike or bowl-like structure; lateral apophyses strongly sclerotized and large. **Third sternal complex** with caudodorsally directed peglike apodemes arising laterad of and well separated from second sternal apodemes. **Second tergal apodeme** a low wall continuous across midline, variable in shape. Other tergal apodemes not strongly developed. **Posterior margin of abdominal sternum VIII** evenly and slightly convex (recurved at lateral ends).

Holotype male: ECUADOR: Provincia de/ Francisco de Orellana/ Yasuni National Park/ S00° 40.478 W76° 23.866// 27.IV.2005, CRBartlett/ N Nazdrowicz, D Chang/ ex:@Hg Vapor light/night// PSS RESEARCH/ 08-030-7// HOLOTYPE/ *Empoasca concava* n. sp./ P.S. Southern 2008 (NCSU). Paratypes: 9 males, 7 females same collection data as holotype (NCSU, UDEL).

The specific name *concava*, a Latin adjective meaning hollowed or arched inward, refers to the shape of the second sternal apodemes.

In the key to *Empoasca* of eastern Peru (Southern, 1982), this species keys to couplet 64 and *E. olara* Langlitz. Nonetheless, *E. concava* differs from *E. olara* in numerous ways (e.g. anal hook not abruptly narrowed, aedeagal shaft narrow and gradually tapered from base, style without distinct dentifer) and is not closely related. *E. concava*, belongs among the *Empoascini* based on the venation of the hind wings, body size and shape, and the general structure of the genitalia. Based on the forewing venation, the shape of the style, and the downward-folded dorsal apodemes of the first abdominal sternal complex, it seems probable that *E. concava* will eventually be moved from *Empoasca* to another (probably new) genus within *Empoascini*. At this time I have chosen not to describe a new monobasic genus for this species in the hope that the confusing state of genera within the *Empoascini* will soon be resolved.

***Empoasca coofa* n. sp.**

(Figs. 1c, 4)

Body (male): Length: 3.5–3.9 mm; crown length: 0.23–0.26 mm; crown projection: 0.07–0.11 mm; crown projection ratio: 0.30–0.45; head length (including eyes): 0.42–0.48 mm; interocular width: 0.38–0.41 mm; head width (including eyes): 0.81–0.83 mm; face length: 0.84–0.93 mm; interantennal width: 0.30–0.33 mm.

pronotal width: 0.79–0.85 mm; pronotal length: 0.40–0.46 mm; hind tibia length: 1.58–1.63 mm; hind tarsus length: 0.58–0.61 mm; hind tarsomere I length: 0.38–0.44 mm; hind tarsomere I/hind tarsus ratio: 0.62–0.76. Body generally pale yellow-brown with cream markings (all specimens available appear to have been collected or stored in alcohol, possibly affecting color). Crown (Fig. 1c) pale yellow-brown with large subhyaline spot on either side of midline. Coronal suture approaching but not reaching anterior margin. Face yellow-brown with cream markings; frontal suture ending below ocelli, nearer eye than midline. Pronotum yellow-brown along anterior margin, with cream spots, the majority of pronotum subhyaline. Scutellum yellow-brown with cream markings on midline and lateral margins. Forewings yellowish subhyaline in basal 2/3, hyaline, brownish in apical 1/3; apical veins R2 and RM confluent basally (second apical cell triangular and stalked). Hind wing venation similar to *Empoasca fabae*. **Body (female):** Length: 3.9–4.2 mm. Coloration, markings and wings similar to those of male.

Pygofer tapered on both dorsal and ventral margins to narrowly rounded apex (Fig. 4a); stout macrosetae (11–18) along dorsal margin and in rough diagonal line across outer face of pygofer; 3–4 filamentous setae scattered on outer face. **Plate** in lateral view expanded dorsolaterally near base, thence subparallel-margined to rounded apex, curving evenly upward but not expanded in apical 1/3; in ventral view, expanded laterally near base. A-group setae (2–3); B-group setae (16–24) relatively uniform in distribution, roughly uniseriate along dorsolateral margin to apex of plate; C-group setae (18–21) biseriate near base of plate, uniseriate apically (ca. last 6); D-group setae (27–35) roughly bi- or tri-seriate, extended almost to anterior margin of plate. **Style** in lateral view parallel margined to dentifer, bowed slightly dorsad at body/dentifer junction, ca. 4 setal bases or sensory pits laterally at apex of body, teeth (5–7) low, ridgelike, widely spaced (spacing decreasing apically), apex rounded; in ventral view (Fig. 4g) body bowed mediad, dentifer angled posterolaterad. **Pygofer process** in lateral view angled slightly dorsad near base thence relatively straight, tapered slightly to apex, long, nearly reaching apex of plate, apically flattened dorsoventrally and spoon-shaped (Fig. 4h), in some specimens a few aculeae are scattered on dorsal surface near apex (difficult to see); in ventral view angled toward midline from near base, straight or very slightly bowed inward, apically with very fine serrations on medial margin (Fig. 4i). **Anal hook** in lateral view (Fig. 4j) directed ventrad, reaching ca. mid-point of pygofer, slightly sinuate, tapered to sharp apex; in caudoventral view (Fig. 4d) bifurcate in transverse plane, outer ramus curved mediad, inner ramus a variably developed lobe (may be broader and more distinct than in Fig. 4d) directed mediad. **Aedeagus** in lateral view (Fig. 4c1) with preatrium bowed caudad at base thence straight, shaft diverging from atrium at near right angle thence curved dorsad, nearly as long as preatrium, tapered apically to acute apex, each side of shaft with a very small process at about mid-length, closely appressed to the shaft and often very difficult to see (apparently absent in one specimen), dorsal margin of shaft with triangular or hook-shaped (Fig. 4c2) expansion just beyond mid-length; in ventral view preatrium narrow basally, expanding to broad atrium, shaft parallel-sided to truncate apex, gonopore appearing terminal or subterminal on ventral side. **Connective** (Fig. 4e) broader than long, anterior bar well sclerotized, apical notch broad and deep. **Dorsum of genital capsule** (Fig. 4k) with horns distinct and widely separated, bridge indistinct.

First sternal complex (Fig. 4m) with dorsal apodeme well developed, medial notch variable but in some specimens constricted above base forming a two-step taper. **Second sternal apodemes** (Fig. 4n) reaching 4.0–4.3 (length: 0.18–0.23 mm; width: 0.28–0.33 mm), well separated medially, subparallel-sided to rounded apices. **Second tergal apodemes** developed as vertical plates extended from dorsolateral surface towards midline, flattened at medial end in sagittal plane (Figs. 4p, q), apodemes closely appressed but separate at midline (sometimes slightly more widely separated and concave medially than in Fig. 4q). **Posterior margin of abdominal sternum VIII** nearly straight with very small, inconspicuous medial notch.

Holotype male: Colombia / Boy Sogamoso / 29 May 1946 // EA Chapin / Sta 46-23 // PSS RESEARCH / 06-241-01 // HOLOTYPE / *Empoasca* / *coofa* n.sp. / P. S. Southern 08 (NCSU). Paratypes: 13 males, 13 females, same collection data as holotype (NCSU, USNM).

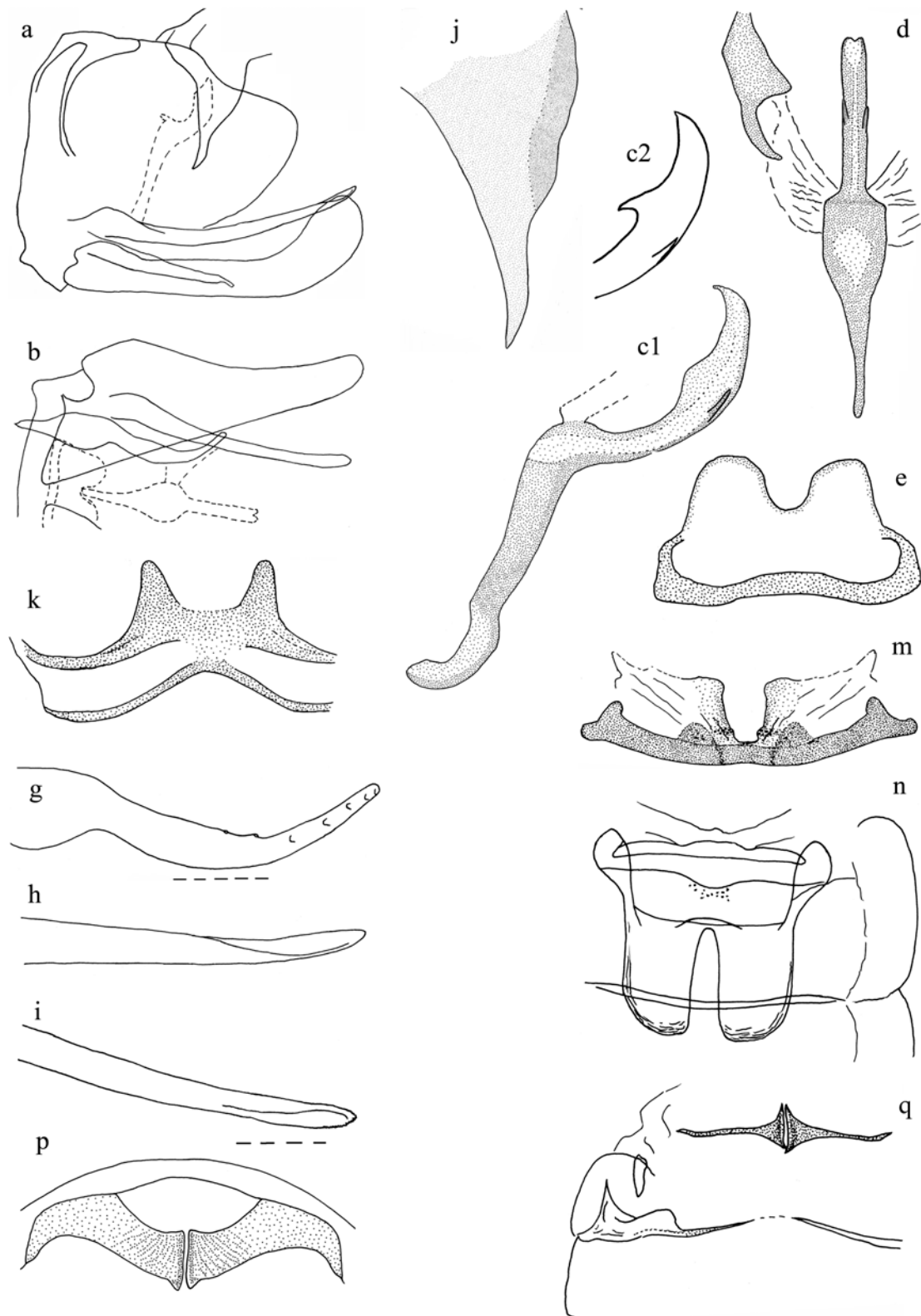


FIGURE 4. *Empoasca coofa* n. sp. a. genital capsule, lateral view (broken line = outline of aedeagus); b. genital capsule, ventral view (broken line = outline of aedeagus); c1. aedeagus, lateral view; c2. aedeagus, variation in apical portion of shaft, lateral view; d. aedeagus, left anal hook and dorsal aedeagal support, posteroventral view; e. connective, ventral view; g. style, ventral view; h. pygofer process, lateral view of apical portion; i. pygofer process, ventral view of apical portion; k. pattern of sclerotization of dorsal surface of genital capsule, dorsal view; m. first sternal complex, anterior view; n. base of abdomen and second sternal apodemes, ventral view; p. second tergal apodemes, anterior view; q. base of abdomen, dorsal view.

The specific name *coofa* is an arbitrary combination of letters treated as a feminine noun in apposition.

In the key to *Empoasca* of eastern Peru (Southern, 1982), *E. coofa* keys to couplet 17 (if the aedeagal processes are present and judged to be at least 1/10th the length of the shaft) and *Empoasca trindula* Southern. This species differs from *E. trindula* in having the aedeagal processes (if present) arising from near the middle of the shaft rather than from the base, the unique structure of the second tergal apodemes – flattened in a sagittal plane medially, the length of the second sternal apodemes which extend no further than 4.3, and the broad and deep medial notch in the dorsal apodeme of the first sternal complex. If the aedeagal processes are absent, not seen, or judged to be less than 1/10th the length of the shaft, *E. coofa* keys to couplet 42 and either *Empoasca celta* Southern or *Empoasca lecta* Southern. However, *E. coofa* differs from both these species in external coloration, the anal hook much less deeply bifid in caudoventral view, the triangular or hooklike expansion on the dorsal margin of the aedeagal shaft, the form of the second tergal apodemes, and in the much shorter second sternal apodemes. *E. coofa* appears most closely related to *Empoasca ecuadorensis* Southern. Both species have relatively small processes arising from the shaft of the aedeagus, transversely bifurcate anal hooks, the aedeagal shaft initially diverging from the line of the atrial complex but then curving dorsad, short second sternal apodemes, and second tergal apodemes and flattened on the medial ends into plate-like structures which are closely opposed but are not fused. However, the aedeagal shaft of *E. coofa* is longer and that of *E. ecuadorensis* lacks a dorsal expansion. The outer ramus of the anal hook of *E. ecuadorensis* is much narrower and is bowed anteriorly with the apex directed caudad. Though the second tergal apodemes of both are flattened sagittally at the midline, the apodemes of *E. coofa* appear to be separated from the dorsum for most of their length (at most there may be an obscure membranous connection), while those of *E. ecuadorensis* are clearly connected to the dorsum except at the midline. *E. coofa* is considered to be a member of the *papae* group (see below).

***Empoasca longibrachiata* Southern 1982**

(Figs. 1d, e)

E. longibrachiata was described based on six specimens from Peru and one from British Honduras (now Belize). Material provided by Dr. Chris Dietrich (Illinois Natural History Survey) and by Dr. Charles Bartlett (Dept. of Entomology and Applied Ecology, Univ. of Delaware) included three additional specimens from Peru, six from Belize and one from Ecuador (Provincia de / Francisco de Orellana / Yasuni National park / S 00° 40.478 W 76° 23.866 // 27-IV-2005, CR Bartlett / N Nazdrowicz, D Chang / ex. @ Hg vapor light/night). The original description of this species noted that although most specimens were not distinctly marked (Fig. 1d), one paratype had distinctive red-orange markings. The material mentioned above included one additional specimen from Peru so marked (Fig. 1e).

Species groups

Two closely related (and perhaps overlapping) species groups mentioned but not named by Southern (2006) are here named the *dolonis* group and the *papae* group.

The *dolonis* group includes *E. anfracta* Southern 1982, *E. celta* Southern 1982, *E. dolonis* Oman 1936, *E. hardini* Langlitz 1966, *E. joshuai* Southern 2006, *E. lecta* Southern 1982, *E. neogaea* Southern 1982, *E. parvicornis* Southern 1982, and *E. plex* Southern 1982. The *dolonis* group is characterized by pygofer processes flattened dorsoventrally (and often shallowly spoon-shaped) apically, bearing aculeae on the dorsal surface, and minutely serrate on the medial apical margin; styles with the dentifer bowed upward in lateral view, rounded apices, and low teeth largely confined to a small area near the apex; the second tergal apodeme devel-

oped as a transverse wall of variable shape; and the ninth tergum with horns relatively narrow and separated basally; second sternal apodemes well developed, usually reaching abdominal segment 5.5 or beyond.

The *papae* group includes *E. cispnora* Langlitz 1966, *E. coofa*, *E. ecuadorensis* Southern 2006, *E. papae* Oman 1936, *E. salazari* Southern 1982, and *E. trindula* Southern 1982. This group is similar to the *dolonis* group in several characters, including having the pygofer process apically flattened, bearing at least sparse aculeae, and microserate on the medial margin apically, and in having the anal hook bifurcate (or most obviously bifurcate) in a transverse plane. Unlike the *dolonis* group, species in the *papae* group have styles with truncate apices and teeth less bunched apically. Some species bear processes on the aedeagal shaft, but in all cases these are narrow and peglike. Relationships and limits of these two Neotropical groups await a comprehensive study including cladistic analysis.

Color forms in *Empoasca*

Color dimorphism apparently occurs in males of *E. longibrachiata*, *Empoasca versicolor* Southern, *Empoasca sessibulis* Southern and possibly *Empoasca edentula* Young. In all of these, the genitalia of the two color forms are essentially identical. Davidson and DeLong (1942) in describing *Empoasca omani* var. *iguala* stated that “this form is very similar to *omani* in the internal male genital characters” and establish it as a variety of *omani* based on its difference in external coloration. It is possible that in some or all of these cases the two color forms represent sibling species. However (as noted in Southern’s (1982) discussion of *E. versicolor*) *E. versicolor*, *E. sessibulis*, and *E. edentula* are closely related and share the same two color patterns. It is less parsimonious to conclude that the same color pattern has evolved (or been lost) in three separate lines than that dimorphism is a feature common to three related species. The apparent dimorphism in *longibrachiata* and *omani* is further evidence that dimorphic coloration is common in the genus *Empoasca*.

Although it has been established that color forms in some temperate-zone leafhoppers are related to season (photoperiod) (Hepner, 1969; Whitcomb et al., 1972), I have no evidence that this is the case in *Empoasca*. Both color forms of *E. versicolor*, *E. sessibulis*, and *E. longibrachiata* have been collected from the same location and within a few days. More extensive collecting would be needed to discount the possibility that these forms were collected during a period of overlap. However, it does not seem likely that in an area of low variation in photoperiod that these color forms are temporal in nature. Types of *E. omani* and *E. omani* var. *iguala* were collected in summer and late fall, respectively, but I have not seen enough specimens of either form to speculate as to whether these are temporal or geographic color forms.

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