A REVISION OF THE GENUS *OEDICARENA* LOEW (DIPTERA: TEPHRITIDAE)

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ABSTRACT

The New World genus *Oedicarena* is revised to include five species: *latifrons* (Wulp), *beameri* Norrbom and Ming, n. sp., *nigra* Hernández, n. sp., *tetanops* (Loew), and *persuasa* (Osten Sacken). Primary types of all species except *tetanops* were examined and a lectotype is designated for *persuasa*. The synonymy of *Spilographa obfuscata* Wulp with *latifrons* is confirmed. Descriptions, illustrations, and a key to the species are presented. Host information for *Oedicarena* is summarized, the larva of *latifrons* is briefly decribed, and the presence of four spermathecae in female *Oedicarena* is reported.

KEY WORDS: Diptera, Tephritidae, Taxonomy, Mexico, United States of America.

RESUMEN

El género *Oedicarena* (= *Rhagoletoides* Foote) de México y el sudoeste de los Estados Unidos incluye cinco especies: *latifrons* (Wulp), *beameri* Norrbom y Ming, n. sp., *nigra* Hernández, n. sp., *tetanops* (Loew), y *persuasa* (Osten Sacken). Hemos examinado los tipos de todas las especies con excepción de *tetanops* y designamos un lectotipo por *persuasa*. Se confirma la sinonimia de *Spilographa obfuscata* Wulp con *latifrons*. Se presentan las descripciones, con ilustraciones, y una clave de las especies. También, se describe la larva de *O. latifrons*, registramos la información sobre plantas huéspedes de *Oedicarena*, y citamos la presencia de cuatro espermatecas en la hembra.

PALABRAS CLAVE: Diptera, Tephritidae, Taxonomía, México, Estados Unidos de América.

Oedicarena Loew (1873) includes five species, two of which are newly described in this paper. The genus appears to be restricted to the southwestern United States and the highlands of central and northern Mexico, and it is poorly represented in most museum collections. Almost nothing is known about the biology of *Oedicarena*, but one species has been bred from fruit of a species of *Solanum* (Solanaceae) and two others have been collected on *Solanum* plants. There are considerable differences in the shape of the aculeus (ovipositor) tip among the species, suggesting that different parts of the plants may be utilized or that fruit morphology among the hosts may differ considerably. *Oedicarena* females are unusual among tephritids in possessing four spermathecae.

MATERIALS AND METHODS

The following institutions and individuals kindly loaned the specimens examined in this study: American Museum of Natural History (AMNH), R. T. Schuh; British Museum (Natural History) (BMNH), N. P. Wyatt and I. M. White; Canadian National Collection (CNC), J. R. Vockeroth; Estación de Biología Chamela, Jalisco (EBCJ), T. H. Atkinson; Kansas State University (KSU), H. D. Blocker; Michigan State University (MSUL), R. L. Fischer; Museum of Comparative Zoology, Harvard University (MCZ), J. M. Carpenter and S. R. Shaw; Snow Entomological Museum, University of Kanas (SMEK), G. W. Byers and J. K. Gelhaus; University of California, Davis (UCD), R. Schuster; University of Michigan (UMAA), M. O'Brien; Utah State University (USU), W. J. Hanson. The acronyms and UNAM represent the National Museum of Natural History, Smithsonian Institution, and the Instituto de Biología, Universidad Nacional Autónoma de México, respectively.

We follow the morphological terminology of Teskey (1981) for larvae, and of McAlpine (1981) and White (1988), except as noted in Norrbom and Kim (1988), for adults. We measured the height of the gena and the width of the parafacial at their narrowest points, but the width of the antennal flagellomere refers to its broadest diameter. We measured the length of syntergosternite 7 (ovipositor sheath, oviscape) of the female along its side because the irregular shape of the base of this sclerite prevented consistent measurement in the usual medial location. The width of the apex of segment 7 was measured with it flattened completely. The length of the distiphallus was measured from the base of the membranous lateral lobe or the corresponding area when this lobe was absent.

RELATIONSHIPS

Oedicarena clearly belongs to the subfamily Trypetinae as evidenced by the presence of well-developed scapular setae and slender, unicolorous postocular setae. The information known about its host plants and mode of breeding is limited (one species breeds in the fruit of a *Solanum* species), but also corroborates this classification. The relationship of *Oedicarena* to other Trypetinae is not well resolved. Within the subfamily, it belongs to the tribe Trypetini, but both the Trypetini and the Trypetinae are poorly defined at present (they are not defined on the basis of synapomorphies).

The wing pattern in *Oedicarena*, with transverse bands, including an

accesory costal or intercalary band (Bush, 1966; Foote, 1981), suggests that it might be related to a group of taxa including *Rhagoletis* Loew and several other genera (Norrbom, in prep.), although the accessory band is only intermittently present in these taxa. Many species within this group, like *Oedicarena*, also breed in Solanaceae. Based primarily on electrophoretic data, Berlocher and Bush (1982) suggested that *Zonosemata* Benjamin and *Rhagoletis striatella* Wulp are more closely related to *Oedicarena* than to other *Rhagoletis*. Although these taxa (and perhaps some of the other Solanaceae-feeding Neotropical *Rhagoletis*) may form a monophyletic group, their relationship to *Oedicarena* is probably more distant, because *Oedicarena* lacks three probable synapomorphies of the taxa most closely related to *Rhagoletis*: 1) syntergosternite 7 of the female does not have a weakly sclerotized ventroapical area; 2) the surstyli are not of the *Rhagoletis* type, i.e. longer than the inner surtyli and with a mesal lobe at about the level of the prensisetae (not present in *Zonosemata*, probably because of secondary modification); and 3) the antennal flagellomere lacks a small dorsoapical acute lobe. *Oedicarena* could possibly be the sister group of all of the taxa related to *Rhagoletis*, but it is more likely the sister taxon of *Paraterellia* Foote. These two genera have very similar male terminalia in which the epandrium is elongate, with the surstyli arising far from its posterior margin, there are not anteriorly directed lobes on the interparameral sclerite, and the hypandrial apodeme is well developed. The last character is probably plesiomorphic, but may be significant because the apodeme is weak or absent in *Rhagoletis* and related taxa and in many other trypetine taxa (e.g. *Trypeta* Meigen). *Rhagoletis* and related taxa have a short epandrium and have strong anteriorly projecting lobes on the interparameral sclerite. Further analysis of the relationships of the rest of the Trypetini is needed to resolve the polarity of these characters and the relationships of *Oedicarena*.

Synapomorphies for *Oedicarena* include the following: 1) female with four spermathecae; 2) scutum with distinctive microtrichial pattern, with bare spots at the inner ends of the parts of the transverse suture and at the bases of the dorsocentral setae; and 3) postocular setae poorly differentiated. To our knowledge, the first two characters are unique to *Oedicarena* within the Tephritidae. Other tephritids have two or there spermathecae and a variety of microtrichial patterns on the scutum, but none as in *Oedicarena*. The postoculars are poorly developed in some species of *Dacus* Fabricius and in some Adramini (Hardy, 1974), but this similarity is almost certainly due to convergence. The spots on the humeral crossvein and cell bcu, which might be interpreted as an incomplete subbasal band, might also be a synapomorphy of *Oedicarena*. Many other

Trypetini, including most of those related to *Rhagoletis,* have a complete subbasal band. We do not consider the rows of femoral setae to be a synapomorphy of *Oedicarena* because in *O. tetanops* (Loew) and *persuasa* (Osten Sacken) these setae are no stronger than in many other Trypetini.

Because we do not know its sister group, we could not analyze character polarities within *Oedicarena* with much confidence, however, it seems evident that there are two monophyletic subgroups: *tetanops* and *persuasa*; and *latifrons* (Wulp), *beameri* Norrbom and Ming, n. sp., and *nigra* Hernández, n. sp. We have listed the characters that appear to have phylogenetic significance in Table 1 and show the distributions of the character states in Table 2. Figure 1 represents our hypothesis of the cladistic relationships among the five species. Several probable synapomorphies

TABLE 1

Characters of significance in the analysis of phylogenetic relationships among the species of *Oedicarena.* Unless otherwise stated, state a is hypothesized as plesiomorphic

1. Eye size — a) large; b) small.
2. Scutum ground color — a) brown; b) yellow. This character is highly variable in tephritids and its polarity in *Oedicarena* is unresolved.
3. Acrostichal setae — a) present; b) absent.
4. Scutellum color — a) yellowish; b) often with diffuse brownish apical spot.
5. Anteroventral and posteroventral rows of femoral setae — a) setae weak; b) setae stout.
6. Bands through r-m and dm-cu — a) connected; b) not connected. The polarity of this character is unresolved.
7. Apex of cell r_{2+3} — a) with costal band connecting spots or bands at apices of R_{2+3} and R_{4+5}; b) without costal band connecting spots or bands at apices of R_{2+3} and R_{4+5}.
8. Apex of cell R_{4+5} — a) spot or band broad in middle of cell; b) spot or band narrow in middle of cell.
9. Color of halter knob — a) light; b) dark.
10. Angle between surstylus and epandrium — a) no more than 45°; b) at least 60°.
11. Smaller prensiseta of inner surstylus — a) blunt; b) usually acute.
12. Basal lateral lobe on distiphallus — a) present; b) absent.
13. Distiphallus with dorsal and ventral lobes apically — a) absent; b) present. The polarity of this character is unresolved.
14. Aculeus length — a) less than 0.75 times length of segment 7; b) 0.90-1.20 times length of segment 7; c) more than 1.20 times length of segment 7.
15. Shape of aculeus tip — a) acute; b) truncate with small medial point.
16. Sides of aculeus tip — a) non-serrate; b) serrate.
17. Spermatheca sclerotization — a) moderate; b) strong.

TABLE 2

Character state distributions in species of *Oedicarena*

	Character																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
latifrons	a	a/b	a	b	b	a	b	b	a	a	a	a	b	b	a	a	a
nigra	a	a	b	b	b	b	b	b	b	a	a	a	b	c	a	b	a
beameri	a	a	a	b	b	a	a	b	b	a	a	a	b	c	a	b	a
tetanops	b	b	a	a	a	b	b	a	a	b	b	b	a	a	b	a	b
persuasa	b	b	a	a	a	a	a	a	a	b	b	b	a	a	b	a	b

support the monophyly of the two subgroups. Only characters 6 and 7 might contradict this hypothesis, but both involve wing patterns, which are highly subject to homoplasy in tephritids. The length of the aculeus (ovipositor), the shape of its tip, and the color of the halter suggest that *beameri* and *nigra* are more closely related to each other than to *latifrons*.

The morphological and distributional patterns within the two subgroups of *Oedicarena* are noteworthy. *Oedicarena beameri* and *nigra* are sympatric with *latifrons*, although apparently not with each other. They differ distinctly from each other and *latifrons* in genitalic as well as other characters. *Oedicarena tetanops* and *persuasa*, which have disjunct distributions, differ only in wing pattern and very slightly in genitalic characters. The later two taxa may be the result of a recent speciation event or may even be incompletely isolated.

GENUS *Oedicarena* Loew

Oedicarena Loew 1873: 247, 329 (Type species — *Trypeta tetanops* Loew, by monotypy); Williston 1896: 121, 1908: 286 (in part); Coquillett 1899: 267, 1910: 578; Snow 1894: 162, 1903: 219 (in part); Aldrich 1905: 604 (synonym of *Spilographa*); Curran 1932: 3, 1934: 289 (in part); Hering 1939: 168, 1940: 4; Aczél 1949: 251, 1954: 74; Foote 1960b: 114, 1965b: 675, 1967: 32; 1980: 38; Steyskal and Foote 1977: 152; Berlocher and Bush 1982: 136.

Trypeta (Oedicarena); Loew 1873: 332; Osten Sacken 1877: 344, 1878: 190.

Spilographa (Oedicarena); Wulp 1899: 406.

Spilographa; Wulp 1899: 406 (in part); Cresson 1907: 100.

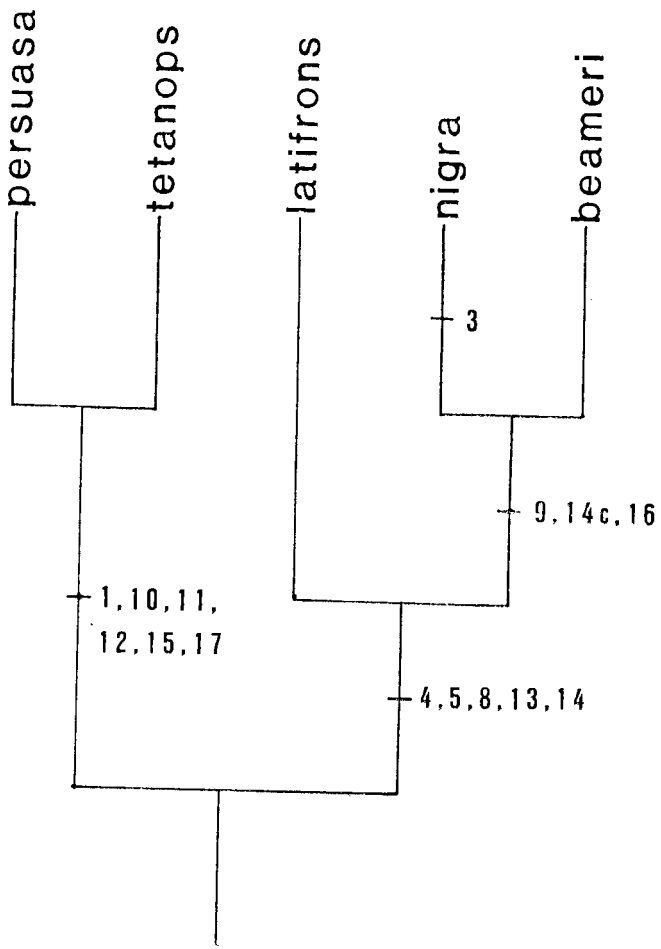

Fig. 1. Hypothesized cladistic relationships among the species of *Oedicarena*. Numbers refer to the characters and states listed in Tables 1 and 2.

Phorellia (Oedicarena); Hendel 1914: 28.
Phorelia; Hendel 1914: 28 (in part); Aczél 1949: 250 (in part).
Rhagoletoides Foote 1960a: 145 (Type species — *Spilographa latifrons* Wulp, by monotypy; Foote 1960b: 114, 1965a: 238, 1965b: 675; 1967: 41.
[synonymized by Steyskal and Foote 1977: 152].

Diagnostic description. **Head** —frons setulose, swollen in lateral view; 3 pairs of frontal setae; 2 pairs of orbital setae, posterior pair reclinate; ocellar setae well developed; postocular setae unicolorous, extremely weak,

slender, poorly differentiated from postgenal setae; face with prominent carina; antenna much shorter than face, first flagellomere rounded apically. **Thorax** – scutum densely microtrichose, except bare spots at inner end of transverse suture and at base of dorsocentral seta, and sometimes posterior margin or narrow margin along postpronotal lobe; lateral scapular setae well developed, medial pair sometimes weak; 1 pair of dorsocentral setae, closer to line through postalar setae than to line through supra-alar setae; acrostichal setae present, except in *nigra*; postpronotal lobe yellow to orange brown, concolorous with lower part of anepisternum; upper margin of anepisternum with whitish stripe, sometimes faint or absent in *tetanops* and *persuasa*. **Legs** – apical one-third to one-half of at least middle and hind femora with anteroventral and posteroventral rows of small, sometimes stout setae; mid tibia without row of outstanding setae posteriorly. **Wing** – hyaline with brown bands and spots; without complete subbasal band, but humeral crossvein and apex of cell bcu each covered by dark spot, and cell bc, base of cell br, area of cells r_1 and r_{2+3} basal to r-m, and narrow borders of Cu and bm-cu often faint yellow; cell bm mostly or entirely hyaline; band from cell sc across r-m reaching at least to Cu_1; small intercalary band in middle of cell r_1; band or series of spots from apex of cell r_1 across dm-cu; apex of cell r_{4+5} with spot(s) or costal band; r-m at about middle of cell dm; R_{4+5} usually with dorsal setae only between base and r-m. **Male terminalia** – epandrium elongate, surstylus arising far from posterior margin; surstylus long, straight or posteriorly curved, without distinct mesal lobe; interparameral sclerite without strongly projecting anterior lobes; inner surstylus subequal to surstylus; aedeagal apodeme with arms separate basally; distiphallus with or without membranous lateral lobe at base **Female terminalia** – syntergosternite 7 with apex evenly sclerotized; 4 spermathecae, variable in shape, but usually spherical with narrow sclerotized neck, surface with minute acute projections.

Remarks. *Oedicarena* was only provisionally established as a genus for *Trypeta tetanops* by Loew (1873: 247), although later in the same work he treated it as a genus or as a subgenus of *Trypeta* Meigen. Names conditionally established before 1961 are available according to Article 15 of the International Code of Zoological Nomenclature (Ride *et al.*, 1985).

Oedicarena nigra Hernández, n. sp. does not run correctly to *Oedicarena* in the key to the Neotropical genera of the Trypetinae in Foote (1980). Because it lacks acrostichal setae, *nigra* keys to *Pseudophorellia* Lima or *Ischyropteron* Bigot. To remedy this, we suggest that couplets 14-16 of Foote's key be replaced by the following:

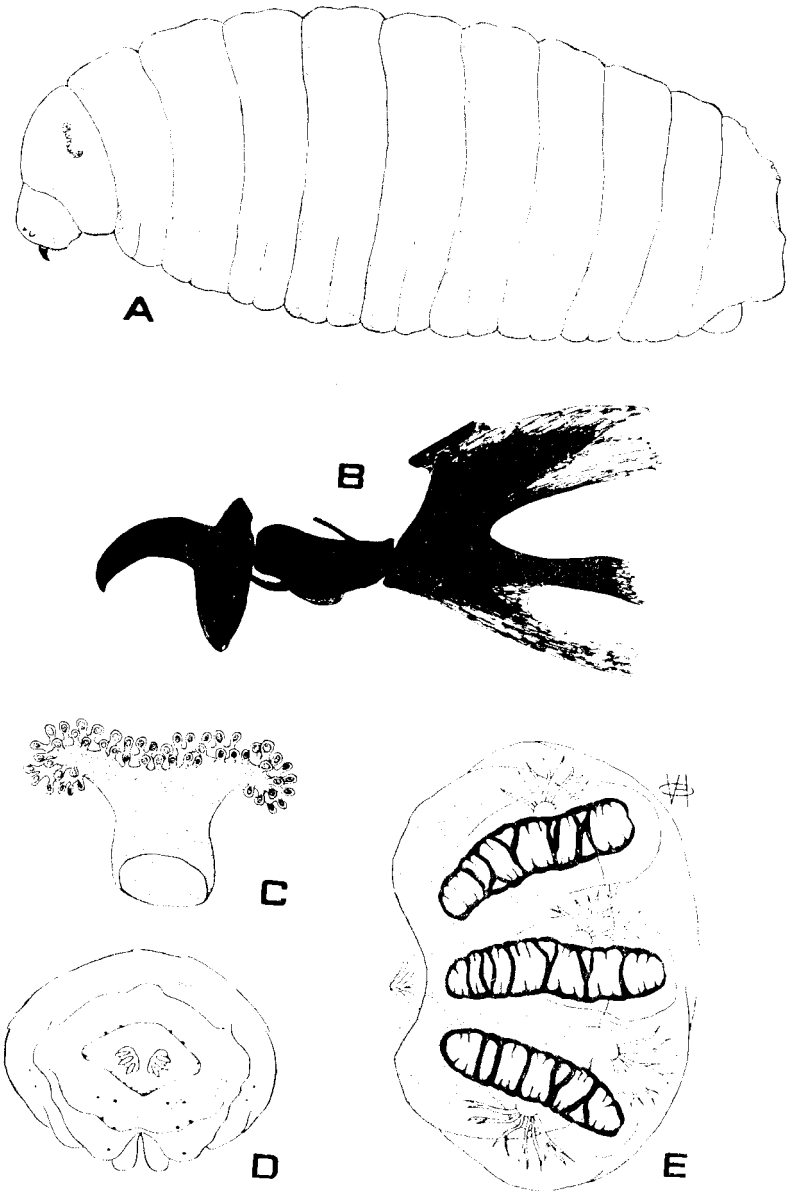

Fig. 2. Third stage larva of *O. latifrons*: A, habitus, lateral view; B, cephalopharyngeal skeleton; C, anterior spiracle; D, abdominal segment 8, posterior view; E, posterior spiracle.

14. Scutellum with sides flattened, forming distinct angle with dorsal part; acrostichal setae absent; scutum usually without microtrichia 15
Scutellum with sides rounded, meeting dorsal part in smooth curve; acrostichal setae usually present (absent in *Oedicarena nigra*); scutal microtrichia variable .. 16
15. Vein r-m proximal to middle of cell dm; wing hyaline basally, evenly dark apical to vein dm-cu ..... *Ischyropteron* Bigot
Vein r-m apical to middle of cell dm; wing pattern extending through most of disk ..... *Pseudophorellia* Lima
16. Mouthparts geniculate, longer than height of head; only basal pair of scutellar setae present ..... *Hetschkomyia* Hendel
Mouthparts not geniculate; usually two pairs of scutellar setae 17

According to the original description, *Hetschkomyia* Hendel (1914) has acrostichal setae ("Ein Paar Praescutellare"). It probably belongs in the Tephritinae considering the shape of the mouthparts, but a reexamination of the type species is needed to confirm this hypothesis. Foote (1980) reported a possibly undescribed species of *Oedicarena* from the West Indies based on a male from Cuba in the USNM, the wing of which was photographed for Foote's Fig. 88. We do not consider this male an *Oedicarena*. It does not have dense scutal microtrichia, with bare spots at the base of the dorsocentral setae and the mesal ends of the transverse suture, it has a complete subbasal wingband, and the surstylus has a mesal lobe typical of *Rhagoletis* and related genera. This specimen keys to *Rhagoletotypeta* in Foote (1980) because it possesses a white medial stripe on the scutum, but the classification of this probably undescribed species remains unresolved.

Host plants. Host plant data for *Oedicarena* are limited. Ramos *et al.* (1979) reared *O. latifrons* from fruit of "la papa", and we examined numerous other specimens of this species that were reared from fruit of "papa silvestre", "papa, *Solanum* sp.", and *Solanum* sp., plus an adult that was collected on a potato plant. "Papa" is the Spanish common name for potato (*Solanum tuberosum* L.) (Sanchez, 1969) and "papa silvestre" translated literally is "wild potato", but we are unsure if all of the above records refer to escaped plants of *tuberosum* or to some related *Solanum* species. Potato appears to be an adopted host for *latifrons* because *S. tuberosum* is native to the Andes (Hunziker, 1979). Adults of *O. nigra* also have been collected on a similar *Solanum* species, but this fly has not been reared.

We examined several specimens of *O. tetanops* collected in Mexico that were labelled with "*Solanum rostratum* Dun.", a species commonly known as "buffalo bur" in the western United States. It is unclear from these labels whether the specimens were reared from *S. rostratum*, or just collected on the plants, but this species would appear to be a likely host. According

to McGregor *et al.* (1986), it is native to the Great Plains and is introduced in the southwest and Mexico. This suggests that other *Solanum* species are native hosts of *tetanops* in Mexico. Berlocher and Bush (1982) collected adults of a species they called *latifrons* on *S. rostratum* in Mexico. Because of their description of the aculeus, we suspect that these specimens were actually *tetanops* (see "Remarks" under *tetanops*). Based on the shape of the aculeus, Berlocher and Bush hypothesized that this species may breed in the flowers of its hosts rather than the fruit. Considering the diversity of aculeus shapes in *Oedicarena*, the different species may utilize a variety of host tissues.

KEY TO THE SPECIES OF *Oedicarena*

1. Gena narrow, height 0.23-0.30 times longest diameter of eye; wing with apical spot or band broad in middle of cell r_{4+5}, with inner margin convex (Fig. 3A-E); aculeus long and narrow, over 0.90 times as long as segment 7, tip usually exposed; aculeus tip acute, serrate or with small subapical steps (Fig. 6A,C,E); surstylus forming angle of no more than 45° with lower margin of epandrium (Fig. 4A,C,E) 2
   Gena broad, height 0.46-0.68 times longest diameter of eye; wing with apical band narrow in middle of cell R_{4+5} (Fig. 3F-G) or with separate spots at apices of R_{4+5} and M (Fig. 3D); aculeus short and broad, no more than 0.67 times as long as segment 7; aculeus tip stout with tiny medial point (Fig. 6F,H); surstylus forming angle of at least 60° with lower margin of epandrium (Fig. 4G) 4
2. Acrostichal setae present; wing with band over r-m extending at least 2/3 distance from Cu_1 to posterior margin, often connected with band over dm-cu (Fig. 3A-B,E); aculeus tip gradually tapering or with sides parallel basal to acute part, sides entire or finely serrate; distiphallus with elongate ventral apical lobe 3
   Acrostichal setae absent; wing with band over r-m extending at most 1/3 distance from Cu_1 to posterior margin, never connected with band over dm-cu (Fig. 3C-D); aculeus tip sagittate, sides concave basal to acute part, acute part with strong serrations (Fig. 6E); distiphallus with ventral apical lobe short (Fig. 5C) ..... *nigra* Hernández, n. sp.
3. Wing with band or spot at apex of R_{2+3} not connected to spot in cell r_{4+5} (Fig. 3A-B); knob of halter yellow or light brown; aculeus tip gradually tapering, with small subapical steps (Fig. 6A); distiphallus with long dorsal and ventral apical lobes, each with pair of strong slender lateral sclerites (Fig. 5A) ..... *latifrons* (Wulp)
   Wing with band or spot at apex of R_{2+3} conected to spot in cell r_{4+5} by

costal band (Fig. 3E); knob of halter brown; aculeus tip parallel sided, then abruptly acute, sides of acute part finely serrate (Fig. 6C); distiphallus with short dorsal and elongate ventral apical lobes, only the ventral lobe with pair of weak slender lateral sclerites (Fig. 5B)..... ..... *beameri* Norrbom and Ming, n. sp.

4. Wing (Fig. 3G-H) with spots at apices of R_{4+5} and M, rarely narrowly connected along costa, but never connected to spot or band at apex of R_{2+3}; bands over r-m and dm-cu not connected at posterior margin; (Mexico) ..... *tetanops* (Loew)
Wing (Fig. 3F) with broad costal band from apex of R_{2+3} to apex of M, connected with band at apex of R_{2+3}; bands over r-m and dm-cu usually connected at posterior margin; (SW. U.S) ... *persuasa* (Osten Sacken)

Oedicarena latifrons (Wulp)

(Fig. 3A-B, 4A-B, 5A, 6A-B)

Spilographa latifrons Wulp 1899: 407 (Holotype — ♀ (BMNH), MEXICO: DURANGO: Ciudad, 8100 ft., Forrer); Foote 1965a: 238.
Spilographa obfuscata Wulp 1899: 406 (Holotype — ♂ (BMNH), MEXICO GUERRERO: Omilteme, 8000 ft., vii., H. H. Smith). [synonymized by Foote 1965a: 238].
Phorellia latifrons; Hendel 1914: 28; Aczél 1949: 250.
Phorellia obfuscata; Hendel 1914: 28; Aczél 1949: 250.
Rhagoletoides latifrons; Foote 1960: 146, 1965a: 238, 1965b: 675, 1967: 41.
Oedicarena latifrons; Steyskal and Foote 1977: 153; Foote 1980: 38; (?) Berlocher and Bush 1982: 137.
(not) *Spilographa obfuscata*; Cresson 1907: 100. [misidentification, see *nigra*].

Description. — Length, male 5.84-6.58 mm, female 7.01-7.48 mm. **Head** genal height 0.28-0.36 mm, 0.23-0.29 times longest diameter of eye; parafacial at narrowest point 0.08-0.14 mm wide, 0.38-0.60 times width of antennal flagellomere. **Thorax** — scutum microtrichose medially, ground color entirely orange or, except for margins, dark brown; scutellum brown or yellow with diffuse brown apical spot; acrostichal setae present. **Legs** — femora usually light brown and no darker than tibiae, with anteroventral and posteroventral rows of short stout setae on apical third, especially differentiated on mid-and hindleg. **Wing** (Fig. 3A-B) — band covering r-m extending at least 2/3 distance from Cu_1 to posterior margin, usually connecting with band covering dm-cu; band covering dm-cu sometimes interrupted in cell r_{4+5}, not interrupted and even in width between

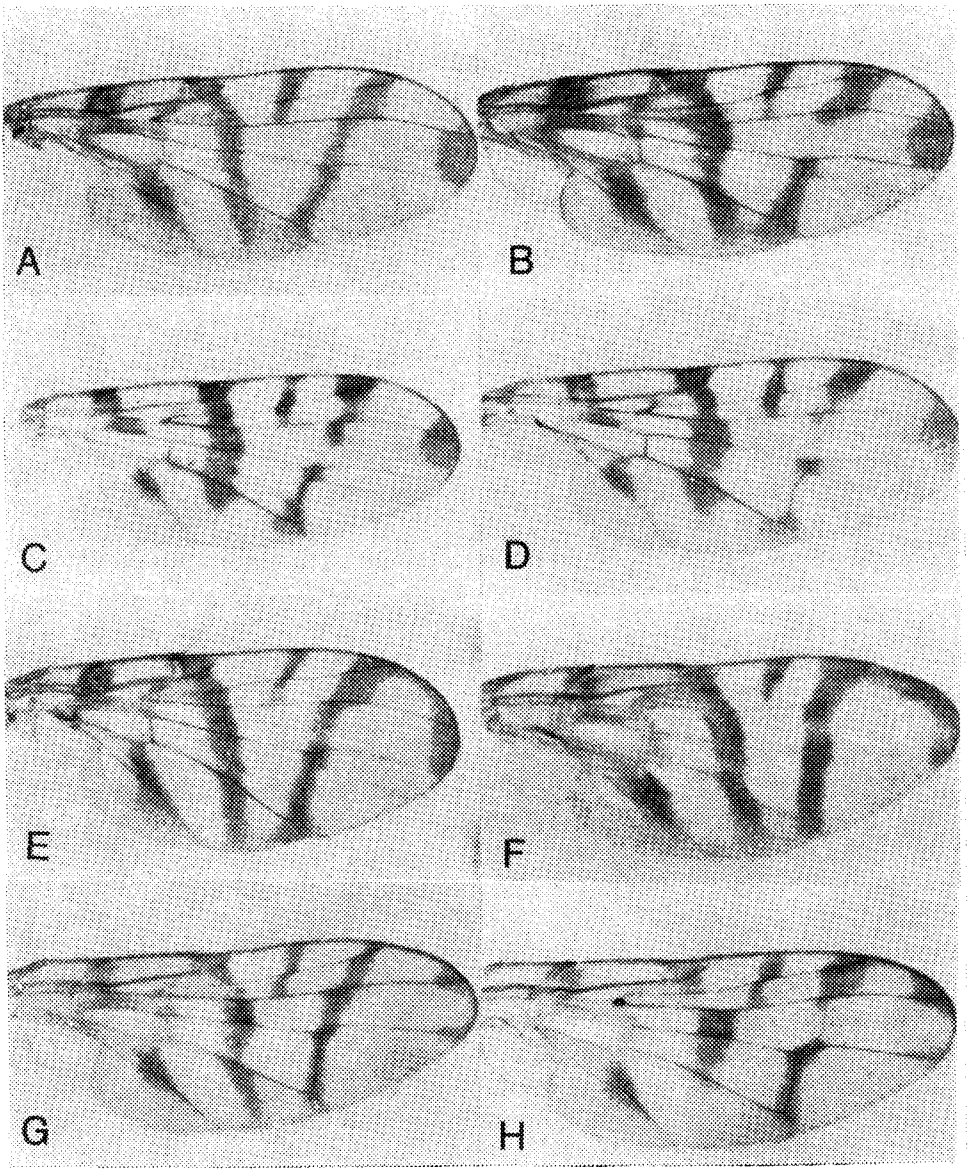

Fig. 3. Wings: A-B, *O. latifrons*; C-D, *O. nigra*; E, *O. beameri*; F, *O. persuasa*; G-H, *O. tetanops*.

M and Cu_1; single ovate spot, widest within cell r_{4+5} or along R_{4+5}, covering apices of R_{4+5} and M, not connected to spot or band at apex of R_{2+3}; spot at apex of cell bcu large, usually covering all of Cu_2 and often more than half of Cu_2+A_1; halter with knob yellow or light brown. **Male terminalia** — surstylus 0.41-0.45 mm long, in lateral view (Fig. 4A) forming angle of less than 45° with lower margin of epandrium, apex (Fig. 2B) strongly concave; inner surstylus with smaller prensiseta blunt; aedeagus 2.53-2.70 mm long; distiphallus (Fig. 5A) 0.83-0.87 mm long, sclerotized apical part 0.66-0.71 mm long, aplically with elongate dorsal and ventral lobes, each with pair of strong slender lateral sclerites, at base with membranous lateral lobe. **Female terminalia** — syntergosternite 7, 0.85-0.87 mm long, 0.47-0.51 mm wide at apex, 1.70-1.83 times as long as wide at apex; aculeus 0.84-0.93 mm long, 0.98-1.09 times as long as syntergosternite 7, 0.22-0.23 mm wide at base, ratio of length to width at base 3.86-4.29; aculeus tip (Fig. 6A) elongate, acute, with small subapical steps; spermathecae (Fig. 6B) moderately sclerotized, often collapsed in our preparations. **Third stage larva** (Fig. 2A) — length 7.0-9.0 mm, diameter 2.0-2.5 mm, robust and creamy white. Cephalic segment with cephalopharyngeal skeleton (Fig. 2B) strongly sclerotized except for semihyaline windows in ventral cornua; mandible short and robust; preoral cavity surrounded by 6 oral ridges. Thorax with rows of spinules on ventral creeping welt on all segments; anterior spiracle (Fig. 2C) yellow brown, with fine reticulation covering base, and with 41-54 papillae in 2 rows. Abdomen with rows of spinules on ventral creeping welt on all segments, extending almost completely around segments 7 and 8; segment 8 (Fig. 2D) with fine tubercles distributed symmetrically, and spiracular plate slightly above median line; posterior spiracle (Fig. 2E) with peritreme and rimae strongly sclerotized; spiracular hairs short and stout, generally with 6 trunks with few branches; anal lobes simple; anal elevation with several rows of spinules.

Distribution. Highland areas of Mexico and the United States from Guerrero and Puebla to Colorado.

Remarks. The redescriptions of the holotypes of *obfuscata* and *latifrons* in Foote (1965a) are reversed. Foote stated that the holotype of *obfuscata* is a female, and that of *latifrons* is a male, but, but the opposite is true. Wulp (1899) incorrectly stated that both holotypes were males. Both specimens are identifiable by their *Biologia Centrali-Americana* labels with the respective species names, and by their differences in wing pattern and leg color, which were described by Wulp. The dark color of the femora of the holotype of *obfuscata* is unusual for this species, but the male terminalia, wing pattern, and color of the halter indicate that this specimen

is conspecific with the holotype of *latifrons*. The names *obfuscata* and *latifrons* were published simultaneously but *latifrons* is valid on the authority of the first reviser (Foote 1965a).

The scutum is entirely orange in the specimens from Arizona, New Mexico, and Colorado, but is mostly dark brown in the specimens from Mexico. This appears to be a consistent geographical difference. The description of the third stage larva is based upon 6 specimens examined by VHO.

Specimens examined.—Holotypes of *latifrons* and *obfuscata*; MEXICO: (state unknown) Mt. Orizaba, Arriba de Temalaquilla, 17.viii.1949, "frutos de papa silvestre, emerged 12-29.vi.1950", J. C. Hawkes, 4♂ 1♀ (USNM); PUEBLA: Oyameles, 15.vii.1976, "ex. larvas en *Solanum* sp.", 6♂ 26♀ 6 larvae (UNAM); Guadalupe Victoria, 5.vii.1976, "ex. larvas en *Solanum* sp.", 1♂ 3♀ (UNAM); Tlatlahuitepec, "larva in fruit *Solanum* sp., 'papa' ", 7.vi.1977, C. Garcia Martell, 1♂ 1♀ (USNM); MORELOS 2 km NW. Huitzilac, 2750 m, 18vii.1984, J. Butze, 3♂ 2♀ (UNAM); Lagunas de Zempoala Nat. Park, 9400 ft., 22.viii.1969, G. W. Byers, 1 ♂ (SMEK), 1 ♀ (USNM); Cuernavaca, 8000 ft., 15.viii.1943, F. M. Snyder, 1♂ (AMNH); DISTRITO FEDERAL: La Cima, 18.vii.1984, A. Iburra, 1♀ (UNAM); Milpa Alta, C. Tulmiac, 30.vii.1983, G. Arzate, 1♂ (UNAM); México: 15.5 mi. E. Toluca, 6.viii.1963, Byers & Naumann, 1♀ (SMEK), Amecameca, 8000 ft., 17.viii. 1956, R. & K. Dreisbach, 1♀ (USNM); 7 km S. Amecameca 8000 ft., 12.viii.1962, G. L. Bush, 2♂ (MSUL); Tequesquinahuac, C. Tlaloc, 24.vii.1980, J. Butze, 1♀ (UNAM); same locality, 21.vii.1984, A. Ibarra, 1♀ (UNAM); La Puerta, vii.1986, "ex. larvas en *Solanum* sp.", 1♀ (UNAM); San Felipe del Progreso, vii.1976, "ex. larvas en *Solanum* sp.", 1♂ 1♀ (UNAM); TLAXCALA: La Malinche, 3400 m, 19.viii.1980, E. Ramírez, 1♂ (UNAM); MICHOACAN: Huajumbaro, 7600 ft., 5.viii.1962, G. L. Bush, 2♂ (MSUL); HIDALGO: km 90 Pachuca-Tampico, 14.iii.1986, F. Arias & R. Medina, 1♂ (UNAM); QUERETARO: San Juan del Río, 6.viii.1949, J. G. Hawkes, 3♂ (USNM); DURANGO: 10 mi. W. El Salto, "on potato plant", 12.vii.1964, J. F. McAlpine, 1♂ (CNC); SONORA: Sonora, 5.v.1962, C. Garcia Martell, 1♀ (EBCJ); UNITED STATES: ARIZONA: Catalina Mts., Mt. Lemon, 6.000 ft., 27.vii, J. Bequaert, 1♂ (MCZ); NEW MEXICO: White Mt., S. fork Eagle Creek, 8000 ft., 13.viii, Townsend, 1♂ (USNM); COLORADO: Weld County, Pawnee Natl. Grassland, 9.viii.1970, R. T. Bell, 1♂ (USNM).

Oedicarena beameri Norrbom and Ming, n. sp.

(Fig. 3E, 4C-D, 5B, 6C-D)

Holotype. — ♀ (SMEK), USA: ARIZONA: Santa Rita Mountains, 18.viii.1935, R. H. Beamer.

Paratype. — ♂ (SMEK), same data, on same pin as holotype.

Description. — Length, male 5.76 mm, female 6.17 mm. **Head** — genal height 0.33 mm, 0.26-0.30 times longest diameter of eye; parafacial at narrowest point 0.08-0.09 mm wide, 0.36-0.45 times width of antennal flagellomere. **Thorax** — scutum microtrichose medially, ground color, ex-

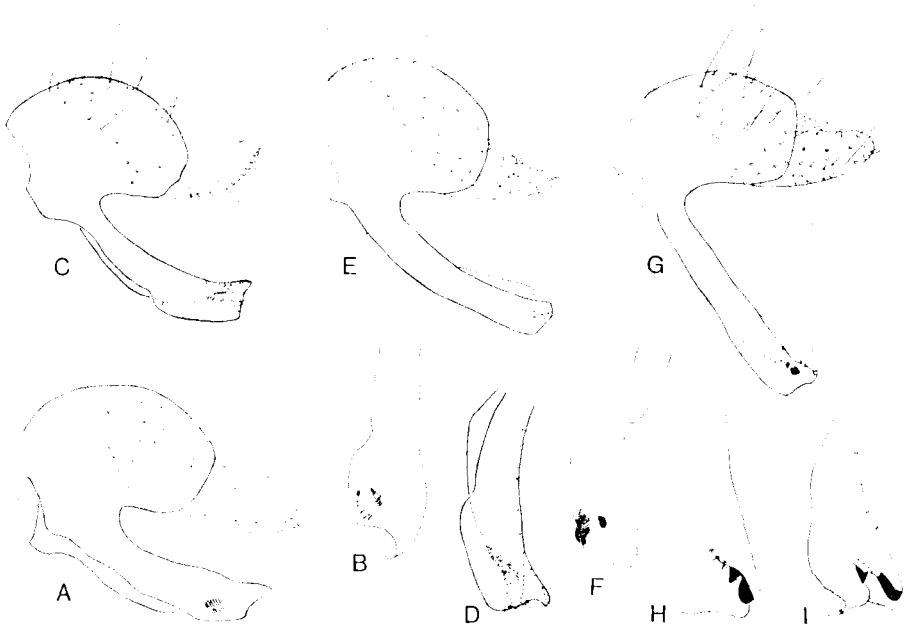

Fig. 4. Male terminalia: A-B, *O. latifrons*; C-D, *O. beameri*; E-F, *O. nigra*; G-H, *O. tetanops*; I, *O. persuasa*; A, C, E, G, epandrium and left surstylus, lateral view; B, D, F, apex of left surstylus ventrolateral view; H-I, right surstylus, mesal view.

cept for margins, dark brown; scutellum orange or yellow, with or without diffuse brown apical spot; acrostichal setae present. **Legs** — femora light brown and no darker than tibiae, with well differentiated anteroventral and posteroventral rows of short stout setae on apical third of all legs. **Wing** (Fig. 3E) — band covering r-m extending to posterior margin, connecting with band covering dm-cu; band covering dm-cu uninterrupted in cell r_{4+5} and even in width between M and Cu_1; complete costal band extending from apex of R_{2+3} to apex of M, much wider in cell r_{4+5} than in cell r_{2+3}, connected to band covering dm-cu; spot at apex of cell bcu large, covering all of Cu_2 and more than half of Cu_2+A_1; halter with knob moderate to dark brown. **Male terminalia** — surstylus 0.50 mm long, in lateral view (Fig. 4C) forming angle of about 45° with lower margin of epandrium, apex (Fig. 4D) strongly concave; inner surstylus with smaller prensiseta blunt, larger prensiseta extremely large; aedeagus 3.33 mm long; distiphallus (Fig. 5B) 1.21 mm long, sclerotized apical part 0.80 mm long, apically with short, entirely membranous dorsal lobe and elongate ventral lobe with pair of weak slender lateral sclerites, at base with membranous

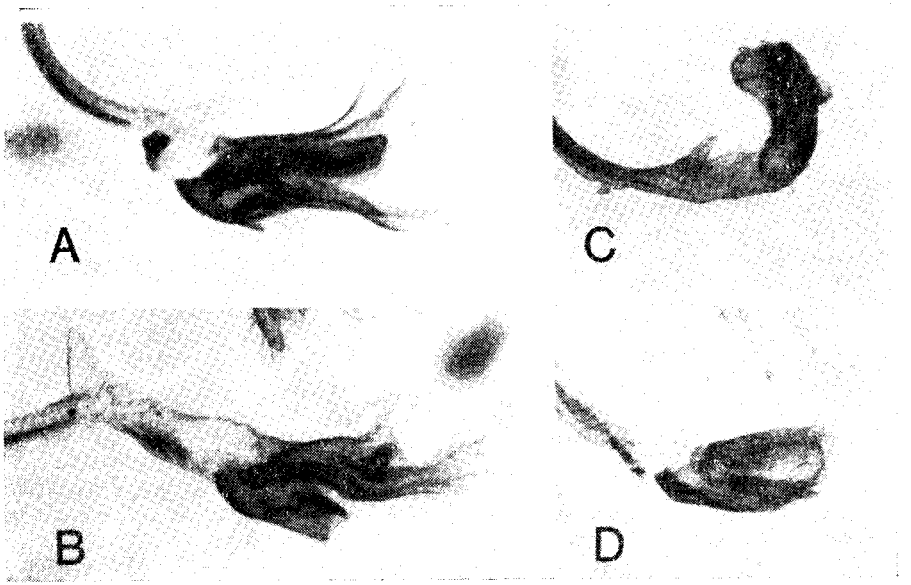

Fig. 5. Male distiphallus: A, *O. latifrons*; B. *O. beameri*; C. *O. nigra*; D, *O. tetanops*.

lateral lobe. **Female terminalia** – syntergosternite 7, 0.99 mm long, 0.50 mm wide at apex, 1.98 times as long as wide at apex; aculeus 1.35 mm long, 1.36 times as long as syntergosternite 7, 0.28 mm wide at base, ratio of length to width at base 3.55; aculeus tip (Fig. 6C) parallel sided, then sharply acute, acute part finely serrate; spermathecae (Fig. 6D) moderately sclerotized, one pair globose, one pair extremely elongate and slender.

Distribution. Known only from the type locality in Arizona.

Remarks. The shape of the two elongate spermathecae of the holotype is unusual and may be abnormal. The spermathecae are usually globose in *latifrons* but their shape is variable. The size of the large prensiseta in the male paratype of *beameri* may also be variable.

Etymology. This species is named for the collector of the types, R. H. Beamer.

Specimens examined. Holotype, paratype.

Oedicarena nigra Hernández, n. sp.

(Fig. 3C-D, 4E-F, 5C, 6E)

Spilographa obfuscata; Cresson 1907: 100. [misidentification].

Holotype. ♀ (UNAM), MEXICO: DISTRITO FEDERAL: La Cima, 18.vii.1984, "on *Solanum* sp.", V. Hernández.

Paratypes. MEXICO: DURANGO: Navios, 26 mi. E. El Salto, 8000 ft., 2.viii.1964, L. A. Kelton, 1 ♀ (CNC), 1 ♀ (USNM); 10 mi. W. El Salto, 9000 ft., 12.vii.1964, J. F. McAlpine, 1 ♀ (CNC); MICHOACAN: Tzintzuntzan, 7000 ft., 6.viii.1962, G. L. Bush, 1 ♂ (USNM) 1 ♀ (MSUL); Huajumbaro, 7600 ft., 5.viii.1962, G. L. Bush, 1 ♀ (MSUL); HIDALGO: 5 mi. W. Pachuca, 7900 ft., 28.viii.1962, Marston, 1 ♂ (KSU); MEXICO: Chapingo, 29.viii.1980, J. B. Karren, 1 ♀ (USU); 2 km N. Tenango del Valle, 8600 ft., 9.viii.1962, G. L. Bush, 1 ♂ (MSUL); Toluca, 29.viii.1974, S. Berlocher, 1 ♂ (MSUL); DISTRITO FEDERAL: La Cima, 18.vii.1984, "on *Solanum* sp", E. Ramírez, 1 ♂ (UNAM); Xochimilco, Sta. Cruz Acalpixca, 13.viii.1983, G. Arzate, 1 ♂ (UNAM); MORELOS: Lagunas de Zempoala Nat. Park, 9400 ft., 22.viii.1969, G. W. Byers, 1 ♂ (SMEK); same locality, 9200 ft., 11.viii.1962, G. L. Bush, 1 ♂ (USNM), 1 ♀ (MSUL); Tetela del Volcán, 30.ix.1978, G. Arzate, 1 ♀ (UNAM); same locality, 23.vii.1984, A. Ibarra, 1 ♀ (UNAM); VERACRUZ: km 120 Autopista Puebla-Orizaba, 2000 m. 17.vii.1978, J. Butze, 1 ♀ (UNAM); Jalapa, 1-6.viii.1961, R. & K. Dreisbach, 1 ♀ (USNM).

Description. — Length, male 5.88 mm, female 5.27-5.93 mm. **Head** — genal height 0.26-0.28 mm, 0.25-0.29 times longest diameter of eye; parafacial at narrowest point 0.08 mm wide, 0.36-0.40 times width of antennal flagellomere. **Thorax** — scutum with weak medial bare stripe, ground color, except for margins, dark brown; scutellum brown or yellow with diffuse dark apical spot; acrostichal setae absent. **Legs** — femora usually dark brown, darker than tibiae, with well differentiated anteroventral and posteroventral rows of short stout setae on apical third on all legs. **Wing** (Fig. 3C-D) — band covering r-m extending at most ½ distance from Cu_1 to posterior margin, never connecting with band covering dm-cu; band covering dm-cu always interrupted in cell r_{4+5}, interrupted or narrowed between M and Cu_1; single ovate spot, widest within cell r_{4+5} or along R_{4+5}, covering apex of R_{4+5} and usually apex of M, not connected to spot or band at apex of R_{2+3}; spot at apex of cell bcu small, usually covering less than ½ of Cu_2 and only base of Cu_2+A_1; halter with knob dark brown. **Male terminalia** — surstylus 0.50 mm long, in lateral view (Fig. 4E) forming angle of no more than 45° with lower margin of epandrium, apex (Fig. 4F) weakly concave; inner surstylus with smaller prensiseta blunt; aedeagus 2.50 mm long; distiphallus (Fig. 5C) 0.70 mm long, sclerotized apical part 0.39 mm long, apically with short, entirely

membranous dorsal lobe and short ventral lobe with pair of slender lateral sclerites, at base with membranous lateral lobe. **Female terminalia** – syntergosternite 7, 0.70 mm long, 0.43 mm wide at apex, 1.68 times as long as wide at apex; aculeus 0.96-1.02 mm long, 1.32 times as long as syntergosternite 7, 0.18-0.23 mm wide at base, ratio of length to width at base 4.00-5.25; aculeus tip (Fig. 6E) sagittate, acute part with large serrations; spermathecae moderately sclerotized, often collapsed in our preparations.

Distribution. Highlands of central and northern Mexico.

Remarks. Cresson (1907) reported a male from Guadalajara, Mexico as *obfuscata* (= *latifrons*), but from his description of the wing bands and the halter color, the specimen was probably *nigra*. We were unable to locate any specimens of *Oedicarena* in the Academy of Natural Sciences, Philadelphia, where most of Cresson's material is deposited.

Etymology. The name of this species is derived from the Latin "nigra" (dark or black), in reference to the general coloration of the body.

Specimen examined. – Holotype; 19 paratypes.

Oedicarena tetanops (Loew)

(Fig. 3G-H, 4G-H, 5D, 6F-G)

Trypeta tetanops Loew 1873: 245 (Syntype(s) – ♂ (Zoologisches Museum, Der Humboldt – Universität zu Berlin), MEXICO, Deppe; not examined).
Trypeta (Oedicarena) tetanops; Osten Sacken 1877: 344, 1878: 190.
Spilographa (Oedicarena) tetanops; Wulp 1899: 406.
Spilographa tetanops; Aldrich 1905: 604.
Phorellia (Oedicarena) tetanops; Hendel 1914: 28.
Oedicarena tetanops; Loew 1873: 279; Coquillett 1910: 578; Hering 1939: 168, 1940: 4; Aczél 1949: 251, 1954: 74; Foote 1960: 114, 1965b: 675, 1967: 32, 1980: 38; Stelyskal and Foote 1977: 153.
(?) *Oedicarena latifrons*; Berlocher and Bush 1982: 137.

Description. – Length, male 6.09-7.0 mm, female 5.78-7.23 mm. **Head** – genal height 0.49-0.61 mm, 0.46-0.68 times longest diameter of eye; parafacial at narrowest point 0.16-0.23 mm wide, 0.81-1.15 times width of antenal flagellomere. **Thorax** – scutum ground color entirely yellow or

orange brown; scutellum yellow without brown apical spot; acrostichal setae present. **Legs** — femora yellow to light brown, concolorous with tibiae, with weakly differentiated anteroventral and posteroventral rows of short stout setae on apical third on mid- and hindleg only. **Wing** (Fig. 3G-H) — band covering r-m seldom extending to posterior margin, never connecting with band covering dm-cu; band covering dm-cu sometimes interrupted in cell r_{4+5}, not interrupted and usually even in width between M and Cu_1; apices of R_{1+5} and M with spots, rarely narrowly conected along costa; spot at apex of cell bcu small, usually covering less than one third of vein Cu_2; halter with knob light brown. **Male terminalia** — surstylus 0.53-0.60 mm long, in lateral view (Fig. 4G) forming angle of at least 60° with lower margin of epandrium, apex (Fig. 4H) with posterior lobe more pronounced than in *persuasa*; inner surstylus with smaller prensiseta usually acute; aedeagus 2.58-2.70 mm long; distiphallus (Fig. 5D) 0.60-6.65 mm long, sclerotized part 0.45-0.53 mm long, without apical lobes or basal lateral lobe. **Female terminalia** — syntergosternite 7, 1.12-1.27 mm long, 0.36-0.53 mm wide at apex, 2.41-3.13 times as long as wide at apex; aculeus 0.62-0.70 mm long, 0.49-0.63 times as long as syntergosternite 7, 0.31 mm wide at base, ratio of length to width at base 2.20-2.25; aculeus tip (Fig. 6F) short, truncate with small medial point, point slightly less acute than in *persuasa*; spermathecae strongly sclerotized, usually distinctly spherical (Fig. 6G).

Distribution. Highlands of central and northern Mexico.

Remarks. Loew based his description on at least one male, but he did not specify the number of specimens, so any types than are discovered must be considered syntypes. The specimens from the Distrito Federal, Mexico reported as *latifrons* by Berlocher and Bush (1982) may actually be this species. Although no specimens could be located for reexamination (S. H. Berlocher, pers. comm), Berlocher and Bush's description of the aculeus as being "very short and unsclerotized" better fits *tetanops*. The male in the MCZ from Guadalupe, Distrito Federal has an extra crossvein between R_{1+5} and M just posterior to dm-cu, but is otherwise normal.

Specimens examined. — MEXICO: MORELOS: Tepotzlan, 26.ix.1957, B. & K. Dreisbach, 1♂ (USNM); DISTRITO FEDERAL: 4♂ 1♀ 1? (USNM); Xochimilco, 22.vii.1947, H. Wagner, 1♂ (UMAA); Xochimilco, Sta. Cruz Acalpixca, 13viii.1983, G. Arzate, 1♂ (UNAM); Tuluchualco, viii.1923, E. G. Smyth, 1♂ (USNM); Guadalupe, 5.ix.1903, 1♂ (MCZ); Mexico City, 17.ix, J. Muller, 1♂ (USNM); Camino de Camarones, 6.ix. 1937, W. E. Stone, 1♂ (USNM); Tacubaya, ix, 1♀ (UNAM); MEXICO: Montecillos,

"*Solanum rostratum* Dun. (Solanaceae)", 25.viii.1982, S. Anaya R., 1 ♂ (USNM); Texcoco, 2240 m., "*Solanum rostratum*", 8.ix.1982, S. Anaya R., 1 ♀ (EBCJ); Texcoco, 12.viii.1954, 3 ♂ (SMEK), 1 ♂ (USNM); Chapingo 21.ix.1960, F. Pacheco, 1 ♀ (EBCJ); Tepexpan, 6900 ft., 12.viii.1954,. 1 ♂ (SMEK), 1 ♂ (USNM); TLAXCALA: Huamantla, 23.ix.1961, F. Pacheco, 1 ♂ (EBCJ); MICHOACAN: Morelia, 6.ix.1938, L. J. Lipovsky, 1 ♂ (SMEK); HIDALGO: 18 mi. SE. Ixmiquilpan, 19.vii.1963, G. W. Byers, 1 ♀ (USNM); Tepeji, 36 mi. N.Mexico City, 24.ix.1961, G. L. Bush, 1 ♂ 1 ♀ (MSUL); JALISCO: Guadalajara, 2.x.1966, G. E. & A. S. Bohart, 2 ♂ (USU), 1 ♀ (USNM); same locality, 1.ix.1971, W. J. Hanson, 1 ♂ (USU); AGUASCALIENTES: Aguascalientes, 3-5.viii.1963, P. J. Spangler, 1 ♀ (USNM); CHIHUAHUA: 9 mi. S. Hidalgo del Parral, 1-9.vii.1967, R. C. Gardner, 1 ♀ (UCD).

Oedicarena persuasa (Osten Sacken)

(Fig. 3F, 4I, 6H)

Trypeta (Oedicarena) persuasa Osten Sacken 1877: 341 (Lectotype [here designated] — ♂ (MCZ, type no. 10245), USA: COLORADO: Denver Co., Denver, 10.vii, P. R. Uhler and A. S. Packard); Osten Sacken 1878: 190.
Oedicarena persuasa; Snow 1903: 219; Foote 1960: 114, 1965b: 675; Steyskal and Foote 1977: 153.
Spilographa (Oedicarena) persuasa; Wulp 1899: 406.
Spilographa persuasa; Aldrich 1905: 604.

Description. — Length, male 5.76-6.85 mm, female 7.29-7.52 mm. **Head** genal height 0.49-0.65 mm, 0.47-0.60 times longest diameter of eye; parafacial at narrowest point 0.22-0.26 mm wide, 1.09-1.18 times width of antennal flagellomere. **Thorax** — scutum ground color entirely yellow or orange brown; scutellum yellow without dark apical spot; acrostichal setae present. **Legs** — femora yellow to light brown, concolorous with tibiae, with weakly differentiated anteroventral and posteroventral rows of short stout setae on apical third on mid- and hindleg only. **Wing** (Fig. 3F) — band covering r-m extending to posterior margin, usually connecting with band covering dm-cu; band covering dm-cu not interrupted in cell r_{1+5}, continuous and even in width between M and Cu_1; broad continuous band from apex of R_{2+3} to apex of M; spot at apex of cell bcu large, usually covering more than half of Cu_2; halter with knob light brown. **Male terminalia** — surstylus 0.55 mm long, in lateral view very similar to Fig. 4G, forming angle of at least 60° with lower margin of epandrium, apex (Fig. 4I) with posterior lobe less pronounced than in *tetanops*; inner surstylus with smaller prensiseta usually acute; aedeagus 2.50-2.62 mm long; distiphallus 0.59-0.60 mm long, sclyerotized part 0.47-0.48 mm long, very similar to Fig. 3C, without apical lobes or basal lateral

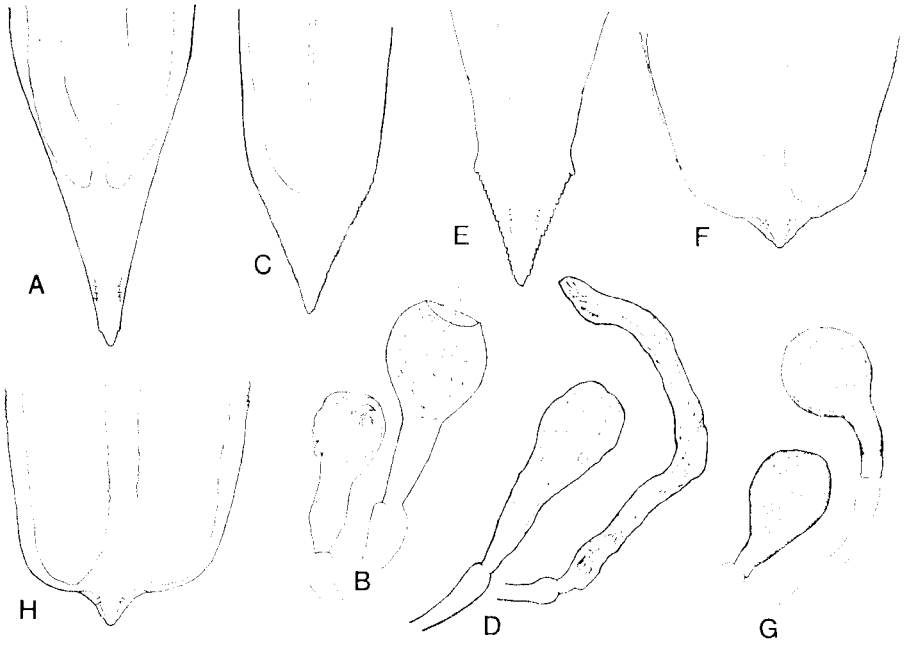

Fig 6. Female terminalia: A-B, *O. latifrons*; C-D, *O. beameri*; E. *O. nigra*; F-G, *O. tetanops*; H, *O. persuasa*; A, C, E-F, H, aculeus tip, ventral view; B. D, G, spermathecae (two of four).

lobe. **Female terminalia** — syntergosternite 7, 1.19-1.21 mm long, 0.43-0.47 mm wide at apex, 2.57-2.79 times as long as wide at apex; aculeus 0.59-0.65 mm long, 0.49-0.55 times as long as syntergosternite 7, 0.29-0.31 mm wide at base, ratio of length to width at base 2.00-2.10; aculeus tip (Fig. 6H) short, truncate with small medial point, point slightly more acute than in *tetanops*; spermathecae strongly sclerotized, usually distinctly spherical.

Distribution. Northern Texas to Colorado and Nebraska.

Remarks. The lectotype has hand written labels with "Denver, July 10" and "Oedicarena persuasa 0. S.", a machine printed label with "Osten Sacken Coll.", and a "Type 10245" label. The paralectotype, which is missing its head, is similarly labelled except there is no date and there is an additional label with "33". Osten Sacken stated that there were only 2 syntypes, both male.

Specimens examined.—Lectotype; USA: TEXAS: Forestburg, 14.vii.1940, L. H. Bridwell, 1 ♂ (USNM); KANSAS: Finney Co., 8 mi S. Garden City, 19.vii.1967, G. F. Hevel, 2 ♂

1 ♀ (USNM); NEBRASKA: Chapman, 10.viii.1950, R. R. Dreisbach & R. K. Schwab, 3 ♂ (MSUL); COLORADO: Denver Co., Denver, P. R. Uhler and A. S. Packard, 1 ♂ paralectotype (MCZ, type no. 10245); Jefferson Co., Plainview, 9-14.vii.1922, 1 ♂ (MCZ); Prowers Co., 1 mi. N. Hartman, 27.viii.1963, N. & B. Marston, 1 ♀ (KSU); Boulder, 5.ix.1927, A. H. Sturtevant, 1 ♀ (USNM); Boulder, 2.viii.1905, 1 ♂ (MCZ); Wray, 17-19. viii.1919, 1 ♂ (AMNH); La Junta, 2.viii.1920, 4 ♂ 4 ♀ (AMNH).

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Nota técnica

UN METODO SENCILLO PARA MARCAR ESCARABAJOS

En etología, la necesidad de reconocer a cada elemento de una población se acentúa cuando se hacen estudios de comportamiento sexual y no hay diferencias aparentes entre los sexos. Tal es el caso de los escarabajos rodadores del estiércol (tribu Scarabaeini), en donde machos y hembras son indistinguibles a simple vista, pero que, durante el periodo de nidificación tienen pautas de comportamiento notablemente diferentes (ver Halffter y Matthews, 1966, *Folia Entomol. Mex. 12-14*: 1-312; Halffter y Edmonds, 1982, *The nesting behavior of dung beetles. Publ.* 10. Inst. Ecol. 176 pp). Para poder analizar estos comportamientos con mayor precisión en laboratorio y campo, he desarrollado un método sencillo para identificar cada sexo e inclusive cada individuo. Este método de marcaje me ha permitido observar comportamientos no conocidos o muy poco estudiados en los Scarabaeini.

MÉTODO DE MARCAJE. **Limpieza del insecto.** Se frota la parte del cuerpo que se va a marcar con un pedazo de papel sanitario ligeramente humedecido con alcohol y se vuelve a limpiar con un papel seco. **Colocación de la marca de pintura.** Preferentemente se usa pintura de agua para carteles con una consistencia pastosa. La marca se pone con ayuda de una aguja de disección sobre el pronoto o el élitro y debe estar lo más pegada al cuerpo sin que sobresalga, ya que pequeños montículos de pintura son sitios ideales para que la tierra se vaya adhiriendo a ellos. Hay que dejar secar la pintura colocando a cada individuo marcado en un recipiente, durante 10 minutos aproximadamente. **Colocación de la capa protectora.** Para evitar que se caiga la marca de pintura, se utiliza como película protectora una gota de pegamento comercial a base de cianoacrilato. La co-

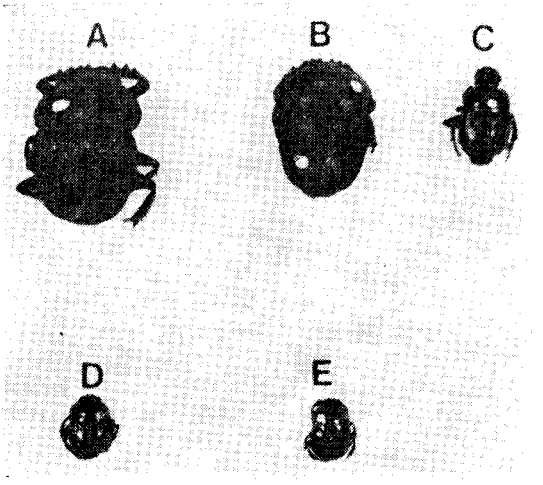

Fig. 1. Ejemplos de especies marcadas. A: *Scarabaeus cicatricosus*. B: *Scarabaeus semipunctatus*. C: *Canthon humectus*. D: *Canthon indigaceus chevrolati*. E: *Canthon cyanellus cyanellus*.

locación de la capa se hace con una aguja de disección doblada para que la horquilla formada retenga una cantidad pequeña de pegamento; una vez colocada, si sobresale del cuerpo, se puede eliminar el exceso absorbiéndolo con la punta de un papel sanitario. Posteriormente, se deja secar la cubierta colocando a cada insecto en un recipiente por separado durante una hora. **Sitios de colocación.** El sitio de marcaje depende del comportamiento de la especie estudiada. Por ejemplo, he observado que en los Scarabaeini el pronoto es el mejor sitio de colocación (fig. 1), en cambio en las especies de la familia Silphidae lo más conveniente es colocar la marca en la parte posterior de los élitros. Se pueden usar colores que contrasten con el color del insecto, siempre y cuando esto no afecte el comportamiento de los individuos. **Sobrevivencia.** La sobrevivencia es de más de 90%. Sólo en los casos en que se aplicó mal el pegamento y cubrió parte de la cabeza hubo muertes.

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