

# *Halictophagus naulti* sp. n. (Strepsiptera: Halictophagidae), a New Species Parasitic in the Corn Leafhopper (Homoptera: Cicadellidae) from Mexico

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**ABSTRACT** A new species of Strepsiptera *Halictophagus naulti* (Halictophagidae) that is parasitic in the corn leafhopper *Dalbulus maidis* (Delong & Wolcott) from the Mexican state of Morelos is described.

**KEY WORDS** *Halictophagus naulti*, *Dalbulus maidis*, Strepsiptera, Halictophagidae, Homoptera, Cicadellidae

THE CORN LEAFHOPPER, *Dalbulus maidis* (Delong & Wolcott), is the most important leafhopper pest of maize in Latin America (Nault 1990). This species transmits three pathogens: the corn stunt spiroplasma (CSS), the maize bushy stunt phytoplasma (MBSP), and the maize rayado fino marafivirus (MRFV) (Nault 1980). The distribution of these pathogens coincides with the distribution of the corn leafhopper, which occurs throughout the southern United States (California, Florida, and Texas) to Argentina, including the Caribbean Islands (Nault 1983). In addition, *D. maidis* is found at a wide range of elevations from sea level to 3,200 m (Nault et al. 1979).

Mesoamerica (throughout central Mexico to Nicaragua) is considered the center of origin of *D. maidis*, and the 13 species of the genus *Dalbulus* have been collected from maize and its closest relatives (teosintes and gamagrasses *Tripsacum*) (Triplehorn and Nault 1985, Nault 1990, Nault and Styer 1994). *Dalbulus gramalotes* Triplehorn & Nault is the only species collected outside Mesoamerica (Nault 1990). This geographic range is not only the center of origin for *Dalbulus* spp. but also for their parasitoids (Moya-Raygoza and Trujillo-Arriaga 1993).

To date, taxa of the parasitoids of *D. maidis* have been recorded from Mesoamerica. Adults of *D. maidis* are parasitized by the fly *Eudorylas* (*Metadorylas*) *absconditus* Hardy (Diptera: Pipunculidae) in Texcoco state, Mexico (Vega et al. 1991), and by the wasp *Gonatopus bartletti* Olmi (Hymenoptera: Dryinidae) in four Mexican states: Jalisco (Moya-Raygoza and Trujillo-Arriaga 1993), Guanajuato, Mexico, and Veracruz (Vega and Barbosa 1990). In Nicaragua the eggs of *D. maidis* are parasitized by the wasps *Anagrus* sp. (Hymenoptera: Mymaridae) and *Paracentrobia* sp.

(Hymenoptera: Trichogrammatidae) (Gladstone et al. 1994). Furthermore, in Mesoamerica, *Dalbulus elimatus* (Ball) is parasitized by *E. (Metadorylas) absconditus* (Vega et al. 1991) and *Gonatopus flavipes* Olmi, whereas *D. quinquenotatus* Delong & Nault is parasitized by the dryinids *Gonatopus moyaraygozai* Olmi and *Anteon ciudadadi* Olmi (Moya-Raygoza and Trujillo-Arriaga 1993).

Here we report a new species, *Halictophagus naulti* (Strepsiptera), parasitic on *D. maidis* that was collected from maize in July 1994 from Tlaltizapán, state of Morelos, Mexico. The stylopized adults were reared individually in maize plants to obtain adult *H. naulti*, from which three males and several females were collected.

*Halictophagus* has a cosmopolitan distribution and parasitizes four families of Homoptera (Kathirithamby 1989) and six subfamilies of Cicadellidae (Freytag 1985, Kathirithamby 1992a). Strepsiptera have shown potential for controlling leafhopper pests such as *Perkinsiella vitiensis* Kirkaldy, 70% of which are parasitized by *Elenchooides perkinsi* Pierce on sugar cane in Fiji (Clausen 1972). Riek (1975) described a new species *Halictophagus irwini* parasitic in *D. distans* L. from Natal, South Africa. These results suggest that *H. naulti* might be used as biological control of *D. maidis*.

Eleven species of Strepsiptera have been described from Mexico (Table 1). Kifune and Brailovsky (1987) provided a list and keys to Strepsiptera of Mexico, and Kathirithamby (1992b) provided an up-to-date list of Strepsiptera from Mesoamerica.

## *Halictophagus naulti* sp. n.

**Adult Male (Fig. 9).** Head width, 0.34–0.36 mm.

**Maxilla.** Maxilla three times longer than mandibles (base, 0.03–0.05 mm; palpi, 0.11–0.12 mm) (Figs. 1 and 12).

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Table 1. List of Strepsiptera from México

Taxa	Location	Host
Family Corioxenidae Kinzelbach, 1971		
Subfamily Triozocerinae Kinzelbach, 1970		
Genus <i>Triozocera</i> Pierce, 1909		
<i>maxicana</i> Pierce, 1909	Veracruz*, Oaxaca	<i>Pangaeus bibineautus</i> (Say) (Hem: Cydnidae)
<i>texana</i> Pierce, 1911		
<i>tecpanensis</i> Brailovsky & Márquez, 1974	Guerrero*	Unknown
<i>vernalis</i> Kifune & Brailovsky, 1987	Puebla*: Jalisco	Unknown
Family Halictophagidae Perkins, 1905		
Subfamily Halictophaginae Perkins, 1905		
Genus <i>Halictophagus</i> Curtis, 1831		
<i>acutus</i> Bohart, 1943	Atzacapotzalco, D.F.*	<i>Draeculacephala mollipes</i> (Say) <i>D. minerva</i> Ball (Hom: Cicadellidae)
Family Elenchidae Perkins, 1905		
Subfamily Elenchinae Perkins, 1905		
Genus <i>Elenchus</i> Curtis, 1831		
<i>koebelei</i> Pierce, 1908	Northern District*	<i>Liburnia campestris</i> Van Duzee. (Hom: Delphacidae)
<i>koebelei</i> Pierce, 1908		
<i>tenicornis</i> Baumert, 1959		
<i>heidemanni</i> Pierce, 1918		
<i>heidemanni</i> Pierce, 1918		
<i>mexicanus</i> (Pierce, 1961)	Veracruz*	(Sogata) <i>Liburnai cubana</i> (Crawford) (Hom: Delphacidae)
<i>butzei</i> Brailovsky, 1981	Veracruz*	unknown
Family Myrmecolacidae Saunders, 1872		
Genus <i>Caenocholax</i> Pierce, 1909		
<i>fenyesi</i> Pierce, 1909	Veracruz; Tabasco	Unknown
Genus <i>Stichotrema</i> Hofender 1910		
<i>trilobulatum</i> Brailovsky, 1974	Galeana*, Guerrero	Unknown
syn. of <i>S. beckeri</i>		
Oliveria & Kogan, 1959		
(Kinzelbach & Pohl, 1994)		
<i>mexicanum</i> Kifune & Brailovsky, 1987	Veracruz*	Unknown
Family Stylopidae Kirby, 1813		
Genus <i>Melittostylops</i> Kinzelbach, 1971		
<i>hesparapium</i> Kinzelbach, 1971	Chihuahua*; Baja California	<i>Hesperapis rhodocera</i> (Cockerell) <i>H. leucura</i> Cockerell (Hym. Melittidae)

\*; type locality.

**Mandibles.** Mandibles do not meet in center (length of mandibles, 0.04 mm) (Fig. 10).

**Antennae.** Seven-segmented with flabellum on IIIrd-VIth segments (IIIrd flabellum, 0.22–0.23 mm; IVth flabellum, 0.19–0.22 mm; Vth flabellum, 0.10 mm; VIth flabellum, 0.11 mm) (Figs. 2 and 10).

**Thorax.** Scutum + prescutum, 0.14–0.16 mm; scutellum, 0.10 mm. Postlumbium with two long indentations, length at middle region, 0.06–0.07 mm. Postnotum very long, 0.29–0.30 mm, and as long as scutum + prescutum, scutellum and postlumbium (Fig. 4).

**Wing.** Sc, R1, and R2 prominent; R3 pale and long and a third longer than R2; R5 meets dent in margin of wing; MA two-thirds the length of CuA, CuP present. Length of wing (along its longest length), 1.05–1.25 mm (Fig. 7).

**Abdomen.** A cone-shaped projection present on VIIIth abdominal sternite which is darker in color than the rest of the sternites (Figs. 3, 5, and 11). Xth abdominal segment as long as IXth (length of VIIIth sternite, 0.07–0.09 mm; length of IXth abdominal ster-

nite, 0.09–0.10 mm; length of Xth abdominal sternite, 0.09 mm).

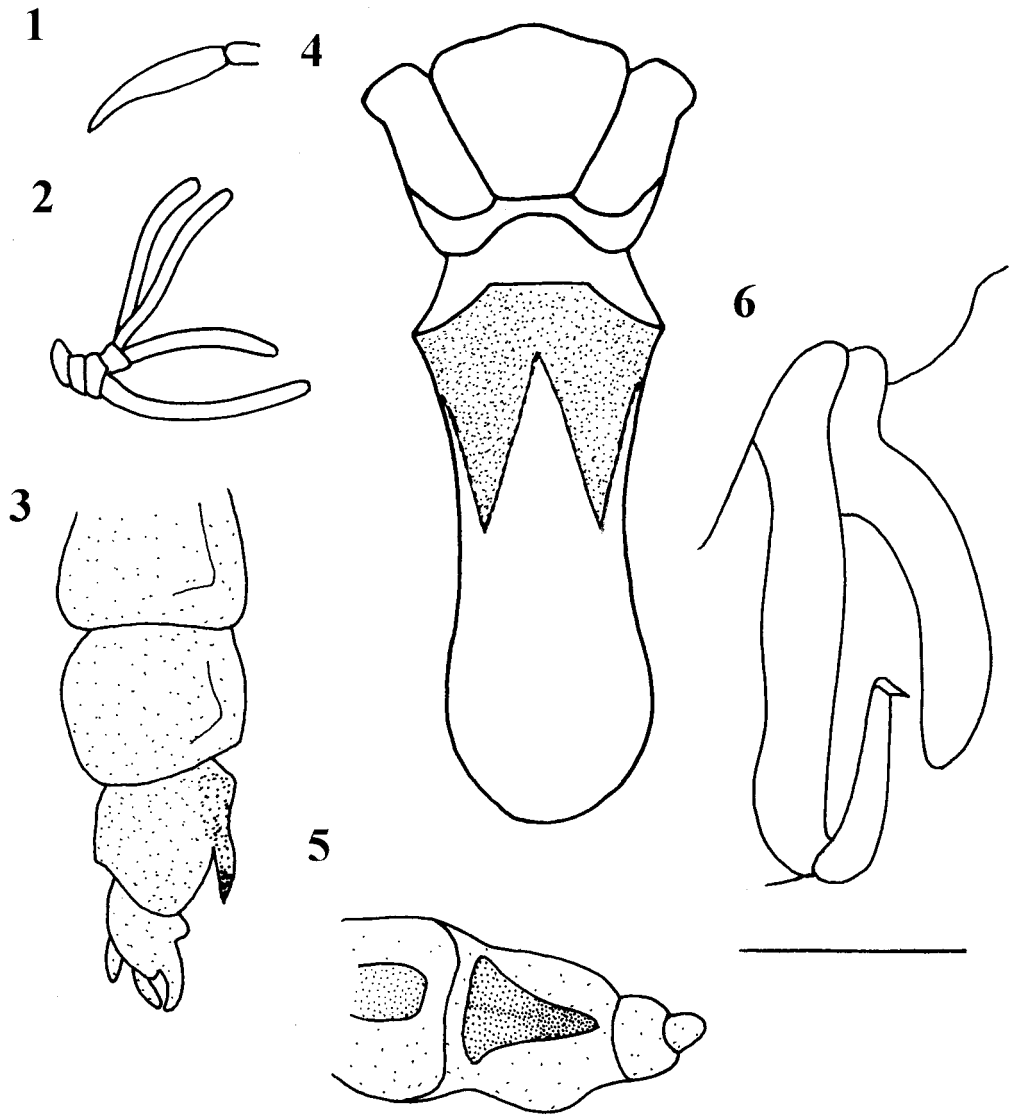
**Aedeagus.** Aedeagus with a small curved apex (Fig. 6).

**Male Cephalotheca.** Unknown.

**Female.** Pale yellow above and brown below the opening of the brood canal. The triangular sclerotized collar (within the host) (Kathirithamby 2000) is visible through the transparent host cuticle. Opening of brood canal broad with semicircular upper margin (Fig. 8).

Length of cephalothorax, 0.18–0.21 mm; width of cephalothorax, 0.16–0.17 mm; length of brood canal opening, 0.10 mm; width of opening, 0.04–0.05 mm.

**Type Material.** Holotype: ♂, Tlaltizapán, Morelos, MEXICO, 23-VII-94 (G. Moya-Raygoza and W. Styer). Paratypes: 3 ♀♀, in host, Tlaltizapán, Morelos, Mexico, 31-VII-94 (G. Moya-Raygoza and W. Styer). 1 ♂, Tlaltizapán, Morelos, Mexico, 23-VII-94 (G. Moya-Raygoza and W. Styer). 1 ♀, in host, Tlaltizapán, Morelos, Mexico, 31-VII-94 (G. Moya-Raygoza and



Figs. 1-6. (1) Maxilla. Scale bar = 0.2 mm. (2) Antennae. Scale bar = 0.2 mm. (3) Lateral view of abdominal segments. Scale bar = 0.2 mm. (4) Dorsal view of thorax. Scale bar = 0.3 mm. (5) Ventral view of VIII and IX abdominal segments. Scale bar = 0.2 mm. (6) Lateral view of IX abdominal segment with aedeagus. Scale bar = 0.2 mm.

W. Styer). All of the above are at the Hope Entomological Collections, Oxford University Museum of Natural History. 2 ♂♂, Tlaltizapán, Morelos, Mexico, 6-VII-94 (G. Moya-Raygoza and W. Styer). 1 ♀, in host, Tlaltizapán, Morelos, Mexico, 6-VII-94 (G. Moya-Raygoza and W. Styer). The last two are in the Colección Entomológica, C.U.C.B.A., Universidad de Guadalajara, Mexico.

**Etymology.** The new species is named after L. R. Nault, who has been working on *Dalbulus* for 26 years.

**Diagnosis.** The new species differs from male *H. lopesi* Oliveira and Kogan (1959) from Brazil by the shape of the apex of the aedeagus, which is only slightly curved, whereas in *H. lopesi* the apex is a smooth hook with an elongated point. It differs from

*H. barberi* (Pierce 1908) by the longer maxilla, the postnotum, which is twice as long as scutum + prescutum, scutellum, and postlumbium, whereas in *H. barberi* postnotum as long as scutum + prescutum, scutellum, and postlumbium. It differs from male *H. irwini* by the shape and structure of the antennal segments, particularly the longer flabella of the III and IV segments; by the shape and structure of the curved anterior margin of the scutellum, and the absence of the very stout, broadly based spines on the IX abdominal sternite. It differs from female *H. irwini* by the opening of the brood-canal, with its semicircular upper margin, and the collar within the host is a short triangular area, whereas in *H. irwini*

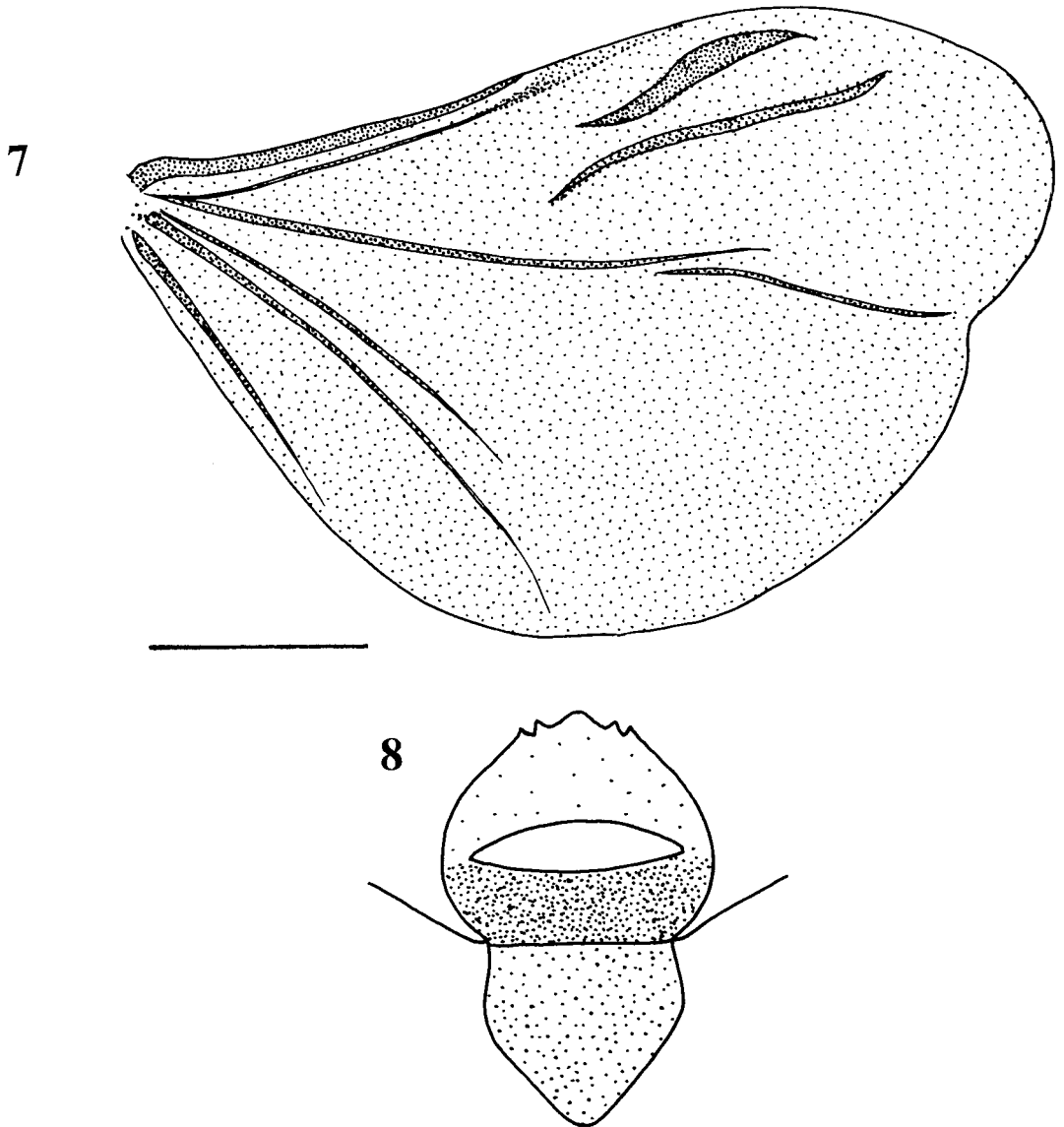


Fig. 7-8. (7) Right wing. Scale bar = 0.2 mm. (8) Cephalothorax of female. Scale bar = 0.2 mm.

the brood canal opening is subrounded and the collar is very large and extends to IV abdominal segment. It differs from male *H. acutus* Bohart (1943) by the absence of the spoon-shaped III antennal segment, and a longer indented posterior margin of postlumbium; a longer projection in the VIII abdominal segment, only slightly curved apex of the aedeagus. It differs from female *H. acutus* by a cephalothorax that is as long as it is broad (in *H. acutus* it is longer than broad) and the shape of the brood-canal opening.

The male of the new species is distinguished from all other *Halictophagus* by the triangular extension on the VIII abdominal sternite and the two long indentations in the posterior margin of the postnotum.

#### Acknowledgments

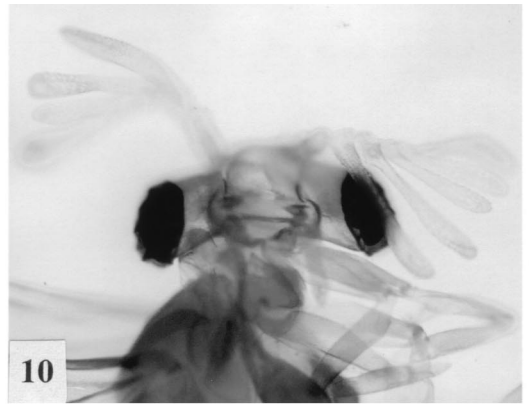
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#### References Cited

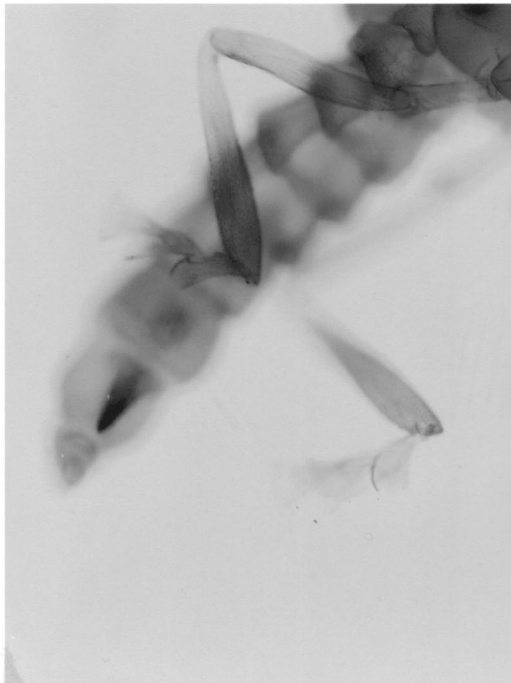
- Baumert, D. 1959. Mehrjährige Zuchten einheimischer Strepsipteren. 2. Imagines, Lebenszyklus, und Artbestimmung von *Elenchus tenuicornis* Kirby. Zool. Beitr. 4: 343-409.
- Bohart, R. M. 1943. New species of *Halictophagus* with a key to the genus in North America (Strepsiptera, Halictophagidae). Ann. Entomol. Soc. Am. 36: 341-359.
- Brailovsky, H. 1974. Una nueva especie de *Stichotrema* Hofeneder 1910 (Strepsiptera: Myrmecolacidae) para México. Rev. Soc. Mex. Hist. Nat. 35: 167-173.



9



10



11



12

Figs. 9–12. (9) Adult male. Scale bar = 400  $\mu$ m. (10) Front view of head of male.  $1 \times 16$ . (11) Ventral view of abdomen of male.  $1 \times 21$ . (12) Maxilla.  $1 \times 128$ .

- Brailovsky, H. 1981. Una nueva especie de *Elenchus* Curtis 1831 (Strepsiptera: Elenchidae) para México. An. Inst. Biol. Univ. Nac. Auton. Mex. (Zool.) 51: 373–376.
- Brailovsky, H., and M. Márquez. 1974. Una nueva especie mexicana de *Triozocera* Pierce (Strepsiptera, Mengeidae). An. Inst. Biol. Univ. Nac. Auton. Mex. (Zool.) 45: 105–110.

- Clausen, C. P. 1972. Entomophagous insects. Haffner, New York.
- Curtis, J. 1831. *Elenchus walkeri* [with comments by A. H. Haliday]. Br. Entomol. 8: 385.
- Freytag, P. H. 1985. The insect parasites of leafhoppers and related groups, pp. 423–467. In L. R. Nault and J. G.

- Rodriguez [eds.], The leafhoppers and planthoppers. Wiley, New York.
- Gladstone, S. M., A. de la Llana, R. Rios, and L. Lopez. 1994. Egg parasitoids of the corn leafhopper, *Dalbulus maidis* (Delong and Wolcott) (Homoptera: Cicadellidae) in Nicaragua maize. Proc. Entomol. Soc. Wash. 96: 143–146.
- Hofeneder, K. 1910. *Stichotrema* n.g. *Dalla-Torreanus* n. sp. Eine in einer Orthoptere lebende Strepsiptere. Zool. Anz. 36: 47–49.
- Kathirithamby, J. 1989. Review of the order Strepsiptera. Syst. Entomol. 14: 41–92.
- Kathirithamby, J. 1992a. Descriptions and biological notes of Halictophagidae (Strepsiptera) from Australia, with a checklist of the world genera and species. Invertebr. Taxon. 6: 159–196.
- Kathirithamby, J. 1992b. Strepsiptera of Panama and Mesoamerica, pp. 421–431. In D. Quintero and A. Aiello [eds.], Insects of Panama and Mesoamerica. Oxford University Press, Oxford.
- Kathirithamby, J. 2000. Morphology of the female Myrmecolacidae (Strepsiptera) including the *apron*, and an associated structure analogous to the peritrophic matrix. Zool. J. Linn. Soc. 128: 269–287.
- Kifune, T., and H. Brailovsky. 1987. Two new species of the Mexican Strepsiptera in the collection of the Instituto de Biología, Universidad Nacional Autónoma de México. Kontyu 55: 132–138.
- Kifune, T., and H. Brailovsky. 1988. Consideración sinoptica de los Estrepsipteros Mexicanos y un prospecto a investigaciones futuras. An. Inst. Biol. Univ. Nac. Auton. Mex. Zool. 58: 221–230.
- Kinzelbach, R. K. 1970. *Loania canadensis* n. gen. n. sp. und die Untergliederung der Calliphaxenidae (Insecta: Strepsiptera). Senckenb. Biol. 51: 99–107.
- Kinzelbach, R. K. 1971. Morphologische Befund an Fächerflügler und ihre phylogenetische Bedeutung (Insecta: Strepsiptera). Zoologica 119: 256pp.
- Kinzelbach, R. K., and H. Pohl. 1994. The fossil Strepsiptera (Insecta: Strepsiptera). Ann. Entomol. Soc. Am. 87: 59–70.
- Kirby, W. 1813. VI. Strepsiptera, a new order of insects proposed; and the characters of the order, with those of its genera, laid down. Trans. Linn. Soc. Lond. 11: 86–123.
- Moya-Raygoza, G., and J. Trujillo-Arriaga. 1993. Dryinid (Hym. Dryinidae) parasitoids of *Dalbulus* leafhopper (Hom.: Cicadellidae) in México. Entomophaga 38: 41–49.
- Nault, L. R. 1980. Maize bushy stunt and corn stunt: a comparison of disease symptoms, pathogen host ranges, and vectors. Phytopathology 70: 659–662.
- Nault, L. R. 1983. Origins in Mesoamerica of maize viruses and mycoplasmas and their leafhopper vectors, pp. 259–266. In R. T. Plumb and J. M. Thresh [eds.], Plant virus epidemiology: the spread and control of insect borne viruses. Blackwell, Oxford, UK.
- Nault, L. R. 1990. Evolution of an insect pest: maize and the corn leafhopper, a case study. Maydica 35: 165–175.
- Nault, L. R., and W. E. Styer. 1994. High elevation gamagrass is host to two new endemic *Dalbulus* species in Mexico (Homoptera: Cicadellidae: Deltocephalinae). Ann. Entomol. Soc. Am. 87: 257–262.
- Nault, L. R., D. T. Gordon, R. E. Gingery, O. E. Bradfute, and J. Castillo Loayza. 1979. Identification of maize viruses and mollicutes and their potential insect vectors in Peru. Phytopatology 69: 824–828.
- Oliveira, S. J., de, and M. Kogan. 1959. A contribution to the knowledge of the Brazilian Strepsiptera (Insecta). Mem. Inst. Oswaldo Cruz 57: 219–233.
- Perkins, R.C.L. 1905. Leafhoppers and their natural enemies (Part III) (Stylopidae). Bull. Hawaii. Sugar Planters' Assoc. Exp. Stn. 1: 91–111.
- Pierce, W. D. 1908. A preliminary review of the classification of the order Strepsiptera. Proc. Entomol. Soc. Wash. 9: 75–85.
- Pierce, W. D. 1909. A monographic revision of the twisted winged insects comprising the order Strepsiptera. Bull. U.S. Natl. Mus. 66: 232pp.
- Pierce, W. D. 1911. Strepsiptera. Wytzman: Genera Insectorum 121 (fasc.): 1–54.
- Pierce, W. D. 1918. The comparative morphology of the order Strepsiptera together with records and descriptions of insects. Proc. U.S. Nat. Mus. 54: 391–501.
- Pierce, W. D. 1961. A new genus and species of Strepsiptera parasitic on a leafhopper vector of a virus disease of rice and other gramineae. Ann. Entomol. Soc. Am. 54: 467–474.
- Riek, E. F. 1975. A new strepsipteran from Natal (Insecta: Halictophagidae). Ann. Natal Mus. 22: 465–469.
- Triplehorn, B. W., and L. R. Nault. 1985. Phylogenetic classification of the genus *Dalbulus* (Homoptera: Cicadellidae) and notes on the phylogeny of the Macrostelini. Ann. Entomol. Soc. Am. 78: 291–315.
- Vega, F. E., and P. Barbosa. 1990. *Gonatopus barletti* Olmi [Hymenoptera: Dryinidae] in México: a previous unreported parasitoid of the corn leafhopper *Dalbulus maidis* (Delong & Wolcott) and the Mexican corn leafhopper *Dalbulus elimatus* (Ball) [Homoptera: Cicadellidae]. Proc. Entomol. Soc. Wash. 92: 461–464.
- Vega, F. E., P. Barbosa, and A. P. Perez. 1991. *Eudorylas* (*Metadorylas*) sp. (Diptera: Pipunculidae), a previously unreported parasitoid of *Dalbulus maidis* (Delong & Wolcott) and *Dalbulus elimatus* (Ball) (Homoptera: Cicadellidae). Can. Entomol. 123: 241–242.

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