

**ERETMOCERUS HALDEMAN (HYMENOPTERA: APHELINIDAE) IMPORTED
AND RELEASED IN THE UNITED STATES FOR CONTROL OF *BEMISIA*
(*TABACI* COMPLEX) (HOMOPTERA: ALEYRODIDAE)**

GREGORY ZOLNEROWICH AND MIKE ROSE

(GZ) Department of Entomology, Texas A&M University, College Station, TX 77843, U.S.A. (e-mail: gzolner@acs.tamu.edu); (MR) Department of Entomology, Montana State University, Bozeman, MT 59717, U.S.A. (e-mail: mrose@ycsi.net).

Abstract.—A key to the species of *Eretmocerus* imported by USDA-APHIS and released in the United States for the control of *Bemisia* (*tabaci* complex) is provided. *Eretmocerus emiratus* n. sp., *E. hayati* n. sp., and *E. melanoscutus* n. sp. are described. A lectotype for *E. mundus* Mercet is designated and a redescription provided. Material labelled from Padappai, India, contained mixed forms. No formal name is assigned to this material.

Key Words: *Eretmocerus*, Aphelinidae, *Bemisia*, Aleyrodidae, biological control

Species of *Eretmocerus* Haldeman (Hymenoptera: Chalcidoidea: Aphelinidae) are being utilized in biological control programs directed against *Bemisia* (*tabaci* complex) (Homoptera: Aleyrodidae) around the world (Rose et al. 1996, Rose and Zolnerowich 1997). Rose and Zolnerowich (1997) provided a key and discussion of species of *Eretmocerus* present within the U.S. This paper, which is part of a larger study of *Eretmocerus* species of the world, provides a key and descriptions of species that attack *Bemisia* (*tabaci* complex) that were imported and released into the U.S. by the U.S. Department of Agriculture, Animal Plant Health Inspection Service Biological Control Laboratory in Mission, Texas. Although a number of foreign collections were made, and numerous laboratory cultures of exotic populations were maintained by the USDA, this paper treats only those species that were actually released into the field. Each culture initiated was assigned a unique quarantine accession number, which is reported below with the appropriate species.

Because of confusion regarding the use of the names *Bemisia tabaci* (Gennadius) A-strain, *B. tabaci* B-strain, and *B. argentifolii* Bellows and Perring on specimen labels and in the literature (Brown et al. 1995, Rosell et al. 1997), we refer to hosts from this group as *Bemisia* (*tabaci* complex). Species in the *Bemisia* (*tabaci* complex) are major agricultural pests with a wide range of plant hosts (Mound and Halsey 1978, Brown and Bird 1992). Direct and indirect damage to food, cash, and ornamental crops have been well documented (Byrne et al. 1990, Brown and Bird 1992, Perring et al. 1993).

There are currently 13 described species of *Eretmocerus* from the New World and 30 species from the Old World. Because most species of *Eretmocerus* have been reared from agricultural pests, little is known of the actual range of these species. Likewise, little is known about species found outside of agricultural settings.

All the species of *Eretmocerus* treated in this paper have only four setae on the me-

soscutum and are parasites of *Bemisia* (*tabaci* complex). In contrast, nine of the 12 species present in the U.S. have six setae present on the mesoscutum (Rose and Zolnerowich 1997) and can be readily distinguished from the species discussed here. The species already present in the U.S. with only four setae on the mesoscutum are *Eretmocerus debachi* Rose and Rosen, *E. furuhashii* Rose and Zolnerowich, and *E. rosei* Evans and Bennett. *Eretmocerus debachi* and *E. furuhashii* are parasites of the bayberry whitefly, *Parabemisia myricae* (Kuwana) and can be identified using the key provided by Rose and Zolnerowich (1997). *Eretmocerus rosei* attacks *Dialeurodes kirkaldyi* (Kotinsky) and is distinct in having the anterior pair of setae on the scutellum greatly reduced (Evans and Bennett 1996).

In addition, the pedicel of the males discussed in this paper are much darker than those found in the native species discussed in Rose and Zolnerowich (1997). This difference holds true for live, critical point-dried, and slide-mounted specimens. This very dark pedicel is a useful way to distinguish exotic males from native males in the field.

The male portion of the key is based on fuscous patterns of specimens cleared in chloral phenol and glacial acetic acid and mounted in Hoyer's. Care should be used in using the key to identify males that are mounted otherwise.

METHODS

High quality microslide mounts are necessary to correctly examine and identify species of *Eretmocerus*. Because clearing and mounting specimens in balsam removes all or most of their color, most specimens used in this study were cleared in chloral phenol and glacial acetic acid and mounted in Hoyer's medium as described by Rosen and DeBach (1979), and the cover slips were sealed with two coats of red GLPT, a nonconducting insulating varnish used in electronics (GC Electronics, Rockford, Il-

linois). When possible, type material was critical point-dried and mounted on cards or slide-mounted in balsam. Descriptions of color or pigment are given for both critical point-dried and Hoyer's-mounted specimens where appropriate. Terms and measurements follow those of Rose and Zolnerowich (1997).

Label data for holotypes are presented exactly as recorded on the specimen labels, with the data for each individual label enclosed by quotation marks and each line of the label separated by a slash. Label data for material other than holotypes are standardized. Each culture maintained by USDA-APHIS received a unique quarantine accession number, and those numbers are reported along with the label data.

The following acronyms represent institutions or individuals who are repositories for type material or are otherwise mentioned in the text: BMNH, The Natural History Museum, London, United Kingdom; MJR, personal collection of M. J. Rose; MM, Museo de Madrid, Spain; TAMU, Texas A&M University, College Station; UCR, University of California, Riverside; USNM, National Museum of Natural History, Smithsonian Institution, Washington, D.C.

KEY TO SPECIES OF *ERETMOCERUS* IMPORTED INTO THE UNITED STATES FOR CONTROL OF *BEMISIA*

- 1. Female, antenna with 2 funicular segments (as in Fig. 3) 2
- Male, antenna without funicular segments 5*
- 2(1). Scutellum completely fuscous; mesoscutum distinctly fuscous in at least the anterior half *E. melanoscutus*, n. sp.
- Scutellum not fuscous; mesoscutum not fuscous, or if fuscous areas present they are restricted to the anterior 1/3 3
- 3(2). First funicular segment short and triangular, its dorsal surface 1/3, occasionally slightly

*Note that fuscous patterns used to identify males are taken from specimens cleared in chloral phenol and glacial acetic acid and mounted in Hoyer's.

- more than $\frac{1}{3}$, the length of its ventral surface (Fig. 1) *E. emiratus*, n. sp.
- First funicular segment longer, its dorsal surface at least $\frac{1}{2}$ the length of its ventral surface (Figs. 3, 5, 7) 3
- 4(3). Ventral surface of first funicular segment slightly shorter than ventral surface of second funicular segment (Fig. 3); mesoscutum usually without fuscous areas in anterior $\frac{1}{3}$ *E. hayati*, n. sp.
- Ventral surface of first funicular segment equal in length to ventral surface of second funicular segment (Fig. 7); mesoscutum usually with fuscous areas in anterior $\frac{1}{3}$ *E. mundus*
- 5(1). Scutellum fuscous but distinctly lighter in color along lateral margins (Fig. 12), mesoscutum fuscous and usually lighter along lateral margins; forefemur with proximal $\frac{1}{4}$ clear and distal $\frac{3}{4}$ fuscous, mid- and hind femora with proximal $\frac{1}{3}$ - $\frac{1}{2}$ clear and remainder fuscous *E. hayati*, n. sp.
- Mesoscutum and scutellum evenly fuscous across their widths (Fig. 13); all femora uniformly pale amber to fuscous 6
- 6(5). Metanotum completely fuscous, occasionally lighter in lateral $\frac{1}{3}$ (Fig. 13); femora and tibiae dark fuscous, all tarsi uniformly dark *E. melanoscutus*, n. sp.
- Metanotum not completely fuscous (Figs. 11, 14); femora and tibiae not dark fuscous, tarsi not uniformly dark 6
- 7(6). Metanotum fuscous to slightly fuscous medially (Fig. 11) *E. emiratus*, n. sp.
- Metanotum clear, or lateral $\frac{1}{3}$ slightly fuscous with medial portion clear (Fig. 14) *E. mundus*

***Eretmocerus emiratus* Zolnerowich and
Rose, new species**
(Figs. 1-2, 11)

Diagnosis.—Females of *E. emiratus* can be distinguished by the extremely short and triangular first funicular segment (Fig. 1). Females are most similar to *E. melanoscutus*, which has a distinctly longer first funicular segment (Fig. 5) and a fuscous scutellum.

Males of *E. emiratus* can be recognized by the metanotum that is fuscous medially and clear laterally (Fig. 11) when mounted in Hoyer's. The most similar species, *E. melanoscutus*, differs in having the entire metanotum fuscous (Fig. 13).

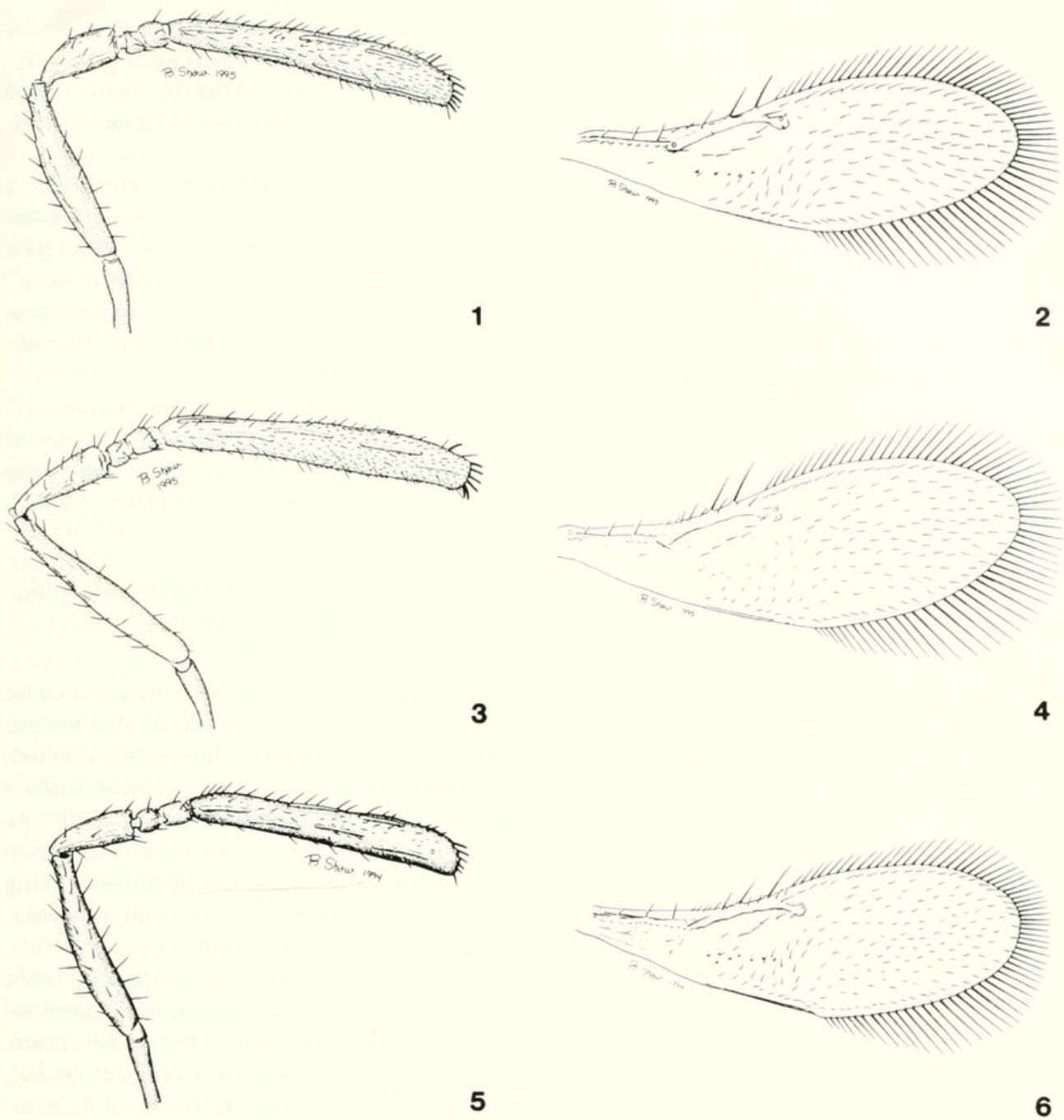
Female.—Length of critical point-dried

specimens 0.5–0.6 mm. Critical point-dried specimens with head pale yellow, vertex yellow to yellow orange. Eyes grey green, ocelli red. Antenna pale testaceous. Septa forming reticulate sculpture of mesoscutum fuscous, length of fuscous area varying from restricted to anterior margin to covering anterior $\frac{1}{3}$ of mesoscutum, cells between septa, remainder of dorsal mesosoma, and dorsal gaster yellow orange; pronotum, mesopleuron, and remainder of gaster pale yellow. Each leg with coxa, femur, and tibia pale testaceous, tarsi slightly darker, last tarsal segment darkest.

Specimens mounted in Hoyer's with head amber. Eyes red. Radicle pale amber, scape pale amber, or fuscous at distal end, pedicel fuscous, funicular segments slightly fuscous, club fuscous with multiporous plate sensilla darker. Mesoscutum usually fuscous along anterior margin, occasionally clear; parapsis and axillae clear. Scutellum usually fuscous along anterior and posterior margins, occasionally clear. Metasoma clear. Tegula fuscous. Foretarsus darker than tibia, last tarsal segment of mid- and hind legs fuscous. Forewing with costal cell and venation slightly fuscous and frenal fold fuscous. Hind wing venation fuscous.

Face and occiput with transverse substrigulate sculpture, interscrobal area vertically substrigulate. Antenna (Fig. 1) with radicle $3.0\text{--}5.1\times$ as long as wide; scape $4.0\text{--}6.5\times$ as long as wide, $2.2\text{--}3.1\times$ length of radicle, $2.0\text{--}2.7\times$ length of pedicel, $0.64\text{--}0.76\times$ length of club; pedicel $2.0\text{--}2.62\times$ as long as wide, $1.0\text{--}1.4\times$ length of radicle; $0.36\text{--}0.48\times$ length of scape, $0.26\text{--}0.31\times$ length of club. First funicular segment $0.58\text{--}0.81\times$ as wide as long; second funicular segment $0.76\text{--}1.17\times$ as long as wide. Club $5.3\text{--}6.6\times$ as long as wide, $1.3\text{--}1.6\times$ length of scape, $3.2\text{--}3.9\times$ length of pedicel.

Mesoscutum with 4 setae and reticulate sculpture that becomes elongate laterally, and with substrigulate sculpture postero-medially. Parapsis with 2 setae and substrigulate sculpture; axilla with 1 seta and substrigulate sculpture. Scutellum with elon-



Figs. 1–6. 1–2, *Eretmocerus emiratus*. 1, Female antenna. 2, Female forewing. 3–4, *E. hayati*. 3, Female antenna. 4, Female forewing. 5–6, *E. melanoscutus*. 5, Female antenna. 6, Female forewing.

gate reticulate sculpture that becomes substrigulate medially and with 4 setae and 2 placoid sensilla. Propodeum with substrigulate sculpture. Endophragma extending to gastral tergite II.

Forewing (Fig. 2) 2.9–3.4× as long as wide at width I, 2.6–3.1× as long as maximum width of disc. Longest anterior alary fringe 0.25–0.35× width of disc, longest posterior alary fringe 0.50–0.66× width of

disc. Base of wing usually with 1 seta which may occasionally be absent, distal portion of costal cell usually with 2 setae. Marginal vein with 3 long setae, 6–9 setae between marginal vein and linea calva. Linea calva with a line of 5–7 tubercles on ventral surface of wing near posterior end of linea calva; a group of 13–18 setae including those forming distal edge of linea calva point toward anterior margin of wing,

remaining 75–110 setae in disc point to distal apex of wing.

Hind wing $7.5\text{--}8.3\times$ as long as wide.

Gastral tergite I with substrigulate sculpture anteriorly and anterolaterally; lateral margins of tergites coriaceous with stippling; gastral tergites I–VI usually with paired setae as follows: 1, 1, 1, 1, 2, 1 but can be 1, 1, 1, 1, 1–2, 1. Syntergum with 4 setae.

Ovipositor slightly exerted, $0.88\text{--}1.18\times$ length of club, $1.2\text{--}1.5\times$ length of scape, $1.0\text{--}1.2\times$ length of midtibia.

Male.—Length of specimens mounted in Hoyer's $0.55\text{--}0.65$ mm. Specimens mounted in Hoyer's (Fig. 11) with head amber to orange. Eyes dark red. Radicle and scape pale amber, scape occasionally fuscous at distal end, pedicel dark fuscous, club slightly fuscous, multiporous plate sensilla dark fuscous. Pronotum fuscous. Mesoscutum fuscous, occasionally darker in the anterior half or along the anterior margin, septa forming sculpture darker than cells; parapsis and axillae clear. Scutellum fuscous, darkest along anterior and posterior margins, septa forming sculpture darker than cells. Metanotum slightly fuscous medially. Propodeum fuscous between spiracles, with a clear area anteromedially. Gastral tergites I, III–VI, and syntergum slightly fuscous, gastral tergite II slightly fuscous medially. Aedeagus slightly fuscous. Each leg slightly fuscous from femur to end of last tarsal segment, tarsi darker than tibiae, last tarsal segment darkest. Tegula fuscous. Forewing with base, costal cell, venation, and frenal fold amber fuscous. Hind wing with base of vein slightly fuscous.

Host.—Reared from *Bemisia (tabaci)* complex) on okra, *Abelmoschus esculentus* (Malvaceae).

Discussion.—This species has been released in Arizona, California, and Texas. In the Middle East, *Eretmocerus emiratus* is similar to *E. roseni* Gerling. Both species have the first funicular segment reduced, but *E. roseni* has the club $4\text{--}4.5\times$ as long

as wide and is a parasite of *Acaudaleyrodes citri* (Priesner and Hosni) (Gerling 1972).

Etymology.—Named for the United Arab Emirates, the country where it was originally collected.

Holotype.—♀ mounted in balsam on a slide labelled, "original material:/United Arab Emirates/Ras al Khaimah/xi.11.1995/Porter & Romadan/ex: Bemisia/on: okra" "USA: Texas/Hidalgo Co./Mission Biological/Control Laboratory/M95104/Lab culture." Deposited in USNM.

Paratypes.—Same data as holotype (1 ♀ mounted in balsam, 7 ♀ and 17 ♂ mounted in Hoyer's, 9 ♀ card-mounted). Paratypes deposited with BMNH, MJR, TAMU, USNM.

***Eretmocerus hayati* Zolnerowich and
Rose, new species**
(Figs. 3–4, 12)

Diagnosis.—Females of *E. hayati* can be distinguished by the length of the ventral surface of the first funicular segment, which is slightly shorter than the ventral surface of the second funicular segment (Fig. 3). Females of *E. hayati* are most similar to those of *E. mundus*, which differ in having the ventral surfaces of the funicular segments equal in length (Fig. 7).

Males of *E. hayati* can be distinguished by the clear areas in the lateral portions of the scutellum, and usually the mesoscutum, of specimens mounted in Hoyer's (Fig. 12). Males are most similar to those of *E. mundus*, which differ in having the mesoscutum and scutellum evenly colored across their widths (Fig. 14).

Female.—Length of critical point-dried specimens $0.48\text{--}0.60$ mm. Critical point-dried specimens with head pale yellow, vertex orange yellow. Eyes grey green, ocelli red. Antenna with scape testaceous, darker at the extreme apex; flagellum darker than scape. Mesoscutum usually orange yellow, occasionally with septa forming reticulate sculpture in anterior $\frac{1}{3}$ fuscous with cells between septa orange yellow; remainder of dorsal mesosoma and gaster yellow orange.

Lateral areas of mesosoma yellow, gaster yellow or yellow orange laterally. Legs with coxae, femora, and tibiae testaceous, tarsi testaceous or slightly darker than tibiae, last tarsal segment darkest.

Specimens mounted in Hoyer's with head amber. Eyes red. Radicle pale amber to slightly fuscous, scape pale amber to slightly fuscous, darker along apex of ventral edge, pedicel amber to slightly fuscous, funicular segments amber or slightly fuscous, club fuscous to slightly fuscous with multiporous plate sensilla darker. Mesoscutum, axillae, parapsis, scutellum, metanotum, propodeum, and metasoma clear, or anterior margin of mesoscutum slightly fuscous. Forefemur and tibia slightly fuscous, foretarsus fuscous and darker than tibia. Mid- and hind femora and tibiae slightly fuscous, mid- and hind tarsi 1–3 clear to slightly fuscous, last tarsal segment fuscous and darker than preceding segments. Tegula slightly fuscous. Forewing faintly fuscous from base to distal end of stigmal vein and frenal fold, costal cell slightly fuscous, venation and frenal fold fuscous. Hind wing venation slightly fuscous.

Face and occiput with transverse substrigulate sculpture, interscrobal area vertically substrigulate. Antenna (Fig. 3) with radicle $2.9\text{--}5.5\times$ as long as wide; scape $4.4\text{--}6.8\times$ as long as wide, $2.2\text{--}3.2\times$ length of radicle, $1.9\text{--}2.4\times$ length of pedicel, $0.60\text{--}0.75\times$ length of club; pedicel $2.3\text{--}3.5\times$ as long as wide, $1.0\text{--}1.5\times$ length of radicle, $0.4\text{--}0.5\times$ length of scape, $0.29\text{--}0.35\times$ length of club. First funicular segment $0.76\text{--}1.2\times$ as wide as long; second funicular segment $0.78\text{--}1.34\times$ as long as wide. Club $5.6\text{--}7.0\times$ as long as wide, $1.3\text{--}1.6\times$ length of scape, $2.7\text{--}3.4\times$ length of pedicel.

Mesoscutum with 4 setae, anterior half with reticulate sculpture, laterally and posteriorly with elongate reticulate to substrigulate sculpture. Parapsis with 2 setae and substrigulate sculpture; axilla with 1 seta and substrigulate sculpture. Scutellum with elongate reticulate to substrigulate sculpture and with 4 setae and 2 placoid sensilla. Pro-

podeum with substrigulate sculpture. Endophragma extending to posterior half of gastral tergite II or anterior half of gastral tergite III.

Forewing (Fig. 4) $3\text{--}3.7\times$ as long as wide at width I, $2.7\text{--}3.4\times$ as long as maximum width of disc. Longest anterior alary fringe $0.25\text{--}0.45\times$ width of disc, longest posterior alary fringe $0.53\text{--}0.78\times$ width of disc. Base of wing usually with 1 seta which may occasionally be absent, distal portion of costal cell usually with 2–3 setae. Marginal vein with 3 long setae, 5–9 setae between marginal vein and linea calva. Linea calva with 5–6 tubercles on ventral surface of wing near posterior end of linea calva; a group of 13–22 setae including those forming distal edge of linea calva point toward anterior margin of wing, remaining 95–120 setae in disc point to distal apex of wing.

Hind wing $7.8\text{--}10.5\times$ as long as wide.

Gastral tergite I with substrigulate sculpture anteriorly, laterally with reticulate to substrigulate sculpture; lateral margins of tergites faintly coriaceous with stippling; gastral tergites I–VI with paired setae as follows: 1, 1, 1, 1, 1–2, 1. Syntergum with 4 setae.

Ovipositor exerted, $0.79\text{--}1.0\times$ length of club, $1.0\text{--}1.5\times$ length of scape, $0.76\text{--}1.1\times$ length of midtibia.

Male.—Length of critical point-dried specimens $0.43\text{--}0.58$ mm. Critical point-dried specimens with head pale yellow, vertex orange yellow. Eyes grey green, ocelli red. Scape pale yellow to testaceous in proximal $\frac{2}{3}$, becoming more fuscous in distal $\frac{1}{3}$, pedicel dark fuscous, club testaceous. Pronotum dorsally and laterally fuscous, remainder pale yellow. Mesoscutum varying from fuscous in the anterior $\frac{1}{3}$ with remainder orange yellow to entirely dark brown, or with septa forming sculpture fuscous and cells between septa orange. Axillae and parapsis orange. Scutellum entirely fuscous, or with septa forming sculpture fuscous and cells between septa orange. Metanotum orange, or orange medially and fuscous lat-

erally. Propodeum orange medially, lateral $\frac{1}{3}$ fuscous. Gastral tergites orange dorsally, medially fuscous orange. Mesosoma and gaster pale yellow laterally. Legs with coxae testaceous, forefemur with proximal $\frac{1}{4}$ testaceous and remainder slightly fuscous, mid- and hind femora with proximal $\frac{1}{2}$ testaceous and remainder slightly fuscous, tibiae slightly fuscous, tarsi fuscous.

Specimens mounted in Hoyer's (Fig. 12) with head pale amber. Eyes red. Radicle slightly fuscous, scape slightly fuscous, becoming darker at the apex, margins of apex dark, pedicel dark fuscous, club slightly fuscous, multiporous plate sensilla darker than club. Pronotum fuscous to slightly fuscous. Mesoscutum fuscous, darker in anterior half and along the anterior margin, septa forming sculpture darker than cells, usually lighter along lateral margins; parapsis and axillae clear. Scutellum fuscous, darkest along anterior and posterior margins, septa forming sculpture darker than cells, lighter along lateral margins. Metanotum slightly fuscous, or only slightly fuscous in lateral $\frac{1}{5}$ – $\frac{1}{3}$. Propodeum fuscous between spiracles, with a clear area medially. Gastral tergites I–IV slightly fuscous medially. Aedeagus slightly fuscous. Foreleg with distal $\frac{3}{4}$ of femur fuscous, tibia and tarsi slightly darker than femur, with last tarsal segment darkest. Mid- and hind legs with distal $\frac{1}{3}$ – $\frac{1}{2}$ of femora slightly fuscous, tibiae fuscous and darker than femora, tarsi fuscous and occasionally darker than tibiae, with last tarsal segment darkest. Tegula fuscous. Forewing slightly infusate from base to distal end of stigmal vein and frenal fold, costal cell, venation, and frenal fold fuscous. Hind wing with venation fuscous.

Host.—Reared from *Bemisia (tabaci) complex* on *Solanum melongena*, eggplant (Solanaceae).

Discussion.—This species has been released in Arizona, California, and Texas.

Eretmocer *hayati* is similar to *E. longipilus* Khan and Shafee, an Indian species which has similar antennae. *Eretmocer* *longipilus* differs in having an extremely

elongate posterior alary fringe that is nearly as long as the width of the forewing, and the shape of the forewing is different (Khan and Shafee 1980).

Etymology.—Named in honor of Dr. M. Hayat of the Aligarh Muslim University, India.

Holotype.—♀ mounted in balsam on a slide labelled, "original material/INDIA: Thirumala/20.xii.1992/Kirk & Lacey/ex: *Bemisia tabaci*/on: *Solanum melongena*" "USA: Texas/Hidalgo Co./Mission Biological/Control Laboratory/M93005 Lab culture." Deposited in USNM.

Paratypes.—Same data as holotype (4 ♀, 4 ♂ mounted in balsam, 7 ♀ card-mounted); Pakistan: Punjab, Multan, 11.iv.1995, Kirk & Akey, *Bemisia* on eggplant (*Solanum melongena*), M95012 (29 ♀, 28 ♂ slide-mounted, 20 ♀, 13 ♂ card-mounted). Paratypes deposited with BMNH, MJR, UCR, TAMU, USNM.

Other specimens examined.—USA: Texas, Hidalgo Co., Mission Biological Control Laboratory, M93005 Lab culture. INDIA: Thirumala, 20.xii.1992, *Bemisia tabaci* on *Solanum melongena* (28 ♀, 5 ♂); M93005, 23.xii.1992 (5 ♀, 1 ♂); M93005, 15.xii.1993 (15 ♀, 2 ♂); M93005, 3.x.1994 (7 ♀, 25 ♂). PAKISTAN: Punjab, Multan, 18.iv.1995, Kirk & Akey, M95012 (10 ♀, 7 ♂), Punjab, Multan, 11.xi.1995, Kirk & Lacey, M95105 (17 ♀, 10 ♂).

***Eretmocer* *melanoscutus* Zolnerowich and Rose, new species**
(Figs. 5–6, 13)

Diagnosis.—Females of *E. melanoscutus* can be distinguished by the fuscous mesoscutum and scutellum, and the first funicular segment that is shorter than the second (Fig. 5). *Eretmocer* *mundus* is most similar but does not have a fuscous scutellum and the ventral surface of the first funicular segment is equal in length to the ventral surface of the second funicular segment (Fig. 7).

Males of *E. melanoscutus* are distinguished by the completely fuscous meta-

notum of specimens mounted in Hoyer's (Fig. 13). It is most similar to *E. emiratus*, which has the lateral portions of the metanotum not fuscous (Fig. 11).

Female.—Length of specimens mounted in Hoyer's 0.57–0.73 mm. Specimens mounted in Hoyer's with head amber. Eyes red. Radicle, scape, and pedicel slightly fuscous, funicular segments clear, much paler than pedicel and club, club fuscous with multiporous plate sensilla darker. Anterior half of mesoscutum fuscous, darkest along anterior margin, septa forming sculpture darker than cells between septa; parapsis and axillae clear. Scutellum fuscous, darkest along anterior and posterior margins, septa forming sculpture darker than cells between septa. Propodeum with lateral margins slightly fuscous. Tegula fuscous. Foretarsus darker than remainder of foreleg, last tarsal segment of mid- and hind legs slightly fuscous. Forewing infusate from base to distal end of stigmal vein and frenal fold, remainder hyaline, venation and frenal fold fuscous. Hind wing venation fuscous.

Face and occiput with transverse substrigulate sculpture, interscrobal area vertically substrigulate. Antenna (Fig. 5) with radicle $2.8\text{--}4.3\times$ as long as wide; scape $4.5\text{--}6.7\times$ as long as wide, $2.2\text{--}3.2\times$ length of radicle, $2.0\text{--}2.6\times$ length of pedicel, $0.6\text{--}0.7\times$ length of club; pedicel $1.9\text{--}2.8\times$ as long as wide, $0.9\text{--}1.3\times$ length of radicle, $0.37\text{--}0.50\times$ length of scape, $0.24\text{--}0.35\times$ length of club. First funicular segment $0.7\text{--}1.0\times$ as wide as long; second funicular segment $0.85\text{--}1.20\times$ as long as wide. Club $5.1\text{--}6.8\times$ as long as wide, $1.4\text{--}1.6\times$ length of scape, $2.9\text{--}4.2\times$ length of pedicel.

Mesoscutum with 4 setae, anterior half with reticulate sculpture, remainder with elongate reticulate sculpture. Parapsis with 2 setae and substrigulate sculpture; axilla with 1 seta and substrigulate sculpture. Scutellum with elongate reticulate sculpture and with 4 setae and 2 placoid sensilla. Propodeum with substrigulate sculpture. Endophragma extending to posterior half of gastral tergite II.

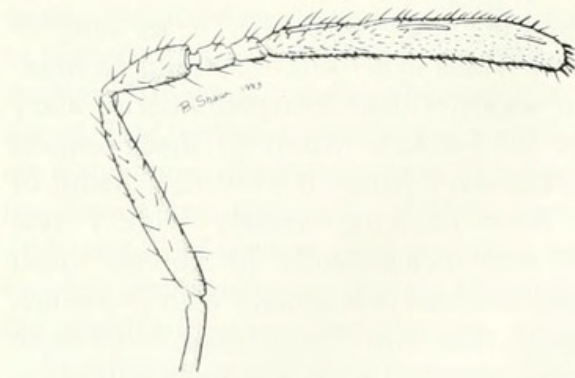
Forewing (Fig. 6) $3.1\text{--}3.7\times$ as long as wide at width I, $2.7\text{--}3.2\times$ as long as maximum width of disc. Longest anterior alary fringe $0.21\text{--}0.43\times$ width of disc, longest posterior alary fringe $0.43\text{--}0.72\times$ width of disc. Base of wing usually with 1 seta which may occasionally be absent, distal portion of costal cell usually with 1–5 setae. Marginal vein with 3 long setae, 4–10 setae between marginal vein and linea calva. Linea calva with a line of 5–9 tubercles on ventral surface of wing near posterior end of linea calva; a group of 14–27 setae including those forming distal edge of linea calva point toward anterior margin of wing, remaining 68–123 setae in disc point to distal apex of wing.

Hind wing $7.7\text{--}9.2\times$ as long as wide.

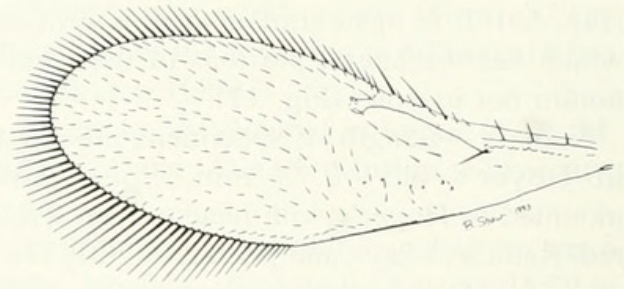
Gastral tergite I with substrigulate sculpture medially that becomes reticulate to substrigulate anterolaterally; lateral margins of tergites faintly coriaceous with stippling; gastral tergites I–VI usually with paired setae as follows: 1, 1, 1, 1, 2, 1, but can be 1, 1, 1, 2, 2, 1. Syntergum with 4 setae.

Ovipositor slightly exserted, $0.87\text{--}1.0\times$ length of club, $1.24\text{--}1.6\times$ length of scape, $1.16\text{--}1.35\times$ length of midtibia.

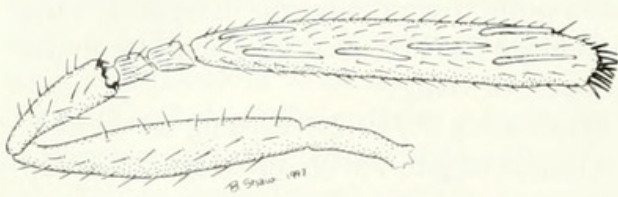
Male.—Length of specimens mounted in Hoyer's 0.53–0.62 mm. Specimens mounted in Hoyer's (Fig. 13) with head amber. Eyes red. Radicle and scape fuscous, lighter than pedicel, pedicel dark fuscous, club fuscous, multiporous plate sensilla darker. Pronotum fuscous. Mesoscutum fuscous, darker along anterior margin, septa forming sculpture darker than cells; parapsis and axillae clear. Scutellum fuscous, darkest along anterior and posterior margins. Metanotum fuscous, occasionally lighter in lateral $\frac{1}{2}$. Propodeum fuscous, lighter lateral to spiracles and with a clear area medially. Gastral tergites slightly fuscous. Aedeagus slightly fuscous. Coxae and trochanters slightly fuscous, remainder of legs uniformly fuscous and much darker than coxae and trochanters. Tegula fuscous. Forewing slightly infusate from base to distal end of stigmal vein and frenal fold, costal cell, venation,



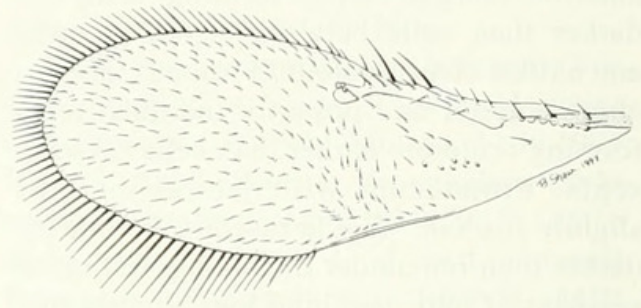
7



8



9



10

Figs. 7–10. *Eretmocerus mundus*. 7, Female antenna. 8, Female forewing. 9, Lectotype female, antenna. 10, Lectotype female, forewing.

and frenal fold fuscous. Hind wing with base and venation slightly fuscous.

Host.—Reared from *Bemisia* (*tabaci* complex) on *Chromolaena odorata* (Asteraceae), *Cucurbita moschata* (Cucurbitaceae), and *Xanthium* (Asteraceae).

Discussion.—This species has been released in Arizona, California, and Texas.

Etymology.—A combination of *melano* and *scutum*, denoting the unique fuscous scutellum found in females.

Holotype.—♀ mounted in Hoyer's on a slide labelled, "Loc THAILAND:/Chiang Mai/Date III.17.1994/Host Bemisia/tabaci/Det/19/On Chromalaena [sic]/odorata" "Name Eretmocerus/♀/Sp 1/Det/19/Coll Lacey & Kirk/No. M94036/Corr." Deposited in USNM.

Paratypes.—THAILAND: same data as holotype (6 ♀, 11 ♂). Paratypes deposited with BMNH, MJR, TAMU, USNM.

Other specimens examined.—THAILAND: Chiang Dao, III.15.1994, *Bemisia*

tabaci on *Xanthium*, M94033 (3 ♀, 2 ♂); Chiang Mai, XII.8.1994, J. Goolsby, *Bemisia tabaci* on *Chromolaena odorata*, M94036 lab culture (17 ♀); Nonthabur, Sai Noi, Klong Hai Roi, III.9.1994, Lacey & Kirk, *Bemisia tabaci* on *Cucurbita moschata*, M94023 lab culture (8 ♀, 7 ♂); Pang Hang, III.15.1994, Lacey & Kirk, *Bemisia tabaci* on *Xanthium*, M94032 (2 ♀); Pisenaroh, III.12.1994, Lacey & Kirk, *Bemisia tabaci* on *Cucurbita moschata*, M94027 (3 ♀, 1 ♂).

Eretmocerus mundus Mercet
(Figs. 7–10, 14)

Eretmocerus mundus Mercet, 1931: 200.
[MM, type examined].

Type material.—Lectotype here designated, ♀ mounted in Hoyer's on a slide labelled, "Name Eretmocerus/mundus Merc./Remount ♀ tipo/Rose 1997" "Loc Beas de Segura/(Jaen) La Mesa/Date 19" "Eret-

mocer/mundus Mercet, 1931/LECTO-TYPE/det. G. Zolnerowich." Remounted from a slide labelled, "MUSEO DE MADRID/LAB. DE ENTOMOL./Eretmocer/mundus Merc./♀ tipo/Beas de Segura/(Jaen) La Mesa."

Diagnosis.—Females of *E. mundus* can be distinguished by the ventral surface of the first funicular segment being equal in length to the ventral surface of the second funicular segment (Fig. 7). Females of *E. mundus* are most similar to those of *E. hayati*, which differ in having the ventral surface of the first funicular segment shorter than the ventral surface of the second funicular segment (Fig. 3).

Males of *E. mundus* are distinguished by the metanotum which is not fuscous, or only slightly fuscous laterally (Fig. 14). Males are most similar to those of *E. hayati*, which differ in having clear lateral areas on the scutellum and usually on the mesoscutum, and a slightly fuscous metanotum (Fig. 12).

Female.—Length of critical point-dried specimens 0.46–0.61 mm. Critical point-dried specimens with head yellow, vertex orange yellow. Eyes grey green, ocelli red. Antenna testaceous, scape usually darker at extreme apex. Septa forming reticulate sculpture of mesoscutum fuscous, length of fuscous area varying from restricted to anterior margin to covering anterior $\frac{1}{3}$ of mesoscutum, cells between septa, remainder of dorsal mesosoma, and dorsal gaster orange yellow; lateral areas of mesosoma and gaster pale yellow. Legs with coxae, femora, and tibiae testaceous, tarsi slightly darker than tibiae, last tarsal segment darkest.

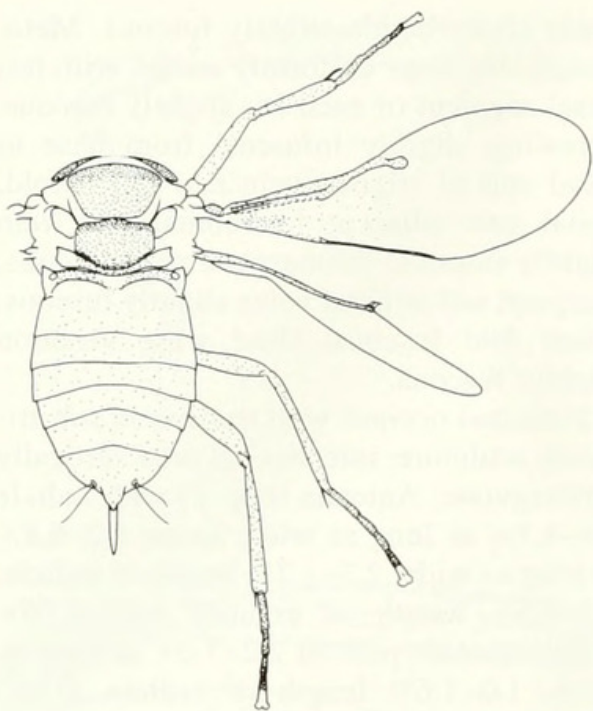
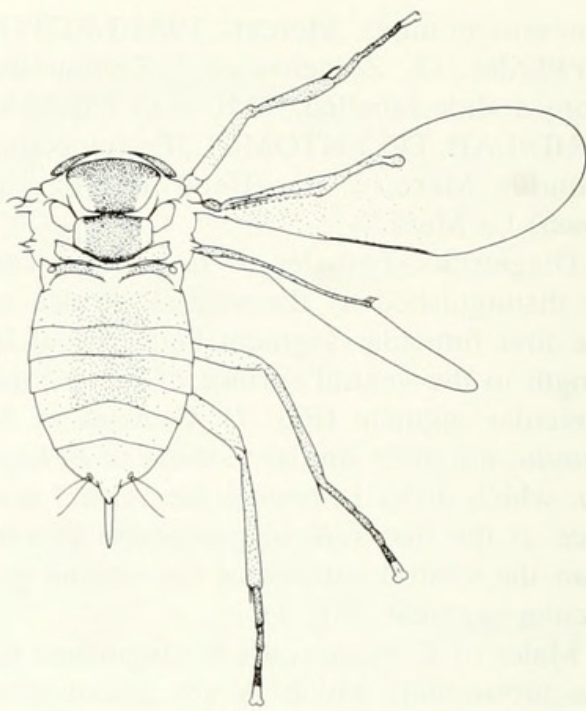
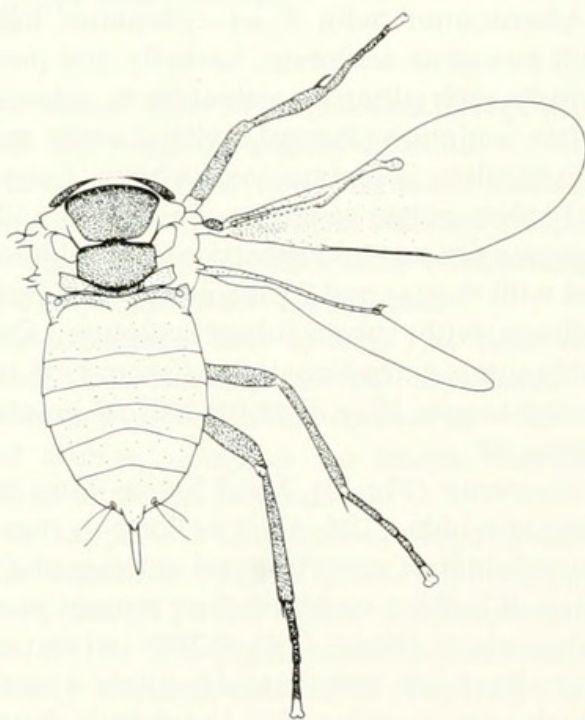
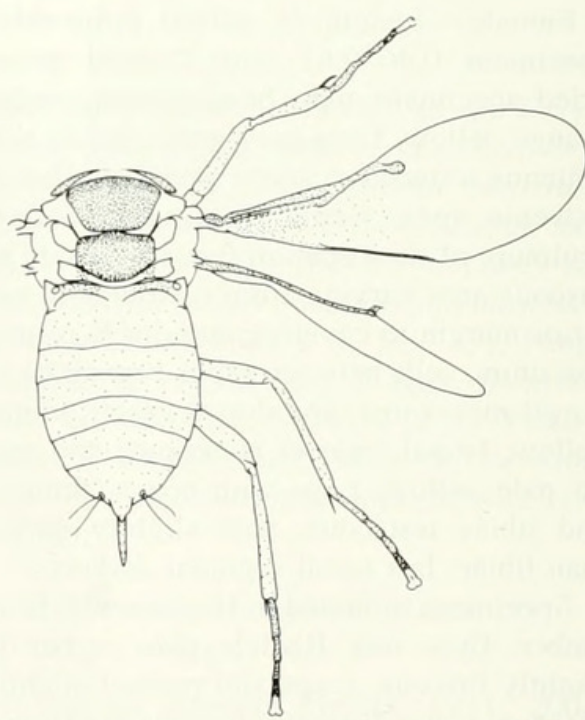
Specimens mounted in Hoyer's with head amber. Eyes red. Radicle pale amber to slightly fuscous, scape and pedicel slightly fuscous, scape distinctly fuscous at extreme apex, funicular segments clear to slightly fuscous and less dark than pedicel or club, club fuscous with multiporous plate sensilla darker than club. Mesoscutum clear, or anterior margin slightly fuscous. Parapsis, axillae, scutellum, metanotum, and propo-

deum clear. Tegula slightly fuscous. Mesosoma clear. Legs uniformly amber, with last tarsal segment of each leg slightly fuscous. Forewing slightly infusate from base to distal end of stigmal vein and frenal fold, costal cell adjacent to submarginal vein slightly fuscous, submarginal vein fuscous, marginal and stigmal veins slightly fuscous, frenal fold fuscous. Hind wing venation slightly fuscous.

Face and occiput with transverse substrigulate sculpture, interscrobular area vertically substrigulate. Antenna (Fig. 7) with radicle $2.6\text{--}4.7\times$ as long as wide; scape $5.2\text{--}6.8\times$ as long as wide, $2.3\text{--}3.7\times$ length of radicle, $2.0\text{--}2.5\times$ length of pedicel, $0.62\text{--}0.76\times$ length of club; pedicel $2.2\text{--}3.0\times$ as long as wide, $1.0\text{--}1.6\times$ length of radicle, $0.40\text{--}0.48\times$ length of scape, $0.26\text{--}0.35\times$ length of club. First funicular segment $0.84\text{--}1.3\times$ as wide as long; second funicular segment $0.93\text{--}1.4\times$ as long as wide. Club $5.7\text{--}7.4\times$ as long as wide, $1.3\text{--}1.6\times$ length of scape, $2.85\text{--}3.85\times$ length of pedicel.

Mesoscutum with 4 setae, anterior half with reticulate sculpture, laterally and posteriorly with elongate reticulate to substrigulate sculpture. Parapsis with 2 setae and substrigulate sculpture; axilla with 1 seta and substrigulate sculpture. Scutellum with elongate reticulate to substrigulate sculpture and with 4 setae and 2 placoid sensilla. Propodeum with substrigulate sculpture. Endophragma extending to posterior half of gastral tergite II or anterior half of gastral tergite III.

Forewing (Fig. 8) $3.0\text{--}3.5\times$ as long as wide at width I, $2.6\text{--}3.2\times$ as long as maximum width of disc. Longest anterior alary fringe $0.2\text{--}0.4\times$ width of disc, longest posterior alary fringe $0.43\text{--}0.70\times$ width of disc. Base of wing usually with 1 seta which may occasionally be absent, distal portion of costal cell usually with 2–3, rarely 4, setae. Marginal vein with 3, rarely 4 long setae, 5–7 setae, occasionally 8–10, between marginal vein and lineae calva. Lineae calva with 5–9 tubercles on ventral surface of wing near posterior end of lineae cal-

**11****12****13****14**

Figs. 11-14. Male habitus as mounted in Hoyer's. 11, *Eretmocerus emiratus*. 12, *E. hayati*. 13, *E. melanoscutus*. 14, *E. mundus*.

va; a group of 11–24 setae including those forming distal edge of linea calva point toward anterior margin of wing, remaining 80–122 setae in disc point to distal apex of wing.

Hind wing $6.3\text{--}8.9\times$ as long as wide.

Gastral tergite I with substrigulate sculpture anteriorly, laterally with reticulate to substrigulate sculpture; lateral margins of tergites faintly coriaceous with stippling; gastral tergites I–VI usually with paired setae as follows: 1, 1, 1, 1, 1–2, 1. Syntergum with 4 setae.

Ovipositor slightly exserted, $0.8\text{--}1.0\times$ length of club, $1.14\text{--}1.5\times$ length of scape, $0.95\text{--}1.3\times$ length of midtibia.

Male.—Length of critical point-dried specimens $0.45\text{--}0.59$ mm. Critical point-dried specimens with head pale yellow, vertex orange. Eyes grey green, ocelli red. Scape yellow testaceous in proximal $\frac{2}{3}$, becoming darker in distal $\frac{1}{3}$, pedicel dark fuscous, club testaceous. Pronotum dorsally and laterally fuscous, remainder pale yellow. Mesoscutum and scutellum varying from entirely dark brown to slightly fuscous, or with septa forming sculpture dark brown and cells between septa orange. Axillae and parapsis orange, metanotum orange medially and fuscous orange in lateral $\frac{1}{4}\text{--}\frac{1}{3}$, propodeum fuscous orange between spiracles and pale yellow lateral to spiracles. Gastral tergites fuscous orange. Mesosoma yellow laterally, gaster orange yellow laterally. Each leg with coxa, femur, and tibia testaceous, tarsi slightly darker than tibia, last tarsal segment darkest.

Specimens mounted in Hoyer's (Fig. 14) with head amber. Eyes red. Radicle clear, scape clear, slightly fuscous at extreme apex, pedicel dark fuscous, club fuscous, multiporous plate sensilla darker. Pronotum slightly fuscous. Mesoscutum fuscous to slightly fuscous, darker along anterior margin, septa forming sculpture darker than cells; parapsis and axillae clear. Scutellum fuscous to slightly fuscous, darkest along anterior and posterior margins, septa forming sculpture darker than cells. Metanotum

clear or lateral $\frac{1}{3}$ fuscous with medial portion clear. Propodeum clear, or slightly fuscous between spiracles and clear medially. Gastral tergites slightly fuscous. Aedeagus fuscous. Femora, tibiae, and tarsi pale amber or slightly fuscous, tarsi slightly darker than tibiae, last tarsal segment darkest. Tegula fuscous. Forewing with base, costal cell, venation, and frenal fold fuscous. Hind wing with venation fuscous.

Host.—Reared from *Bemisia* (*tabaci* complex) on *Abelmoschus* and *Gossypium* (Malvaceae), *Brassica* (Cruciferae), *Cucumis* (Cucurbitaceae), *Ipomoea* (Convolvulaceae), *Lantana* (Verbenaceae), and *Sonchus* (Asteraceae).

Discussion.—This species has been released in Arizona, California, Florida, South Carolina, and Texas.

Mercet (1931) described *E. mundus* from an unknown whitefly on eggplant, *Solanum melongena* (Solanaceae). The original material consisted of two females collected September 1, 1931, at Beas de Segura, Jaen Province, Spain. Mercet's description of the male was derived from specimens collected at the R. Osservatorio di Fitopatologia per le Puglie in Italy.

The two females Mercet deposited in the Museo de Madrid were missing for a number of years. Searches for Mercet's specimens at the Museo de Madrid by E. M. Perez, the museum curator, and M. J. Verdu and M. Fabrigat Marti failed to produce any specimens of *Eretmocerus* deposited by Mercet. Extensive personal communications and a request for information on the missing specimens published in *Chalcid Forum* also failed to produce the missing specimens. A type slide with one female was found by J. L. Nieves-Aldrey in 1997, who sent it to G. Evans. The type was then remounted by M. Rose. The antenna and forewing shown in Figs. 9–10 are drawn from the lectotype.

Mercet's original description contained a unique character found on the mesoscutum, "... almost glabrous, with only one pair of fine long setae ..." Mercet made an error,

as the mesoscutum of the lectotype has a total of four setae, but the position of the anterior pair of setae in the original mount made them extremely difficult to see.

Silvestri (1934) created a nomen nudum when he used the name *Eretmocerus masii* for 18 female and 21 male specimens reared from *Bemisia tabaci* collected in Italy without providing a description. Viggiani (1965) synonymized *Eretmocerus masii* with *Eretmocerus mundus*, and provided a redescription of *E. mundus* based on Silvestri's specimens of *E. masii*. Silvestri's specimens of *E. masii* were not available for study.

Specimens examined.—ISRAEL: Ein Gev, 9.x.1994, *Bemisia* on *Ipomoea*, M94118, Kirk and Lacey (3 ♀, 1 ♂); Ein Sedi (Dead Sea), 10.x.1994, *Bemisia* on *Lantana*, M94116, Kirk and Lacey (1 ♀, 1 ♂); Gat, 8.x.1994, *Bemisia tabaci* on *Brassica oleracea* (kohlrabi), M94103, Kirk and Lacey (8 ♀, 12 ♂); Gat, 8.x.1994, *Bemisia* on *Sonchus*, M94105, Kirk and Lacey (5 ♀, 4 ♂); Gat, 8.x.1994, *Bemisia tabaci* on *Abelmoschus esculentus*, M94110, Kirk and Lacey (1 ♀, 1 ♂); Golan, Ma'aleh Samla, 8.x.1994, *Bemisia tabaci* on *Cucumis melo* (cantaloupe), M94120, Kirk and Lacey (5 ♀, 7 ♂); Negev Desert, 11.x.1994, *Bemisia* on *Cucumis melo*, *Cucumis sativus*, M94124, Kirk and Lacey (3 ♀, 1 ♂); Spain: Mazarron, Casas Nuevas, 23.xi.1994, *Bemisia* on *Ipomoea*, M94128, Kirk and Lacey (1 ♀, 6 ♂); Valencia, Alicante, Mazarron, 1.xi.1993, *Bemisia tabaci* on *Lantana* or eggplant, WF 582B, WF 582C, Lacey and Kirk (16 ♀, 11 ♂); Murcia, 2.xii.1991, *Bemisia tabaci* on cotton, Kirk, Chen, and Sobhain (7 ♀); USA: Texas: Hidalgo Co., Mission Biological Control Laboratory, M92014 lab culture, original material: SPAIN: Murcia, i.1992, ex. *Bemisia tabaci*, M92014, Kirk, Chen, and Sobhain (43 ♀, 28 ♂); Hidalgo Co., Mission Biological Control Laboratory, M93004 lab culture, original material: Spain: Murcia, ex. *Bemisia tabaci*, M93004, Kirk and Lacey (22 ♀, 21 ♂).

M92019, PADAPPAL, INDIA

This culture of *Eretmocerus* labelled as originating from Padappal, India, contained two distinct species and a rare intermediate form. It is not clear exactly what species, or if more than one species, were released in the field. Records of release sites are not available. Most of the specimens examined from this culture material were assignable to *Eretmocerus mundus*, which is redescribed in this paper and has the ventral surface of the first funicular segment as long as the ventral surface of the second funicular segment (Fig. 7). Other specimens from this culture were placed as *Eretmocerus hayati*, which is described in this paper and has the ventral surface of first funicular segment slightly shorter than ventral surface of second funicular segment (Fig. 3). Rare females have the length of the first funicular segment intermediate between *E. mundus* and *E. hayati*.

Lack of original material and the presence of three distinct forms in this culture preclude additional comments.

ACKNOWLEDGMENTS

This research was supported by funds from USDA-APHIS, USDA-ARS, USDA-National Research Initiative, the Southern Regional Sustainable Agriculture and Education Program, and the Texas Higher Education Coordinating Board. The work of G. Zolnerowich was supported by a USDA-APHIS-National Biological Control Institute Postdoctoral Fellowship in Systematics.

We thank J. Goolsby and L. Wendel for their kind collaboration and for providing specimens. We thank T. Dahms, M. Hayat, V. Jashnosh, M. Schauff, and G. Viggiani for loans of type material. We are grateful to K. Hoelmer for his comments and B. Shaw for the drawings.

LITERATURE CITED

- Brown, J. K. and J. Bird. 1992. Whitefly-transmitted geminiviruses and associated disorders in the

Americans and the Caribbean Basin. *Plant Disease* 76: 220–225.

Brown, J. K., D. R. Frohlich, and R. C. Rosell. 1995. The sweetpotato or silverleaf whiteflies: Biotypes of *Bemisia tabaci* or a species complex? *Annual Review of Entomology* 40: 511–534.

Byrne, D. N., T. S. Bellows, Jr., and M. P. Parrella. 1990. Whiteflies in agricultural systems, pp. 227–261. *In* Gerling, D., ed., 'Whiteflies: Their Bio-nomics, Pest Status, and Management'. Intercept, Ltd. 348 pp. Andover, U.K.

Evans, G. A. and F. D. Bennett. 1996. A new *Eretmocer* (Hymenoptera: Aphelinidae) species reared from *Dialeurodes kirkaldyi* (Homoptera: Aleyrodidae). *Florida Entomologist* 79: 579–582.

Gerling, D. 1972. Notes on three species of *Eretmocer* Haldeman occurring in Israel with a description of a new species. *Entomologische Berichten* 32: 156–161.

Khan, M. Y. and S. A. Shafee. 1980. Species of the genus *Eretmocer* Haldeman (Aphelinidae: Eretmocerinae) from India. *Oriental Insects* 14: 363–369.

Mercet, R. G. 1931. Notas sobre Afelínidos (Hym. Chalc.) 4.a nota. *EOS, Revista Española de Entomología* 7(4): 395–410.

Mound, L. A. and S. H. Halsey. 1978. *Whitefly of the World*. British Museum (Natural History) and John Wiley and Sons. 340 pp.

Perring, T. M., A. D. Cooper, R. J. Rodriguez, C. A. Farrar, and T. S. Bellows, Jr. 1993. Identification of whitefly species by genomic and behavioral studies. *Science* 259: 74–77.

Rose, M. and G. Zolnerowich. 1997. *Eretmocer* Haldeman (Hymenoptera: Aphelinidae) in the United States, with descriptions of new species attacking *Bemisia (tabaci)* complex (Homoptera: Aleyrodidae). *Proceedings of the Entomological Society of Washington* 97: 1–27.

Rose, M., G. Zolnerowich, and M. Hunter. 1996. Systematics, *Eretmocer*, and Biological Control, pp. 477–497. *In* Gerling, D., ed., '*Bemisia* 1995: Taxonomy, biology, damage, control and management'. Intercept, LTD. 702 pp. Andover, U.K.

Rosell, R. C., I. D. Bedford, D. R. Frohlich, R. J. Gill, J. K. Brown, and P. G. Markham. 1997. Analysis of morphological variation in distinct populations of *Bemisia tabaci* (Homoptera: Aleyrodidae). *Annals of the Entomological Society of America* 90: 575–589.

Rosen, D. and P. DeBach. 1979. *Species of Aphytis of the World* (Hymenoptera: Aphelinidae). Dr. W. Junk BV. 801 pp. The Hague.

Silvestri, F. 1934. *Compendio di Entomologia Applicata. Parte Speciale*. Vol. 1 (Fogli 1–28). Portici. 448 pp. Italy.

Viggiani, G. 1965. *Ricerche sugli Hymenoptera Chalcidoidea. I. Le specie italiane del genere Anthemus* How. (Hym. Encyrtidae) e nota descrittiva sull' *Eretmocer masii* Silv. (Hym Aphelinidae). *Bolletina del Laboratorio di Entomologia Agraria "Filippo Silvestri" di Portici* 23: 249–264.



Zolnerowich, Gregory and Rose, M. 1998. "ERETMOCERUS HALDEMAN (HYMENOPTERA: APHELINIDAE) IMPORTED AND RELEASED IN THE UNITED STATES FOR CONTROL OF BEMISIA (TABACI COMPLEX) (HOMOPTERA: ALEYROD IDAE)." *Proceedings of the Entomological Society of Washington* 100, 310–323.

View This Item Online: <https://www.biodiversitylibrary.org/item/54709>

Permalink: <https://www.biodiversitylibrary.org/partpdf/54501>

Holding Institution

Smithsonian Libraries

Sponsored by

Smithsonian

Copyright & Reuse

Copyright Status: In copyright. Digitized with the permission of the rights holder.

Rights Holder: Entomological Society of Washington

License: <http://creativecommons.org/licenses/by-nc-sa/3.0/>

Rights: <https://biodiversitylibrary.org/permissions>

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at <https://www.biodiversitylibrary.org>.