ERETMOCERUS HALDEMAN (HYMENOPTERA: APHELINIDAE) – PARASITOIDS OF WHITEFLIES TRIALEURODES VAPORARIORUM AND BEMISIA (TABACI COMPLEX) IN MEXICO, WITH A KEY AND DESCRIPTION OF A NEW SPECIES

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RESUMEN Se describe una especie nueva, Eretmocerus evansi sp. nov., de los Estados de Tamaulipas y Querétaro de la República Mexicana. Se agregan las características del género Eretmocerus y la clave para la identificación de nueve especies de este género de México; se presenta la sinopsis de especies de Eretmocerus, los parasitoides de las moscas blancas Trialeurodes vaporariorum y Bemisia (tabaci complejo), con datos sobre sus diagnosis, hospederos, distribución geográfica y los materiales examinados.

DESCRIPTORES Aleyrodidae, Aphelinidae, Eretmocerus, sinopsis, México.

ABSTRACT Eretmocerus evansi sp. nov., from the States of Tamaulipas and Querétaro, Mexico, is described. Characteristics of the genus Eretmocerus, a key to nine species of this genus from Mexico, and a synopsis of the species of Eretmocerus from Mexico, parasitoids of Trialeurodes vaporariorum and Bemisia (tabaci complex), with data on their diagnosis, hosts, geographical distribution, and examined material are included.

KEYWORDS Aleyrodidae, Aphelinidae, Eretmocerus, synopsis, Mexico.

INTRODUCTION

The genus Eretmocerus Haldeman, 1850 includes some species, which are very important in biological control and in integrated pest management of whiteflies (Homoptera: Aleyrodidae) – serious pests of agricultural crops. Bemisia (tabaci complex) are one of mayor pests of many vegetable, fruits, technical and ornamental plants in USA, Mexico, the Caribbean, Central and South America, the Middle East, India and Africa (Rose & Zolnerowich 1997).

Species from the genus Eretmocerus were introduced into many countries for biological control of pests. Information on fauna and biology of parasitoids of whiteflies Bemisia tabaci (Gennadius), also Trialeurodes vaporariorum (Westwood), serious pests of agricultural crops in Mexico, is insufficient.

In Mexico three Eretmocerus species were known as parasitoids of these whiteflies: Eretmocerus emiratus (Zolnerowich and Rose), E. eremicus (Rose and Zolnerowich) and E. mundus Mercet. These species were introduced for biological control of Bemisia (tabaci complex) (Cervantes & Cota 1992, Hennessey et al. 1995, Cota Gómez et al. 1998). Results and efficiency of these species in several States of Mexico were published in many articles and notes (Rodríguez-del-Bosque & Arredondo Bernal 2005).
Researchers are able to identify species of parasitoids of both *T. vaporariorum* and *Bemisia* (*tabaci* complex), imported and originated locally. Therefore genus *Eretmocerus* became an intensive taxonomic and biological studied during last ten years worldwide. Rose & Zolnerowich (1997, 1998) described many new species and published a review of eight *Eretmocerus* species attacking *Bemisia* (*tabaci* complex) in the United States. Hayat (1998) revised *Eretmocerus* of India; from 15 species known to occur in India, 13 were described from different areas of India and two species are parasitoids of *B. tabaci*.

The genus *Eretmocerus* comprises over 60 described species and has a cosmopolitan distribution. Species of *Eretmocerus* develop as primary ecto-endoparasitoids of whiteflies and are important natural enemies for biological control of some pests. Publications of Rose & Zolnerowich (1997, 1998) included materials from Mexico, and they described some new species collected in Mexico. But special study of Mexican *Eretmocerus* till present was absent, including study of parasitoids of *T. vaporariorum* and *Bemisia* (*tabaci* complex). According to our previous study of publications, there are currently nine described species of *Eretmocerus* known to occur in Mexico as parasitoids of different whiteflies (Myartseva & Ruíz Cancino 2000, Myartseva et al. 2004, Coronado Blanco et al. 2005, Ruíz Cancino et al. 2005). Most species were reared from whiteflies – agricultural pests. Little is known about *Eretmocerus* species found outside of agricultural areas, as parasitoids of whiteflies inhabited on ornamental and wild plants.

**MATERIALS AND METHODS**

The special study of the family Aphyelinidae of Mexico, including genus *Eretmocerus*, was began in 1998. The principal method of collecting of parasitoids was rearing (Noyes 1982). Collected leaves from different plants with whitefly pupas were brought to laboratory and kept in plastic and glass containers of different size depending on number of pupas. All material was controlled and delivered from other insects. Emerged parasitoids were collected with aspirator and transferred to 70% alcohol for preserving. Later part of specimens were dissected and mounted on slides in Canada balsam. All material was fully labelled. For identification of whiteflies was utilized author’s experience from previous study of whiteflies and their parasitoids (Myartseva et al. 1998).

For identification of *Eretmocerus* species were used morphological criteria based principally on some parts of head and body with any modifications, and keys composed by Rose & Zolnerowich (1997) and Zolnerowich & Rose (1998). Basic morphological criteria for females are: configuration of antennal segments, relative proportions of antennal segments lengths (radicle, scape, pedicel, funicular segments, and club), setation of mesosoma (midlobe of mesoscutum, axillae, side lobes), length to width ratios of fore and hind wings, relative length of marginal fringe, relative lengths of stigmal and marginal veins, number of setae on base of fore wing, number of setae between marginal vein and linea calva, relative lengths of mdtibial spur and midbasitarsus, relative lengths of ovipositor, club and midtibia and their ratios. Some species have very small morphological differences, and for their differentiation is needed biosystematic study or electrophoretic analysis.

This work is result of collecting, rearing, and taxonomical study of *Eretmocerus* parasitoids of whiteflies *T. vaporariorum* and *Bemisia* (*tabaci* complex) of Mexico during period 1998-2006. In the article are presented the review of all nine Mexican *Eretmocerus* species, including introduced species, also key for identification of females, and description of a new species – parasitoids of *T. vaporariorum* and *Bemisia* (*tabaci* complex).
The synopsis includes short diagnosis, distribution, host records, material studied and comments for each species.

Eretmocerus haldemani Howard, 1908 is not included into key and review, because, according to last Database of Chalcidoidea (Noyes 2005) this species is not presented in Mexico. In article of Hennessey et al. (1995) it was misidentification, possibly of E. eremicus (as californicus Howard). Later following to Hennessey et al. (1995) this species was cited in other articles, including our publications (Myartseva & Ruíz Cancino 2000: 22 and Myartseva et al. 2004: 756).

The type of a new species of Eretmocerus will be deposited in the University of California, Riverside, California, USA. Remain specimens are preserved in the Universidad Autónoma de Tamaulipas, Tamaulipas, Mexico. The following abbreviations are used for depositories of the type material: UAT – Museum of Insects of UAM Agronomía y Ciencias of the Universidad Autónoma de Tamaulipas, Ciudad Victoria, Tamaulipas; UCRC – Research Entomological Museum of the University of California, Riverside, California; USNM – U.S. National Museum of Natural History, Washington, D.C., USA.

Following Zolnerowich & Rose (1998), in article is used name for Bemisia species as Bemisia (tabaci complex), because of confusion regarding the use of names B. tabaci A-strain, B. tabaci B-strain and B. argentifolii Bellows and Perring.

RESULTS AND DISCUSSION

Diagnosis of genus Eretmocerus Haldeman

Eretmocerus Haldeman (1850): 111 (type species E. corni Haldeman, by monotypy).


Diagnosis. Female with 5-segmented antenna: radicle/scape cylindrical, pedicel, two funicular segments short, to anelliform or triangular, club large, cylindrical or gradually widened distad and spatulate or fusiform, with sparse longitudinal sensilla. Mandible 3-dentate or with two teeth and short truncation. Antennal toruli closer to mouth margin. Eyes small. Ocelli usually arranged in obtuseangled triangle. Midlobe of mesoscutum dominantly with 4-6 long setae. Scutellum with two pairs of long setae. Propodeum usually on posterior margin medially with triangular projection, on anterior margin with a flat, scale-like seta with a bifid apex near each spiracle. Endophagma well-developed. Fore wing variable in dimensions and the length of marginal fringe. Marginal vein usually with 3-4 setae, submarginal vein with 2-3 setae. Disc sparsely setose, with linea calva closed posteriorly by a few setae and tubercles, basal cell with 1-3 setae. Hind wing narrow, the length of marginal fringe variable. Legs long and slender, tarsal formula 4-4-4. Midtibial spur usually about 0.5X the midbasitarsus. Metasoma of variable length, but usually longer than head and mesosoma combined. Ovipositor slightly exserted or not, but stylets may be strongly exserted, sometimes with curved apice.

Male with 3-segmented antenna: radicle, scape, pedicel and club. Club long and curved, bearing numerous sensilla. Phallobase of genitalia ventrally with two rod-like prolongations distad, digital sclerites well-developed, each with two denticles. Length of body usually 0.4-0.8 mm. Color of body predominantly yellow, with minimum of brownish suffusions. Sculpture finely reticulate.

Hosts. Aleyrodidae.

Distribution. Almost cosmopolitan.

According to G. A. Evans (USDA/APHIS, Systematic Entomology Laboratory, Beltsville, MD, USA) opinion about division of species groups of Eretmocerus without taxonomic
status (unpublished data), new species *Eretmocerus evansi* sp. n. can be belong to *californicus* species group.

**Key to species of the genus *Eretmocerus* – parasitoids of whiteflies *Trialeurodes vaporariorum* and *Bemisia* (tabaci complex) in Mexico (females)**

1. Mesosoma brown orange, in contrasting with head and metasoma. Antenna see in Fig. 8................. *staufferi* Rose & Zolnerowich
   - Body yellow, mesosoma not contrasting with head and metasoma.................2
2. Midlobe of mesoscutum with 4 setae......3
   - Midlobe of mesoscutum with 6 setae ......4
3. First funicular segment quadrate, second segment longer than wide, club 5.7-7.4 times as long as wide (Fig. 7) .................. *mundus* Mercet
   - First funicular segment triangular, second segment subquadrate, club 5.3-6.6 times as long as wide (Fig. 3) ................... *emiratus* Zolnerowich & Rose
4. Club 4.5-5.1 times as long as wide, ovipositor 1.5 times as long as club and 1.3 times as long as midtibia (Fig. 6) ................. *joeballi* Rose & Zolnerowich
   - Club more than 5.4 times as long as wide...............................5
5. Club more than 7.5 times as long as wide (Fig. 1), ovipositor 0.8-0.9 times as long as club and midtibia .........................*antennator* Myartseva et Ruíz
   - Club 5.9-7.3 times as long as wide, ovipositor variable .......................6
6. Club 5.9-7.0 times as long as wide, longer than ovipositor and as long as midtibia (Fig. 2) ......................... *corni* Haldeman
   - Club as long as ovipositor.................7
7. Club (Fig. 4, 9) as long as midtibia ......8
   - Club (Fig. 5) longer than midtibia, 7.0-7.3 times as long as wide, fore wing 2.9 times as long as wide its marginal fringe 0.4 times as long as maximum width of wing.............................. *evansi* sp. n.
8. Club 6.5-7.3 times as long as wide, fore wing 2.7 times as long as wide, its marginal fringe 0.35 times as long as maximum width of wing .......... ............... *eremicus* Rose & Zolnerowich
   - Club 6.2-7.1 times as long as wide, fore wing 2.6 times as long as wide, its marginal fringe 0.28 times as long as maximum width of wing .......... ............... *tejanus* Rose & Zolnerowich

**Review of species**

1. *Eretmocerus antennator* Myartseva et Ruíz, 2006 (Fig. 1)

   *Eretmocerus antennator* Myartseva et Ruíz, 2006: Fig. 1.
   Described from Mexico, holotype female in UCRC.

   **Hosts.** *T. vaporariorum*, *Tetraleurodes* sp.

   **Distribution.** Mexico (Coahuila, Tamaulipas).

   **Diagnosis.** Female of *E. antennator* can be distinguished by unusual elongate club (Fig. 1), which 7.5-9.0 times as long as wide, scape 4.4-5.7 times as long as wide, midlobe of mesoscutum with 6 setae, the ovipositor about 0.8-0.9 times as long as club and midtibia.

   It is very similar to *E. haldemani* and *E. staufferi*, which also have the extremely elongate club, but in *E. haldemani* – club is only 7.5-8.3 times as long as wide and pedicel 0.5 X the length of scape, type material was reared from *Aleuroplatus coronata* (Quaintance) on oak (Howard 1908); *E. staufferi* has club 8.2-9.1 times as long as wide, but it is one species that has mesosoma brown orange. *Eretmocerus antennator* is similar also to *E. exilis* Rose, *E. tejanus* Rose and Zolnerowich and *E. delhiensis* Mani. Female of *E. exilis* has club about 6.9 times as long as wide, pedicel about 2.1 as long as wide, scape about 4.5 times as long as wide, and was reared from *Aleurothrixus floccosus* (Maskell). *Eretmocerus tejanus* has the club...
6.2-7.1 times as long as wide and 2.8 times as long as pedicel, reared from *Bemisia* (tabaci complex). Female *E. delhiensis* has pedicel usually at least 2.5 times as long as wide, but less than three times, club not less than six times as long as wide, but usually less than seven times, ovipositor subequal in length to club and midtibia, reared from whiteflies on sugar cane in India.


2. Eretmocerus corni Haldeman (Fig. 2)

Eretmocerus corni Haldeman (1850): 110, Figs. 6-7.

Described from USA, neotype female in USNM.

Hosts. Aleurocanthus sp., Aleurothrixus porteri Quaintance and Baker, Aleurotuberculatus takahashii David and Subramaniam, B. tabaci, Dialeurolonga fici David and Subramaniam, P. quercus (Signoret), Siphoninus phillyreae (Haliday), Trialeurodes packardi (Morrill), T. vaporariorum, Tetraleurodes corni (Haldeman) (Noyes 2005).

Distribution. Argentina, Chile, China, Egypt, Greece, Hawaii, Italy, Pakistan, Paraguay, U.K., USA; Mexico 1 – Tamaulipas.

Diagnosis. Club (Fig. 2) elongate, with apex truncate, 5.9-7.0 times as long as wide, scape 4.9 times as long as wide, pedicel 2.4-3.1 times as long as wide and 0.25-0.29, rarely 0.30 times as long as the club, first funicular segment triangular, second segment subquadrate; midlobe of mesoscutum with six setae; fore wing 2.7 times as long as maximum width of disc, marginal fringe 0.3 X the width of wing; between marginal fringe and linea calva 10-11, occasionally 10-15 setae; ovipositor 0.8 X the length of club, equal in length to midtibia.


Comments. Eretmocerus corni was released in Egypt for biocontrol of S. phillyreae (Abd-Rabou 1998). In Argentina it is used against T. vaporariorum (López & Botto 2005). In Mexico three females of Eretmocerus were reared from T. vaporariorum and B. tabaci. The author carefully measured and compared morphological features of Mexican specimens with description of E. corni in Rose & Zolnerowich (1997) and not found differences of females reared in Mexico from this description. Thus, E. corni is new record for Mexico.

3. Eretmocerus emiratus Zolnerowich and Rose (Fig. 3)


Described from United Arab Emirates, holotype female in USNM.

Hosts. Bemisia argentifolii, B. tabaci.

Distribution. Egypt, Ethiopia, United Arab Emirates, USA (Arizona, California, Texas); Mexico (Baja California Norte, introduced).

Diagnosis. Midlobe of mesoscutum with four setae; the club (Fig. 3) 5.3-6.6 times as long as wide, scape 4.0-6.5 times as long as wide, pedicel 2.0-2.62 times as long as wide, first funicular segment extremely short, second segment subquadrate; fore wing 2.9-3.4 times as long as maximum width, marginal fringe 0.25-0.35 X the width of disc, between marginal vein and linea calva 6-9 setae; ovipositor 0.88-1.18 times as long as club and 1.0-1.2 times as long as midtibia.

Comments. Eretmocerus emiratus was imported and released in the United Status for biocontrol of Bemisia (tabaci complex) (Zolnerowich & Rose 1998). In 1998 it was introduced to Mexico, Valle de Mexicali,
against whitefly *B. argentifolii* (Cota Gómez et al. 1998).

4. **Eretmocerus eremicus** Rose and Zolnerowich (Fig. 4)

*Eretmocerus eremicus* Rose & Zolnerowich (1997): 10-14, Fig. 10-12, 30.

Described from USA (Arizona), holotype female in USNM.

**Hosts.** *Bemisia* (tabaci complex), *T. abutiloneus* (Haldeman), *T. vaporariorum*.

**Distribution.** USA (Arizona, California, Massachusetts), UAE, Egypt, Spain, Italy, Morocco, Belgium, Canary Islands; Mexico (Tamaulipas\(^2\), Baja California).


**Diagnosis.** Club (Fig. 4) 6.5-7.3 times as long as wide, pedicel 3-4 times as long as wide, scape 5.1 times as long as wide, first funicular segment triangular, second segment 1.1 times as long as wide; midlobe of mesoscutum with six setae; fore wing 2.7 times as long as maximum width of wing, marginal fringe 0.35 X the width of disc, between marginal vein and linea calva 6-12 setae; ovipositor equal in length to club and to midtibia.


\(^2\) New record for Tamaulipas.

5. **Eretmocerus evansi** Myartseva, sp. n. (Fig. 5)

**Diagnosis.** Females of *E. evansi* sp. n. can be distinguished by club, which 7.0-7.3 times as long as wide and 1.7-1.8 times as long as scape, midlobe of mesoscutum with six setae, ovipositor equal in length to club and 1.1 times as long as midtibia.

**Eretmocerus evansi** sp. n. extremely close to *E. eremicus* and *E. tejanus*, but differs from both species in following: In *E. eremicus*—scape 5.1 times as long as wide, pedicel 3-4 times as long as wide and 0.30-0.39 X the length of club, club 6.5-7.3 times as long as wide, between marginal vein and linea calva 6-12 setae, stigmal vein 1.5 times shorter than marginal vein, hind wing 6.9 times as long as wide, ovipositor in length equal to midtibia. In *E. tejanus*—scape 5.0 times as long as wide, pedicel 3.0-3.7 times as long as wide and 0.29-0.36 X the length of club, club 6.5-7.3 times as long as wide, hind wing 7.3 times as long as wide, ovipositor equal in length to midtibia. In *E. evansi*—scape 5.0-5.5 times as long as wide, pedicel 2.9-3.2 times as long as wide and 0.30-0.33 X the length of club, club usually seven times as long as wide, at most 7.3 X, between marginal vein and linea calva 11-12 setae, stigmal vein slightly shorter than marginal vein, hind wing 8.3 times as long as wide, ovipositor equal to club longer than midtibia.

**Eretmocerus evansi** sp.n. is similar also to *E. exilis* and *E. corni*, but differs from both species by following: In *E. exilis*—second funicular segment subquadrate, apex of club...
sloped, club two times as long as scape, fore wing 2.5 times as long as maximum width of wing, its base with three setae, marginal fringe of hind wing shorter than maximum wing width, midtibia 2.5 times longer than basitarsus, reared from *A. floccosus*. In *E. evansi* – second funicular segment quadrate, apex of club truncate, club 1.7-1.8 times as long as scape and equal to ovipositor length, fore wing 2.9 times as long as maximum width of wing, its base with one seta, marginal fringe of hind wing longer than maximum wing width, midtibia 2.7 times longer than basitarsus, reared from *B. tabaci* and *T. vaporariorum*. In *E. corni* – scape 4.9 times as long as wide and 0.4 X the length of club, pedicel 2.4-3.1 times as long as wide and 0.25-0.29 X the length of club, rarely 0.30 X, second funicular segment subquadrate, club 2.5 times longer than scape, ovipositor equal to midtibia, reared from *Trialeurodes packardi*, which is not registered in Mexico. In *E. evansi* – scape 5.0-5.5 times as long as wide and 0.55-0.60 X the length of club, pedicel 2.9-3.2 times as long as wide and usually 0.30-0.33 X the length of club, second funicular segment quadrate, club 1.7-1.8 times longer than scape, ovipositor equal to midtibia, reared from *B. tabaci* and *T. vaporariorum*. *Eretmocerus evansi* sp. n. has club equal to ovipositor and longer than midtibia, like to *E. californicus*, but last species has tapered shape of club, which 5.2-6.6 times as long as wide.

**Male.** Unknown.


6. *Eretmocerus joeballi* Rose and Zolnerowich (Fig. 6)

*Eretmocerus joeballi* Rose & Zolnerowich (1997): 17-18, Fig. 18-19. Described from USA (California), holotype female in USNM.

**Hosts.** *Bemisia* (*tabaci* complex), *Tetraleurodes* sp.
**Distribution.** USA (California); Mexico (Coahuila, Tamaulipas).

**References.** Myartseva et al. (2004): 756; Ruíz Cancino et al. (2005): 934.

**Diagnosis.** Club (Fig. 6) with apex slightly deflexed, 4.5-5.1 times as long as wide, scape 4.5 times as long as wide, pedicel 2.0-2.3 times as long as wide, equal in length to radicle, first funicular segment triangular, second segment 1.4 times as wide as long; midlobe of mesoscutum with six setae; forewing 2.4 times as long as maximum width of wing, marginal fringe 0.3 X the width of wing, between marginal vein and linea calva 7-13 setae; ovipositor 1.5 times as long as club and 1.3 times as long as midtibia.


7. **Eretmocerus mundus** Mercet (Fig. 7)


**Hosts.** Acaudaleyrodes citri (Priesner and Hosny), Aleuroplatus cadabae (Priesner and Hosny), Aleyrodinae sp., A. proletella (L.), Asterobemisia avellanae (Signoret), A. carpini (Koch), Bemisia afer (Priesner and Hosny), B. argentifolii, B. ovata (Gouch), B. tabaci, Dialeurodes kirkaldyi (Kotinsky), Neomaskellia bergii (Signoret), S. phillyreae, T. ricini (Misra), T. vaporariorum (Noyes 2005), Tetraleurodes sp.

**Distribution.** Cosmopolitan; Mexico (Baja California Norte, introduced).


**Diagnosis.** Midlobe of mesoscutum with four setae; the club (Fig. 7) tapered towards apex, 6.0-7.0 times as long as wide, pedicel about 0.5 times as long as scape, first funicular segment quadrate, second segment usually at least slightly longer than wide; forewing about three times as long as wide, its marginal fringe 0.3 X the wing width; between marginal vein and linea calva 6-10 setae; midtibial spur nearly 0.33 X the length of basitarsus; ovipositor slightly longer than both club and midtibia.

**Comments.** *Eretmocerus mundus* was introduced successfully into many countries for control *Bemisia (tabaci)* complex and other whitefly species (Zolnerowich & Rose 1998). In 1992 *E. mundus* was introduced from Spain to Valle de Mexicali, Baja California against *B. argentifolii*; here it parasitized 44.5% of pest (Cervantes & Cota 1992).

8. **Eretmocerus staufferi** Rose and Zolnerowich (Fig. 8)

*Eretmocerus staufferi* Rose & Zolnerowich (1997): 20-22, Fig. 23-25, 32. Described from Texas, USA, holotype female in USNM.

**Hosts.** Bemisia (tabaci complex), *T. abutiloneus, T. vaporariorum*.

**Distribution.** USA (Arizona, California, Texas); Mexico (Tamaulipas).

**References.** Myartseva et al. (2004): 756.

**Diagnosis.** Mesosoma distinctly brown-orange, in contrasting to yellow head and metasoma; club (Fig. 8) extremely elongate, 8.2-9.1 times as long as wide, scape 5.7 times as long as wide, pedicel 3.3 times as long as wide; first funicular segment triangular, second segment 0.9 times as long as wide; midlobe of mesoscutum with six setae; forewing 2.7 times as long as wide, marginal fringe 0.3 X the width of disc; between marginal vein and linea calva 8-12 setae; ovipositor 0.8 X the length of club and 0.9 X the length of midtibia.

Comments. Trialeurodes vaporariorum is new host record for E. staufferi.

9. Eretmocerus tejanus Rose and Zolnerowich (Fig. 9)

Eretmocerus tejanus Rose & Zolnerowich (1997): 22-26, Fig. 26-28, 33.
Described from Texas, USA, holotype female in USNM.

Hosts. Bemisia (tabaci complex).
Distribution. USA (Texas), Martinique; Mexico (Tamaulipas).

Diagnosis. Club (Fig. 9) 6.2-7.1 times as long as wide, scape five times as long as wide, pedicel 3.0-3.7 times as long as wide, first funicular segment triangular, second segment subquadrate; midlobe of mesoscutum with six setae; fore wing 2.6 times as long as maximum width of wing, marginal fringe 0.28 X the width of disc; between marginal vein and linea calva 9-14 setae; ovipositor equal in length to club and midtibia.


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