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Description of *Eretmocerus cocois* sp. n. (Hymenoptera: Chalcidoidea), a parasitoid of *Aleurotrachelus atratus* (Hemiptera: Aleyrodidae) on the coconut palm

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Abstract

Eretmocerus cocois Delvare sp. n. (Hymenoptera, Chalcidoidea) is described and illustrated. The adults emerge from fourth instar larvae of *Aleurotrachelus atratus* Hempel (Hemiptera, Aleyrodidae) which presently heavily infests the coconut plantations in Comoros Islands. It is compared with *E. pallidus* Dozier a diagnosis of which is given, together with new illustrations and with two other *Eretmocerus* also reared from *Aleurotrachelus* nymphs. A lectotype is selected for *E. pallidus*.

Key words: *Eretmocerus*, *Eretmocerus cocois*, Chalcidoidea, *Aleurotrachelus atratus*, *Cocos nucifera*, parasitoid, biological control, Guadeloupe, Comoros Islands

Introduction

Coconut plantations in the Comoros islands have been damaged since the beginning of this century due to *Aleurotrachelus atratus* Hempel (Hemiptera, Aleyrodidae), with heavy losses in yields and even, in the most harmful situations, by the death of the trees (Ollivier 2003; Julia 2003; Streito *et al.* 2004; Ollivier & Delvare 2005). The whitefly, while presently distributed in a number of countries (Howard *et al*. 2001), is of Neotropical origin (Mound & Halsey 1978), having been described from Brazil; it is now known from many tropical countries (Martin 2005). It was subsequently introduced on several islands of the Indian Ocean: Comoros Islands (including the Grande Comore, Moheli, Anjouan and Mayotte) (Ollivier 2003), Madagascar, Mozambique and Mauritius (Beaudoin-Ollivier *et al*. 2004) and finally La Reunion (Youssoufa *et al*. 2006); it was recently quoted from continental Africa: Mozambique, Uganda (Gerling *et al*. 2006). Searches for natural enemies in the Comoros islands failed to recover any parasitoids and only a few predators (ladybirds and green lacewings) were present but evidently could not control the populations of *A. atratus* (Ollivier & Delvare 2005). Conversely, in La Reunion, similar searches revealed the presence of two parasitoids, respectively *Cales noacki* Howard (Hymenoptera, Chalcidoidea) and an undescribed species belonging to the genus *Eretmocerus* (Hymenoptera, Chalcidoidea) (Youssoufa *et al*. 2006). The first species emerged from the second and third instars larvae of *A. atratus*; it had been introduced in La Reunion in 1976 to control the citrus whitefly *Aleurothrixus floccosus* (Maskell) (Étienne 1978; Quilici *et al*. 2003). It is also known from a number of

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other hosts (see Noyes 2002 for a review) including *A. atratus* in the Canary Islands (Hernandez-Suarez *et al*. 2003). The second species was reared for the first time by one of us (JE) in Guadeloupe Island in 1994. It parasitizes a percentage of the populations of its host in La Reunion. It always emerged from the fourth instar larvae.

A biological control program was therefore initiated by CIRAD, funded by PRPV and is presently carried out by INRAPE and CIRAD in order to introduce this *Eretmocerus* into Comoros Islands from a population screened in La Reunion (Youssoufa *et al*. 2006). The present paper describes of this wasp and compares it with the known New World species.

Abbreviations and acronyms for institutions

F1	First funicular segment
F2	Second funicular segment
3P	Pôle Protection des Plantes, Saint-Pierre, La Réunion
BMNH	The Natural History Museum, London, UK
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement, Montpellier, France
CNC	Canadian National Collection of Insects, Ottawa, Canada
INRAPE	Institut National de Recherche pour l'Agriculture, la Pêche et l'Environnement, Moroni, Union des Comores
JE	Jean Étienne collection, Guadeloupe
MNHN	Muséum National d'Histoire Naturelle, Paris, France
PRPV	Programme Régional de Protection des Végétaux de la Commission de l'Océan Indien
USNM	United States National Museum, Washington D.C., USA

Material and methods

Morphological study. Specimens of the parasitoid were reared from colonies of *Aleurotrachelus atratus*, even sometimes from isolated fourth instar larvae. They were originating from several different islands (see material examined). They were either stored dried on cotton layers or in ethanol 70%, for examination of the morphological characters. In this case they were critical point dried. Part of this sample was used for permanent slide-mountings in Canada balsam mostly according to Noyes (1982) but the specimens were coloured with chlorazol black as recommended by Carayon (1969). The illustrations were provided using a microscope Leica DMLB linked to a video camera. The Perfect-Image 6.01 system designed by Claravision was used to generate multifocus photographs.

The type series of *Eretmocerus pallidus* Dozier was examined. All *Eretmocerus* specimens reared from *Aleurotrachelus* spp. in Guadeloupe and Martinique were compared, in most cases after slide-mounting. In the following descriptions numbers within brackets denote less encountered values of the variables.

Quantitative study. A preliminary quantitative study was carried out on several variables, e.g. measurements of parts of the body and appendices and various ratios (see Table 1). These measurements were made from slide-mounted specimens using a Leitz Laborlux 12 microscope and a micrometer. However no statistical treatment was performed as the sample was reduced for most of the included *Eretmocerus* species. This study was carried out mostly to present graphic illustrations of the variation encountered in the four included *Eretmocerus* spp.

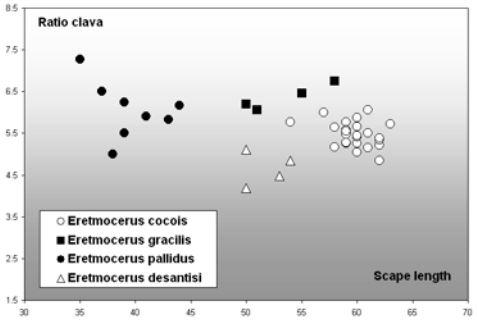


Fig. 1

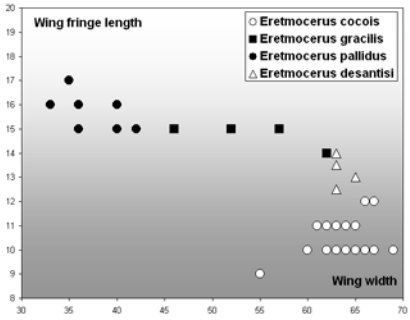
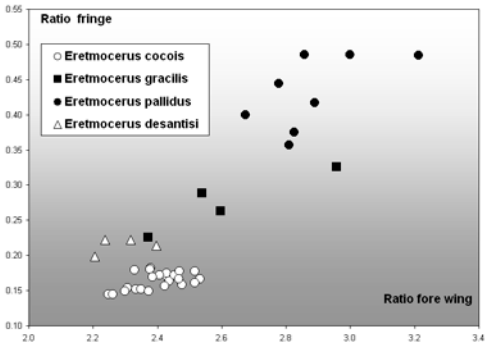


Fig. 2



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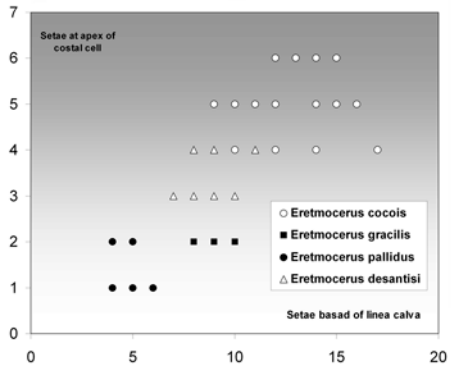

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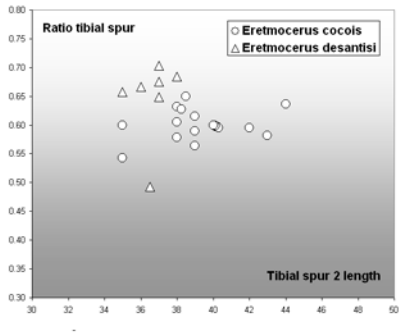

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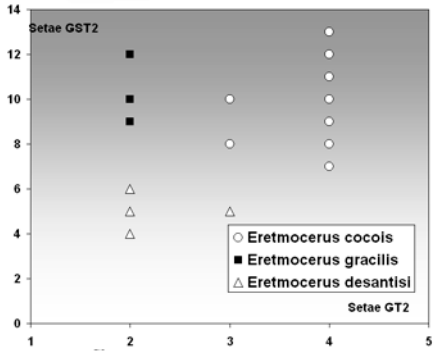


Fig. 6

FIGURES 1–6. Quantitative study on some *Eretmocerus* spp.: relationships between primary variables and ratios. 1. Scatterplot of scape length and ratio clava (= clava length/clava width). 2. Scatterplot of forewing width and fore wing fringe length. 3. Scatterplot of ratio fringe and fore wing length. 4. Scatterplot relative to the abundance of setae on fore wing: hairs basad of linea calva/hairs at apex of costal cell. 5. Scatterplot of ratio tibial spur (= length of tibial spur/length of basitarsus) and mid tibia length. 6. Scatterplot concerning the abundance of setae on gaster. Abbreviations as in Table 1.

Molecular study. Sequencing. Finally a fraction of the samples were stored in ethanol 100% for genetic analysis. Two genes were used for sequencing, respectively CO1 (mitochondrial gene) and 28S (nuclear). Specimens of *Eretmocerus mundus* Mercet reared in Morocco from *Bemisia tabaci* (Gennadius) were selected as the outgroup. Total genomic DNA was extracted from adult insect preserved in 100% ethanol using the Puregene kit (GENTRA system, Minneapolis, USA). Each sequence was obtained from the DNA of one individual. We amplified fragments of CO1 mtDNA and 28S rDNA D4–D5 and D8–D10 respectively for 690 and 600–800 bp. For the CO1 fragment, the primers used are C1-J-2183 (alias Jerry) from Simon *et al*. (1994) and uea8 from Zhang and Hewitt (1996). Sequencing was performed directly from the PCR product. The PCR program : one step at 94°C for 3 min followed by 40 cycles of 92°C for 30 s, 48°C for 60 s, 72°C for 90 s, and a final extension step at 72°C for 10 min. For the 28S fragments, the primers used are 28S-D4-5F and 28S-

D4-5R, 28S-D8-10F and 28S-D8-10R from Belshaw and Quicke (2002). These primers were also used for direct sequencing. The PCR program : one step at 94°C for 3 mn followed by 35 cycles of 92°C for 30 s, 52°C for 30 s, 72°C for 120 s, and a final extension step at 72°c for 10 min. For all the fragments, PCRs were performed in 25 µl and consisted of 2µl of DNA sample, 2.5µl of 10X Taq buffer (Qiagen),1µl of MgCl2 (25 mM), 0.5µl of dNTPs (10mM), 1.75µl of each primer (10µM) , 0.125µl of Taq (Qiagen) and we added sterile distilled de-ionized water to give a final reaction volume of 25µl. Twenty-six specimens (Table 2) were sequenced at the Centre National de Séquençage (Paris). The sequence regions were unambiguous and the alignment was hence straightforward. Sequences of *E. mundus* from Nador and Agadir, of *E. desantisi* from Guadeloupe, of *E. cocois* from Guadeloupe and Reunion, Étang-Salé have been submitted to GenBank (accession numbers EU017330 to EU017344); the aligned data matrix is available upon request from the authors.

TABLE 1. Primary variables: measurements from body parts and various appendages; secondary variables: ratios used from initial measurements. Length and width reflect maximal dimensions for relevant appendages. Some variables (number of setae) are discrete.

Abbreviation	Appendage or body part	Measurement
Primary variables		
Sc L	antenna	length of scape
Cl L	antenna	length of clava
Cl W	antenna	width of clava
FW L	fore wing	length of fore wing
FW W	fore wing	width of fore wing
FWF L	fore wing	maximal length of posterior fringe
S Cc	fore wing	number of setae at apex of costal cell
S SM	fore wing	number of dorsal setae on submarginal vein
S LC	fore wing	number of setae basad of linea calva
M LC	fore wing	number of microtrichiae below linea calva
Bt2 L	Mid leg	length of mid basitarsus
Tb2 S L	Mid leg	length of apical spur of mid tibia
S GTS2	Gastral sternite 2	number of setae behind apex of phragma
S GT2	Gastral tergite 2	number of dorsolateral setae on tergite 2
Secondary variables = ratios		
ratio clava	Cl L : Cl W	
ratio fore wing	FW L : FW W	
ratio fringe	FWF L : FW W	
ratio tibial spur	Tb2 S L : Bt2 L	

Analysis. Kimura's two-parameter model of base substitution was used to calculate genetic distances with MEGA version 3.1 software (Kumar *et al*. 2004). The data were analyzed by Neighbor-Joining with the same program and a subset was analyzed in parsimony with PAUP version 40b10 (Swofford 2001) using the branch and bound option. Bootstrap support was evaluated with 1000 replicates starting with a random tree.

Results

Descriptions of species

***Eretmocerus cocois* Delvare sp. n.**
(Figs 8–20)

Material examined. Type material. – **Holotype** ♀ (slide-mounted in Canada balsam) (BMNH): Petit-Canal, Parc Paysager, 20.x.2006, ex *Aleurotrachelus atratus* Hempel on *Cocos nucifera* (J. Etienne) [Ref. Etienne

GP 2449, CIRAD 19307]. **Paratypes** (BMNH, CIRAD, CNC, JE and MNHN). **GUADELOUPE**: 30 ♀♀ 3 ♂♂ (15 ♀♀ 1 ♂ slide-mounted), same references as holotype, but some collected on 03.vi.2006 [Ref. Etienne GP 2411 CIRAD 19216]; 2 ♀♀ (slide-mounted) Sainte-Anne, same host and collector, 23.i.1994 [Ref. Etienne GP 894, CIRAD 12947].

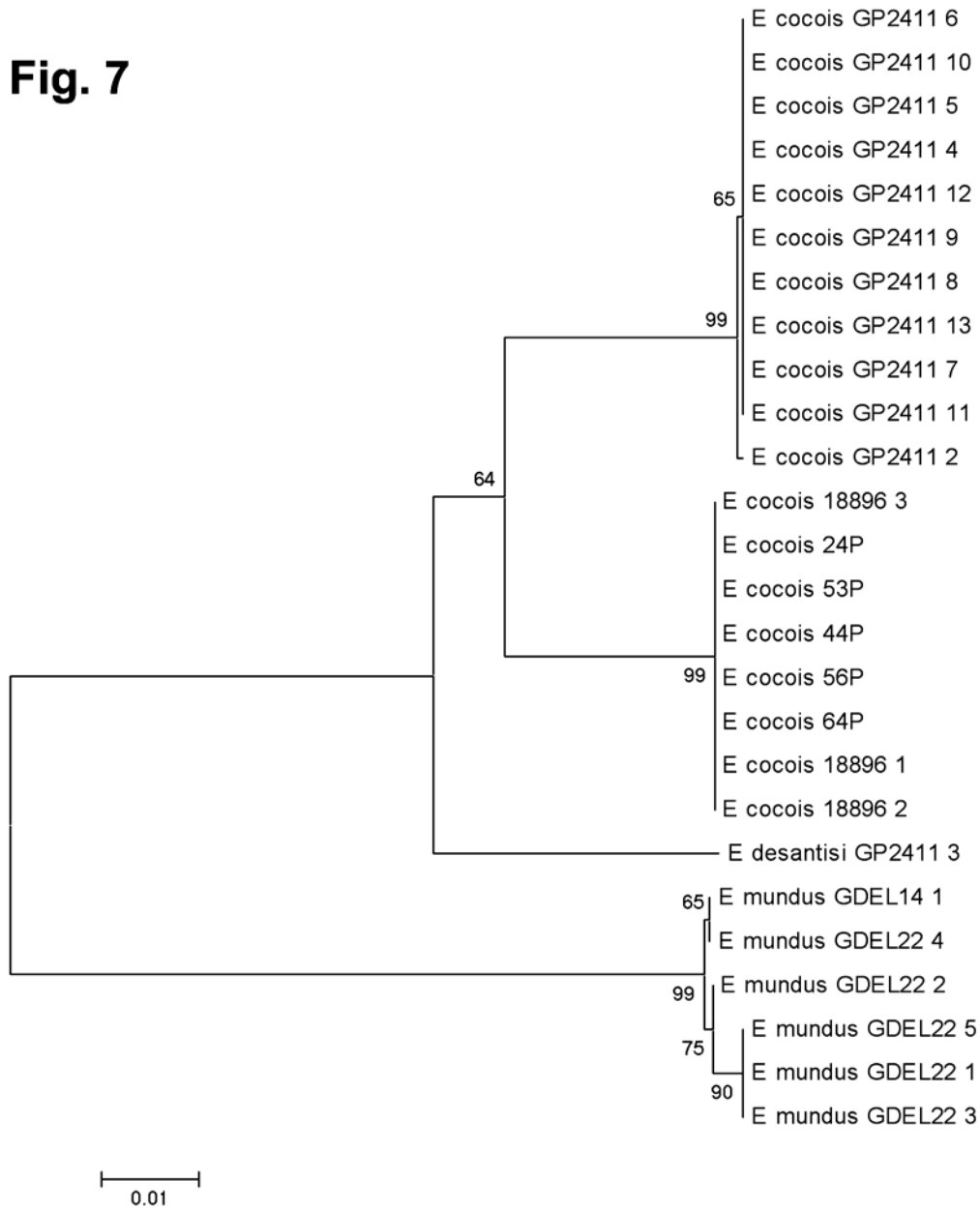


FIGURE 7. Tree achieved in NJ from the CO1 gene. Bootstrap values indicated above or below branches.

Other material (in CIRAD Monpellier and 3P Reunion). – All specimens have been reared from *A. atratus*. A part of them emerged from fourth instar larvae of the host. The associate plant is mostly *Cocos nucifera* (except otherwise mentioned). LA REUNION: 1 ♀ (slide-mounted) Bassin Martin, 15.i.2004, ex *A. atratus* on *Roystonea oleracea* (G. Delvare); 2 ♀ 17.x.2005 (N. Borowiec) [Ref. CIRAD 19041, 19046]; 40 ♀♀ (12 ♀♀ slide-mounted) Étang Salé, 4 m, 21.27525°S 055.38200°E, respectively 24.xi.2005, 21.iii.2006, 11.iv.2006, 29.v.2006, 02.vi.2006, 09.vi.2006 (N. Borowiec) [Ref. CIRAD 19034, 19037, 19045, 19153, 19154, 19162, 19167, 19168, 19169, 19170, 19218, 19220, 19222, 19223, 19225, 19227, 19228, 19229, 19231, 19234, 19237]; 1 ♀ Grand Bois, 21.iii.2006 (N. Borowiec) [Ref. CIRAD 19159]; 1 ♀ Piton-Saint-Leu, 07.vi.2006 (N.

Borowiec) [Ref. CIRAD 19242]; 2 ♀♀ (slide-mounted) Piton-Saint-Leu, 09/18.x.2006 (N. Borowiec) [Ref. CIRAD 19363 and 19366]; 2 ♀♀ (1 ♀ slide-mounted) Saint-Benoît, 20 m, 21.03790°S 055.70988°E, 02.ii.2006, 05.vi.2006 (N. Borowiec) [Ref. CIRAD 19235, 19238]; 1 ♀ Sainte-Marie, 02.ii.2006 (N. Borowiec) [Ref. CIRAD 19160]; 10 ♀♀ 3 ♂ (6 ♀♀ 1 ♂ slide-mounted) Sainte-Suzanne, Franche Terre, 52 m, 20.90169°S 55.58002°E, 31.i.2006, 05.vi.2006 (N. Borowiec) [Ref. CIRAD 19028, 19029, 19030, 19245]; 1 ♀ (slide-mounted) Saint-Leu, Grand Fond, 236 m, 21.19601°S 55.30213°E, 20.x.2005 (D. Pastou) [Ref. CIRAD 19042]; 1 ♂ (slide-mounted) Saint-Pierre, 138 m 21.32423°S 55.48626°E, ex *A. atratus* on *Dypsis lutescens*, 17.xi.2005 (N. Borowiec) [Ref. CIRAD 19047]. MAYOTTE. 32 ♀♀ 1 ♂ (7 ♀♀ slide-mounted), vii–xii 2004 (A.-L. Abdoul Karimé) [Ref. CIRAD 18896, 18898].

TABLE 2. Specimens used for the molecular study. *Eretmocerus mundus* employed as outgroup.

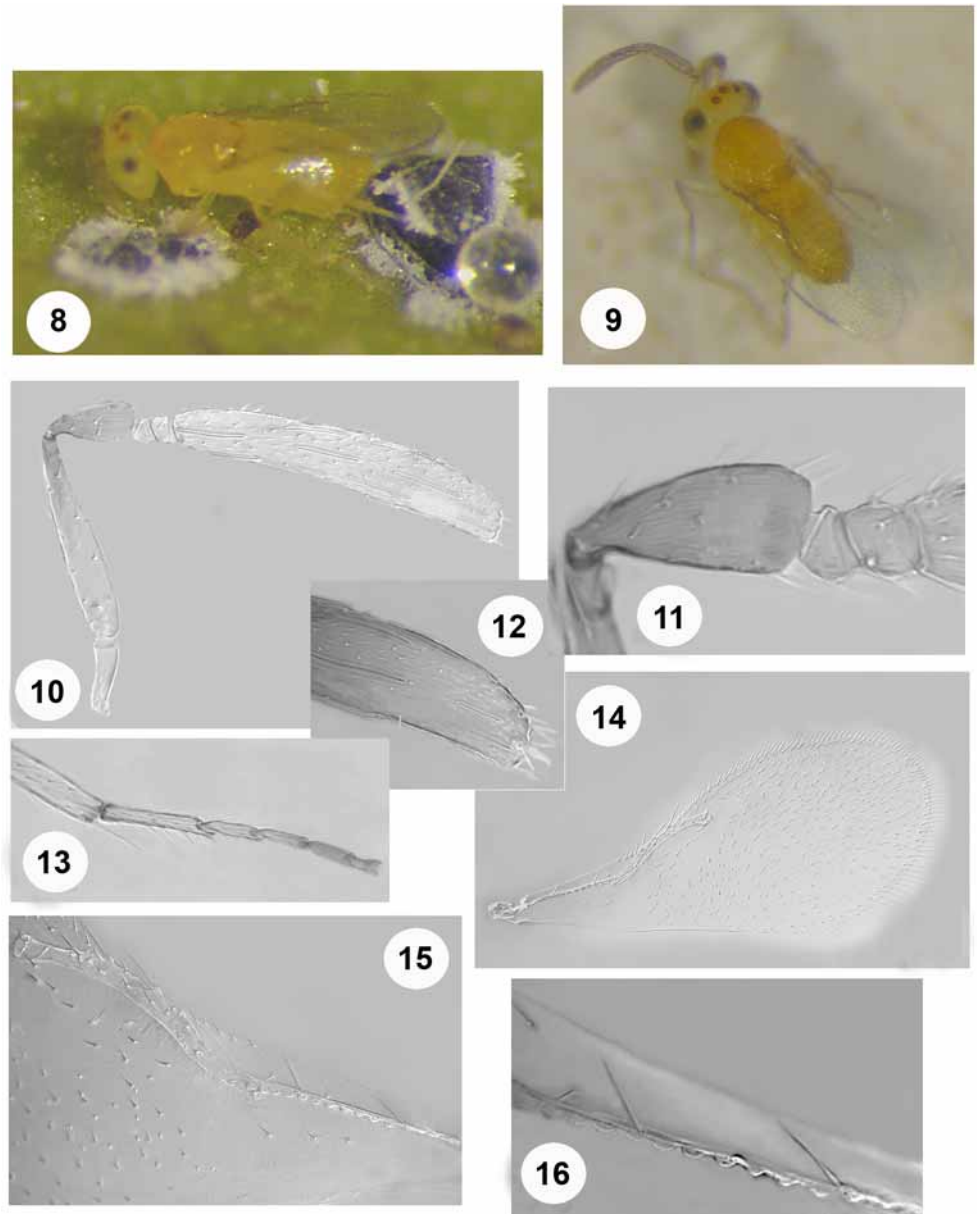
Species	Reference	Country or island	Locality	Date of collect	N	Insect host	Plant species	Collector
Eretmocerus mundus Mercet	GDEL 14	Morocco	near Nador	29/09/05	1	*Bemisia tabaci*	*Cucumis melo*	Delvare G.
Eretmocerus mundus Mercet	GDEL 22	Morocco	Agadir	02/04/03	5	*Bemisia tabaci*	*Lantana camara*	Delvare G.
Eretmocerus desantisi Rose	GP 2411	Guadeloupe	Petit-Canal	03/06/06	1	*Aleurotrachelus atratus*	*Cocos nucifera*	Étienne J.
Eretmocerus cocois sp. n.	GP 2411	Guadeloupe	Petit-Canal	03/06/06	11	*Aleurotrachelus atratus*	*Cocos nucifera*	Étienne J.
Eretmocerus cocois sp. n.	18896	Mayotte		31/12/04	3	*Aleurotrachelus atratus*	*Cocos nucifera*	Abdoul-Karimé A.-L.
Eretmocerus cocois sp. n.	24P	La Reunion	Étang-Salé	29/03/06	1	*Aleurotrachelus atratus*	*Cocos nucifera*	Borowiec N.
Eretmocerus cocois sp. n.	44P	La Reunion	Étang-Salé	29/05/06	1	*Aleurotrachelus atratus*	*Cocos nucifera*	Borowiec N.
Eretmocerus cocois sp. n.	53P	La Reunion	Étang-Salé	24/05/06	1	*Aleurotrachelus atratus*	*Cocos nucifera*	Borowiec N.
Eretmocerus cocois sp. n.	56P	La Reunion	Petite-Ile	30/05/06	1	*Aleurotrachelus atratus*	*Cocos nucifera*	Borowiec N.
Eretmocerus cocois sp. n.	64P	La Reunion	Saint-Paul	07/06/06	1	*Aleurotrachelus atratus*	*Cocos nucifera*	Borowiec N.

Female (Fig. 8). Length of critical point-dried specimens 0.8 mm. Body orange yellow. Pronotum and metanotum, except in middle behind dorsellum, darkened. Mid lobe of mesoscutum often slightly brownish except a median yellow stripe. Apices of mandibles dark-brown. Tarsi dirty yellow. Wings hyaline. Veins yellowish.

Head (Fig. 17). Malar space about as long as height of eyes. Vertex 1.15–1.35 times as long as height of eyes. Eyes 0.60–0.80 times as wide as high in frontal view. Frons with substrigulate sculpture. Mandibles with 2 teeth and a dorsal truncation. Scrobal area bearing 10–15 hairs in addition to 2 hairs visible just above ventral margin of clypeus. Lateral outline of gena clearly rounded in frontal view. Frons bearing 10–12 pairs of hairs arranged on each side on 2 adorbital rows. Upper frons with 10–12 pairs of hairs. Scrobal lines converging above and joining together in front of mid ocellus. Oblique lines present on upper frons, joining scrobal lines to eyes. Eyes hairy, hairs about as long as diameter of a facet. Dorsal outline of vertex distinctly rounded.

Antenna (Figs 10–12). Radicula 0.35–0.40 times as long as scape. Scape slightly tapering to apex, 4.5–5.5 times as long as wide. Pedicel 2.0–2.25 times as long as wide and 0.4–0.5 times as long as scape. F1 triangular, its ventral margin convex and more than 2 times as long as the dorsal one. F2 transverse, its basal and apical margins oblique and almost subparallel. Clava 5.0–6.0 times as long as wide, 1.55–1.80 times as long as

scape and 3.3–4.1 times as long as pedicel. Maximal width of clava near its apex; dorsal outline of clava slightly convex, ventral outline hardly concave. Apex of clava truncate and bearing peg-like setae.



FIGURES 8–16. *Eretmocerus cocois* Delvare sp. n. (♀: Figs 8, 10–16; ♂: Fig. 9). 8. Female habitus. 9. Male habitus. 10. Antenna. 11. Pedicel and funicle. 12. Apex of clava. 13. Mid tarsus. 14. Fore wing. 15. Base of fore wing. 16. Submarginal vein enlarged.

Mesosoma (Figs 18–19). Mid lobe of mesoscutum with 3 pairs of setae, occasionally with supernumary setae; anterior half with reticulate sculpture, the meshes of which are larger and more visible behind pronotum; sculpture turning to substrigulate medially in posterior half, with elongate but not quite distinct meshes. Each lateral lobe with 2 setae. Each axilla with 1 seta and substrigulate sculpture. Scutellum with 2 pairs of setae and 1 pair of placoid sensilla lateral to and closer to posterior setae. Scutellum with substrigulate sculpture medially, the less distinct meshes turning isodiametric on the sides. Endophragma extending to slightly less than half of gaster length.

Mid leg (Fig. 13). Mid basitarsus 0.33–0.40 times as long as tibia. Apical spur of mid tibia 0.55–0.65 times as long as mid basitarsus.

Fore wing (Figs 14–16). Fore wing 2.25–2.5 times as long as wide. Longest posterior fringe 0.14–0.18 times as long as fore wing maximal width. Marginal vein 0.39–0.44 times as long as costal cell. Stigmal vein 0.45–0.65 times as long as marginal vein when stigmal vein is measured from apex of marginal vein to apex of stigma (as Graham, 1969) and 0.65–0.80 times so when stigmal vein is measured from base of last dorsal seta on marginal vein to apex of stigma (as Rose & Zolnerowich, 1997). Basal cell with 2 setae. Costal cell with 2 ventral setae in front of submarginal vein and 4–6 apical dorsal setae. Submarginal vein bearing 2 dorsal setae basad parastigma and a placoid sensillum at mid length between them. Parastigma with 3 dorsal setae. Marginal vein with 3 long dorsal setae. Fore wing disc with 10–15 hairs arranged on 2 rows basad of linea calva and 9–11 (7–13) microtrichiae below linea calva.

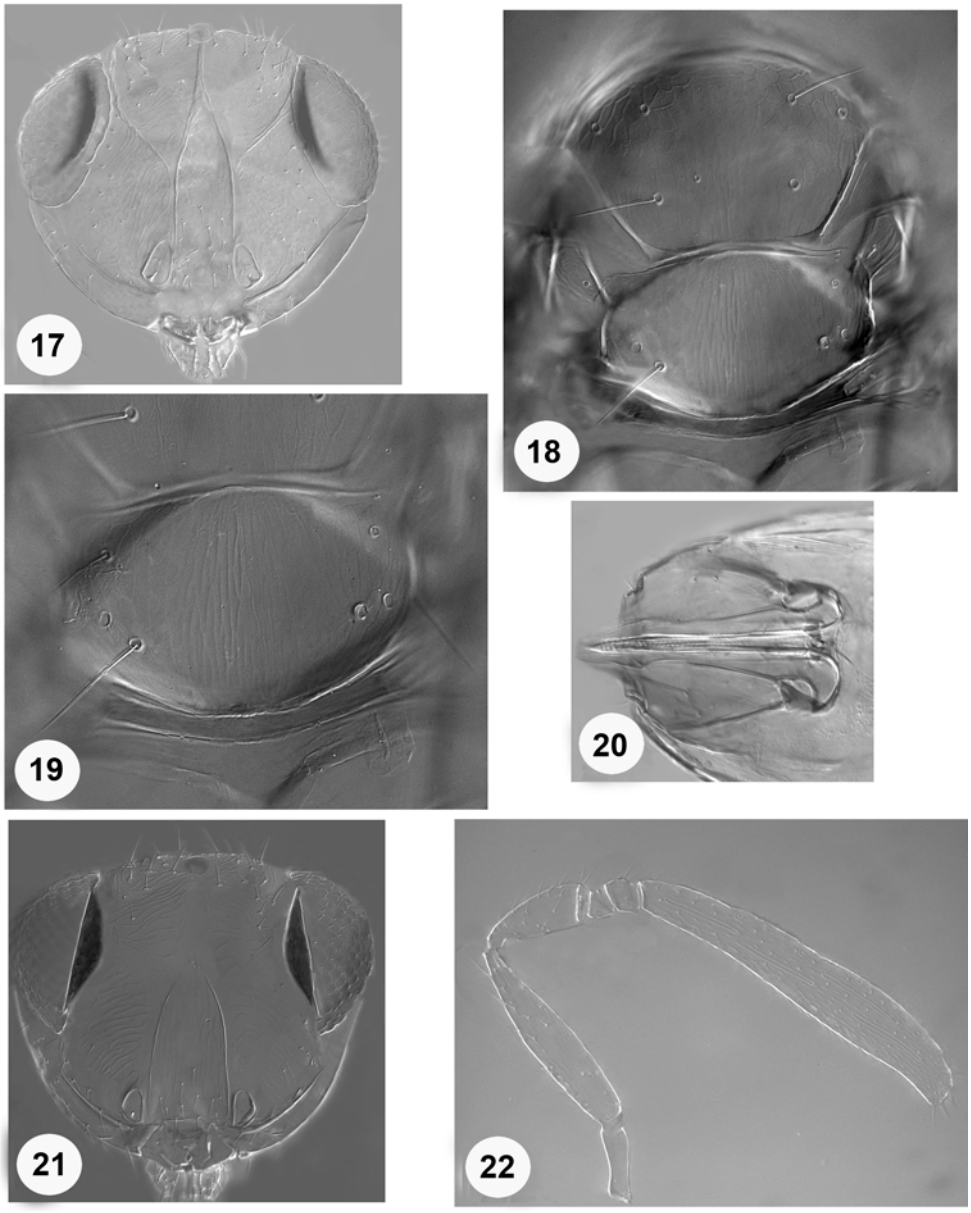
Gaster. Gastral tergites 1–5 with paired setae as follows: 2(1), 2(1), 2, 2(3), 2. Syntergum with 4 setae. Gastral sternites with an area bearing 10(8)–12(13) setae behind apex of phragma. Ovipositor curved upwards posteriorly, 0.75–1.0 times as long as mid tibia when seen in dorsal view on slide-mountings (Fig. 20).

Male (Fig. 9). – Length of critical point-dried specimens 0.8 mm. Body orange yellow dorsally. Lower face, frons, meso- and metapleuron, lateral side and ventral part of gaster pale yellow. Mandibles darkish. Scape pale yellow, pedicel moderately infuscate, flagellum dirty yellow with dark sensilla. Pronotum with 2 infuscate stripes, on each side of median line, along its posterior margin. Tegula infuscate. Metanotum slightly infuscate laterally. Propodeum strongly infuscate except in middle and on lateral margins. Legs pale yellow but tarsi moderately and uniformly infuscate. Wings hyaline, veins yellowish, setae and hairs dark. Aedeagus infuscate.

Diagnosis. The species can be separated from all described species known from the New World according to this set of characters: upper frons with oblique lines; dorsal outline of vertex distinctly convex; scape 4.5–5.5 times as long as wide; pedicel 2.0–2.25 times as long as wide and 0.4–0.5 times as long as scape; F1 subtriangular; clava 5.0–6.0 times as long as wide with maximal width near its apex, its dorsal outline slightly convex, its ventral outline hardly concave; mid lobe of mesoscutum with 3 pairs of setae; fore wing posterior fringe relatively short, maximal length 0.14–0.18 times as long as width of wing; costal cell with 4–6 apical dorsal hairs; submarginal vein with 2 dorsal setae; gastral tergites with paired setae as 2, 2, 2, 2, 2 and 10–12 sternal setae at apex of phragma.

Discussion. When using Rose and Zolnerowich (1997), *E. cocois* is keyed out as *E. joebelli* Rose and Zolnerowich. However, in that species the submarginal vein of the fore wing bears 3 dorsal hairs basad parastigma, the longest posterior fringe is 0.3 times as width of wing, the costal cell bears only 2 apical dorsal hairs, the clava is only 1.6 times as long as scape and the first three tergites bear only 1 seta on each side. The other recent Nearctic species described and not included in the above key are also different. *E. rui* (Zolnerowich & Rose 2004) and *E. perseae* (Rose & Zolnerowich 2004) have longer pedicel and clava. *Eretmocerus rosei* has 2 pairs of setae only on the mid lobe of the mesoscutum (Evans & Bennet 1996). *Eretmocerus cocois* shares with *E. picketti* Rose and Zolnerowich (2003) similar proportions of the antenna (especially of funicle and clava) and of the fore wing; however its coloration is different (pale yellow in *E. picketti*), its pedicel slightly shorter and the submarginal vein has only 2 dorsal setae basad parastigma (3 in *E. picketti*). Concerning the Neotropical species, the clava of *E. portoricensis* Dozier and *E. paulistus* Hempel, as figured by Dozier (1932) and Rose (2000) are clearly shorter and have much more convex dorsal outline. *Eretmocerus pallidus* Dozier fits the antennal habitus exhibited by *E. cocois*. The examination of the type series of *E. pallidus* showed that this species is different. The fore wing is relatively narrower and has a longer fringe, the submarginal vein bears 3 dorsal setae basad parastigma, the costal cell bears only 1–2 dorsal apical hairs, the marginal vein is relatively longer, the disc of the fore wing bears only 4–6 setae basad linea calva and the ovipositor is longer than the mid tibia. *Eretmocerus pallidus* is otherwise known only from its type series which was reared from a colony of *Tetraleurodes* sp. collected on *Annona squamosa*. The other Neotropical species were recently described by Rose (2000) from specimens reared from *A. floccosus*. They are all different from *E. cocois*: either they have only 2 pairs of setae on the mid lobe of the mesoscutum or their submarginal vein

bears only 2 dorsal setae basad parastigma. The clava is also obviously different. Hence in the key provided by Rose (2000) for the *Eretmocerus* spp. parasitoids of *A. floccosus*, *E. cocois* would run at couplet 11 together with *E. comperei* Rose and *E. dozieri* Rose. These species have a shorter scape (4.2–4.3 times as long as wide) and their posterior fringe is longer (1/3 of fore wing width). *Eretmocerus aleyrodiphagus* (Risbec) was quoted by De Santis and Fidalgo (1994) from *Aleurotrachelus socialis* Bondar in Colombia. Nevertheless the remnants of the type are in such a condition that it is impossible to recognize it from the described species. Conversely Evans and Castillo (1998) and then Trujillo *et al*. (2004) quoted having reared an undescribed *Eretmocerus* from the same whitefly.



FIGURES 17–22. Figs 17–20. ♀ *Eretmocerus cocois* Delvare sp. n. 17. Head in frontal view. 18. Mesonotum. 19. Scutellum. 20. Ovipositor. Figs 21–22. ♀ *Eretmocerus gracilis* Rose. 21. Head in frontal view. 22. Antenna.

Finally, *E. cocois* is readily recognized from the other species reared from *Aleurotrachelus* spp. in Antilles by special coloration, proportions of antennal segments, the presence of 3 pairs of setae on the mid lobe of the mesoscutum, its submarginal vein bearing only 2 dorsal setae and its short fringe on the fore wing.

Biology. As far as is known, *E. cocois* is a highly specialized species, emerging only from fourth instar nymphs of *Aleurotrachelus atratus*. This result comes from various field collects and also from specificity screenings carried out in laboratory (Youssoufa *et al*. 2006).

Distribution. The species is presently known from the following islands: Guadeloupe, Mayotte and La Reunion. It was probably involuntarily introduced in these last two islands, possibly together with its host.

Eretmocerus pallidus Dozier
(Figs 24–26)

Eretmocerus pallidus Dozier, 1932: 115–117. Type locality: HAITI: Damien. Host: *Aleurothrixus floccosus.*

Material examined (in USNM). Type material. – **Lectotype** ♀ (here designated, see Fig. 23 for placement on slide). Labelled: Eretmocerus pallidus Dozier/reared from Tetraleurodes minutissima Dozier on Annona squamosa/Port-au-Prince, Haiti/April 11, 1931/H.L. Dozier. **Paralectotypes**. 3 ♀♀ (on the same slide) and 4 ♀♀ on another slide.

Diagnosis. Mostly the antennae and appendices are visible as the specimens were slide-mounted without clearing. Radicula 0.37–0.42 times as long as the scape. Scape 3.20–4.60 times as long as wide. Pedicel (1.8) 2.0–2.1 (2.5) times as long as wide and 0.40–0.54 times as long as scape. F1 subtriangular with ventral length much longer than dorsal one. Clava 5.0–6.5 (7.25) times as long as wide, 1.75–1.85 times as long as scape and 3.25–3.90 (4.70) times as long as pedicel. Mid lobe of mesoscutum with 3 pairs of setae. Scutellum with 2 pairs of setae and a pair of placoid sensilla. Forewing 2.8–3.2 times as long as wide. Posterior fringe maximal length 0.40–0.50 times as width of wing. Marginal vein 0.45–0.55 times as long as costal cell. Stigmal vein 0.31–0.41 (0.55) times as long as marginal vein when measured as Graham (1969) or 0.48–0.62 times so when measured as Rose and Zolnerowich (1997). Costal cell with 1–2 apical dorsal hairs. Submarginal and marginal veins bearing each 3 dorsal setae. Fore wing disc bearing 4–6 hairs basad of linea calva, mostly on 1 row. 8–10 microtrichiae visible below linea calva. Length of apical spur of mid tibia 0.48–0.62 times as long as relevant basitarsus. Ovipositor 1.04–1.16 times as long as mid tibia.

This species can be recognized by its unusual small size (0.6 mm), relative proportion of antennal segments, presence of 3 pairs of setae on mid lobe of mesoscutum, relatively narrow fore wing, long marginal fringe, presence of 3 dorsal setae on submarginal vein and ovipositor, slightly longer than mid tibia.

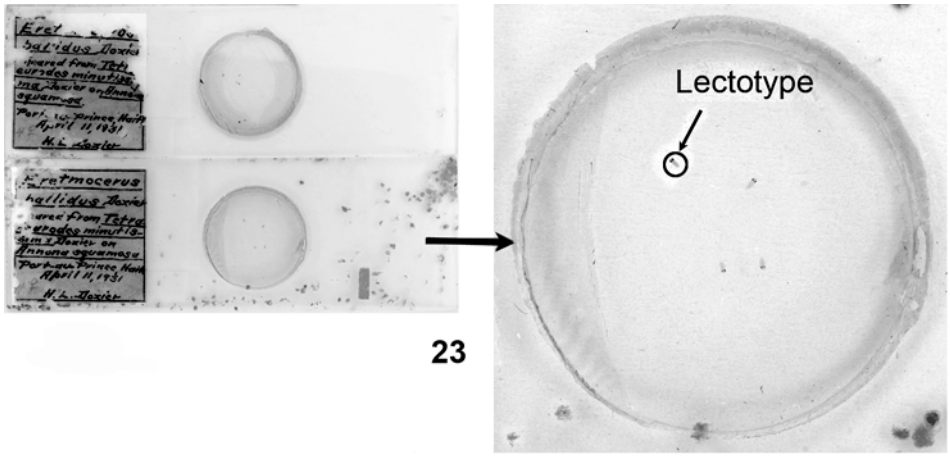
Eretmocerus desantisi Rose

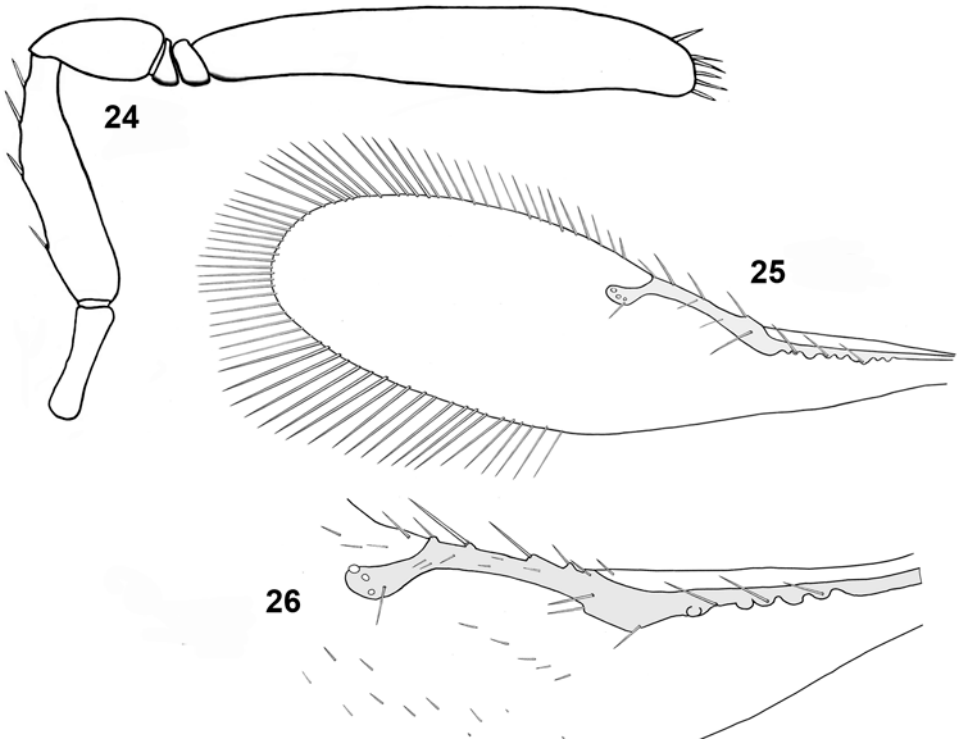
Eretmocerus desantisi Rose, 2000: 10, 18–20, figs 15–16. Type locality. PARAGUAY: Asunción. Host: *Aleurothrixus floccosus.*

Material examined (in CIRAD). 4 ♀♀ (slide-mounted) **GUADELOUPE**: Petit-Canal, Parc Paysager, 03.vi.2006 and 20.x.2006, ex *Aleurotrachelus atratus* on *Cocos nucifera* (J. Etienne) [Ref. Etienne GP 2411 and GP 2449, CIRAD 19216 and 19307]. **MARTINIQUE**: Corps-de-Garde, 5 ♀♀ (3 ♀♀ slide-mounted), 14.i.2006, same host and associate plant (A. Triboire) [Ref. CIRAD 19033] (in CIRAD). **LA RÉUNION**: Grande Anse, 1 ♀ (slide-mounted), same host and associate plant, 14.i.2004 (G. Delvare) [Ref. CIRAD 18136].

Diagnosis. Body entirely pale yellow, without transverse stripe on metanotum. Head with similar habitus and proportions as for *E. cocois*. Frons with oblique grooves. Scape 3.9–4.6 times as long as wide. Clava 4.5–5.1 times as long as wide, its dorsal margin fairly convex. Mid lobe of mesoscutum with 2 pairs of setae. Submarginal vein bearing 2 dorsal setae basad parastigma. Costal cell with 3–4 apical dorsal hairs. Fore wing disc with 7–11 hairs basad linea calva. Apical spur of mid tibia about two thirds as long as relevant basitarsus. Gastral tergites 1–5 with paired setae as follows: 1,1,1(2),2,2. Only 4–6 sternal setae behind apex of phragma.

The species was identified with the key provided by Rose (2000). The identity of the specimens examined is somewhat doubtful as their relative measurements slightly differ from that calculated from figures supplied by the author. Nevertheless the same measurements fit perfectly those of the description.





FIGURES 23–26. Type series of *Eretmocerus pallidus* Dozier. 23. Slide-mountings showing the placement of the selected lectotype. 24. Antenna. 25. Fore wing. 26. Base of forewing.

***Eretmocerus gracilis* Rose**
(Figs 21–22)

Eretmocerus gracilis Rose, 2000: 11, 24–26, figs 21–22. Type locality. PERU: Sojo. Host: *Aleurothrixus floccosus*.

Material examined (in CIRAD). **GUADELOUPE**: 3 ♀♀ (slide-mounted): Lamentin, Ravine Chaude, 01.v.1995, ex *Aleurotrachelus trachoides* Back (J. Etienne) [Ref. Étienne GP 1100, CIRAD 13690]; 1 ♀ (slide-mounted) Pointe-des-Châteaux, 18.xii.1991, ex Aleyrodidae on *Erithalis fruticosa* (Rubiaceae) [Ref. Étienne GP 597, CIRAD 11492]. **SAINT KITTS**: 1 ♀ (slide-mounted) Fairview, 04.i.1994, on *Cocos nucifera* [Ref. Étienne KP4, CIRAD 13050(1)].

Diagnosis. The Caribbean specimens perfectly fit Rose's (2000) description and figures. Head not rounded in frontal view; dorsal outline of vertex only slightly convex. Frons without oblique lines. Scrobal lines apparently not joining together above. Pedicel 2.20–2.50 times as long as wide and 0.48 times as long as scape. Clava 6.10–6.75 times as long as wide and 1.75–1.85 times as long as scape. Dorsal outline of clava almost straight except at apex, ventral outline slightly concave near apex. Mid lobe of mesoscutum with 3 pairs of setae. Marginal fringe of fore wing 0.26–0.33 times as long as the width of the wing. Submarginal vein with 3 dorsal setae basad parastigma. Costal cell with only 2–3 apical dorsal hairs. Fore wing disc with 8–10 hairs basad of linea calva. Apical spur of mid tibia about half as long as relevant basitarsus.

Tentative key for *Eretmocerus* spp. reared from *Aleurotrachelus* and *Tetraleurodes* spp.

1 Posterior marginal fringe of fore wing very long, 0.35–0.50 times as long as width of wing. Fore wing relatively narrow, more than 2.7–3.2 times as long as broad. Very small species: 0.50–0.60 mm long. [Mid lobe of mesoscutum with 3 pairs of setae]..... *pallidus* Dozier

1' Marginal fringe of fore wing shorter, at most 0.33 times as long as width of wing. Fore wing broader, most often less than 2.6 times as long as broad. Larger species: 0.80–0.90 mm long. [Mid lobe of mesoscutum with 3 or 2 pairs of setae] 2

2(1) Mid lobe of mesoscutum with 2 pairs of setae. Body completely pale yellow ..... *desantisi* Rose

2' Mid lobe of mesoscutum with 3 pairs of setae. Body sometimes orange yellow and/or with a sinuous dark transverse stripe on metanotum 3

3(2') Submarginal vein of fore wing bearing 2 dorsal setae basad parastigma .....*cocois* sp. n.

3' Submarginal vein of fore wing with 3 dorsal setae 4

4(3') Pedicel long, 3.65 times as long as wide ..... *perseae* Rose and Zolnerowich

4' Pedicel shorter, less than 3 times as long as wide.....5

5(4') Clava relatively longer, more than 6 times as long as wide. Fore wing slightly narrower, more than 2.5 times as long as wide, with posterior fringe longer, 0.26–0.33 times as long as width of wing. Gastral tergites 1 and 2 with only 1 lateral seta on each side..... *gracilis* Rose

5' Clava shorter only 5.1 times as long as wide. Fore wing broader, 2.5 times as long as wide with posterior fringe only 2.1 times as long as wing width. Gastral tergites 1 and 2 most often with a pair of setae on each side..... *picketti* Rose and Zolnerowich

Quantitative study

(Table 1; Figs 1–6)

Figure 1 represents relationships concerning antennal variables which are commonly used to discriminate *Eretmocerus* species (Hayat 1972; Viggiani & Battaglia 1983; Rose & Zolnerowich 1997; Zolnerowich & Rose 1998; Rose, 2000); these variables possibly discriminate the species but the values are very close for the three species reared from *Aleurotrachelus* spp. and need caution to be used. The ratio clava would segregate them but the available sample is too reduced to come to a definitive conclusion. The relative length of the fore wing fringe readily separates *E. cocois* from *E. pallidus* and to a lesser extent from *E. gracilis* (Figs 2–3). The number of hairs present either on wing disc or on veins are also reliable sources of information (Fig. 4); these variables mostly separate *E. cocois* from *E. pallidus* and less evidently from *E. gracilis*. The ratio of the basitarsus incompletely discriminates *E. cocois* from *E. desantisi* (Fig. 5). Finally a relationship using the gastral setae reliably distinguishes *E. cocois* from that species (Fig. 6).

Molecular study

Results. 28S rDNA D4–D5 – The fragment amplified is 666 bp and the length of the region analyzed is 618 bp. Only 5 sites were variable and parsimony informative. Hence the gene was too much conserved to be useful for species discrimination and phylogenetic inference.

28S rDNA D8–D10 – The fragment amplified is 867 bp including 15 variable sites, 10 of them being parsimony informative. The few sites which could be used point out the following relationship: *E. mundus* (*E. desantisi* (*E. cocois* Guadeloupe + *E. cocois* Reunion)).

CO1 – The fragment includes 826 bp, including variable sites, of which 137 are parsimony informative. The second codon position is the most variable one with 87 variable sites, followed by the third codon position (32 sites) and finally the first one (20 sites). The base composition is strongly biased (ACGT = 0.34, 0.09, 0.12, 0.45) in this mitochondrial region. Minimal intraspecific variation occurs within *E. mundus* (0.4 %). Genetic divergence between species ranges from 13.9 to 15.5 % and is maximal between the outgroup and the two other species (Table 3). The divergence between *E. desantisi* and *E. cocois* is much smaller (5.7 to 6.5 % according to the clone of the latter species). The intraspecific variation within *E. cocois* depends greatly on the origin of the specimens. The populations from Guadeloupe and Reunion-Mayotte are genetically identical or almost so (only one bp difference within the sample from Guadeloupe) but exhibit high variation between them (4.6 %). The tree obtained (Fig. 7) in NJ and parsimony is the same as that summarized above.

TABLE 3. CO1 sequence divergence (%) (below the diagonal) and number of differences (above the diagonal) based on pair-wise comparisons among *Eretmocerus* populations. Abbreviations. cocoG: *E. cocois* clone from Guadeloupe; cocoRM: *E. cocois* clone from Mayotte and Reunion islands; desaGu: *E. desantisi* from Guadeloupe; munNa: *E. mundus* from Nador (Morocco); munAg: *E. mundus* from Agadir. The sequences are identical within the *E. cocois* clone from Mayotte-Reunion and nearly so within the clone from Guadeloupe (1 bp difference for 1 specimen, the other sequences being identical).

	munNa	munAg	desaGu	cocoGu	cocoRM
muNa	–	3	113	117	109
muAg	0.4	–	113	117	109
desaGu	14.9	14.9	–	41	46
cocoGu	15.2	15.6	5.7	–	32
cocoRM	13.9	14.2	6.5	4.6	–

Discussion

The high genetic divergence between the two clones of *E. cocois* would suggest that they belong to two different species. Such a suggestion is reinforced by the fact that the pair-wise distance between *E cocois* and *E. desantisi* is not much greater (5.7–6.5 versus 4.6 %). Nevertheless this does not match the morphological and available biological data. We could not find any structural or quantitative character which would segregate these populations, the individuals of which are mixed on the figured scatterplots (Figs 1–6). *Eretmocerus cocois* apparently is a highly specific parasitoid, restricted to one host species. Intensive explorations carried out in Guadeloupe and Martinique to find natural enemies of whiteflies of economic importance never recovered *E. cocois* as a parasitoid of *A. trachoides* while it was reared any time a colony of *A. atratus* was collected. No other specimen of *E. cocois* was reared from other whitefly species (over 40 species) collected by JE in Guadeloupe. Similarly, tests on host specificity carried out in the laboratory at the Pole 3P in Reunion island showed that while females of *E. cocois* systematically oviposit in *A. atratus* nymphs they rarely do so on *A. trachoides* nymphs of the same instar (NB, in preparation). How could this genetic divergence be

explained? As the region of origin of *A. atratus* is the Neotropics (it was described from Brazil) (Streito *et al*. 2004) and because of the strict specificity of *E. cocois* for this host, in all probability this aphelinid has the same origin and was involuntarily introduced in some islands of the Indian Ocean. A unique specimen of *Eretmocerus* reared from *A. atratus* was collected by S. Quilici in 1999 and received at Cirad Montpellier (GD, pers. comm.) while the whitefly was observed for the first time in the same island in 1996 (Streito *et al*. 2004). It therefore seems that the introduction of both the host and its parasitoid are relatively recent and cannot explain the above genetic divergence. On the other hand *E. cocois* certainly exhibits a thelytokous reproduction: males are rare and sexually inactive (NB, in preparation). A similar situation was reported for an Australian clone of *E. mundus* (De Barro *et al*. 2000, Ardeh 2005). The latter author studied the intra- and interpopulation genetic divergence between different populations of *E. mundus* and a few other species of *Eretmocerus*, using the mitochondrial gene CO2 and the nuclear genes rDNA 28S ITS1 and ITS2. The magnitude of sequence divergence for the first gene was very high both within the Australian clone of *E. mundus* (3.5 %) and between this clone and Mediterranean populations of the same species (9.8 %). This is not surprising as thelytokous reproduction, often related in insects with infection by the cytoplasmic bacterium *Wolbachia* (Huigens & Stouthamer 2003), generates reproductive isolation inducing genetic divergence. This is one of the reasons—among many others—advocated by Rubinoff *et al*. (2006) to prevent the use of any threshold measure of genetic distance for species discrimination. Concerning *E. cocois*, it would be interesting to expand the sampling in the region of supposed origin of the parasitoid to assess whether several clones are present or not. The examination of a population from Martinique would be especially appropriate. According to P. Ryckewaert (pers. comm.) a colony of inhabitants from Martinique was established in La Reunion and exchanges and travels between the islands are frequent; this might have been the way of introduction of *A. atratus* and *E. cocois*. Identical CO1 sequences for *E. cocois* populations in the two islands would confirm this pathway.

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References

Ardeh, M.J. (2005) *Whitefly control potential of* Eretmocerus *parasitoids with different reproductive modes*. PhD dissertation, Wageningen University, 112 pp.

Beaudoin-Ollivier, L., Streito, J.C., Ollivier, J., Delvare, G., Julia, J.-F., Ryckewaert, P. & Ali, Y.M. (2004) *Aleurotrachelus atratus* Hempel (Hemiptera: Aleyrodidae) and its emergence as pest of coconut (*Cocos nucifera* L.), in the Comoro Islands. Oral presentation at 2nd European Whitefly Symposium, Croatia, cavtat, 5th–9th October 2004.

Carayon, J. (1969) Emploi du noir chlorazol en anatomie microscopique des insectes. *Annales de la Société Entomologique de France (N. S.)*, 5(1), 179–193.

De Barro, P.J., Driver, F., Naumann, I.D., Schmidt, S., Clarke, G.M. & Curran, J. (2000) Descriptions of three species of *Eretmocerus* Haldeman (Hymenoptera: Aphelinidae) parasitizing *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) and *Trialeurodes vaporariorum* (Westwood) (Hemiptera: Aleyrodidae) in Australia based on morphologi-

cal and molecular data. *Australian Journal of Entomology*, 39, 259–269.
De Santis, L. & Fidalgo, P. (1994) Catalogo de Himenopteros Calcidoideos. *Serie de la Academia Nacional de Agronomia y Veterinaria* 13, 1–145.
Dozier, H.L. (1932) The identity of certain whitefly parasites of the genus *Eretmocerus* Hald., with descriptions of new species. *Proceedings of the Entomological Society of Washington*, 34, 112–118.
Étienne, J. (1978) Introduction à La Réunion de *Cales noacki* How. (Hymenopt., Aphelinidae) pour lutter contre *Aleurothrixus floccosus* Maskell (Homopt., Aleurodidae). *Fruits*, 33(12), 883–886.
Evans, G.A. & Bennett, F.D. (1996) A new *Eretmocerus* (Hymenoptera: Aphelinidae) species reared from *Dialeurodes kirkaldyi* (Homoptera: Aleyrodidae). *Florida Entomologist*, 79(4), 579–582.
Evans, G.A. & Castillo, J.A. (1998) Parasites of *Aleurotrachelus socialis* (Homoptera: Aleyrodidae) from Colombia including descriptions of two new species (Hymenoptera: Aphelinidae: Platygasteridae). *Florida Entomologist*, 31(2), 171–178.
Gerling, D., Kyamanywa, S. & Legg, J. (2006) Some new whitefly pests in Africa. Second Whitefly Symposium, Croatia.
Graham, M.W.R. de V. (1969) The Pteromalidae of north-western Europe (Hymenoptera: Chalcidoidea). *Bulletin of the British Museum (Natural History) (Entomology), Supplement* 16, 1–908.
Hayat, M. (1972) The species of *Eretmocerus* Haldeman, 1850 (Hymenoptera: Aphelinidae) from India. *Entomophaga*, 17(1), 99–106.
Hernandez-Suarez, E., Carnearo, A., Aguiar, A., Prinsloo, G., La Salle, J. & Polaszek, A. (2003) Parasitoids of whiteflies (Hymenoptera: Aphelinidae, Eulophidae, Plastygastridae; Hemiptera: Aleyrodidae) from the Macaronesian archipelagos of the Canary Islands, Madeira and the Azores. *Systematics and Biodiversity*, 1(1), 55–108.
Howard, F.W., Moore, D., Giblin-Davis, R.M. & Abad, R.G. (2001) *Insects on Palms*. CAB International, Wallingford, 400 pp.
Huigens M.E. & Stouthamer R. (2003) Parthenogenesis associated with *Wolbachia. In*: Bourtzis K. & Miller T.A (Eds), *Insect symbiosis*. CRC Press: Boca Raton, pp. 247–266.
Julia, J.-F. (2003) *Rapport de Mission Entomologique aux Comores en appui au projet DECVAS du 30 mars au 13 avril 2003*. CIRAD-CP, Montpellier, 21 pp.
Kumar, S., Tamura, K. & Nei, M. (2004) MEGA3: Integrated software for Molecular Evolutionary Genetics Analysis and sequence alignment. *Briefings in Bioinformatics*, 5, 150–163.
Martin, J.H. (2005) Whiteflies of Belize (Hemiptera: Aleyrodiae). Art 2. – a review of the subfamily Aleyrodinae Westwood. *Zootaxa*, 1098, 1–116.
Mound, L.A. & Halsey, S.H. (1978) *Whiteflies of the world. A systematic catalogue of the Aleyrodidae (Homoptera) with host plant and natural enemy data*. Bristish Museum (Natural History) and John Wiley and Sons, Chichester, New York, etc, 340 pp.
Noyes, J.S. (1982) Collecting and preserving chalcid wasps (Hymenoptera: Chalcidoidea). *Journal of Natural History*, 16, 315–334.
Noyes, J.S. (2002) *Interactive catalogue of World Chalcidoidea*. Taxapad, Scientific Names for Information Management (Cd-Rom).
Ollivier, J. (2003) *Rapport de Mission aux Comores en appui au projet DECVAS du 18 au 30 novembre 2002*. CIRAD-CP, Montpellier, 33 pp.
Ollivier, L. & Delvare, G. (2005) *Projet de lutte biologique contre les aleurodes du cocotier aux Comores. Rapport de mission aux Comores du 9 au 20 octobre 2005*. INRAPE-CIRAD-PRPV, Montpellier, 41 pp.
Quilici, S., Vincenot, D. & Franck, A. (2003) *Les auxiliaires des cultures fruitières à l'île de La Réunion*. CIRAD Editions, Saint-Pierre, La Réunion, 167 pp.
Rose, M. (2000) *Eretmocerus* Haldeman (Hymenoptera: Aphelinidae) reared from *Aleurothrixus floccosus* (Maskell) (Homoptera: Aleyrodidae) in the Americas. *Vedalia*, 7, 3–46.
Rose, M. & Zolnerowich, G. (1997) *Eretmocerus* 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*, 99(1), 1–27.
Rose, M. & Zolnerowich, G. (2003) *Eretmocerus picketti* new species (Hymenoptera: Chalcidoidea: Aphelinidae), reared from *Tetraleurodes acaciae* (Quaintance) (Homoptera: Aleyrodidae). *Pan-Pacific Entomologist*, 79(2), 119–127.
Rose, M. & Zolnerowich, G. (2004) *Eretmocerus perseae* n. sp. (Hymenoptera: Chalcidoidea: Aphelinidae) reared from *Tetraleurodes perseae* Nakahara (Homoptera: Aleyrodidae: Aleyrodinae) living on avocado in Michoacan, Mexico. *Vedalia*, 11, 45–52.
Rubinoff, D., Cameron, S. & Will, K. (2006) A genomic perspective on the shortcomings of mitochondrial DNA for "Barcoding" identification. *Journal of Heredity*, 97, 581–594.
Simon, C., Frati, F., Beckenbach, A., Crespi, B. Liu, H. & Flook, P.L. (1994) Evolution, weighting, and phylogenetic utility of mitochondrial gene sequences and a compilation of conserved polymerase chain reaction primers. *Annals of the Entomological Society of America*, 87, 651–701.

Streito, J.-C., Ollivier, J. & Beaudoin-Ollivier, L. (2004) Deux ravageurs nouveaux du cocotier (*Cocos nucifera* L.) pour la faune des Comores : *Aleurotrachelus atratus* Hempel, 1922 & *Paraleyrodes bondari* Peracchi, 1971 (Hemiptera, Aleyrodidae). *Bulletin de la Société Entomologique de France*, 109(1), 67–72.

Swofford, D.L. (2001) *PAUP. Phylogenetic Analysis Using Parsimony and other methods. Version 4.0 beta version.* Sinauer, Sunderland, Massachusetts, USA.

Trujillo, H.E., Arias, B., Guerrero, J.M., Hernandez, P., Belloti, A. & Peña, J.E. (2004) Survey of parasitoids of whiteflies (Homoptera: Aleyrodidae) in cassava growing regions of Colombia and Ecuador. *Florida Entomologist*, 87(3), 268–273.

Viggiani, G. & Battaglia, D. (1983) Le specie italiane del genere *Eretmocerus* Hald. (Hymenoptera: Aphelinidae). *Bollettino del Laboratorio di Entomologia Agraria 'Filippo Silvestri', Portici*, 40, 97–101.

Youssoufa, M.A., Issimaila M.A., Chadhouliati, A.C., Borowiec, N., Quilici, S., Ollivier, L., Delvare, G. & Reynaud, B. (2006) *Programme de lutte biologique contre les aleurodes (Hemiptera: Aleyrodidae) nuisibles au cocotier aux Comores*. 6ème Conférence Internationale Francophone d'Entomologie, Rabat, Maroc, July 02–06, 2006.

Zhang D.X. & Hewitt, G.M. (1996). Nuclear integrations: challenges for mitochondrial DNA markers. *Trends in Ecology and Evolution*, 11**,** 247–251.

Zolnerowich, G. & Rose, M. (1998) *Eretmocerus* Haldeman (Hymenoptera: Aphelinidae) imported and released in the United States for control of *Bemisia* (*tabaci* complex*) (Homoptera: Aleyrodidae). Proceedings of Entomological the Society of Washington*, 100(2), 310–323.

Zolnerowich, G. & Rose, M. (2004) *Eretmocerus rui* n. sp. (Hymenoptera: Chalcidoidea: Aphelinidae), an exotic natural enemy of *Bemisia* (*tabaci* group) (Homoptera: Aleyrodidae) released in Florida. *Florida Entomologist*, 87(3), 283–287.