New Neotropical Culicoides and redescription of Culicoides reticulatus Lutz (Diptera: Ceratopogonidae)

MARIA CLARA ALVES SANTARÉM1,5, ROSIMEIRE LOPES DA TRINDADE2, TIAGO DO NASCIMENTO DA SILVA1, ELOY GUILLERMO CASTELLÓN3, CÁTIA ANTUNES DE MELLO PATIU4 & MARIA LUIZA FELIPPE-BAUER1

1Coleção de Ceratopogonidae, Laboratório de Diptera, Instituto Oswaldo Cruz, Av. Brasil 4365, CEP 21040-900, Rio de Janeiro, RJ, Brazil. E-mail: mcalves@ioc.fiocruz.br; tnsilva@ioc.fiocruz.br; mlfbauer@ioc.fiocruz.br
2Divisão de Zooloigia, Instituto de Pesquisas Científicas e Tecnológicas do Estado do Amapá, Rod. Juscelino Kubitschek, km 10, Fazendinha, CEP 68903-419/68903-197, Macapá, AP, Brazil. E-mail: rostitrindade@hotmail.com
3Laboratório de Insetos Sinantrópicos, Instituto Nacional de Pesquisas da Amazônia, Av. André Araújo, 2936, Aleixo, CEP 69060-001, Manaus, Amazonas, Brazil. E-mail: eloygcb@gmail.com
4Departamento de Entomologia, Museu Nacional/UFRJ, Quinta da Boa Vista, s/n., São Cristóvão, CEP 20940-040, Rio de Janeiro, RJ, Brazil. E-mail: camello@acd.ufrj.br
5Programa de Pós-Graduação em Zoologia, Museu Nacional/UFRJ, Quinta da Boa Vista, s/n., São Cristóvão, CEP 20940-040, Rio de Janeiro, RJ, Brazil

Abstract

Seven new species of the Culicoides reticulatus species group are described and illustrated based on specimens from Colombia, Panama and Brazilian states of northern (Amazonas, Pará and Roraima) and southeast region (Rio de Janeiro). The new species are compared with their similar congener, Culicoides reticulatus Lutz, and a systematic key, table with numerical characters to the females of the species are provided. Redescription of Culicoides reticulatus Lutz is given based on type series deposited in the Ceratopogonidae Collection of the Oswaldo Cruz Foundation, Brazil. The distribution of these species is presented in figure 9.

Key words: Culicoides reticulatus Lutz, bloodsucking midges, Brazil, Colombia, Panama, new species

Resumo


Palavras-chave: Culicoides reticulatus Lutz, maruins, Brasil, Colômbia, Panamá, espécies novas

Introduction

The precise identity of Culicoides reticulatus Lutz has been subject of considerable confusion in the literature as mentioned below. Lutz (1913) described the species from specimens collected in the States of Rio de Janeiro, São Paulo (Santos) and Bahia. He pointed out that the third palp segment of the female present a rounded pit in swollen mid portion and a scutum with a prominent pattern with four median anterior yellowish spots arranged as a leaf clover. Lutz also cited that the immature stages can be found in crab holes in mangroves areas and the females
can bite human, horses and cow in the vicinity of these areas. Barbosa (1943) described the male and redescribed the female from specimens collected in mangrove areas of Recife, Pernambuco, Brazil and, as it was observed by Lutz, corroborated that the third palpal segment of the female present one distinct palpal pit. Forattini & Galvão (1955), studying material from Brazil (São Vicente and Caraguatatuba, São Paulo State) and Panama, redescribed C. reticulatus and observed differences in the number of palpal pits, varying from one to three. Wirth & Blanton (1959), in their revision of Culicoides from Panama, redescribed this species and cited the presence of a double sensory pit in female specimens. Posteriorly, Wirth & Blanton (1973) expanded its distribution to Colombia and Costa Rica and Wirth et al. (1988) mentioned its occurrence in Brazil, Colombia, Panama, Costa Rica and Honduras, being this distribution considered as valid until now. In order to better known the identity of this species, we studied specimens identified as C. reticulatus, including the only known type series from Bahia, Brazil, deposited in Ceratopogonidae Collection of the Oswaldo Cruz Foundation (CCER), Rio de Janeiro, Brazil.

The study revealed that the specimens identified as C. reticulatus from different regions are significantly different from type specimens and represent seven undescribed species, which are herein described and illustrated: C. amazonicus Santarém, Felippe-Bauer & Trindade, C. diplus Santarém & Felippe-Bauer, C. fluminensis Santarém & Felippe-Bauer, C. irregularis Santarém, Felippe-Bauer & Castellón, C. profundus Santarém, Felippe-Bauer & Trindade, C. pseudoreticulatus Santarém, Felippe-Bauer & Castellón and C. rhombus Santarém, Felippe-Bauer & Castellón. Culicoides reticulatus Lutz is also redescribed and a key, table with numerical characters for the identification and map with distribution of these related species is included.

Material and methods

Individual studied specimens are deposited in the following collections:

CCER Collection of Ceratopogonidae, Instituto Oswaldo Cruz, Rio de Janeiro, Brazil.
FSP Entomological Collection, Faculdade de Saúde Pública, USP, São Paulo, Brazil.
ILMD Laboratory of Biodiversity in Health, Instituto Leônidas e Maria Deane, Manaus, Amazonas, Brazil.
MLP Entomological Collection, Museu de La Plata, La Plata, Argentina.
MPEG Invertebrate Collection, Museu Paraense Emílio Goeldi, Pará, Brazil.

The slide mounted specimens deposited in the above collections was take on loan for study. Diagnostic characters were illustrated or microphotographed using a Nikon Eclipse E 200 and a Zeiss AX10 microscope, and the plates were prepared using GIMP Portable 2.6. The general terminology used is that employed for Culicoides by Felippe-Bauer (2003). Terms for structures follow the Manual of Central America Diptera (Brown et al., 2009). The measurements of structures are included in the text, those of the spermathecae are in micrometers, while those of the wings are in millimeters. Meristic information is given as range, following by the mean and number of specimens examined.

Results

While studying material identified as C. reticulatus Lutz from diverse localities, we observed differences in the taxonomic parameters actually used in Culicoides. The only female specimen studied by Forattini & Galvão (1955) from São Vicente has difference in the number of palpal pits (two well separate pits on left palpus and three on right palpus). The presence of different number of pits in the third palpal segment in the same specimen is not common and probably constitutes an anomaly as observed for other Culicoides species by Felippe-Bauer & Silva (2006). The only female specimen from Caraguatatuba present PR=2.1, P/H ratio =1.25 and one oval palpal pit in transverse position. The meristic data, the shape of the third palpal segment and the position of the palpal pit are also different from the type series of C. reticulatus, and we don't consider this diverse specimen in our redescription of C. reticulatus.

Unfortunately, Wirth & Blanton (1973) and Wirth et al. (1988) not cited the deposit house of the specimens from Costa Rica and Honduras, studied by them. Asking the Instituto Nacional de Biodiversidad (InBIO Costa
Culicoides reticulatus Lutz, redescription
Figs. 1A–K; Fig. 9

Culicoides reticulatus Lutz, 1913: 49 (female; Brazil - Rio de Janeiro, São Paulo and Bahia; fig. wing, male, larva; bionomy, larva in crab holes in mangrove edge; in part material from Bahia); Rieth, 1915: 417 (bionomics data, based on Lutz 1913); Costa Lima, 1937: 413 (key); Barbosa, 1943: 261 (male, female; Brazil - Pernambuco; figs. wing, palpus, male terminalia); Vargas, 1945: 43 (in list); Barbosa, 1947: 5, 25 (key, distrib.); Macfie, 1948: 73 (key); Vargas, 1949: 205 (in list); Ortiz, 1950: 464 (distrib); Iriarte, 1950: 398 (in list); Fox, 1955: 254 (in list); Forattini, 1957: 432 (in neotropical catalog; figs.; in part specimens from Bahia and Pernambuco); Spinelli & Wirth, 1986: 56 (key, fig. wing); Wirth et al., 1988: 42 (in Atlas; fig. wing; distrib.; in part material from Brazil, not Pará); Borkent & Wirth, 1997: 80 (in catalog); Borkent & Spinelli, 2000: 41 (in catalog; distrib.; in part material from Bahia and Pernambuco); Borkent & Spinelli, 2007: 74 (in catalog; distrib. in part material from Bahia and Pernambuco); Borkent, 2014: 99 (in catalog).

Diagnosis. Female: This species is distinguished by the following combination of characters: large sized species; eyes separated by diameter of ½ ommatidium; palpus with shallow, rounded sensory pit in middle portion; PR 2.6–3.0 (n=6); proboscis long. Male: parameres stem, slightly sinuous in median portion, without ventral lobe; basal arch of aedeagus extending ½ of total length.

Female. Head. Brown. Eyes bare (Fig.1C), separated by a distance equal to a diameter of ½ ommatidium. Pedicel brown, flagellum (Fig.1D) pale brown; AR 1.0–1.4 (1.02, n=5); sensilla coeloconica on flagellomeres...
1.6–8. Palpus (Fig.1F) brown; 3rd segment fusiform, slightly swollen in middle length, with a shallow, rounded sensory pit in middle portion; PR 2.6–3.0 (2.8, n=6). Proboscis long; P/H ratio 1.14–1.17 (1.16, n=4); mandible with 23–25 (n=4) teeth.

**FIGURE 1.** *Culicoides reticulatus* Lutz. Female: A. Wing; C. Eyes separation, anterior view; D. Antenna; E. Spermathecae; F. Palpus; G. Femora and tibiae of fore-, mid- and hind legs (left to right), lateral view. Male: B. Wing; H. Palpus; I. Terminalia; J. Aedeagus; K. Parameres.
Thorax. Dark brown. Scutum without distinct pattern in slide mounted specimens. Wing (Fig.1A) with contrasting pattern: second radial cell including dark spot; pale spot over R-M extending from M₁ to costal margin, subdivided; r₁ with four small and separated pale spots: first, rounded, between the second radial cell and M₁; second, poststigmatic extending behind second radial cell, abutting wing margin; third, in the middle of cell, rounded, smaller than second one; fourth, distal pale spot slightly reaching wing margin; m₁ with two pale spots, the distal one far from wing margin and greater than the proximal one; m₂ with four pale spots: one proximal, near CuA, two between the medial and mediocubital forks and a distal one not reaching the wing margin; cuₐ with a rounded pale spot in the middle of cell; anal cell with a faint basal pale area and one distal pale spot near mediocubital fork; wing base with a faint pale spot on M₁; M₂ and CuA₁ with pale apices; macrotrichia scarcely distributed on distal half of wing; wing length 1.30 (n=4) mm; breadth 0.57–0.59 (0.55, n=4) mm; CR 0.64 (n=4). Halter knob brown, stem pale. Legs (Fig.1G) mostly brown; femora with subapical pale bands, tibiae with subbasal pale bands; hind tibia pale apically; hind tibial comb with four spines, the one nearest the spur longest.

Abdomen. Brown. Two subequal ovoid spermathecae (Fig. 1E), measuring 46.4 µm (n=5) by 32.8 µm (n=4) and 43.5 µm (n=4) by 31 µm (n=2). Rudimentary third spermatheca present.

Male. Similar to female with usual sexual differences. AR 0.93 (n=1). Palpus (Fig.1H) with 3rd segment short, two round sensory pits; PR 1.6 (n=1). Wing length 1.03 (n=1) mm, breadth 0.43 (n=1) mm, CR 0.63 (n=1), pattern of pale spots as in figure 1B. Terminalia (Fig.1I): tergite 9 not observable in slide mounted specimen; sternite 9 straight on distal margin; gonocoxite 2x longer than greatest breadth, ventral and dorsal root slender, elongated; gonostylus tapering distally, distal portion slightly curved. Parameres (Fig.1K) separated, each with a sclerotized basal knob; stem long, curved near base and slightly sinuous in median portion, without ventral lobe; apical portion tapered, abruptly bent, without lateral fringe of spicules. Aedeagus (Fig.1J) Y-shaped, lateral arms strongly sclerotized, basal arch triangular extending ½ of total length; distal portion slender, tapering to blunt tip without median or distal processes.

Specimens examined. Type series, 1 male, 7 females on one microscope slide, labeled "Culicoides reticulatus Lutz, 1913, Bahia, A. Lutz prep." (CCER n.2983- Costa Lima collection).

Distribution and bionomics. Culicoides reticulatus is now restricted to Brazilian states of Bahia and Pernambuco (Fig. 9). It is associated to mangrove areas from these states and cited by Lutz (1913) biting human, horses and cow in the vicinity of these areas.

Discussion. Forattini et al (1960) captured larva and pupa of Culicoides in mangrove areas and described them as C. reticulatus without correlation with adult stage. Due to incertitude if this description is related to C. reticulatus Lutz and, constitutes five new species as described below. Then, we think that the bionomic data cited by Veras & Castellón (1998) for C. reticulatus from Amazonas State, as well as the records published by Wirth & Blanton (1973) and Castellón et al (1993) for this species in Amazonas and Para states, cannot be considered due to the misidentification of these species.

Culicoides amazonicus Santarém, Felippe-Bauer & Trindade sp. nov.
Figs. 2A–G; Fig. 9

Diagnosis. Female: This species is easily distinguished by the following combination of characters: palpus 3rd segment swollen, with large, shallow, oval sensory pit on middle of segment; PR 2.6–3.2; long proboscis; mandible with 24 teeth; two unequal spermathecae.

Female. Head. Brown. Eyes bare (Fig.2B), narrowly separated, smaller than ½ ommatidium. Pedicel brown, flagellum pale brown, first eight flagellomeres paler on proximal ½; AR 0.98–1.04 (1.0, n=7) (Fig.2C); sensilla coeloconica on flagellomeres 1.6–8, two on 1, 6–7 and three on 8. Palpus (Fig.2G) brown; 3rd segment swollen, with a large, shallow, oval sensory pit in middle of segment; PR 2.6–3.2 (2.8, n=10). Proboscis long; P/H ratio 1.03–1.16 (1.11, n=11); mandible with 24 teeth.

Thorax. Dark brown. Prominent pattern of yellowish patches well defined (Fig. 2F); pale humeral depressions present. Scutum with two pale areas in the anterior submedian portion arranged as leaf clover and two pale areas in posterior submedian portion; lateral portion, with anterior and posterior pale areas; pale prescutellar depressions...
FIGURE 2. *Culicoides amazonicus* sp. nov., female. A. Wing; B. Eyes separation, anterior view; C. Antenna; D. Fore-, mid- and hind legs (left to right); E. Spermathecae; F. Scutum; G. Palpus.

present; scutellum yellowish laterally; postscutellum brown. Wing (Fig. 2A) with contrasting pattern: second radial cell including dark spot; pale spot over R-M extending from M₁ to the costal margin, subdivided; r₃ with four small and separated pale spots: first, rounded, between the second radial cell and M₁; second, poststigmatic, extending behind second radial cell, abutting wing margin; third, rounded, in the middle of cell similar to the second one; fourth, distal pale spot slightly reaching wing margin; m₁ with two pale spots, the distal one far from
wing margin and greater than proximal one; m₂ with four pale spots: one proximal, near CuA, two between the medial and mediocubital forks, a distal one not reaching wing margin; cuₐ with a rounded and small pale spot in the middle of cell; anal cell with a faint, basal pale area, one distal pale spot near mediocubital fork and one very faint pale spot reaching wing margin, not present in some specimens; wing base with a pale spot on Mₙ; M₁, M₂ and CuA, with pale apex; macrotrichia scarcely distributed; wing length 0.87–0.95 (0.92, n=10) mm; breadth 0.42–0.47 (0.46, n=10) mm; CR 0.62–0.66 (0.64, n=10). Halter knob brown laterally, stem pale. Legs (Fig.2D) mostly brown; femora with subapical pale bands, tibiae with subbasal pale bands; hind tibia apically; hind tibial comb with four spines, the one nearest the spur longest.

Abdomen. Brown. Two unequal ovoid spermathecae (Fig.2E), measuring 49.7 µm by 35.2 µm (n=10) and 38.2 µm by 28.1 µm (n=9), with sclerotized ducts with 7.5 µm (n=9). Long, slender, rudimentary third spermatheca present (22.5 µm).

Male. Unknown.


Distribution and bionomics. This species is restricted to Brazilian state of Pará (Fig. 9). It is associated with forest areas in farms.

Etymology. This species is named in tribute of the Brazilian Amazon Region, where the specimens were collected.

**Culicoides diplus Santarém & Filippe-Bauer sp. nov.**

Figs. 3A–H; Fig. 9

*Culicoides reticulatus*: Wirth & Blanton, 1959: 393; Wirth & Blanton, 1973: 446 (distrib.; in part, at least specimens from Colombia and Panama); Wirth *et al*., 1988: 42 (in Atlas; fig. wing; distrib. in part, at least specimens from Colombia and Panama); Borkent & Spinelli, 2007: 74 (in catalog; distrib. in part, at least specimens from Colombia and Panama).

Diagnosis. Female: This species can be easily distinguished by 3rd segment of palpus with two well defined sensory pits on distal 2/3 of the segment, the basal one ventrally and the distal one laterally; PR 2.5–2.8. Male: tergite 9 long, tapering, with very short and blunt apicolateral processes, with distinctly posteromedial notch; parameres stem sinuous and swollen in median portion ending in a ventral lobe; basal arch of aedeagus extending 2/3 of total length.

Female. Head. Brown. Eyes bare (Fig. 3E), narrowly separated, smaller than ½ ommatidium. Pedicel brown, flagellum pale brown, first eight flagellomeres paler on ½ proximal; AR 1.04–1.13 (1.08, n=2) (Fig. 3C); sensilla coeloconica on flagellomeres 1, 6-8, two on 1, three on 6-8. Palpus (Fig.3D) brown; 3rd segment with two well defined sensory pits on distal 2/3 of the segment, the basal one ventrally and the distal one laterally; PR 2.5–2.8 (2.7, n=4). Proboscis long; P/H ratio 1.0–1.05 (1.02, n=2); mandible with 21 teeth (n=2).

Thorax. Dark brown. Scutum without distinct pattern in slide mounted specimens. Wing (Fig.3A) with contrasting pattern: second radial cell including dark spot; pale spot over R-M extending from M₁ to the costal margin, subdivided; r₁ with four small and separated pale spots: first, rounded, between the second radial cell and M₁; second, poststigmatic, extending behind second radial cell, abutting wing margin; third, rounded, in middle of cell, similar to the second one; fourth, distal pale spot slightly reaching wing margin; m₁ with two pale spots, the distal one far from wing margin and greater than the proximal one; m₂ with four pale spots: one proximal, near CuA, two between the medial and mediocubital forks, a distal one not reaching wing margin; cuₐ with a rounded pale spot in the middle of cell; anal cell with a faint, basal pale area and two distal pale spots, one near mediocubital fork and other reaching wing margin; wing base with a pale spot on M₁; M₂ and CuA, with pale apex; macrotrichia scarcely distributed on the distal third of wing; wing length 0.94–0.98 (0.96, n=3) mm; breadth 0.46–0.50 (0.47, n=3) mm; CR 0.66–0.67 (0.66 n=3). Halter knob brown in middle, stem pale. Legs (Fig. 3H) mostly brown; femora with subapical pale bands, tibiae with subbasal pale bands; hind tibia apically; hind tibial comb with four spines, the one nearest the spur longest.
Abdomen. Brown. Two subequal ovoid spermathecae (Fig. 3F), measuring 48 µm (n=2) by 41.3 µm (n=2) and 45 µm (n=2) by 37 µm (n=2); long, slender, rudimentary third spermatheca present (15 µm) in some specimens.

Male. Similar to female with usual sexual differences. Sensilla coeloconica on flagellomeres 1,7–10, one on 1,7–8, two on 9, three on 10; AR 0.84 (n=1); PR 1.5 (n=1); wing length 0.80–0.85 (0.83, n=2) mm, breadth 0.35–0.38 (0.36, n=2) mm, CR 0.61 (n=2), pigmentation pattern as in figure 3B. Terminalia (Fig.3G) tergite 9 long, tapering, with very short and blunt apicolateral processes, with distinctly posteromedial notch; sternite 9 straight on
distal margin. Gonocoxite two times longer than greatest breadth, ventral and dorsal root slender, elongated; gonostylus with ½ distal portion slightly curved. Parameres separated, each with a sclerotized basal knob; stem long, curved near base and sinusuous and swollen in median portion ending in a ventral lobe; apical portion tapered, abruptly bent, without lateral fringe of spicules. Aedeagus Y-shaped, lateral arms strongly sclerotized, basal arch triangular extending 2/3 of total length; distal portion rounded without median or distal processes.

**Type data and depository.** Holotype female, COLOMBIA, Valle Rio Raposo, II.1965, light trap, Lee col., (CCER). Allotype male, Garachine RP, PANAMA, 24.II.1953, FS Blanton col. (FSP). Paratypes, five as follows: two females, same data except V.1965 (CCER; MLP); one female, same data as holotype except VIII.1965 (MLP); one female, PANAMA, Mojinga Swamp, Ft Sherman, 28.VIII.1951, FS Blanton col. (FSP); one male, same data as allotype (FSP).

**Distribution and bionomics.** This species is restricted to Colombia and Panama (Fig. 9). It is associated with mangrove areas in these countries.

**Etymology.** The name of this species is based on the presence of two palpal pit on third palpal segment (Greek—diplóos = two).

---

**Culicoides fluminensis** Santarém & Felippe-Bauer, sp. nov.

Figs. 4A–D

*Culicoides reticulatus* Lutz, 1913: 49 (female; Brazil - Rio de Janeiro, São Paulo and Bahia; fig. wing, male, larva; bionomy, larva in crab holes in mangrove edge; in part material from Rio de Janeiro); Forattini, 1957: 432 (in neotropical catalog; figs.; in part specimens from Rio de Janeiro); Wirth & Blanton, 1973: 446 (distrib. in part material from Rio de Janeiro); Borkent & Spinelli, 2000: 41 (in catalog; distrib.; in part material from Rio de Janeiro); Borkent & Spinelli, 2007: 74 (in catalog; distrib. in part material from Rio de Janeiro).

**Diagnosis.** Female: This species is easily distinguished by the following combination of characters: large sized species; 3rd segment of palpus with a small, shallow, rounded, sensory pit in middle portion; PR 2.6–3.2; long proboscis; single pale spot over R-M; anal cell with two distal pale spots, one near mediocubital fork and other not reaching wing margin; two unequal spermathecae.

**Female.** Head. Brown. Eyes bare (Fig.4B), narrowly separated, smaller than ½ ommatidium. Pedicel brown, flagellum pale brown, first eight flagellomeres paler on proximal ½; AR 0.95–1.12 (1.03, n=6); sensilla coeloconica on flagellomeres 1,6–8, two on all flagellomeres. Palpus (Fig. 4C) brown; 3rd segment slightly swollen with a small, shallow, rounded sensory pit in middle portion; PR 2.6–3.2 (2.9, n=4). Proboscis long; P/H ratio 1.05–1.18 (1.14, n=9); mandible with 20 teeth.

**Thorax.** Dark brown. Prominent pattern of yellowish patches well defined; pale humeral depressions present. Scutum with two pale areas in the anterior submedian portion arranged as leaf clover and two pale areas in posterior submedian portion; lateral portion with anterior and posterior pale areas; pale prescutellar depressions present; scutellum yellowish laterally; postscutellum brown. Wing (Fig.4A) with contrasting pattern: second radial cell including dark spot; one pale spot over R-M extending from M₁ to the costal margin, slightly subdivided in some specimens; r₁ with four small and separated pale spots: first, oval, between the second radial cell and M₁; second, poststigmatic, extending behind second radial cell, abutting wing margin; third, rounded, in middle of cell, smaller than others; fourth, distal pale spot slightly reaching wing margin; m₁ with two pale spots, the distal one far from wing margin and greater than proximal one; m₂ with four pale spots: one proximal, near CuA, two between the medial and mediocubital forks, a distal one, small, not reaching wing margin; cuₐ with a rounded pale spot in the middle of cell; anal cell with a faint, basal pale area and two distal pale spots, one near mediocubital fork and other, faint, not reaching wing margin; wing base with a pale spot on M; M₁, M₂ and CuA₁ with pale apex; macrotrichia scarcely distributed on the distal third of wing; wing length 1.03–1.16 (1.08, n=10) mm; breadth 0.49–0.54 (0.51, n=10) mm; CR 0.63–0.66 (0.65, n=10). Halter knob brown in middle, stem pale. Legs (Fig.4D) mostly brown; femora with subapical pale bands, tibiae with subbasal pale bands; hind tibiae apically; hind tibial comb with four spines, the one nearest the spur longest.

**Abdomen.** Brown. Two unequal ovoid spermathecae in bad condition in slide mounted specimens. Long, swollen, rudimentary third spermatheca present (12.5 μm).
**FIGURE 4.** *Culicoides fluminensis* sp. nov., female. A. Wing; B. Eyes separation, anterior view; C. Palpus; D. Femora and tibiae of fore-, mid- and hind legs (left to right).

**Male.** Unknown.

**Type data and depository.** Holotype female, BRAZIL, Rio de Janeiro, Macaé, Barra de Macaé, R. Idelbrando Alves Barbosa, 22°20'S 41°45'O, 29.III.1989, New Jersey trap, FEEMA col. (CCER). Paratypes nine females as follows: six, same data as holotype (CCER); three, same data as holotype, except 25.IV.1989 (2 CCER; MNRJ).

**Distribution and bionomics.** This species is restricted to Brazilian state of Rio de Janeiro (Fig. 9). It was collected near mangrove areas from the municipality of Macaé.

**Etymology.** This species is named after the originaries of the state of Rio de Janeiro, where the specimens were collected.
**Culicoides irregularis** Santarém, Felippe-Bauer & Castellón sp. nov.
Figs. 5A–F; Fig. 9

**Diagnosis.** Female: This species is easily distinguished by the following combination of characters: palpus 3rd segment with a multiple, shallow, irregular sensory pit; PR 2.0–2.9; moderately long proboscis; mandible with 16 teeth; two unequal ovoid spermathecae.

**FIGURE 5.** *Culicoides irregularis* sp. nov., female. A. Wing; B. Eyes separation, anterior view; C. Antenna; D. Fore-, mid- and hind legs (left to right); E. Spermathecae; F. Palpus.
Female. Head. Brown. Eyes bare (Fig. 5B), narrowly separated, smaller than ½ ommatidium. Pedicel brown, flagellum pale brown, first eight flagellomeres paler on proximal ½; AR 1.04–1.25 (1.12, n= 24) (Fig. 5C); sensilla coeloconica on flagellomeres 1,6–8; two on 1, three on 6–7 and three - four on 8. Palpus (Fig. 5F) brown, 3rd segment swollen with a multiple, shallow, irregular sensory pit in ventral, dorsal and lateral side of segment; PR 2.0–2.9 (2.6, n=31). Proboscis moderately long; P/H ratio 0.80–0.94 (0.84, n=28); mandible with 16 teeth.

Thorax. Dark brown. Scutum without distinct pattern in slide mounted specimens. Wing (Fig. 5A) with contrasting pattern: second radial cell including dark spot, pale spot over R-M extending from M to the costal margin, subdivided; r, with four small and separated pale spots: first, rounded, between the second radial cell and M1; second, poststigmatic, extending behind second radial cell, abutting wing margin; third, rounded, in middle of cell; fourth, distal pale spot slightly reaching wing margin; m1, with two pale spots, the distal one far from wing margin; m, with four pale spots: one proximal, two between the medial and mediocubital forks, a distal one not reaching wing margin; cu1, with a rounded pale spot in the middle of cell; anal cell with a basal pale area and a pale spot near mediocubital forks; wing base with a pale spot on M; M1, M2 and CuA1, with pale apex; macrotrichia scarcely distributed on the distal third of wing; wing length 0.85–1.05 (0.98, n=31) mm; breadth 0.37–0.47 (0.44, n=31) mm; CR 0.58–0.68 (0.65, n=31). Halter knob brown in middle, stem pale. Legs (Fig. 5D) mostly brown; femora with subapical pale bands, tibiae with subbasal pale bands; hind tibial comb with four spines, the one nearest the spur longest.

Abdomen. Brown. Two unequal ovoid spermathecae (Fig. 5E), measuring 48.2 µm (n=25) by 37.5 µm (n=25) and 39.5 µm (n=23) by 33 µm (n=23), with sclerotized ducts measuring 7.5 µm (n=20); long, slender, rudimentary third spermatheca present (17.2 µm); slightly sclerotized ring present (7.5 µm).

Male. Unknown.

Type data and depository. Holotype female, BRAZIL, Roraima, Maracá, 26.VI.1987, CDC light trap, "mata 1m", E. Castellon & S. Gomes cols. (CCER); paratypes 32 females, same data except: three (2 CCER; ILMD); three, "mata 10 m" (2 CCER; MNRJ); three, 15.VIII.1987, "mata 5m" (2 ILMD; CCER); one, 30.VII. 1987 "mata 10m" (CCER); one, "mata 5m" (CCER); one, 24.VI.1987 (ILMD); two, 24.VII.1987 "mata 5m" (CCER; ILMD); one, 24.V 1987 "mata 5m" (ILMD); one, 25.VI.1987 "mata 5m" (CCER); one, 25.VII.1987 (ILMD); one, 25.VI. 1987 "mata 10m" (ILMD); one, 21.VI.1987 (CCER); one, 17.VI.1987 (ILMD); one, 16.VI.1987 (CCER); one, 23.VI.1987 "mata 5m" (CCER); one, 23.VII.1987 "mata 5m" (ILMD); one, 27.VII.1987 (CCER); one, 27.V 1987 "mata 5m" (ILMD); one, 27.VII.1987 (CCER); one, 27.V 1987 "mata 10m" (ILMD); one, 31.VIII.1987 (ILMD); one, 31.VIII.1987 "mata alagada" (ILMD); one, Rio Pardo, Amazonas, 21-22.VI.2010, "peridomicilio", CDC light trap, F. Pessoa col. (ILMD).

Distribution and bionomics. This species is restricted to Brazilian states of Roraima and Amazonas (Fig.9). It was associated with forest environments far from coastal regions.

Etymology. The name of this species is related with the irregular sensory pit present in third palpal segment (Latin—irregulare = irregular).

Culicoides profundus Santarém, Felippe-Bauer & Trindade sp. nov.
Figs. 6A–G; Fig. 9

Diagnosis. Female: This species is easily distinguished by the following combination of characters: palpus 3rd segment swollen, with large, deep sensory pit in middle portion, opening in a small, rounded pore; PR 1.8–2.4; moderately long proboscis; mandible with 16 teeth.

Female. Head. Brown. Eyes bare (Fig. 6G), narrowly separated, smaller than ½ ommatidium. Pedicel brown, flagellum pale brown, first eight flagellomeres paler on proximal ½; AR 1.02–1.18 (1.10, n=19) (Fig. 6C); sensilla coeloconica on flagellomeres 1,5–6–8, two on 1, one or two on 5, three on 6 and 7 and four on 8. Palpus (Fig. 6E) brown; 3rd segment swollen, with a large, deep sensory pit in middle portion, opening in a small, rounded pore; PR 1.8–2.4 (2.1, n=25). Proboscis moderately long; P/H ratio 0.86–0.95 (0.90, n=25); mandible with 16 teeth (n=2).
Thorax. Dark brown. Prominent pattern of yellowish patches well defined (Fig. 6B); pale humeral depressions present. Scutum with two pale areas in the anterior submedian portion arranged as leaf clover and two pale areas in posterior submedian portion; lateral portion with anterior and posterior pale areas; pale prescutellar depressions present; scutellum yellowish laterally; postscutellum brown. Wing (Fig. 6A) with contrasting pattern: second radial cell including dark spot; pale spot over R-M extending from M₁ to the costal margin, subdivided; r₁ with four, small...
and separated pale spots: first, irregular, elongate, transverse, S shaped in some specimens, between the second radial cell and M; second, poststigmatic, extending behind second radial cell, abutting wing margin; third, nearly rounded, in the middle of cell similar to the second one; fourth, distal pale spot lightly reaching wing margin, sometimes connected with third one; m₁ with two pale spots, the distal one far from wing margin; m₂ with four pale spots: one proximal, near CuA, faint and small, two between the medial and mediocubital forks, a distal one not reaching wing margin; cuₐ with a rounded and small pale spot in the middle of cell; anal cell with a faint, basal pale area and one distal pale spot near mediocubital fork; wing base with a pale spot on M; M₁ and CuA with pale apex; macrotrichia scarcely distributed on distal third of wing; wing length 0.82–0.97 (0.93, n=26) mm; breadth 0.40–0.50 (0.46, n=26) mm; CR 0.60–0.67 (0.64, n=26). Halter knob brown in middle, in distal ½ in some specimens, stem pale. Legs (Fig. 6D) mostly brown; femora with subapical pale bands, tibiae with subbasal pale bands; hind tibiae pale apically; hind tibial comb with four spines, the one nearest the spur longest.

Abdomen. Brown. Two slightly unequal ovoid spermathecae (Fig. 6F), measuring 42 µm by 35.7 µm (n=25) and 36 µm by 30.5 µm (n=22), with sclerotized ducts with 6.25 µm (n=16). Long, slender, rudimentary third spermatheca present (22.5 µm); short, cylindrical sclerotized ring present (5 µm).

**Types data and depository.** Holotype female, BRAZIL, Vila de Patauaine, Pará, Ourém, "Fazenda Gavião Real", 01º29'44" S 47º13'07" W, 28-29.XI.2008, CDC light trap, forest, Trindade & Guimarães cols. (MPEG); Paratypes, 25 females, same data, except: one, Juruti, "Fazenda Rezende, Comunidade do Café Torrado", 02º18'77"S 56º05'24"W, 17-18.XII.2007 (CCER); one, 26-27.VI.2008 (MPEG); one, Paragominas, "Fazenda do Dr. Jorge Artur, próximo ao igarapé da casa do caseiro", 03-04.XII.2008, Trindade & Quaresmas cols. (MPEG); six, 04-05.XII.2008 (4 MPEG; 1 CCER; 1 MNRJ); seven, 02-03.XII. 2008 (4 CCER; 3 MPEG); seven, Amazonas, Rio Pardo, VI-VIII.2010, CDC light trap, "borda de floresta", F. Pessoa col. (ILMD); one, same data except 17-18.VII.2010, "peridomicilio" (ILMD); one, same data except 21-22.VI.2010, "floresta" (ILMD).

**Male.** Unknown.

**Distribution and bionomics.** This species is restricted to Brazilian states of Pará and Amazonas (Fig. 9). It was associated with farm environments in three municipalities of Pará State and with forest areas in Amazonas State, both far from coastal regions.

**Etymology.** The name of this species is related with the presence of deep sensory pit on third palpal segment (Latin—profundu = deep).

*Culicoides pseudoreticulatus* Santarém, Felippe-Bauer & Castellón sp. nov.

Figs. 7A–F; Fig. 9

**Diagnosis.** Female: This species is easily distinguished by the following combination of characters: palpus 3rd segment with a shallow, round sensory pit in middle portion of segment, with no well-defined contours on distal ½; PR 2.0–2.7; proboscis moderately long; mandible with 19 teeth.

**Female.** Head. Brown. Eyes bare, (Fig. 7B) narrowly separated, smaller than ½ ommatidium. Pedicel brown; flagellum pale brown, first eight flagellomeres paler on proximal ½; AR 0.90–1.04 (0.98, n=4) (Fig. 7C); sensilla coeloconica on flagellomeres 1, 6–8; two on 1, 6 and 7 and three on 8. Palpus (Fig. 7E) brown, 3rd segment slightly swollen, with a shallow, round sensory pit in middle portion of segment, with no well-defined contours on distal ½; PR 2.0–2.7 (2.4, n=6). Proboscis moderately long; P/H ratio 1.0–1.06 (1.03, n=4); mandible with 19 teeth.

Thorax. Dark brown. Scutum without distinct pattern in slide mounted specimens. Wing (Fig. 7A) with contrasting pattern: second radial cell including dark spot; pale spot over R-M extending from M₁ to the costal margin, subdivided; r₁ with four small and separated pale spots; first, rounded, between the second radial cell and M₁; second, poststigmatic, extending behind second radial cell, abutting wing margin; third, rounded, in middle of cell, similar to the second one; fourth, distal pale spot slightly reaching wing margin; m₁ with two pale spots, the distal one far from wing margin and greater than proximal one; m₂ with four pale spots: one proximal, faint, near CuA, two between the medial and mediocubital forks, a distal one not reaching wing margin; cuₐ with a rounded pale spot in the middle of cell; anal cell with a faint basal pale area and a distal pale spot near mediocubital fork; wing base with a pale spot on M; M₁, M₂ and Cu₁ with pale apex; macrotrichia scarcely distributed on the distal ½ of wing; wing length 0.80–0.90 (0.86, n=7) mm; breadth 0.35–0.45 (0.42, n=7) mm; CR 0.61–0.66 (0.63,
n=7). Halter knob brown in middle, stem pale. Legs (Fig. 7D) mostly brown; femora with subapical pale bands, tibiae with subbasal pale bands; hind tibia pale apically; hind tibial comb with four spines, the one nearest the spur longest.

Abdomen. Brown. Two slightly unequal ovoid spermathecae (Fig. 7F), measuring 49.5 µm (n=5) by 35 µm (n=5) and 43.2 µm (n=3) by 35 µm (n=3), with sclerotized ducts measuring 6.25 µm (n=3); long, slender, rudimentary third spermatheca (15 µm) present in some specimens.

**FIGURE 7.** *Culicoides pseudoreticulatus* sp. nov., female. A. Wing; B. Eyes separation, anterior view; C. Antenna; D. Femora and tibiae of fore-, mid- and hind legs (left to right); E. Palpus; F. Spermathecae.
Male. Unknown.

Type data and depository. Holotype female, BRAZIL, Roraima, Maracá, 28.VII.1987, CDC light trap, "mata 10m", E. Castellon & S. Gomes cols. (CCER); paratypes, six females, same data except: one, 23.VII.1987, "mata 5m" (CCER); two, 30.VII.1987 (MNRJ; ILMD); one, 24.VII.1987, "mata 5m" (ILMD); one, 31.VIII.1987, "mata 1m" (ILMD); one, Amazonas, Rio Pardo, 21-22.VI.2010, CDC light trap, "galinheiro", F. Pessoa col. (ILMD).

Distribution and bionomics. This species is restricted to Brazilian states of Roraima and Amazonas (Fig.9). It was associated with forest environments far from coastal regions.

Etymology. The name of this species is related with its similar congener, C. reticulatus Lutz (Greek—pseudo = false; Latin—reticulatus = reticulated).

*Culicoides rhombus* Santarém, Felippe-Bauer & Castellón sp. nov.

Figs. 8A–F; Fig. 9

**Diagnosis.** Female: This species is easily distinguished by the following combination of characters: palpus 3rd segment rhomboidal, with a shallow, well-developed irregular sensory pit that reaches the extreme distal portion of segment; PR 2.5–3.0; proboscis long.

**Female.** Head. Brown. Eyes bare (Fig. 8B), narrowly separated, smaller than ½ ommatidium. Pedicel brown, flagellum pale brown, first eight flagellomeres paler on proximal ½; AR 1.05–1.10 (1.06, n=4) (Fig. 8C); sensilla coeloconica on flagellomeres 1, 6–8, two on 1, three on 6, two on 7 and three on 8. Palpus (Fig. 8F) brown, 3rd segment swollen at middle length, rhomboid, with a shallow, well-developed irregular sensory pit that reaches the distal portion of segment; PR 2.5–3.0 (2.6, n=7). Proboscis long; P/H ratio 1.08–1.28 (1.13, n=6); mandible with 23 teeth.

Thorax. Dark brown. Scutum without distinct pattern in slide mounted specimens. Wing (Fig. 8A) with contrasting pattern: second radial cell including dark spot; pale spot over R-M extending from M₁ to the costal margin, subdivided; r₁ with four small and separated pale spots: first, rounded, between the second radial and M₁; second, poststigmatic, extending behind second radial cell, abutting wing margin; third, rounded, in middle of cell, similar to the second one; fourth, distal pale spot slightly reaching wing margin; m₁ with two pale spots, the distal one far from the wing margin and greater to the proximal one; m₂ with four pale spots: one proximal, near Cu₁, two between medial and mediocubital forks, a distal one not reaching wing margin; cuₐ, with a rounded pale spot in the middle of cell; anal cell with a faint basal pale area near base and a distal pale spot near mediocubital fork; wing base with a pale spot on M₁; M₁, M₂ and Cu₁ with pale apex; macrotrichia scarcely distributed on the distal third of wing; wing length 0.85–0.97 (0.92, n=7) mm; breadth 0.40–0.45 (0.43, n=7) mm; CR 0.64–0.66 (0.65, n=7). Halter knob brown, stem pale. Legs (Fig. 8D) mostly brown, femora with subapical pale bands, tibiae with subbasal pale bands; hind tibiae apically; hind tibial comb with four spines, the one nearest the spur longest.

Abdomen. Brown. Two slightly unequal ovoid spermathecae (Fig. 8E), measuring 45.5 µm (n=6) by 37 µm (n=6) and 38.7 µm (n=5) by 32.5 µm (n=5), with sclerotized ducts measuring 4.3 µm (n=6); long, slender, rudimentary third spermatheca present (17.5 µm).

**Male.** Unknown.

Type data and depository. Holotype female, BRAZIL, Roraima, Maracá, 28.VII.1987, CDC light trap, "mata", E. Castellon & S. Gomes cols. (CCER). Paratypes six females, same data except: one, 28.VI.1987, "mata 10m" (CCER); one, 30.VII.1987, "mata 5m" (MNRJ); one, 22.VII.1987, "mata 5m" (ILMD); one, 27.VII.1987, "mata 5m" (ILMD); one, Amazonas, Rio Pardo, 17-18.2010, CDC light trap, Capoeira, F. Pessoa col.; one same data except VI-VIII.2010, "borda de floresta" (ILMD).

Distribution and bionomics. This species is restricted to Brazilian states of Roraima and Amazonas (Fig. 9). It was associated with forest environment far from coastal regions.

Etymology. The name of this species is related with the rhomb shape aspect of the third palpal segment (Greek—rhómbos = rhombus).
FIGURE 8. *Culicoides rhombus* sp. nov., female. A. Wing; B. Eyes separation, anterior view; C. Antenna; D. Femora and tibiae of fore-, mid- and hind legs (left to right); E. Spermathecae; F. Palpus.
**FIGURE 9.** Geographical distribution of *Culicoides reticulatus* and the seven new related species.

**TABLE 1.** Table with numerical characters to *C. reticulatus* Lutz and the seven new related species.

<table>
<thead>
<tr>
<th>Species*</th>
<th>Wing length</th>
<th>C.R.</th>
<th>A.R.</th>
<th>Pattern sensilla</th>
<th>P.R.</th>
<th>P/H ratio</th>
<th>Mandible teeth</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>C. amazonicus</em> sp. nov.</td>
<td>0.92 mm (0.87–0.95)</td>
<td>0.64 (0.62–0.66)</td>
<td>1.0 (0.98–1.04)</td>
<td>1,6–8</td>
<td>2.8 (2.6–3.2)</td>
<td>1.11 (1.03–1.16)</td>
<td>24</td>
</tr>
<tr>
<td><em>C. diplus</em> sp. nov.</td>
<td>0.96 mm (0.94–0.98)</td>
<td>0.66 (0.66–0.67)</td>
<td>1.08 (1.04–1.13)</td>
<td>1,6–8</td>
<td>2.7 (2.5–2.8)</td>
<td>1.02 (1.0–1.05)</td>
<td>21</td>
</tr>
<tr>
<td><em>C. fluminensis</em> sp. nov.</td>
<td>1.08 mm (1.03–1.16)</td>
<td>0.65 (0.63–0.66)</td>
<td>1.03 (0.95–1.12)</td>
<td>1,6–8</td>
<td>2.9 (2.6–3.2)</td>
<td>1.14 (1.05–1.18)</td>
<td>20</td>
</tr>
<tr>
<td><em>C. irregularis</em> sp. nov.</td>
<td>0.98 mm (0.85–1.05)</td>
<td>0.65 (0.58–0.68)</td>
<td>1.12 (1.04–1.25)</td>
<td>1,6–8</td>
<td>2.6 (2.0–2.9)</td>
<td>0.84 (0.80–0.94)</td>
<td>16</td>
</tr>
<tr>
<td><em>C. profundus</em> sp. nov.</td>
<td>0.93 mm (0.82–0.97)</td>
<td>0.64 (0.60–0.67)</td>
<td>1.10 (1.02–1.18)</td>
<td>1,(5)</td>
<td>2.1 (1.8–2.4)</td>
<td>0.90 (0.86–0.95)</td>
<td>16</td>
</tr>
<tr>
<td><em>C. pseudoreticulatus</em> sp. nov.</td>
<td>0.86 mm (0.80–0.90)</td>
<td>0.63 (0.61–0.66)</td>
<td>0.98 (0.90–1.04)</td>
<td>1,6–8</td>
<td>2.4 (2.0–2.7)</td>
<td>1.03 (1.0–1.06)</td>
<td>19</td>
</tr>
<tr>
<td><em>C. reticulatus</em> Lutz</td>
<td>1.3 mm</td>
<td>0.64</td>
<td>1.02 (1.0–1.04)</td>
<td>1,6–8</td>
<td>2.8 (2.6–3.0)</td>
<td>1.16 (1.14–1.17)</td>
<td>23–25</td>
</tr>
<tr>
<td><em>C. rhombus</em> sp. nov.</td>
<td>0.92 mm (0.85–0.97)</td>
<td>0.65 (0.64–0.66)</td>
<td>1.06 (1.05–1.1)</td>
<td>1,6–8</td>
<td>2.6 (2.5–3.0)</td>
<td>1.13 (1.08–1.28)</td>
<td>23</td>
</tr>
</tbody>
</table>

*: arranged alphabetically.
Culicoides sp.

We examined a single specimen of Culicoides collected near a cave in a forest area from Amazonas State, which has a similar wing pattern to C. reticulatus Lutz. It differ from this species and the other seven new species described here by the aspect of the third palpal segment, which is cylindrical, without pits, with scattered sensilla distributed on the segment, P.R. 3.0. These data led us to conclude that this specimen belong to a new species. However, due to the bad montage condition, the specimen don't offer accurate data to make a description and we think eventually describe it after collection of more specimens in this Amazon site.

Specimen examined: 1 female, BRAZIL, Amazonas, Balbina, 08.V.1985, CDC light trap, E Castellón & S Gomes cols. (ILMD).

Taxonomic discussion

The new species described herein are similar to C. reticulatus by the number and distribution of the pale spots of the wing, by the leaf clover pattern of yellowish patches on anterior submedian portion of scutum and by the distribution pattern of sensilla coeloconica on flagellomeres. The notorious differences are the aspect of 3rd palpal segment and the number, shape and position of the sensory pit, when present.

C. reticulatus is now restricted to Brazilian States of Bahia and Pernambuco, while the others seven new species are described for Rio de Janeiro State (C. fluminensis), Brazilian Amazon Region (C. amazonicus, C. irregularis, C. profundus, C. pseudoreticulatus and C. rhombus) and Colombia and Panama (C. diplus). Culicoides amazonicus and C. profundus were found in sympathy in the municipalities of Juruti and Paragominas, Pará State. Culicoides irregularis, C. profundus, C. pseudoreticulatus and C. rhombus occur simultaneously in Rio Pardo, in the municipality of Presidente Figueiredo, Amazonas State. Also, C. amazonicus, C. pseudoreticulatus and C. rhombus occur in Maraca, Roraima State. Sympatric species, with the similar pattern of wing spots and presenting differences in the aspect of palpal pits, were observed for the first time in Neotropical Region, by Felippe-Bauer et al. (2003) for species of the paraensis species group.

Culicoides diplus and C. fluminensis are collected in mangrove areas, the same biotope cited by Lutz (1913) for C. reticulatus. Although, C. reticulatus has wing length (1.3 mm) bigger than C. fluminensis (1.08 mm) and C. diplus (0.96 mm). Also, C. diplus has smaller P/H ratio (1.02) than C. reticulatus (1.16) and C. fluminensis (1.14). The others five new species described from Amazon region are associated to farm and forest areas. This can explain the difference in palpal pit, since this structure is known by the olfactory function in host seek (Blackwell, 2004).

Culicoides irregularis and C. profundus are the only species that has a moderately long proboscis (P/H ratio <1.00) and a lower number of mandible teeth (16 teeth), which differs from C. reticulatus and the other five new species that presents a long proboscis (P/H ratio ≥1.00) and a higher number of mandible teeth (20-25 teeth). Also, the spermathecae are subequal in C. reticulatus and C. diplus, slightly unequal in C. profundus, C. pseudoreticulatus and C. rhombus and unequal in C. amazonicus, C. fluminensis and C. irregularis. Culicoides fluminensis is the only species that has a single pale spot over R-M, whereas in the other species this pale spot is subdivided. All these species were included in reticulatus species group.

Acknowledgement

To Gustavo Spinelli for send us the data of specimens deposited in Museo de La Plata. To Maria Anice Mureb Sallum (Faculdade Saúde Pública, USP), Felipe Pessôa (Instituto Leônidas e Maria Deane, FIOCRUZ) and Orlando Tobias Silveira (Museu Paraense Emílio Goeldi) for the loan of part of material for study. To Coordenação de Aperfeiçoamento de Pessoal de Ensino Superior (Capes) for financial support.
References


http://dx.doi.org/10.1590/s1010-81752006000300001


http://dx.doi.org/10.1590/s0074-02761913000100005


Vargas, L. (1945) Nota sobre ceratopogonidos y Culicoides. Revista del Instituto de salubridad y enfermedades tropicales. 6, 42–49.


http://dx.doi.org/10.5479/si.00963801.109-3415.237
