



The predator muscid *Neodexiopsis rufipes* (Macquart, 1851) (Diptera) with ultrastructural morphology of the adult proboscis and eggs



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ABSTRACT

Studies on the ultrastructural morphology of species by means of Scanning Electron Microscopy (SEM) provide information about their habits and biological adaptations to the environment. Flies of the Neotropical genus *Neodexiopsis* Malloch (Muscidae: Coenosiini) show notable adaptations related to the environment and feeding, at each of their life stages. Adults are predators of small insects and inhabit forests or pastures, while eggs are adapted to aquatic environments. This study focused on the species *Neodexiopsis rufipes* (Macquart, 1851). We present for the first time the ultrastructural morphology with SEM images of the egg, which shows a respiratory structure (a kind of plastron) adapted to lentic environments, as well as of the proboscis, which shows hook-like teeth adapted to capture the prey in flight and transport it to a place for feeding. Also, we present a complete morphological description of *N. rufipes* with detailed images of the terminalia, and propose a new synonymy: *N. microchaeta* as a new junior synonym of *N. rufipes*.

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1. Introduction

Studies on the ultrastructural morphology of species by means of Scanning Electron Microscopy (SEM), which allows obtaining comprehensive and detailed images of the structures, provide information not only for the identification of species, but also for the interpretation of the biological significance of ultrastructures as adaptations to the environment, feeding, etc. Some studies have explored ultrastructures in insects, focusing on the adaptation of the eggs to the environment (Hinton, 1981) or on the adaptations of the proboscis to the feeding behavior (Elzinga and Broce, 1986).

The Coenosiinae, a particular subfamily of Muscidae, shows notable adaptations related to the environment and feeding, at each of its life stages. This subfamily has a worldwide distribution and the adults are generally predators of a variety of small insects and other arthropods (Carvalho et al., 2005). The Coenosiinae are important contributors to the natural regulation of populations of agricultural and veterinary pests such as aphids, whiteflies, black flies (Simuliidae), and mosquitoes (Culicidae) (Savage and

Vockeroth, 2010). Also, the immature stages are adapted to aquatic or semi-aquatic habitats (Skidmore, 1985).

One of the richest genera of the Coenosiini tribe in the Neotropical region is *Neodexiopsis* Malloch. This genus has over 100 valid species, more than 85% recorded in South America (Carvalho et al., 2005). The biology of *Neodexiopsis* is poorly known. Adults inhabit forests or pastures, and the only reference on immature stages is a larva found in the gallery of a beetle in the bark of a pine tree. (Savage and Vockeroth, 2010). The main studies carried out on this genus are taxonomic ones (Costacurta et al., 2005; Couri and Albuquerque, 1979; Malloch, 1934; Snyder, 1957, 1958).

Neodexiopsis rufipes was originally described by Macquart (1851) in *Choetura* Macquart, based on a single male specimen captured in Maldonado (Uruguay). Later, Albuquerque (1949) made a brief description on the specimen, designated the lectotype, and proposed *Macquartiopsis* Albuquerque as a new genus name for *Choetura*, because the original name was preoccupied in birds. After that, Pont (2012) made some nomenclatorial changes on this species, and finally, Carvalho et al. (1993) transferred the species to *Neodexiopsis*. Another species, *Coenosia microchaeta* Malloch, 1934, was described based on female specimens from Montevideo (Uruguay) and Buenos Aires (Argentina). Pont (1972) transferred the species to the genus *Neodexiopsis*, establishing the current valid combination. Neither species has been collected since then.

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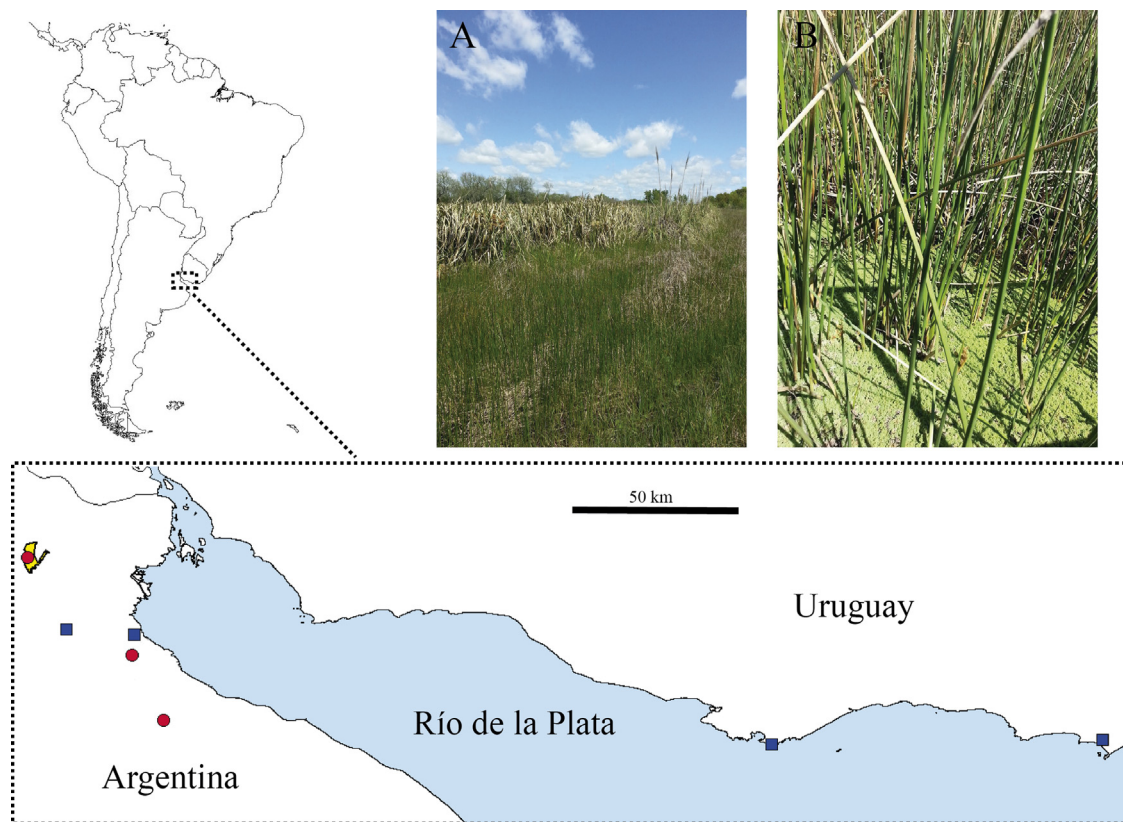


Fig. 1. Geographic distribution of *Neodexiopsis rufipes*. Yellow area: Natural Reserve Otamendi, red dots: new record, blue square: bibliographic record. Landscape pictures: (A) grasslands; (B) swampy lagoon where several specimens were collected. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

The aim of this paper is to present for the first time the ultrastructural morphology of the egg of *N. rufipes*, which shows adaptations to lentic environments, and the ultrastructure of the adult proboscis by means of SEM images, along with a redescription of the male and female of *N. rufipes* with detailed images of the terminalia, and propose a new synonymy: *N. microchaeta* as a new junior synonym of *N. rufipes*.

2. Materials and methods

Specimens were collected by active capture with an entomological net over vegetation and a Malaise trap, in two localities of the province of Buenos Aires. Particularly a large number of specimens, including males and a female specimen ovipositing, were collected with a hand net over reeds in a small swampy lagoon (−34.235958, −58.891540), in the Natural Reserve Otamendi, located in the delta of the province of Buenos Aires (Argentina). This reserve is close to Paraná de las Palmas and Luján Rivers, and has a plain composed of flood grasslands, canals, swampy lagoons and wetlands (Fig. 1). Specimens were identified using the original description (Malloch, 1934) and comparison with images of type specimens. Descriptions were elaborated with images of type specimens and specimens collected. To study the morphology of terminalia, the abdomen of selected specimens was detached and transferred to 90% lactic acid for two weeks. After clearing, the genital structures were removed and temporarily mounted on concave glass slides in glycerine. After the study, the dissected parts were placed in a plastic microvial with glycerine and pinned with the respective specimen. The terminology used for the external morphology follows Cumming and Wood (2009), except for the term “postpedicel” for “antennal flagellomere” as in Stuckenberg (1999). The terminology of the description of the eggs follows Hinton (1981), Skidmore (1985), and Grzywacz

et al. (2012) for the terms “hatching pleats” and “hatching line”. The terminology of the description of the proboscis follows Elzinga and Broce (1986).

All the specimens studied belong to the following institutions (acronyms in parentheses): The Natural History Museum, London, United Kingdom (BMNH), Muséum National d’Histoire Naturelle, Paris, France (MNHN), Museo Argentino de Ciencias Naturales “Bernardino Rivadavia”, Buenos Aires, Argentina (MACN), and Museu Nacional, Universidade Federal do Rio de Janeiro, Brazil (MNRJ). The specimens collected were deposited at the MACN. Type specimens were observed with digital images housing in web sources.

The eggs used for SEM were extracted from the abdomen of one female. A total of 13 eggs were dehydrated through 80, 90, and 99.5% ethanol, dried at critical point in CO₂ and coated with gold-palladium in a Thermo VG Scientific SC 7620 sputter coater. Images were taken with a Philips XL30 TMP scanning electron microscope at the MACN.

Measurements were digitally obtained with the software Leica Application Suite EZ Version 2.1.0, and the software Olympus cellSens Standard and Combine ZM was used for image processing. Digital photographs were taken using an Olympus DP 25 digital camera mounted on an Olympus SZX 16 stereomicroscope. Maps were made using the software DIVA-GIS, version 7.5.

3. Results

Neodexiopsis rufipes (Macquart, 1851)

Neodexiopsis microchaeta (Malloch, 1934). **New synonymy.**

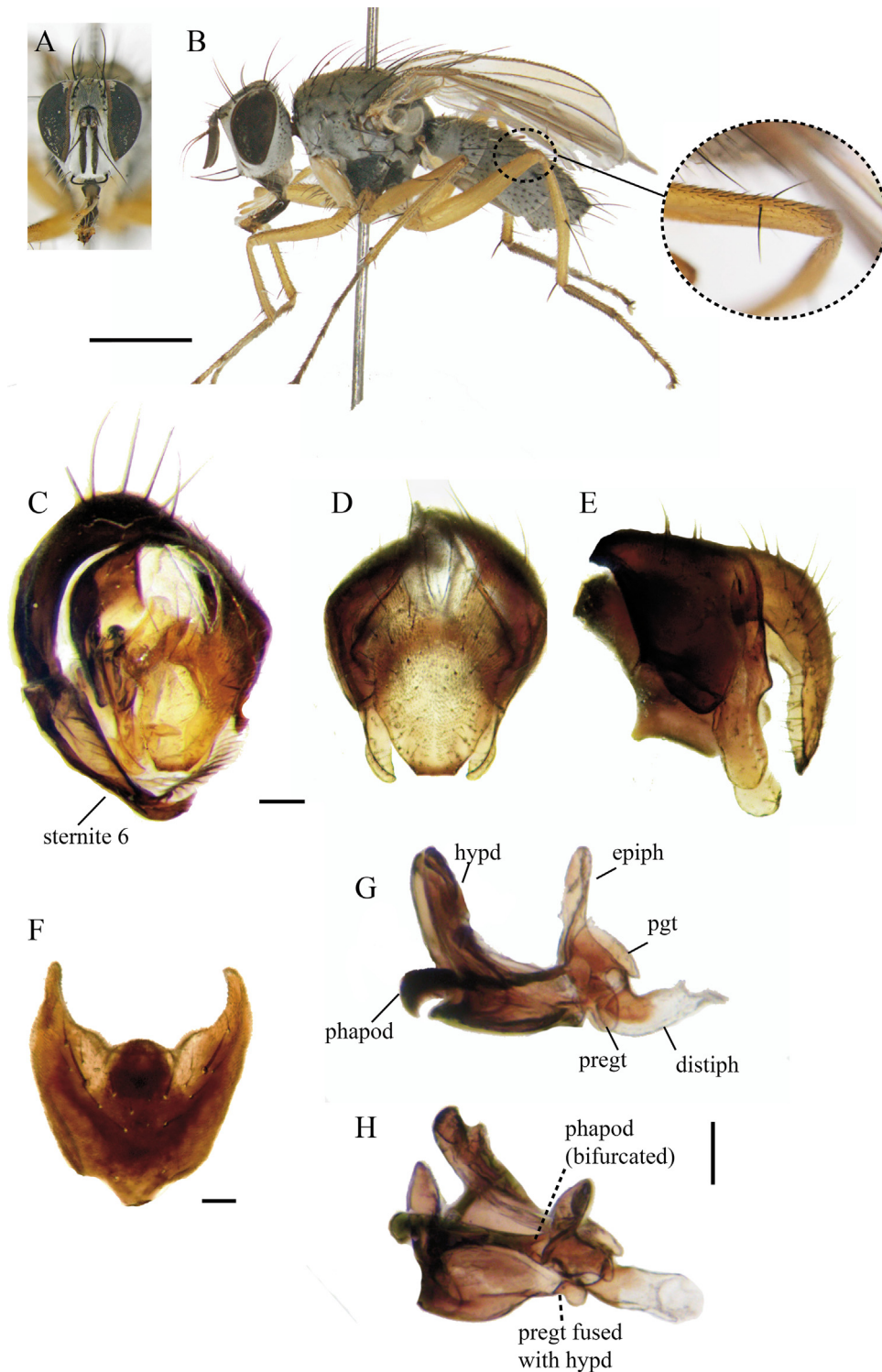


Fig. 2. *Neodexiopsis rufipes*, male. (A) Head, frontal view. (B) Lateral view with detail of dorsal and posterodorsal preapical setae at hind femur. (Scale bar = 1 mm). (C) Tergite and sternite 6. (D) Cercal plate and surstyli, posterior view. (E) Cercal plate and surstylus, lateral view. (F) Sternite 5. (G) Phallic complex, lateral view. (H) Phallic complex, dorsal view. (Scale bar = 0.1 mm). (Abbreviations: distiph, distiphallus; epiph, epiphallus; hypd, hypandrium; pgt, postgonite; phapod, phallapodeme; pregt, pregonite).

3.1. Adult

Male (Fig. 2A–H). Length. Body: 3.68–5.04 mm, wing: 3.09–4.27 mm.

Head (Fig. 2A). Black. Dichoptic, frons at vertex 1/3 of the head width; eyes bare. Frons black with grey pollinosity, fronto-orbital plate, parafacial and gena black with silver pollinosity; ocellar tri-

angle light brown, 3–4 pairs of frontal setae and 1 pair of reclinate orbital setae. Ocellar setae short and thin. Inner vertical seta reclinate, outer vertical seta divergent. Gena with white fine setae, and a ventral row of black to dark brown setae. Antenna black, apical angle of postpedicel acute; in lateral view inserted above to the mid-level of the eye; arista swollen at base, with his longest hairs hardly longer than its basal diameter. Palpus yellow, filiform.

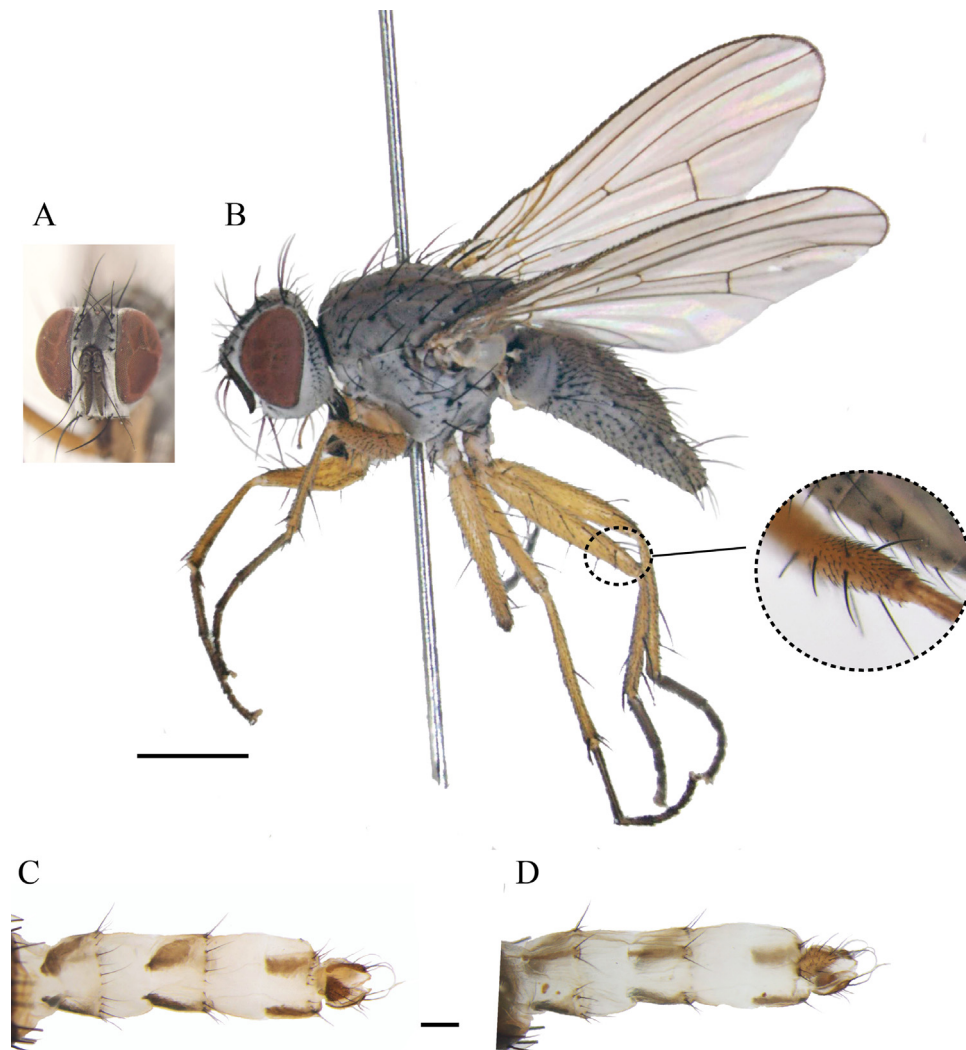


Fig. 3. *Neodexiopsis rufipes*, female. (A) Head, frontal view. (B) Lateral view with detail of anterodorsal, dorsal and posterodorsal preapical setae at hind femur. (Scale bar = 1 mm). (C) Ovipositor, dorsal view. (D) Ovipositor, ventral view (scale bar: 0.2 mm).

Thorax. Black with grey pruinescent; anterior spiracle white and posterior spiracles brown. Chaetotaxy: acrostichals irregular; dorsocentrals 1 + 3; basal postpronotal setae 2; intra-alars 1 + 2; supra-alars 1 + 1; notopleurals 2. Prealar absent. Scutellum with a short basal pair of seta, a long and strong discal pair of setae, and a short apical pair of setae. Anepisternum with a series of 2–3 strong setae; katepisternals 1 + 1 + 1, forming an equilateral triangle, and with short hair; anepimeron, katepimeron, and meron bare; proepisternals 1–2 upwards; proepimeral 2 (one upward and one downward shorter). Prosternum bare.

Wing. Hyaline, without clouds. Transverse cross-veins straight; vein R 4 + 5 and vein M parallel; veins bare. Both calypters hyaline with white margins; lower calypter glossiform, about twice as long as upper calypter; halter and knobs yellow.

Legs. Yellow. Coxa with several strong setae on anterior surface. Fore femur with a tuft of 3–5 setae at base on anteroventral surface, with 2–3 spaced setae on ventral surface, 3 setae in basal third on posterior surface, and only on dorsal surface with covering setulae, the remaining surfaces glabrous; fore tibia with one median posteroventral seta, three preapical setae, and a yellow comb at apex on anterior surface. First tarsomere with one seta at base. Mid femur with 2–3 short setae in basal third on anterior surface, 3–4 short setae in basal third on posterior surface, one long seta on ventral surface, 2 preapical setae on posterodorsal to posterior sur-

face, and only on posterodorsal surface with covering setulae, the remaining surfaces glabrous; mid tibia with one anterior seta and one posterior setae of similar length in middle third, anterior seta more basal, and 3–4 preapical setae. Hind femur with 2 setae in basal third on anterior surface, with 3–4 posteroventral setae on basal third, with one long seta on ventral surface, and 1 preapical seta on posterodorsal surface and 1 preapical seta on dorsal surface, the remaining surfaces glabrous; hind tibia with one anterodorsal long and one a little shorter posterodorsal setae on middle third, inserted at the same level, preapical seta on posterior surface, and one preapical seta on ventral surface.

Abdomen. Black with grey pollinosity. Tergite 5 with four long discal setae, inner ones shorter than outer ones. Sternite 1 bare. Sternite 5 triangular, sclerotized; with two long setae, two pointed lateral processes, and an elevated median area on posterior margin, and some little setae on posterior middle (Fig. 2F). Sternite 6 asymmetric, only with left arm (Fig. 2C).

Terminalia. Cercal plate longer than wide, setulose, with anterior margin straight and strongly sclerotized (Fig. 2D). Inner concavity with several setae in lateral view (Fig. 2E). Surstylus concave like a spoon, with strong setae on inner surface; and with a pointed process at middle in lateral view (Fig. 2D–E). Hyandrium short tubular, as long as wide. Aedeagus with phallapodeme straight strongly sclerotized, dilated at apex, with the bifurcated

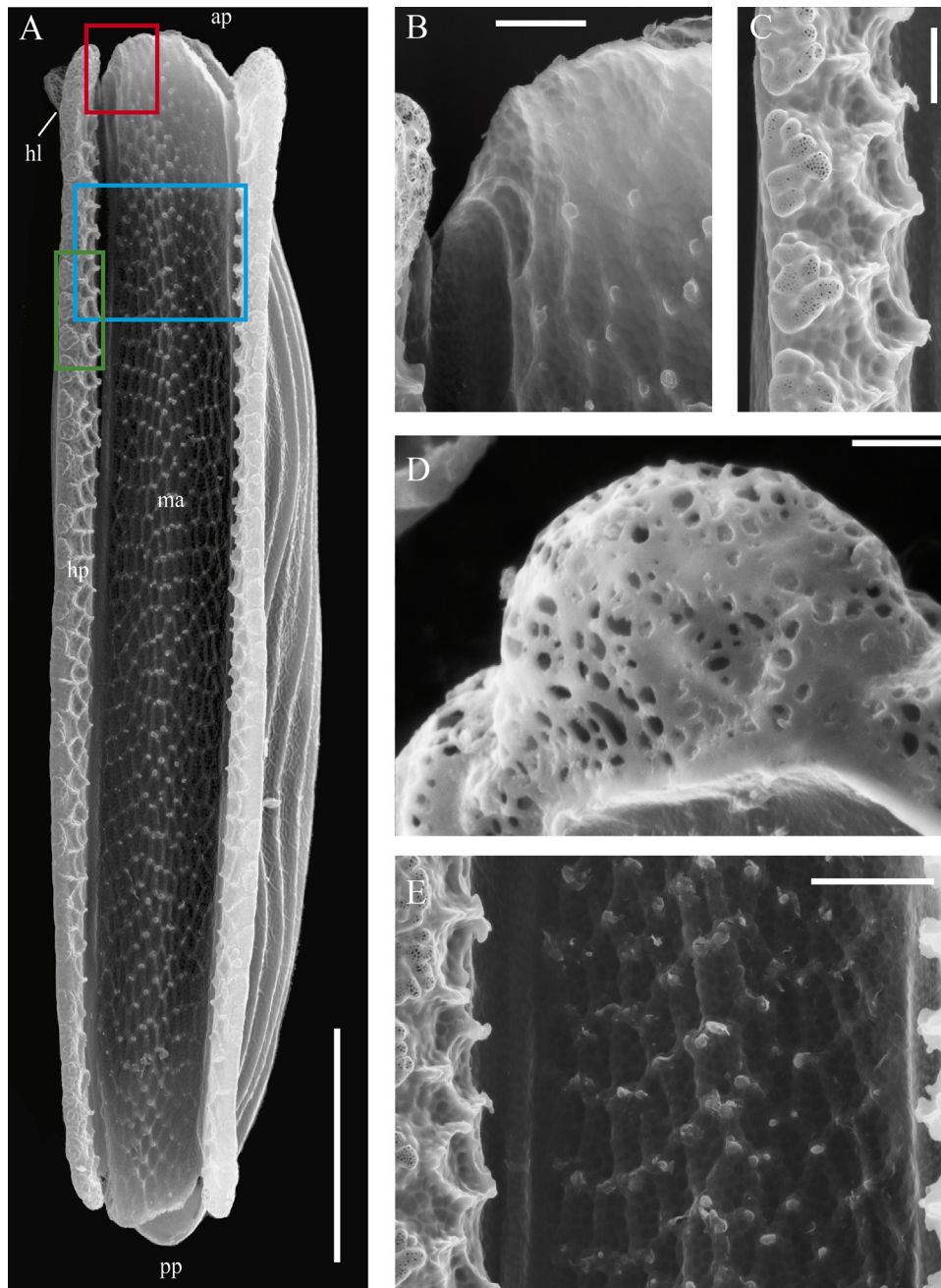


Fig. 4. SEM micrographs of the egg of *Neodexiopsis rufipes*. (A) Dorsal view, red square: detailed in Fig. 4B; green square: detailed in Fig. 4C; blue square: detailed in Fig. 4E. (B) Detailed image of the anterior pole. (C) Detailed image of the papillae groups of hatching pleats. (D) Detailed image of a papillae. (E) Detailed image of median area. (Abbreviations: ap, anterior pole; hl, hatching line; hp, hatching pleat; pp, posterior pole). Scale bars = (A) 200 μm ; (B) 20 μm ; (C) 50 μm ; (D) 5 μm ; (E) 50 μm . (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

base that articulates with epiphallus, and longer than hypandrium in lateral view (Fig. 2H); pregonite developed, kidney-shaped, ventrally fused with the hypandrium; postgonite developed, with setula; epiphallus sclerotized, and distiphallus tubular, and slightly sclerotized at base (Fig. 2G).

Female (Fig. 3A–D). Length. Body: 4.51–5.44 mm, wing: 4.04–4.99 mm.

Differs from male as follows: **Head** (Fig. 3A). Ocular triangle with grey pollinosity. Gena with yellow setae. Palpus yellow, darker at tip in some specimens. **Thorax**. Black with grey pruinescent, with three fine brown vitta along acrostichal and dorsocentral rows of setae. **Legs**. All legs with covering setulae (without glabrous areas). Fore femur with 4 setae on posterodorsal surface in apical half, a

row of setae on posterior surface, a row of short seta on anteroventral surface, and a row of long and spaced setae on ventral surface. Mid femur with 3–4 setae in basal half and one long seta in apical half on anterior surface, a row of short setae on anteroventral surface, 3–4 setae in basal half on posteroventral surface, and 2 preapical setae on posterodorsal to posterior surface. Hind femur with a row of setae on anterodorsal and anteroventral surfaces and 3–4 long setae on posteroventral surface on basal third, and 3 preapical seta on posterodorsal, dorsal and anterodorsal surfaces, hind tibia with one long seta on anterodorsal surface and one short seta on anteroventral surface in middle third. **Abdomen**. Black with grey pollinosity and a brown central line in all tergites. Tergites 6, 7, and 8 with 2 long and thick parallel sclerotized plates; epiproct

triangular, cercus long (Fig. 3C). Sternites 6 and 7 long and rectangular; sternite 8 divided into 2 small and linear sclerotized plates, each with 2 setae on distal margin; hypoproct triangular, setulos with 4 strong setae on distal margin (Fig. 3D). Three spermathecae.

Type material. *Coenosia microchaeta*: holotype female, pinned in good condition (BMNH). <http://data.nhm.ac.uk/object/4e20c080-2f6f-4d87-a8c8-be45b53b6696>. 2) *Choetura rufipes*: lectotype male, pinned in bad condition (MNHN). <http://coldb.mnhn.fr/catalognumber/mnhn/ed/ed8545>

Other specimens examined. ARGENTINA: Buenos Aires: 1 female, 4 males, Burzaco, –34.831380, –58.395056, x/xi-2011, Mulieri leg. (MACN); 1 male, Devoto, Capital Federal, –34.591370, –58.511231, 5-x-1925, Bridaroli leg. (MACN); 1 female, 1 male, Jose Clemente Paz, –34.5200, –58.7600, 2.x.1939, Oglobin leg. (MNRJ), 26 females, 3 males, RN Otamendi, Campana, –34.235958, –58.891540, 22-vii-2015, Patitucci leg. (MACN); 2 females, RN Otamendi, Campana, –34.235958, –58.891540, 21-x-2015, Mulieri leg. (MACN).

Distribution (Fig. 1). ARGENTINA: Buenos Aires. URUGUAY: Maldonado; Montevideo.

3.2. Comments

Males of *N. rufipes* present a peculiar character: all the femora are glabrous on the anterior surfaces, and so the anterodorsal preapical seta of the hind femur is absent. This last particular character was also observed by Snyder (1957) in males of two species collected in Puerto Rico. However, there is no doubt about its position among *Neodexiopsis* as the dorsal preapical seta on the hind femur is present and the structure of the cercal plate (posterior concavity and quadrangular shape) matches with the diagnostic character of the genus (Couri and Pont, 2000). We herein propose *N. microchaeta* as a synonym of *N. rufipes*, in view of the following observations. The type localities of both species were close to each other, on the north coast of the Río de la Plata River, Uruguay. LDP collected a large number of specimens together, including males, females and a female specimen ovipositing. Morphological similarities included: short and fine ocellar setae, white setae on the gena, short apical scutellar setae, and the same leg chaetotaxy, and femora totally glabrous (only males). It is important to mention that Albuquerque (1949) made a short redescription of *N. rufipes*, based on the examination of the male lectotype, but probably because of the bad conditions of the material some structures were misinterpreted. The following corrections in the redescription are necessary: the fore tibia has a posterior seta (not anterior) and the hind tibia has an anterodorsal and a posterodorsal seta (and not posteroventral) long, at middle, inserted at the same level.

Neodexiopsis rufipes is included in key for Brazilian species of *Neodexiopsis* in Costacurta et al. (2005).

3.3. Egg

Length: $1378.78 \pm 91.12 \mu\text{m}$, width $336.52 \pm 44.40 \mu\text{m}$.

Colour creamy-white. The egg is elongated, rounded at the posterior pole. The dorsal surface is flat, with a broad median area and two development pleats. The hatching pleats are parallel, extending outwards with regard to the median area. The pleats diverge from the median area towards the anterior and posterior poles and their extremes are rounded (Fig. 4A).

The reticulated pattern of the median area presents elevated and thin ridges, thickened in the vertices, which become weaker or less marked toward the poles (Fig. 4A, B, E). The inner surface of the hatching pleats presents a reticulated pattern with more conspicuous and elevated ridges than the median area (Fig. 4E). Throughout the hatching line, we observed groups of papillae (Fig. 4C) with small perforations (Fig. 4D), whose number decreases towards the

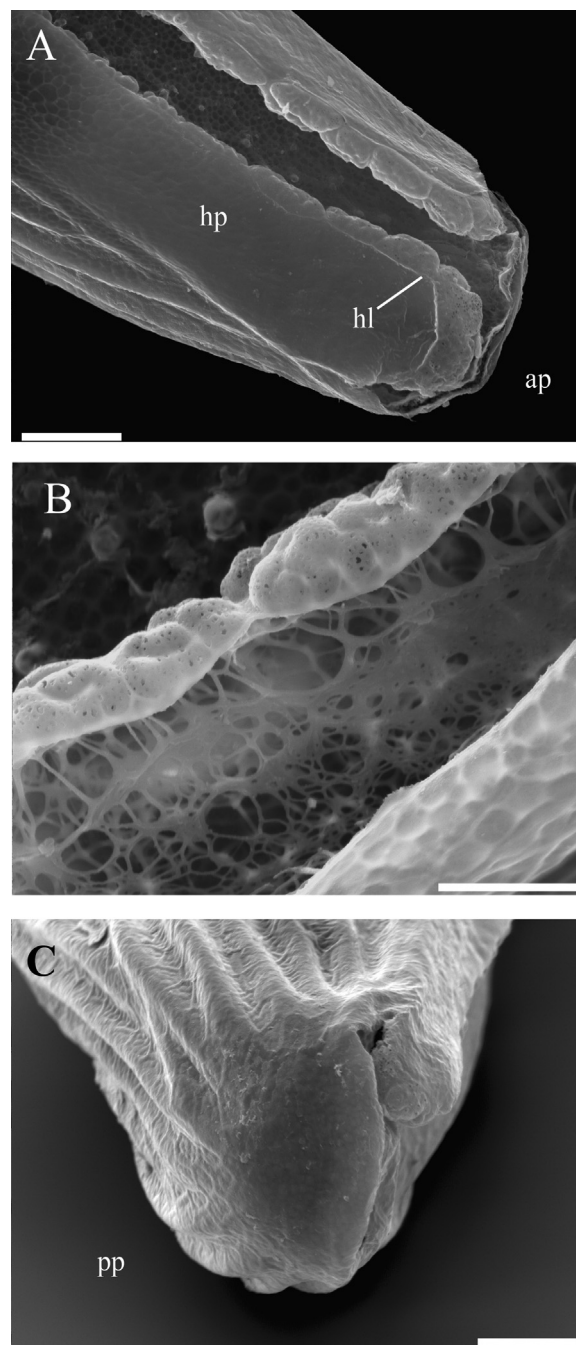


Fig. 5. SEM micrographs of the egg of *Neodexiopsis rufipes*. (A) Detailed image of the reticular pattern of the outer surface of hatching pleats. (B) Detailed image of inner meshwork. (C) Detailed image of the posterior pole without orifices. (Abbreviations: ap, anterior pole; hl, hatching line; hp, hatching pleat; pp, posterior pole). Scale bars = (A) 50 μm , (B–C) 20 μm .

poles (Fig. 4A, C). These papillae are a respiratory structure (a kind of plastron). On the other hand, the outer surface of the hatching pleats presents a diffuse and small marked reticular pattern that reduces towards the poles (Fig. 5A). The inner meshwork layer presents round aeropyles of similar size towards the groups of papillae (inner surface of hatching pleats), and smaller and with a more irregular size towards the outer surface of the hatching pleat (Fig. 5B). We observed no perforations or orifices at the posterior pole (Fig. 5C).

The ventral surface is convex with a corrugated longitudinal pattern (Fig. 6A) and a hexagonal pattern with elevated ridges,

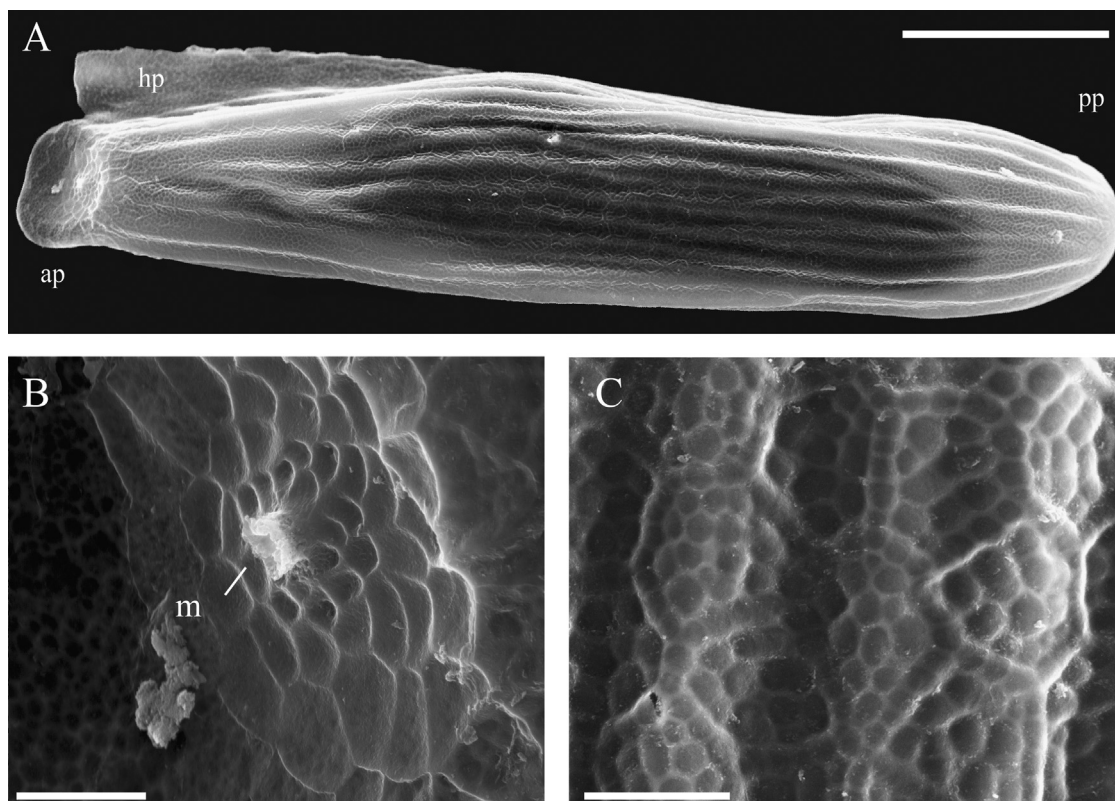


Fig. 6. SEM micrographs of the egg of *Neodexiopsis rufipes*. (A) Ventral view. (B) Micropylar plate. (C) Detailed image of the reticular pattern of the ventral surface. (Abbreviations: ap, anterior pole; hp, hatching pleat; m, micropyle; pp, posterior pole). Scale bars = (A) 200 μm ; (B–C) 20 μm .

probably a reflection of the shapes of the follicular cells (Fig. 6C). The micropylar plate has a defined dorsal wall (Fig. 6A) and the micropyle is surrounded by concentric circles (Fig. 6B).

3.4. Comments

The information available on the eggs of species of the subfamily Coenosinae is scarce.

Skidmore (1985) summarized the information and presented some drawings with brief descriptions of the eggs of some Limnophoriini and one Coenosini (*Coenosia tigrina* (Fabricius)). After that, some isolated drawings without description of eggs of *Neodexiopsis sulina* (Couri, 1987), *N. paranaensis*, and *N. pura* (Costacurta et al., 2005) were published. These eggs and the one presented in this paper show two development pleats that diverge from the median area towards the anterior and posterior poles, so these can be considered as *Phaonia*-type according to Skidmore's (1985) classification.

Studies of eggs with SEM images, which provide more comprehensive and detailed descriptions, can contribute with new interpretations of the biology of species. Most of the few studies that have presented descriptions of muscid eggs by using SEM are focused on species with sanitary, veterinary or forensic relevance (Cortinhas et al., 2016; Grzywacz and Pape, 2010; Patitucci et al., 2017). The only two species of Muscidae without sanitary or forensic relevance whose eggs were studied by means of SEM images are *Coenosia strigipes* Stein (Kühne, 2000) and *Limnophora riparia* (Coenosinae: Limnophoriini) (Hinton, 1981; Merritt and Wotton, 1988). Regarding the former, Kühne (2000) presented a dorsal image of the egg, with a brief description where he mentioned a series of irregular bulbs on the hatching pleats that are united in a straight line at the posterior pole, and considered the egg as *Phaonia*-type, following Skidmore's (1985) classification. Unlike C.

strigipes, *N. rufipes* presents the hatching pleats open at the posterior pole. Regarding *L. riparia*, Merritt and Wotton (1988) reported that the adults lay the eggs exposed or partially submerged on fresh moss or algae in semi-aquatic or aquatic habitats like waterfalls, lake outlets, spillways, and splash zones of streams (lotic environments). Detailed SEM images of the eggs of this species show a pair of anterior plastron-bearing horns formed in the prolongation of the anterior ends of the pleats (Hinton, 1969: 356, Fig. 31). A plastron-bearing horn is a structure through which oxygen may be absorbed when the egg is in the water, but through which little water is lost when the egg is dry (Hinton, 1969).

In the present study, we observed a series of plastron-bearing horns placed along the hatching line in *N. rufipes*. These horns are similar to the anterior single plastron-bearing horn observed in *L. riparia*. Hinton (1981) suggested that, in aquatic environments where the oxygen pressure decreases, eggs compensate this issue by increasing the water-air interface of the plastron to extract the oxygen diluted in the water. Considering the series of plastron-bearing horns and that several specimens of *N. rufipes* were collected close to a wetland, we suggest that the eggs of this species could be adapted to lentic environments.

3.5. Adult proboscis

In predaceous Muscidae (as *Neodexiopsis*), stages IV to VI of the eversion process of the adult proboscis include the appearance of the sharp elongate prestomal teeth that cut the prey. At stage IV of *N. rufipes*, the pseudotracheal membrane begins to fold and the tips of the first row of four strong sclerotized prestomal teeth appear (Fig. 7A). As the membrane continues to fold, nine pseudotracheae, an anterior and a posterior rasp-like tongue, and a second row of teeth begin to appear (Fig. 7B–D). The teeth of the second row are very short, with two sharp terminal tines (Fig. 7C–D). *Neodexiopsis*

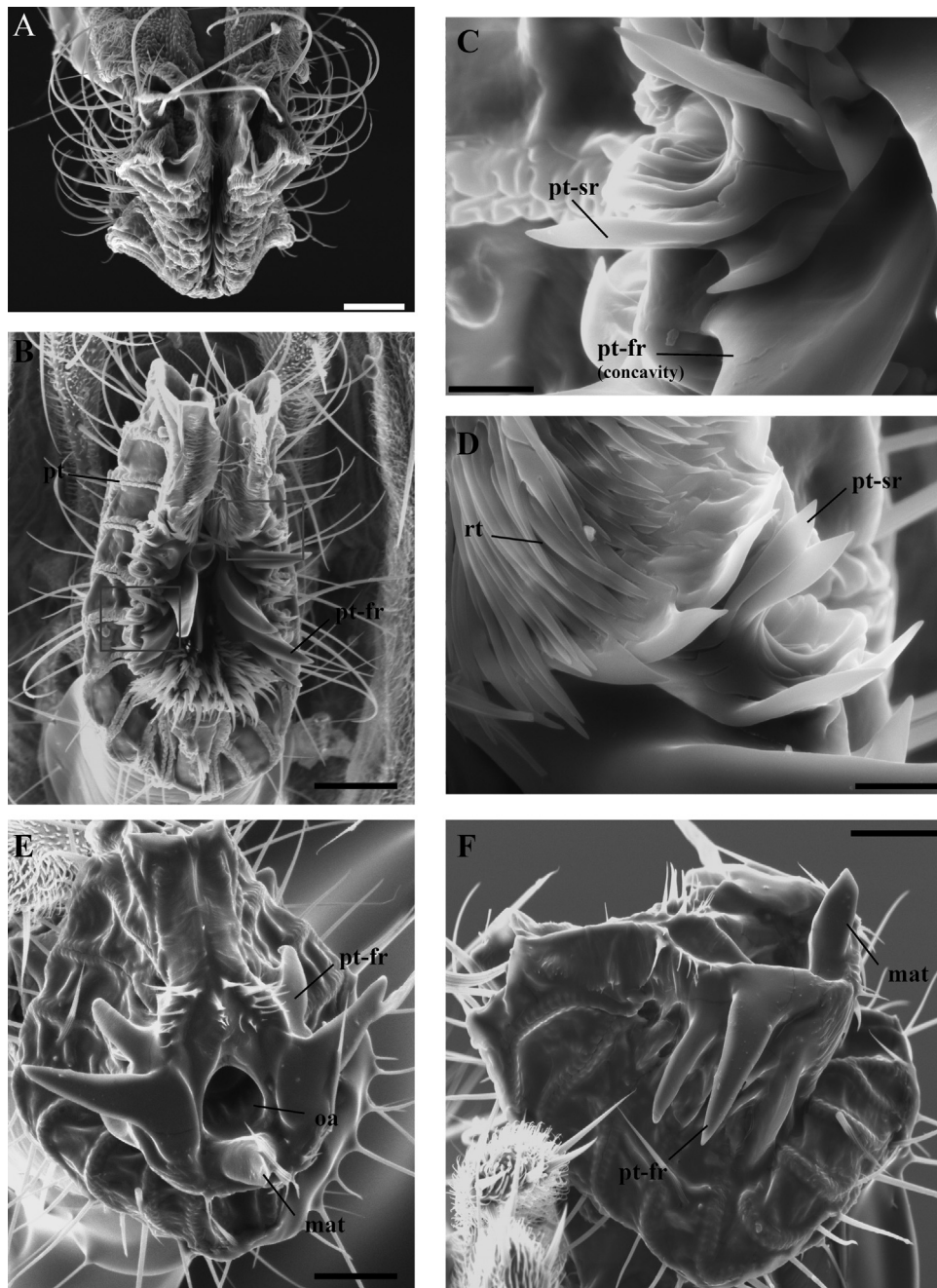


Fig. 7. SEM micrographs of the proboscis of *Neodexiopsis rufipes*. (A) Stage IV. (B) Stage V, red square: detailed in Fig. 7C; green square: detailed in Fig. 7D. (C) Detailed image of first row of prestomal teeth a concave external surface. (D) Detailed image of rasp-like tongues. (E) stage VI, ventral view. (F) stage VI, lateral view. (Abbreviations: mat, middle anterior teeth; oa, oral aperture; pt, pseudotrachea; pt-fr, prestomal teeth, first row; pt-sr, prestomal teeth, second row; rt, rasp-like tongues). Scale bars = (A–B, E–F) 50 μm ; (C–D) 10 μm . (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

rufipes has four hook-like teeth in the first row; these are single pointed, with a broad base and a concave external surface (Fig. 7C, E–F). When the eversion reaches stage VI, the middle anterior teeth and the oral aperture are exposed (Fig. 7E). Also at this stage, the first row of teeth is rotated out for the scraping position (Fig. 7F).

3.6. Comments

Few studies have presented SEM images of the prestomal teeth of Coenosiinae species. Elzinga and Broce (1986) compared the labella of 35 families of flies, including some predator muscids (e.g.: *Coenosia tigrina*, *Lispe nasoni* Stein, and *Limnophora narona* (Walker)). Kühne (1992) presented a detailed description of the

proboscis of *C. tigrina* and later compared the prestomal teeth with those of other species of *Coenosia* (Kühne, 2000). In addition, Steidle et al. (1995) presented a detailed description of the eversion process of the proboscis of *Lispe candicans* Kowarz. Finally, Kühne et al. (2005) showed the prestomal teeth of *Schoenomyza litorella* (Fallen) through the transparent proboscis. The reduced number of pseudotracheae observed in *N. rufipes* (9) is similar to that observed in *C. tigrina* (8–9) and *L. candicans* (9). Also, we noted a reduction in the number of prestomal teeth in *N. rufipes* (4), as in *Coenosia atra* Meigen (4–5) (Kühne, 2000), *C. tigrina* (5–7), *S. litorella* (3), and *L. candicans* (5). The hook-like teeth in the first row of *N. rufipes* is similar to that observed in all other species, except in *S. litorella*,

which presents three teeth with a pair of lateral points at the base (Kühne et al., 2005).

Elzinga and Broce (1986) observed that species with prestomal teeth and pseudotracheal reductions are either predaceous or blood-feeders. Also, Steidle et al. (1995) proposed that the pseudotrachea is used to ingest food at the eversion stages II–IV, but that after stage IV, food can be ingested directly through the oral aperture.

Recent studies on *Coenosia attenuata* Stein have shown that this fly can detect a flying prey, perform a high-speed aerial capture (Gonzalez-Bellido et al., 2011), and return with the prey to the place where it had been waiting (to hunt) for feeding (Kühne et al., 2005). These flies generally feed on insects of the same size or smaller than themselves. As a result, the remains of numerous adult prey items are found below or on the take-off sites (e.g., on leaves) (Bonsignore, 2016). Considering the high-speed aerial capture of these flies, we suggest that the hook-like prestomal teeth of the first row in addition to piercing the cuticle, could fix and hold prey to transport it towards a place in the vegetation for feeding.

4. Conclusions

Although *Neodexiopsis* is one of the richest genera of Coenosiini in South America, their habits and adaptations to the environment are poorly known. The combination of traditional morphological studies with ultrastructural morphology allows acquiring high-quality data sets based on adults and immature stages. The respiratory ultrastructure of eggs described in this work can be important for the extraction of oxygen from lentic environments. In addition, it allows better establishing the association of the immature stages of these flies with aquatic environments. On the other hand, the ultrastructure of the hook-like prestomal teeth of the adult proboscis contributes to understanding part of the mechanism used by these flies for the capture of their prey. These kinds of studies could generate more detailed information, and thus expand the knowledge, about the biology of this genus. On the other hand, more comprehensive taxonomy studies may allow a better resolution of this large and problematic genus.

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