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REDESCRIPTION OF *Neotropiella quinqueoculata* (COLLEMBOLA: NEANURIDAE: PSEUDACHORUTINAE), THE WIDEST DISTRIBUTED SPECIES IN THE NEOTROPICS WITH NEW RECORDS

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REDESCRIPTION OF *Neotropiella quinqueoculata* (COLLEMBOLA: NEANURIDAE: PSEUDACHORUTINAE), THE WIDEST DISTRIBUTED SPECIES IN THE NEOTROPICS WITH NEW RECORDS

Redescripción de *Neotropiella quinqueoculata* (Collembola: Neanuridae: Pseudachorutinae), la especie con más amplia distribución en los neotrópicos y nuevos registros

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ABSTRACT. *Neotropiella quinqueoculata* (Denis, 1931) is redescribed, SEM photos and drawings are included, new localities and intraspecific variation data are provided, and phenology and ontogenetical development with specimens from Estación Biología Tropical de Los Tuxtlas, Veracruz Mexico are given. The complement to original descriptions of *N. silvestrii* (Denis, 1929) and *N. carli* (Denis, 1924) are also added. New records, confirmation or ratifications of distribution for the three taxa from Mexico and countries from Central America are given; Barcode Index Number (BIN) from BOLD System is included for *N. quinqueoculata* material from Panama. An identification key for members of the genus is also provided.

Keywords: Taxonomy, chaetotaxy, neotropics, ontogeny, intraspecific variation-

RESUMEN. Se redescrive *Neotropiella quinqueoculata* (Denis, 1931) con fotos MEB, y dibujos, se proporcionan nuevos registros y variación intraespecífica, así como la fenología y desarrollo ontogenético con ejemplares de la Estación de Biología Tropical de Los Tuxtlas, Veracruz; adicionalmente se hacen complementos a las descripciones de *N. silvestrii* (Denis, 1929) y *N. carli* (Denis, 1924); se proporcionan nuevos registros y confirmación de registros de las tres especies en México y países de América Central; el número Barcode Index (BIN) del BOLD System se incluye para *N. quinqueoculata* con material de Panamá, así como una clave de identificación para la identificación de los miembros del género.

Palabras clave: Taxonomía, chaetotaxia, neotrópicos, ontogenia, variación intraespecífica.

INTRODUCTION

Members of the genus *Neotropiella* Handschin, 1942, can be found in soil and litter, but they are also inhabitants of decomposing wood, bark of trees, and moss on branches of trees and even in epiphytic plants, but are more often collected by pitfall traps (Palacios-Vargas *et al.*, 2018), and Malaise traps; they also can be obtained from the forest canopy using fogging (Palacios-Vargas, *et al.*, 1998). Most species have been described from the Neotropical Region where they are distributed from Jalisco State, Mexico (Magaña-Martínez and Palacios-Vargas, 2010) to Argentina (Bernava and Palacios-Vargas, 2008), but never in the USA or Canada. The genus is supposed to have 18 species of which 16 are known from the Neotropical Region, 14 have been cited from Brazil

(Abrantes *et al.*, 2012; Queiroz *et al.*, 2013; Bellini *et al.*, 2020), others are known from several countries in Central and South America, the exceptions are *N. mirabilis* (Handschin, 1929) and *N. murphyi* Massoud, 1964, which were described from Ethiopia and Malaysia respectively and their taxonomical position has been questioned by Queiroz *et al.* (2013) and Bellini *et al.* (2020); we have excluded them from the genus. Most records of *N. quinqueoculata* should be verified, because for the brief original diagnosis, most of the specimens seem to belong to it. Many descriptions in *Neotropiella* are very short and with very few specimens (one or two), with few chaetotaxy information and no morphological variation included as shown in the comparative table by Bellini *et al.* (2020).

After Bellini *et al.* (2020) *N. carli* and *N. meridionalis* (Brazil, Cuba) and *N. quinqueoculata* (Costa Rica) have unclear descriptions and were proposed as *species inquirendae*, but *N. carli* can be separate by the presence of two pairs of big lateral teeth on unguis. After this study we confirm the validity of *N. carli* and *N. quinqueoculata*.

In this contribution we give information of phenology and ontogeny of *N. quinqueoculata* obtained from a tropical rain forest at Los Tuxtlas, Veracruz, collected through of pitfall traps, during a monthly sampling period of one year.

Background. Originally members of this genus were considered part of *Ceratrimera* Börner, 1906. Handschin (1942) revised and separate it into two new genera, *Aethiopella* and *Neotropiella*, both characterized by well-developed furcula and the presence of a moruliform postantennal organ. The main difference between them is the number of eyes per side: 8 in *Aethiopella* and 5 in *Neotropiella* (Handschin, 1942). Massoud (1967) included in his key *N. mirabilis* (Handschin, 1929) from Ethiopia and *N. murphyi* (Massoud, 1964) from Malasia which should be verified.

All the information about this genus in the Americas was gathered by Mari Mutt and Bellinger (1990, 1996) until 1996 which include: *N. araguaensis* Rapoport and Maño, 1969 (Diaz and Najt 1995 synonymized to *N. carli*; *N. arlei* Najt, Thibaud and Weiner, 1990 (French Guiana); *N. carli* Denis, 1924; Diaz and Najt, 1995 (Venezuela); *N. digitomucronata* Thibaud and Massoud, 1983; Diaz and Najt, 1995 (Venezuela); *N. durantei* Diaz and Najt, 1995 (Venezuela); *N. gordae* Diaz and Najt, 1995 (Venezuela); *N. pedisensilla* Najt, Thibaud and Weiner, 1990 (French Guiana); *N. quinqueoculata* (Denis, 1931); Palacios-Vargas and Gomez-Anaya, 1993 (Mexico); Diaz and Najt, 1995 (Venezuela); *N. silvestrii* (Denis, 1929); Diaz and Najt, 1995 (Venezuela); *N. vanderdrifti* Massoud, 1963; Najt *et al.*, 1990 (French Guiana); Diaz and Najt, 1995 (Venezuela); Palacios-Vargas and Gomez-Anaya, 1993 (Mexico) as *N. cf. vanderdrifti*. Most recent contributions are from Queiroz *et al.* (2013) who described three new species; Bellini *et al.* (2020)

describing another one and Palacios-Vargas and Callohuari who included molecular information.

The species of *Neotropiella* which was cited from litter of the surroundings of Juxtlahuaca caves, correspond to *N. quinqueoculata* (Hoffmann *et al.*, 1986). Maes and Palacios-Vargas (1988) cited from Matagalpa the genus and here it is confirmed to belong to *N. quinqueoculata*. Palacios-Vargas and Iglesias (2008) have cited the presence of *Neotropiella* in litter close to the entrance of caves, but never inside. Mari Mutt and Bellinger (1990, 1996) cited this genus in Argentina, Brazil, Costa Rica, Cuba, Ecuador, Galapagos, Guadalupe, Martinica, Maria Galante, Nicaragua, Puerto Rico and Venezuela, showing that it has an extensive distribution in the Americas.

Palacios-Vargas *et al.* (2018) in one study of monthly variation of leaf litter Collembola collected by pitfall traps in the tropical rainforest of Los Tuxtlas, Veracruz, Mexico found that they represent 10% of specimens collected.

MATERIAL AND METHODS

Specimens were collected during an ecological project on soil, litter and canopy microarthropods at the tropical rain forest of Los Tuxtlas, Veracruz (Palacios-Vargas *et al.*, 2018), which were preserved in ethanol 75% and later about 100 of them slide mounted in Hoyers' solution at Laboratorio de Ecología y Sistemática de Microartrópodos, Faculty of Sciences, Universidad Nacional Autónoma de México for study. Material from Panama comes from the recent project: "Application of metabarcoding tools to long-term monitoring of soil fauna" (Yves Basset and Héctor Barrios).

For the molecular study each of the five specimens from Mexico and Panama was photographed and sent for sequencing with the standard COI-5P marker ("DNA barcode", Ratnasingham & Hebert, 2013) at the Canadian Centre for DNA Barcoding, but as the Mexican material was collected in alcohol and stored for some time in the Biological Station without refrigeration, no sequences were obtained. Only from one specimens of Panama the sequence was obtained.

For the morphology study, specimens or cuticles were mounted in Hoyer's solution after clearing the specimens. Some old slides were remounted to be able to study chaetotaxy and morphological variation.

The numbers in parenthesis after the collectors name are the catalog numbers of each slide which are in the data base of the collection of the Faculty of Sciences of UNAM and also in the CONABIO.

Abbreviations used in the text. Abd - abdominal segment; Ant - antennal segment; Cx - coxa; Fe - femur; hr - anal valve setae; I - seta "i", m - microseta; m' - ventral microsensillum; ms - microsensillum; PAO - postantennal organ; Scx I - subcoxa I; Scx II - subcoxa II; Sgd - dorsal guard sensillum; Sgv - ventral guard sensillum; Tita - tibiotarsus; Th - thoracic segment; Tr - trochanter; VT - ventral tube; a - anterior row of setae; m - median row of setae; p - posterior row of setae; S - antennal sensillum, sensilla; ss - body sensorial seta, L, vestigial tuberculate labial seta L; cf - cuticular fold; - oca, ocm, ocp - anterior, median and posterior ocular setae; sf -ventral sensorial field of Ant IV.

For the labial setation we have used the system of Fjellberg (1998), the ventral chaetotaxy of antennae is based in the proposal of Smolis (2008).

RESULTS

Class Collembola Lubbock, 1870
Oder Poduromorpha Börner, 1913
Family Neanuridae Börner, 1901
Genus *Neotropiella* Handschin, 1942

New Diagnosis of *Neotropiella*
Handschin, 1942

Very dark blue-purple Neanurids with stocky body and a conspicuous mouth beak. Chaetotaxy with micro and macrosetae, usually smooth, sometimes slightly barbulate, never with strong hypertrichoses. Head with only four subdorsal setae and no seta c1. Intersegments in thorax poorly developed and glabrous, no paratergal expansions in thorax or abdomen.

Usually from moderate to big size (1 mm to 4 mm). Antenna characterized by a trilobed apical antennal bulb, from 5 to 7 dorsal sensilla, one microsensillum and one subapical organite; ventral sensorial file with few (sometimes absent) to more than one hundred modified elbowed setae. Ant III organ often displaced to Ant. IV and composed of two sensory tubes placed in a single groove, covered by a prominent fold of tegument; maxilla without fringed or toothed lamellae, the capitulum with two-three basally fused lamella, one ending in a hook or acuminate; mandible with 3-6 teeth; eyes reduced to 5 + 5; PAO always present and moruliform, with simple vesicles from 14 to 70; cephalic chaetotaxy with reduced row "C" and only 4 subdorsal setae. Labium with setae A and C longer than B and D; setae E, F and G, and lateral "f", "e" and "i" always present, there is also a vestigial apical tuberculate seta L; tibiotarsi without tenent hairs, ungues very strong and one inner and one or two pairs of lateral teeth; ventral tube always with 4+4 setae; tenaculum and furcula always present, dens always with six setae; mucro separated from dens and with two lamellae usually well developed. Anal spines absent, but three eversible anal vesicles present.

Type species: *Neotropiella silvestrii* (Denis, 1929) from Cuba

Remarks: Descriptions of *N. mirabilis* (Handschin, 1929) from Ethiopia and *N. murphyi* Massoud, 1965 from Malaysia are very brief, but because they have six pairs of eyes and paratergites clear developed them can't be considered in the genus. *N. malkini* Arlé, 1981 from Colombia with only two mandibular teeth, lacks lamella on mucro and has paratergites with strong hypertrichosis, was recently changed to *Sernatropiella* Palacios-Vargas, 2019.

One of the problems for identifying members of the genus is the use of variable characters as OPA vesicles number, which have often been used since Massoud (1967) and repeated by other authors as Heckman (2001). In the new key we tried to use chaetotaxy but we added other characters because it is not known in all the taxa.

Key to adult species of *Neotropiella* from the Americas

1A - Body with macrosetae besides the microsetae and sensorial setae **2**
1B - Body without macrosetae, only microsetae (seldom mesosetae) and sensorial formula 0,2,2/111110 **3**
2A - Macrosetae on thorax and abdomen appearing to have sensorial formula 3,4,4/333421; Ant IV ventral file around 100 setae; PAO from 20 to 80 vesicles; maxilla hooked; 1.5-3.3 mm long *N. quinqueoculata* (Denis, 1931), from Mexico to Argentina.
2B - Macrosetae of the head, thorax and abdomen, appearing to have sensorial formula 3,4,4/555533; Ant IV without ventral file, only 8-10 spiniform setae; PAO 25-32 vesicles; maxilla pointed; 3.4 mm long *N. arlei* Najt, Thibaud & Weiner, 1990; Brazil, French Guiana.
3A - Unguis with two big pairs of lateral teeth .. **4**
3B - Unguis with one pair or no lateral teeth **6**
4A - PAO with 20-30 or less vesicles; maxilla hooked; Ant IV with 5 sensilla, file with 28-35 setae; unguis teeth usually developed; from 2.4 to 3.5 mm long *N. gordae* Diaz & Najt, 1995; Venezuela.
4B - PAO with 50 or more vesicles; maxilla pointed; unguis teeth strongly developed **5**
5A - PAO with 50–65 vesicles; Ant IV file with about 100 setae; 4.3-6.0 mm long *N. carli* (Denis, 1924); Brazil, French Guiana, Guyana, Peru, Venezuela.
5B - PAO with 65–70 vesicles; 6 mm long *N. murphyi* Massoud, 1964; Malaysia.
6A - Body with plurichaetosis; PAO with 27-36 setae; Ant IV with 6 sensilla, no ventral file but 5-8 spine-like setae; 0.6-1.2 mm long *N. plurichaetosa* Thibaud & Oliveira, 2010; Brazil.
6B - Body without plurichaetosis, only micro and mesosetae besides sensorial setae **7**
7A - Ant IV file present, with 0 or more clear modified setae **8**
7B - Ant IV file absent, Ant IV with 20 or less ventral spiniform setae **11**
8A - Ant IV file with more than 140 modified setae; PAO with 38-40 vesicles; mandible with 5 teeth, basal one big; maxilla hooked; dens short

with long setae, about 2.5 times the mucro; 2.5-3.8 mm long *N. insularis* Queiroz, Silveira & Mendonça, 2013; Brazil.
8B - Ant. file with about 100 modified setae; PAO 35-50 vesicles, mandible with 4 teeth, basal one small, maxilla pointed; dens long with short setae, about 5 times mucro; 2.5-3.0 mm long *N. silvestrii* Denis, 1929; Cuba.
8C - Ant IV file with about 76 or less modified setae; PAO with less than 34 or more than 50 vesicles **9**
9A - Ant IV with 7 sensilla, file with 40 modified setae; PAO with 50-60 vesicles; mandible with 5 teeth, maxilla pointed; 2.2-2.6 mm long *N. durantei* Diaz & Najt, 1995; Venezuela.
9B - Ant IV with 6-7 sensilla, file with 100-140 modified setae; PAO with 17-37 vesicles; mandible with 4 teeth, maxilla hooked; 1.6-2.1 mm long *N. peruana* Palacios-Vargas & Callohuari, 2020; Peru.
9C - Ant IV sensorial field with 46 or more modified setae; PAO with 34 or less vesicles; mandible with 4 teeth, maxilla apex pointed **10**
10A - Ant IV sensorial file with 76 modified setae; PAO with 34 vesicles; mandible with 4 teeth, maxilla pointed; De field with 4 setae + ss on Th II and III; 0.7 mm long *N. digitomucronata* Thibaud & Massoud, 1983; Brazil, Ecuador, Guadeloupe, Venezuela.
10B - Ant IV sensorial field with 46 modified setae; PAO with 20-22 vesicles; De field with 3 setae + ss on Th II and III; 1.1 mm long *N. pedisensilla* Najt, Thibaud & Weiner, 1990; French Guiana.
11A - Th I with 4+4 dorsal setae **12**
11B - Th I with 3+3, or 2+2 dorsal setae **14**
12A - Ant IV with 7-8 sensilla and 7-8 ventral modified setae; PAO with 23-27 vesicles; mandible with 5 teeth; 0.8-2.3 mm *N. macunaimae* Queiroz, Silveira & Mendonça, 2013; Brazil
12B - Ant IV with 6 sensilla and 9-20 ventral modified setae; PAO with less than 30 vesicles **13**
13A - Ant IV with 18-20 ventral modified setae; PAO with 27-29 vesicles; mandible with 6 teeth, maxilla hooked; De field with 3 setae + ss on Th

II and III; 0.8-1.1 mm long ... *N. barbatae* Queiroz, Silveira & Mendonça, 2013; Brazil.

13B - Ant IV with 9 modified ventral setae; PAO with 14-20 vesicles; mandible with 5 teeth, maxilla pointed; De field with 4 setae + ss on Th II and III; 0.8-1.5 mm long *N. arretada* Bellini, Weiner, Queiroz & Paz, 2020; Brazil.

14A - Th I with 2+2 setae; Ant. IV with 7 dorsal sensilla; PAO with 18-23 vesicles; mandible with 6 teeth; 2 mm long *N. vanderdrifti* Massoud, 1963; Surinam.

14B - Th I with 3+3 setae; Ant. IV with 6 dorsal sensilla; PAO with 7-10 vesicles; mandible with 4 teeth; 0.35-0.65 mm long *N. minima* Thibaud & Oliveira, 2010; Brazil.

***Neotropiella quinqueoculata* Denis, 1931**
(Figs. 1-18, 22-27).

Material: MEXICO: Veracruz State: Los Tuxtlas, the high evergreen rainforest of the Los Tuxtlas Tropical Biology, Field Station at 18°35'06" North latitude and 94°4'29", West longitude and 180 m above the sea, ex Pit fall traps. M. Madora col. Redescription and intraspecific variation is based on specimens from this locality because they were very abundant.

Diagnostic description. This is the only species known with a peculiar dorsal chaetotaxy on adults; macrosetae presence gives the appearance of having the following formula (macro and sensorial included): 3,4,4/333421. There is one pair of macrosetae dorsally on Abd VI. Thorax I has one microseta, two macrosetae, one microsetae and one macrosetae per side, besides two additional dorso-lateral microsetae. Abd V has on posterior row one microseta, sensorial setae, one microseta and one macroseta per side. Besides some additional dorso-lateral microsetae, Abd VI with one pair of macrosetae and one unpaired seta p0.

Redescription. Body length average, females (n=10): 2.27 mm (range 1.5-2.64 mm); males and preadults (n=15): 1.99 mm (range 1.6-2.4) juveniles (n=10): 1.3 (range 0.4-1.87). About 368 specimens are kept in alcohol but are not paratypes as sex cannot be determined. Color in ethanol: dark blue to dark purple (Fig. 1).

Ratio head diagonal: antenna = 1:1.1. Ant I with 9 setae, Ant II with 12 setae. Ant III and IV fused dorsally, ventrally well separated. Sensory organ of Ant III apically displaced, with two big tubular sensilla in a single groove and slightly bending towards each other, covered by a big fold of tegument (Fig. 2); two longer and subcylindrical guard sensilla; sgd thicker and longer than sgv, ventral microsensillum present (Fig. 3). Ant IV with trilobed apical bulb, six sensilla, dorsolateral microsensillum and subapical organite (Fig. 2); ventral side with about 90 small setae, forming a big sensorial field (Fig. 3, 22). First instar with reduction of sensorial structures (Figs. 4, 5).

Dorsal chaetotaxy composed of smooth microsetae (10 µm), long macrosetae (62 µm) and sensory setae (65 µm) similar in size and appearance to macrosetae. Sensillar formula by half tergum: 022/111110, very clear in juveniles (Figs. 10, 12), but in adults due to the presence of macrosetae seems to be 344/33421 (Fig. 11, 13, 14). Head without setae row v, only 4 subdorsal and lacking setae c1, in both juveniles and adults (Fig. 10, 11). Th I in adult with 7+7 setae (Fig. 11), three of them macrosetae; juveniles only with 4 microsetae. Abd V with apparently 2 + 2 sensorial setae, because of the presence of one pair of macrosetae (Fig. 14). Abd VI with one pair of macrosetae (m2) and one median seta p0 (Fig. 14). Chaetotaxy of legs from subcoxa II to tibiotarsus, from leg I to III: 0, 3, 5, 12, 19; 3, 5, 5, 11, 18; 3, 5, 5, 11, 18. No clavate tenent hairs on tibiotarsi; femora with a long ventral seta. Unguis with one middle inner tooth and 1 + 1 lateral teeth (Fig. 24) but sometimes one big pair and one small basal pair (Fig. 16). Unguis elongated almost as long as tibiotarsus III, ratio Tita III: unguis 1:1.2. Ventral tube with 4+4 setae (one seta bigger than others on each side). Abd II with 4+4 ventrolateral setae. Tenaculum with three teeth on each ramus (Fig. 25). Furcula present: manubrium (205 µm) with 15+15 ventral setae (microsetae 37 µm; 3+3 are macrosetae, 66 µm); dens smooth with striae in anterior side and with strong graduation and with 6+6 short setae (37-42 µm) on posterior side (Fig. 15, 26); mucro (82 µm) separated from dens (ratio manubrium: dens; mucro = 1: 0.8; 0.4) with three lamellae, the

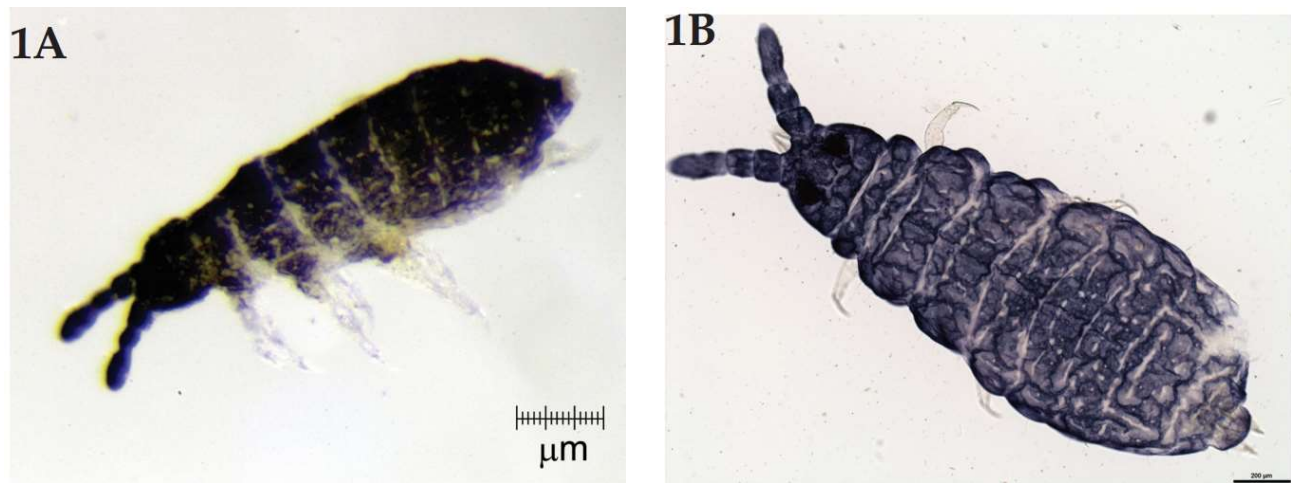


Figure 1. Habitus of *Neotropiella quinqueoculata*. A. Specimen from Barro Colorado Island, Panama in alcohol; B. Slide mounted specimen from Los Tuxtlas, Mexico. Scale bar in A, is 150 μm; in B, 200 μm.

external one greatly developed and enlarged tapering before mucro apex, which is elongated and slightly hooked (Fig. 26). One pair of macrosetae (m2) and one unpaired dorsal seta p0 on Abd VI (p0). Each anal valve with 14–15 setae, one being distal-lateral, and 2 setae hr; Abd VI with 2 setulae hr in the ventral side (Fig. 14). Genital plate of female with 3 + 3 pregenital setae, 10–12 circumgenital and 2 eugenital (Fig. 17, 27), male with 3 + 3 pregenital, 20–22 circumgenital and 5 + 5 eugenital setae (Fig. 18).

Morphological Variation. As noticed by Lawrence (1971) there is a strong variation in the morphology of this species which is very widely distributed; so, here I present the results of the characters which often are use in the taxonomy of this genus. Bellini *et al.* (2020) gave a table with the number of specimens upon 17 species known; most of them were very few, and not intraspecific variation was included.

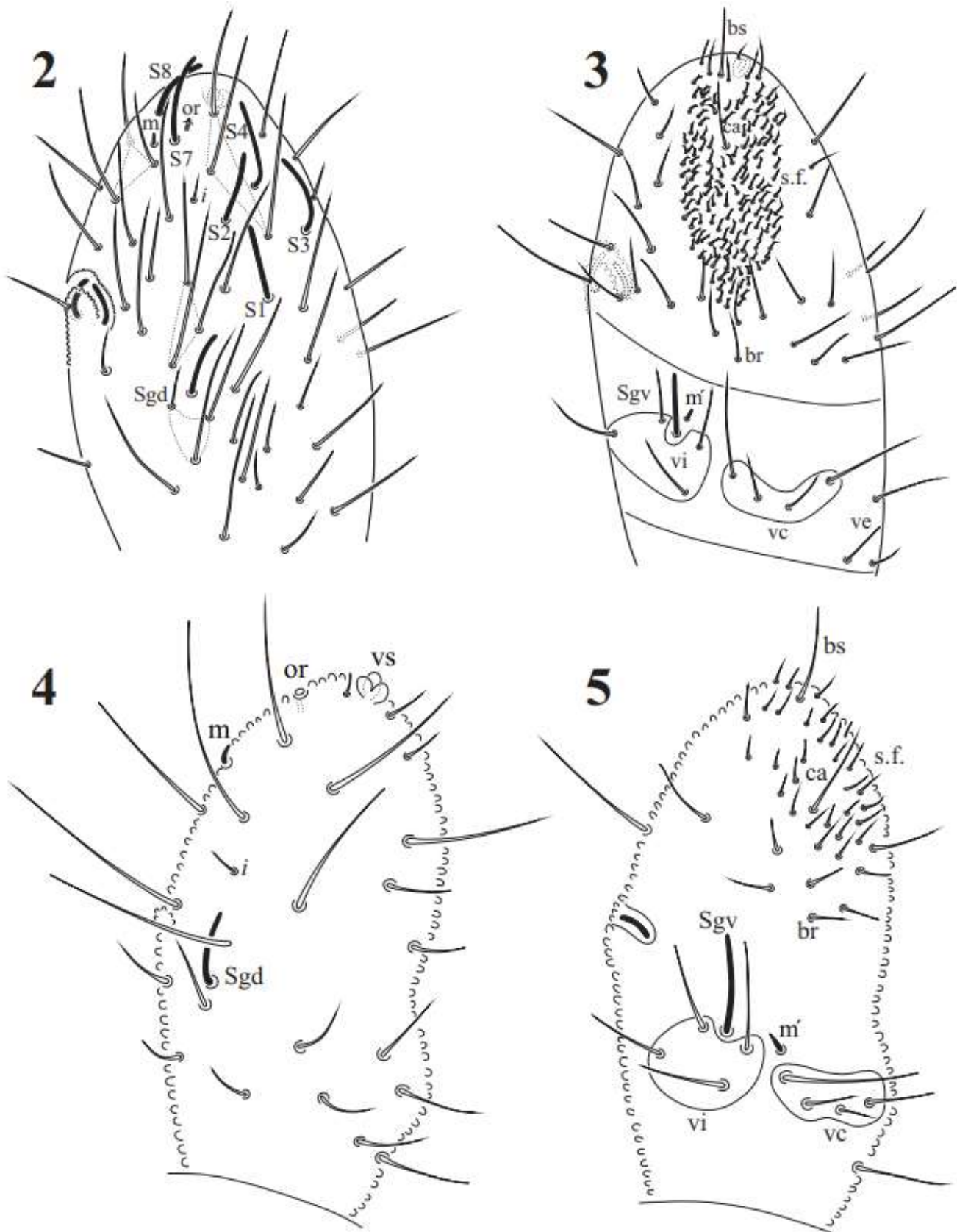
They were measure 22 adult specimens from 11 localities; the average is 2.0 mm, the smallest was from Guatemala (1.5 mm) and the biggest from Costa Rica (3.3), where the type locality is. Ant IV sensilla are 6, but few specimens had 7 or even 5.

Due to the shape of the buccal cone, the small size of the mandible (Massoud, 1967), and position, it is difficult to study, and it is hard to tell the real number of teeth. Maxilla very often are protruded out of the mouth and easier to study.

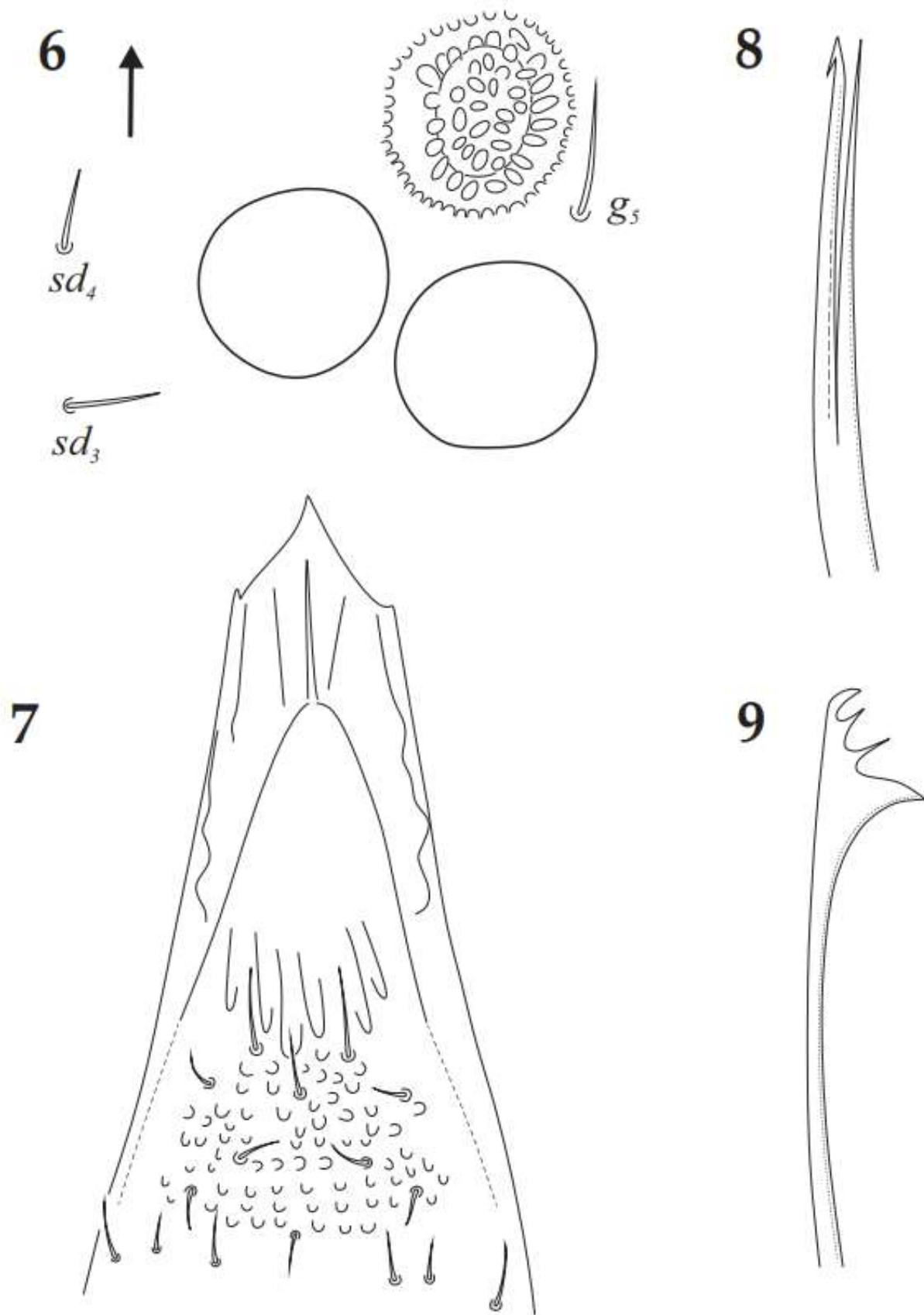
For a variation of the morphology 197 slide-mounted specimens from 24 localities (see new records) from Costa Rica, Cuba, Honduras,

Mexico, Nicaragua and Panamá, were studied, but sometimes some characters were impossible to see. Most specimens come from pitfall traps (59), litter (46), NTP-80 (40), Malaise traps (20), and a few from fumigation (9), decomposing trunk (5) and soil (3). Many specimens correspond to different juvenile instars (76), females (35), females preadults (2), males (20), males preadults (6); other specimens (55) were too dark or damaged for studying the genital plates. Ant IV ventral file, close to 140 modified setae (6 specimens), about 100 modified setae (67 cases), less than 15 setae in juveniles (2). Eyes are very constant, 5 + 5, but in some cases one eye can be smaller, and in one case, it was found one specimen with only 5 + 4 eyes. PAO, minimum vesicles 20, maximum 53 vesicles. Lawrence (1971) studied specimens of this species from Mato Grosso, Brazil, and the PAO had 21–89 vesicles. Mandibles have 4 teeth (18 specimens), 3 teeth (4). Maxilla hooked (122), 78 were not possible to study. In eleven cases it was pointed (1 from Xochitepec, 8 from Tlayacapan (Morelos) and 2 from Chamela (Jalisco).

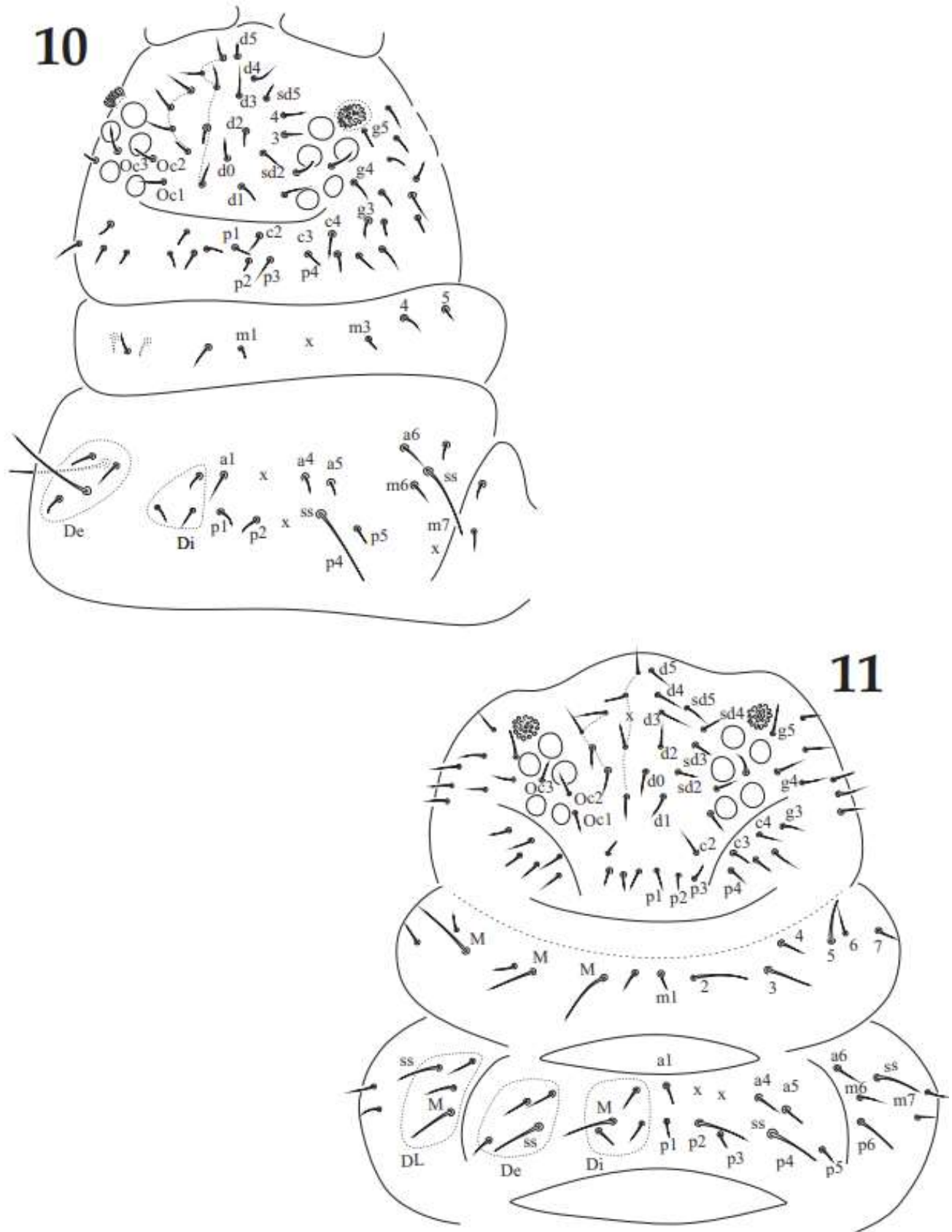
Head chaetotaxy seems to be very constant (Figs. 10, 11) in juveniles and adults; even sometimes a few cases of asymmetries can be found. Unguis is very constant, one inner and two lateral teeth (133 cases), 1 + 3 (4); 1 + 4 (6), and sometimes there can be one very small pair of additional lateral teeth (Fig. 16) in the distal part of unguis, besides the 1 + 2 regular teeth.



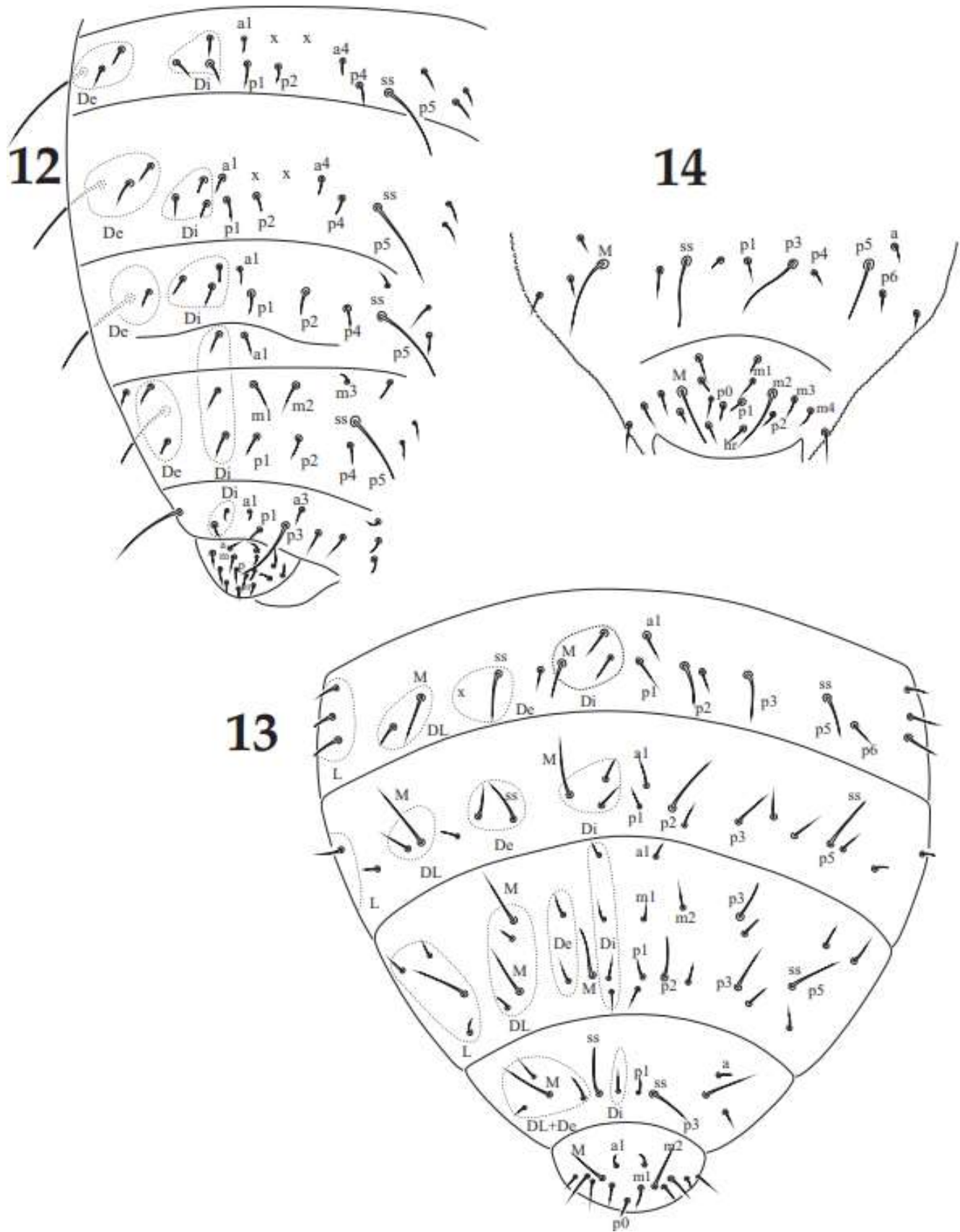
Figures 2-5. *Neotropiella quinqueoculata*. 2. Ant. III-IV dorsal view of one adult; 3. Ant. III-IV in ventral view of one adult; 4. Ant. III-IV dorsal view of one juvenil; 5. Ant. III-IV ventral view of one juvenil.



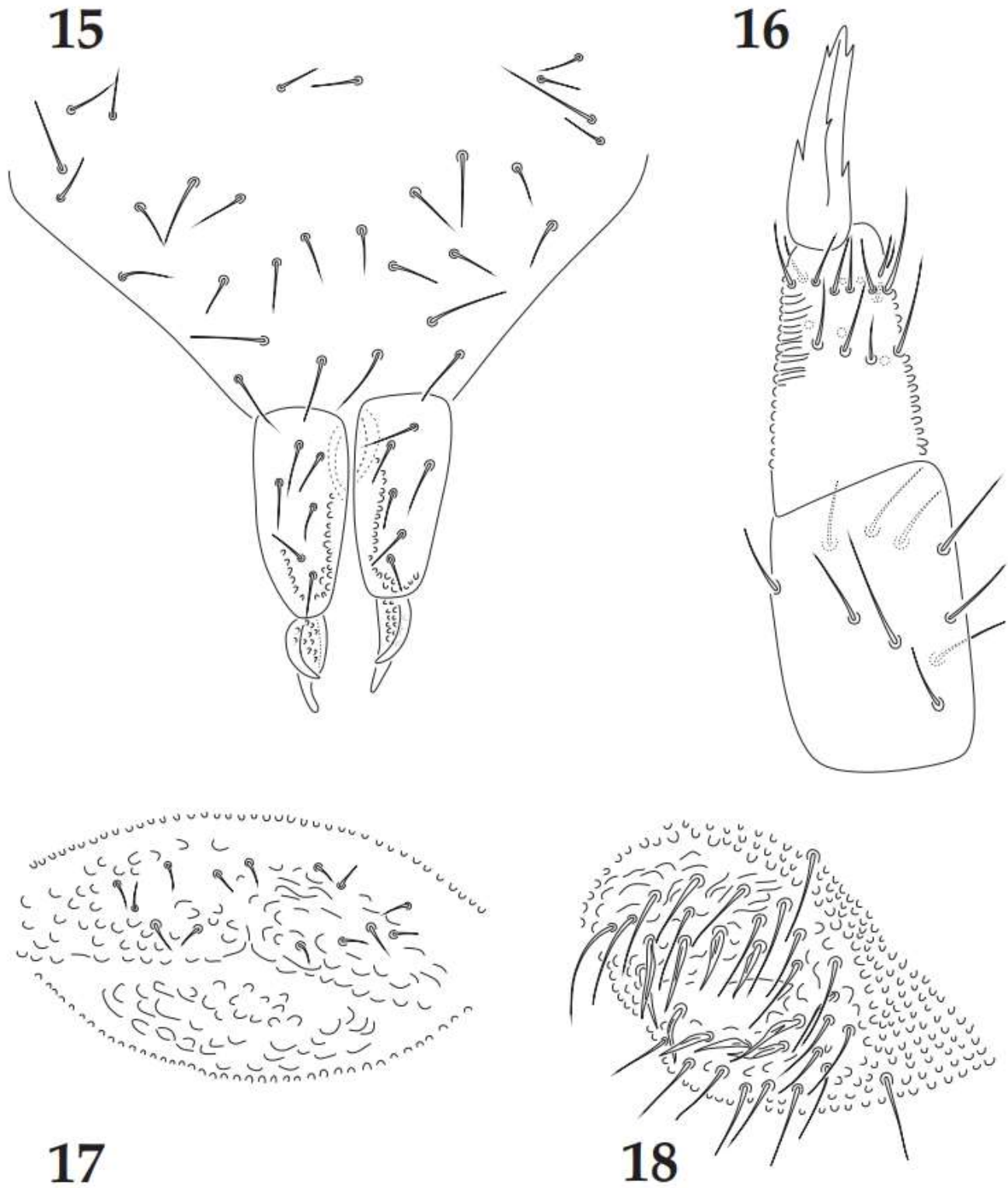
Figures 6-9. *Neotropiella quinqueoculata*. 6. OPA and close eyes; 7. labrum quetotaxy; 8. Maxila; 9. Mandible.



Figures 10-11. *Neotropiella quinqueoculata*. 10. Head and thorax chaetotaxy of juvenile, first instar; 11. Head and thorax chaetotaxy of one adult.



Figures 12-14. *Neotropiella quinqueoculata*. 12. Abdominal chaetotaxy in a juvenil of 1st instar; 13. Abdominal chaetotaxy in an adult; 14. Abd V and VI chaetotaxy of adult.



Figures 15-18. *Neotropiella quinqueoculata*. 15. Furcula; 16. Tibiotarsus III; 17. Female genital plate; 18. Genital plate of male.

Body chaetotaxy variation was studied on Th I and Abd V which can be very useful for the species isolation, even it was found is found a small variation.

One Th I seta m1 is usually microseta (132 cases) and sometimes (12) can be longer as a mesoseta; m2 and m3 are macroseta (99 and 91 cases respectively) seta m4, is microseta (96), seta 5 is macroseta (52), but in juveniles most of them are microsetae. In the first instar there are only 4 microsetae (Fig. 10). On Abd V, seta p1 is microseta (90 cases), macroseta (32) or sometimes mesoseta (4), there is not seta p2, and p3 is the sensorial seta (156 cases) and only in one case it was microseta, p4 is microseta (112 cases), and sometimes it is longer as mesoseta (12), seta p5 is macroseta (69 cases), mesoseta (11), or microseta (55), seta p6 is microseta (67 cases), mesosetae (5) or macrosetae (12). This is might be due to the different development of individuals, but also to some other phenomena as ecomorphosis. With this information we concluded that the formula including macroseta and sensorial setae is: 3,4,4/333421 (Figs. 11, 14).

Remarks. *Neotropiella quinqueoculata* (Denis, 1931) was described originally from Costa Rica, two specimens from San José and another from the slopes of Irazú volcano. The description (translated by author) only says: “Maximum size 1.3 mm, very dark violet; shape thick, all the seta simple; tegument granulose, no conical and low. 5 eyes on each side. OPA with more than 30 vesicles; in a subcircular file. Ant III and IV badly separated. Olfactive setae (sensilla) on Ant IV apical curved, apical bulb trilobed. No tenent hairs. Ungues very long in the middle. Furcula well developed, dens with an anterior surface smooth with striae, posterior surface granulose, 6 setae. Mucro hooked, with 2 lamellae. Mandible with 4 teeth, maxillae styliform” As the description was very brief, Bellini *et al.* (2020) proposed it as *species inquerenda*, but with the present redescription we conclude that it is valid and well-differentiated. *N. quinqueoculata* belongs to the group of species with more than 100 modified setae on the ventral sensorial file of Ant IV: *N. carli* and *N. insularis*. It differs in having only one pair of lateral teeth of medium

size, while the other species have 2 + 2 big teeth. It also differs from the last species in having more abundant setae on Th I and the presence of macrosetae on the segments with the following formula of sensorial setae and macrosetae from Th I to Abd VI: 3,4,4/333421.

New localities. COSTA RICA: Sierra de Talamanca: Parque Nacional Tapantí. *Ex* rotten trunk, 19-VII-2010, J. Palacios-Vargas and Diego Fernández col. (FC-UNAM:LESM-AC:QL239, FC-UNAM:LESM-AC:QL240, FC-UNAM:LESM-AC:QL241); *Idem*, Turrialba, CATIE 560 m humus, 14-VII-1978, P. Werner col. (FC-UNAM:LESM-AC:QL242).

CUBA: Santiago de Cuba; Cuato Sur, San Luis el Mango, litter, D. Prieto col. 15-VII-1998.

GUATEMALA: Zacapa: La Unión, cloud forest, *ex* litter, 17-IV-2017, 3 specimens, M. Barrios col. San Cristobal, Acasaguasitlan, finca San José el Olvido, el Progreso, *Quercus-Liquidambar* forest *ex* litter, 17-V-2017. 2 specimens. M. Barrios col. (FC-UNAM:LESM-AC:QL017, FC-UNAM:LESM-AC:QL018, FC-UNAM:LESM-AC:QL019, FC-UNAM:LESM-AC:QL020, FC-UNAM:LESM-AC:QL021).

HONDURAS: Olancho, La Muralla, 15.09916, 8674061 = 150 m, 153 om, FS 3^a, Llama, # WA1-C-01-1 ALL, cloud forest, sifted leaf litter, 2-V-2010, 6 specimens, F. Soto-Adames col. (FC-UNAM:LESM-AC:QL037, FC-UNAM:LESM-AC:QL038, FC-UNAM:LESM-AC:QL039, FC-UNAM:LESM-AC:QL040, FC-UNAM:LESM-AC:QL041, FC-UNAM:LESM-AC:QL042). *Idem*, Comayagua: 12 Km ENE, Comayagua, 14.48139, /87.53225 = 150 m, 2,140 m, FS2A, Llama # WA-C-02-ALL, Cloud forest, siefted leaf, ICAF, litter, 5-V-2010, 1 specimen F. Soto-Adames col. (FC-UNAM:LESM-AC:QL036); Cloud forest, siefted leaf, ICAF, litter, 6-VI-2010, 4 specimens F. Soto col. (FC-UNAM:LESM-AC:QL029, FC-UNAM:LESM-AC:QL033, FC-UNAM:LESM-AC:QL034, FC-UNAM:LESM-AC:QL035). *Idem*, PM, Cerro Azul, mcambar, 18.47113, -8789935 = 150 m, 1,120 m alt. FSA, Lamma # WA-C-04-1-ALL, cloud forest, 20-V-2010, 1, F. Soto-Adames; *Idem*, Ocatepec, 13 Km E nuevo Ocatepec, 14.25603-89.06901 = 150 m, 2,200 al. FS5A Llama # WA-C-01-ALL, cloud forest, 25-V-2011, 3 specimens, F. Soto-Adames col. (FC-

UNAM:LESM-AC:QL030, FC-UNAM:LESM-AC:QL031, FC-UNAM:LESM-AC:QL032).

MEXICO. Ciudad de México. Xochitepec, *Eucaliptus* forest, 18-IX-1976, 1 specimen, L. Cervantes col. (FC-UNAM:LESM-AC:QL044).

Chiapas: Chajul, tropical rain forest, fogging, 25 VII-1994, 1 specimen, G. Ríos col. *Idem*, 29-VII-1995, 1 specimen. (FC-UNAM:LESM-AC:QL015, FC-UNAM:LESM-AC:QL243).

Jalisco, Chamela: Estación de Biología tropical, fogging, 9-1992; fogging, 18-VIII-1992, J. Palacios col. IX-1992. Fogging, 16-XI-1992, *ex soil*, J. Palacios col. (FC-UNAM:LESM-AC:QL043, FC-UNAM:LESM-AC:QL045, FC-UNAM:LESM-AC:QL046, FC-UNAM:LESM-AC:QL047).

Morelos: Tlayacapan, NTP-80, 1-VI-1996, 14 specimens, J. M. Márquez col. (FC-UNAM:LESM-AC:QL084, FC-UNAM:LESM-AC:QL085, FC-UNAM:LESM-AC:QL086, FC-UNAM:LESM-AC:QL087, FC-UNAM:LESM-AC:QL088, FC-UNAM:LESM-AC:QL089, FC-UNAM:LESM-AC:QL090, FC-UNAM:LESM-AC:QL091, FC-UNAM:LESM-AC:QL092, FC-UNAM:LESM-AC:QL093, FC-UNAM:LESM-AC:QL094, FC-UNAM:LESM-AC:QL095, FC-UNAM:LESM-AC:QL096, FC-UNAM:LESM-AC:QL097, FC-UNAM:LESM-AC:QL098).

Oaxaca: Cerro Pelón, 2,800 m alt. 26-II-1984, C. Castillo col. (FC-UNAM:LESM-AC:QL083).

Tabasco: Tapijulapa: Cuevas de Las Sardinias, *ex litter*, 3 specimens, 6-XII-2001, *Idem*, litter, 12-X-1989; *Idem*, litter from outside, 5 specimens, 14-III-2002, D. Estrada col. (FC-UNAM:LESM-AC:QL069, FC-UNAM:LESM-AC:QL070, FC-UNAM:LESM-AC:QL071, FC-UNAM:LESM-AC:QL072, FC-UNAM:LESM-AC:QL073, FC-UNAM:LESM-AC:QL074, FC-UNAM:LESM-AC:QL075, FC-UNAM:LESM-AC:QL076, FC-UNAM:LESM-AC:QL077).

Veracruz: Jalapa: La Herradura, bosque mesófilo de montaña, NTP-80 traps, 26-X-1998, (FC-UNAM:LESM-AC:QL009, FC-UNAM:LESM-AC:QL062, FC-UNAM:LESM-AC:QL063, FC-UNAM:LESM-AC:QL064, FC-UNAM:LESM-AC:QL065, FC-UNAM:LESM-AC:QL066, FC-UNAM:LESM-AC:QL067, FC-UNAM:LESM-AC:QL068.) 8 specimens, F. Alvarez col. *Idem*, Totula, mata oscura, zacopan, selva media subcaducifolia, NTP-80, 22-X-1998, 3 specimens, F. Álvarez col. (FC-UNAM:LESM-AC:QL055, FC-UNAM:LESM-AC:QL060, FC-UNAM:LESM-AC:QL061).

Córdoba, San Rafael, Calería Ojo de Agua, subcaducifolia, 1127M, NTP80, 24-VII-1998, F. Alvarez col., *Idem*, Caleria Ojo de Agua, 1127M, NTP80, 26-VII-1998, 6 specimens, F. Alvarez col., *Idem*, selva media subcaducifolia, 1127M, NTP80, 23-X-X-1998, 3 specimens, F. Alvarez col., *Idem*: 1127M, NTP80, 28-XI-1998, 1 specimen, F. Alvarez col. (FC-UNAM:LESM-AC:QL048, FC-UNAM:LESM-AC:QL049, FC-UNAM:LESM-AC:QL050, FC-UNAM:LESM-AC:QL051, FC-UNAM:LESM-AC:QL052, FC-UNAM:LESM-AC:QL053, FC-UNAM:LESM-AC:QL054, FC-UNAM:LESM-AC:QL056, FC-UNAM:LESM-AC:QL057, FC-UNAM:LESM-AC:QL058, FC-UNAM:LESM-AC:QL059.)

Tlapacoyan: Río Alceca, litter, 10-IV-2015, 3 specimens, J. G. Palacios-Vargas, col. (FC-UNAM:LESM-AC:QL099.); *Idem:* Pico de Orizaba: C2, PF21, brabch2/2, 1-II-2012, F. Alvarez col. (FC-UNAM:LESM-AC:QL001, FC-UNAM:LESM-AC:QL002).

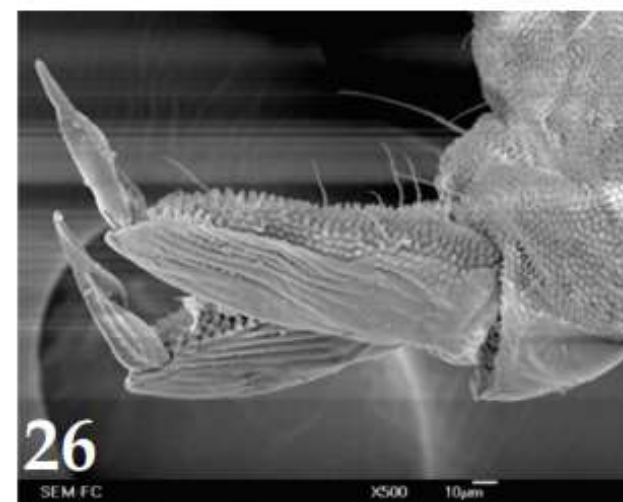
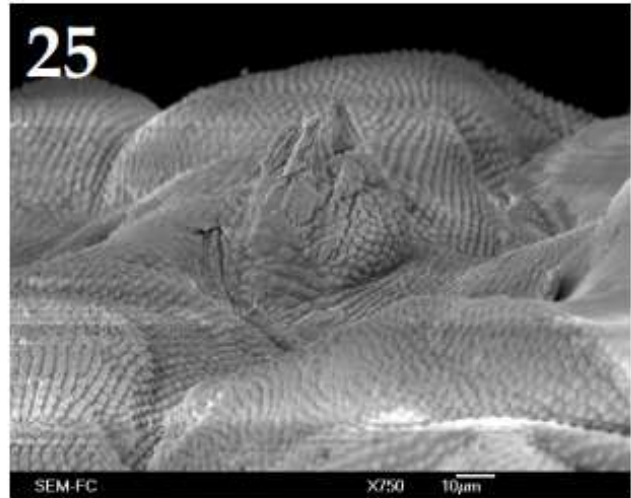
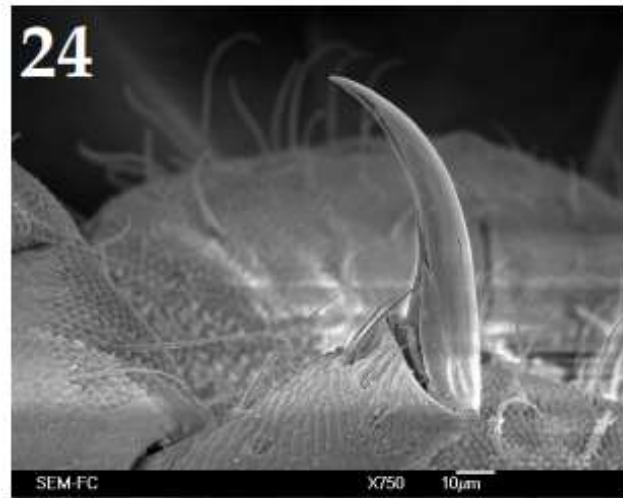
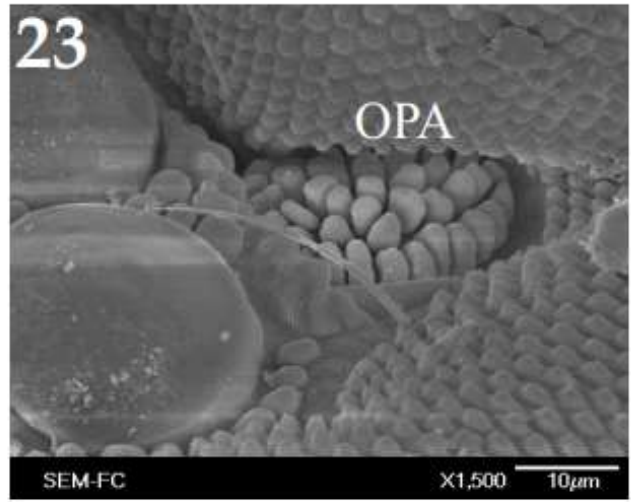
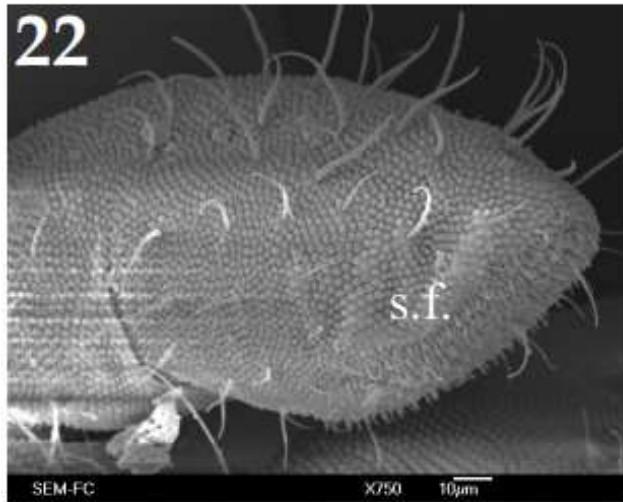
IPF1A, blanch 8/2, blanc 26/6, 5 specimens 1-II-2012, A. Alvarez col. IPF1A, Branch 8/2, 1-II-2012, 1 specimens, F. Alvarez col. (FC-UNAM:LESM-AC:QL003, FC-UNAM:LESM-AC:QL004, FC-UNAM:LESM-AC:QL005, FC-UNAM:LESM-AC:QL006, FC-UNAM:LESM-AC:QL007, FC-UNAM:LESM-AC:QL008, FC-UNAM:LESM-AC:QL102).

(FC-UNAM:LESM-AC:QL100, FC-UNAM:LESM-AC:QL101).

Coatepec: La pitaya, necro-trap NTP-80, 26-X-1998, 2 specimens.

Quintana Roo: cenote Koox 2007, 1 specimen N. Marcos col. (FC-UNAM:LESM-AC:QL078 Tulum: Cenote Hogt, Pitfall, 14-X-2007, D. Estrada col. Actún Chen III, *ex trunk*, 17-X-1997, 3 specimens, J. Palacios col. (FC-UNAM:LESM-AC:QL079, FC-UNAM:LESM-AC:QL080, FC-UNAM:LESM-AC:QL081 FC-UNAM:LESM-AC:QL082).

NICARAGUA: Matagalpa: Fuente Pura, Malaise trap, 21-VII-1994. 16 specimens J.-M. Maes col. (FC-UNAM:LESM-AC:QL222, FC-UNAM:LESM-AC:QL223, FC-UNAM:LESM-AC:QL224, FC-UNAM:LESM-AC:QL225, FC-UNAM:LESM-AC:QL226, FC-UNAM:LESM-AC:QL227, FC-UNAM:LESM-AC:QL228, FC-UNAM:LESM-AC:QL229, FC-UNAM:LESM-AC:QL229).



Figures 22-25. *Neotropiella quinqueoculata*. 22. Ant. IV lateral view; 23. OPA and closest eyes; 24. Ungues I; 25, tenaculum; 26. Furcula in lateral view; 27. Female genital, anal plate and anal vesicles

AC:QL230, FC-UNAM:LESM-AC:QL231, FC-UNAM:LESM-AC:QL232, FC-UNAM:LESM-AC:QL233, FC-UNAM:LESM-AC:QL235, FC-UNAM:LESM-AC:QL236, FC-UNAM:LESM-AC:QL237, FC-UNAM:LESM-AC:QL238) *Idem*, 6-VII-1994, J.-M. Maes col. *Idem*, Masaya: Las Flores, Malaise traps, 2 specimens, 21-VII-1994, J.-M. Maes col. *Idem*, Estelí: Mesas de Moropotenté, soil from forest *Acacia pennatula*, 22-VIII-07, C3(8), M3(P9), M2 (1). P. Andrés col. (FC-UNAM:LESM-AC:QL217, FC-UNAM:LESM-AC:QL218)

PANAMA: West Distrito la Chorrera: Barro Colorado Island, 11-IV-2017, 2 specimens, Y. López *et al.* Col. (FC-UNAM:LESM-AC:QL201, FC-UNAM:LESM-AC:QL202). ZET2-500B *Idem*, WHE2-400B. *Idem*, 26-XII-2017, 2 (FC-UNAM:LESM-AC:QL203, FC-UNAM:LESM-AC:QL204). 2 specimens ARM3-100. *Idem*; 18-XII-2018, (FC-UNAM:LESM-AC:QL205). ZET1-300B; *Idem*. 9-I-2018, (FC-UNAM:LESM-AC:QL206). WHE2-100B; 04-04-2017 (FC-UNAM:LESM-AC:QL207); ZET2-250B; *Idem*, 1-VI-2017, ARM2-200A; *Idem*, 14-03-2017, (FC-UNAM:LESM-AC:QL209), ARM3-050B; *Idem*, B-ARM4-march 2017, 450B; *Idem*, Colón, Prov. San Lorenzo, forest, 9°17'N 79°58' W. by Berlese, M-C-2-03C3,30,IX-2003, N. Winchester, & K. Jordan col.

Phenology. Specimens were collected in a one-hectare plot (100 × 100 m) from an undisturbed area of the tropical rainforest (2 km from the installations of Los Tuxtlas, Biological Field Station) (Palacios-Vargas *et al.*, 2018). The plot was divided into 25 quadrants of 20 × 20 m. Five equidistant traps (every 20 m) at the top, middle and bottom of the study plot. Monthly, during 2015 they were placed 15 pitfall traps with 75% alcohol preservative along these transects. Traps were operated in the field for five days each month. 445 specimens of *N. quinqueoculata* were collected (10% of a total of 4430 Collembola specimens from 32 genera) in one year. They were captured from January to December of 2015, except August. Slides were prepared from each month; their distribution was as follows: January 9 juveniles; February one male preadult; March one male; May one juvenile; June 20 juveniles, 5 males preadults, 3 females and 3 preadult females;

July one juvenile; September 4 juveniles; October 7 juveniles, 2 males, one preadult male, one female; November 4 juveniles, one male, 2 preadult males, 4 females. June, October, and November are when most of the different development states were found, and juveniles are present in most of the months.

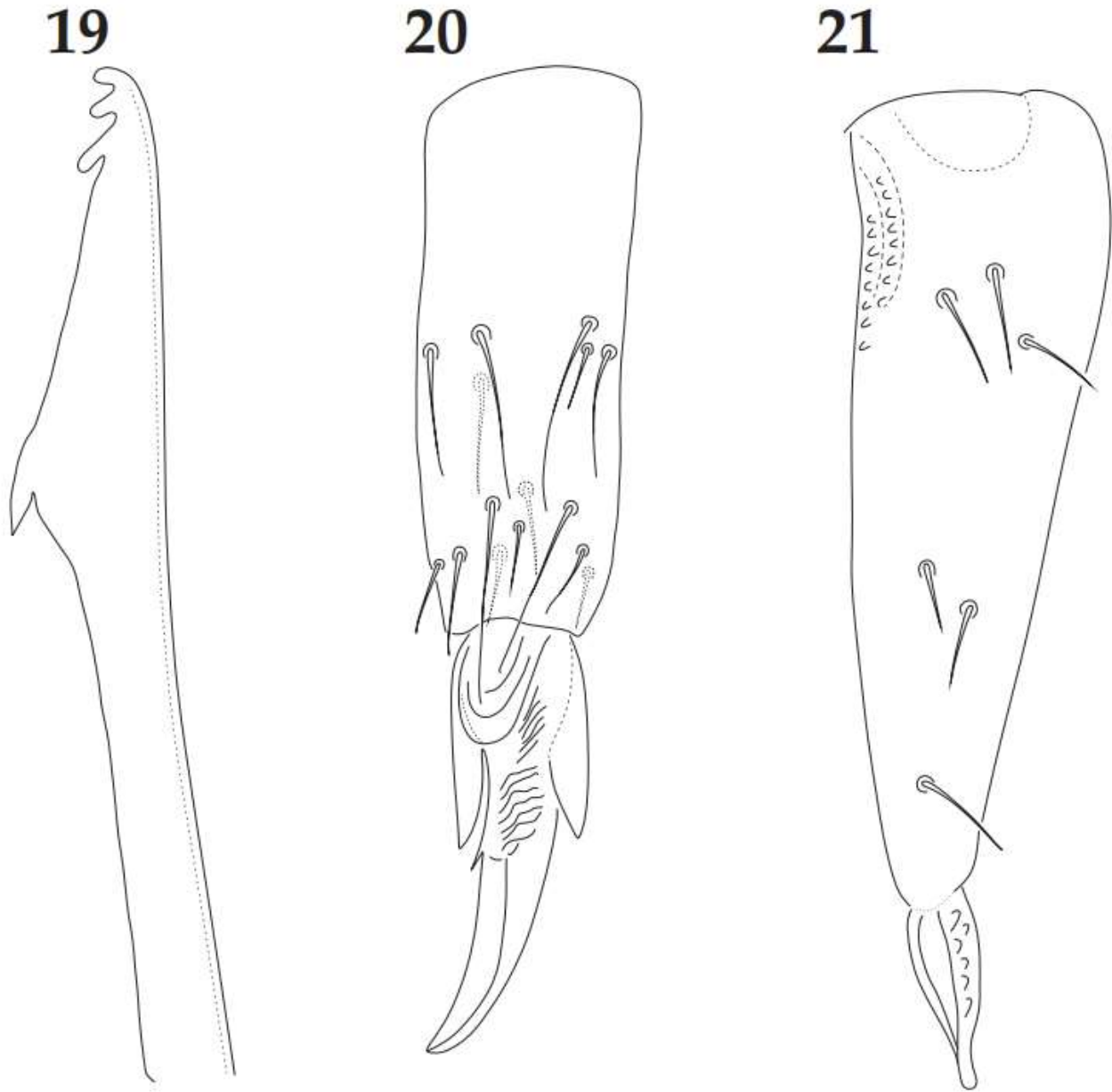
Neotropiella silvestrii (Denis, 1929)

The original description of *N. silvestrii* from Santiago de Cuba is very brief. The specimens we have studied are, one female and one male from Guatámamo (Finca Macazón), has a tropical rain forest, it is a 350 m asl. Ant IV sensorial file with many (about 100) modified setae. Mandible has 4 teeth, basal one bends (Fig. 19). OPA with 32-35 vesicles. Th I with four setae, all of them microsetae. Unguis with one median and two enormous teeth. Dens with six very short setae (Fig. 20); mucro very short (1/5 the length of dens) with lamella slightly developed. Abd V posterior row with microsetae, sensory seta, and two microsetae.

A complement to the description. Specimens from Puerto Rico measurements, one 1.8 mm and another 2.5 mm. They are mounted but still very dark blue, almost black.

Ratio head diagonal: antenna = 1:1.2. Ant I 11 setae. Ant II with 12 setae. Ant III and IV fused dorsally, ventrally well separated. Ratio of Ant I: II; III-IV: 1:1.14; 2.7. Sensory organ of Ant III is displaced apically, with two big tubular sensilla in a single groove and bending towards each other, covered by a big fold of tegument; Sgd thicker than surrounding setae, ventral microsensillum present. Ant IV with trilobed apical bulb, dorsal sensilla difficult to distinguish among setae and dorsolateral microsensillum. Ventral side of Ant IV with about 40 medium size setae, not elbowed, but forming a sensory field.

Eyes 5+5 on a dark eye patch, one of them smaller than others. PAO elliptical, moruliform, slightly bigger than the small eye “A” (ratio 1: 0.8) and shorter than other eyes (1: 1.1), bearing 35 simple vesicles. Maxilla styliform with two fused lamellae with an acuminate apex; mandible with 3 teeth of the same size, and one basal big and bent (Fig. 19).



Figures 19-21. *Neotropiella silvestri*. 19. Mandible; 20. Tibiotarsus III, 21. Dente and mucro.

Buccal cone typical of the genus. The labium with setae A–G, e, f and l. Dorsal chaetotaxy composed of smooth microsetae (33-40 μm), sensorial setae (60-70 μm). Sensillar formula by half tergum: 022/111110. Ratio microsetae: sensorial setae = 1: 2.0. Abd VI with one posterior unpaired seta. Legs relatively long. Chaetotaxy of leg III from coxa II to tibiotarsus, 5, 5, 11, 17. No tenent hairs; femora with a long ventral seta. Unguis with one middle inner thin and short tooth and 1 + 1 big lateral and

similar size teeth (Fig. 20). Unguis shorter (55 μm) than tibiotarsus III (95 μm), ratio Tita III: unguis 1: 0.58. Ventral tube with 4+4 setae. Tenaculum with three teeth on each ramus. Furcula long, dens long and thin (55 μm) with 6+6 short setae; mucro (15 μm) separated from dens (ratio dens: mucro = 1: 0.27) with small lamella tapering before the apex (Fig. 21). One pair of macrosetae (m2) and one unpaired dorsal seta on Abd VI (p0). Each anal valve with 14–15 setae, one

being distal-lateral, and 2 setae hr; Abd VI with 2 setulae in the ventral side. No genital plates were studied.

Remarks. After the original description of Denis (1929), specimens were 2.5-3 mm long. They are back color, mouth beak well developed, and antennae with two last segments white. Type specimens were from Puerto Boniato, Santiago de Cuba. The description is very brief, but he gives very distinctive morphological characters: “Body segmentation as *Ceratimeria*. 5 + 5 eyes. PAO of the size of one eye, oval and moruliform. The sensorial organ of Ant III made of 2 long tubes curved, in one groove, horseshoe shaped. Ant IV very long, sensilla present but not differentiated from ordinary setae. The apical bulb is trilobed. Legs without tenent hairs. Unguis with lateral teeth simple and one internal tooth, no empodial appendix. Furcula well developed, dentes about 4 times the size of unguis. Mucro with 3 lamellae, difficult to see except the external”

New records. PUERTO RICO: El Yunque. J. G. Palacios-Vargas, col. **CUBA:** *Provincia Guantánamo*, El Salvador, Finca la Macazón. Tropical rain forest, 350 m a. s. l. 3 specimens. 1-V-1993, L. F. Armas col. **MEXICO:** Chiapas: Tapachula, Unión Rojo, ex coffee litter, R. Novelo col.

Molecular results. DNA was successfully obtained from only one specimen of *N. quinqueoculata* from Panama, sequence **BCICL158 (length 658 bp linear DNA)**, deposited in the project BCICL the Barcode of Life Data System (<http://www.barcodinglife.org/index.php>). The cuticle of the specimen was recovered and mounted in Hoyer’s solution, which represents the voucher and is kept at the author’s institution.

After the new generic diagnosis, we have done, *N. mirabilis* (Handschin, 1929) and *N. murphyi* Massoud, 1965, do not fit on it; they need to be reviewed and accommodate in other genera or create new taxa to put them. *N. meridionalis* (Arlé, 1939) needs to be redescribed because the original descript is very brief.

Note. Lawrence (1971) studied specimens of *N. quinqueoculata* from Mato Grosso, Brazil; the PAO had 21-89 vesicles; he said that this character includes the number given for almost all

the word species of *Neotropiella* and questioned the value of vesicles for splitting them based on short series. He noted that all OPA vesicles arise from the basal, poriferous lobe, and the range of vesicles is from 20 to 80 in the same sample. He studied with SEM the OPA and noted that specimens with a small number of vesicles have a relatively larger size, showing and tendency to subdivide, and these are arranged in groups of 3-4 indicating the position of the subdivided vesicle from which they arose, and without the SEM is difficult to count the number of vesicles, due to their transparency and subdivision, so the number of vesicles is not a reliable character for separating the species and not either if they are simple or composed as it was supposed to be a differential character of *N. insularis*.

The head chaetotaxy of *Neotropiella* seems to be very stable in all the members; it has five dorsal setae and only 4 subdorsal setae, and no c2. Th I have 2 + 2 setae on *N. vanderdrifti* and 3 + 3 in *N. minima*; *N. digitomucronata* has 5 + 5 but all the other species whom descriptions are included is 4 + 4 setae. Abd IV has 4 + 4 setae between the s. s., except *N. vanderdrifti* and *N. minima* (3 + 3) and *N. plurichaetosa* (7+7). Setation on Abd V and VI can be important for the characterization of different taxa.

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REFERENCES

- ABRANTES, E. A., BELLINI, B. C., BERNARDO, A.N., FERNANDES, L. H., DE MENDONÇA, M. C., DE OLIVEIRA, E. P., QUEIROZ, G. C., SAUTTER, K. D., DA SILVEIRA T. T. AND ZEPPELINI, D. (2012). Errata Corrigenda and update for the "Synthesis of Brazilian Collembola: an update to the species list." Abrantes et al. 2010. *Zootaxa*, 2388: 1-22, *Zootaxa*, 3168: 1–21. doi.10.11646/zootaxa.3168.1.1.
- ARLÉ, R. (1939). Novas espécies de Pseudachorutini (Collembola) do Rio de Janeiro e Arredores. *Boletim Biológico*, (N. S.), 4: 67–72.
- ARLÉ, R. (1981). Conspecto das espécies brasileiras de Pseudachorutinae com descrição de uma espécie nova da Colômbia (Insecta, Collembola). *Acta Amazonica*, 1(3): 583–593. doi.10.1590/1809-43921981113583.
- BELLINI, B. C., WEINER, W. M., QUEIROZ, G. C. AND PAZ, R. V. (2020). A Survey of *Neotropiella* Handschin, 1942 (Collembola, Neanuridae, Pseudachorutinae) with the description of a new Brazilian species. *Insects*, 11(7): 438. doi.10.3390/insects11070438.
- BERNAVA LABORDE, V. AND PALACIOS VARGAS, J. G. (2008). Collembola. Pp. 151–166. In: G. S. Debandi Roig y L. Claps (Eds.). *Biodiversidad de Artrópodos Argentinos*. Volumen I. Morrone y Coscarón
- BÖRNER, C. (1906). Das System der Collembolen - Nebst Beschreibung neuer Collembolen des Hamburger Naturhistorischen Museums. *Jahrbuch der Hamburgischen Wissenschaftlichen Anstalten*, 23: 147–186.
- DENIS, J. R. (1924). Sur les Collemboles du Muséum de Paris (1er Partie). *Annales de la Société Entomologique de France*, 93: 211–260.
- DENIS, J. R. (1929). Notes sur les collemboles récoltés dans ses voyages par le professeur F. Silvestri. *Bollettino del Laboratorio di zoologia generale e agraria della R. Scuola superiore d'agricoltura in Portici*, 22: 166–180.
- DENIS, J. R. (1931). Collemboles de Costa Rica avec une contribution au species de l'ordre. Contributio alla conoscenza del microgenton di Costa Rica (II). *Bollettino del Laboratorio di zoologia generale e agraria della R. Scuola superiore d'agricoltura in Portici*, 25: 69–170. doi.10.1038/067582a0.
- DIAZ, A. AND NAJT, J. (1995). Collemboles (Insectes) des Andes vénézuéliennes. *Bulletin du Muséum National d'Histoire Naturelle*, Paris, 16: 417–435.
- FJELLBERG, A. (1998). The Collembola of Fennoscandia and Denmark, Part I: Poduromorpha, *Fauna Entomologica Scandinavica*, 35: 1–84. doi.10.1163/ej.9789004157705.i-265.28.
- HANDSCHIN, E. (1929). Collembola from Abyssinia. *Transactions of the Entomological Society of London*, 77: 15–28. https://doi.org/10.1111/j.1365-2311.1929.tb00678.x
- HANDSCHIN, E. (1942). Materialien zur Revision der Collembolen Die Gattung *Ceratrimera* C.B. sensu Womersley. *Verhandlungen der Naturforschenden Gesellschaft in Basel*, 53: 265–284.
- HECKMAN, C. W. (2001). *Encyclopedia of South American Aquatic Insects: Collembola*. Kluwer, Kindle edition. 418 p.
- HOFFMANN, A., PALACIOS-VARGAS J. G. AND MORALES MALACARA. B. (1986). Manual de Bioespeleología (con nuevas aportaciones de Morelos y Guerrero, Mexico). Universidad Nacional Autónoma de Mexico, 274 p.
- LAWRENCE, P. N. (1971). A review of the genus *Neotropiella* Handschin, 1942 (Insecta Collembola). *Revue d'Écologie et Biologie du Sol*, 8(3): 465–470.
- Maes, J. M. and Palacios-Vargas, J. G. (1988). Catálogo de los Insectos Apterygota de Nicaragua. *Revista Nicaragüense de Entomología*, 4: 1–9.
- Magaña-Martínez, C. S. and Palacios-Vargas. J. G. (2010). Colémbolos (Hexapoda) del Nevado de Colima, Jalisco, México. *Dugesiana*, 17(1): 73–80.
- Mari-Mutt, J. A. and Bellinger. P. F. (1990). *A catalog of the Neotropical Collembola, including nearctic areas of Mexico*, Florida, USA. 237 p.
- Mari-Mutt, J. A. and Bellinger. P. F. (1996). Supplement to the catalog of neotropical Collembola, August 1989 to April 1996, *Caribbean Journal of Science*, 32(2): 166–175.
- Massoud, Z. (1963). Les Collemboles Pseudachorutiniens, Brachystomelliens et Neanuriens de la Côte d'Ivoire, *Bulletin de l'Institut fondamental d'Afrique Noire*, 25, sér. A (1): 57–76.
- Massoud, Z. (1963). Les Collemboles Poduromorphes du Surinam. *Studies on the Fauna of Suriname and other Guyanas*, 6: 43–51.

- MASSOUD, Z. (1964). UN NOUVEAU COLLEMBOLÉ PODUROMORPHE DE MALAISIE. *REVUE D'ÉCOLOGIE ET BIOLOGIE DU SOL*, 1(4): 701–704.
- MASSOUD, Z. (1967). Monographie des Neanuridae, Collemboles Poduromorphes à pièces buccales modifiées. Pp. 7–399. In: C. Delamare Deboutteville and E. H. Rapoport. (Eds.). *Biologie de l'Amérique Australe* (Vol. 3). – Éditions du CNRS, Paris. doi.10.1126/sciencie.146.3642.389-a.
- NAJT, J., THIBAUD, J. M. AND WEINER, W. M. (1990). Collemboles (Insecta) poduromorphes de Guyane française. *Bulletin Du Museum National D'histoire Naturelle Section A Zoologie Biologie et Ecologie Animales*, 12(1): 95–121.
- PALACIOS-VARGAS, J. G. (2019). An extraordinary new genus and species of Pseudachorutinae (Collembola: Neanuridae) from Colombia. *Zootaxa*, 4609(2): 373–387. doi.10.11646/zootaxa.4609.2.11.
- PALACIOS-VARGAS, J. G. AND CALLOHUARI, Y. T. (2020). A new species of the genus *Neotropiella* (Handschin, 1942) Collembola: Neanuridae) from Peru. *Biodiversity Data Journal*, 8: 1–8.
- PALACIOS-VARGAS, J. G., CASTAÑO MENESES, G. AND GÓMEZ-ANAYA, J. A. (1998). Collembola from the canopy of a Mexican tropical deciduous forest. *Pan-Pacific Entomologist*, 74(1):47–54.
- PALACIOS-VARGAS, J. G. AND GÓMEZ-ANAYA, J. A. 1993. Los Collembola (Hexapoda: Apterygota) de Chamela, Jalisco, Mexico (Distribución Ecológica y Claves). *Folia Entomológica Mexicana*, 89: 1–34.
- PALACIOS-VARGAS, J. G., IGLESIAS, R. R. (2008). Comparación entre la fauna de ácaros y colémbolos mexicanos y brasileños en ambientes subterráneos. *Mundos Subterráneos*, 18-19:15–38.
- PALACIOS, J. G., MEJÍA, B. E., COATES, R., MADORA, M. AND CASTAÑO, G. (2018). Monthly variation of leaf litter Collembola in the tropical rainforest of Los Tuxtlas, Veracruz, Mexico. *Soil Organisms*, 90(3): 131–140.
- QUEIROZ, G. C., DA SILVEIRA T. C. AND MENDONÇA, M. C. (2013). New species of *Neotropiella* Handschin, 1942 (Collembola: Neanuridae) from Brazil. *Soil Organisms*, 85(1): 41–49.
- RATNASINGHAM, S. AND HEBERT, P. D. (2013). A DNA-based registry for all animal species: the Barcode Index Number (BIN) system. *PloS one*, 8(7): 66–213. doi.10.1371/journal.pone.0066213.
- SMOLIS, A. (2008). Redescription of four Polish *Endonura* Cassagnau, 1979 (Collembola, Neanuridae, Neanurinae), with a nomenclature of the ventral chaetae of antennae. *Zootaxa*, 1858: 9–36. doi.10.11646/zootaxa.1858.1.2.
- THIBAUD, J. M. AND MASSOUD. (1983). Les Collemboles des Petites Antilles. III. – Neanuridae (Pseudachorutinae). *Revue d'Écologie et Biologie du Sol*, 20: 111–129.
- THIBAUD, J. M. AND OLIVEIRA, E. P. (2010). Note sur les Collemboles de l'Amazonie Brésilienne II - Neanuridae: Pseudachorutinae ad. part. avec la description de deux espèces nouvelles. *Revue française d'Entomologie (N.S.)*, 32(3-4): 135–140.