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ARTICLE

Neurostigma xanthopterum New, 1980 (Psocodea: Psocoptera: Epipsocidae): updated diagnosis, description of a female specimen, morphological variations and a checklist of all known species of the genus

Natália Soares Reategui[1,2]; José Albertino Rafael[1,3] & Alberto Moreira da Silva-Neto[1,4]

[1] Instituto Nacional de Pesquisas da Amazônia (INPA), Coordenação de Pesquisas em Entomologia (CPEN), Programa de Pós-Graduação em Entomologia. Manaus, AM, Brasil.
[2] ORCID: https://orcid.org/0000-0002-9286-0109. E-mail: reategui.nathi@gmail.com (corresponding author)
[3] ORCID: https://orcid.org/0000-0002-0170-0514. E-mail: jarafael@inpa.gov.br
[4] ORCID: https://orcid.org/0000-0002-4522-3756. E-mail: bio.alberto@gmail.com

Abstract. The holotype of the *Neurostigma xanthopterum* New, 1980 is here illustrated based on photographs. We also describe and illustrate a previously unknown female individual that is assigned to this species. New records for five localities in the Brazilian state of Amazonas, one in the Brazilian state of Acre and another in the Brazilian state of Amapá, are presented. The mouthparts of both sexes are here describe and illustrate. Thirteen types of variation and anomalies in the fore-hindwing veins were found. We found unique patterns in the number and shape of transverse veins in the pterostigma between individuals. We also identified a large variation in the denticles present in the lacinia. Therefore, we suggest these variable characteristics (fore-hindwing veins and lacinia denticles) are not to be used for the diagnosis of species of this genus. A revised diagnosis of *N. Xanthopterum* is also presented.

Keywords. Biodiversity; Epipsocetae; Neotropics; Taxonomy.

INTRODUCTION

Neurostigma Enderlein, 1900 is one of the 31 genera in the psocopteran family Epipsocidae. *Neurostigma* presently includes fourteen species, 11 of which are currently known only from male specimens, two species from only female specimens, and only one species known from both sexes (Table 1) (Badonnel, 1986; Enderlein, 1900; González-Obando *et al.,* 2021; Mendivil-Nieto *et al.,* 2020; Mockford, 1991; New, 1980; Roesler, 1940). As far as known, the genus is restricted to the Neotropical region, with Colombia (7 species) and Brazil (6 species) being the most species-rich countries for *Neurostigma* in the region (Table 1) (González-Obando *et al.,* 2021; Silva-Neto & Garcia-Aldrete, 2020).

Neurostigma xanthopterum New, 1980 was first described on basis on a male holotype and 11 male paratypes that were collected in the Reserva Adolpho Ducke, Manaus, Amazonas, Brazil. In the introduction of his paper, New (1980) reports that the types of *N. Xanthopterum* were deposited in the collections of INPA (Manaus) and that, when possible, paratypes were deposited in the British Museum (Natural History) London. However, in the list of materials examined, New (1980) does not explicitly indicate the specific place where the specimens of *N. Xanthopterum* were deposited. New (1984) registered 53 specimens of *N. Xanthopterum* for the Reserva Adolpho Ducke. However, this study does not where the collected speciments were deposited or on the sex of these specimens.

After 40 years, Mendivil-Nieto *et al.* (2020) recorded *N. Xanthopterum* for Colombia based on two male specimens. Recently, two of us (AMSN and NSR) found the Holotype of *N. Xanthopterum* in the Invertebrate Collection of the *Instituto Nacional de Pesquisas da Amazônia,* in Manaus, Amazonas, Brazil (INPA). However, no paratypes were found in the collection. This indicates that the paratypes of *N. Xanthopterum* were likely deposited at the British Museum (Natural History) of London (or these specimens were lost). Similarly, one of us (NSR) recently found in a miscellany of insects preserved in 80% ethanol, at the INPA.

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Table 1. Species of *Neurostigma,* sexes known, general distribution and distribution in Brazilian States (between parentheses).

Species	Sexes known	Distribuition
N. chaetocephalum Enderlein, 1900	Male	Peru
N. dispositum Roesler, 1940	Both	Brazil (Amazonas, Mato Grosso, Santa Catarina, São Paulo), México, Peru
N. enderleini New, 1980	Male	Brazil (Amazonas)
N. paucivenosum New, 1980	Male	Brazil (Amazonas),
N. Xanthopterum New, 1980	Male	Brazil (Amazonas), Colômbia
N. roesleri New, 1980	Female	Brazil (Amazonas)
N. furcivenula Badonnel, 1986	Female	Colômbia
N. radiatum Mockford, 1991	Male	Brazil (Roraima)
N. garcialdretei Mendivil-Nieto, Gonzalez-Obando & Carrejo-Gironza, 2020	Male	Colômbia
N. lienhardi González-Obando, Carrejo-Gironza, Mendivil-Nieto & Garcia-Aldrete, 2021	Male	Colômbia
N. mockfordi González-Obando, Carrejo-Gironza, Mendivil-Nieto & Garcia-Aldrete, 2021	Male	Colômbia
N. newi González-Obando, Carrejo-Gironza, Mendivil-Nieto & Garcia-Aldrete, 2021	Male	Colômbia
N. thorntoni González-Obando, Carrejo-Gironza, Mendivil-Nieto & Garcia-Aldrete, 2021	Male	Colômbia
N. valderramae González-Obando, Carrejo-Gironza, Mendivil-Nieto & Garcia-Aldrete, 2021	Male	Colômbia

The collected individuals included 14 male specimens of *N. Xanthopterum* and five female specimens that corresponds to the unknown females of this species. These individuals were collected in the Brazilian states of Amazonas, Acre and Amapá.

The purpose of this paper is to describe and illustrate the female of *N. Xanthopterum,* to describe the variation of the fore-hindwing venation in the species, to describe and illustrate the mouthparts of both sexes (including variations of the lacinia denticles), to include new records, to illustrate the holotype of the *N. Xanthopterum* with photos, and to present an updated diagnosis of *N. Xanthopterum,* with female characters included.

MATERIAL AND METHODS

The holotype of the *N. Xanthopterum,* 14 male specimens and five female specimens were available for study. Thorax and the remaining parts of the holotype (as head and left wings) were stored in a separate micro-vial with ethanol. The mouthparts and left wings of holotype were dissected and mounted on one slide. The non-type specimens were dissected in 80% ethanol, and their parts were mounted on permanent slides in Canada balsam: head, right antenna with distal flagellomeres and mouthparts (right and left lacinia, right maxillary palp, right mandible, left mandible, labium and labrum), and right legs, right and left wings, and genitals. Before dissecting, the specimen was placed in 80% ethanol under a dissecting microscope, illuminated with cold, white light, and observed at 50X to record color. Standard measurements (in µm), were taken with a filar micrometer. Abbreviations of parts measured are as follows: FW and HW: right fore- and hindwing lengths, F, T, t1, t2 and t3: lengths of femur, tibia and tarsomeres 1, 2 and 3 of right hind leg, f1…fn: lengths of flagellomeres 1…n of right antenna, Mx1-Mx4: lengths of segments of right maxillary palpus, IO: minimum distance between compound eyes in dorsal view of head, D and d: antero-posterior and transverse diameter, respectively, of right compound eye in dorsal view of head, PO: d/D.

The specimens were stored in "CD boxes" as described in Silva-Neto *et al.* (2016). The *N. Xanthopterum* specimens, except for the holotype, were named as follows: Male (M1…Mn) and Female (F1…Fn). Photographs of parts of the specimens were taken with a Leica DFC500 digital camera attached to a Leica M205C stereomicroscope, connected to a computer with the Leica Application Suite LAS V3.6 software, which includes an Auto-Montage module (Syncroscopy software). Map of the species locality was made with Geographic Information System (QGIS).

All examined specimens of *N. Xanthopterum* were deposited in the Invertebrate Collection of the *Instituto Nacional de Pesquisas da Amazônia,* in Manaus, Amazonas, Brazil (INPA).

RESULTS

Neurostigma xanthopterum New, 1980 (Figs. 1-11)

Neurostigma xanthoptera New, 1980: 194; Rafael *et al.,* 1983: 916 (Deposition of type); New, 1984: 3 (Ecology).
Neurostigma xanthopterum Lienhard & Smithers, 2002: 122 (Catalogue); García-Aldrete & Mockford, 2009: 667 (species list); Mendivil-Nieto *et al.,* 2020: 132 (new species and new record); Silva-Neto & García-Aldrete, 2020: 3 (species list); González-Obando *et al.,* 2021: 83 (new species).

Update diagnosis: Head with vertex narrowed, bilobed, raised and distinctly emarginate medially (Figs. 1, 2A, 3B, 4A). Forewings with their proximal part half yellowish to brown, basally with a large club-shaped hyaline area between vein R and vein M+CuA; with large irregular dark brown spots from base of Pterostigma to CuP (Figs. 10A-B, 10D-G) or present only from M+CuA to CuP (Figs. 2B-C, 4B, 10C). A small dark brown spot at the base of the Pterostigma and this one with its transverse veins pigmented along its entire length (Figs. 2B-C, 7-9). Hindwings with their proximal part half yellowish to brown, with two

hyaline areas almost elliptic (Figs. 2G, 4C, 11). Phallosomal arch narrow and widening at the ends, anteriorly with a U-shaped area, then with a small transverse part, almost straight, posteriorly elongated vertically, ending in an almost elliptical area, with convex inner margin and blunt outer margin (Fig. 2J). Endophallus heart-shaped, radular sclerites with small denticles, more pronounced in midline (Fig. 2J). Hypandrium U-shaped, more sclerotized on the sides (Fig. 2I). Ninth sternum with a v-shaped recess in the middle of the posterior margin and a deep recess in the anterior region, giving rise to two similar areas, almost elliptical and anteriorly open ending in a membranous area (Fig. 4E). Gonapophyses with short, blunt ended heel, distally culminated, with v2 heavily sclerotized, with three setae on outer lobe; V3 weakly sclerotized, swollen and elongated (Fig. 4G).

Male

As described by New (1980).

Female

Color: Body dark brown, with yellowish spots with tergal lobes of meso and metathorax light brown; thoracic pleura brown with clear spots (Figs. 3A-C). Head with light reddish spots between front and postclypeus, and on the inner inferior margin of compound eyes and the antennal orbit; vertex yellowish; black compound eyes; ocelli blackened (Figs. 3B-C, 4A). Escape and pedicel with dark spots, light brown flagelomeres. Maxillary palps with blackened contours (Fig. 5A). Labrum basally yellow, distally pale yellow (Fig. 5B). Labium anteriorly with black spots near the lateral margins of the prementum, with transverse linear spots on the labial palps and paraglosas (Fig. 5C). Coxae and trochanters brown; femurs brown, darker basally, with four dark brown spots in the distal region; light brown tibiae; tarsomeres 1 and tarsomeres 2 light brown. Forewings with their proximal part half yellowish to brown, basally with a large club-shaped hyaline area between vein R and vein M+CuA; with large irregular dark brown spots from M+CuA to CuP; brown veins (Figs. 3A, 4B). A small dark brown spot at the base of the Pterostigma and this one with its transverse veins pigmented along its entire length (Figs. 3A, 4B, 7). Hindwings with their proximal part half yellowish to brown, with two hyaline areas almost elliptic; brown veins (Figs. 3A, 4C). Brown abdomen. Clunium hyaline. Subgenital plaque, gonapophysis and ninth sternum pale brown. Epiproct and paraproct almost hyaline. Eggs almost entirely yellow, with whitish margins (Figs. 3D-E).

Morphology: Head with abundant macrosetae, mainly on vertex, it is narrowed, bilobed, raised and distinctly emarginate medially; small compound eyes (Figs. 3A-C, 4A). Outer cusp of lacinial tip broad, with 5-7 denticles (Figs. 5F-L; see also variation of males with 4-7 lacinia denticles (Figs. 6F-W)). Labrum with abundant setae with labral sclerites curved outwards at bases (Fig. 5B). Labial palps almost elliptical (Fig. 5C). Mandibles asymmetrical, elongate and with outer margin angled (Figs. 5D-E). Thorax

Figure 1. *Neurostigma xanthopterum.* (male I). (1) Lateral view. Scale in mm.

with many setae and with four large sets of macrosetae, one on each side of the anterior scutal lobe and one on each side of the anterior margins of the lateral scutal lobes (Figs. 3B-C). Forewings with narrow pterostigma extending distally, with number and shape of transverse veins varying (Fig. 7, see also variation of males (Figs. 8-9)); Rs, proximal to transverse vein r-m, strongly convex; R_{2+3} and R_{4+5} almost touching basally and separating distally; M with five branches (Fig. 4B). Hindwings elongate; M simple, unbranched, R_{2+3} vein slightly curved at the base and R_{4+5} vein almost straight (Fig. 4C). Subgenital plate broad, U-shaped, no pigmented area, setae as illustrated (Fig. 4D). Ninth sternum with a v-shaped recess in the middle of the posterior margin and a deep recess in the anterior region, giving rise to two similar areas, almost elliptical and anteriorly open ending in a membranous area (Fig. 4E). Gonapophyses with short, blunt ended heel, distally culminated, with v2 heavily sclerotized, with three setae on outer lobe; V3 weakly sclerotized, swollen and elongated (Fig. 4G). Epiproct trapezoidal, with invaginations in the center and with setae as illustrated (Fig. 4F). Paraprocto broad, almost elliptical, sensory fields with 28-29 tricobothria on basal

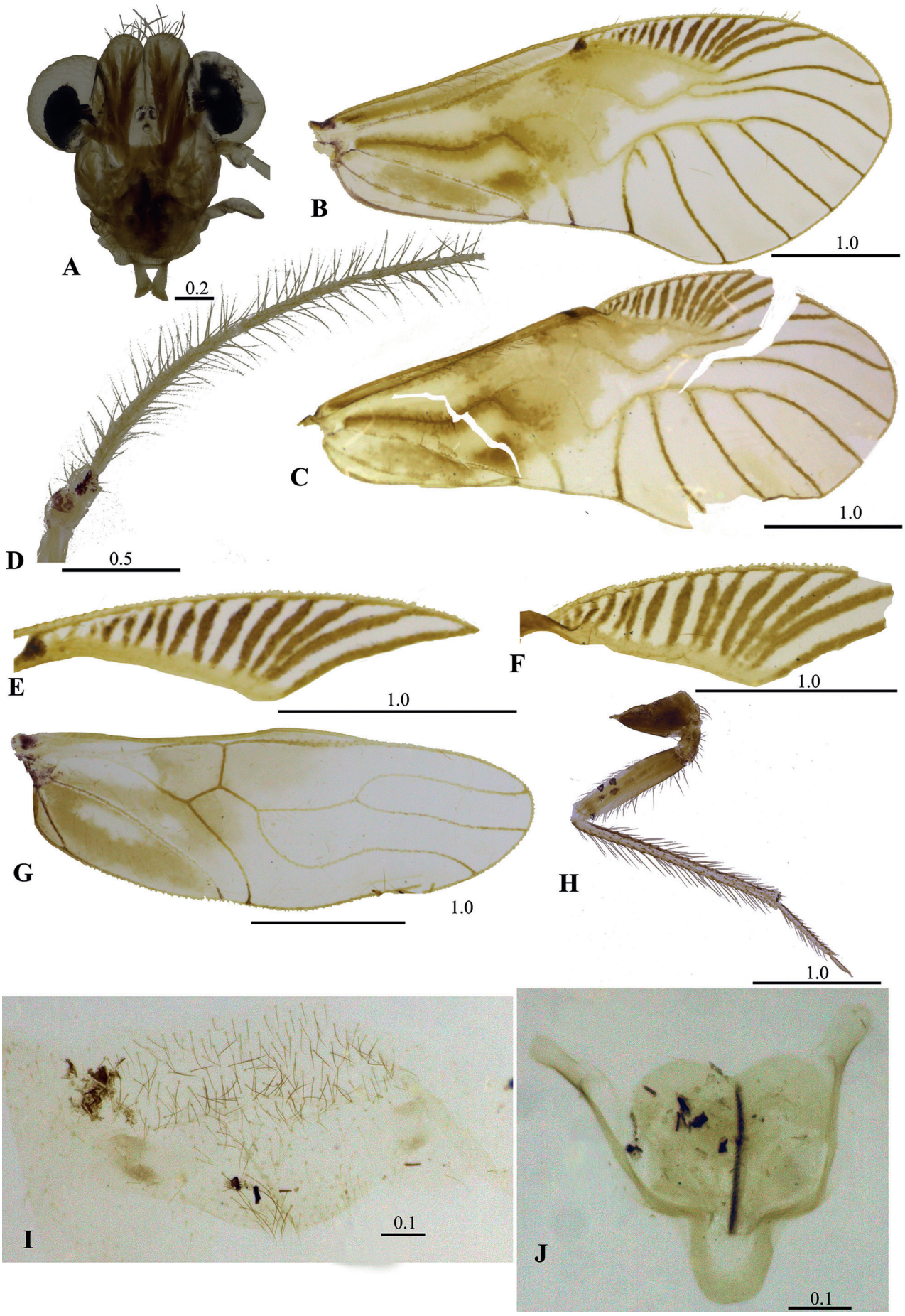

Figure 2. *Neurostigma xanthopterum* (Holotype male): (A) Front view of head; (B) Right forewing; (C) Left forewing; (D) Right antenna; (E) Pterostigma of right forewing; (F) Pterostigma of left forewing; (G) Right hindwing; (H) Right hindleg; (I) Hypandrium; (J) Phallosome. Scales in mm.

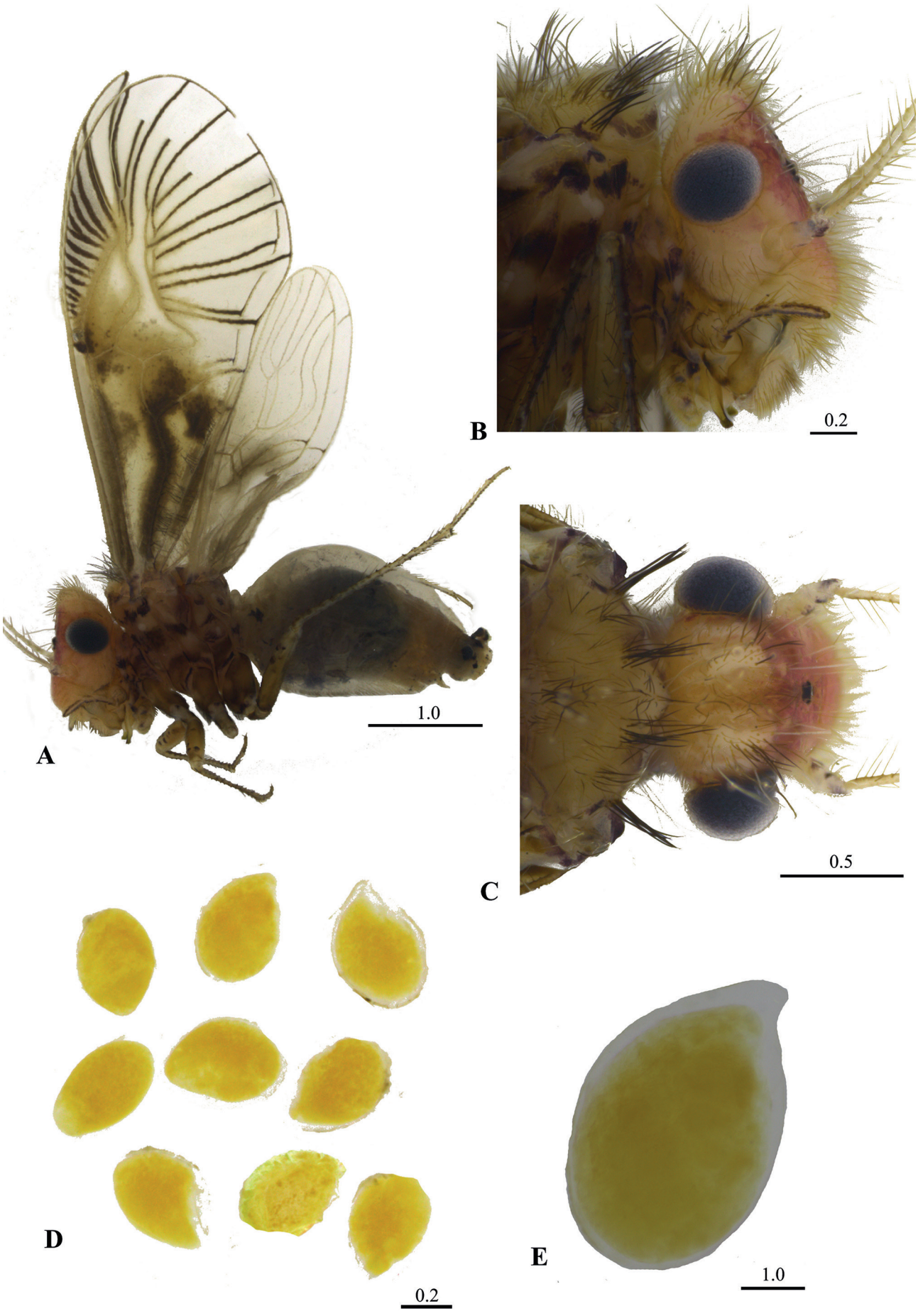

Figure 3. *Neurostigma xanthopterum* (Female I): (A) Lateral view; (B) Zoom of lateral view of head; (C) Zoom of dorsal view of head; (D) Eggs; (E) Zoom of an egg. Scales in mm.

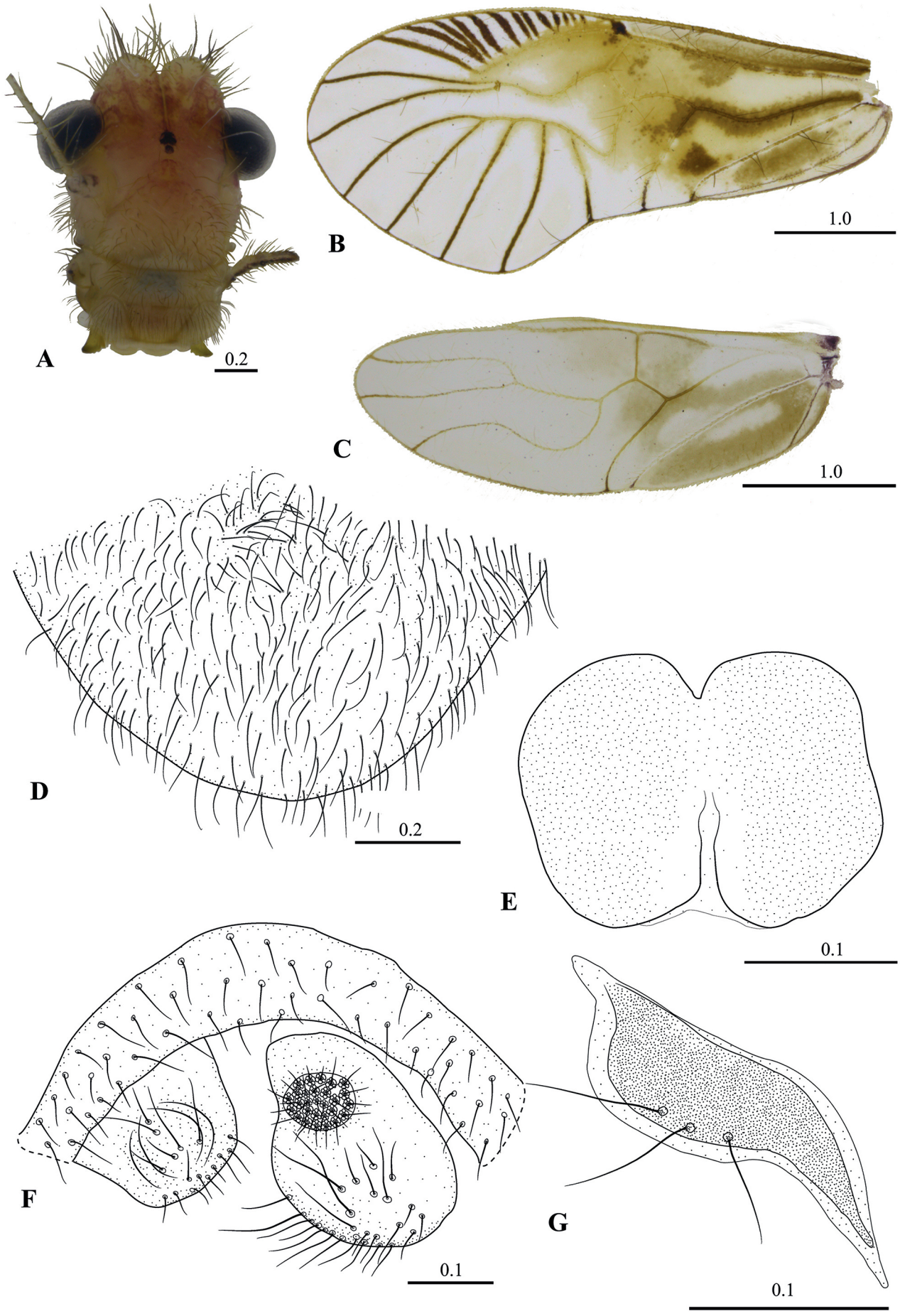

Figure 4. *Neurostigma xanthopterum* (Female I): (A) Front view of head; (B) Right forewing; (C) Right hindwing; (D) Placa subgenital; (E) Ninth sternum; (F) Clunium, right paraproct and epiprocto; (G) Right gonapophyses. Scales in mm.

rosettes; setae as illustrated (Fig. 4F). Eggs almost elliptical, with an almost triangular tip like a peduncle (Figs. 3D-E).

Measurements (in microns): FW: 4666, HW: 3146, F: 910, T: 1694, t1: 523, t2: 158, f1: 577, f2: 406, f3: 521, Mx2: 126, Mx4: 264, IO: 626, D: 351, d: 279.

MATERIAL EXAMINED

Holotype (Fig. 2): Brazil, Amazonas, Manaus, Reserva Florestal Adolpho Duck, 02°57′48.0″S, 59°55′22.2″W. 14.ii.1978. Malaise trap. J. Arias & N.D. Penny. (Deposited in INPA).

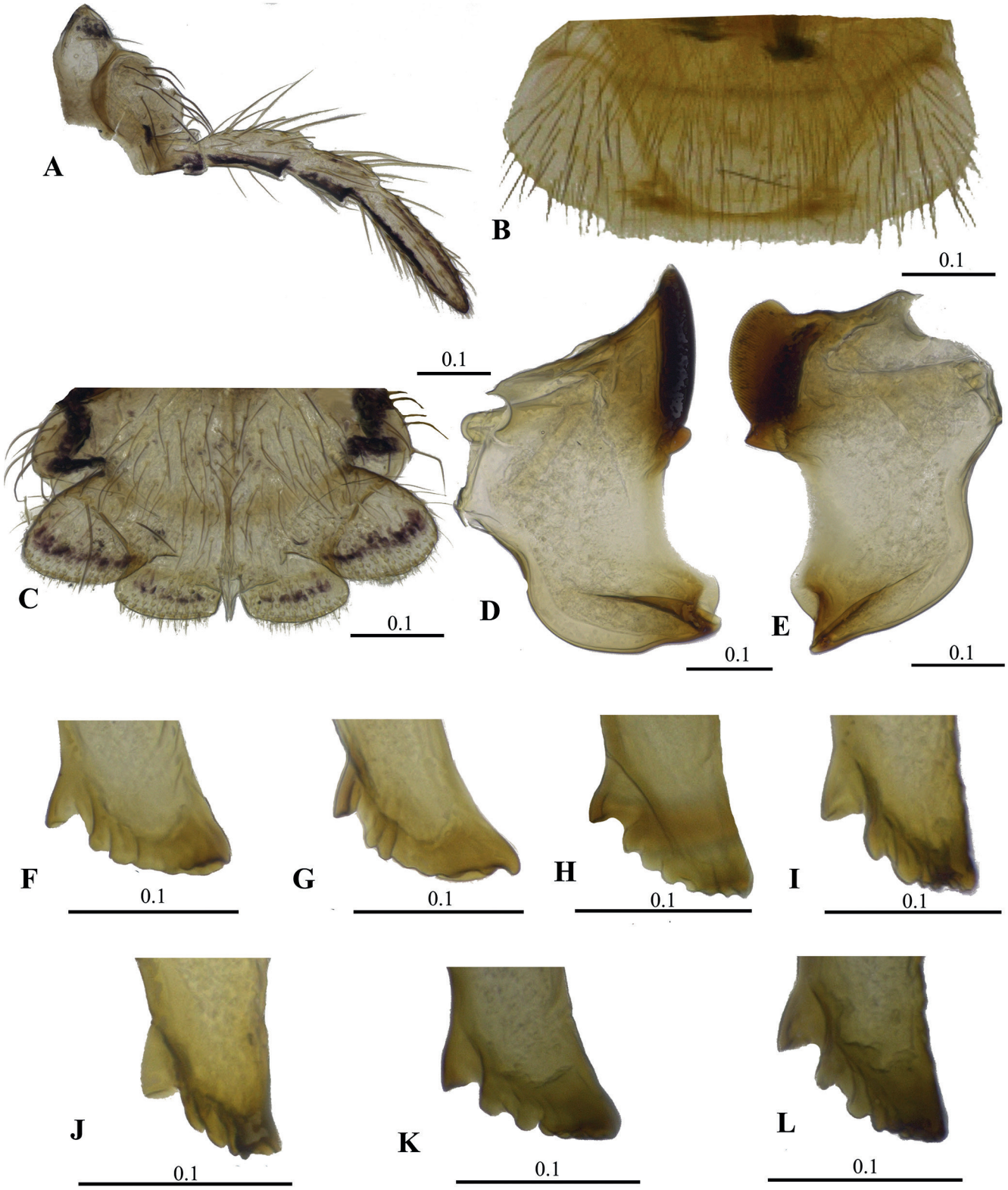

Figure 5. Mouthparts of *Neurostigma xanthopterum* (Females): (A) Rigth maxillary palp of FI; (B) Labrum of FI; (C) Labium of FI; (D) Right mandible of FI; (E) Left mandible of FI; (F) RI of FI; (G) LI of FI; (H) RI of FII; (I) LI of FII;(J) RI of FIII; (K) RI of FIV; (L) LI of FIV. Scales in mm. Abbreviations: FI...FIV: female I...female IV; RI: right lacinia; LI: Left lacinia.

Other examined material: 5 Females: Female I (INPA) – Brazil, Amazonas, Manaus, Reserva Florestal Adolpho Duck, parcela L1. 02°57′50.0″S, 59°56′17.6″W. 01-15.x.2014. Malaise trap. Silva-Neto & D.M. Female II (INPA) Brazil, Amazonas, Manaus, EMBRAPA, Guaraná convencional, 02°53′42.18″S, 59°59′10.58″O. 10.xi.2012.

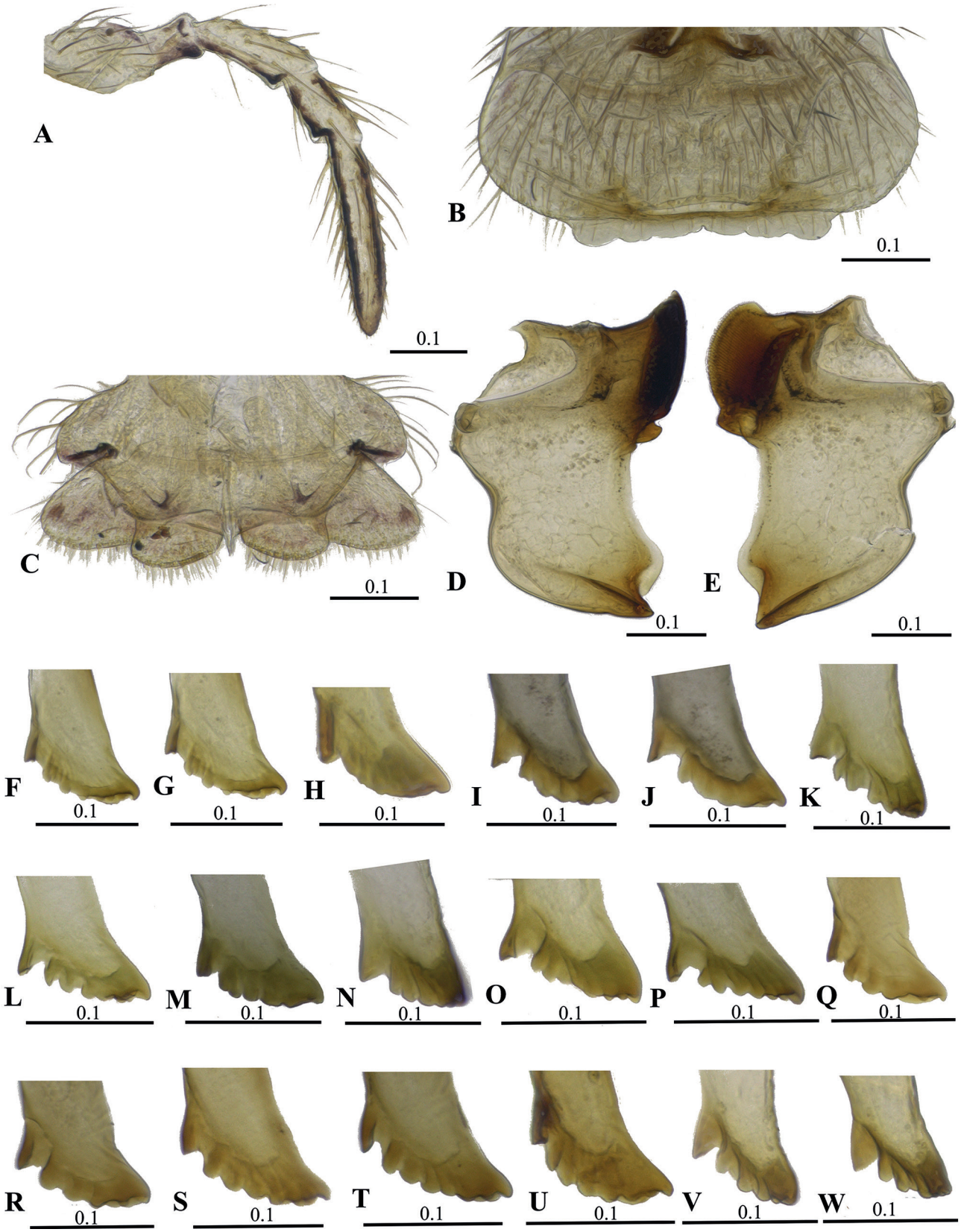

Figure 6. Mouthparts of *Neurostigma xanthopterum* (male I…male XIII): (A) Right maxillary palp of MI; (B) Labrum of MI; (C) Labium of MI; (D) Right mandible of MI; (E) Left mandible of MI; (F) RI of MI; (G) LI of MI; (H) 43. RI of MII; (I) RI of the MIII; (J) LI of MIII; (K) RI of MV; (L) LI of MV; (M) RI of MVI; (N) LI of MVI; (O) RI of MVIII; (P) LI of MVIII; (Q) RI of MX; (R) LI of MX; (S) RI of MXI; (T) LI of MXI; (U) RI of MXII; (V) RI of MXIII; (W) LI of MXIII. Scales in mm. Abbreviations: MI…MXIII: male I…male XIII; RI: right lacinia; LI: Left lacinia.

Female III (INPA) Brazil, Amazonas, Manaus, Reserva Biológica de Cueiras, km 14, 02°35′21″S, 60°06′55″W. 18.viii-01.viii.2016. J.A. Rafael-Rede BIA. Female IV (INPA) Brazil, Amazonas, Borba, Rio Abacaxis, 04°22′16.0″S, 59°14′59.5″W. 02-04.vi. 2006. J.A. Rafael & equipe. Female V (INPA) same data as female 1 except ix.2001. F. Vidal. **14 Males:** Male I (INPA) – Brazil, Amazonas, Reserva Florestal Adolpho Duck. Portion L1. 02°57′50.0″S, 59°56′17.6″W. 01-15.x.2014. Malaise trap. Silva-Neto, A.M. & Mendes, D.M. Male II (INPA) Brazil, Amazonas, Careiro Castanho, BR-319, km 121, sítio S. Paulo. 04°12′48″S, 60°49′04″W. 18-30.ix.2016. J.A. Rafael & F.F. Xavier. Male III (INPA) Brazil, Amazonas, Novo Aripuanã, Lago Xadá. 05°15′39″S, 60°42′32″W. iv.2005. Male IV (INPA) Brazil, Amazonas, Acre, Bujari, FES Antimary 09°20′01″S, 68°19′17″W. 18-31.vi.2017. E.F. Morato & J.A. Rafael cols – Rede BIA. Male V (INPA) Brazil, Rondônia, BR-319, 450 m. 05°54′52.9″S, 62°25′37.0″W. plot 3 km 50, 23-27.x.2019. Male VI (INPA) same data male II except, km 181, 15-30. ix.2016. Male VII (INPA) Brazil, Amazonas, Manaus, Rod. AM-010, km 26, ix.2001. J.F. Vidal. Male VIII (INPA) same data as male II except, 15-30.ix.2016. Male IX (INPA) same data as male I except IG. Ipiranga, 02°57′50.0″S, 59°56′17.6″W. 31.xii.2002. J. Vidal. Male X (INPA) same data as male VII. Male XI (INPA) same data as male I except, ix.2001. J.F. Vidal. Male XII (INPA) same data as male VII. Male XIII (INPA) same data as male V except, 1,250 m. 23-27.x.2019. Male XIV (INPA) Brazil, Amapá, Oiapoque BR-156, 03°39′35″N, 51°46′17″W. km 25, 05-17. xii.2019. Malaise. J.A. Rafael, S. Lima, F.F. Xavier.

Variations and anomalies in the fore and hindwing veins

Below, the thirteen different types of variations and anomalies, of the fore- and hindwing veins, found in males and females of *N. Xanthopterum* are described:

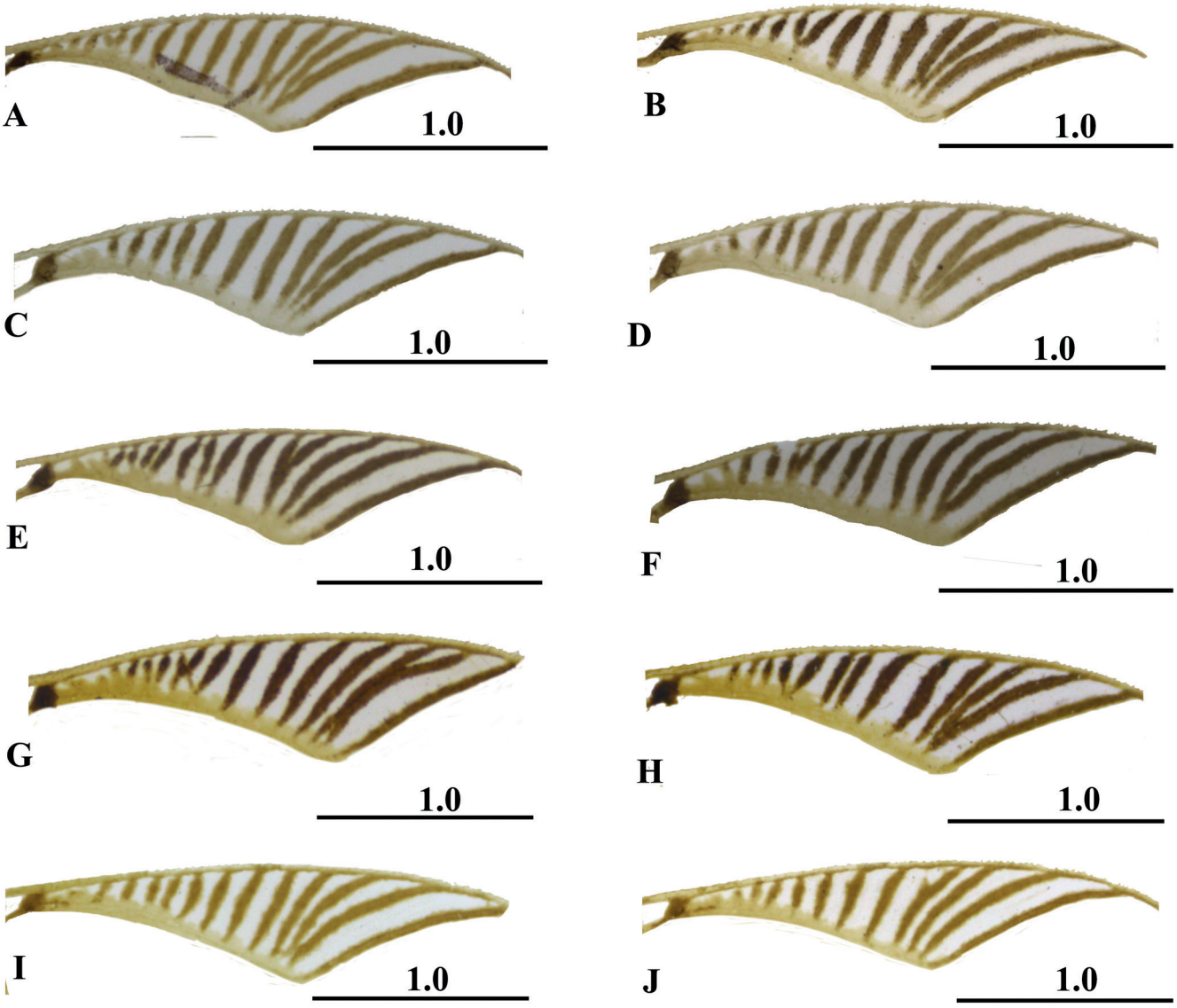

Figure 7. Pterostigma of the *Neurostigma xanthopterum* (female I…female IV): (A) PRF of FI; (B) PLF of FI; (C) PRF of FII; (D) PLF of FII; (E) PRF of FIII; (F) PLF of FIII; (G) PRF of FIV; (H) PLF of FIV; (I) PRF of FV; (J) PLF of FV. Scales in mm. Abbreviations: FI…FIV: female I…female IV; PRF: pterostigma of right forewing, PLF: pterostigma of left forewing.

Type 1. Forewing M with four primary branches; with a cell analogous to areola postica; with the proximal region between veins R_{2+3} and veins R_{4+5} distinctly wider than in the forewings of the holotype (Fig. 10A).

Type 2. Forewing M with five primary branches, with M3 distally forked resulting in M3a, M3b; with the proximal region between veins R_{2+3} and veins R_{4+5} distinctly wider than in the forewings of the holotype (Fig. 10B).

Type 3. Forewing M with five primary branches, with vein Rs forming a small cell before the bifurcation that gives rise to veins R_{2+3} and R_{4+5} (Fig. 10C).

Type 4. Forewing M with six primary branches, with M5 and M6 arising from the same point of the main branch of the M vein, with the proximal region between veins R_{2+3} and veins R_{4+5} distinctly wider than in the forewings of the holotype (Fig. 10D).

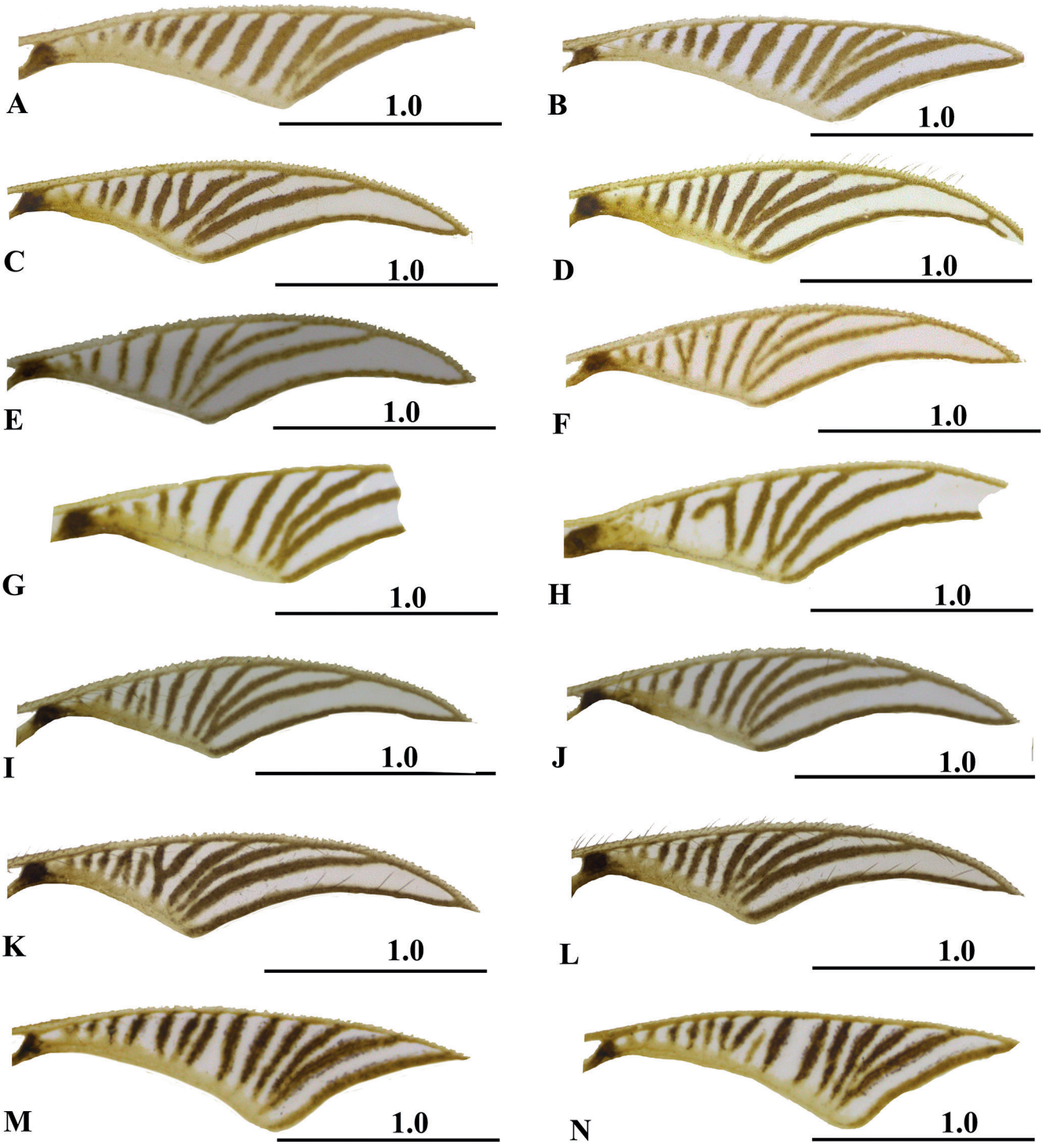

Figure 8. Pterostigma of the *Neurostigma xanthopterum* (male I…male VII): (A) PRF of MI; (B) 70. PLF of MI; (C) PRF of MII; (D) PLF of MII; (E) PRF of MIII; (F) PLF of MIII; (G) PRF of MIV; (H) PLF of MIV; (I) PRF of MV; (J) PLF of MV; (K) PRF of MVI; (L) PLF of MVI; (M) PRF of MVII; (N) PLF of MVII. Abbreviations: MI…MVII: male I… male VII. PRF: pterostigma of right forewing, PLF: pterostigma of left forewing.

Type 5. Forewing M with six primary branches; with the proximal region between veins R_{2+3} and veins R_{4+5} distinctly wider than in the forewings of the holotype (Fig. 10E).

Type 6. Forewing M with six primary branches, with M4 forked resulting in M4a, M4b; with the proximal region between veins R_{2+3} and veins R_{4+5} distinctly wider than in the forewings of the holotype (Fig. 10F).

Type 7. Forewing M with six primary branches, with M6 proximally forked resulting in M6b and M6a as a spurious vein, with the proximal region between veins R_{2+3} and veins R_{4+5} distinctly wider than in the forewings of the holotype (Fig. 10G).

Type 8. Hindwing M with two primary branches (Fig. 11A).

Type 9. Hindwing M with three primary branches (Fig. 11B).

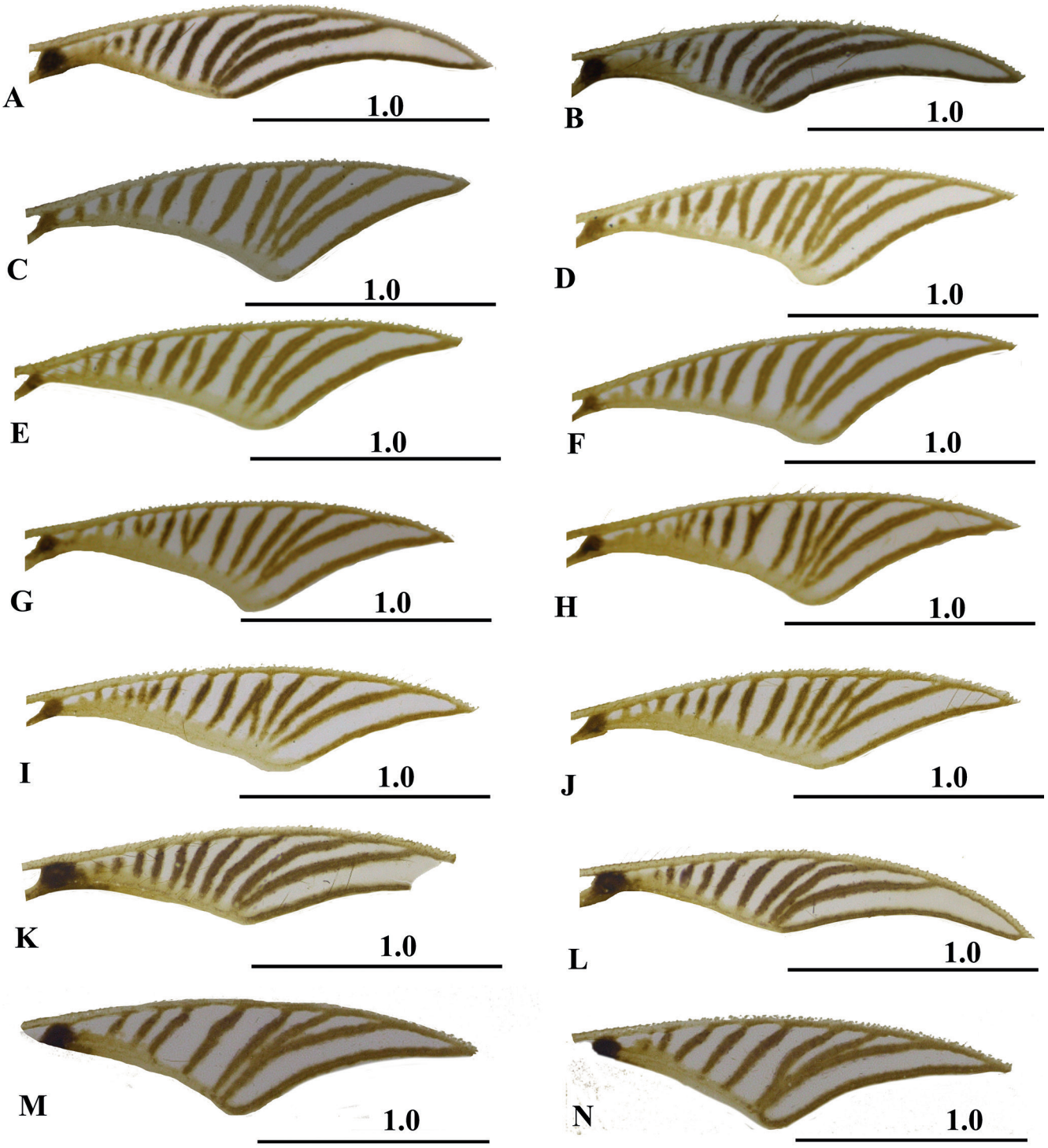

Figure 9. Pterostigma of the *Neurostigma xanthopterum* (male VIII…male XIV): (A) PRF of MVIII; (B) PLF of MVIII; (C) PRF of MIX; (D) PLF of MIX; (E) PRF of MX; (F) PLF of MX; (G) PRF of MXI; (H) PLF of MXI; (I) PRF of MXII; (J) PLF of MXII; (K) PRF of MXIII; (L) PLF of MXIII; (M) PRF of MXIV; (N) PLF of MXIV. Scales in mm. Abbreviations: MVIII…MXIV: male VIII…male VXIV. PRF: pterostigma of right forewing, PLF: pterostigma of left forewing.

Type 10. Hindwing M with three primary branches; R1 with two small spurious veins; M+CuA with a spurious vein; CuA distally forked resulting in CuA2 and a spurious vein CuA1 (Fig. 11C).

Type 11. Hindwing M with four primary branches (Fig. 11D).

Type 12. Hindwing M with four primary branches, with M4 as a small spurious vein (Fig. 11E).

Type 13. Hindwing M with four primary branches, with M4 as a spurious vein; R_{2+3} forked distally (Fig. 11F).

A total of seven males and one female had some type of variation or anomaly described above, at least on one of the fore-hindwing (left or right or both) (Table 2).

DISCUSSION

Previously, the distribution of *N. Xanthopterum* was restricted to Reserva Adolpho Ducke, Manaus Amazonas, Brazil and Estación Biológica Mosiro-Itajura, Vaupés, Colombia (Fig. 12). The new records for other localities in the Brazilian state of Amazonas and for the Brazilian states of Acre and Amapá significantly expand the distribution of this species, reducing its walacean deficit (Fig. 12 and Table 1). The psocid fauna of the Brazilian states of Acre and Amapá are practically unknown, with only three species of *Euplocania* Roesler known for Acre, and no species known for Amapá. The new records of *N. Xanthopterum* are the fourth record of psocids for Acre and the first record of psocids for Amapá (Silva-Neto & Garcia-Aldrete, 2020).

Among the fourteen *Neurostigma* species, only *Neurostigma dispositum* Roesler, *Neurostigma furcivenula* Badonnel and *Neurostigma roesleri* New have known females. With the description of the female of *N. Xanthopterum* in the current study, this number is raised to four species (Table 1). The female of *N. Xanthopterum* is easily distinguished from other known females of this genus by having pigmented wings, while all other

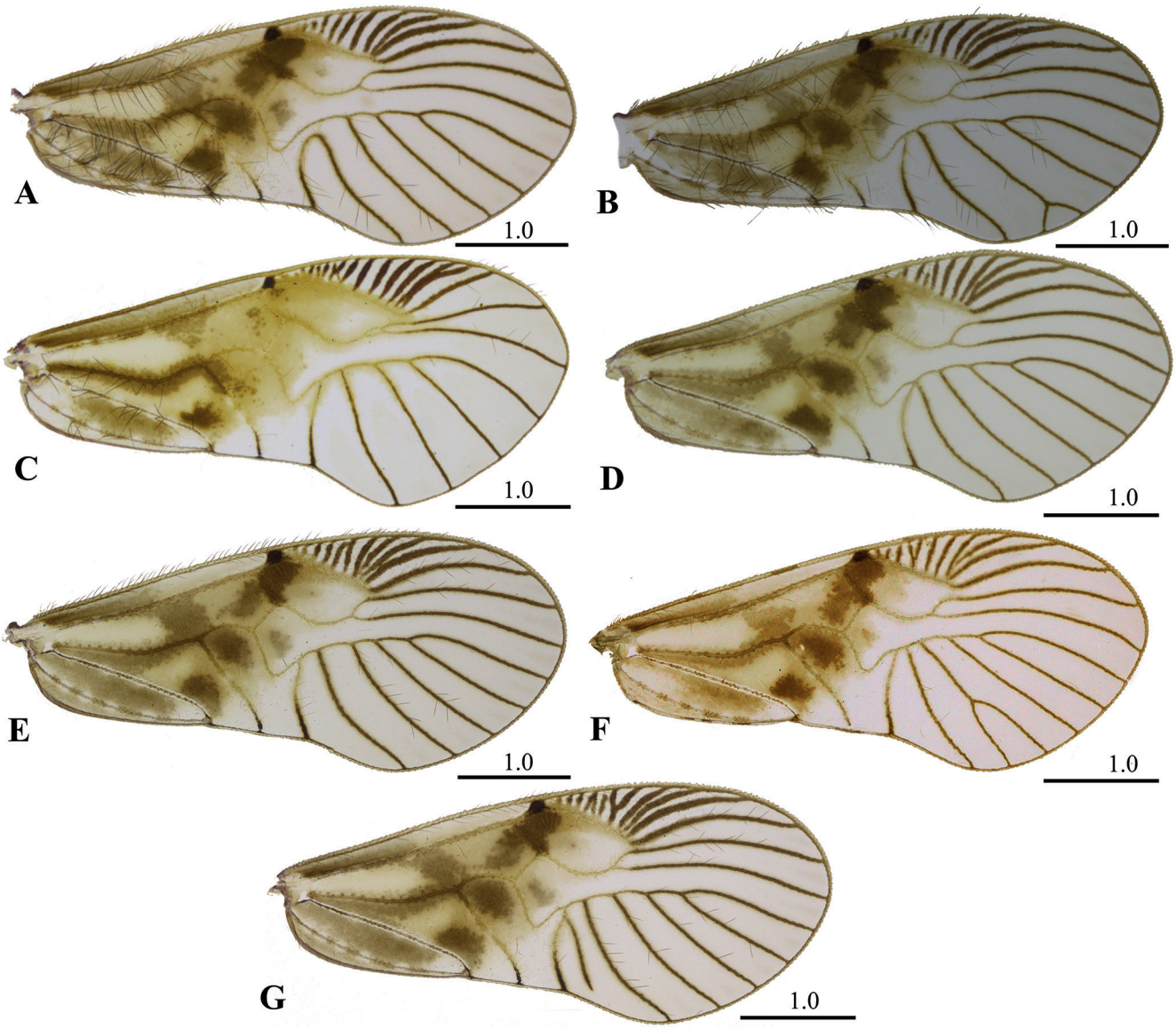

Figure 10. Type of variations in the forewing veins of the *Neurostigma xanthopterum:* (A) Type 1; (B) Type 2; (C) Type 3; (D) Type 4; (E) Type 5; (F) Type 6; (G) Type 7. Scales in mm.

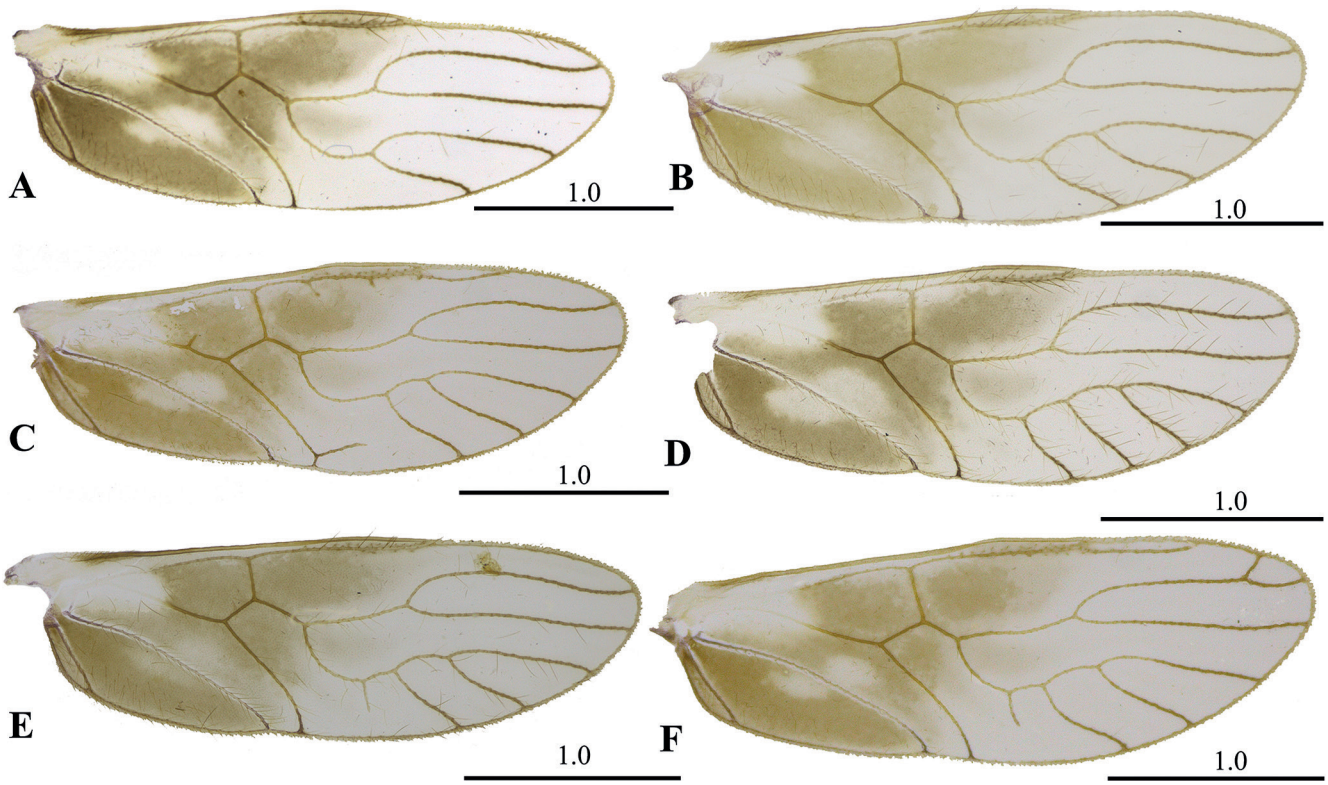

Figure 11. Type of variations in the hindwing veins of the *Neurostigma xanthopterum:* (A) Type 8; (B) Type 9; (C) Type 10; (D) Type 11; (E) Type 12; (F) Type 13. Scales in mm.

Table 2. Variations and anomalies in the fore and hindwing veins of specimens of *Neurostigma xanthopterum* without analyzing the transverse veins of the Pterostigma. Abbreviations: LFwH = left forewing as in holotype, HwH = hidwings as in Holotype.

Specimens of *N. Xanthopterum*	Right forewing	Left forewing	Rigth hindwing	Left hindwing
Male I	LFwH	LFwH	HwH	HwH
Male II	Type 5	Type 2	Type 10	Type 13
Male III	Type 6	Type 5	Type 9	Type 11
Male IV	Type 5	Type 5	Type 12	Type 11
Male V	Type 5	Type 4	Type 8	Type 9
Male VI	Type 5	Type 7	Type 11	Type 11
Male VII	LFwH	LFwH	HwH	HwH
Male VIII	Type 2	Type 1	Type 9	Type 9
Male IX	LFwH	LFwH	HwH	HwH
Male X	LFwH	LFwH	HwH	HwH
Male XI	LFwH	LFwH	HwH	HwH
Male XII	LFwH	LFwH	HwH	HwH
Male XIII	Type 5	Type 5	Type 12	Type 9
Male XIV	LFwH	LFwH	HwH	HwH
Female I	LFwH	LFwH	HwH	HwH
Female II	LFwH	LFwH	HwH	HwH
Female III	LFwH	LFwH	HwH	HwH
Female IV	LFwH	Type 3	HwH	HwH
Female V	LFwH	LFwH	HwH	HwH

Neurostigma species with known females have hyaline wings (see fig. 41 in Roesler, 1940, fig. 56 in New, 1980 and fig. 70 in Badonnel, 1986). Another difference is the presence of only three setae on the gonapophyses in *N. Xanthopterum,* while there are seven setae in *N. dispositum* (See fig. 48 in Roesler, 1940), six setae in *N. roesleri*

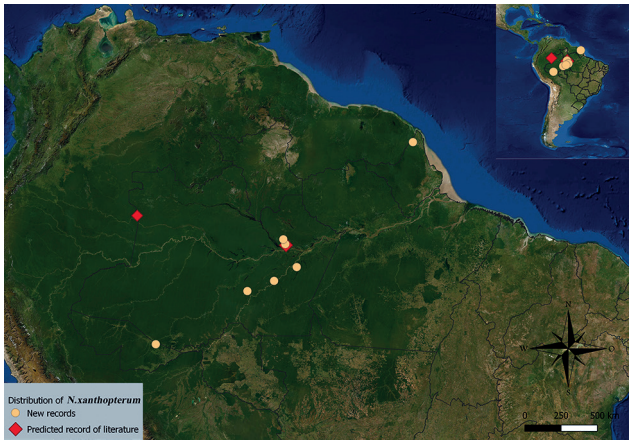

Figure 12. Distribution of the *Neurostigma xanthopterum* specimens.

(see fig. 58 in New, 1980) and four setae in *N. furcivenula* (see fig. 74 in Badonnel, 1986).

This is the first time that the ninth sternum is mentioned for *Neurostigma,* none of the previous authors who have described females of *Neurostigma* have mentioned it, described or illustrated the ninth sternum of females. In other psocid genera the ninth sternum usually has great taxonomic importance in distinguishing species. In the future, with the description of other unknown females of *Neurostigma* or even with the redescription of known females from new specimens collected, the ninth sternum of *N. Xanthopterum* will be comparable with those of other *Neurostigma* species.

The set combination of number and shape of crossveins in the pterostigma of *N. Xanthopterum* is unique for each wing as a type of wing fingerprint

Table 3. The number of pterostigma crossveins in the forewing of specimens of *Neurostigma xanthopterum*.

Specimens of *N. Xanthopterum*	Number of pterostigma crossveins of right forewing	Number of pterostigma crossveins of left forewing
Male I	12 (Fig. 8A)	11 (Fig. 8B)
Male II	8 (Fig. 8C)	8 (Fig. 8D)
Male III	7 (Fig. 8E)	8 (Fig. 8F)
Male IV	9 (Fig. 8G)	7 (Fig. 8H)
Male V	9 (Fig. 8I)	9 (Fig. 8J)
Male VI	10 (Fig. 8K)	10 (Fig. 8L)
Male VII	12 (Fig. 8M)	14 (Fig. 8N)
Male VIII	9 (Fig. 9A)	9 (Fig. 9B)
Male IX	11 (Fig. 9C)	12 (Fig. 9D)
Male X	10 (Fig. 9E)	10 (Fig. 9F)
Male XI	13 (Fig. 9G)	12 (Fig. 9H)
Male XII	13 (Fig. 9I)	13 (Fig. 9J)
Male XIII	10 (Fig. 9K)	9 (Fig. 9L)
Male XIV	7 (Fig. 9M)	8 (Fig. 9N)
Female I	14 (Fig. 7A)	12 (Fig. 7B)
Female II	10 (Fig. 7C)	10 (Fig. 7D)
Female III	11 (Fig. 7E)	13 (Fig. 7F)
Female IV	12 (Fig. 7G)	12 (Fig. 7H)
Female V	11 (Fig. 7I)	11 (Fig. 7J)

(Figs. 7-9). The number of pterostigma crossveins in *N. Xanthopterum* ranged from seven to fourteen (Table 3). Roesler (1940) mentioned that for *N. dispositum* the shape and number of pterostigma crossveins were variable and he illustrated a forewing with six pterostigma crossveins (see fig. 40 in Roesler, 1940) and another forewing with five pterostigma crossveins (see fig. 41 in Roesler, 1940). Badonnel (1986) also illustrated the right forewing and Pterostigma of left forewing of the *N. furcivenula,* and their shape were different. Another morphological structure that presented great variation in *N. Xanthopterum* was the lacinia, which presented different numbers of denticles and tip shape (Figs. 5F-L, 6F-W). Due to this large intraspecific variation in the number and shape of pterostigma crossveins and lacinia denticles, it is possible that these characteristics are not good for the diagnosis of *Neurostigma* species.

Other variations of veins, in addition to the transverse veins of the Pterostigma, were also found, especially in the number of primary branches of the M vein in the fore-hindwing (Figs. 10-11). Two types of variations in particular were very interesting, first the areola postica not fused to the M vein (Fig. 10A) and second the presence of two or more primary branches in the M vein of the hindwings (Fig. 11).

In psocoptera the CuA is usually forked distally into CuA1 and CuA2, and they surround the cell called areola postica. The top of the areola postica, anteriorly arched portion of CuA1, and M are sometimes fused or connected by a cross vein (Yoshizawa, 2005). Enderlein (1900) commented that there was no areola postica in *Neurostigma* when describing *Neurostigma chaetocephalum* Enderlein and that its forewing had vein M five branched. Later Roesler (1940) described *N. dispositum* Roesler and illustrated its right forewing with the presence of an areola postica and M vein three branched (see fig. 40 in Roesler, 1940), but the left forewing had an aberration, with the M vein four branched and with a spurious vein emerging from the forewing margin as if was an incomplete areola postica (see fig. 41 in Roesler, 1940). Roesler (1940) based on these observations of left forewing of the *N. dispositum* commented that its areola postica was separated from the CuA branch, and later connected to the main branch of the M vein, causing additional ramifications in the M vein (four branched); in other words, in the case of *N. chaetocephalum* the areola postica would be fused to vein M and with its cell delimited by the false M4 and M5 veins.

Mendivil-Nieto *et al.* (2020) divided *Neurostigma* into two species groups based on the areola postica fused (Species group I) to vein M or not fused to it (Species group II). Later González-Obando *et al.* (2021) described additional *Neurostigma* species and performed a phylogenetic analysis that did not support the two species groups mentioned above by Mendivil-Nieto *et al.* (2020), but decided to keep these species groups for taxonomic purposes, updating the species included in each of these two species groups. *Neurostigma xanthopterum* is included in species group 1, however the variation of the figure (10A) with areola postica not fused to vein M is a diagnostic feature of species group 2.

Two hypotheses are possible to explain the areola postica origin in *Neurostigma,* the first one already commented above by Roesler (1940), the areola postica originates from the CuA vein, moving away from the CuA vein later and fusing the M vein and the second hypothesis would be that the areola postica originates from vein M and later separates from it. In the case of the second hypothesis, the *Neurostigma* areola postica will not be homologous to the areola postica known from other psocids, as described by Yoshizawa (2005) and commented by Roesler (1940). In the future, embryological studies could resolve this question of the origin of areola postica in *Neurostigma*. A forewing of a Colombian specimen of *N. Xanthopterum,* illustrated by Mendivil-Nieto *et al.* (2020) is as the type 4 described in this present paper (Compare Fig. 10D with fig. 7 in Mendivil-Nieto *et al.,* 2020).

One of the main diagnostic features of Episocidae is the hindwings with unbranched M vein. *Neurostigma* is included in Epipsocidae and all hindwings of its known species followed this pattern. However, the variations found here in the hindwings of some specimens of *N. Xanthopterum* completely deviate from this pattern, ranging from two to four primary branches in the M vein of hindwings (Fig. 11). González-Obando *et al.* (2021) also mentioned Colombian specimens of *N. Xanthopterum* with the hindwing presents M with two to three branches, sometimes with M3 forked.

The vast majority of *Neurostigma* species are known from a few specimens, or even from a single specimen (holotype only). In the future with more specimens collected from the other known *Neurostigma* species, perhaps these morphological variations or aberrations described for *N. Xanthopterum* in this paper will be more common for *Neurostigma* than we imagined.

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