Artículos

Contribution to the knowledge of larval chaetotaxy of the genus *Berosus* (Coleoptera: Hydrophilidae: Hydrophilinae)

Contribución al conocimiento de la quetotaxia larval del género *Berosus* (Coleoptera: Hydrophilidae: Hydrophilinae)

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Revista de la Sociedad Entomológica Argentina vol. 83 núm. 4 9 31 2024

Sociedad Entomológica Argentina
Argentina

Recepción: 22 Julio 2024
Aprobación: 22 Noviembre 2024

Abstract: The primary and secondary chaetotaxy of the larval head capsule and head appendages of eight New World species of *Berosus* Leach (Coleoptera: Hydrophilidae: Hydrophilinae), are described for the first time, together with detailed illustrations of all characters. The chaetotaxy of these eight species is compared to that of other known *Berosus* larvae. Larval chaetotaxy of *Berosus* appears to be very stable and chaetotaxic characters separating species are very subtle. Those chaetotaxic characters which are informative to distinguish among species or groups of species are discussed.
Keywords: Aquatic beetles, Berosini, New World, Primary chaetotaxy, Water scavenger beetles.
Resumen: Se describen por primera vez la quetotaxia primaria y secundaria de la cápsula cefálica y de los apéndices cefálicos de las larvas de ocho especies del Nuevo Mundo del género *Berosus* Leach (Coleoptera: Hydrophilidae: Hydrophilinae), acompañadas de ilustraciones detalladas de todos los caracteres. Se compara la quetotaxia de estas ocho especies con la de otras larvas de *Berosus* previamente conocidas. La quetotaxia larval de *Berosus* resulta ser muy estable, y los caracteres quetotáxicos que diferencian las especies son muy sutiles. Se discuten aquellos caracteres quetotáxicos que resultan informativos para distinguir entre especies o grupos de especies.
Palabras clave: Berosini, Escarabajos acuáticos, Escarabajos acuáticos carroñeros, Nuevo Mundo, Quetotaxia primaria.

INTRODUCTION

Hydrophilidae is the second most diverse family of aquatic beetles, after Dytiscidae, including six subfamilies and approximately 3000 species (Short & Fikáček, 2013; Short, 2018). The tribe Berosini, included in the subfamily Hydrophilinae, is a very distinctive group of water scavenger beetles, strongly supported by both morphological and molecular characters (Archangelsky, 2004, 2008; Short & Fikáček, 2013; Bloom et al., 2014; Rodriguez et al., 2018, 2021). Berosini includes five genera, of which *Berosus* Leach is the only one with a worldwide distribution and the most diverse, over 290 species have been described (Santana et al., 2019). The remaining genera are more restricted in their distribution; *Hemiosus* Sharp and *Derallus* Sharp are restricted to the New World, mostly the Neotropical region, with only a few species reaching the southern Nearctic region. *Allocotocerus* Kraatz and *Regimbartia* Zaitzev, on the other hand, are restricted to the Afrotropical, Australian and Oriental regions.

Within Berosini, larvae of both *Berosus* and *Hemiosus* are highly modified as a result of their adaptations to underwater feeding, and therefore present a very characteristic morphology of their head capsule and mouthparts (Archangelsky, 2008; Rodriguez et al., 2018, 2021). The remaining genera of the tribe retain the ancestral condition of feeding strategy, which is with their heads holding the prey outside the water.

Even though larval knowledge for the tribe is fairly good (larvae have been described for all genera of the tribe), more detailed chaetotaxic studies are necessary. Several larval descriptions of the chaetotaxy of *Berosus* have been presented so far (Fikáček, 2006; Minoshima & Hayashi, 2015; Rodriguez et al., 2015, 2018; Deler-Hernández & Fikáček, 2016; Rodriguez, 2016), nonetheless these represent only a small fraction of the diversity of the genus (about 3-4 % of the species). This contribution aims to improve the knowledge of larval chaetotaxy of the genus *Berosus* by describing and illustrating in detail the chaetotaxy of eight New World *Berosus* species: *Berosus aulus* Orchymont, *Berosus auriceps* Boheman, *Berosus chalcocephalus* Germain, *Berosus coptogonus* Jensen-Haarup, *Berosus cornicinus* Knisch, *Berosus hoplites* Sharp, *Berosus pugnax* LeConte and *Berosus toxacanthus* Oliva. This information will be useful for future comparative and phylogenetic studies within the tribe Berosini and the subfamily Hydrophilinae.

MATERIAL AND METHODS

Studied material

Larvae of all described species were associated by rearing. Information on the biology and ecology of the studied species is available in Archangelsky (1994, 1999, 2002). Larvae of the following species of *Berosus* were examined:

B. aulus: Argentina, La Rioja, Departamento Felipe Varela, Cuesta de Miranda (Rd. 40, km 528), 3.x.1998, M. Archangelsky leg. 29° 21' S, 67° 47' W, 1830 m.

B. auriceps: Argentina, La Rioja, Departamento Castro Barros, Chuquis, 18.xi.1998, M. Archangelsky leg. 29° 09' S, 67° 04' W, 1300 m.

B. chalcocephalus: Argentina, Chubut, Experimental Field of INTA (Instituto Nacional de Tecnología Agropecuaria) in Aldea Escolar, 3.xi.2003, M. Archangelsky leg. 43° 06' S, 71° 33' W, 450 m.

B. coptogonus: Argentina, Córdoba, Salinas Grandes, ditch at intersection Rd. 60 and dirt road to Totoralejos, 13.iii.1999. M. Archangelsky leg. 29° 37' S, 64° 50' W, 185 m.

B. cornicinus: Argentina, Córdoba, Las Mojarras Creek, North of San Roque Lake, 3.iv.1999, M. Archangelsky leg. 31° 20' S, 64° 28' S, 650 m.

B. hoplites: USA, Texas, Llano Co., Enchanted Rock State Natural Area, 22.iii.1990. P. W. Kovarik leg. App. 30° 30' N, 98° 49' W.

B. pugnax: USA, Florida, Highlands Co., north of Archbold Biological Station, 9.vi.1990. M. Archangelsky leg.App. 27°12' N, 81°21' W.

B. toxacanthus: Argentina, Córdoba, Salinas Grandes, ditch at intersection Rd. 60 and dirt road to Totoralejos, 13.iii.1999. M. Archangelsky leg. 29° 37' S, 64° 50' W, 185 m.

Methods

Larval specimens were cleared in warm lactic acid, dissected and mounted on glass slides with Hoyer's medium. Observations (up to 1000 ×) were done with a Leica S6D dissecting microscope and a Leica DMLB compound microscope, drawings were made with the compound microscope using a camera lucida. Drawings were scanned and digitally edited. The material studied is kept in the larval collection of the author and in the larval collection of the Laboratory of Entomology, Buenos Aires University, Argentina (LEBA). Identification of adults was done using the revisions of Van Tassell (1966), Oliva (1989) and Oliva et al. (2002); information on the distribution of the species can be found in Van Tassell (1966) and Oliva (1989, 2007).

Chaetotaxy

Primary (present in first-instar larva) and secondary (arising in later instars) setae and pores were identified in the cephalic capsule

and head appendages. Sensilla present in first-instar larvae were labeled by comparison with the ground plan of chaetotaxy of the family Hydrophilidae (Fikáček et al.,2008; Byttebier & Torres, 2009) and with studies on other Berosini larvae (Minoshima & Hayashi, 2015; Rodríguez et al., 2015, 2018; Rodriguez, 2016), additional sensoria were highlighted with a black square (▪). Homologies were established using the criterion of similarity of position (Wiley, 1981). Sensilla were coded with a number and two capital letters, usually corresponding to the first two letters of the name of the structure on which they are located. Chaetotaxic descriptions of first and third instar larvae are presented, second instar larvae are very similar to the third instar. The following abbreviations were used. AN: antenna; FR: frontale; LA: labium; MN: mandible; MX: maxilla; PA: parietale; gAN: group of antennal sensilla; gAPP: group of sensilla on the inner appendage of the maxilla; gFR1, gFR2: group of sensilla on the frontale; gLA: group of sensilla on the labial palp; gMX: group of sensilla on the maxillary palp.

RESULTS

Identification of larvae of the genus *Berosus*

Berosus larvae are identified by the following combination of characters. ***General morphology:*** 1- frontal lines inversely bell-shaped (absent in third instar larvae); 2- coronal line absent; 3- frontoclypeus strongly asymmetrical: left epistomal lobe strongly projected, right lobe poorly developed; 4- base of left epistomal lobe with a membranous fissure; 5- nasale short, usually with 3-6 poorly developed teeth or serrated (*B. hoplites*); 6- posterior tentorial pits distal, next to base of submentum; 7- cervical sclerites absent or very narrow; 8- first antennomere with a distal membranous projection on inner face; 9- mandibles strongly asymmetrical; 10- right mandible with a strong median tooth and 1-2 smaller teeth on basal half (except for *B. hoplites* with only one median tooth); 11- left mandible grooved, with four teeth, basal tooth sharp, pointing forward; second tooth from base pointing mediad, bearing several sharp projections; third tooth tri- or tetra-furcated; distal tooth subtriangular, pointing mediad and bearing several long projections, simple or branched apically; 12- third maxillary palpomere the longest; 13; mentum lacking dorsal cuticular projections; 14- ligula very short, membranous; 15- legs well developed, five-segmented; 16- spiracular atrium absent; 17- tergite VIII entire; 18- urogomphi absent; 19; tracheal gills at least on some of the abdominal segments (usually on segments I-VII). ***Chaetotaxy:*** 1- seta FR1 long, posterior to or at same level of PA7; 2- seta FR3 displaced anteriorly, close to seta FR8; 3- gFR1 with six short and stout setae; 4- setae of gFR1 evenly distributed or right seta of gFR1 markedly distant from remaining ones; 5- gFR2 asymmetrical, right side bare, left side with 9-16 strong

curved setae; 6- ventral side of left epistomal lobe with 3-4 additional sensilla or spinules; 7- seta FR8 more distal on right side than on left; 8- distribution of sensilla FR11-12 slightly asymmetrical; 9- pore FR14 absent; 10- pore PA6 not too close to occipital margin; 11- seta PA16 and pore PA17 closely aggregated; 12- pore PA27 between setae PA26 and PA28; 13- pore AN4 located at base of distal membranous projection on inner face; 14- pore AN6 distal; 15- AN8-9 absent; 16- seta MN1 minute; 17- pores MN2-4 arranged in a triangle; 18- setae MX7-11 unifid; 19- seta MX7 shorter, straight and in many species blunt or not sharply pointed; 20- seta MX10 long, filiform (except *B. exiguus*); 21- setae MX11 and MX16 long and usually curved inwards; 22- stipes with three secondary setae (L3); 23- mentum lacking secondary setae in second and third instar larvae; 24- pore LA4 absent in first instars; 25- seta LA5 present; 26- seta LA6 and pore LA7 distally placed on prementum; 27- pore LA15 absent.

This paper focuses on the description of the chaetotaxy of the head capsule and head appendages; for more detailed morphological information of thesespecies the original descriptions should be consulted (Archangelsky 1994, 1999, 2002). For the chaetotaxic descriptions *B. aulus* is described in detail and the remaining species are compared with it.

Berosus aulus **Orchymont (Figs. 1-6)**

First instar larva. *Chaetotaxy*. *Head capsule* (Figs. 1a-b; 2a). Frontale with 34 sensilla (excluding gFR2). Six setae of gFR1 short and stout, outer setae on sides of short nasale, right one slightly distant to remaining five. Right epistomal lobe lacking setae; left lobe with 14-15 stout and curved setae (gFR2), outer ones unifid, inner ones bifid. Seta FR1 long, setiform, at about basal two fifths; pore FR2 anteromesal to FR1; seta FR3 short, anterior to FR2, close to nasale; pore FR4 anterolateral to FR2, posterior to inner margin of antennal socket; setae FR5 and FR6 closely grouped, posterior to FR4 and close to frontal line, FR5 long, FR6 short; seta FR7 short, on inner margin of antennal socket; seta FR8 long, anterior to FR3 (right), lateral to FR3 (left); five sensoria anterior to antennal socket, arranged in an irregular longitudinal row in the following order, minute seta FR10, long seta FR9, pore FR13, short seta FR12 and pore FR11 on anterior

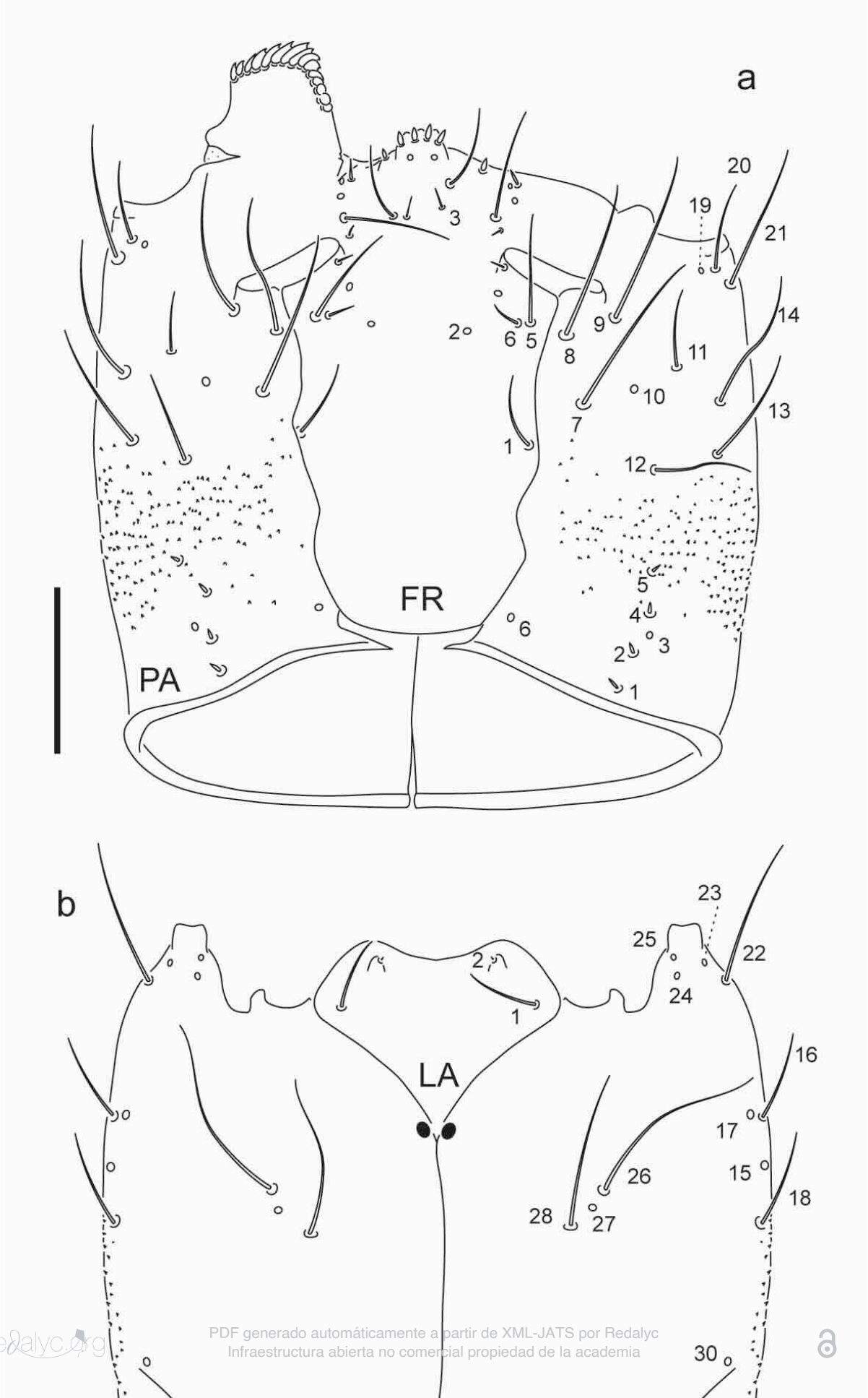


Fig. 1.

Chaetotaxy of first instar larva of *Berosus aulus*

a. Head capsule, dorsal view. b. Head capsule, ventral view. Scale bar= 0.1 mm.

margin, FR11 mesal to FR12; on left side FR11 lateral to FR12; pores FR15 on nasale, behind median setae of gFR1; pore FR14 absent. Ventral face of left epistomal lobe with apparently three basal additional sensoria (▪), two pores and one minute seta or toothlet, these sensoria are difficult to see. Parietale with 30 pairs of sensilla. Dorsal surface with sensilla PA1-5 arranged in an irregular longitudinal line, PA3 pore-like, PA1-2 and PA4-5 minute setae; pore PA6 subbasal, close to frontal line; a transverse line of three long setae at midlength of head capsule, PA7 close to frontal line, PA13 close to outer face, PA12 between both setae, slightly posterior to PA13; long seta PA8 distal to PA7, closer to frontal line; long seta PA9 lateral to PA8, on outer margin of antennal socket; three sensilla lateral to PA7, pore PA10, rather long seta PA11 and long seta PA14; anterolateral corner of head capsule with three sensilla, pore PA19, rather long seta PA20 and long seta PA21. Ventral surface of parietale with three distal pores (PA23-25) on mandibular

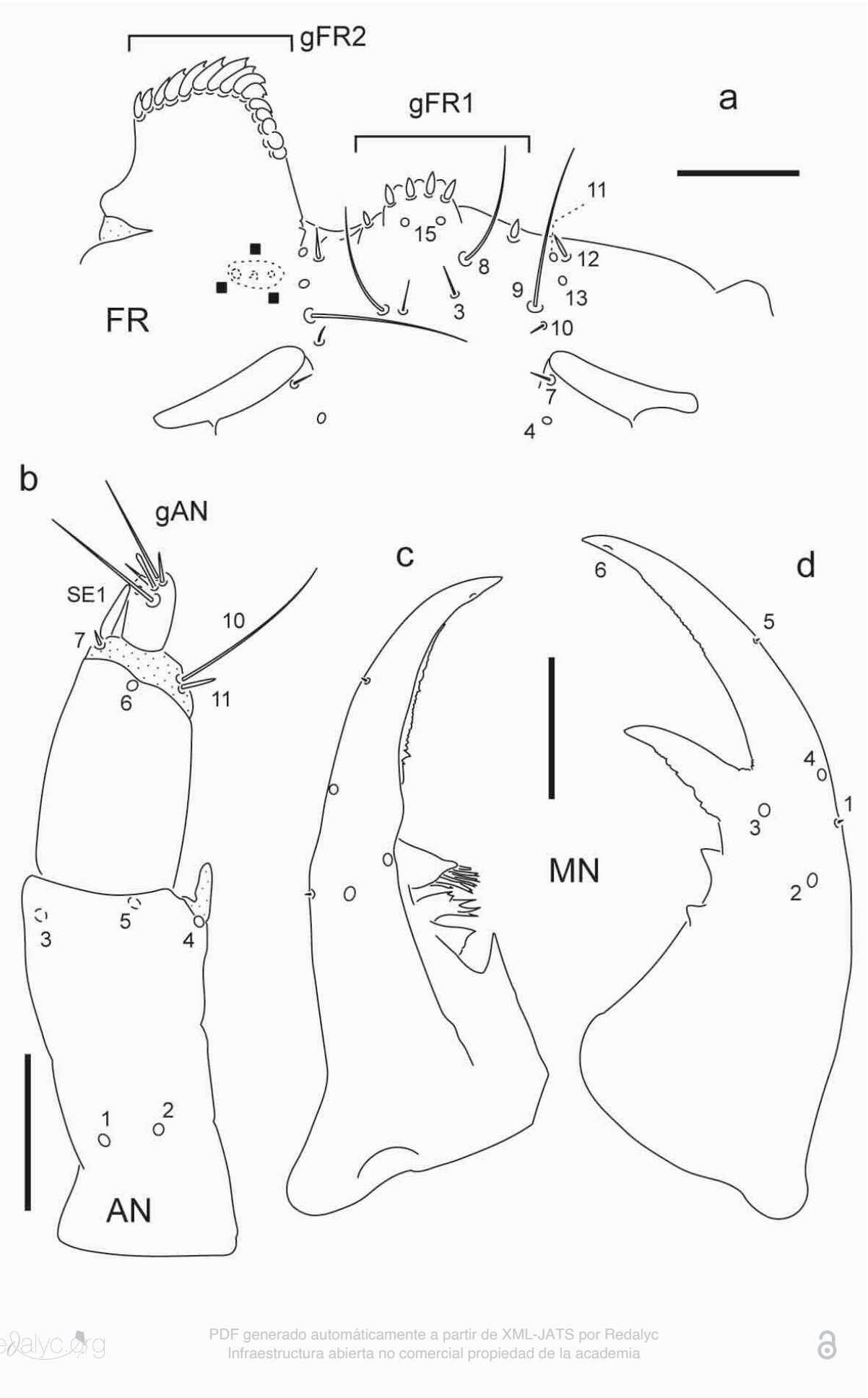


Fig. 2.

Chaetotaxy of first instar larva of *Berosus aulus*.

a. Detail of clypeolabrum, dorsal view. b. Left antenna, dorsal view. c. Left mandible, dorsal view. d. Right mandible, dorsal view. Scale bar= 0.05 mm.

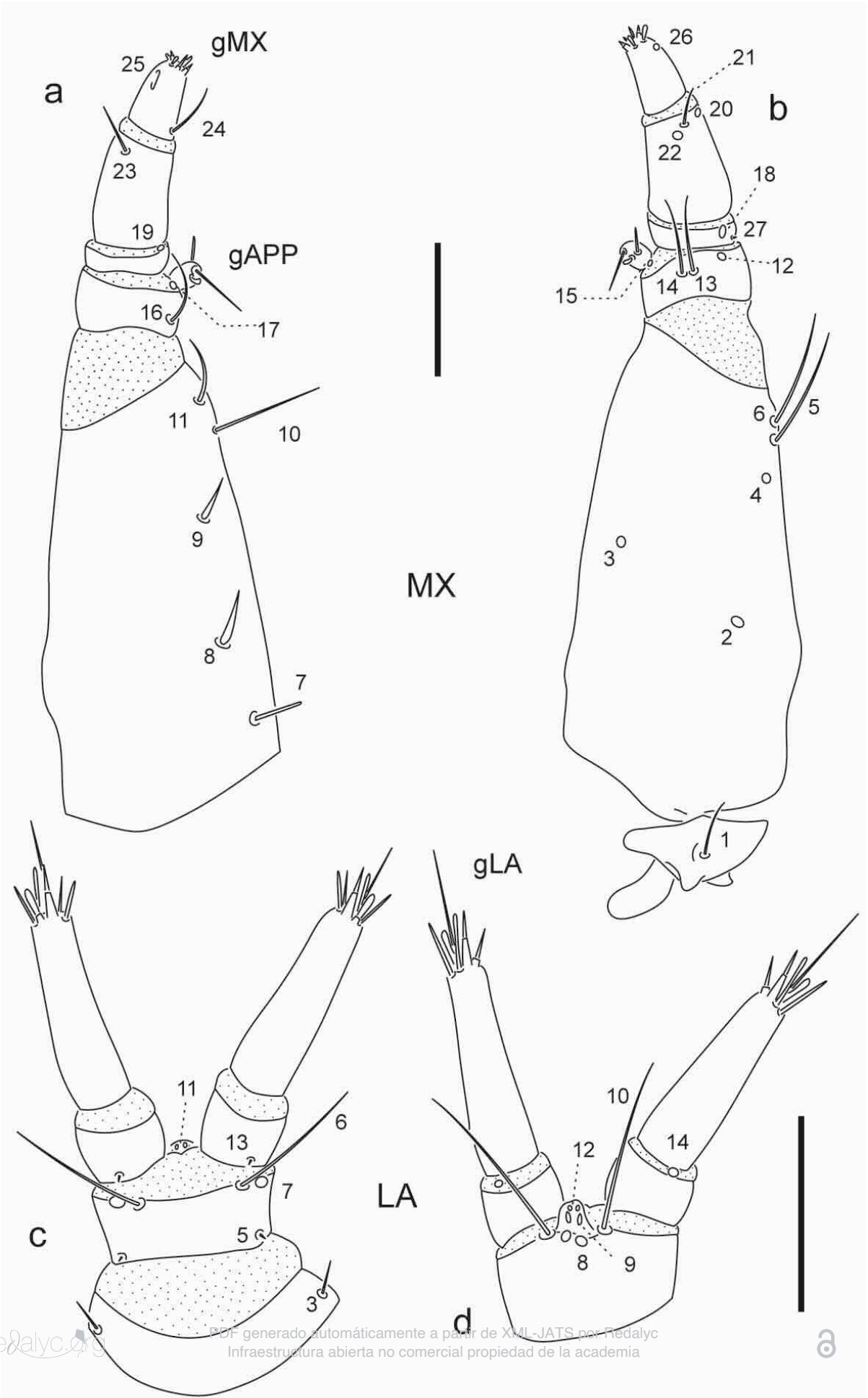


Fig. 3.

Chaetotaxy of first instar larva of *Berosus aulus*.

a. Left maxilla, dorsal view. b. Left maxilla, ventral view. c. Labium, ventral view. d. Labium, dorsal view. Scale bar= 0.05 mm.

acetabulum; long seta PA22 lateral to acetabulum; a group of three sensilla at midlength between gular sulcus and lateral margin closely aggregated, pore-like sensillum PA27 located between long setae PA28 and PA26; outer face of parietale with two long setae and two pores, pore PA17 and long seta PA16 closely aggregated, more distal, pore PA15 posterior to PA16, long seta PA18 posterior to PA15; two subbasal pores, PA30 close to outer face and PA29 closer to gular sulcus, PA29 more basal than PA30.

Antenna (Fig. 2b). A1 with five pore-like sensilla AN1-2 dorsal at basal third; AN3-5 distal, AN3 and AN5 ventral, AN3 close to outer margin, AN4 dorsal, at base of membranous inner sensory appendage. A2 with four distal sensilla dorsally; AN6 apical, pore-like; short seta AN7 on membrane close to base of SE1, setae AN10 and AN11 on membrane on inner face, AN11 short, AN10 long; setae AN8 and AN9 absent. A3 distally bearing gAN with a group of at least 6 sensilla, two of them long setae; SE1 slightly shorter than A3, narrower.

Mandibles (Fig. 2c-d). Each with six sensilla, minute seta MN1 on outer face at about midlength; minute seta MN5 on outer face at about distal fourth; MN2-4 pore-like, forming a triangle at level of distal retinaculum; minute distal pore-like sensillum MN6 close to inner margin, difficult to see; MN1 of right mandible closer to MN4, in left mandible MN1 closer to MN2.

Maxilla (Fig. 3a-b). Cardo bearing short ventral seta MX1. Stipes with a row of short unifid setae on inner face (MX7-11); MX7 short, blunt apically, MX8-9 short, slightly stouter, MX10 long, MX11 long, curved inwards; outer face of stipes with two long distal setae, MX5-6 and one pore, MX4 posterior to MX5, basal half of stipes with two pores MX2-3, MX3 close to inner face. First palpomere with six sensilla, MX16 a rather long basal seta curved inwards on inner face; MX13-14 rather long distal setae on ventral face; remaining sensoria pore-like, MX12 ventral, on distal outer margin, MX15 and MX17 on membrane at base of inner appendage, MX17 dorsal, MX15 ventral; inner appendage with a group of at least three sensilla (gAPP), one of them longer. Second palpomere with three sensilla, pore MX19 mesal, on membrane connecting with following palpomere, pore MX18 ventral, close to outer margin, minute seta MX27 on outer face. Third palpomere bearing four distal sensilla, short seta MX23 dorsal, close to outer face; ventrally with short seta MX21 and two pores, MX20 on outer face and MX22 posterior to MX21. Fourth palpomere with subbasal seta MX24 on inner margin, pore-like sensillum MX26 and digitiform sensillum MX25 on outer

face, subapical; apical portion of palpomere with several short sensilla (gMX).

Labium (Figs. 1b, 3c-d). Submentum with two pairs of setae on anterolateral corners, LA1 long, subbasal, LA2 minute, distal. Ventral side of mentum with one pair of rather short lateral setae, LA3. Prementum dorsally with a pair of closely aggregated distal pores (LA8, distance between pores not larger than width of pore) and a pair of long setae (LA10); pore-like sensilla LA9 distal to LA8, on membrane at base of ligula; ventrally with three pairs of sensilla, long setae LA6 and pore-like sensilla LA7 apical, and minute setae LA5 on laterobasal corner. First palpomere with pore LA14 distally on membrane between first and second palpomeres, ventrally with minute basal seta LA13. Second palpomere with a group of distal short and long sensilla (gLA); LA15 missing. Ligula with two distal pairs of pore-like sensilla, closely aggregated (LA11-12), difficult to see.

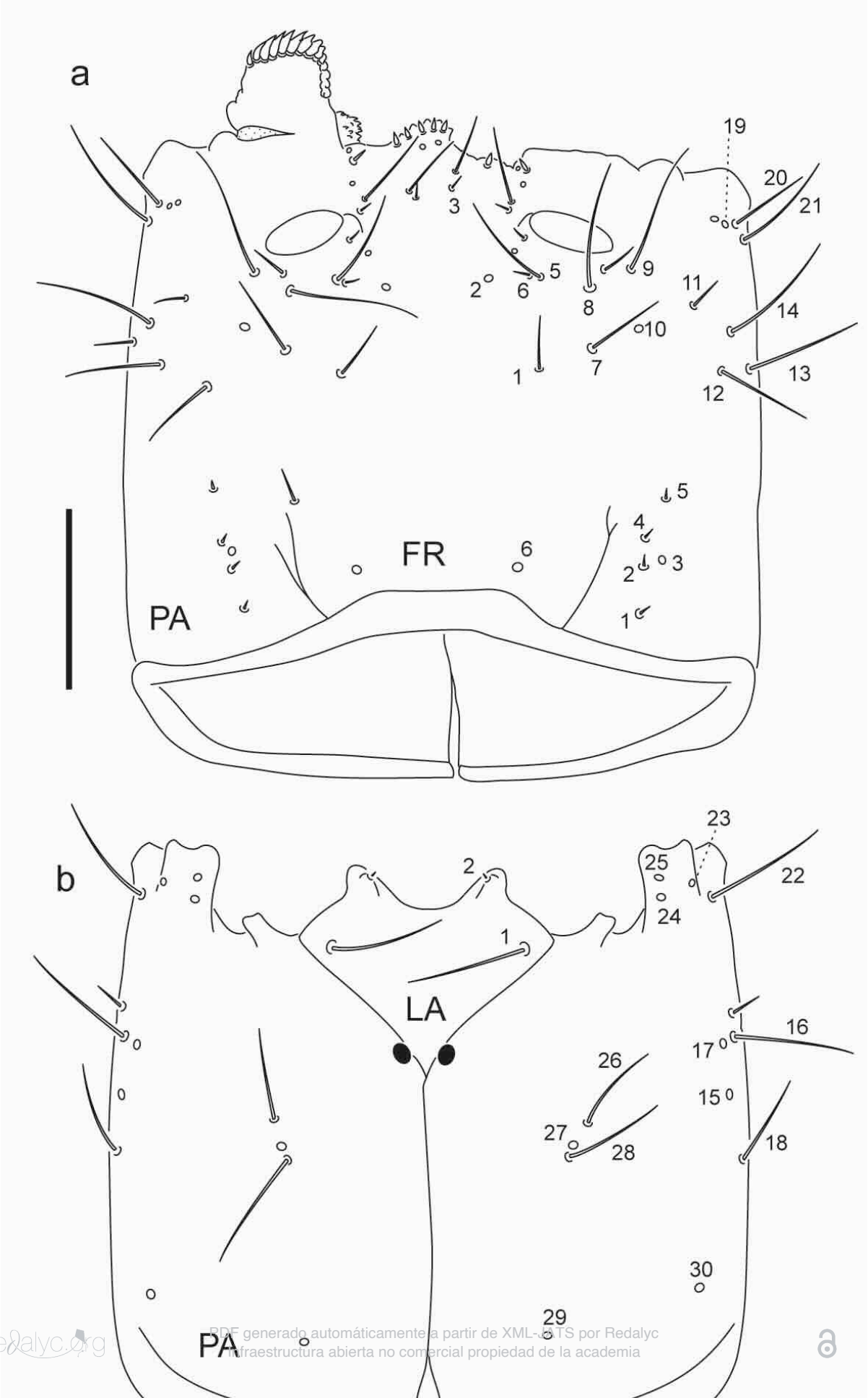


Fig. 4.

Chaetotaxy of third instar larva of *Berosus aulus*.

a. Head capsule, dorsal view. b. Head capsule, ventral view. Scale bar= 0.2 mm.

Third instar larva.*Chaetotaxy*. *Head capsule* (Figs. 4a-b, 5a). Frontale without secondary sensilla, FR1 at midlength. Parietale with three pairs of secondary sensoria dorsally, one short seta placed between PA6 and PA7 (on left side of head capsule, absent on right side in specimen illustrated), one short seta between PA8 and PA9 and one pore-like sensorium near PA19; ventrally with one short seta distal to PA16; setae PA7, PA26 and PA28 proportionally shorter. *Antenna* (Fig. 5b). Without secondary sensilla, AN11 proportionally shorter; SE1

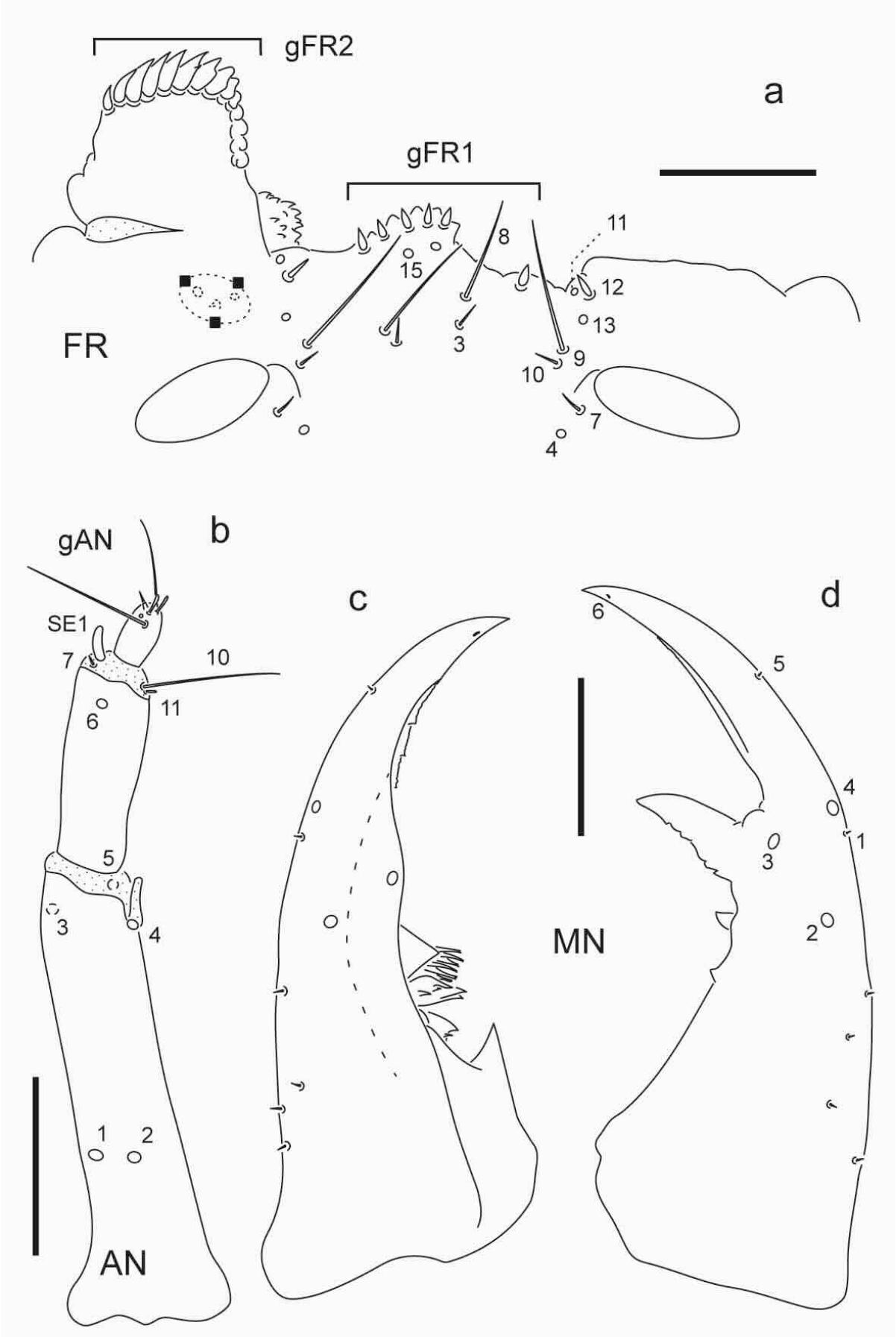
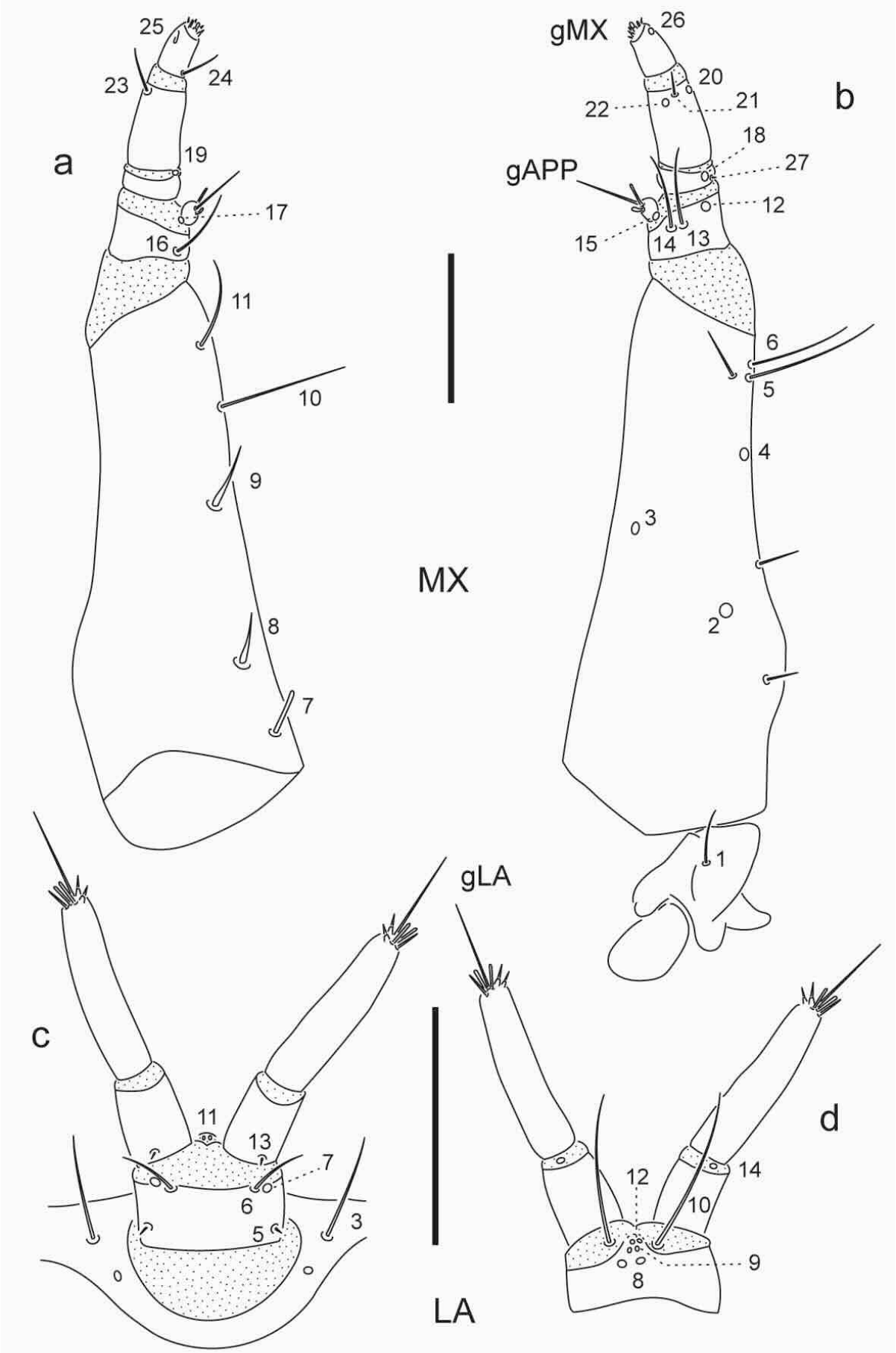


Fig. 5.

Chaetotaxy of third instar larva of *Berosus aulus*.

a. Detail of clypeolabrum, dorsal view. b. Left antenna, dorsal view. c. Left mandible, dorsal view. d. Right mandible, dorsal view. Scale bar= 0.1 mm.


a
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7
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21
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gLA
c
11
13
7
6
5
3
0
LA
d
12
14
10
9
8

Fig. 6.

Chaetotaxy of third instar larva of *Berosus aulus*.

a. Left maxilla, dorsal view. b. Left maxilla, ventral view. c. Labium, ventral view. d. Labium, dorsal view. Scale bar= 0.1 mm.

much shorter, half the length of A3. *Mandibles* (Fig. 5c-d). With four very short secondary setae along outer face between pore MN2 and base of mandible; MN1 in left mandible closer to MN4. *Maxilla* (Fig. 6a-b). Stipes with three rather short secondary setae along outer face, one close to MN5-6 and two on basal half, one anterior to MX2, the other posterior to MX2. *Labium* (Figs. 4b, 6c-d). With one secondary pore on prementum, mesal and posterior to LA3; LA3 proportionally longer; L6 proportionally shorter.

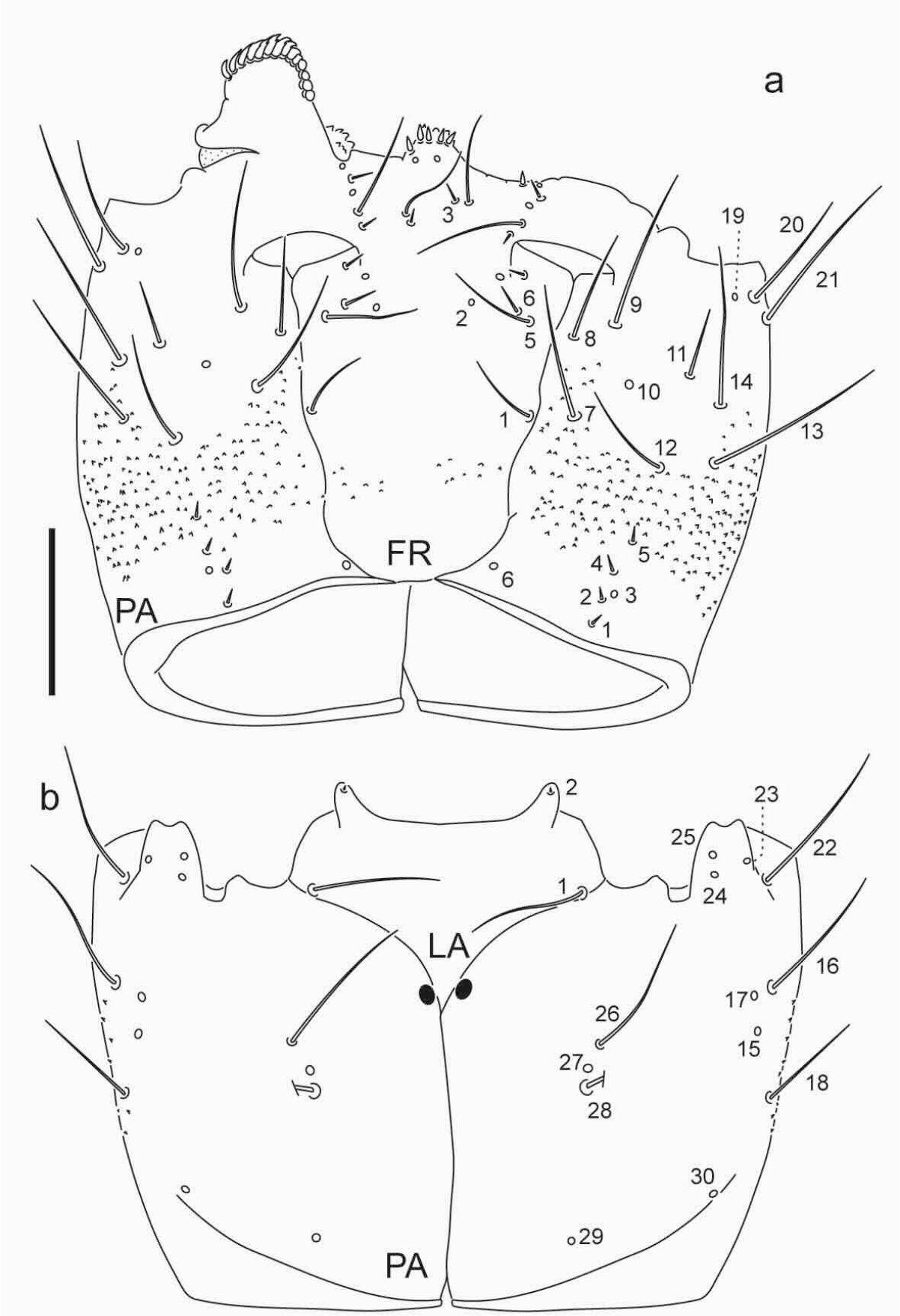

a
FR
PA
b
LA
PA

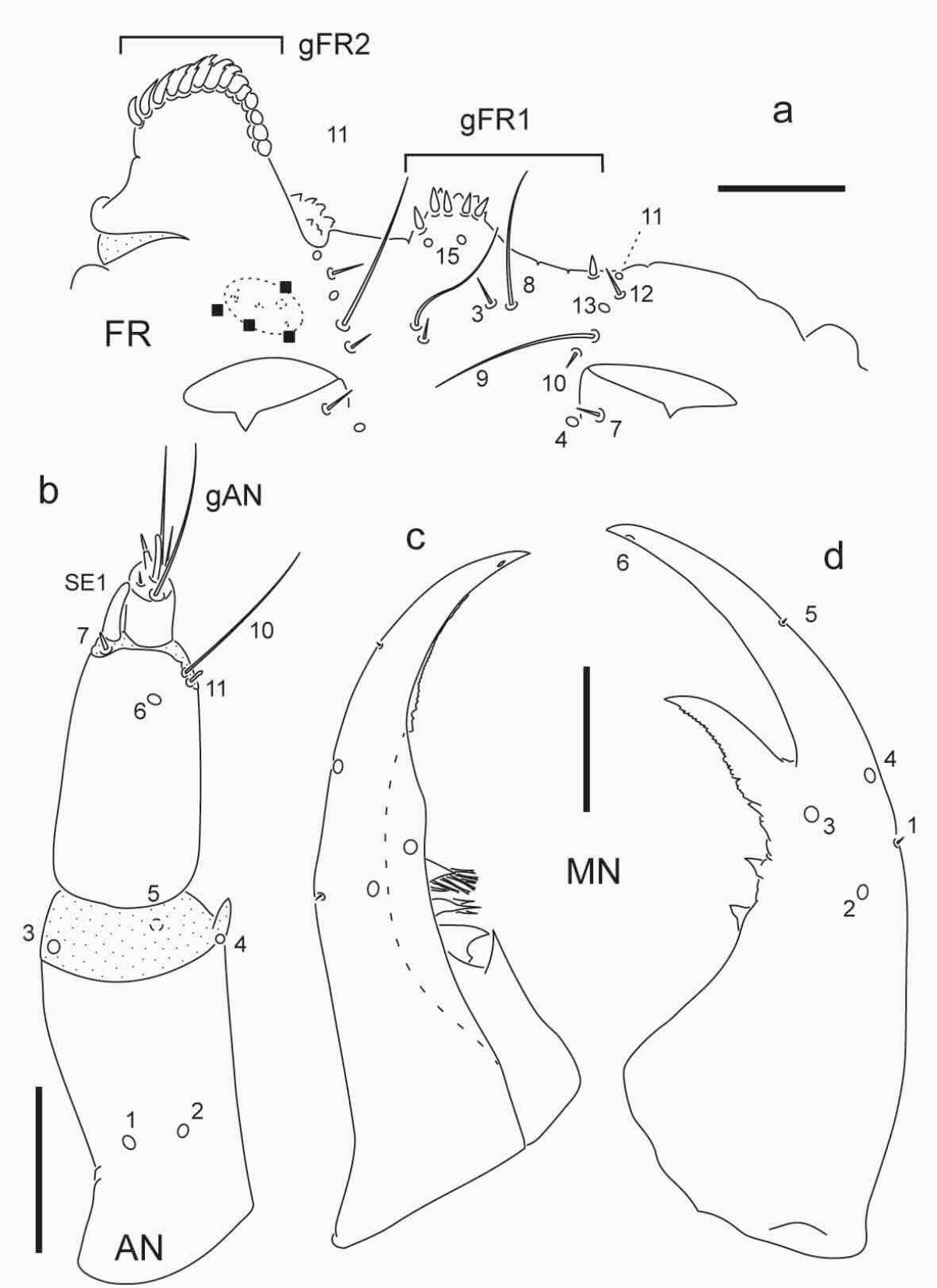
Fig. 7.

Chaetotaxy of first instar larva of *Berosus auriceps*.

a. Head capsule, dorsal view. b. Head capsule, ventral view. Scale bar= 0.1 mm.

***Berosus auriceps* Boheman (Figs. 7-12)**

First instar larva. *Chaetotaxy*. Very similar to that of *B. aulus* except for the following differences. *Head capsule* (Figs. 7a-b, 8a). Frontale with gFR2 bearing 13-14 setae; right seta of gFR1 more distant to remaining ones; seta FR8 on right side lateral to FR3; ventral face of left epistomal lobe with four minute additional sensilla, difficult to see (two pore-like and two minute setae or denticles). *Antenna* (Fig. 8b). A2 with pore AN6 subapical; SE1 slightly shorter. *Mandibles* (Fig. 8c-d). Similar to *B. aulus*. *Maxilla* (Fig. 9a-b). Setae MX5-6, MX13-14 and MX23 slightly longer; long seta of gAPP much longer.


gFR2
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FR
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Fig. 8

Chaetotaxy of first instar larva of *Berosus auriceps*.

a. Detail of clypeolabrum, dorsal view. b. Left antenna, dorsal view. c. Left mandible, dorsal view. d. Right mandible, dorsal view. Scale bar= 0.05 mm.

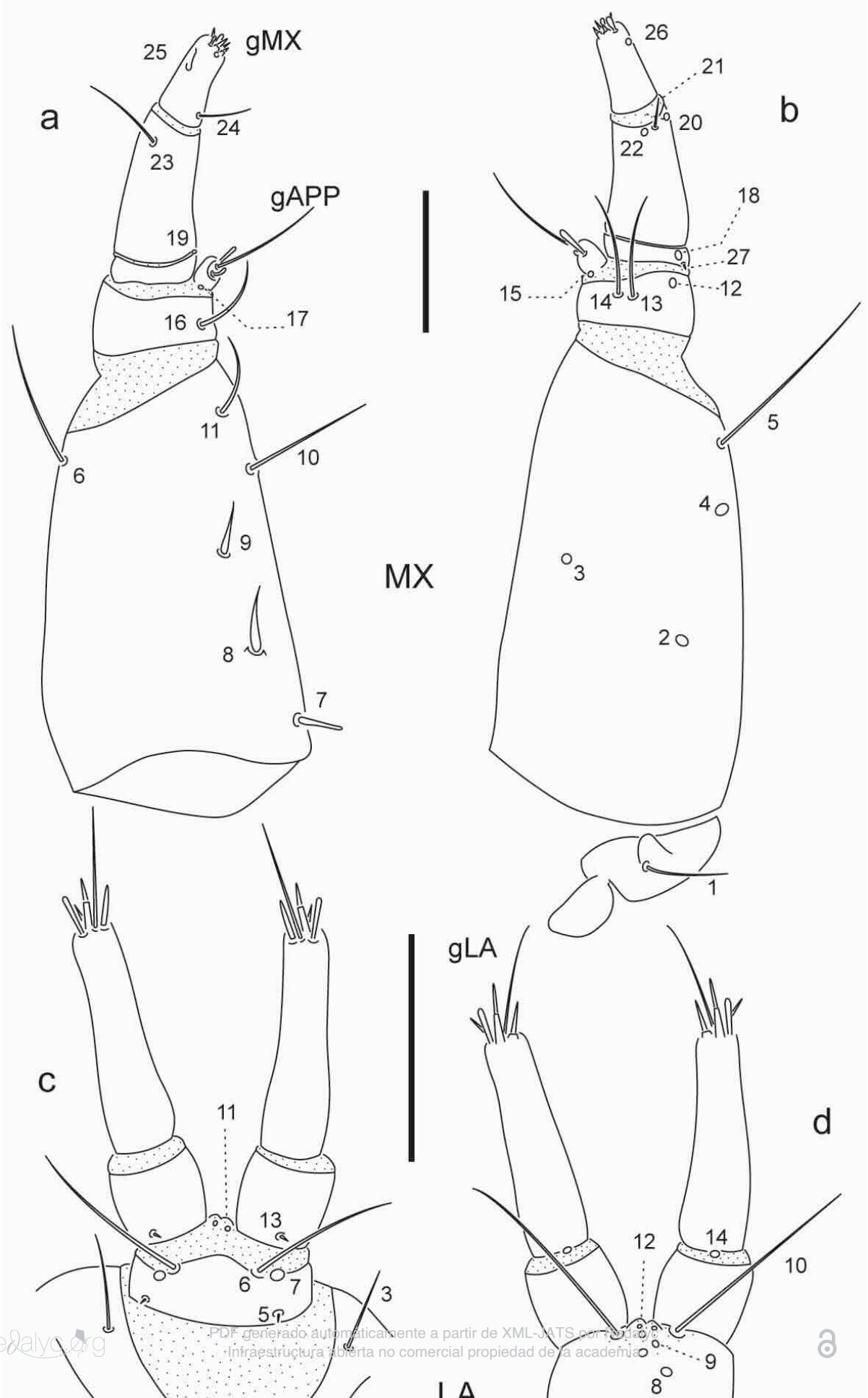


Fig. 9.

Chaetotaxy of first instar larva of *Berosus auriceps*.

a. Left maxilla, dorsal view. b. Left maxilla, ventral view. c. Labium, ventral view. d. Labium, dorsal view. Scale bar= 0.05 mm.

Labium (Fig. 9c-d). Similar to *B. aulus*, borderline between premental sclerite and base of ligula difficult to define.

Third instar larva. *Chaetotaxy. Head capsule* (Figs. 10a-b,11a). Frontale without secondary sensilla; FR1 more distal than in first instar, seta FR8 proportionally shorter; pores FR15 closer to each other. Parietale with seven secondary sensilla, one short seta between PA6 and PA7, one short seta between PA8 and PA9, one pore mesal to PA19, one short seta lateral to PA13 and other short seta lateral to PA14, two short setae one anterior to PA16 and PA17, the other posterior; setae PA11 and PA20 proportionally shorter. *Antenna* (Fig. 11b). Without secondary sensilla; SE1 much shorter. *Mandibles* (Fig. 11c-d). With three minute secondary setae along outer margin between base of mandible and pore MN2. *Maxilla* (Fig. 12a-b). Stipes with three rather short secondary setae along outer face, one close to MN5-6 and two on basal half, one anterior to MX2, the other posterior to MX2; seta MX23 proportionally shorter; long seta of gAPP proportionally shorter. *Labium* (Figs. 10b, 12c-d). With one secondary pore on prementum, mesal and posterior to LA3; seta LA3 proportionally longer; seta LA6 proportionally shorter.

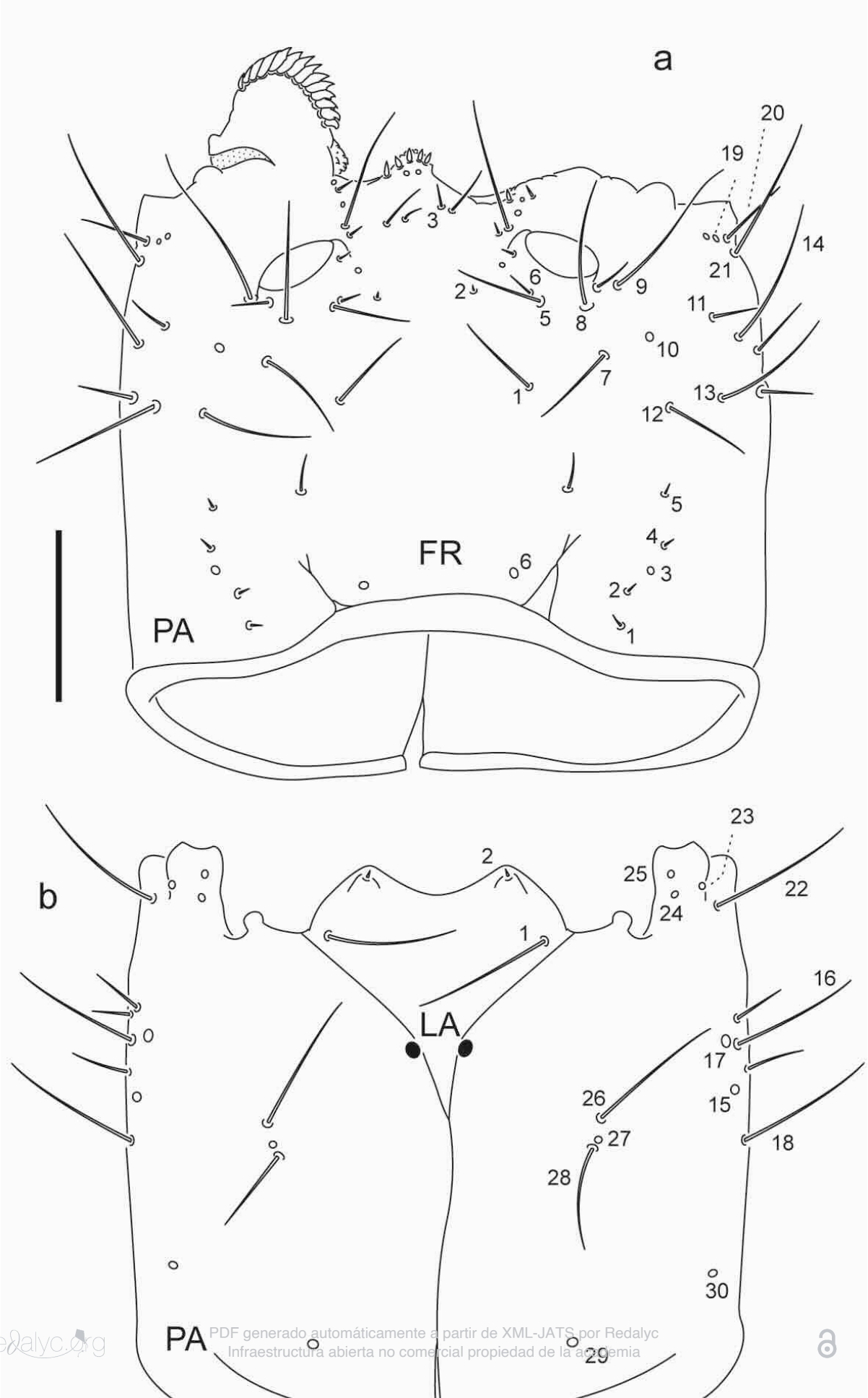


Fig. 10.

Chaetotaxy of third instar larva of *Berosus auriceps*

a. Head capsule, dorsal view. b. Head capsule, ventral view. Scale bar= 0.2 mm.

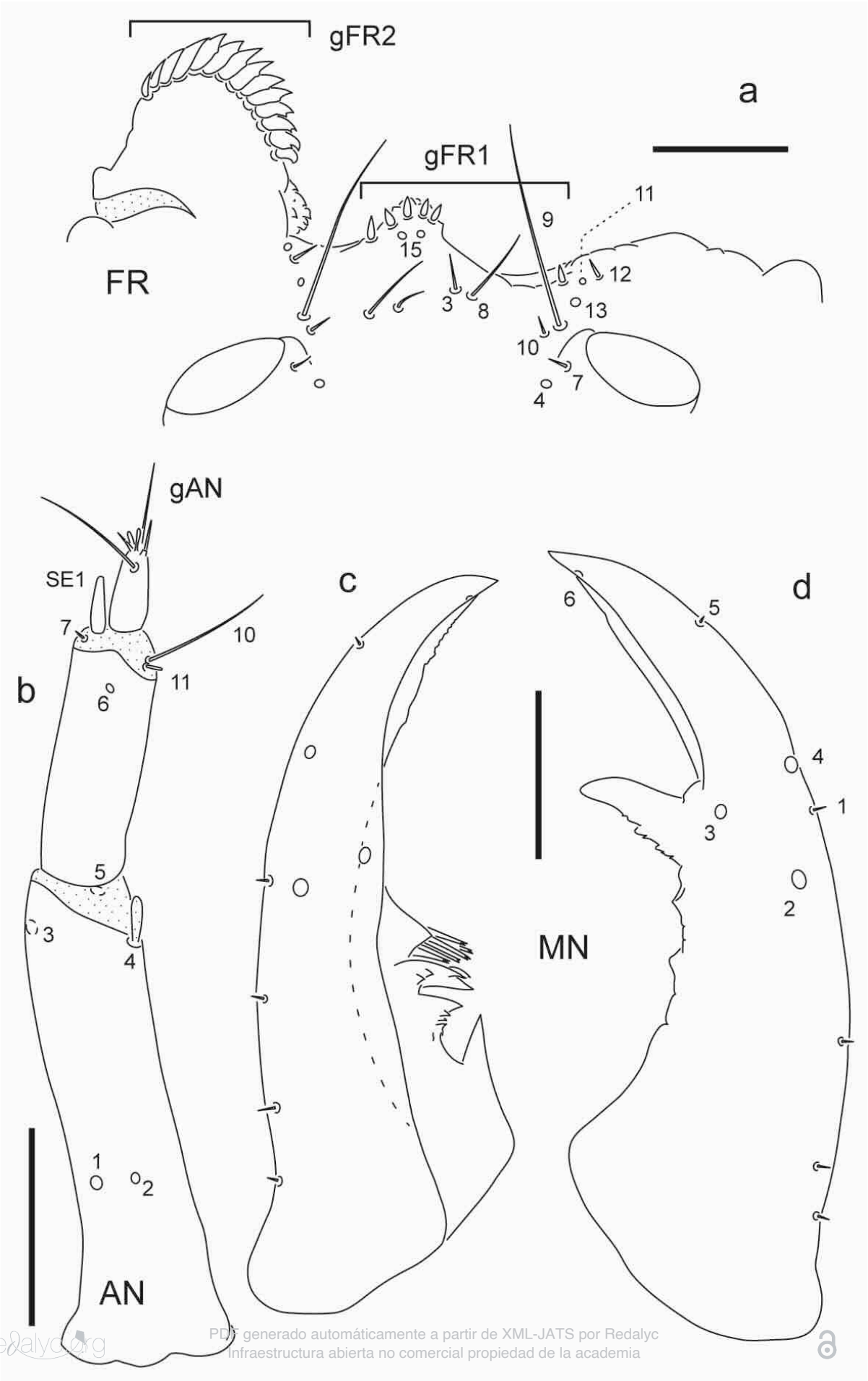


Fig. 11.

Chaetotaxy of third instar larva of *Berosus auriceps*.

a. Detail of clypeolabrum, dorsal view. b. Left antenna, dorsal view. c. Left mandible, dorsal view. d. Right mandible, dorsal view. Scale bar= 0.1 mm.

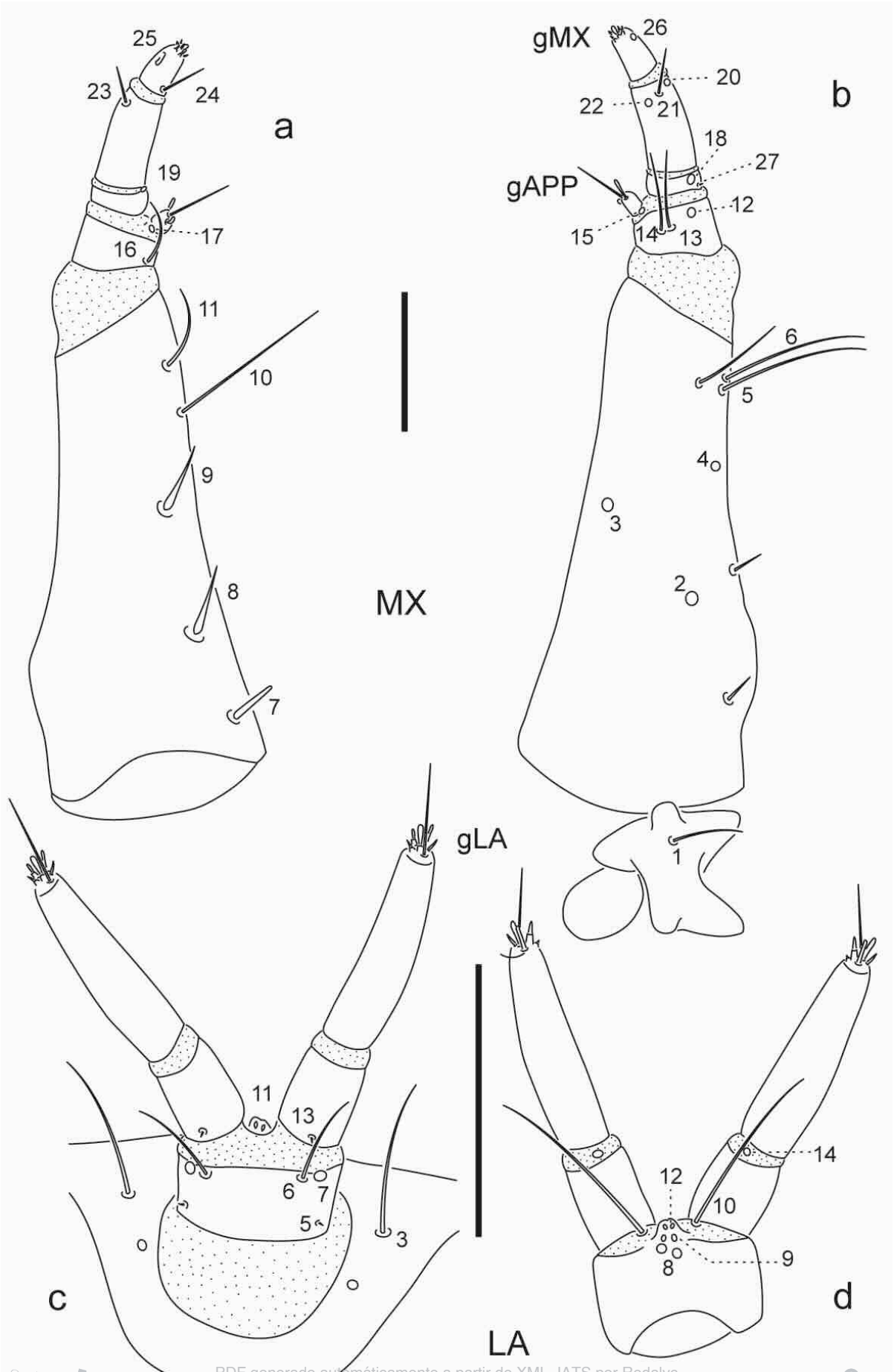


Fig. 12.

Chaetotaxy of third instar larva of *Berosus auriceps*.

a. Left maxilla, dorsal view. b. Left maxilla, ventral view. c. Labium, ventral view. d. Labium, dorsal view. Scale bar= 0.1 mm.

***Berosus chalcocephalus* Germain (Figs. 13-18)**

First instar larva. *Chaetotaxy*. Very similar to that of *B. aulus* except for the following differences. *Head capsule* (Figs. 13a-b, 14a). Frontale with gFR2 bearing 13 setae; ventral face of left epistomal lobe with three minute additional sensilla, difficult to see (two pore-like and one minute seta); seta FR8 on right side lateral to FR3; FR8-9 and PA8-9 shorter; pores PA15 and PA17 closer to each other. *Antenna* (Fig. 14b). A2 with pore AN6 subapical; SE1 slightly shorter. *Mandibles* (Fig. 14c-d). Similar to *B. aulus*. *Maxilla* (Fig. 15a-b). Seta MX24 slightly shorter. *Labium* (Figs. 13b,15c-d). Pores LA8 less closely aggregated (distance between pores larger than width of pore); seta LA10 longer.

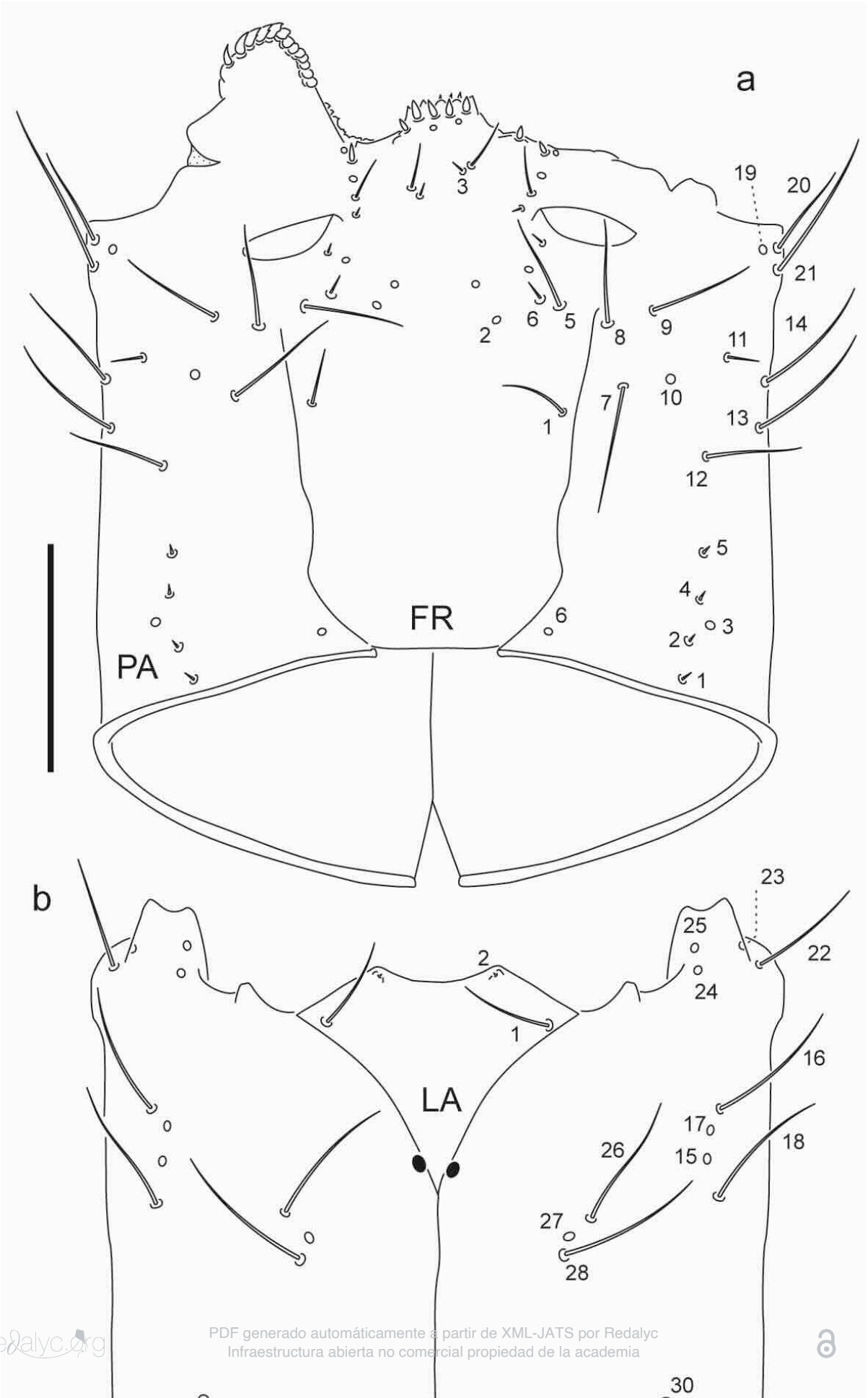


Fig. 13.

Chaetotaxy of first instar larva of *Berosus chalcocephalus*

a. Head capsule, dorsal view. b. Head capsule, ventral view. Scale bar= 0.1 mm.

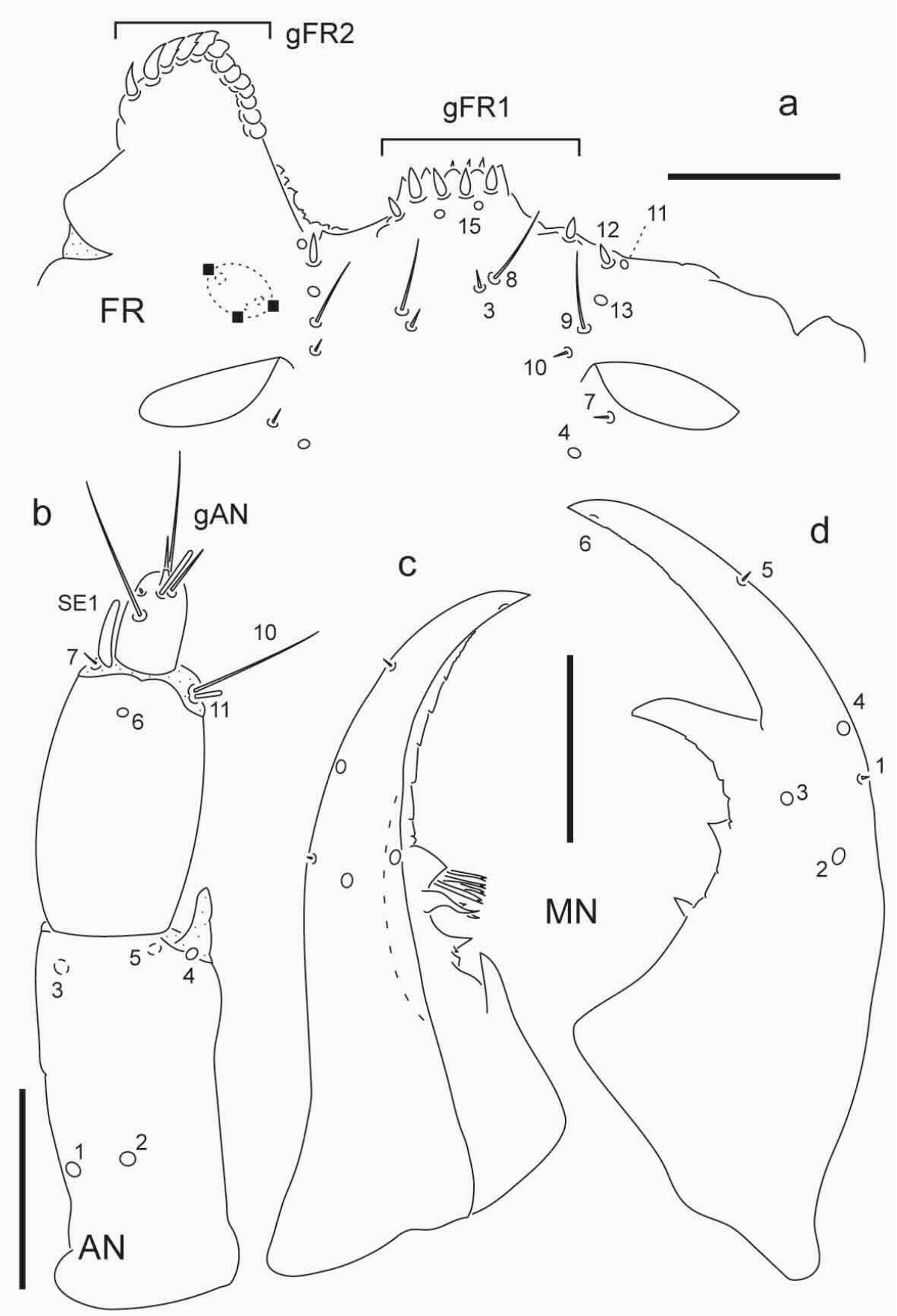


Fig. 14.

Chaetotaxy of first instar larva of *Berosus chalcocephalus*.

a. Detail of clypeolabrum, dorsal view. b. Left antenna, dorsal view. c. Left mandible, dorsal view. d. Right mandible, dorsal view. Scale bar= 0.05 mm.

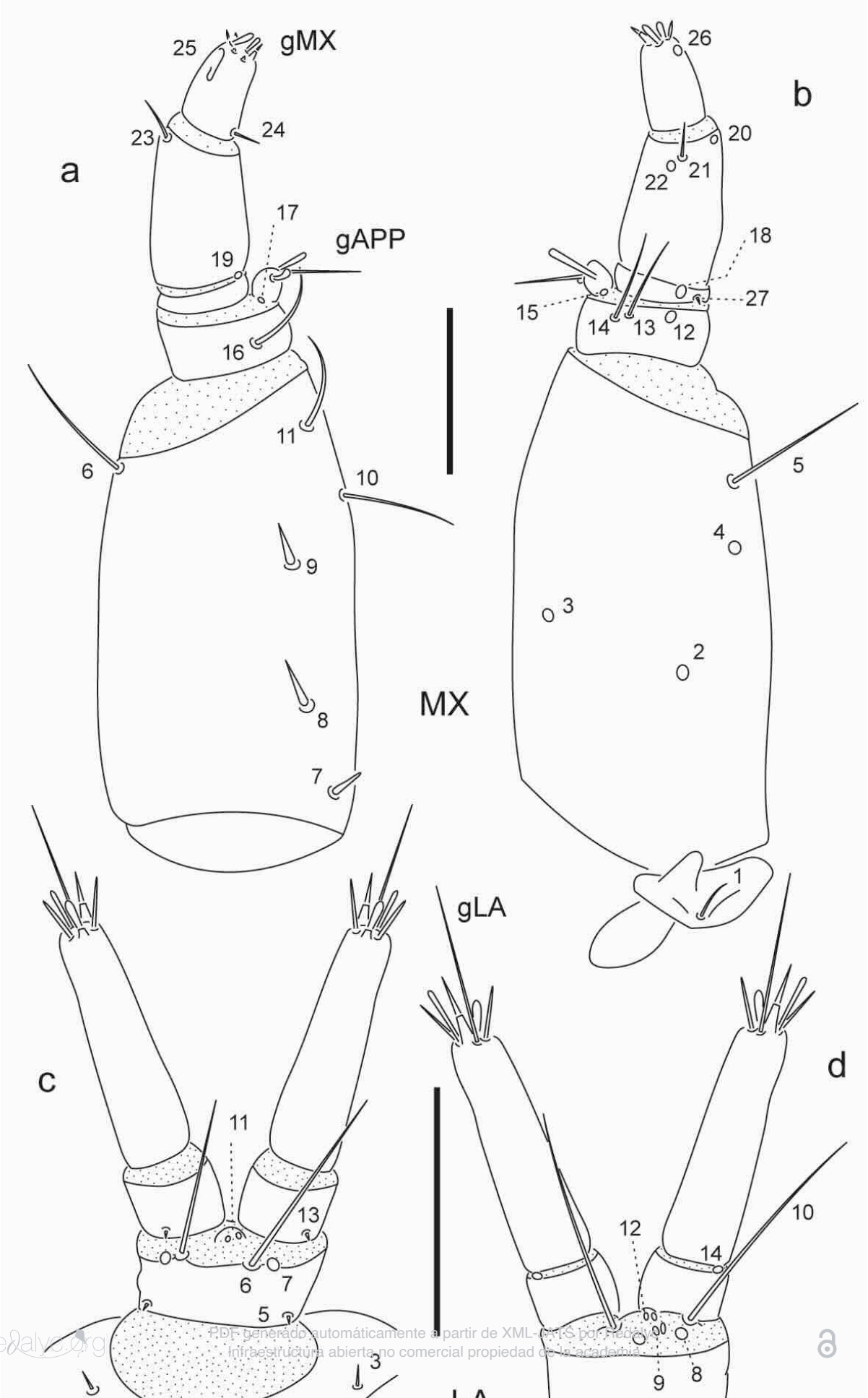


Fig. 15.

Chaetotaxy of first instar larva of *Berosus chalcocephalus*.

a. Left maxilla, dorsal view. b. Left maxilla, ventral view. c. Labium, ventral view. d. Labium, dorsal view. Scale bar= 0.05 mm.

Third instar larva. *Chaetotaxy. Head capsule* (Figs. 16a-b, 17a). Frontale without secondary sensilla; FR1 more distal than in first instar, seta FR6 proportionally longer; seta FR8 on right side anterior to FR3. Parietale with five secondary sensilla, one short seta between PA6 and PA7, one short seta between PA8 and PA9, one pore mesal to PA19, two rather short setae between PA13 and PA14; setae PA8-9 proportionally longer. *Antenna* (Fig. 17b). Without secondary sensilla; SE1 slightly shorter. *Mandible* (Fig. 17c-d). With three or four minute secondary setae along outer margin between base of mandible and pore MN2, seta MN1 of right mandible closer to pore MN4. *Maxilla* (Fig. 18a-b). Stipes with three secondary setae along outer margin, one long, close to MX5-6, remaining two on basal half; MX23 slightly longer. *Labium* (Figs. 16b,18c-d). With one secondary pore on prementum, mesal and posterior to LA3; seta LA3 much longer; seta LA6 proportionally shorter; pores LA8 closer to each other.

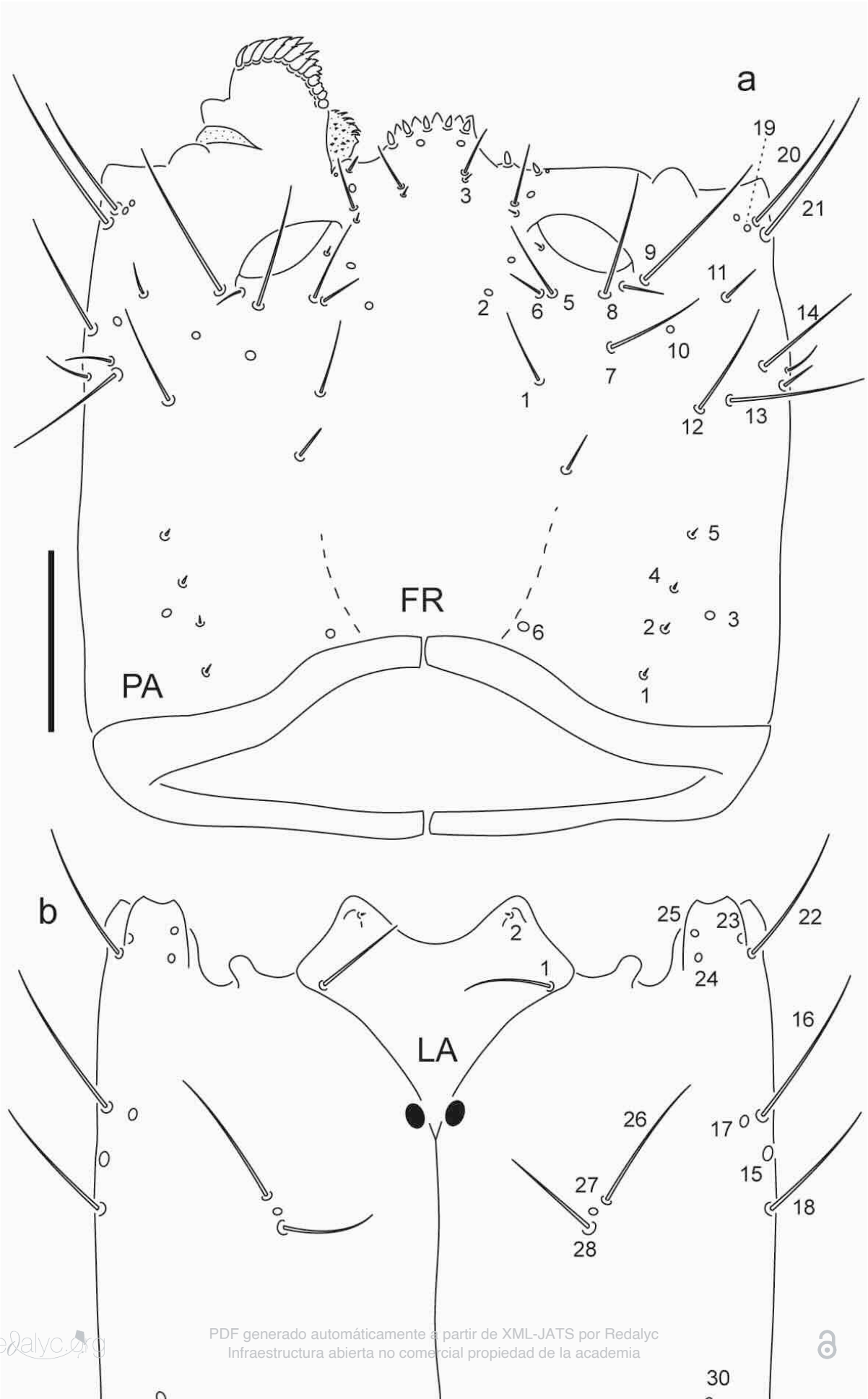


Fig. 16.

Chaetotaxy of third instar larva of *Berosus chalcocephalus*.

a. Head capsule, dorsal view. b. Head capsule, ventral view. Scale bar= 0.2 mm.

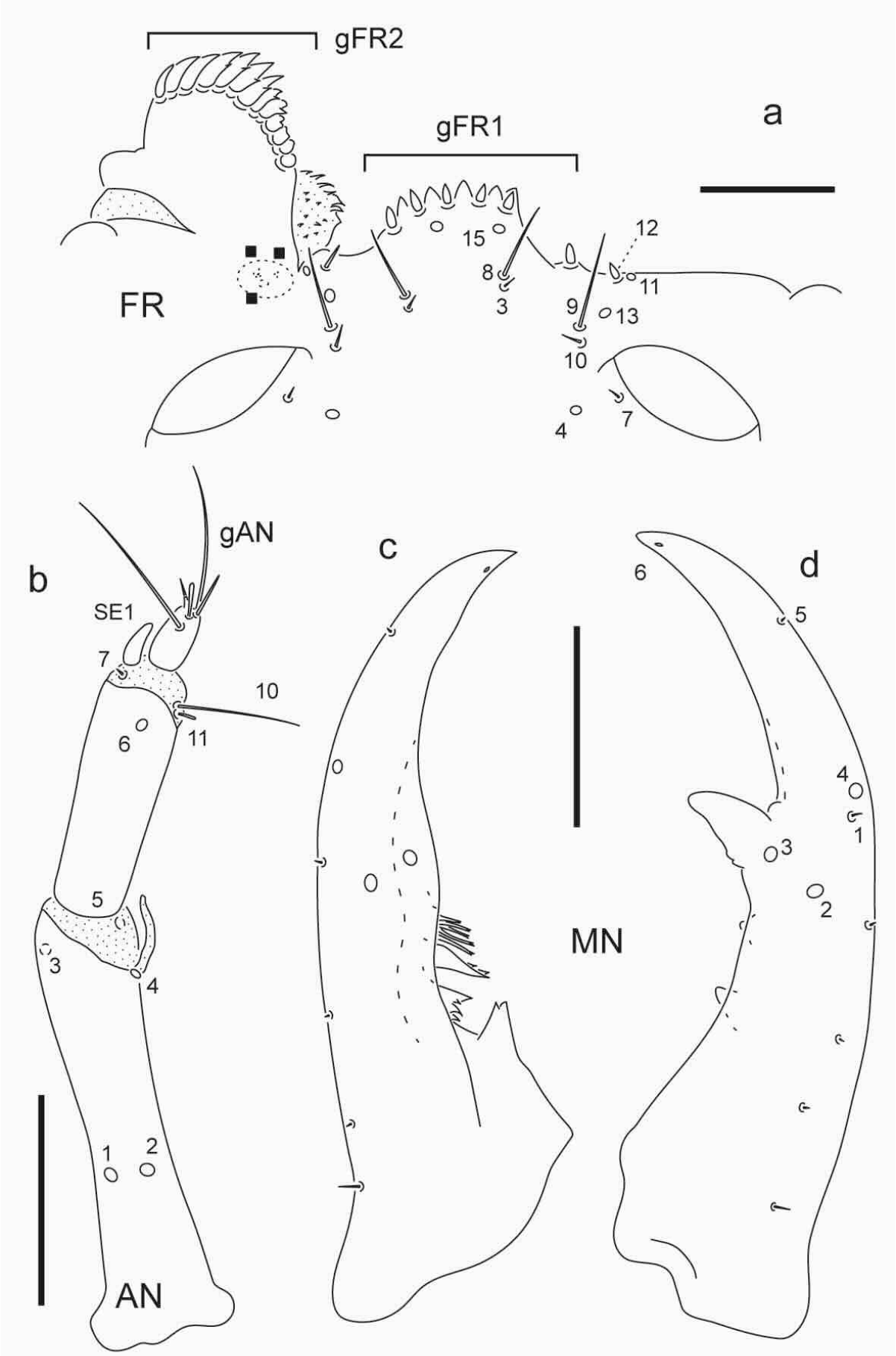


Fig. 17.

Chaetotaxy of third instar larva of *Berosus chalcocephalus*

a. Detail of clypeolabrum, dorsal view. b. Left antenna, dorsal view. c. Left mandible, dorsal view. d. Right mandible, dorsal view. Scale bar= 0.1 mm.

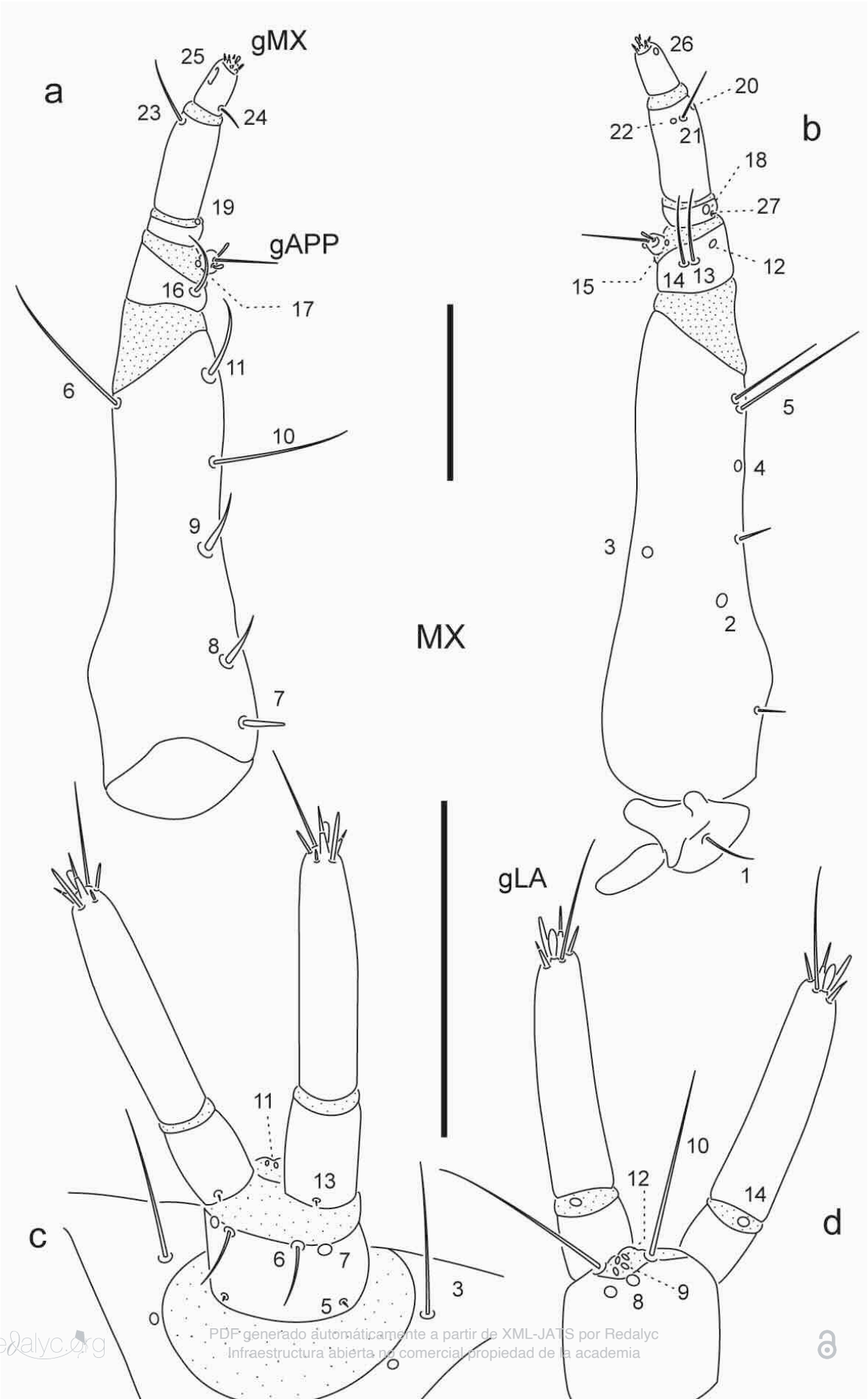


Fig. 18.

Chaetotaxy of third instar larva of *Berosus chalcocephalus.*

a. Left maxilla, dorsal view. b. Left maxilla, ventral view. c. Labium, ventral view. d. Labium, dorsal view. Scale bar= 0.1 mm.

***Berosus coptogonus* Jensen-Haarup (Figs. 19-24)**

First instar larva. *Chaetotaxy*. Very similar to that of *B. aulus* except for the following differences. *Head capsule* (Figs. 19a-b,20a). Frontale with gFR2 bearing 12-13 setae; FR1 longer than in *B. aulus;* ventral face of left epistomal lobe with three minute additional sensilla, difficult to see (two pore-like and one minute seta or denticle); parietale with pore PA3 outwardly displaced; most setae on parietale slightly longer. *Antenna* (Fig. 20b). A2 with pore AN6 subapical; AN10 shorter; SE1 much shorter, half the length of A3. *Mandibles* (Fig. 20c-d). Similar to *B. aulus*, seta MN1 slightly closer to MN4 on right mandible. *Maxilla* (Fig. 21a-b). Seta MX1 slightly shorter. *Labium* (Figs. 19b, 21c-d). Pores LA8 less closely aggregated (distance between pores distinctly greater than width of pores).

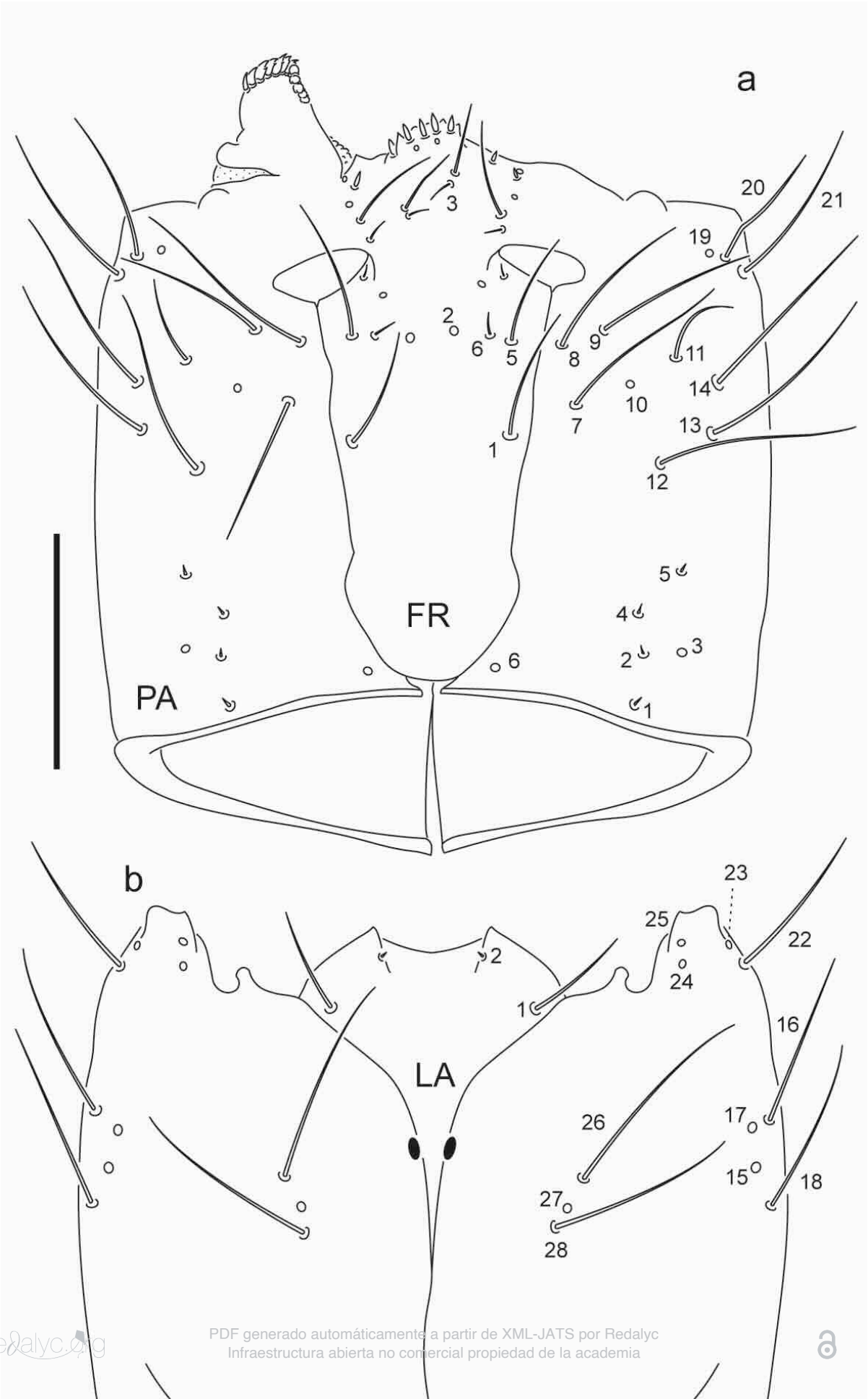


Fig. 19.

Chaetotaxy of first instar larva of *Berosus coptogonus*.

a. Head capsule, dorsal view. b. Head capsule, ventral view. Scale bar= 0.1 mm.

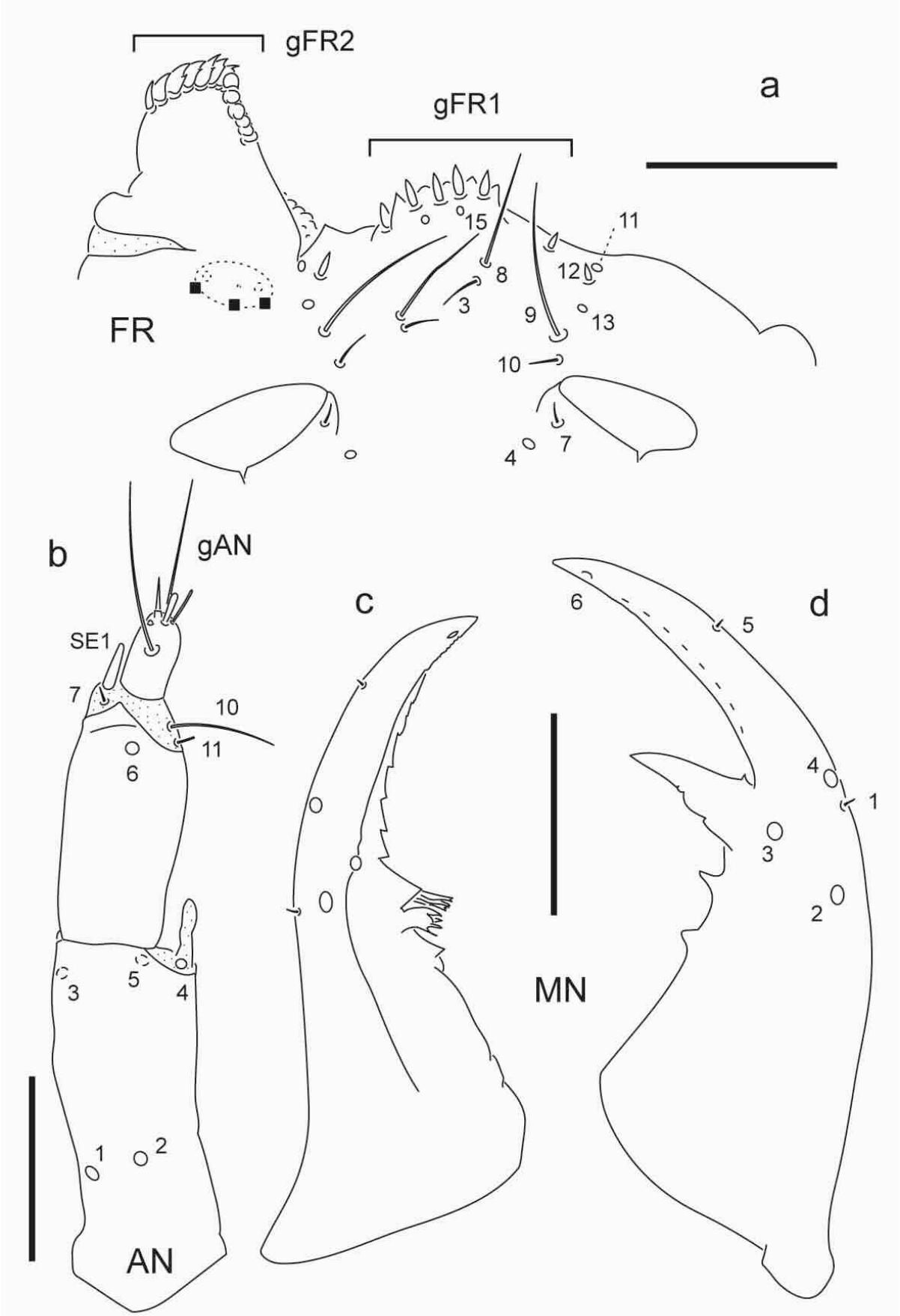

gFR2
gFR1
a
FR
15
11
8
12
3
9
13
10
4
7
b
gAN
SE1
7
10
11
6
3
5
4
1
2
AN
c
MN
6
5
d
4
1
3
2

Fig. 20.

Chaetotaxy of first instar larva of *Berosus coptogonus*.

a. Detail of clypeolabrum, dorsal view. b. Left antenna, dorsal view. c. Left mandible, dorsal view. d. Right mandible, dorsal view. Scale bar= 0.05 mm.

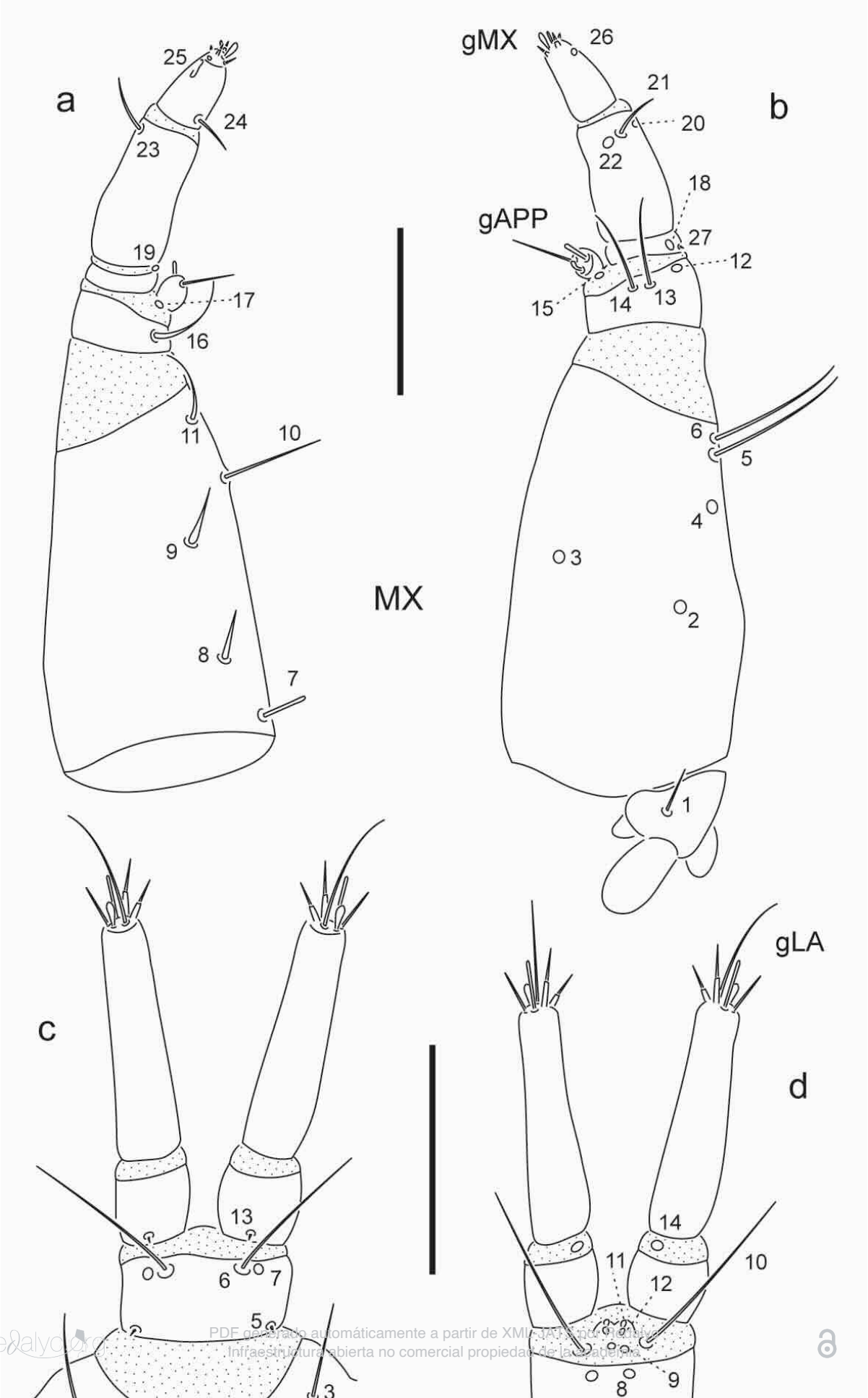


Fig. 21.

Chaetotaxy of first instar larva of *Berosus coptogonus*

a. Left maxilla, dorsal view. b. Left maxilla, ventral view. c. Labium, ventral view. d. Labium, dorsal view. Scale bar= 0.05 mm.

Third instar larva. *Chaetotaxy. Head capsule* (Figs. 22a-b, 23a). Frontale without secondary sensilla; FR1 more distal than in first instar, seta FR3 proportionally longer. Parietale with six secondary sensilla, one short seta between PA6 and PA7, one short seta between PA8 and PA9, one pore mesal to PA19, two short setae lateral to PA13 and PA14, one short seta distal to PA16 and PA17; most setae proportionally shorter. *Antenna* (Fig. 23b). Without secondary sensilla; pores AN1-2 closer to each other; SE1 slightly shorter. *Mandibles* (Fig. 23c-d). With three or four minute secondary setae along outer margin between base of mandible and pore MN2; seta MN1 more distal in left mandible; seta MN5 closer to apex than in first instar. *Maxilla* (Fig. 24a-b). Stipes with three secondary setae along outer margin, one long, close to MX5-6, remaining two on basal half. *Labium* (Figs. 22b, 24c-d). With one secondary pore on prementum, mesal and posterior to LA3; seta LA3 and LA10 proportionally longer; pores LA8 closer to each other.

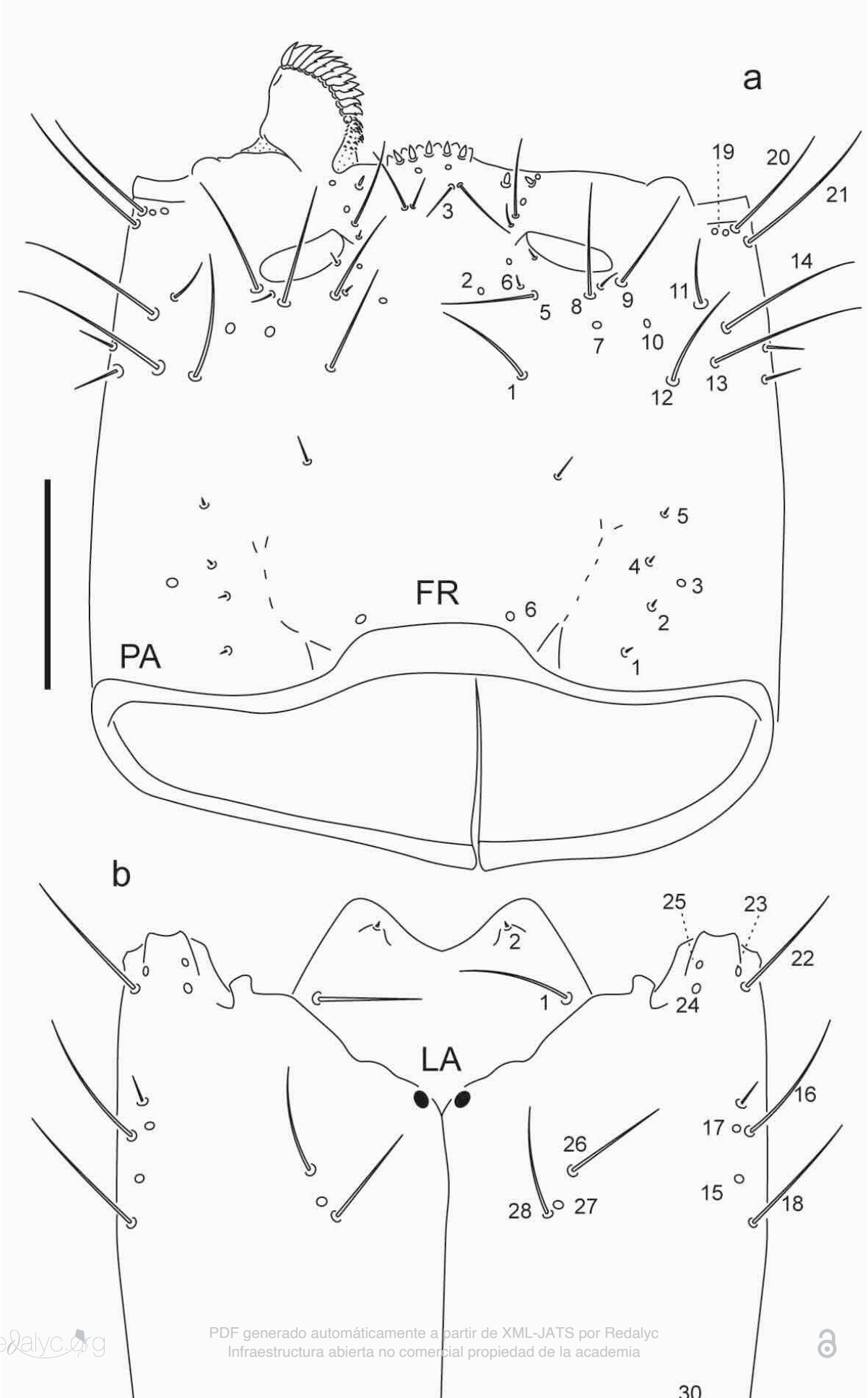


Fig. 22.

Chaetotaxy of third instar larva of *Berosus coptogonus*.

a. Head capsule, dorsal view. b. Head capsule, ventral view. Scale bar= 0.2 mm.

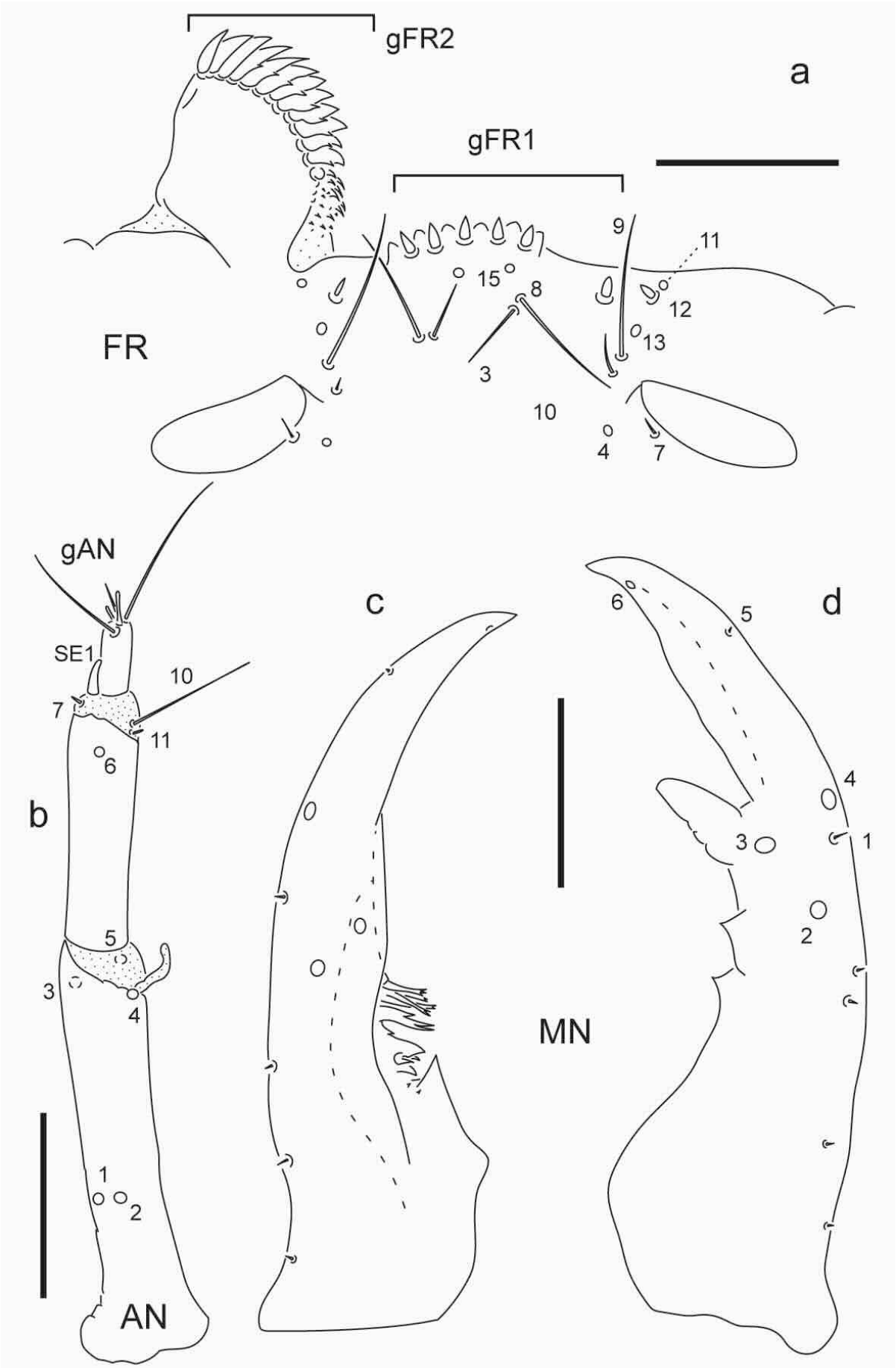


Fig. 23.

Chaetotaxy of third instar larva of *Berosus coptogonus*.

a. Detail of clypeolabrum, dorsal view. b. Left antenna, dorsal view. c. Left mandible, dorsal view. d. Right mandible, dorsal view. Scale bar= 0.1 mm

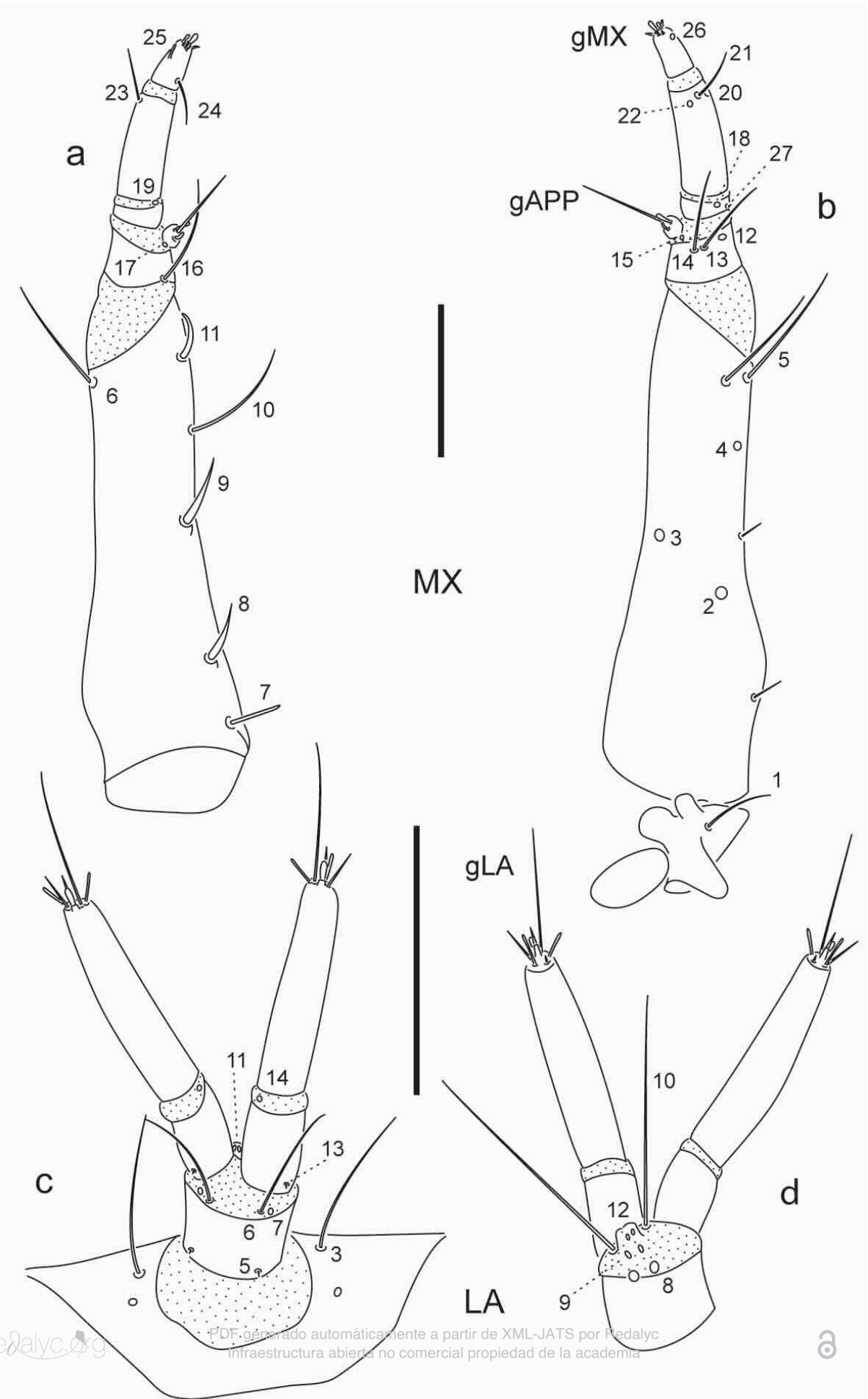


Fig. 24.

Chaetotaxy of third instar larva of *Berosus coptogonus*.

a. Left maxilla, dorsal view. b. Left maxilla, ventral view. c. Labium, ventral view. d. Labium, dorsal view. Scale bar= 0.1 mm.

***Berosus cornicinus* Knisch (Figs. 25-30)**

First instar larva. *Chaetotaxy*. Very similar to that of *B. aulus* except for the following differences. *Head capsule* (Figs. 25a-b, 26a). Frontale with gFR2 bearing 12-13 setae; ventral face of left epistomal lobe with three minute additional sensilla, difficult to see (two pore-like and one minute seta or denticle); FR5 proportionally longer. *Antenna* (Fig. 26b). AN1 and AN2 more basal; A2 with pore AN6 subapical; SE1 slightly shorter. *Mandibles* (Fig. 26c-d). MN1 slightly closer to MN2 on both mandibles. *Maxilla* (Fig. 27a-b). Seta MX10 slightly shorter, MX16 much longer. *Labium* (Figs. 25b,27c-d). Seta LA10 shorter.

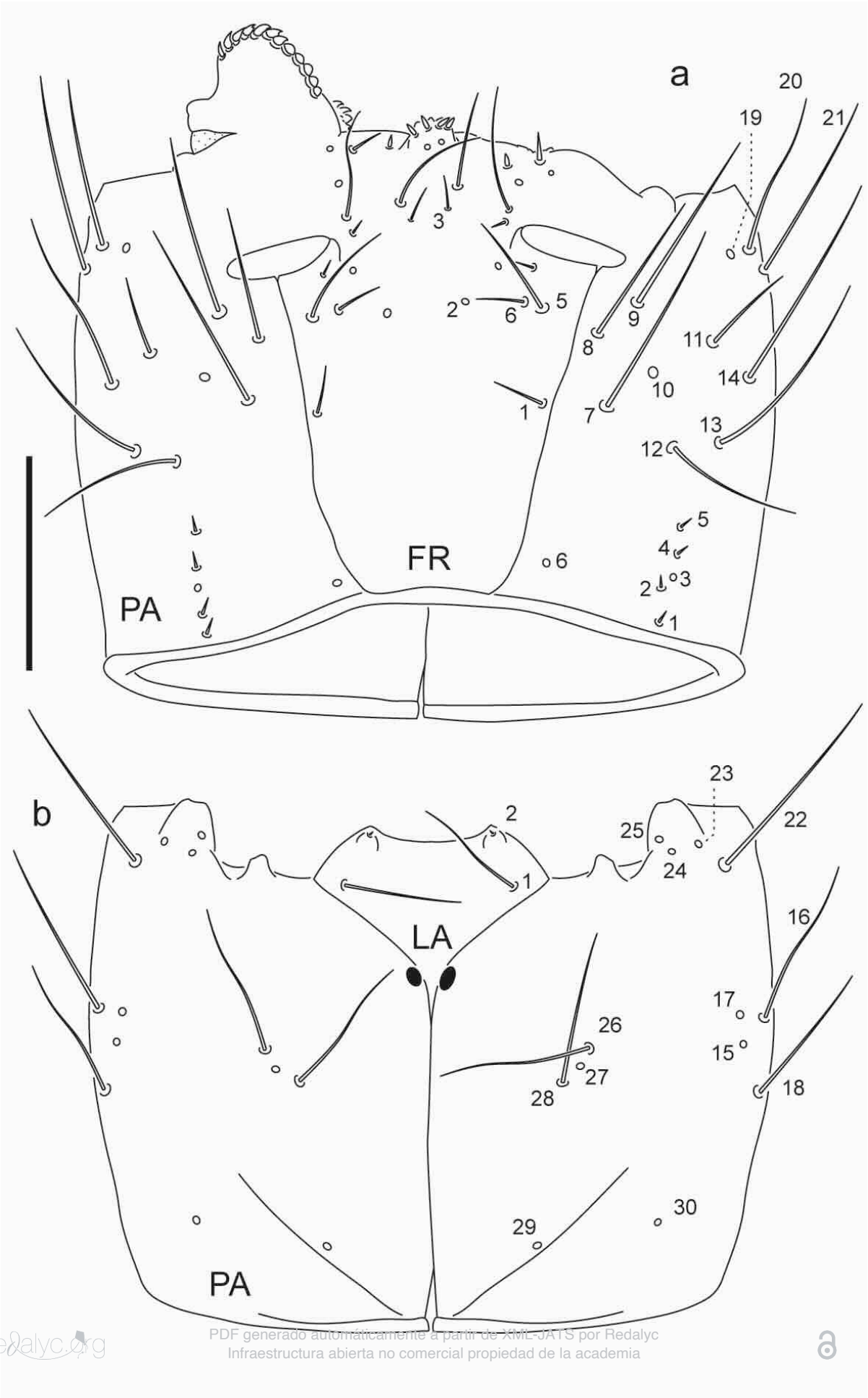


Fig. 25.

Chaetotaxy of first instar larva of *Berosus cornicinus*.

Head capsule, dorsal view. b. Head capsule, ventral view. Scale bar= 0.1 mm.

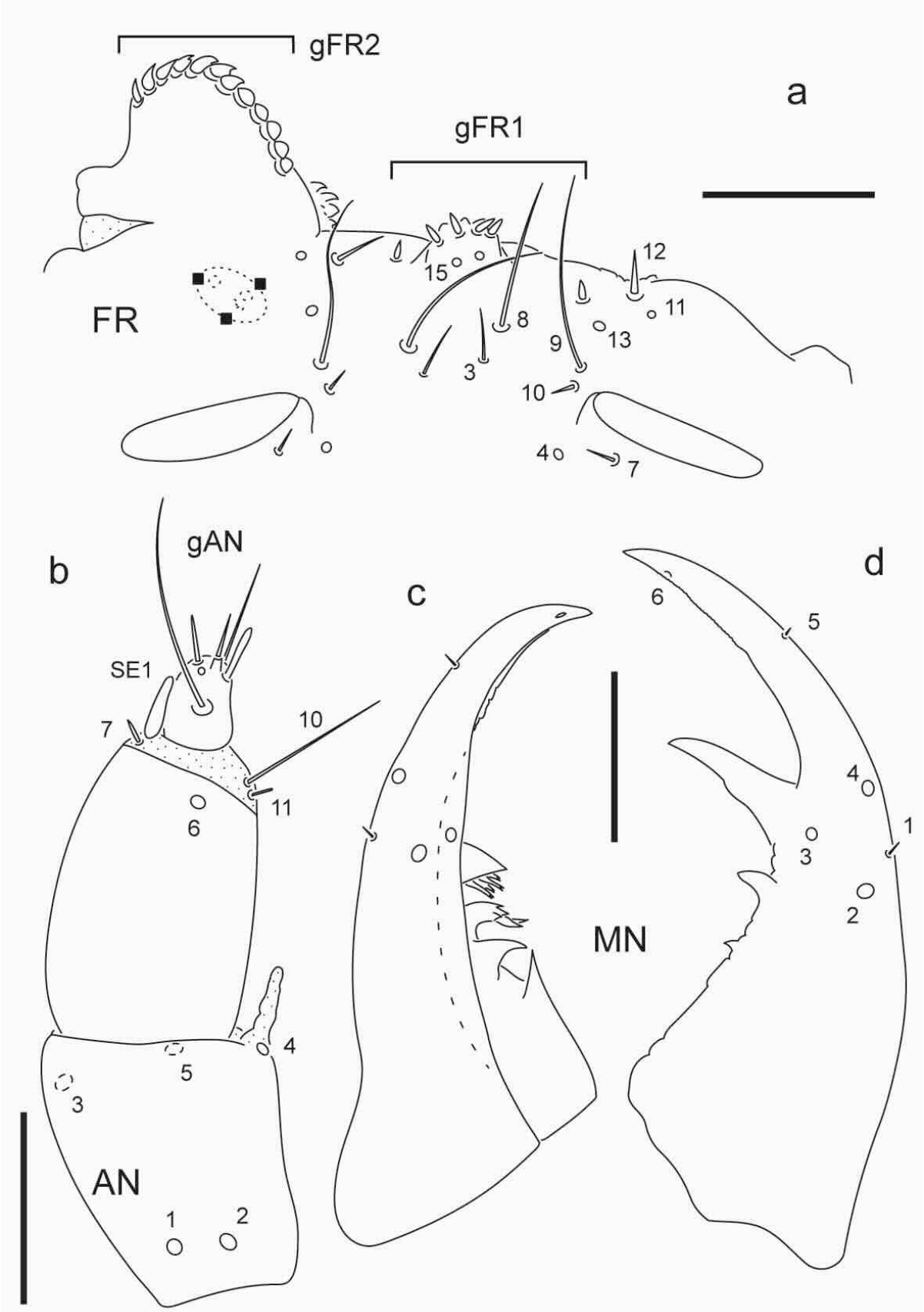

a
gFR2
gFR1
FR
15
12
11
8
9
13
3
10
4
7
b
gAN
SE1
7
10
11
6
4
5
3
AN
1
2
c
MN
d
6
5
4
1
3
2

Fig. 26.

Chaetotaxy of first instar larva of *Berosus cornicinus*.

a. Detail of clypeolabrum, dorsal view. b. Left antenna, dorsal view. c. Left mandible, dorsal view. d. Right mandible, dorsal view. Scale bar= 0.05 mm.

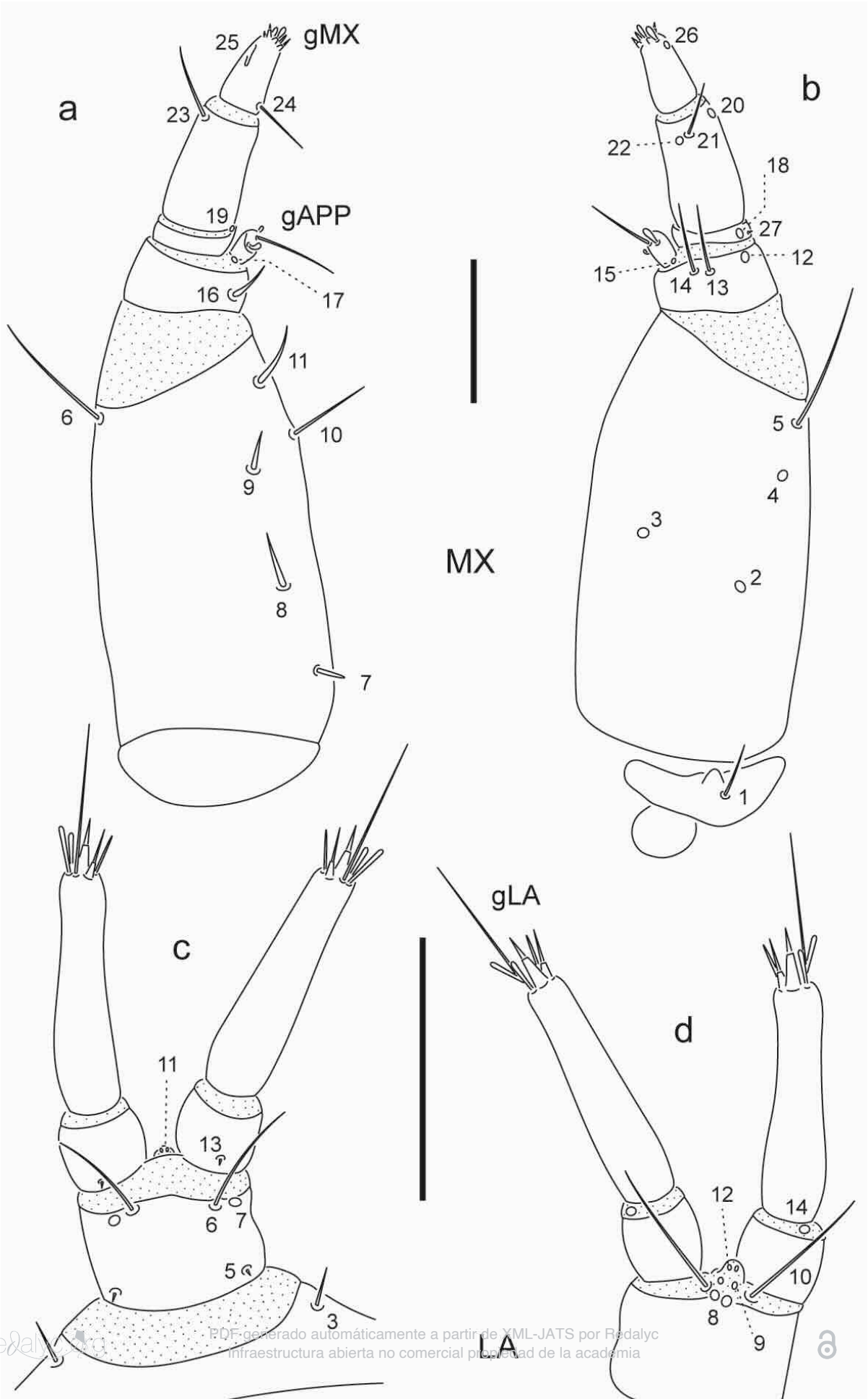


Fig. 27.

Chaetotaxy of first instar larva of *Berosus cornicinus*.

a. Left maxilla, dorsal view. b. Left maxilla, ventral view. c. Labium, ventral view. d. Labium, dorsal view. Scale bar= 0.05 mm.

Third instar larva. *Chaetotaxy. Head capsule* (Figs. 28a-b, 29a). Frontale without secondary sensilla; FR1 more distal than in first instar. Parietale with eight secondary sensilla, two short setae between PA6 and PA7, one short seta between PA8 and PA9, one pore mesal to PA19, one short seta near PA14, two short setae near PA13, one short seta distal to PA16 and PA17. *Antenna* (Fig. 29b). Without secondary sensilla; pores AN1 and AN2 more distal; SE1 slightly shorter. *Mandibles*(Fig. 29c-d). With three minute secondary setae along outer margin between base of mandible and pore MN2; seta MN1 closer to MN4 on both mandibles. *Maxilla* (Fig. 30a-b). Stipes with three secondary rather long setae along outer margin, one close to MX5-6, remaining two on basal half; MX8-11 and MX16 distinctly longer. *Labium* (Figs. 28b,30c-d). Seta LA3 longer; seta LA6 proportionally shorter.

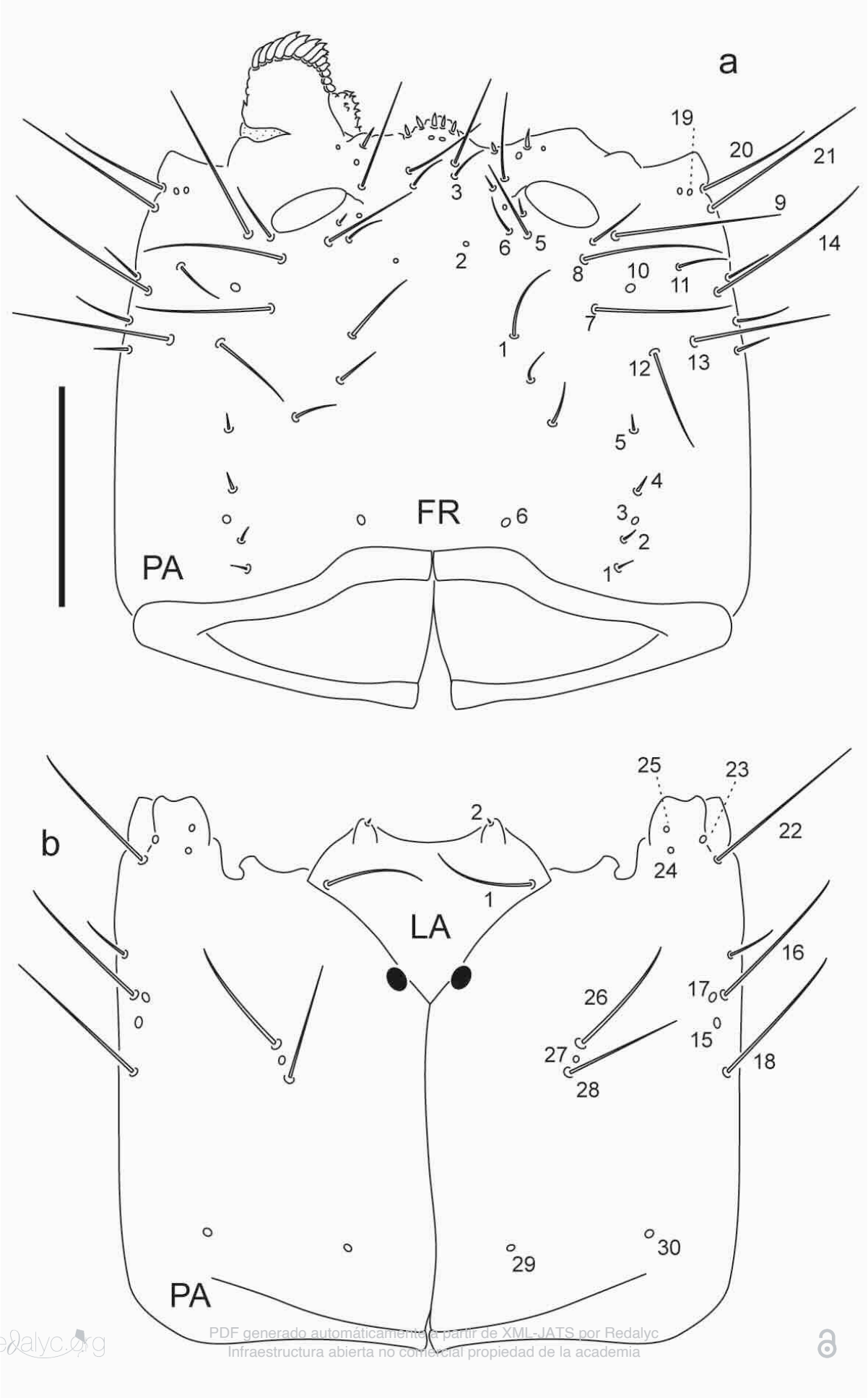


Fig. 28.

Chaetotaxy of third instar larva of *Berosus cornicinus*.

a. Head capsule, dorsal view. b. Head capsule, ventral view. Scale bar= 0.2 mm.

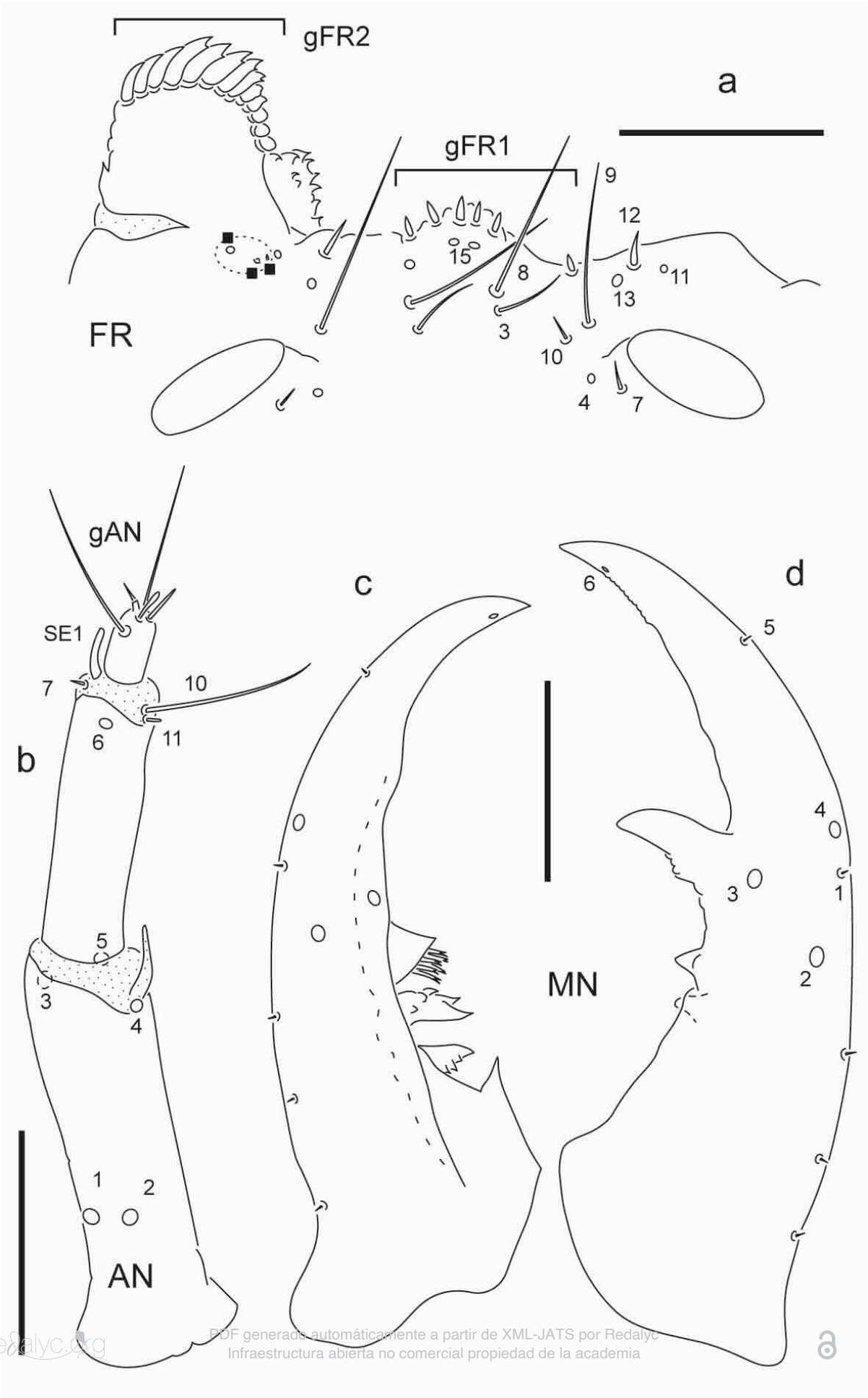


Fig. 29.

Chaetotaxy of third instar larva of *Berosus cornicinus*

a. Detail of clypeolabrum, dorsal view. b. Left antenna, dorsal view. c. Left mandible, dorsal view. d. Right mandible, dorsal view. Scale bar= 0.1 mm.

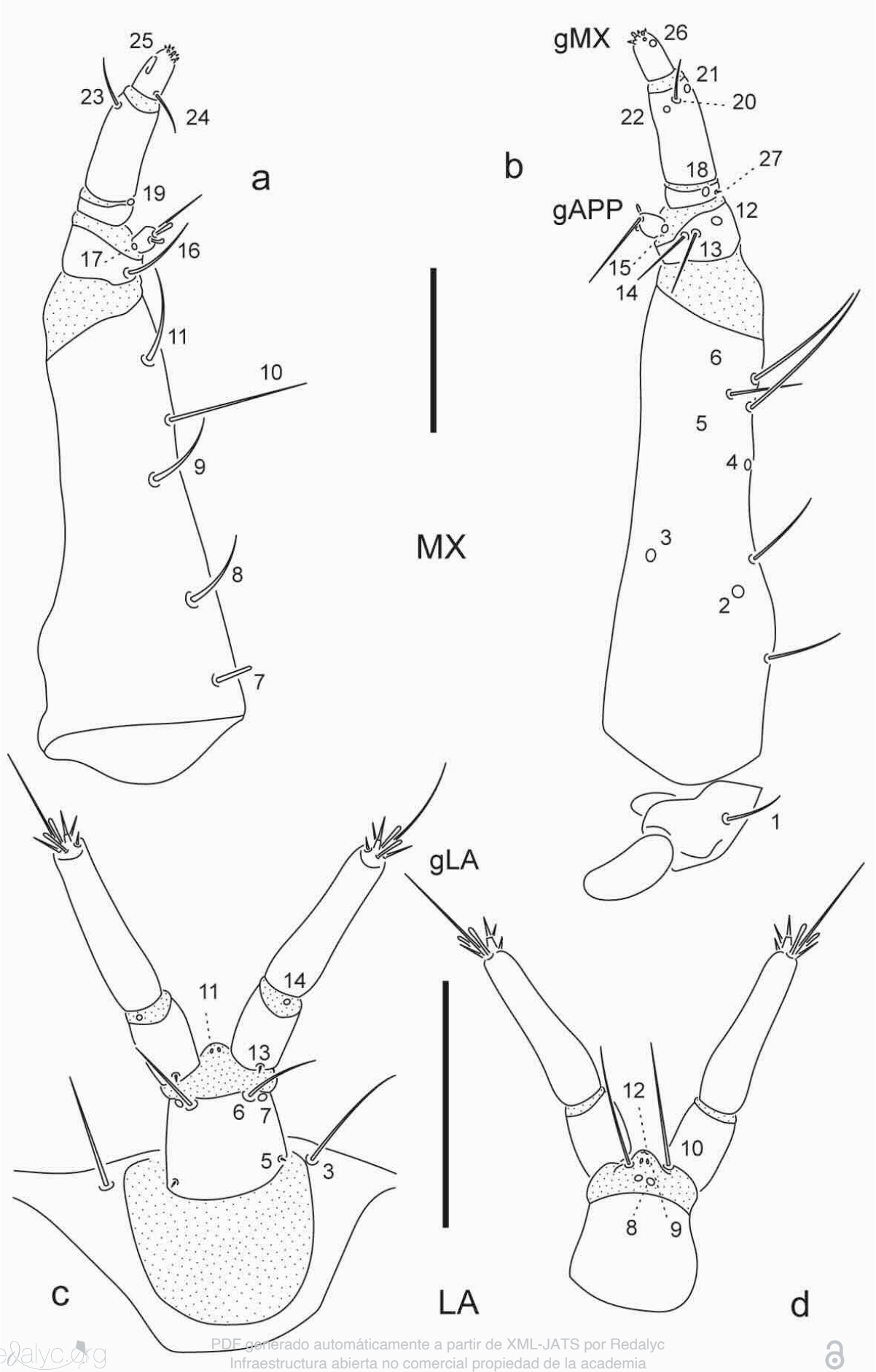


Fig. 30.

Chaetotaxy of third instar larva of *Berosus cornicinus*.

Left maxilla, dorsal view. b. Left maxilla, ventral view. c. Labium, ventral view. d. Labium, dorsal view. Scale bar= 0.1 mm.

***Berosus hoplites* Sharp (Figs. 31-36)**

First instar larva. *Chaetotaxy*. Very similar to that of *B. aulus* except for the following differences. *Head capsule* (Figs. 31a-b, 32a). Frontale with gFR2 bearing 15-16 setae; setae of gFR1 more evenly distributed, right seta of gFR1 less distant to remaining ones; FR3 longer; FR5 slightly shorter; seta FR8 on right side located more laterally to FR3; ventral face of left epistomal lobe with three minute additional sensilla, difficult to see (one pore-like and two minute setae). *Antenna* (Fig. 32b). A2 with pore AN6 subapical, AN10 shorter; membranous process of A1 branched; SE1 much shorter, half the length of A3. *Mandibles* (Fig. 32c-d). MN1 closer to MN2 on left mandible. *Maxilla* (Fig. 33a-b). Seta MX16 shorter. *Labium* (Figs. 31b, 33c-d). Pores LA8 less closely aggregated (distance between pores distinctly greater than width of pores).

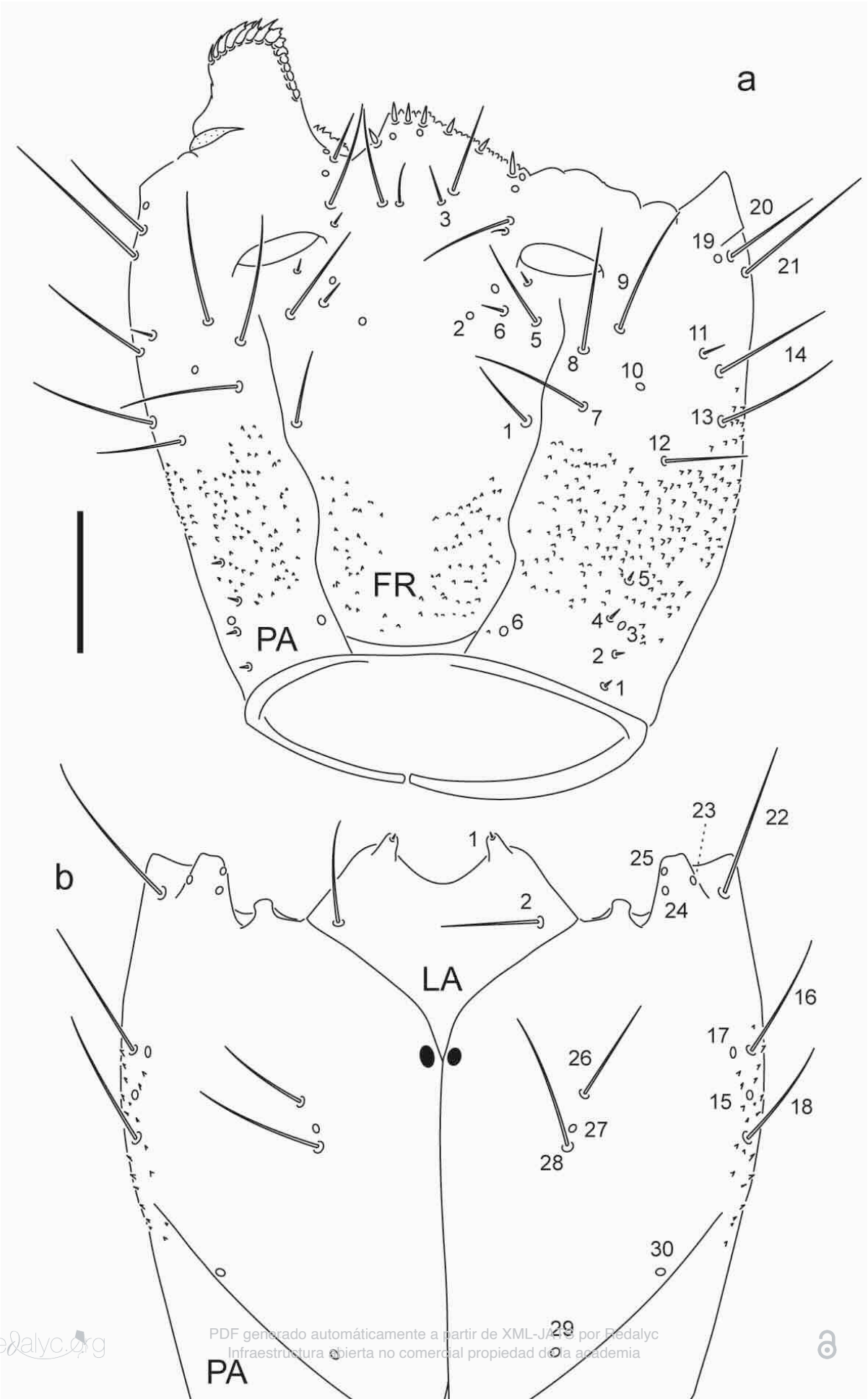
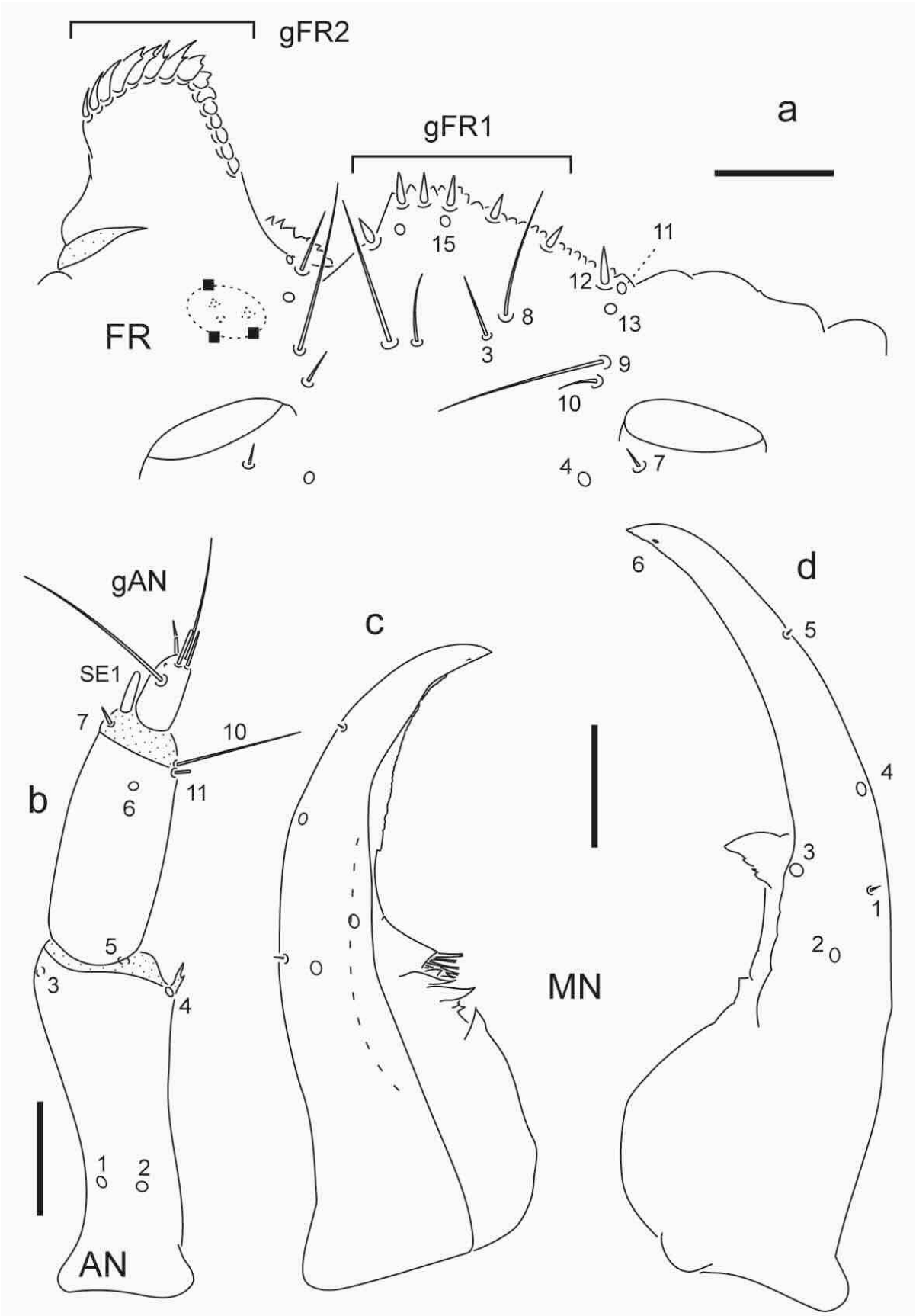


Fig. 31.

Chaetotaxy of first instar larva of *Berosus hoplites*

a. Head capsule, dorsal view. b. Head capsule, ventral view. Scale bar= 0.1 mm.


gFR2
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gAN
SE1
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6
b
5
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AN
c
MN
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d
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1
2

Fig. 32.

Chaetotaxy of first instar larva of *Berosus hoplites*.

a. Detail of clypeolabrum, dorsal view. b. Left antenna, dorsal view. c. Left mandible, dorsal view. d. Right mandible, dorsal view. Scale bar= 0.05 mm.

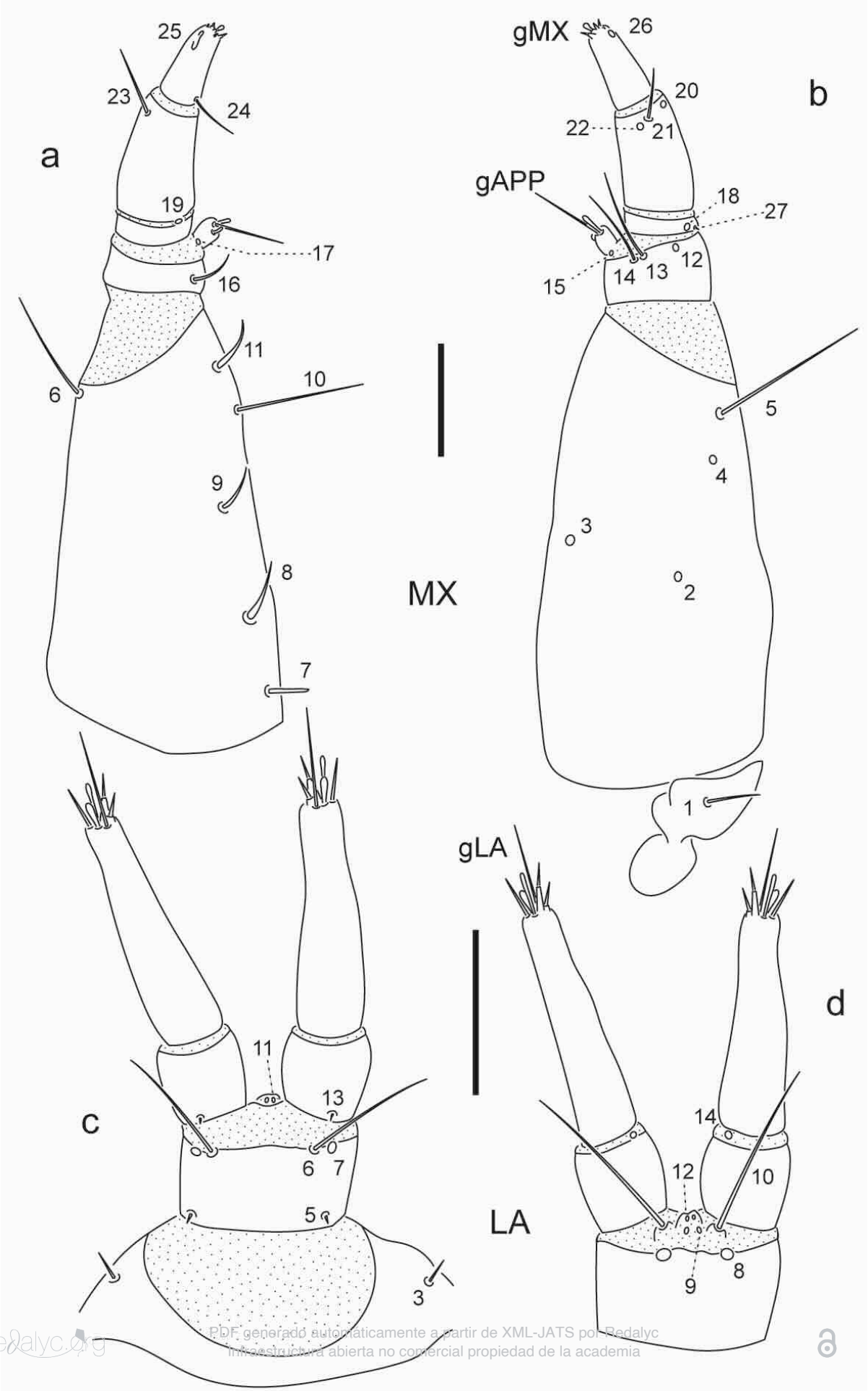

Fig. 33.

Chaetotaxy of first instar larva of *Berosus hoplites*.

a. Left maxilla, dorsal view. b. Left maxilla, ventral view. c. Labium, ventral view. d. Labium, dorsal view. Scale bar= 0.05 mm.

Third instar larva. *Chaetotaxy*. *Head capsule* (Figs. 34a-b,35a). Frontale without secondary sensilla; FR1 more distal than in first instar, setae of gFR1 more evenly distributed; seta FR5 proportionally longer; seta FR8 proportionally longer. Parietale with nine secondary sensilla, three short setae between PA6 and PA7, one short seta between PA8 and PA9, one pore mesal to PA19, two short setae near PA13, two short setae near PA16. *Antenna* (Fig. 35b). Without secondary sensilla; seta AN10 proportionally longer. *Mandibles* (Fig. 35c-d). With three or four minute secondary setae along outer margin between base of mandible and pore MN2, seta MN1 closer to MN4, seta MN5 closer to apex than in first instar. *Maxilla* (Fig. 36a-b). Stipes with three secondary setae along outer margin, one long, close to MX5-6, remaining two short, on basal half; MX14 shorter than MX13, seta MX16 slightly longer. *Labium* (Figs. 34b,36c-d). With one secondary pore on prementum, mesal and posterior to LA3; seta LA3 longer; seta LA6 shorter; pores LA8 more closely aggregated.

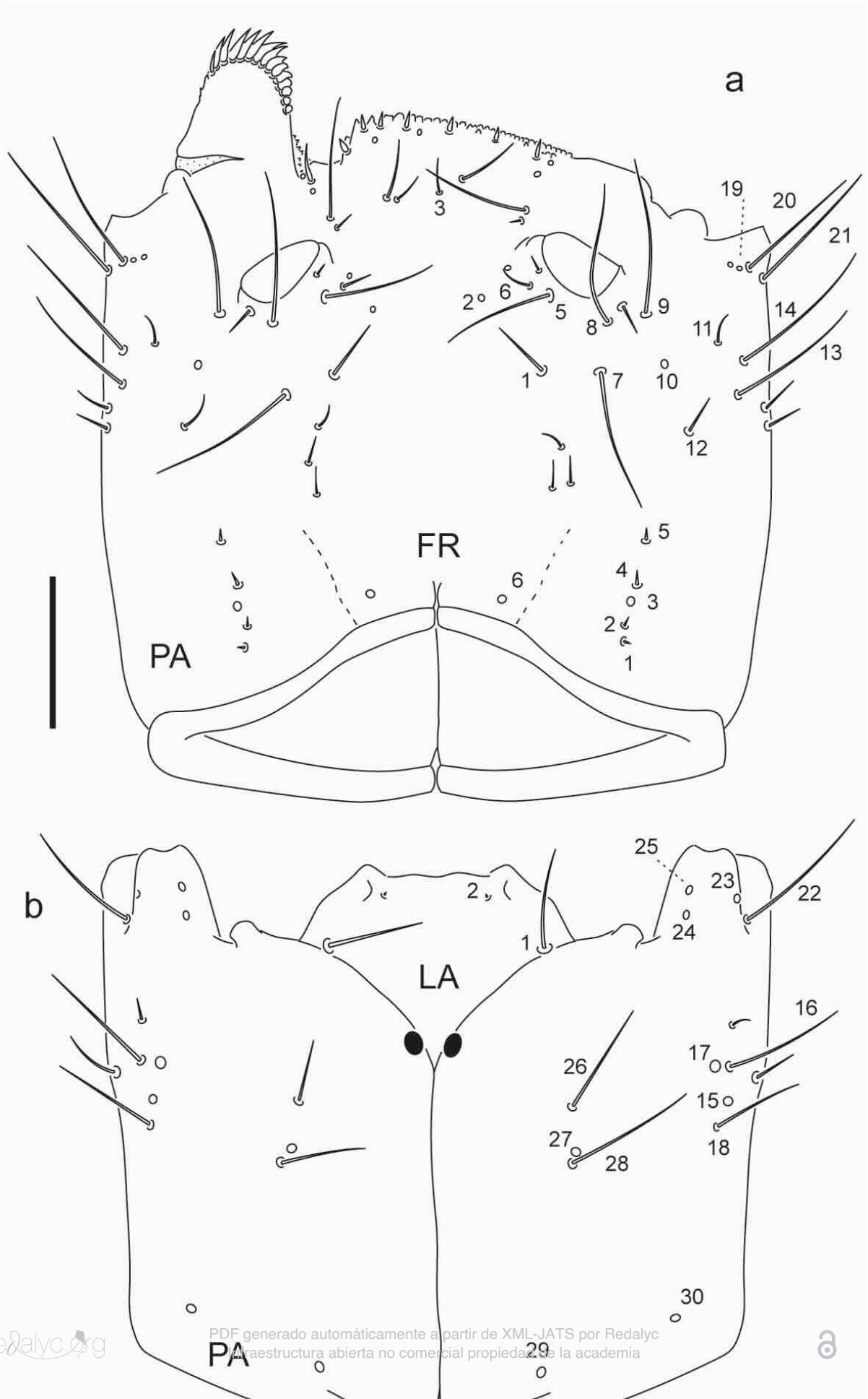

Fig. 34.

Chaetotaxy of third instar larva of *Berosus hoplites*.

a. Head capsule, dorsal view. b. Head capsule, ventral view. Scale bar= 0.2 mm.

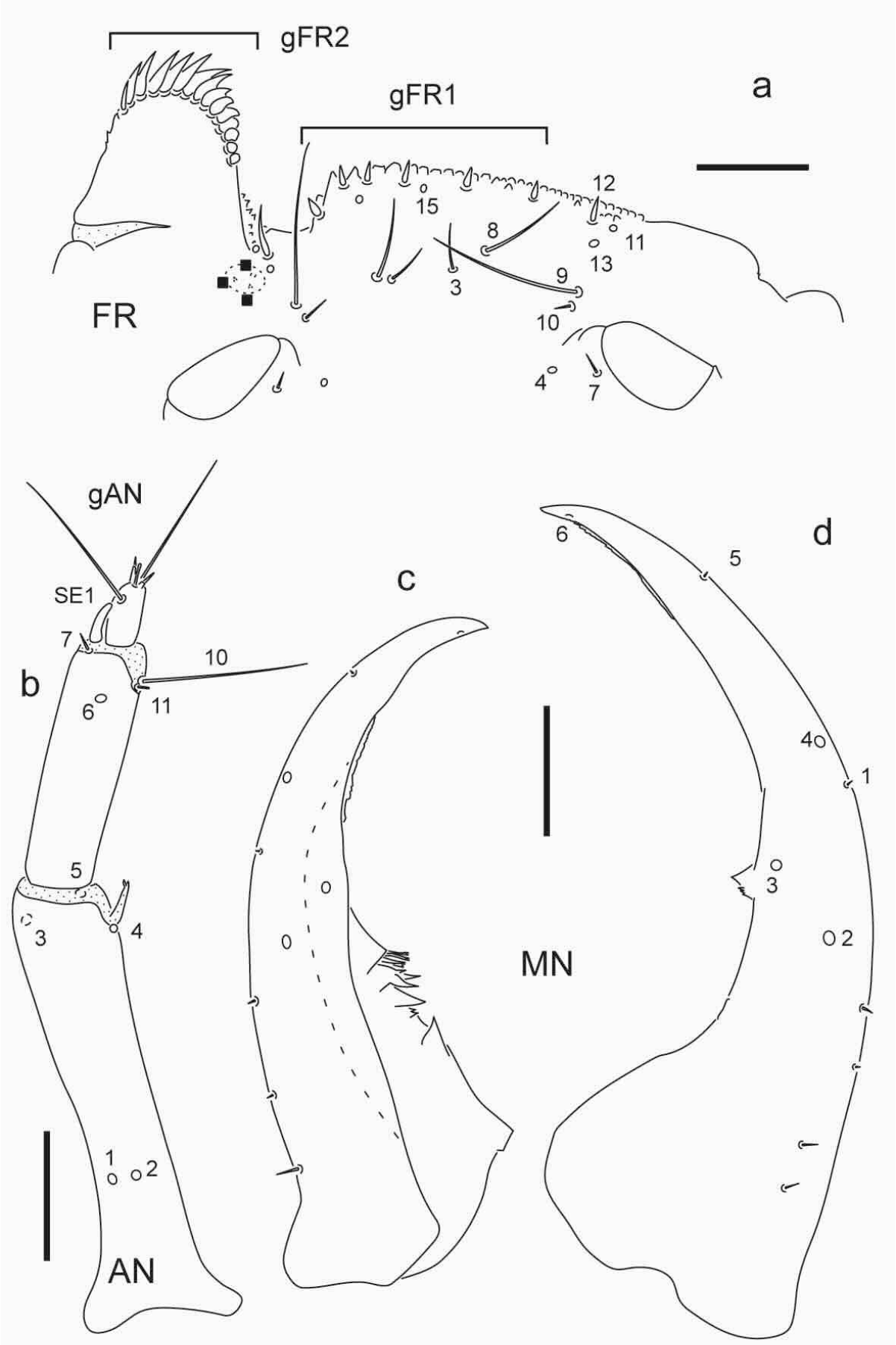
gFR2
gFR1
a
FR
12
15
8
11
13
3
9
10
4
7
gAN
SE1
7
10
b
6
11
5
3
4
1
2
AN
c
MN
d
6
5
4
1
3
2

Fig. 35.

Chaetotaxy of third instar larva of *Berosus hoplites*.

a. Detail of clypeolabrum, dorsal view. b. Left antenna, dorsal view. c. Left mandible, dorsal view. d. Right mandible, dorsal view. Scale bar= 0.1 mm.

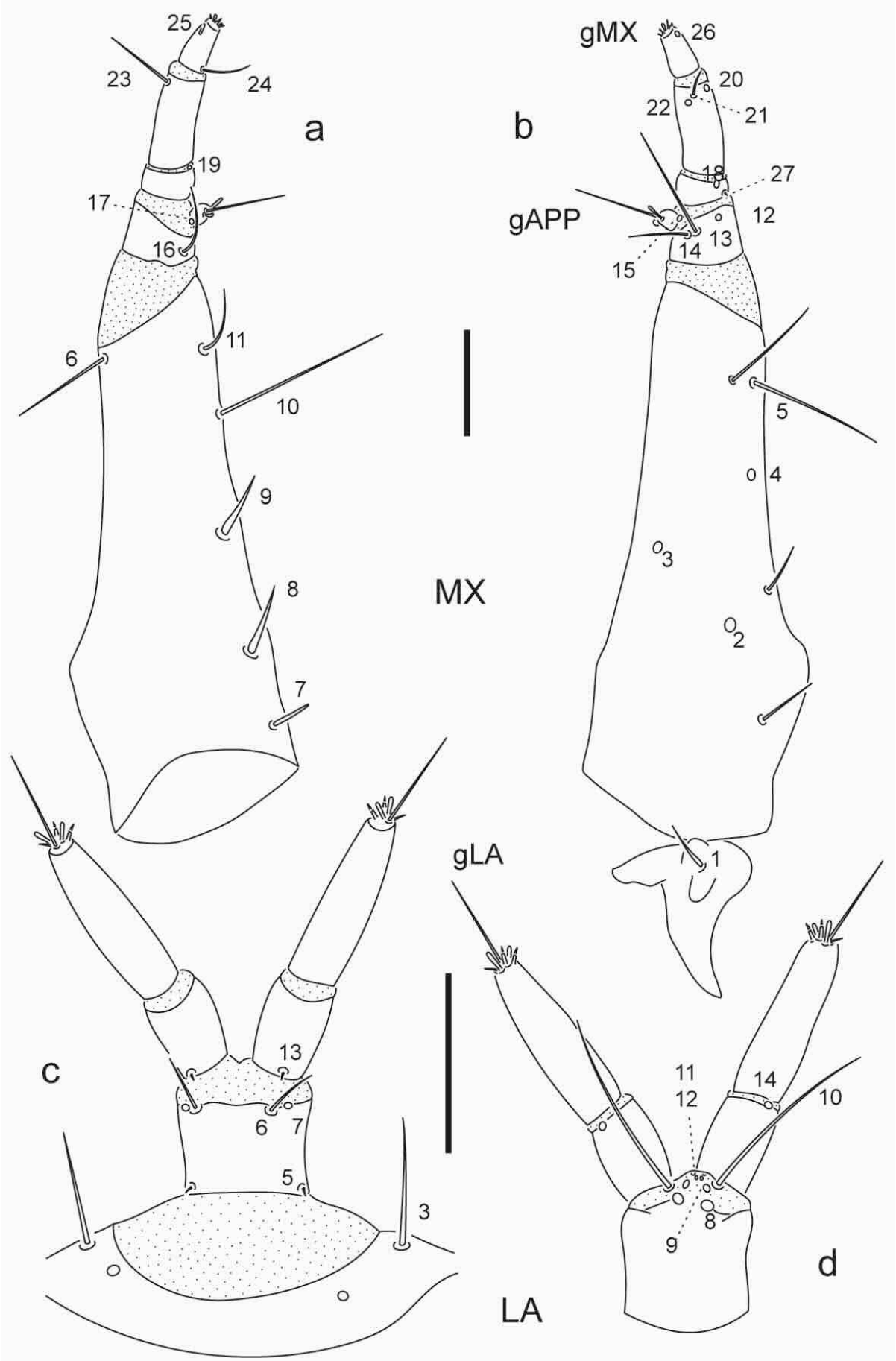

Fig. 36.

Chaetotaxy of third instar larva of *Berosus hoplites*.

a. Left maxilla, dorsal view. b. Left maxilla, ventral view. c. Labium, ventral view. d. Labium, dorsal view. Scale bar= 0.1 mm.

***Berosus pugnax* LeConte (Figs. 37-42)**

First instar larva. *Chaetotaxy*. Very similar to that of *B. aulus* except for the following differences. *Head capsule* (Figs. 37a-b, 38a). Frontale with gFR2 bearing 10-12 setae; pore FR2 close to seta FR5; seta FR8 on right side located more laterally to FR3; ventral face of left epistomal lobe with three minute additional sensilla, difficult to see (two pore-like and one minute seta); seta PA20 much shorter than PA21. *Antenna* (Fig. 38b). A2 with pore AN6 subapical; SE1 slightly shorter. *Mandibles* (Fig. 38c-d). Seta MN1 closer to MN2 than to MN4 on both mandibles. *Maxilla* (Fig. 39a-b). Setae MX13-14 and long seta of gAPP proportionally longer. *Labium* (Figs. 37b, 39c-d). LA3 longer than in *B. aulus*.

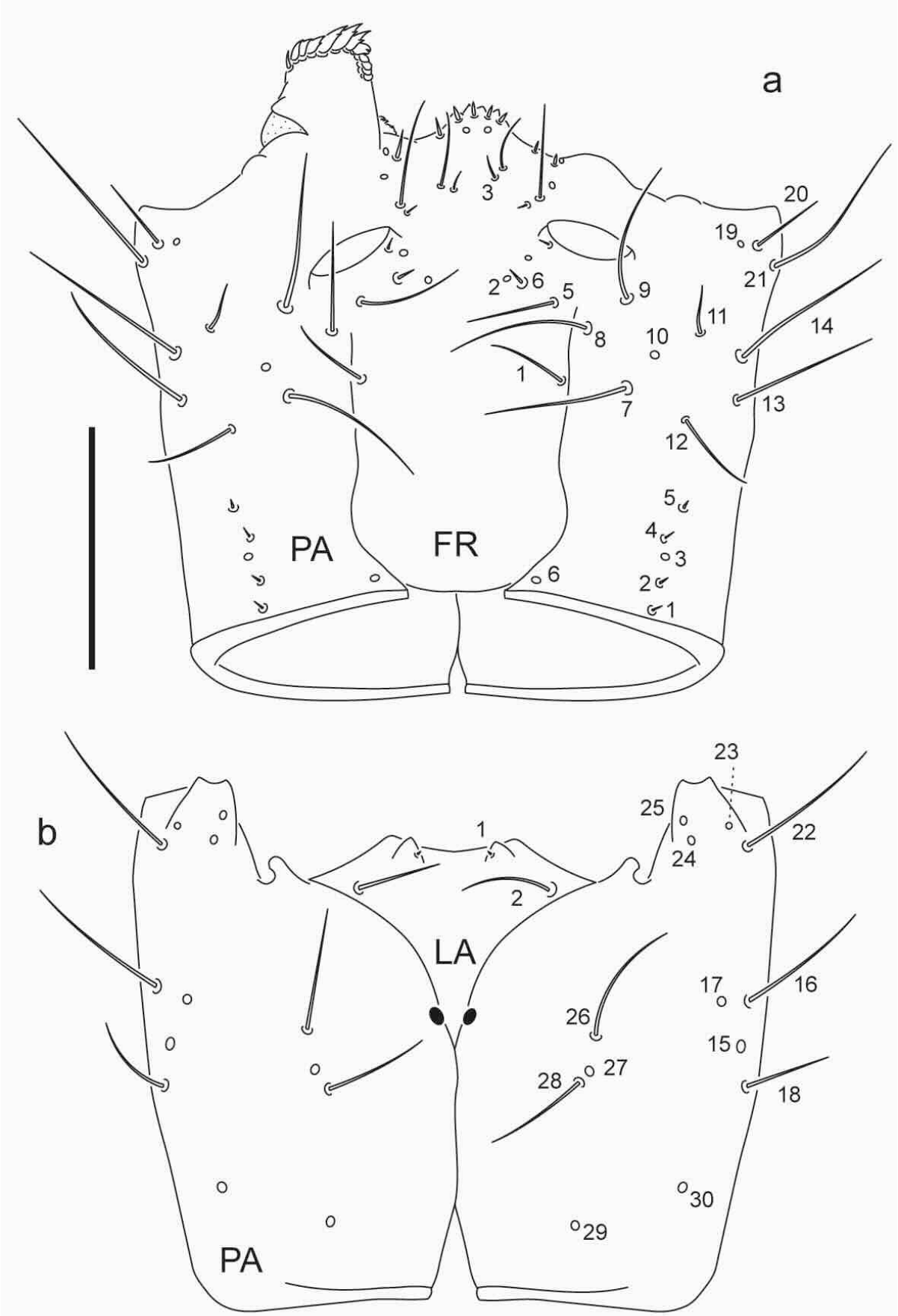

Fig. 37.

Chaetotaxy of first instar larva of *Berosus pugnax*

a. Head capsule, dorsal view. b. Head capsule, ventral view. Scale bar= 0.1 mm.

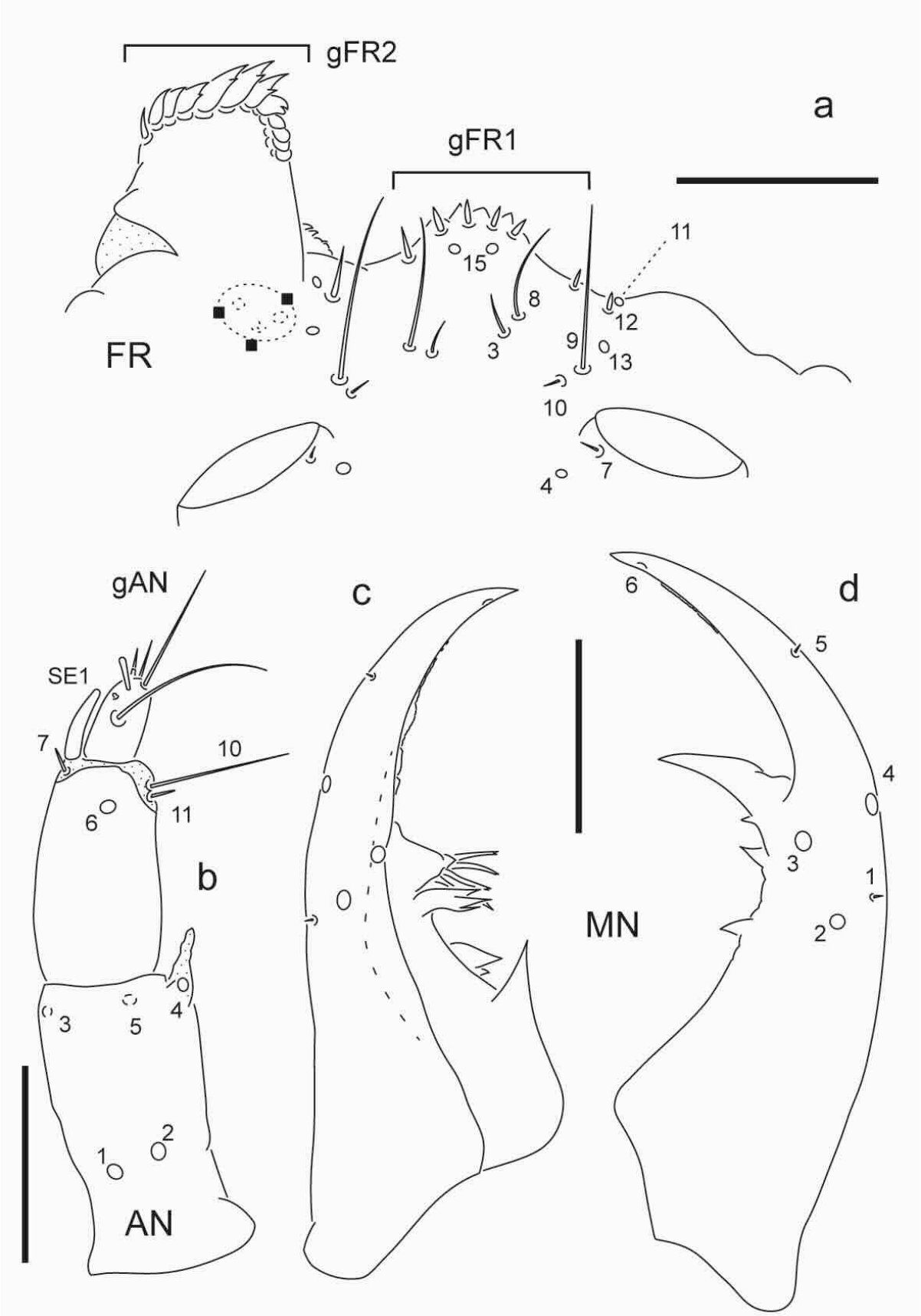

Fig. 38.

Chaetotaxy of first instar larva of *Berosus pugnax*.

a. Detail of clypeolabrum, dorsal view. b. Left antenna, dorsal view. c. Left mandible, dorsal view. d. Right mandible, dorsal view. Scale bar= 0.05 mm.

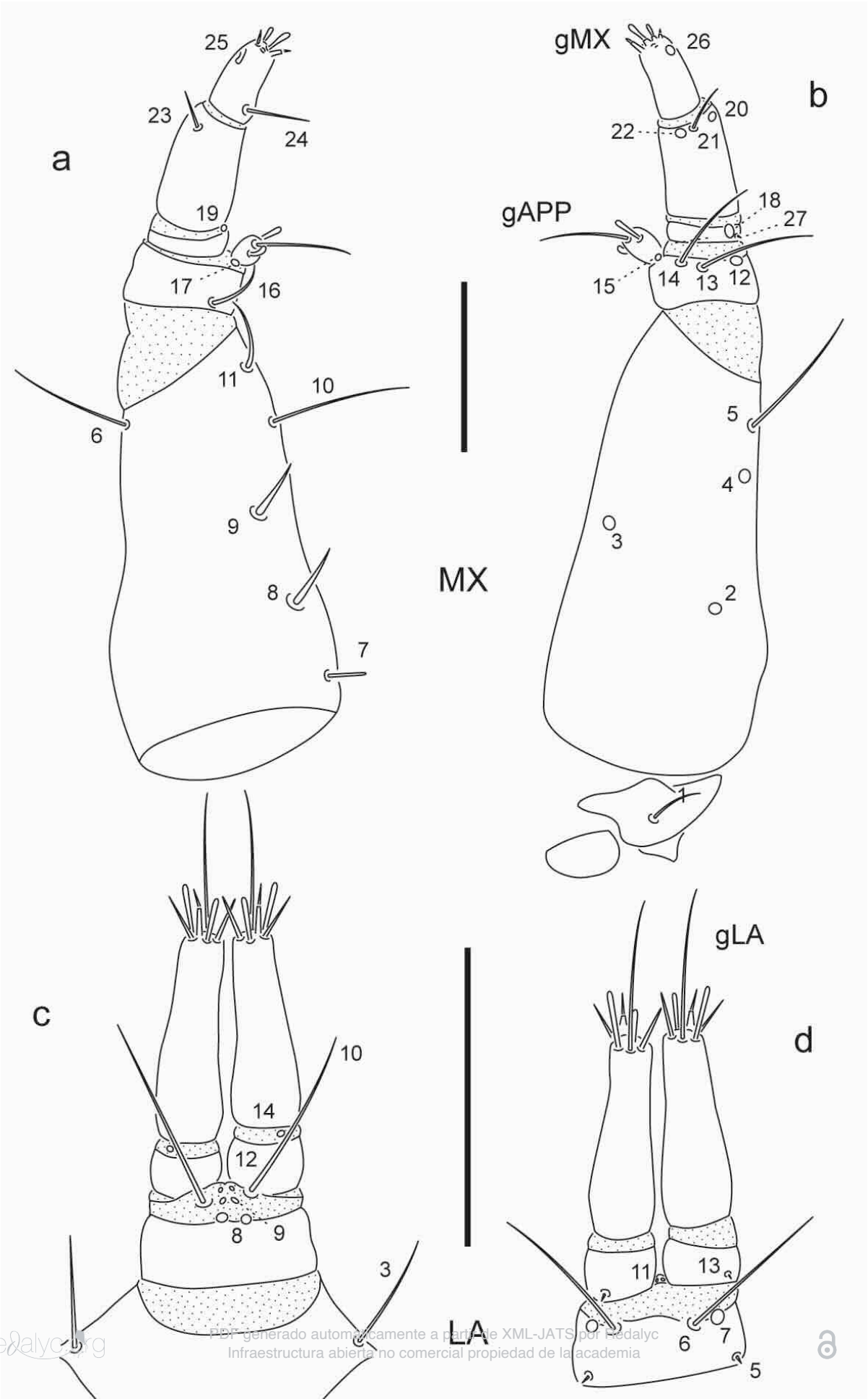

Fig. 39.

Chaetotaxy of first instar larva of *Berosus pugnax*.

a. Left maxilla, dorsal view. b. Left maxilla, ventral view. c. Labium, dorsal view. d. Labium, ventral view. Scale bar= 0.05 mm.

Third instar larva. *Chaetotaxy. Head capsule* (Figs. 40a-b, 41a). Frontale without secondary sensilla; seta FR8 on right side distal to FR3; seta FR9 proportionally longer. Parietale with seven secondary sensilla, one short seta between PA6 and PA7, one short seta between PA8 and PA9, one pore mesal to PA19, one rather short seta between PA13 and PA14, three short setae close to PA16 and PA17; setae PA7-9 and PA11 proportionally longer. *Antenna* (Fig. 41b). Without secondary sensilla; SE1 as long as A3; membranous projection of A1 branched. *Mandibles* (Fig. 41c-d). With three minute secondary setae along outer margin between base of mandible and pore MN2, seta MN1 much closer to MN4 on right mandible. *Maxilla* (Fig. 42a-b). Stipes with three secondary setae along outer margin, one long, close to MX5-6, remaining two on basal half; MX8 much stouter and long; MX23 slightly longer. *Labium* (Figs. 40b, 42c-d). With one secondary pore on prementum, mesal and posterior to LA3; seta LA3 slightly longer; seta LA6 proportionally shorter.

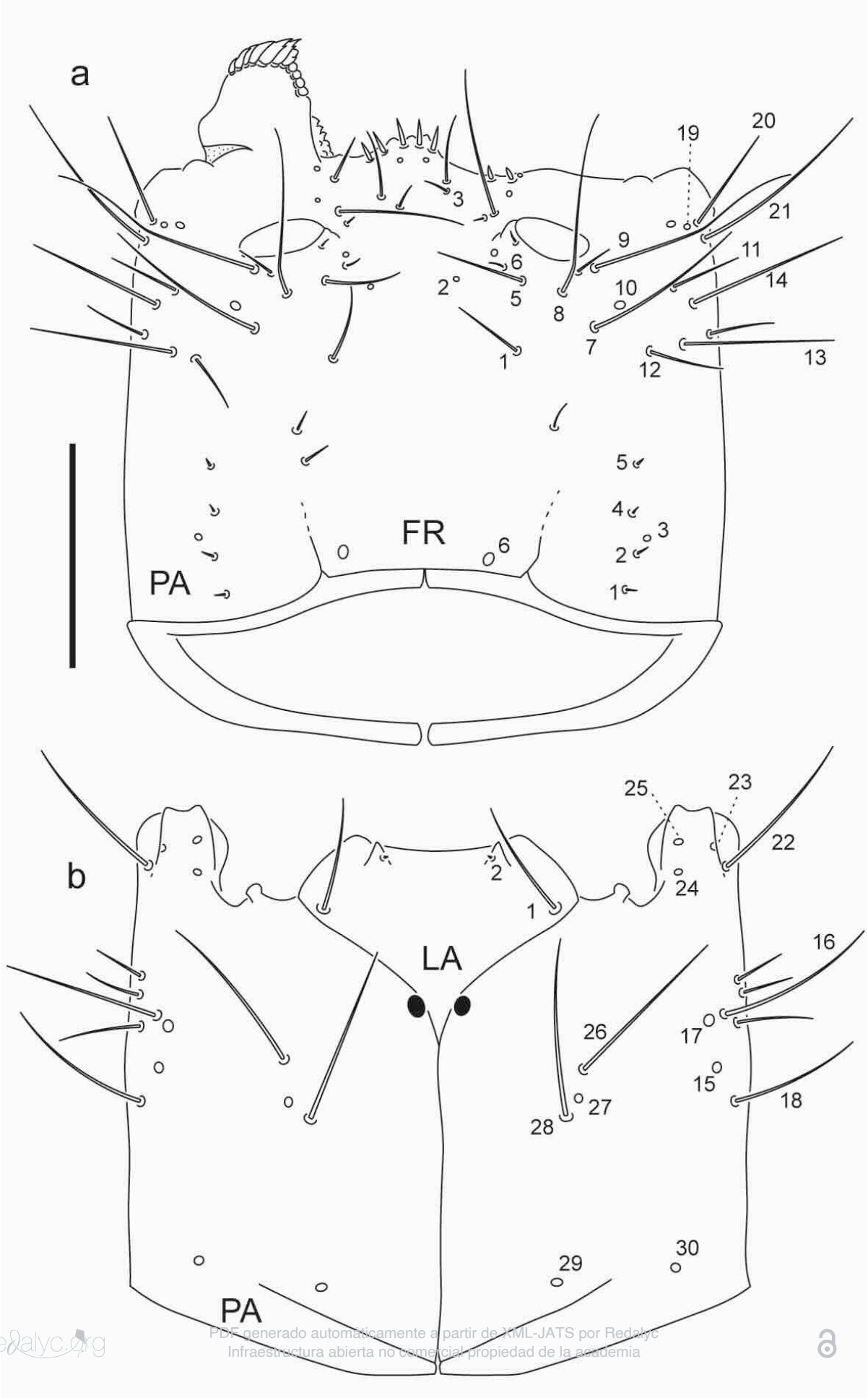

Fig. 40.

Chaetotaxy of third instar larva of *Berosus pugnax*.

a. Head capsule, dorsal view. b. Head capsule, ventral view. Scale bar= 0.2 mm.

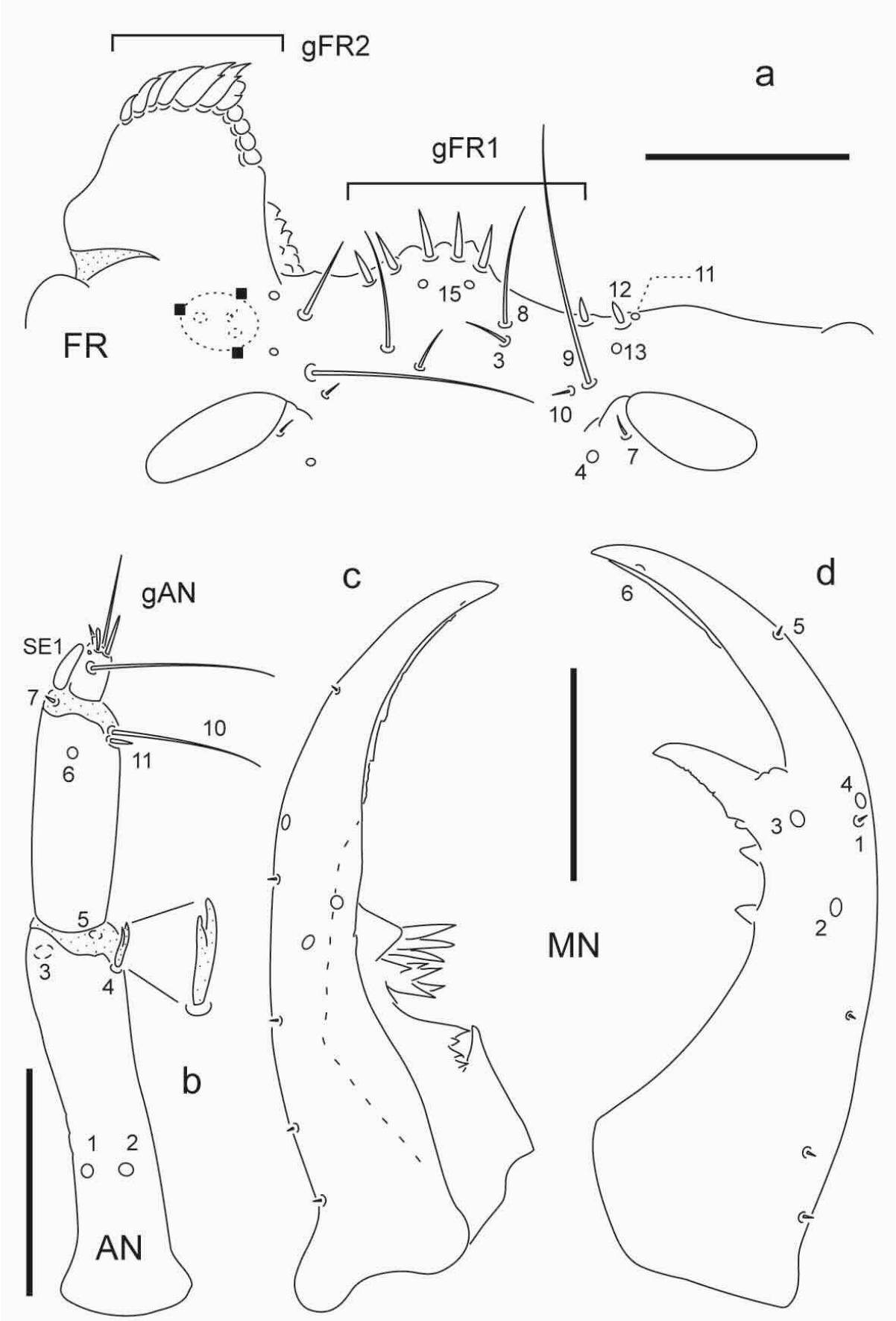

Fig. 41.

Chaetotaxy of third instar larva of *Berosus pugnax*.

a. Detail of clypeolabrum, dorsal view. b. Left antenna, dorsal view. c. Left mandible, dorsal view. d. Right mandible, dorsal view. Scale bar= 0.1 mm.

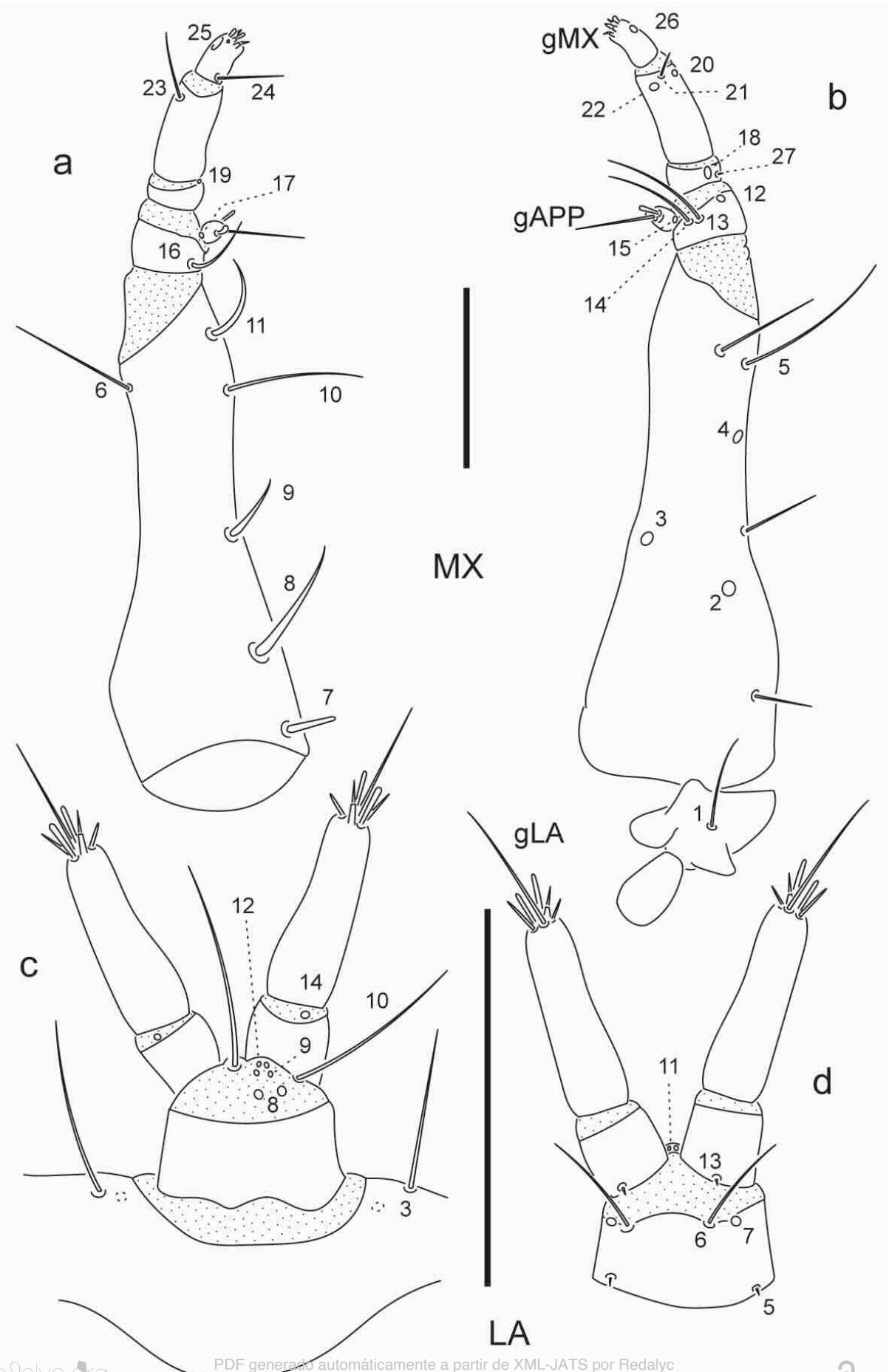

Fig. 42.

Chaetotaxy of third instar larva of *Berosus pugnax*.

a. Left maxilla, dorsal view. b. Left maxilla, ventral view. c. Labium, dorsal view. d. Labium, ventral view. Scale bar= 0.1 mm.

***Berosus toxacanthus* Oliva (Figs. 43-48)**

First instar larva. *Chaetotaxy*. Very similar to that of *B. aulus* except for the following differences. *Head capsule* (Figs. 43a-b,44a). Frontale with gFR1 setae evenly distributed; gFR2 bearing 13-14 setae; ventral face of left epistomal lobe with three minute additional sensilla, difficult to see (two pore-like and one minute seta). *Antenna* (Fig. 44b). A2 with pore AN6 subapical; SE1 much shorter. *Mandibles* (Fig. 44c-d). Seta MN1 on left mandible distal to pore MN2, seta MN1 much closer to MN4 on right mandible. *Maxilla* (Fig. 45a-b). Setae MX13-14 distinctly shorter. *Labium* (Figs. 43b,45c-d). Pore LA8 less closely grouped.

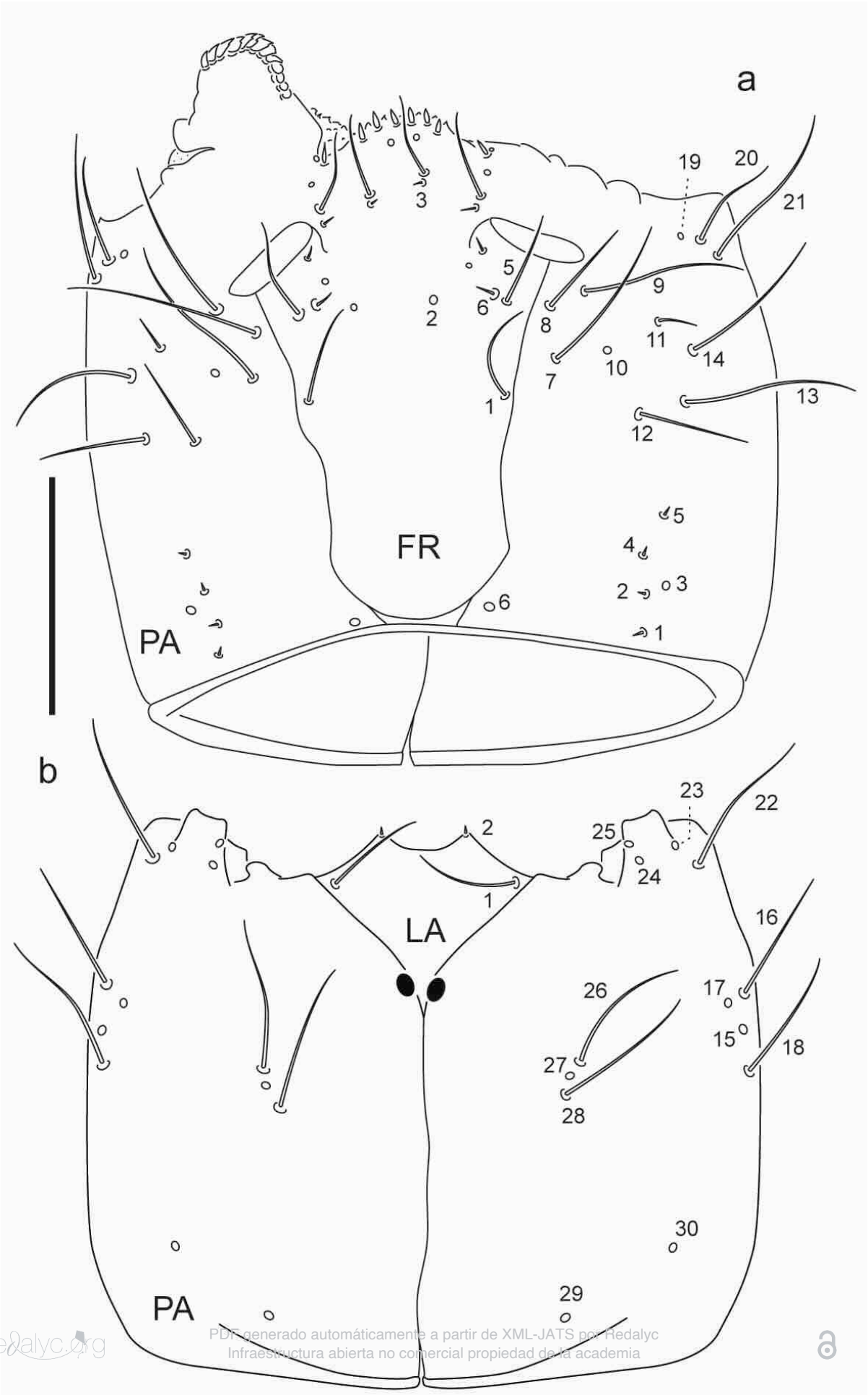

Fig. 43.

Chaetotaxy of first instar larva of *Berosus toxacanthus*.

a. Head capsule, dorsal view. b. Head capsule, ventral view. Scale bar= 0.1 mm.

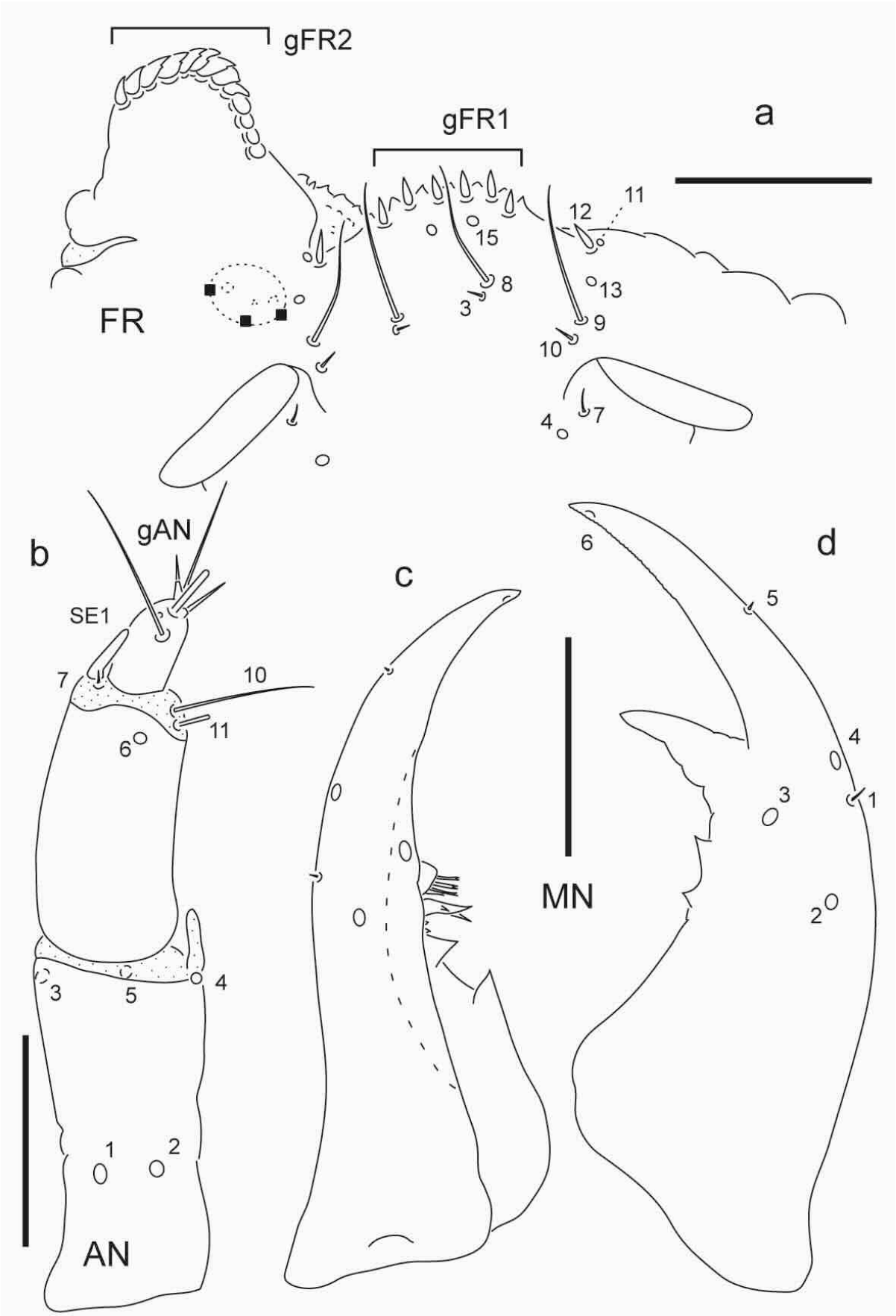

Fig. 44.

Chaetotaxy of first instar larva of *Berosus toxacanthus*.

a. Detail of clypeolabrum, dorsal view. b. Left antenna, dorsal view. c. Left mandible, dorsal view. d. Right mandible, dorsal view. Scale bar= 0.05 mm.

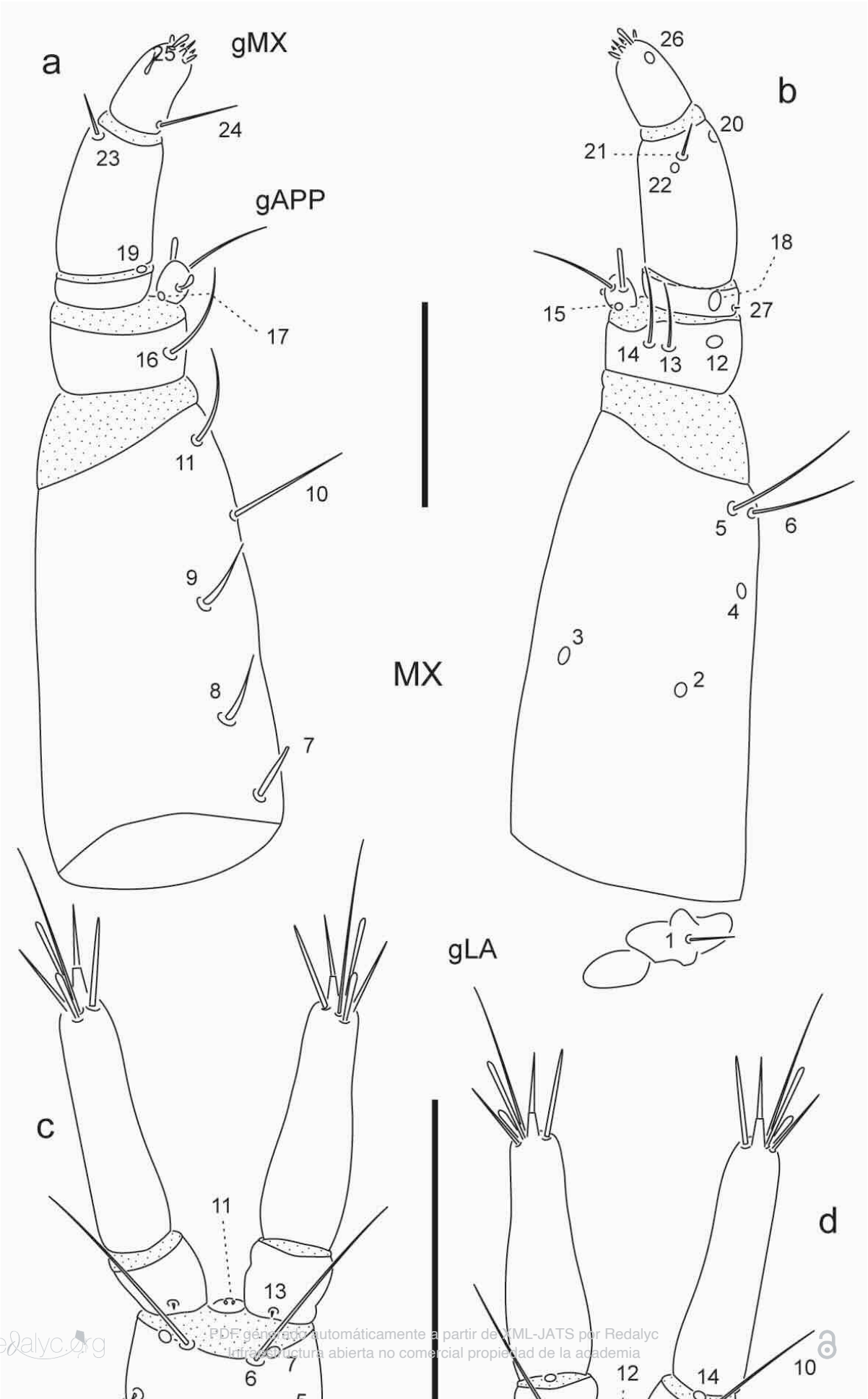

Fig. 45.

Chaetotaxy of first instar larva of *Berosus toxacanthus*.

a. Left maxilla, dorsal view. b. Left maxilla, ventral view. c. Labium, ventral view. d. Labium, dorsal view. Scale bar= 0.05 mm.

Third instar larva. *Chaetotaxy*. *Head capsule* (Figs. 46a-b,47a). Frontale without secondary sensilla; FR1 more distal than in first instar, seta FR9 slightly shorter; seta FR12 on left side closer to gFR1. Parietale with five secondary sensilla, one short seta between PA6 and PA7, one short seta between PA8 and PA9, one pore mesal to PA19, one short seta near PA13, one short seta distal to PA16 and PA17; seta PA20 slightly longer; setae PA26 and PA28 shorter. *Antenna* (Fig. 47b). Without secondary sensilla; AN6 less distal. *Mandibles* (Fig. 47c-d). With three minute secondary setae along outer margin between base of mandible and pore MN2. *Maxilla* (Fig. 48a-b). Stipes with three secondary setae along outer margin, one rather short, close to MX5-6, remaining two on basal half; seta MX11 shorter, setae MX13 and MX14 proportionally longer. *Labium* (Figs. 46b, 48c-d). With one secondary pore on prementum, mesal and posterior to LA3; seta LA6 slightly shorter.

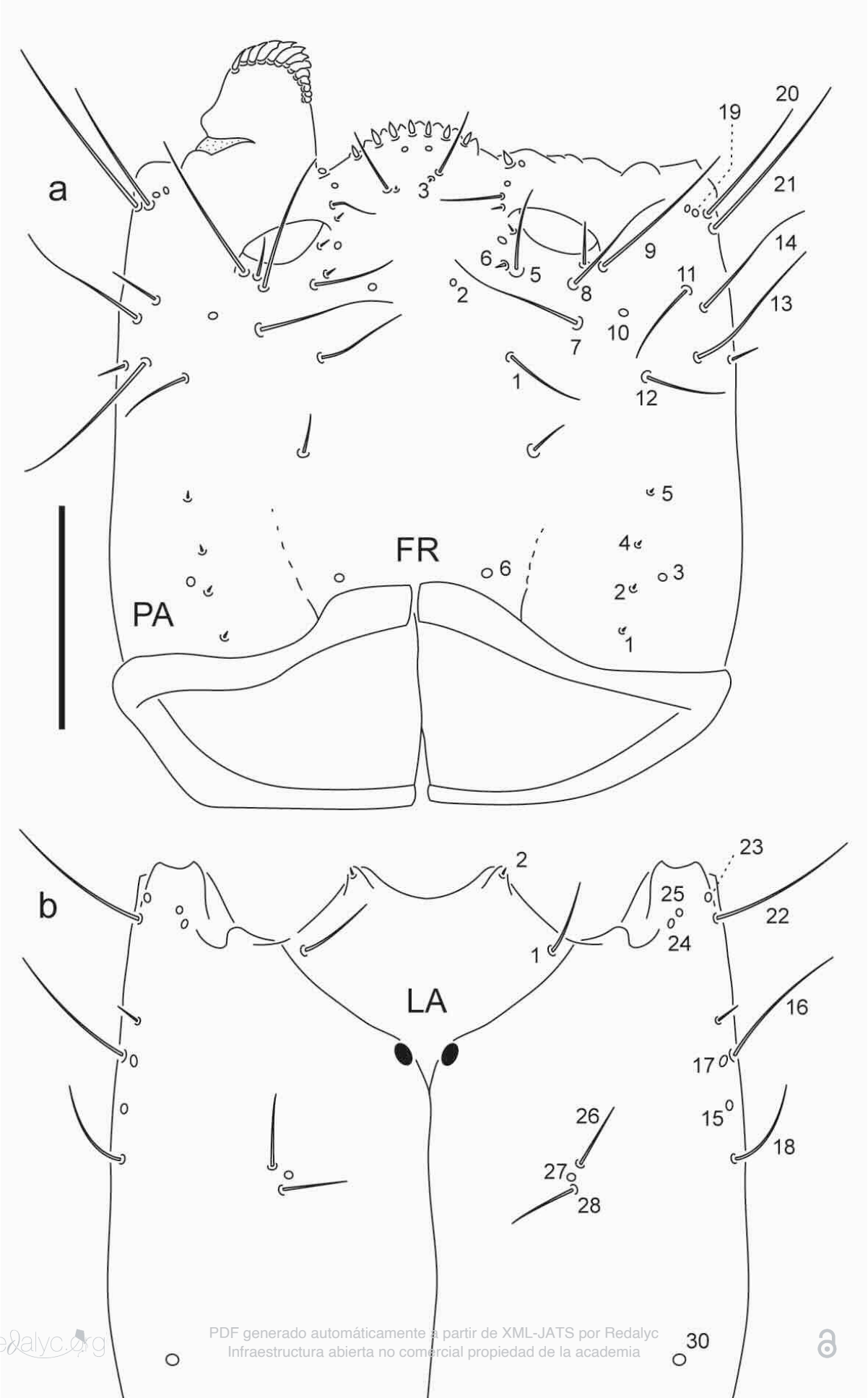

Fig. 46.

Chaetotaxy of third instar larva of *Berosus toxacanthus.*

a. Head capsule, dorsal view. b. Head capsule, ventral view. Scale bar= 0.2 mm.

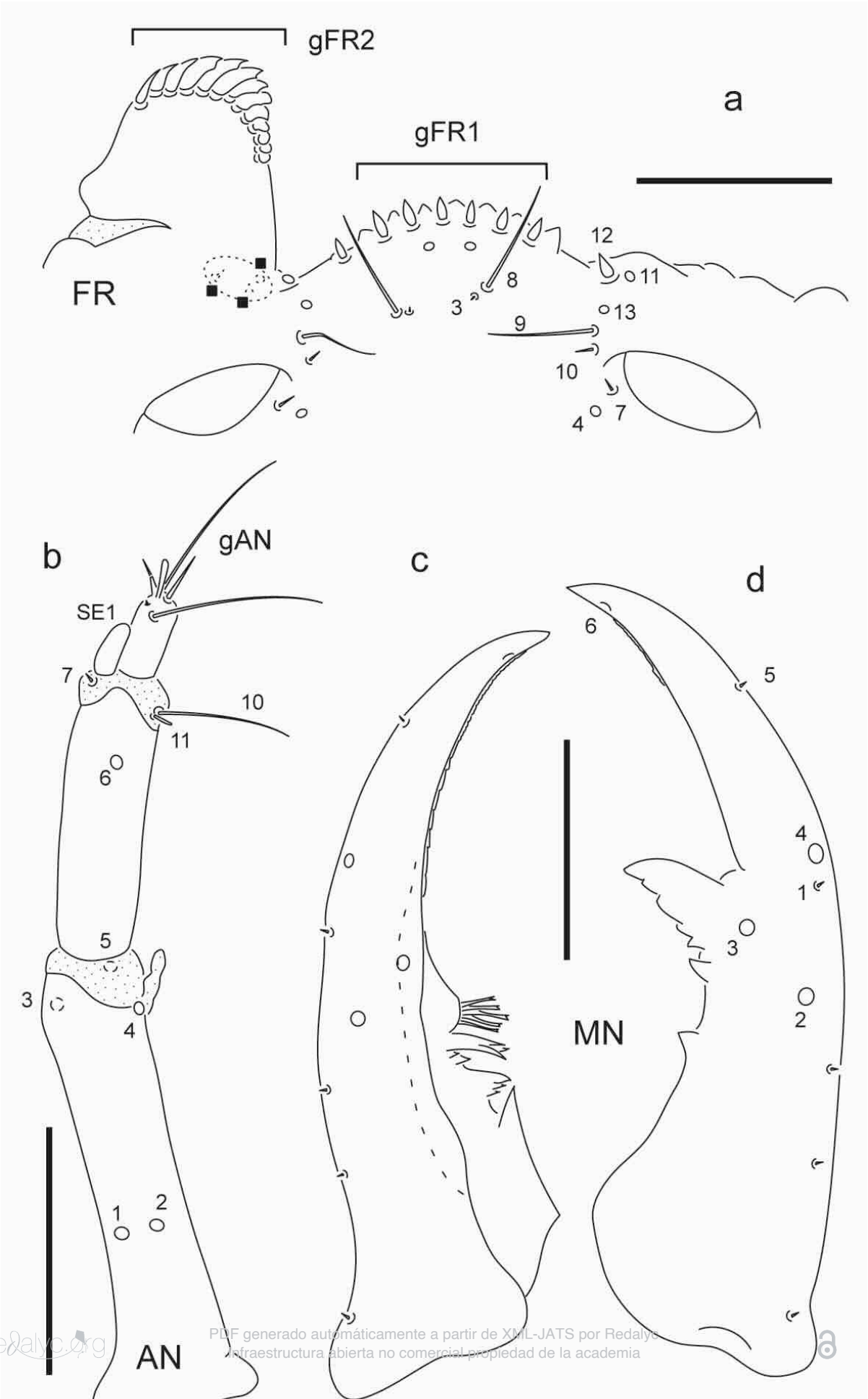

Fig. 47.

Chaetotaxy of third instar larva of *Berosus toxacanthus.*

a. Detail of clypeolabrum, dorsal view. b. Left antenna, dorsal view. c. Left mandible, dorsal view. d. Right mandible, dorsal view. Scale bar= 0.1 mm.

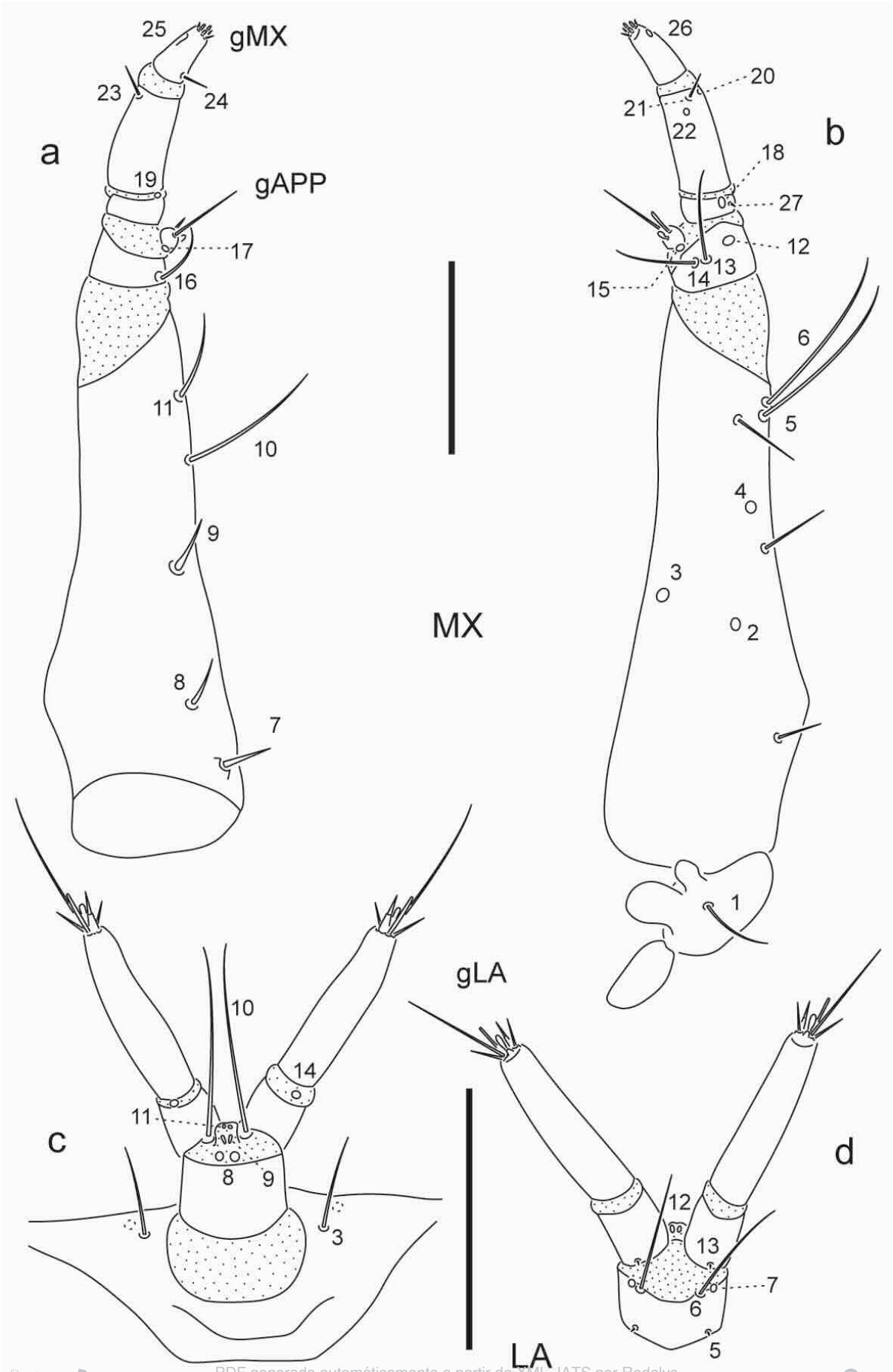

Fig. 48.

Chaetotaxy of third instar larva of *Berosus toxacanthus.*

a. Left maxilla, dorsal view. b. Left maxilla, ventral view. c. Labium, dorsal view. d. Labium, ventral view. Scale bar= 0.1 mm.

DISCUSSION

Comparative notes of chaetotaxic characters among known *Berosus* larvae

Even though *Berosus* is one of the largest genera of Hydrophilidae, larval morphology and chaetotaxy of *Berosus* is very stable. Chaetotaxic characters differentiating species are very subtle, nonetheless some characters or combinations of them are informative to distinguish among species. Rodriguez et al. (2018) presented a detailed discussion of chaetotaxic characters that allowed separating larvae with known chaetotaxy (seven species at that time); that list is here updated and expanded to include all known *Berosus* species with described chaetotaxy.

Frontale. ***Group gFR1:*** Four different arrangements of the gFR1 setae are found (Fikáček, 2006; Minoshima & Hayashi, 2015; Rodriguez et al., 2015,2018; Deler-Hernández & Fikáček, 2016; Rodriguez, 2016); 1- evenly arranged between nasale teeth (*B. exiguus*, *B. festivus*), 2- middle four setae intercalated between nasale teeth, right and left setae located on the right and left clefts respectively (*B. chevrolati*, *B. patruelis*); 3- right seta on the right cleft, remaining five setae intercalated between nasale teeth (*B. adustus*, *B. aulus*, *B. auriceps*, *B. chalcocephalus*, *B. coptogonus*, *B. cornicinus*, *B. decolor*, *B. japonicus*, *B. pallipes*, *B. pugnax*, *B. signaticollis*, *B. toxacanthus*, *B. cf. undatus*); 4- nasale largely serrated and setae more evenly distributed, right seta less distant from remaining ones (*B. hoplites*). The shape and size of gFR1 setae also varies among species (Rodriguez et al., 2018), but it is difficult to clearly group species based on these characters. Minoshima & Hayashi (2015) report an additional pore on the anterior margin of the nasale (as part of gFR1); this pore has not been found in the remaining described *Berosus* larvae (Rodriguez et al., 2015, 2018; Deler-Hernández & Fikáček, 2016; Rodriguez, 2016). ***Group gFR2:*** These setae are present only on the left epistomal lobe, the right one is bare. Based on known larvae of *Berosus* (Minoshima & Hayashi, 2015; Rodriguez et al., 2015, 2018; Deler-Hernández & Fikáček, 2016; Rodriguez, 2016), the number of setae varies between 9 and 16, and is not always constant for the same species: *B. cf. undatus* (9 setae); *B. patruelis* (9-11); *B. chevrolati* (10); *B. festivus* (10-11); *B. pugnax* (10-12); *B. signaticollis* (11); *B. japonicus* (12); *B. coptogonus* and *B. cornicinus* (12-13); *B. adustus* (12-14); *B. chalcocephalus* (13); *B. auriceps* and *B. toxacanthus* (13-14); *B. pallipes* (14-15); *B. aulus* (14-15); *B. decolor* (14-16); *B. hoplites* (15-16, not 18 as previously mentioned by Archangelsky,

1994); *B. exiguus* (16). The shape of these setae also differs, the outer ones are simple and smaller, while the inner ones usually bear a small toothlet; only *B. festivus* and *B. signaticollis* differ from the other species since all the setae are simple. ***Additional sensilla:*** The additional minute sensilla or spinules on the ventral surface of the left epistomal lobe are also present in the eight species described in this paper; these sensilla are very difficult to see and it is easy to miss their presence. These sensilla are also present in *B. adustus*, *B. decolor*, *B. pallipes* and *B. patruelis*, and are only absent in *B. festivus* (Rodriguez, 2016; Rodriguez et al., 2018). They were not mentioned for *B. japonicus*, *B. chevrolati*, *B. exiguus*, *B. signaticollis* and *B. cf. undatus* (Minoshima & Hayashi, 2015;Deler-Hernández & Fikáček, 2016), although they may be present in at least some of these species. Interestingly, these ventral sensilla are present in one *Hemiosus* species, *Hemiosus bruchi* Knisch, a species that shares several characters with *Berosus* larvae (Rodriguez et al., 2018). ***FR11-12:***These sensilla present a slight asymmetry in distribution (Minoshima & Hayashi, 2015; Rodriguez et al., 2015, 2018; Deler-Hernández & Fikáček, 2016; Rodriguez, 2016); on the left side pore FR11 is usually lateral to seta FR12, in *B. auriceps*, *B. chevrolati* and *B. festivus* it is anterior to FR12. On the right side the position of these two sensilla is variable: pore FR11 can be internal (*B. aulus*, *B. auriceps*, *B. decolor*, *B. exiguus*, *B. festivus*, *B. japonicus*, *B. patruelis*) or external to seta FR12 (*B. adustus*, *B. chalcocephalus*, *B. chevrolati*, *B. coptogonus*, *B. cornicinus*, *B. hoplites*, *B. pallipes*, *B. pugnax*; *B. toxacanthus*, *B. cf. undatus*). This pore is not illustrated for *B. signaticollis* (Fikáček, 2006). ***FR12:*** In most described species setae FR12 (Fikáček, 2006; Minoshima & Hayashi, 2015;Rodriguez et al., 2015, 2018; Deler-Hernández & Fikáček, 2016; Rodriguez, 2016) are more or less similar in length on both sides of the head capsule, but in a few species FR12 is much longer on the left side than on the right side (*B. chevrolati*, *B. hoplites*, *B. patruelis* and *B. pugnax*). Additionally, in those species in which FR12 are similar in length two groups of species can be defined, those in which both FR12 are relatively long (*B. adustus*, *B. cornicinus*, *B. exiguus* and *B. festivus*) and those in which both FR12 are short (*B. aulus*, *B. auriceps*, *B. chalcocephalus*, *B. coptogonus*, *B. decolor*, *B. japonicus*, *B. pallipes*, *B. toxacanthus* and *B. cf. undatus*).

Parietale. The relative length between pairs of setae on the parietale (*e.g.* PA12-13 or PA20-21) was proposed as a useful character to separate species (Rodriguez et al., 2018). Nonetheless with the inclusion of the new larvae here described, and also when these characters are compared between instars, there is some variability that obscures the usefulness of these characters.

Mandibular sensilla. The asymmetrical distribution of mandibular sensilla in *Berosus* larvae has been noted in different studies (Minoshima & Hayashi, 2015; Rodriguez, 2016; Rodriguez et al.,

2018). What is more, the relative position also varies between instars, therefore comparative notes should be done among larvae of the same instar. ***First instar larvae:*** First instars are not known for *B. chevrolati*, *B. exiguus* and *B. cf. undatus*. In left mandibles seta MN1 in most species is located at the same level or slightly distal to pore MN2 (Fikáček, 2006; Minoshima & Hayashi, 2015; Rodriguez et al., 2015, 2018; Deler-Hernández & Fikáček, 2016; Rodriguez, 2016), except in *B. festivus* and *B. adustus* where MN1 is clearly posterior to MN2 and *B. pugnax*, where MN1 is slightly posterior to MN2. Additionally, also in the left mandibles, seta MN1 is always closer to pore MN2 than to MN4. On right mandibles the position of MN1 is variable, it is always distinctly distal to pore MN2 except in *B. festivus* and *B. adustus*, where both sensilla are at the same level. Another variable character is the position of seta MN1 in relation to pores MN2 and MN4; in most species MN1 is roughly equidistant between MN2 and MN4 except for *B. festivus* and *B. adustus* here MN1 is distinctly closer to MN1 and *B. coptogonus* where MN1 is much closer to MN4. Regarding the relative position of pore MN4 between setae MN1 and MN5, in all species MN4 is closer to MN1 except for *B. festivus* and *B. adustus*, where MN4 is equidistant between MN1 and MN5. ***Third instar larvae:*** Third instars are not described for *B. festivus* and *B. patruelis*. In third instar larvae MN1 in both mandibles is anteriorly displaced in most species with the following exceptions: left mandible in *B. auriceps* and *B. chalcocephalus*.

Maxillary sensilla. The chaetotaxy of the maxilla is very stable and differences among known species are few. ***MX7:*** In all species described in this paper and also in *B. adustus*, *B. festivus* and *B. pallipes*, MX7 appears as a shorter, almost straight and apically blunt seta; in other described species: *B. decolor*, *B. exiguus*, *B. japonicus*, *B. patruelis*, *B. signaticollis* and *B. cf. undatus*, MX7 is also straighter and shorter, but pointed apically; in *B. chevrolati*, MX7 is broken (Fikáček, 2006; Minoshima & Hayashi, 2015; Rodriguez et al., 2015, 2018; Deler-Hernández & Fikáček, 2016; Rodriguez, 2016). This character needs to be studied in more detail in additional species; one possibility that MX7 is blunt or less sharply pointed than the remaining setae on the inner margin of the stipes may be derived from the fact that it is basal and is in contact with the base of the labium and the mandibles, which could wear out the apex of this seta. ***MX10:*** Third instar larvae of *B. exiguus* can be easily distinguished by the short and spiniform seta MX10, and also by a basal secondary seta on the outer margin of the stipes (Deler-Hernández & Fikáček, 2016); MX10 in the remaining *Berosus* species is filiform, and the basal secondary seta in other known third instars has a more distal position (Minoshima & Hayashi, 2015; all species described above). ***MX13-14:*** First instar larvae of *B. adustus*, *B. festivus* and *B. patruelis* have MX13 much longer than MX14 (Rodriguez, 2016; Rodriguez et al., 2018), in all other known first instar larvae MX13-14 are subequal

in length. ***Secondary setae:*** Third instar larvae of *B. japonicus* and *B. cf. undatus* can be separated from other known species by the presence of only two secondary setae on the outer margin of the stipes (Minoshima & Hayashi, 2015; Deler-Hernández & Fikáček, 2016); *B. pallipes* has four secondary setae on the stipes (Rodriguez, 2016), one long seta near MX5, two short setae along the outer margin between pores MX2 and MX4 and one short basal medioventral seta; the remaining species have three secondary setae on the outer margin of the stipes (Deler-Hernández & Fikáček, 2016).

Labial sensilla. Few differences in the relative position of some labial sensoria can be mentioned. ***LA8:*** In many species the distance between pores LA8 is small, about the width of pore LA8 (all instars of *B. aulus*, *B. cornicinus*, *B. pugnax*, *B. toxacanthus*, third instars of *B. chalcocephalus* and *B. coptogonus*). In the remaining known larvae, the distance between these pores is larger, two times or more the width of the pore (Fikáček, 2006; Minoshima & Hayashi, 2015; Rodriguez et al., 2015, 2018; Rodriguez, 2016). Deler-Hernández & Fikáček (2016) do not mention this pair of pores for the species they describe, but most likely those are the pores illustrated and labelled as LA9, therefore in *B. chevrolati* the distance between both pores is small and in *B. exiguus* and in *B. cf. undatus* is large. ***LA8-9:*** The distance between pores LA8 and LA9 also serves to differentiate larvae of *B. decolor*, *B. pallipes* and *B. signaticollis* from all other known larvae (Fikáček, 2006; Rodriguez et al., 2015; Rodriguez, 2016), in these three species both pores are relatively far from each other while in the remaining species they are relatively close (Minoshima & Hayashi, 2015; Rodriguez, 2016; Rodriguez et al., 2018; all species described above). *B. adustus* shows a unique character state since it is the only known species in which LA9 is posterior to LA8. ***Secondary pore:*** Third instar larvae of *B. cf. undatus* (Deler-Hernández & Fikáček, 2016) and all third instars described in this contribution (except *B. cornicinus*) have a small pore on the prementum, slightly mesal and posterior to seta LA3, not found in other known third instar larvae. This pore is very small and difficult to see, and could not be found in first instars, this makes me consider it as a secondary pore. An alternative interpretation is that this pore could be LA4, which is presumed absent in *Berosus* larvae. More *Berosus* larvae should be studied in order to understand this character, especially when we consider that it is present in all instars of all known *Hemiosus* larvae, the sister group of *Berosus*.

Acknowledgments

I am indebted to Y. Minoshima and G. Rodriguez for their help checking some characters in *Berosus* larvae. CONICET (Consejo Nacional de Investigaciones Científicas y Tecnológicas) is acknowledged for supporting research in the field of Systematics. Financial support was provided by the grant: PICT 01-06156 (Agencia Nacional de Promoción Científica y Técnica, Argentina). Two anonymous reviewers are acknowledged for their comments and corrections, which improved this contribution.

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Información adicional

redalyc-journal-id: 3220

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Contribution to the knowledge of larval chaetotaxy of the genus *Berosus* (Coleoptera: Hydrophilidae: Hydrophilinae)
Contribución al conocimiento de la quetotaxia larval del género *Berosus* (Coleoptera: Hydrophilidae: Hydrophilinae)

Revista de la Sociedad Entomológica Argentina
vol. 83, núm. 4, p. 9 - 31, 2024
Sociedad Entomológica Argentina, Argentina
gsanblas@mendoza-conicet.gob.ar

ISSN-E: 1851-7471

DOI: https://doi.org/10.25085/rsea.830402