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Description of immatures of the genus *Tropisternus* Solier, subgenus *Pristoternus* Orchymont (Coleoptera: Hydrophilidae), with emphasis on the chaetotaxy and morphometry of larval forms

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Abstract

The egg cases, larvae, and pupae of *Tropisternus* (*Pristoternus*) *latus* (Brullé, 1837), *T.* (*P.*) *ovalis* Castelnau, 1840, and *T.* (*P.*) *laevis* (Sturm, 1826) are illustrated and described for the first time. The egg cases are built with or without a mast, which can be ribbon-like or globular; all larval instars have seven anterior denticles in the anterior margin of nasale, and the antennal seta AN8 is present; the pupae bear 6 or 8 styli on the abdominal segments II–VI, the pleural styli can be either short or very long, and horn-like projections may be present on the abdominal segments II–VI. A comparison of the morphology of the egg cases, pupae and larval chaetotaxic and morphometric characters within the genus *Tropisternus* is presented.

Key words: Water scavenger beetles, Hydrophilinae, larva, pupa, egg case

Introduction

The genus *Tropisternus* Solier includes 63 species of aquatic beetles belonging to the family Hydrophilidae (Hansen, 1999; Short & Fikáček, 2011). Species of *Tropisternus* are very frequently collected and often ubiquitous, inhabiting many types of aquatic habitats, from rain puddles and small limnotopes to large lakes and ponds. Adults are detritivorous and can be easily recognized on the basis of their navicular shape, body length less than 15 mm, and the presence of an acute sternal keel. Larvae are carnivorous and typically ambush predators, feeding on a large diversity of prey (Wilson, 1923; Formanowicz & Brodie, 1988). In recent years, several works dealing with the morphology of the preimaginal stages of Neotropical *Tropisternus* have been published (Fernández *et al.*, 2000; Torres *et al.*, 2008, 2011). The genus is presently subdivided into five subgenera: *Tropisternus s. str.*, *Pleurhomus* Sharp, *Homostethus* Orchymont, *Pristoternus* Orchymont, and *Strepitornus* Hansen. *Pristoternus* Orchymont contains 30 species (Hansen, 1999; Spangler & Short, 2008) and is restricted to the Neotropics and the extreme southern Nearctic region. Within *Pristoternus sensu* Hansen (1999), *T. laevis* (Sturm, 1826) and *T. ovalis* Castelnau, 1840 are widely distributed, ranging from Central America to southern South America. On the contrary, *T. latus* (Brullé, 1837) has a more restricted distribution, being known only from specific locations in Brazil (Rio de Janeiro), Uruguay (Montevideo) and Argentina (Buenos Aires and Entre Ríos Provinces).

This paper is meant to be a step towards a better knowledge of the genus *Tropisternus*, and has the following objectives: (i) to describe and illustrate the egg cases, the three larval instars and the pupae of *T. latus, T. ovalis* and *T. laevis*; (ii) to perform detailed morphometric and chaetotaxic studies on selected larval structures; and (iii) to compare the immatures described here with those of other members of the genus.

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Material and methods

Source of material. Adults of *T. latus* and *T. ovalis* were collected in the field and brought alive to the laboratory in order to obtain egg cases. Larvae and pupa of *T. laevis* were obtained from rearing egg cases collected in the field and reared to the adult stage to confirm identification. Rearing techniques followed those detailed in Torres *et al.* (2008).

Methods. Larvae and pupae were fixed with boiling water and then transferred to 96% ethyl alcohol. Egg cases were fixed and preserved in 96% ethyl alcohol. Larval specimens were cleared in lactic acid for several days, dissected and mounted on glass slides with polyvinyl-lacto-glycerol. Observation (at magnifications up to 1000x) and drawings of larvae were made using an Olympus CX31 compound microscope equipped with a drawing tube. Pupae were drawn with a Leica MZ6 stereoscopic microscope equipped with a drawing tube. The material studied is held in the larval collection of P.L.M. Torres (Laboratory of Entomology, Buenos Aires University, Argentina). Adults were identified using the key of Oliva *et al*. (2002).

Taxonomic descriptions. The methods and terms used in the present paper follow those employed in recent papers dealing with the larval morphology and chaetotaxy of members of the subfamily Hydrophilinae (Torres *et al.*, 2008; Byttebier & Torres, 2009). A detailed generic description of the immatures of the genus *Tropisternus* was recently published by Torres *et al.* (2008, 2011). For this reason, most non-chaetotaxic characters commonly recognized as present in all species of the genus are not included in the present descriptions, and only diagnostic or notable features are presented. The description of the subgenus *Pristoternus sensu* Hansen (1999) is based on the three available species including characters common to all of them. Therefore, larvae of *T. latus*, *T. ovalis* and *T. laevis* should be considered similar in all aspects described; the diagnostic characters are included under the treatment of each species.

Morphometric analysis. Several individual measurements were used to calculate ratios, which characterize body shape. Larval structures to be measured were adjusted as parallel as possible to the plane of the objective. The following measurements were taken (with abbreviations shown in parentheses): total body length (TL); maximum body width measured at level of metathorax (MW); head length measured dorsomedially from anterior margin of frontoclypeus to occipital foramen (HL); maximum head width measured at level of stemmata (HW); length of antenna (AL) derived by adding the lengths of the first (A1), second (A2) and third (A3) antennomere; length of stipes (SL); length of maxillary palpus (MPL) derived by adding the lengths of the first (MP1), second (MP2), third (MP3) and fourth (MP4) palpomere; length of maxilla (ML) derived by adding SL and MPL (cardo omitted); length of labial palpus (LPL) derived by adding the lengths of the first (LP1) and second (LP2) palpomere; length of ligula (LigL); maximum width of mentum (MtW); length of prementum (PrmtL) measured from its base to the base of LP1; maximum width of prementum (PrmtW); lengths of pro- (Leg 1 L), meso- (Leg 2 L) and metathoracic (Leg 3 L) leg derived by adding the lengths of coxa (CO), trochanter (TR), femur (FE), tibiotarsus (TITA) and claw (CL). The length of trochanter includes only the proximal portion, the length of distal portion is included in the femoral length.

Chaetotaxy. Primary (present in first-instar larva) and secondary (arising in later instars) setae and pores were distinguished in the cephalic capsule and head appendages. Sensilla present in first-instar larvae of *T. latus*, *T. ovalis* and *T. laevis* were labeled by comparison with the ground plan of chaetotaxy of the family Hydrophilidae (Fikáček *et al.*, 2008; Byttebier & Torres, 2009). Homologies were established using the criterion of similarity of position (Wiley, 1981). Sensilla were coded with two capital letters, in most cases corresponding to the first two letters of the name of the structure on which they are located, and a number. The following abbreviations were used: AN = antenna, FR = frontale, LA = labium, MN = mandible, MX = maxilla, PA = parietale. Setae located at the apices of maxillary and labial palpi were extremely difficult to distinguish due to their position and small size. Accordingly, they are not well represented in the drawings.

Results

Description of the immatures of *Tropisternus* Solier, subgenus *Pristoternus* Orchymont

Diagnosis. ***Egg case:*** whitish, bag-shaped. Subcircular to subtriangular in cross section. With or without mast;

when present, ribbon-like or globular. ***Larva:*** nasale with 7 anterior denticles (all instars), and 2 anteroventral denticles (instars II–III). Distal tooth of mandible bifid apically, with outer lateral surface slightly serrated. Anterolateral angles of mentum strongly projected forward. Prementum about as long as broad (instar I) to 3/4 as long as broad (instar III). Pore LA15 subapical. Seta AN8 present. Seta AN9 absent. ***Pupa:*** abdominal segments II–VI with 6 or 8 styli, pleural styli short or very long. Abdominal segments II–VI with or without horn-like projections.

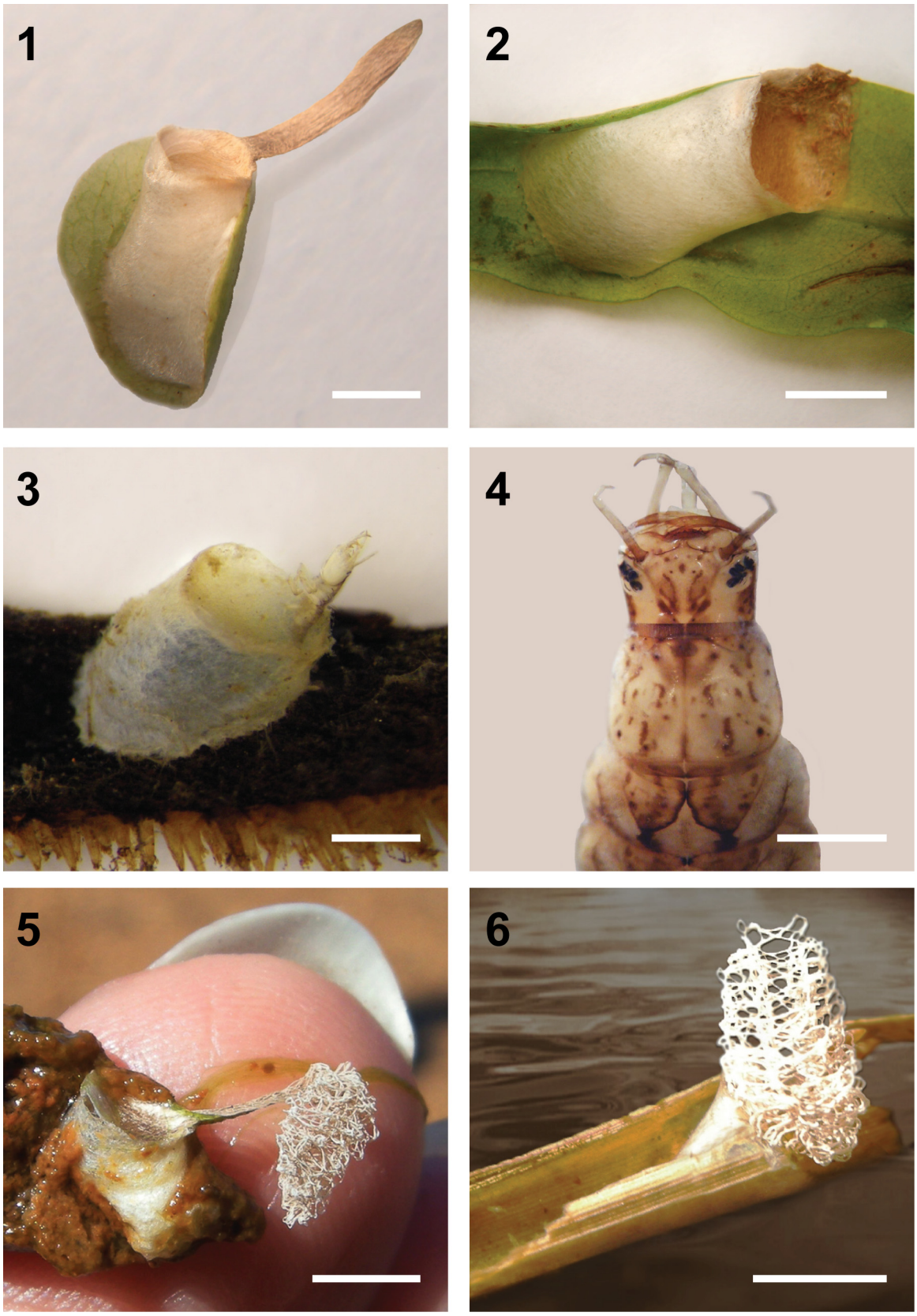
Chaetotaxy of first-instar larva. Head capsule (Figs. 7–9, 12, 22–24, 32–34): frontale (Fig. 12) with 50 sensilla: 4 short setae (FR1, FR3) and 2 pores (FR2) near midline between frontal sulci; 3 setae (FR5, FR6, FR7) and 1 pore (FR4) near the base of each antenna. Nasale (Figs. 12, 24, 34) with 6 equidistant, stout, short setae on anterior margin and 1 minute seta-like sensilla among median teeth (gFR1); 2 pores (FR15) and 2 long setae (FR8) located posteriorly to median setae of nasale. Each epistomal lobe with 2 pores and four distal setae, inner two very short, outer two long (gFR2); 1 minute seta (FR12) and 2 pores (FR11, FR13) between nasale and epistomal lobe. Two long setae (FR9, FR10) and 1 pore (FR14) near each antennal socket. Each parietal (Figs. 7–9, 22–23, 32–33) with 30 sensilla: dorsal surface with a group of 4 setae (PA1, PA2, PA4, PA5) and 1 pore (PA3) placed in a row posteriorly; 1 pore (PA6) near frontal sulci, close to coronal sulcus. Five setae (PA8–PA9, PA11, PA14, PA20) and 3 pores (PA10, PA15, PA19) on the stemmatal area, and 3 setae (PA7, PA12–13) placed posteriorly to stemmata. Ventral surface with 2 setae (PA21, PA22) and 3 pores (PA23, PA24, PA25) near mandibular acetabulum; 2 setae (PA16, PA18) and 1 pore (PA17) on the lateral surface at about mid-length; 2 setae (PA26, PA28) and 1 pore (PA27) near midline, posterior to the tentorial pit; 2 pores (PA29, PA30) on basal third of the parietal. **Antenna (Figs. 13, 29, 39):** A1 with 2 dorsal pores (AN1, AN2) at basal third, and 2 lateral pores (AN3, AN4) and 1 ventral pore (AN5) at the tip. A2 with 1 dorsal pore (AN6) at mid-length, 1 short seta (AN11) and 1 long seta (AN10) apically on inner lateral surface and 2 minute setae (AN7, AN8) and the sensorium (SE1) on outer lateral surface; seta AN9 absent. A3 with 5 short setae and 2 long setae apically projecting mediad (gAN). **Mandible (Figs. 16–17, 27–28, 37–38):** with 1 long seta (MN1) and 3 pores (MN2, MN3, MN4) at mid-length and 1 minute seta (MN5) and 1 pore (MN6) distally. **Maxilla (Figs. 14–15, 30–31, 40–41):** cardo with 1 long seta (MX1). Stipes with 10 sensilla: 5 setae (MX7–11) on inner lateral surface, 2 long distal setae (MX5, MX6) on outer lateral surface and 3 ventral pores: one at the base (MX2), one at about mid-length (MX3) and one distally (MX4). MP1 with 1 dorsal seta at the base (MX16) and 2 setae (MX13, MX14) and 1 pore (MX12) ventrally on distal portion; inner process of MP1 with 2 pores at the base (1 ventral (MX15), 1 dorsal (MX17)), and 1 long and 4 short setae at the tip (gAPP). MP2 with 2 pores (1 ventral (MX18), 1 dorsal (MX19)) and 1 basal seta on the outer lateral surface (MX27). MP3 with 2 subapical setae (MX21, MX23) and 2 distal pores (MX20, MX22). MP4 with 1 long basal seta (MX24) on inner lateral surface, 1 digitiform sensillum (MX25) and 1 ventral pore (MX26) subapically and several short sensilla on apex (gMX). **Labium (Figs. 8, 10–11, 23, 25–26, 33, 35–36):** submentum with 2 pairs of setae (LA1, LA2) (Figs. 8, 23, 33). Mentum with 2 setae (LA3) and 2 pores (LA4) at distal third of ventral surface. Prementum with 2 dorsal pores (LA8) and 2 ventral minute setae (LA5) at the base, 2 minute setae (LA9) and 2 long setae (LA10) dorsally and 2 pores (LA7) and 2 long setae (LA6) ventrally on distal third; ligula with 2 ventral pores (LA11) and 2 dorsal sensilla (LA12) near the tip. LP1 with 1 dorsal pore (LA14) distally and 1 minute ventral seta at the base (LA13). LP2 with 1 subapical dorsal pore (LA15) on outer lateral surface and several apical setae (gLA).

***Tropisternus* (*Pristoternus*) *latus* (Brullé, 1837)**
(Figs. 1–2, 7–19)

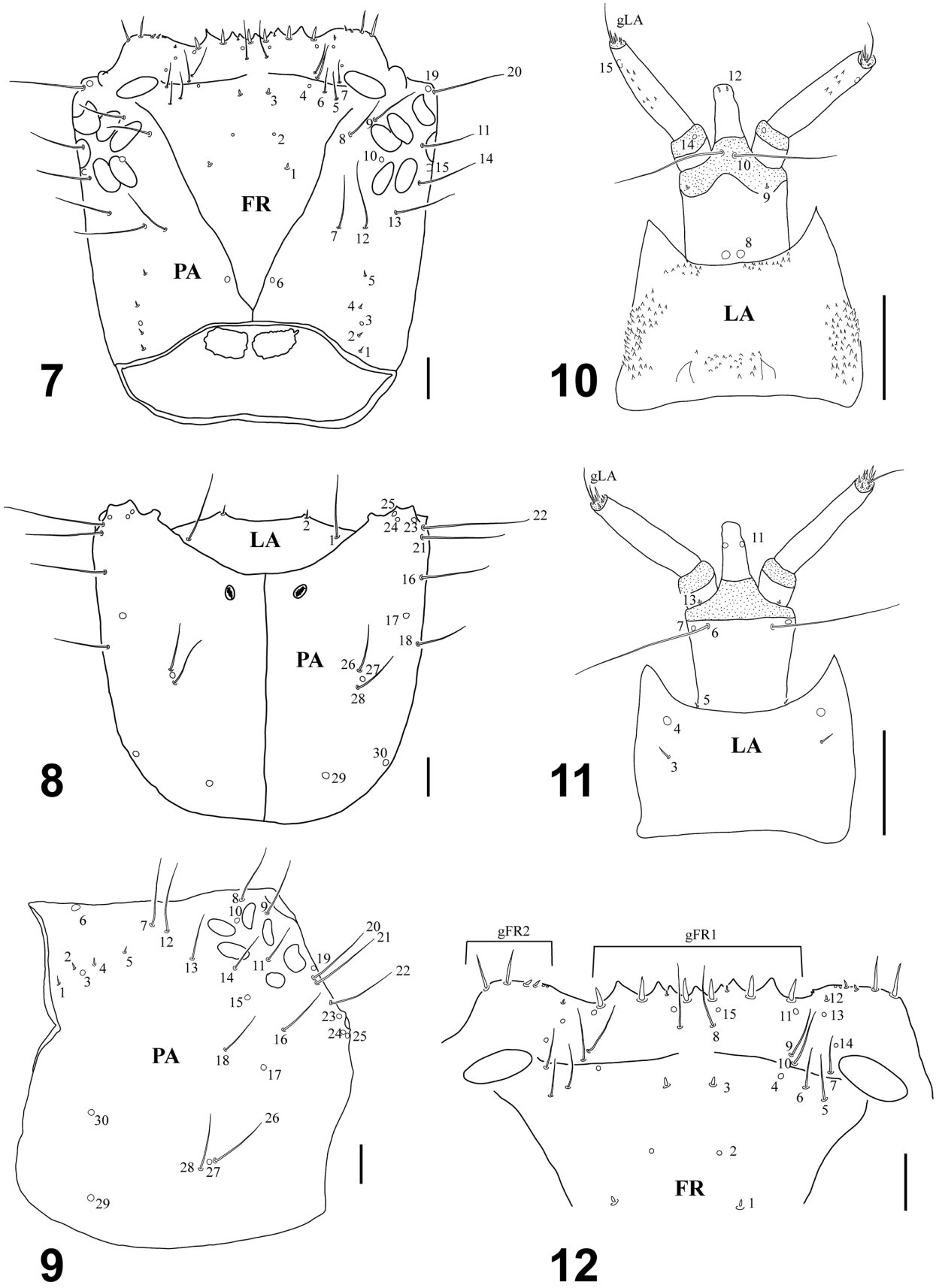
Material examined. Seven egg cases, 8 larvae of instar I, 6 of instar II, 5 of instar III and 5 pupae were used for the descriptions. Breeding adults were collected at the following locality: Argentina: Buenos Aires Province, Sierra de la Ventana (Ernesto Tornquist Provincial Park), X-2007 (see Fig. 1 in Fernández *et al.* 2010).

Description, egg case (Figs. 1–2). Whitish, saccular, subtriangular in cross-section. Mast present (n = 4) (Fig. 1) or absent (n = 3) (Fig. 2). Length = 10.7–12.4 mm, width = 8.3–8.7 mm, height = 5.3–5.8 mm; cap length = 5.2–5.7 mm; mast length= 11.5–12.8 mm. Mast length/cap length = 2.21–2.24.

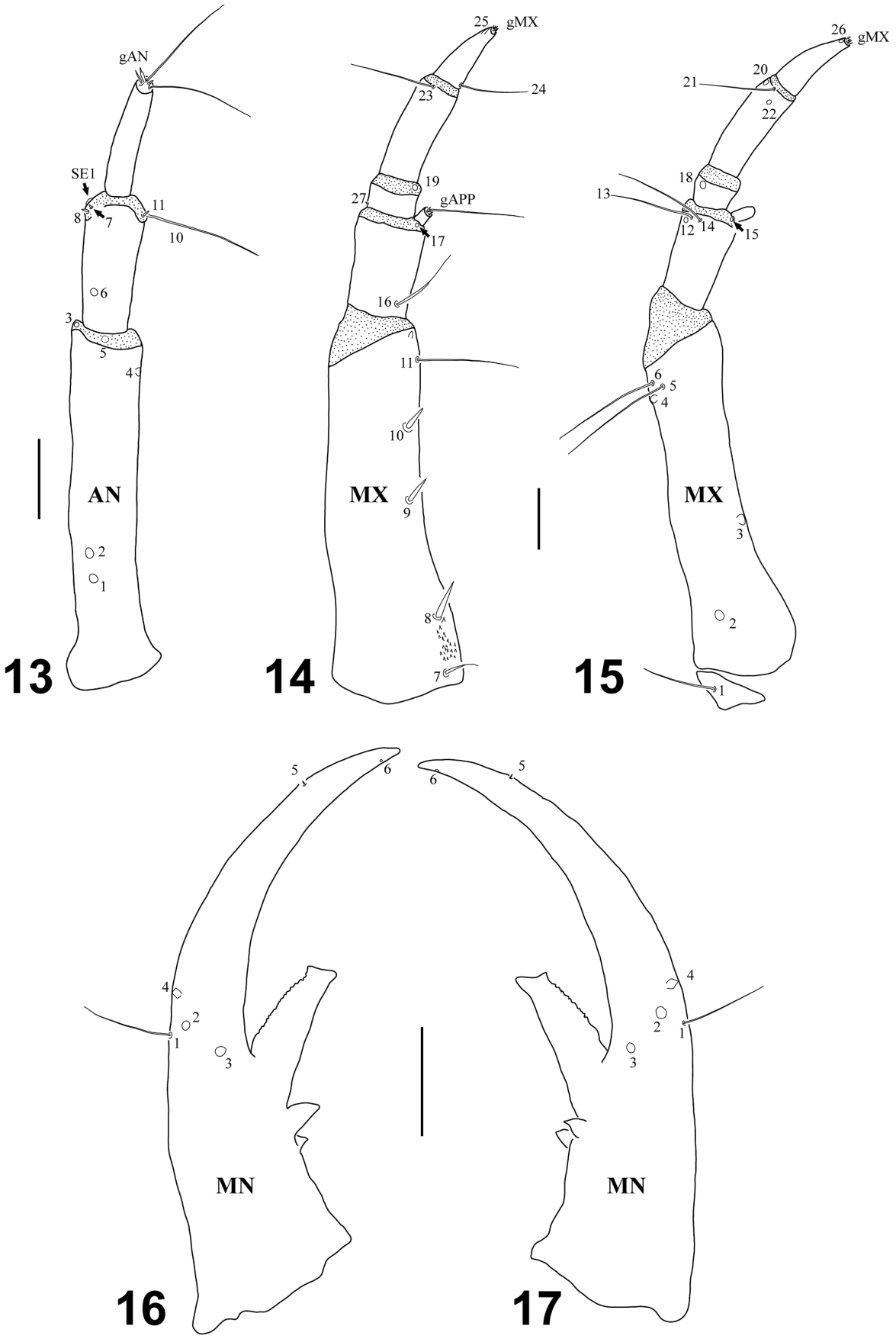
Description, instar I (Figs. 7–17). Color: head capsule testaceous, with pale brown areas around frontal sulci and on dorsolateral surface of parietale. Cephalic and thoracic appendages yellowish. Thoracic tergites testaceous, with some pale brown scattered maculae; thoracic sternites testaceous. **Body:** for morphometric measurements and



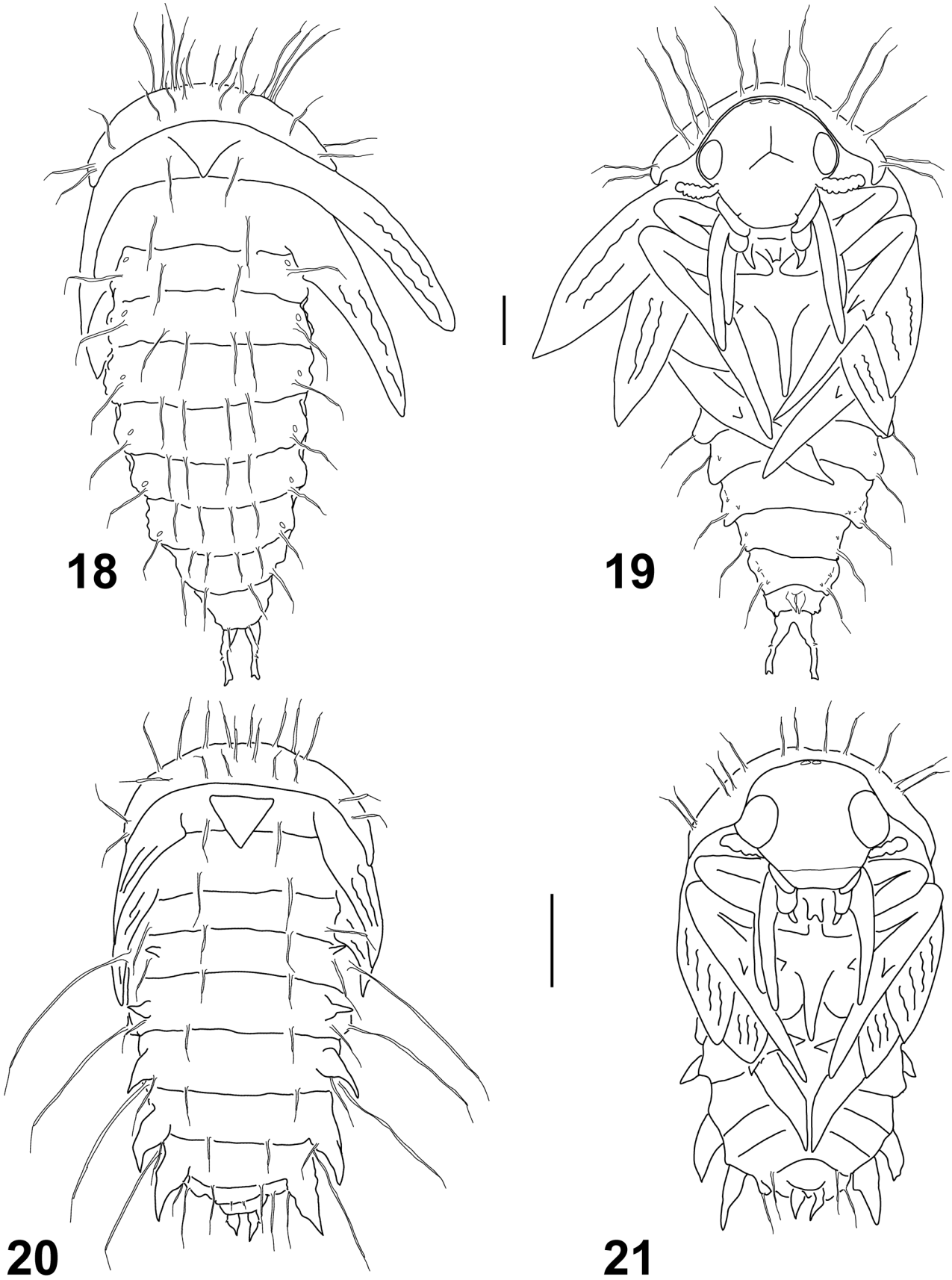
FIGURES 1–6. Egg cases and larva of *Tropisternus*. 1, *T. latus*, egg case with mast; 2, *T. latus*, egg case without mast; 3, *T. ovalis,* egg case with larva emerging; 4, *T. laevis,* third instar larva, anterior aspect in dorsal view; 5, *T. laevis*, egg case showing the globular mast; 6, *T. laevis*, floating egg case as found in nature. Scale bars = 5 mm for figs. 1, 2, 5 and 6; 2 mm for fig. 3; 1 mm for fig. 4.



FIGURES 7–12. *Tropisternus latus*, first instar larva. 7, Head capsule, dorsal view; 8, Head capsule, ventral view; 9, Head capsule, right lateral view; 10, Labium, dorsal view; 11, Labium, ventral view; 12, Frontoclypeus, dorsal view. Scale bars = 0.1 mm.



FIGURES 13–17. *Tropisternus latus*, first instar larva. 13, Left antenna, dorsal view; 14, Left maxilla, dorsal view; 15, Right maxilla, ventral view; 16, Left mandible, dorsal view; 17, Right mandible, dorsal view. Scale bars = 0.1 mm.



FIGURES 18–21. *Tropisternus* pupae. 18, *T. latus*, habitus, dorsal view; 19, *T. latus*, habitus, ventral view; 20, *T. ovalis*, habitus, dorsal view; 21, *T. ovalis*, habitus, ventral view. Scale bars = 1 mm.

TABLE 1. Measurements (in mm) and ratios for the three larval instars of *Tropisternus latus*.

Measure	Instar I	Instar II	Instar III
TL	2.58–4.30	9.00–11.50	15.00–16.50
MW	0.83–1.00	2.00–2.50	3.50–4.00
HL	0.72–0.73	1.20–1.25	1.70–1.73
HW	0.96–0.99	1.55–1.73	2.23–2.25
HL/HW	0.74–0.75	0.72–0.77	0.76–0.77
AL	0.74–0.76	1.25–1.28	1.62–1.71
A1L	0.42–0.44	0.80–0.82	1.10–1.20
A2L	0.18	0.24	0.28
A3L	0.15	0.21–0.22	0.24
A1L/(A2L+A3L)	1.27–1.33	1.80	2.10–2.33
HL/AL	0.96–0.97	0.96–0.98	0.99–1.06
HW/AL	1.29–1.30	1.24–1.35	1.30–1.38
SL	0.54–0.55	0.97–0.99	1.38–1.40
MPL	0.46–0.47	0.67	0.83–0.85
SL/MPL	1.18	1.44–1.47	1.61–1.68
MP1L	0.14	0.24	0.29–0.31
MP2L	0.05	0.08–0.09	0.12–0.13
MP2W	0.06	0.08–0.09	0.08–0.09
MP3L	0.16	0.20	0.26
MP4L	0.11–0.12	0.15	0.16
MP2L/MP2W	0.85–0.92	0.94–1.13	1.39–1.53
ML	1.00–1.02	1.64–1.66	2.23
LPL	0.18–0.19	0.26–0.27	0.25–0.30
LP1L	0.04	0.05–0.06	0.05–0.07
LP2L	0.14–0.15	0.21	0.20–0.23
LP2L/LP1L	3.33–3.50	3.50–3.82	3.29–4.00
LigL/LPL	0.41–0.44	0.41–0.42	0.45–0.52
MtW	0.25	0.47–0.48	0.68–0.69
PrmtW/PrmtL	0.93–1.00	0.86–0.90	0.74–0.78
PrmtW/MtW	0.52	0.40	0.33–0.34
LEG 1 L	1.84–1.89	2.71–2.72	3.76–3.81
LEG 2 L	1.94–1.98	2.87–2.89	4.00–4.08
LEG 3 L	1.99–2.03	3.10–3.13	4.39–4.41
LEG 3/LEG 1	1.05–1.10	1.14–1.15	1.16–1.17
LEG 3/LEG 2	1.01–1.05	1.08	1.08–1.10
LEG 1 (TITA/FE)	0.74–0.80	0.74–0.77	0.72–0.73
LEG 2 (TITA/FE)	0.78–0.80	0.73	0.67–0.71
LEG 3 (TITA/FE)	0.81–0.89	0.78–0.79	0.73–0.76
LEG 1 (CL/TITA)	0.65	0.50–0.51	0.43–0.46
LEG 2 (CL/TITA)	0.64	0.50	0.44–0.47
LEG 3 (CL/TITA)	0.56–0.64	0.45–0.48	0.38–0.41

ratios see Table 1. **Head capsule (Figs. 7–9, 12):** nasale with 7 teeth on anterior margin, without anteroventral denticles (Fig. 12). **Mandibles (Figs. 16–17):** distal tooth of retinaculum bifid apically, outer lateral surface slightly serrate. **Labium (Figs. 10–11):** anterolateral angles of mentum strongly projected forward. Dorsolateral surface of mentum with strong spinulae. Dorsal surface of second labial palpomere with some spinulae. **Chaetotaxy. Antenna (Fig. 13):** seta AN8 present.

Description, instar II. As instar I except for the following features. **Color:** head capsule testaceous with brown areas around frontal sulci, maculae of parietale more notorious. Thoracic tergites with dark brown maculae. **Body:** for morphometric measurements and ratios see Table 1. **Head capsule:** nasale with two anteroventral denticles. **Chaetotaxy. Head capsule:** with 68–84 secondary setae distributed in the area delimited by the intersection of PA6, PA7 and FR1, between PA7 and PA10, between PA21 and PA26, and in the stemmatal area. Outer gFR2 setae blunt or pointed. **Mandibles:** with 2 short secondary setae at the base and 18–21 secondary minute sensilla distributed mainly along dorsolateral surface. **Antenna:** A1 with numerous secondary setae arranged as follows: 12–14 short setae on ventral surface, 19–32 stout spiniform setae on inner lateral surface, 3–4 setae on outer lateral surface, and two distal rings of long setae, apical one with 4–5 setae, the other with 10–11 setae. **Maxilla:** outer lateral surface of stipes with 7–8 hair-like secondary setae at the base, and 32–36 secondary setae unevenly distributed. Outer lateral surface of MP1 with 1 distal secondary seta. **Labium:** Mt with 1 stout secondary seta on each anterolateral angle, 4–6 secondary setae on laterobasal surfaces, 18–21 stout secondary setae on dorsal surface,and 8–11 thin secondary setae on ventral surface.

Description, instar III. As instar II except for the following features. **Body:** for morphometric measurements and ratios see Table 1. **Chaetotaxy. Head capsule:** 78–99 secondary setae with similar distribution as in instar II. **Mandibles:** with 2 short secondary setae at the base and 48–57 secondary minute sensilla distributed mainly along dorsolateral surface. **Antenna:** A1 with numerous secondary setae arranged as follows: 15–20 short setae on ventral surface, 33–36 stout spiniform setae on inner lateral surface, 6–7 setae on outer lateral surface, and two distal rings of long setae, apical one with 5 setae, the other with 9–12 setae. **Maxilla:** outer lateral surface of stipes with 5–6 hair-like secondary setae at the base, and 35–37 secondary setae unevenly distributed. **Labium:** Mt with 1 stout secondary seta on each anterolateral angle, 5–8 secondary setae on laterobasal surfaces, 21–23 stout secondary setae on dorsal surface, and 15–20 thin secondary setae on ventral surface.

Description, pupa (Figs. 18–19). Color: Whitish (young pupae) to pale brown (mature pupae). **Body:** TL (excluding pronotal styli and cerci) = 11.3–12.6 mm; MW = 4.9–5.8 mm. **Head:** posterior surface with two oval sclerites close to midline, without supraorbital styli. Antennae partially hidden by pronotum. Maxillary palpi extending beyond base of mesocoxae. **Thorax:** pronotum with 22 styli distributed as follows: 2 on pronotal disc and 20 on lateral surfaces (10 large styli anteriorly, 2 on each postero-lateral angle, and 6 styli posteriorly). Meso- and metanotum with 2 styli close to midline. Metasternal spine long. Metathoracic legs partially covered by wingpads. Tibiae with two apical spines. **Abdomen:** segment I with 4 styli; segments II–VI with 8 styli (6 in a transverse row on each tergum and 1 about two thirds shorter on each pleural area); segment VII with 6 styli (4 tergal and 1 on each pleural area); segment VIII with a pair of minute styli posteriorly; all styli with irregular surface and bearing a terminal seta; segment IX with 2 long bifid cerci, each bearing 2 spines at mid-length; segments II–VI without tubercles or horn-like projections.

Tropisternus (*Pristoternus*) *ovalis* Castelnau, 1840
(Figs. 3, 20–31)

Material examined. Three egg cases, 8 larvae of instar I, 3 of instar II, 4 of instar III and 2 pupae were used for the descriptions. Breeding adults were collected at the following locality: Argentina: Corrientes Province, Mburucuyá National Park, I-2008 (see Fig. 1 in Torres *et al.* 2012).

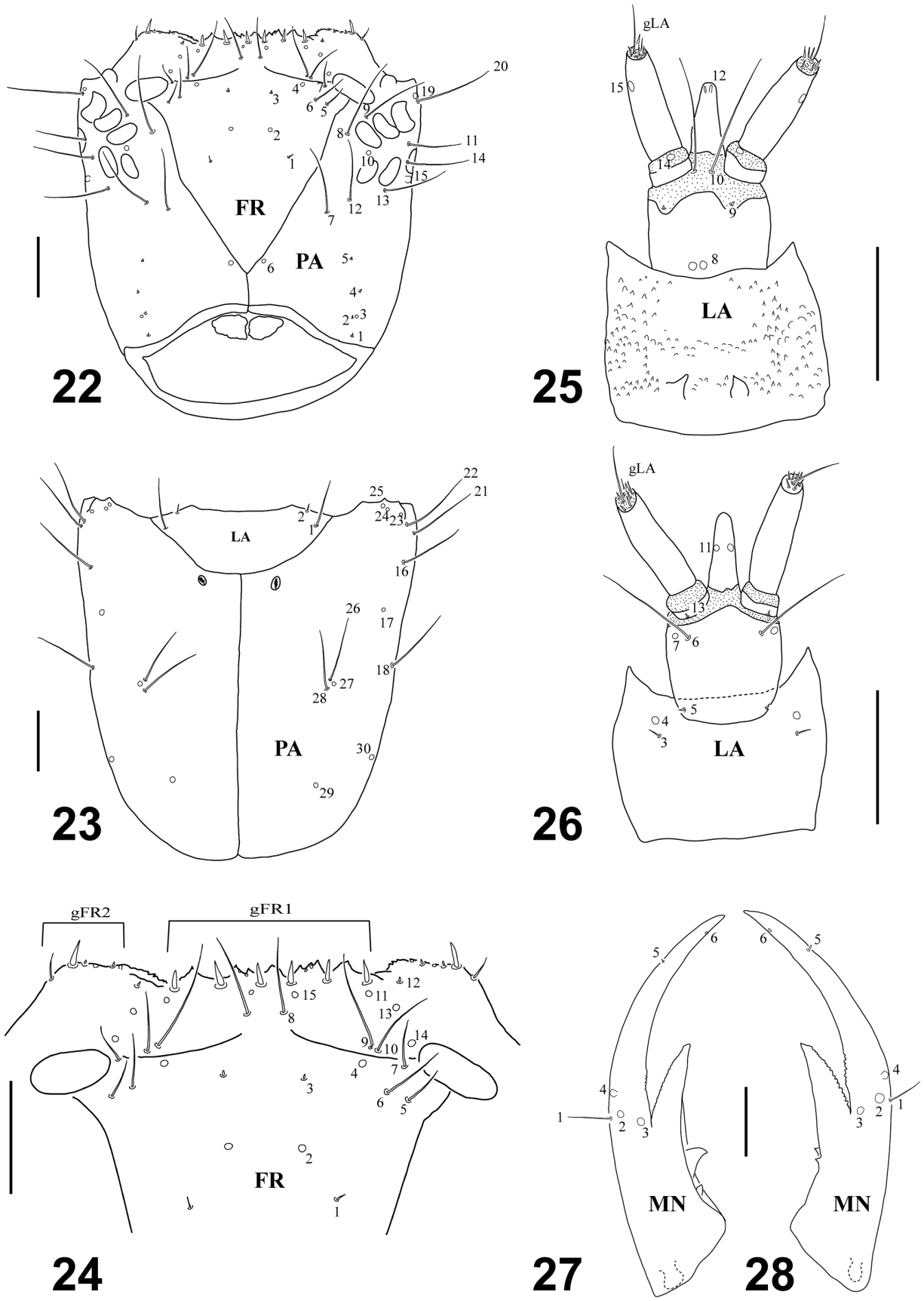
Description, egg case (Fig. 3). Whitish, saccular, subcircular in cross section. Mast absent. Length = 3.7–3.9 mm, width = 3.5–3.7 mm, height = 2.6–2.8 mm; cap length = 2.2–2.5 mm.

Description, instar I (Figs. 22–31). Color: head capsule testaceous, with yellowish areas around frontal sulci and on dorsolateral surface of parietale. Cephalic and thoracic appendages testaceous. Thoracic tergites testaceous with yellowish scattered maculae; thoracic sternites testaceous. **Body:** for morphometric measurements and ratios see Table 2. **Head capsule (Figs. 22–24):** nasale with 7–8 teeth on anterior margin, without anteroventral denticles (Fig. 24). **Mandibles (Figs. 27–28):** distal tooth of retinaculum bifid or unifid apically, outer lateral surface slightly

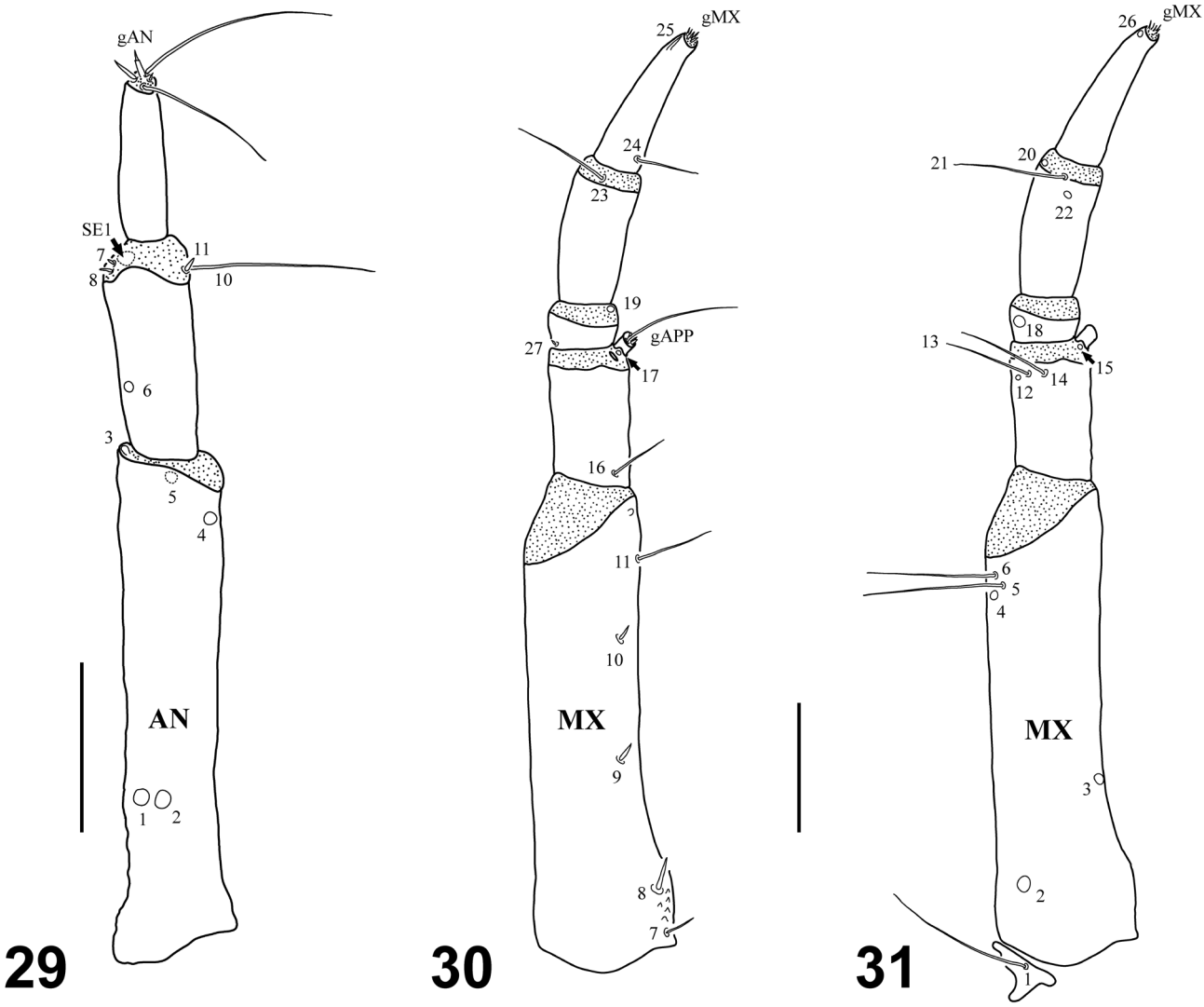
serrate. **Labium (Figs. 25–26):** anterolateral angles of mentum strongly projected forward. Dorsal surface of mentum with strong spinulae, central area with some scattered spinulae. Dorsal surface of second labial palpomere without spinulae. **Chaetotaxy. Antenna (Fig. 29):** seta AN8 present.

TABLE 2. Measurements (in mm) and ratios for the three larval instars of *Tropisternus ovalis*.

Measure	Instar I	Instar II	Instar III
TL	3.30–3.50	4.00–7.50	10.50–12.00
MW	0.60–0.80	0.70–1.50	1.80–1.90
HL	0.46–0.47	0.60–0.72	0.85–0.89
HW	0.58–0.61	0.74	1.10–1.14
HL/HW	0.76–0.78	0.72–0.86	0.75–0.81
AL	0.50–0.51	0.71–0.73	0.84–0.91
A1L	0.28–0.29	0.46–0.47	0.57–0.61
A2L	0.12–0.13	0.14–0.15	0.14–0.16
A3L	0.10	0.11–0.12	0.13–0.14
A1L/(A2L+A3L)	1.22–1.26	1.77	2.07–2.15
HL/AL	0.90	0.83–0.86	0.93–1.06
HW/AL	1.16–1.19	1.16	1.25–1.31
SL	0.36–0.38	0.54–0.57	0.74–0.75
MPL	0.37	0.45–0.47	0.52–0.56
SL/MPL	0.96–1.00	1.21–1.22	1.32–1.45
MP1L	0.11	0.14–0.15	0.16–0.17
MP2L	0.03–0.04	0.04–0.05	0.06
MP2W	0.04	0.04	0.04–0.05
MP3L	0.11	0.14	0.16–0.18
MP4L	0.11–0.12	0.13	0.14–0.15
MP2L/MP2W	0.82–0.89	1.00–1.11	1.30–1.33
ML	0.73–0.75	0.99–1.01	1.27–1.31
LPL	0.11	0.13–0.14	0.15
LP1L	0.02	0.02–0.03	0.03–0.04
LP2L	0.08–0.09	0.10–0.11	0.11–0.12
LP2L/LP1L	3.40–3.60	3.67–4.20	2.75–4.00
LigL/LPL	0.54–0.57	0.46–0.58	0.63–0.67
MtW	0.17	0.25–0.26	0.36–0.38
PrmtW/PrmtL	0.99–1.00	0.85–0.88	0.72–0.75
PrmtW/MtW	0.52–0.54	0.40–0.45	0.32–0.36
LEG 1 L	1.19–1.27	1.72–1.75	2.38–2.44
LEG 2 L	1.25–1.34	1.77–1.89	2.53–2.57
LEG 3 L	1.43–1.44	1.95–2.00	2.85–2.90
LEG 3/LEG 1	1.13–1.20	1.13–1.14	1.17–1.22
LEG 3/LEG 2	1.07–1.15	1.06–1.10	1.11–1.14
LEG 1 (TITA/FE)	0.80–0.88	0.75–0.78	0.75–0.76
LEG 2 (TITA/FE)	0.79–0.81	0.69–0.73	0.68–0.70
LEG 3 (TITA/FE)	0.82–0.87	0.75–0.77	0.68–0.72
LEG 1 (CL/TITA)	0.63	0.54	0.45–0.48
LEG 2 (CL/TITA)	0.53–0.72	0.57–0.61	0.49–0.54
LEG 3 (CL/TITA)	0.63–0.64	0.49–0.55	0.51



FIGURES 22–28. *Tropisternus ovalis*, first instar larva. 22, Head capsule, dorsal view; 23, Head capsule, ventral view; 24, Frontoclypeus, dorsal view; 25, Labium, dorsal view; 26, Labium, ventral view; 27, Left mandible, dorsal view; 28, Right mandible, dorsal view. Scale bars = 0.1 mm.



FIGURES 29–31. *Tropisternus ovalis*, first instar larva. 29, Left antenna, dorsal view; 30, Left maxilla, dorsal view; 31, Right maxilla, ventral view. Scale bars = 0.1 mm.

Description, instar II. As instar I except for the following features. **Color:** head capsule with some maculae present around frontal sulci and on dorsolateral surface of parietale. **Body:** for morphometric measurements and ratios see Table 2. **Head capsule:** nasale with two anteroventral denticles. **Chaetotaxy. Head capsule:** with 17–18 secondary setae distributed in the area between FR1 and PA7, and near PA18. Outer gFR2 setae spiniform. **Mandibles:** with 2 short secondary setae at the base and 29–35 secondary minute sensilla distributed mainly along dorsolateral surface. **Antenna:** A1 with numerous secondary setae arranged as follows: 6–7 short setae on ventral surface, 2 slender setae and 14–15 stout spiniform setae on inner lateral surface, 6–7 setae on outer lateral surface, and two distal rings of long setae, apical one with 3 setae, the other with 7–8 setae. **Maxilla:** outer lateral surface of stipes with 2–4 hair-like secondary setae at the base, and 17–20 secondary setae unevenly distributed. Outer lateral surface of MP1 with 1 distal secondary seta. **Labium:** Mt with 1 stout secondary seta on each anterolateral angle, 4–6 secondary setae on laterobasal surfaces, 10–12 stout secondary setae on dorsal surface, and 4–6 thin secondary setae on ventral surface.

Description, instar III. As instar II except for the following features. **Body:** for morphometric measurements and ratios see Table 2. **Chaetotaxy. Head capsule:** 18–19 secondary setae with similar distribution as in instar II. **Mandibles:** with 2 short secondary setae at the base and 29–40 secondary minute sensilla distributed mainly along dorsolateral surface. **Antenna:** A1 with numerous secondary setae arranged as follows: 4–7 short setae on ventral surface, 1–2 slender setae and 14–15 stout spiniform setae on inner lateral surface, 4–5 setae on outer lateral surface, and two distal rings of long setae, apical one with 3 setae, the other with 7–9 setae. **Maxilla:** outer lateral

surface of stipes with 2–3 hair-like secondary setae at the base, and 14–18 secondary setae unevenly distributed. **Labium:** Mt with 1 stout secondary seta on each anterolateral angle, 6–9 secondary setae on laterobasal surfaces, 10–13 stout secondary setae on dorsal surface, and 6–10 thin secondary setae on ventral surface.

Description, pupa (Figs. 20–21). Similar to the pupa of *T. latus* except for the following features. **Body:** TL (excluding pronotal styli and cerci) = 5.0–5.8 mm; MW = 2.8–3.1 mm. **Thorax:** pronotum with 18–19 styli distributed as follows: 4 on pronotal disc and 14–15 on lateral surfaces (8 large styli anteriorly, 2 on each postero-lateral angle, and 4–5 styli posteriorly). Metasternal spine short. **Abdomen:** segments II–VII with 6 styli (4 in a transverse row on each tergum and 1 about six times longer on each pleural area); segment IX with 2 short, apically unifid cerci; segments II–VI with lateral tubercles or horn-like projections.

Tropisternus (*Pristoternus*) *laevis* (Sturm, 1826)

(Figs. 4–6, 32–41)

Material examined. Four egg cases, 2 larvae of instar I, 2 of instar II, 3 of instar III and 1 pupa were used for the descriptions. Egg cases were collected at the following locality: Argentina: Entre Ríos Province, El Palmar National Park, II-2004 (see Fig. 1E in Torres *et al.* 2007).

Description, egg case (Figs. 5–6). Whitish, of variable shape according to the substrate, mostly subtriangular in cross section. Mast present, distal part of mast made of loosen silk, appearing globular. Length = 5.0–7.4 mm, width = 2.2–7.5 mm, height = 2.5–3.4 mm; cap length = 3.2–3.3 mm; mast length = 6.2–7.0 mm. Mast length/cap length = 1.89–2.19.

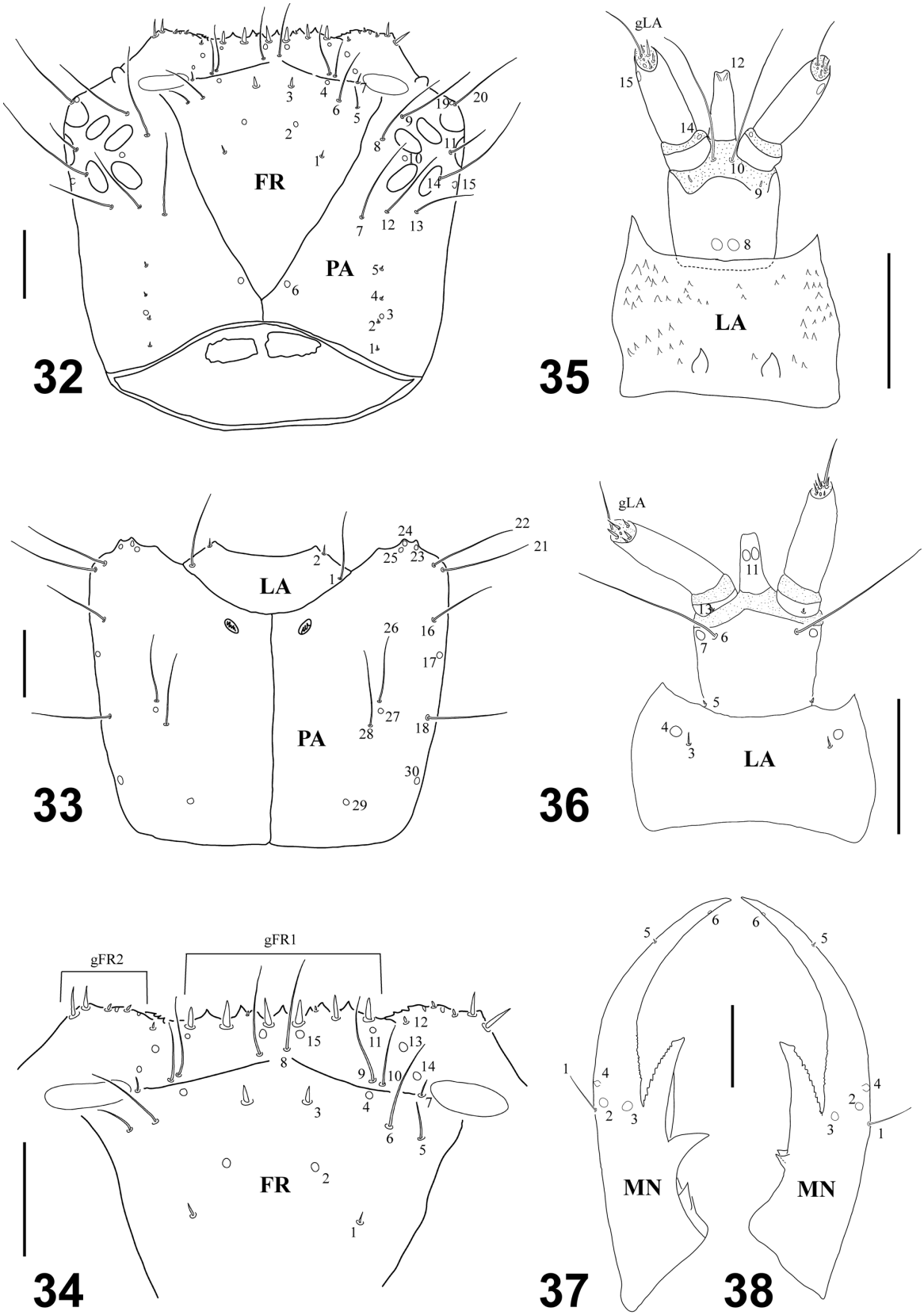
Description, instar I (Figs. 32–41). Color: Head capsule testaceous to pale brown except for some brown areas posterior to nasale, around frontal sulci, and laterally in the parietale. Thoracic tergites testaceous to pale brown, with several brown maculae. Cephalic and thoracic appendages testaceous. **Body:** for morphometric measurements and ratios see Table 3. **Head capsule (Figs. 32–34):** nasale with 7 teeth on anterior margin, without anteroventral denticles (Fig. 34). **Mandibles (Figs. 37–38):** distal tooth of retinaculum bifid apically, outer lateral surface slightly serrate. **Labium (Figs. 35–36):** anterolateral angles of mentum strongly projected forward. Dorsal surface of second labial palpomere without spinulae. Dorsal surface of mentum with strong spinulae, central area with very few scattered spinulae. **Chaetotaxy. Antenna (Fig. 39):** seta AN8 present.

Description, instar II. As instar I except for the following features. **Color:** head capsule with brown color pattern around frontal sulci, parietale with lateral maculae. **Body:** for morphometric measurements and ratios see Table 3. **Chaetotaxy. Head capsule:** with 13–16 secondary setae distributed in the area delimited by the intersection of PA7, PA8 and FR1, and between PA18-30. Outer gFR2 setae spiniform. **Mandibles:** with 2 short secondary setae at the base and 25–33 secondary minute sensilla distributed mainly along dorsal and lateral surfaces. **Antenna:** A1 with numerous secondary setae arranged as follows: 5–8 short setae on ventral surface, 1 slender seta and 13–15 stout spiniform setae on inner lateral surface, 4–5 setae on outer lateral surface, and two distal rings of long setae, apical one with 2–3 setae, the other with 7 setae. **Maxilla:** Outer lateral surface of stipes with 2 hair-like secondary setae at the base, and 25–33 secondary setae unevenly distributed. **Labium:** Mt with 1 stout secondary seta on each anterolateral angle, 2–3 secondary setae on laterobasal surfaces, 10–13 stout secondary setae on dorsal surface, and 3–4 thin secondary setae on ventral surface.

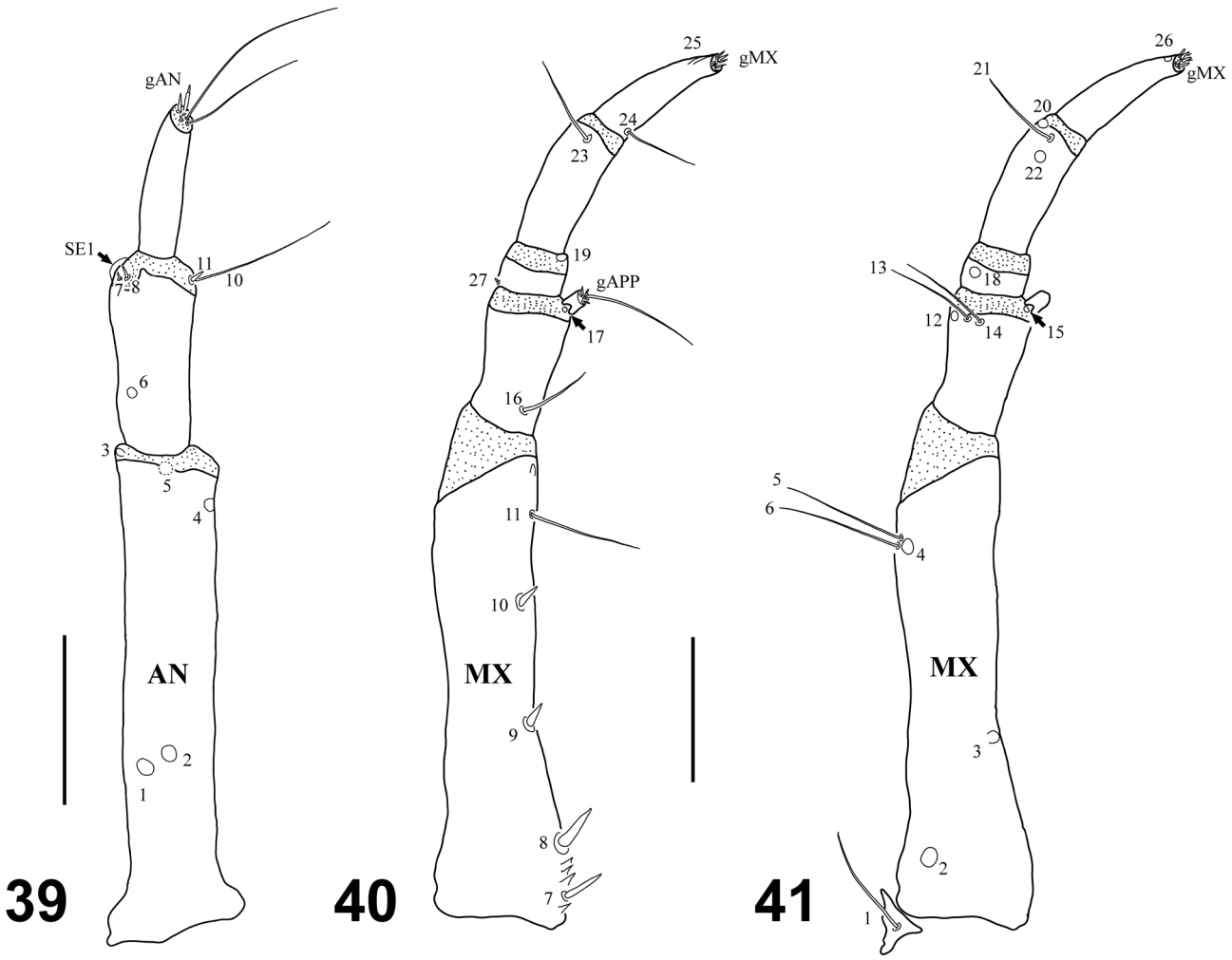
Description, instar III. As instar II except for the following features. **Color:** head capsule with well defined color pattern (Fig. 4). **Body:** for morphometric measurements and ratios see Table 3. **Chaetotaxy. Head capsule:** 13–19 secondary setae with similar distribution as in instar II. **Mandibles:** with 1–2 short secondary setae at the base and 20–23 secondary minute sensilla distributed mainly along dorsal and lateral surfaces. **Antenna:** A1 with numerous secondary setae arranged as follows: 5–6 short setae on ventral surface, 1–3 slender setae and 15–16 stout spiniform setae on inner lateral surface, 6–7 setae on outer lateral surface, and two distal rings of long setae, apical one with 2–3 setae, the other with 6–8 setae. **Maxilla:** Outer lateral surface of stipes with 1–3 hair-like secondary setae at the base, and 13–17 secondary setae unevenly distributed. **Labium:** Mt with 1 stout secondary seta on each anterolateral angle, 3–7 secondary setae on laterobasal surfaces, 13–17 stout secondary setae on dorsal surface, and 5–8 thin secondary setae on ventral surface.

TABLE 3. Measurements (in mm) and ratios for the three larval instars of *Tropisternus laevis*.

Measure	Instar I	Instar II	Instar III
TL	3.55–4.20	3.60–7.10	8.50–11.50
MW	0.75	0.90–1.25	2.10–2.30
HL	0.46–0.47	0.66–0.76	0.93–0.94
HW	0.53–0.56	0.90–1.01	1.09–1.25
HL/HW	0.82–0.85	0.74–0.75	0.74–0.86
AL	0.48–0.49	0.71–0.78	1.04–1.09
A1L	0.27–0.28	0.48–0.51	0.70–0.76
A2L	0.12	0.14–0.15	0.18–0.19
A3L	0.09	0.10–0.12	0.15
A1L/(A2L+A3L)	1.26–1.33	1.93–2.00	2.09–2.30
HL/AL	0.94–0.97	0.93–0.97	0.85–0.90
HW/AL	1.10–1.18	1.26–1.29	1.05–1.14
SL	0.33–0.38	0.52–0.61	0.78–0.89
MPL	0.31–0.32	0.40–0.41	0.49–0.52
SL/MPL	1.07–1.16	1.31–1.48	1.61–1.70
MP1L	0.10	0.14	0.19
MP2L	0.03	0.17–0.19	0.06–0.07
MP2W	0.05	0.05	0.05
MP3L	0.09–0.10	0.11–0.12	0.13–0.15
MP4L	0.09	0.11	0.10–0.13
MP2L/MP2W	0.58–0.74	0.85–0.95	1.20–1.27
ML	0.63–0.70	0.92–1.03	1.27–1.42
LPL	0.09–0.10	0.13	0.18
LP1L	0.02	0.02–0.03	0.04–0.05
LP2L	0.07–0.08	0.10	0.13–0.14
LP2L/LP1L	4.00–4.29	3.82–4.37	2.60–3.50
LigL/LPL	0.49–0.63	0.51–0.62	0.61–0.67
MtW	0.16–0.17	0.25	0.40–0.41
PrmtW/PrmtL	0.88–1.00	0.81–0.82	0.65–0.76
PrmtW/MtW	0.52–0.54	0.41–0.42	0.32–0.33
LEG 1 L	1.02–1.09	1.71–1.74	2.60–2.62
LEG 2 L	1.17–1.20	1.76–1.78	2.77
LEG 3 L	1.21–1.29	1.92–2.05	2.97–3.01
LEG 3/LEG 1	1.18	1.12–1.18	1.14–1.15
LEG 3/LEG 2	1.01–1.10	1.08–1.16	1.07–1.09
LEG 1 (TITA/FE)	0.90–0.93	0.80–0.81	0.77–0.78
LEG 2 (TITA/FE)	0.85–0.93	0.80	0.70–0.73
LEG 3 (TITA/FE)	0.91–0.94	0.80–0.81	0.76–0.77
LEG 1 (CL/TITA)	0.58–0.59	0.39–0.45	0.40–0.43
LEG 2 (CL/TITA)	0.61–0.64	0.46–0.55	0.43–0.47
LEG 3 (CL/TITA)	0.56–0.57	0.48–0.51	0.38–0.39



FIGURES 32–38. *Tropisternus laevis*, first instar larva. 32, Head capsule, dorsal view; 33, Head capsule, ventral view; 34, Frontoclypeus, dorsal view; 35, Labium, dorsal view; 36, Labium, ventral view; 37, Left mandible, dorsal view; 38, Right mandible, dorsal view. Scale bars = 0.1 mm.



FIGURES 39–41. *Tropisternus laevis*, first instar larva. 39, Left antenna, dorsal view; 40, Left maxilla, dorsal view; 41, Right maxilla, ventral view. Scale bars = 0.1 mm.

Description, pupa. Similar to the pupa of *T. latus* except for the following features. **Body:** TL (excluding pronotal styli and cerci) = 7.9 mm; MW = 3.0 mm. **Thorax:** pronotum with 22 styli distributed as follows: 4 on pronotal disc and 18 on lateral surfaces (8 large styli anteriorly, 2 on each postero-lateral angle, and 6 posteriorly). **Abdomen:** segments II–VII with 6 styli (4 in a transverse row on each tergum and 1 about 40% longer on each pleural area).

Discussion

Egg case morphology. Several species of *Tropisternus* are known to build silk egg cases with a mast of variable length (Torres *et al.*, 2008). However, others, like those of *T. noa* Fernández & Bachmann and *T. sahlbergi* (Sharp) lack a mast (Fernández *et al.*, 2000; Torres *et al.*, 2011). The egg cases of *T. ovalis* also lack this structure (Fig. 3), and those of *T. latus* are built with or without it (Figs. 1–2), being both types viable, a condition also known to occur in *T. collaris* (Fabricius) (Lykins, 1972). In *Tropisternus*, the mast is usually horn-like (Torres *et al.*, 2008), but it can also be a ribbon, sometimes totally flat, as in *T. latus* (Fig. 1). The mast in the egg cases of *T. laevis* is remarkable within the genus. It has a globular appearance, as if the silk was loosely woven at the tip (Figs. 5–6). The function of the mast in the hydrophilid egg case is not yet well studied. Some authors have argued that it may play a role in ventilating the eggs within the case (Portier, 1911; Vlasblom & Wolvekamp, 1957; Angus, 1973), others have suggested that the mast is built by the female in order to empty her silk glands after oviposition (Lyonet, 1832; Wilson, 1923), or that may act as a balancer (Portier, 1911) only in the greater hydrophilids such as

Hydrophilus Geoffroy in which the egg case is usually built attached to a leaf that floats freely and not attached to more stable substrates (Wilson, 1923). However, as shown by Lykins (1972) for *T. collaris*, the presence and length of the mast depends on the environmental conditions. According to our results, the absence of a mast is not an issue for egg development in *T. latus*, as also noted by Wilson (1923) for *T. glaber* (Herbst). The peculiar shape of the mast of *T. laevis* may help preventing the egg case to sink, as some have been observed drifting (Torres, pers. obs.). Sunken egg cases are not likely to develop (Laker, 1881; Torres, pers. obs.). More studies are needed to enlighten the function of the mast, if any, in members of *Tropisternus*.

Larval morphology. In recent years, a number of detailed descriptions of larval Hydrophilidae have become available, some of which have incorporated the analysis of the chaetotaxy proposed by Fikáček *et al*. (2008) (Byttebier & Torres, 2009; Minoshima & Hayashi, 2011a, 2011b; Torres *et al.*, 2011; Minoshima & Hayashi, 2012a, 2012b; Minoshima *et al.*, 2012, 2013). The analysis of the sensilla and their distribution has proven to be a valuable source of characters for distinguishing hydrophilid genera (Fikáček *et al.*, 2008) and subgenera (Byttebier & Torres, 2009). However, when examined at the species level, larval morphology and chaetotaxy tend to be quite homogeneous and differences among species are very subtle (Torres *et al.*, 2008; Minoshima & Hayashi, 2011a). Nevertheless, the following differences can be pointed out to distinguish species within *Tropisternus*. The number of teeth on the anterior margin of nasale of *T. latus*, *T. ovalis* and *T. laevis* is seven, as in the subgenus *Pleurhomus*, represented by its sole species *T. sahlbergi,* (Torres *et al.*, 2011) and some species of the subgenus *Tropisternus* (*T. lateralis*, *T. mixtus* (LeConte), *T. noa*, *T. setiger* (Germar, 1824); in the subgenus *Strepitornus* there are five teeth in the nasale (Torres *et al.*, 2008). The outer setae of gFR2 on the epistomal lobes of the frontoclypeus can be blunt in some specimens of second and third instars of *T. latus*, whereas in the rest of the *Tropisternus* species these setae are always spine-like. Another difference is the relative size of the seta PA11, which length is less than half that of PA14 in *T. laevis* (Fig. 32) (a feature shared with *T. sahlbergi*), but more elongated in the rest of the species including *T. latus* and *T. ovalis* (Figs. 7, 22). The number of secondary setae on the head capsule of second and third instars also varies, being less than 20 in *T. laevis* and *T. ovalis*, and more than 60 in *T. latus*. The antennal seta AN8 is present in the three species studied here and in the remaining species except *T. sahlbergi* (Torres *et al.*, 2011), and AN9 is absent as in other *Tropisternus*. With regards to the mentum, the anterolateral angles are well projected forward in *T. latus*, *T. ovalis* and *T. laevis* (Figs. 10, 25, 35), similar to *T. sahlbergi* but opposed to other species such as *T. setiger*, *T. lateralis*, and *T. scutellaris* (Torres *et al.*, 2008; Torres, pers. obs.). The dorsal surface of the mentum is often covered with spinulae; in *T. latus*, *T. ovalis* and *T. laevis* these spinulae are absent from the central area (Figs. 10, 25, 35). Labial seta LA3 is located mesally to LA4 in *T. laevis* (Fig. 36), but not in *T. ovalis* and *T. latus*. It is worth mentioning that the second labial palpomere bears some spinulae in *T. latus*, which is unique within the genus.

Head width is a useful measure that can be used to separate instars of a given species (Tables 1–3). Moreover, when a complete set of data of different species is available, it can be used to identify larvae, particularly of those species in which ranges do not overlap, along with information from adults collected in the same site as larvae, and geographical distribution. For instance, the larvae of *T. latus* are larger than those of other *Tropisternus* (Torres *et al.*, 2008, 2011) and can be distinguished from other known larvae based on head width (Table 1) together with its restricted distribution.

Pupal morphology. As with larvae, pupae of different species share a similar morphology. A comparison of pupae of some species of *Tropisternus* can be found in Torres *et al.* (2008). The main differences between the species studied here rely on the number of styli and the presence of some peculiar structures in the pupa of *T. ovalis*. Apart from the difference in the number of pronotal styli (18–19 in *T. ovalis*, 22 in *T. latus* and *T. laevis*), the abdominal segments II–VI of *T. latus* bear eight styli, as in the pupa of the genus *Hydrobiomorpha* Blackburn (Archangelsky *et al.*, 2004), whereas *T. ovalis* and *T. laevis* bear six styli as most *Tropisternus* pupae. Of these styli, those placed on the pleural area can be short (most *Tropisternus*) or very long (*T. ovalis*). Other remarkable features of *T. ovalis* pupae are the short cerci and the presence of tubercles or horn-like projections on the abdominal segments II–VI, which is unique within Hydrophilidae.

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