

## DESCRIPTION OF THE LARVA OF *POLYNONCUS HEMISPHAERICUS* (BURMEISTER, 1876) (COLEOPTERA: TROGIDAE: OMORGINAE)

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### ABSTRACT

In this paper, we present a detailed description and illustrations of the larval stage of *Polynoncus hemisphaericus* (Burmeister, 1876). This larva was discovered in the region of Magallanes, Chile beneath the carcass of a guanaco. Identification was meticulously verified through the DNA barcode method. Our findings document only the second description of a *Polynoncus* larva, underscoring the critical need to elucidate and document the natural history of this group.

Keywords: DNA barcode, keratin-feeding, larval morphology, Scarabaeoidea, South America

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### INTRODUCTION

Trogidae MacLeay, 1819 are a diverse and phylogenetically well supported family of Scarabaeoidea (Browne and Scholtz 1999; Dietz *et al.* 2023; Strümpher *et al.* 2014, 2016). There are approximately 340 valid species distributed worldwide among five recognized genera: *Trox* Fabricius, 1775, *Phoberus* MacLeay, 1819, *Glyptotrox* Nikolajev, 2016, *Omorgus* Erichson, 1847, and *Polynoncus* Burmeister, 1876 (Strümpher *et al.* 2016; Zidek 2017). Although the taxonomy of the family is well developed, almost everything known is based on adults. Our knowledge about larval morphology is poorly explored, and few authors have paid special attention to immatures of the group (*i.e.*, Baker 1968; Scholtz 1991, 1993a, b) compared to adults.

Like adults, larvae of Trogidae are keratin-feeding, and are consistently found beneath animal remains (Baker 1968), associated with excrement in poultry houses (Lopes *et al.* 2007), or preying on turtle eggs

(Baena *et al.* 2015) or desert locust eggs (Roffey 1958). According to Baker (1968) and Diéguez (2008), some species from North and South America, respectively, can be found in the soil, a few centimeters under a carcass (for additional information about the natural history of larvae, see Baker 1968).

The first study of Trogidae larvae was provided by Waterhouse (1836), who described the immature stage of *Trox arenarius* Fabricius, 1787 [currently a junior synonym of *Trox scaber* (Linnaeus, 1758)]. Since then, only a few studies have been devoted to the description of larvae of Trogidae species from different regions of the world, *e.g.*, North America (Baker 1968; Hayes 1929; Ritcher 1966; Sim 1934), Algeria (Schiödt 1874), Indonesia (Leeffmans 1932), India (Gardner 1946), France (Paulian 1943; Scholtz and Lumaret 1991), Australia (Scholtz 1991), South Africa (Scholtz 1993b), Russia (Shabalin 2013, 2017), and South America (Costa *et al.* 1988; Scholtz 1993a; Scholtz and Peck 1990).

For the South American fauna of Trogidae, only three species have had their larvae described (Zidek 2013, 2017): *Omorgus suberosus* (Fabricius, 1775), *Omorgus persuberosus* (Vaurie, 1962), and *Polynoncus seymourensis* (Mutchler, 1925), with the latter collected in owl pellets on the Galapagos Islands (Costa *et al.* 1988; Scholtz 1993a; Scholtz and Peck 1990). Although Zidek (2013, 2017) indicated that the larvae were also known for *Polynoncus aricensis* (Gutiérrez, 1950), we believe that this is in reference to Diéguez (2008), who gave some natural history information of the larvae but no morphological description.

Still, little is known of the immature stages of *Polynoncus*. We describe here the larva of a second species, *Polynoncus hemisphaericus* Burmeister, 1876, based on a specimen collected in southern Chile. The larva was identified based on a perfect DNA barcode match with an adult collected at the same time. We also summarize the limited natural history information available for larval *Polynoncus*.

## MATERIAL AND METHODS

The description provided herein is based on a single specimen collected in Torres del Paine National Park (51°01.194'S, 72°51.891'W), located in the Magallanes Region of Chile. Together with the larva, five adults identified as *Polynoncus hemisphaericus* Burmeister, 1876 were gathered on 23 January 2005 beneath a guanaco [*Lama glama guanicoe* (Müller, 1776); Artiodactyla: Camelidae] carcass.

To accurately identify the collected larva, we sequenced cytochrome oxidase 1 (CO1) DNA data for the larva and an adult at the Biodiversity Institute of Ontario (Guelph, Ontario, Canada) using the methods described by Hebert *et al.* (2003) and Ahrens *et al.* (2007). The data was analysed in the Barcode of Life Data System (BOLD; <https://boldsystems.org>). The larva and all adult specimens are deposited at the Canadian Museum of Nature (Gatineau, Quebec, Canada).

To separate the mouthparts, precise pressure was applied using fine tweezers to the area adjacent to the cardo. A pin was subsequently employed to fully detach the mandibles and maxillae. Finally, with the aid of a microstyler, the joint line was cut, and the labrum was separated from the clypeus. Following examination and photographs, the mouthparts were placed in a microvial containing 98% alcohol and kept with the specimen. During the dissection process, the right mandible was unfortunately broken. The fragmented pieces were photographed, and the mandible was digitally reconstructed for illustration purposes.

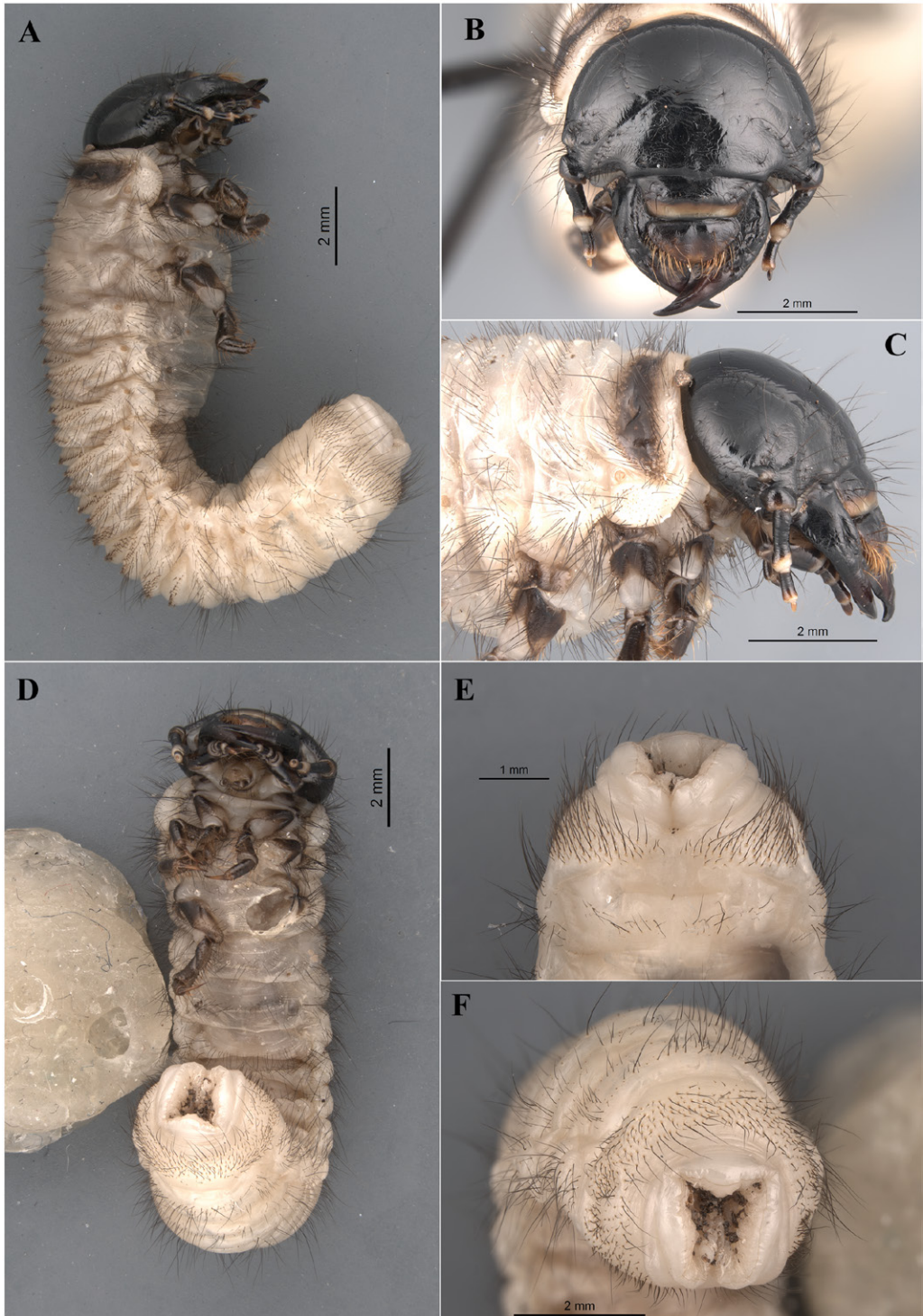
For the larval description and mouthpart dissection, an Olympus SZ51 binocular stereomicroscope was used. The schematic drawing and plates were prepared using the software Adobe Illustrator CC 2015 and Adobe Photoshop CS6, respectively. The photographs that composed Figs. 2 and 3 were made using a Leica model m165C stereomicroscope with DMC 2900 image capture system, and the photographs of Fig. 1 were made using a Leica Z16 APOA apochromatic zoom system with a DMC 5400 image capture system.

For the terminology of external morphology and mouthparts, we followed Baker (1968) with some modification proposed by Costa *et al.* (1988) and Sousa *et al.* (2018).

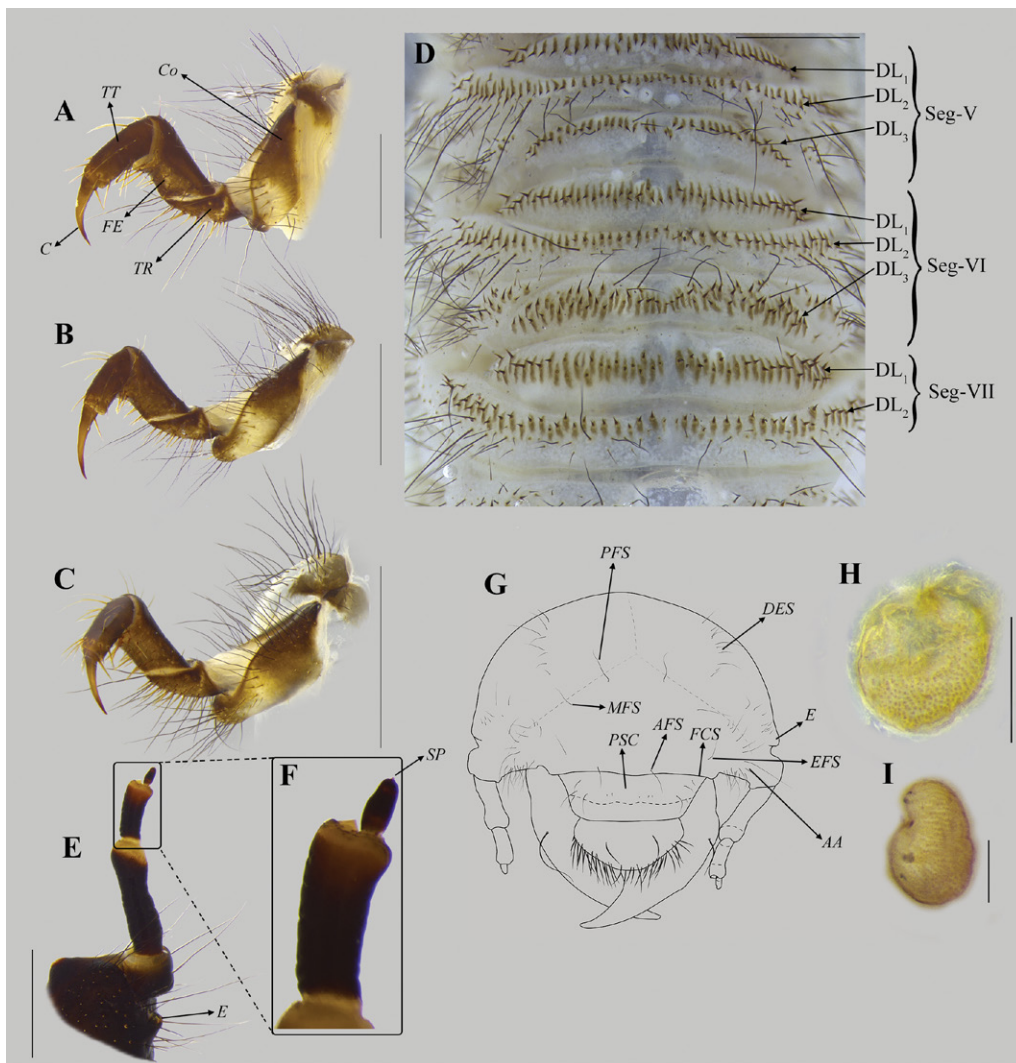
## RESULTS AND DISCUSSION

### *Polynoncus hemisphaericus* (Burmeister, 1876), Second Instar (Figs. 1–3)

**Description. Body:** Length about 19.5 mm, covered in brown setae of different sizes. **Head:** Wider than long, fully sclerotized; black (Fig. 2G). Eyespot (*E*) present, protuberant. **Epicranium:** Each side with single longitudinal row of 8–10 dorsoepicranial setae (*DES*), 2 posterofrontal setae (*PFS*), 2 antero-frontal setae (*AFS*), 2 extero-frontal setae (*EFS*), 10–14 antero-frontal angle seta (*AA*), and 2 median frontal setae (*MFS*). **Antenna** (Figs. 2E, F): With 3 antennomeres; antennomere 1 longer than antennomeres 2 and 3 combined; antennomere 3 reduced (Fig. 2F); sensorial area present near base of last antennomere. Distal portion of terminal antennomere with one visible sensory peg (*SP*). Antennifer prominent. Lateral ocelli present. **Clypeus** (Fig. 2G): Frontoclypeal suture well defined (*FCS*). Preclypeus pale yellow/brown, without setae. Postclypeus (*PSC*) dark with 4–6 setae on each side. **Labium** (Figs. 3E, F): Labial palpus with 2 palpomeres; palpomere 1 with a row of 5–7 setae on inner margin; palpomere 2 with a brush of small sensory pegs apically. Ligula with 2 medium setae and about 15–22 setae apically. Prementum with about 7–9 setae on each side (near base of labial palpus); central band sclerotized, brown. Mentum subrectangular with about 4 setae (2 long and 2 short) on each side; submentum with single row of 6–8 setae on each side. **Hypopharynx** (Fig. 3F): Distal area (*DH*) with longitudinal row of 17–22 setae and transverse row of about 12–14 sensory spots (*SPT*). Proximal area of hypopharynx (*PH*) composed of sclerotized and curved suborma (*ST*) on posterior margin; two subaportorma (*SAT*), parallel centrally, slight curved inward near apex. Transverse linguliform keel present posteromedially



**Fig. 1.** *Polynoncus hemisphaericus* larva. Habitus: A) Lateral (full body), B) Frontal, C) Lateral (head detailed), D) Ventral. E) Raster, F) Y-shaped anal opening.



**Fig. 2.** Morphological structures of larval *Polynoncus hemisphaericus*. Legs: A) Left prothoracic leg, B) Left mesothoracic leg, C) Left metathoracic leg. D) Details of spinules and setae on dorsal lobes of abdominal segments. E) Right antenna. F) Details of distal antennomere. G) Schematic drawing of cephalic structure and arrangement of setae. Spiracles: H) Thoracic, I) Abdominal. Legend: *AA* = setae of anterior frontal angle; *AFS* = anterior frontal setae; *C* = claw; *Co* = coxae; *DES* = dorsal epicranial setae; *E* = eyespot; *EFS* = exterior frontal setae; *FCS* = frontoclypeal suture; *FE* = femur; *MFS* = median frontal setae; *PFS* = posterior frontal setae; *PSC* = postclypeus; *Seg-V* = abdominal segment V; *Seg-VI* = abdominal segment VI; *Seg-VII* = abdominal segment VII; *SP* = sensory peg; *TT* = tibiotarsus. Scale bars: 1 mm (A–E), 0.5 mm (H), and 0.2 mm (I).

between two subapertoria, near subapertoria. Subapertoria surrounded by setae. **Labrum** (Fig. 3G): Lateral margin angulate. Dorsal surface of labrum with about 2 median setae (*MSL*), 3–4 lateral setae (*LSL*), and 2 anterior setae (*ASL*). **Epipharynx** (Fig. 3H): Clithrum (*CL*) with about 5–7 setae. Sensory area of haptomerum (*SA*) with 4–5 sensory spots. Haptomerum area with phobal mass (*P*) of setae on paria, surrounding the pedium (*PE*).

Pedium circular, with mass of about 15 sensory spots above 2 parallel lines of small setae. Lacotorma (*LT*) asymmetrical, divided into prominent dextortorma (*DX*) anteriorly and pternotorma (*PT*) posteriorly. Epitorma (*ET*) acuminate medially, pointed forward. 2 sclerotized and asymmetrical plates on haptolachus (*SPH*) with phobal mass between and short sense cone (*SC*) below. **Mandibles, dorsal view** (Figs. 3A, B [right broken]): With 1 long,

yellow seta on outer margin. Inner margin of left mandible with 4 teeth ( $S_1$ ,  $S_3$ ,  $S_4$  [reduced], and  $S_5$  [ $S_2$  not evident]) and scissorial notch ( $SN$ ). Inner margin of right mandible composed of  $S_1$ ,  $SN$ , and  $S_3$ . Both mandibles with mola ( $M$ ) prominent and brustia ( $BR$ ) formed by tuft of setae. **Maxilla** (Figs. 3I, J): Maxillary palpus composed of 4 palpomeres; palpifer reduced with 1 long seta laterally; palpomere 3 with two setae. Galea ( $G$ ) 4 times longer than wide; uncus ( $UN$ ) present, apically pointed. Lacinia ( $LA$ ) with 30–32 setae on inner margin; apex with two teeth pointed laterally. Stipes ( $STI$ ) with 5–6 setae on outer margin (basally) and single seta apically, near base of galea. Cardo ( $CA$ ) glabrous, forming almost straight angle with stipes. **Thorax** (Figs. 1A, C): Prothorax with two dorsal transverse sclerotized areas bordered with setae; lateral lobe with about 95–100 setae. One cribriform spiracle (Fig. 2H) on each side. Mesothorax and metathorax divided into three dorsal lobes ( $DL$ ):  $DL_1$  with single row of 16–21 setae,  $DL_2$  with about 42–55 setae, and  $DL_3$  with 7–13 spinules. Lateral lobes with about 70–90 setae. **Legs** (Figs. 2A–C): 5-segmented. Prothoracic leg: coxae ( $Co$ ) conical, with basal two-thirds sclerotized (apex slightly membranous); with about 15–19 setae on each side. Trochanter ( $TR$ ) subtrapezoidal, with about 40–50 sparse setae. Femur ( $FE$ ) with superior half almost glabrous, with 12–15 small setae and inferior half covered by 23–25 small sparse setae. Tibiotarsus ( $TT$ ) elongate with terminal whorl of 6 setae plus about 4–5 setae near base. Claw ( $C$ ) long (almost as long as tibiotarsus), with 2 setae latero-ventrally. **Abdomen** (Fig. 1A): 10-segmented, with abdominal spiracles on the first 8 (I–VIII) segments. First 8 segments each with three dorsal lobes ( $DL_{1-3}$ ). Segments I–VI with similar setal pattern: dorsal transverse row in  $DL_1$  of about 31–34 spinules with sclerotized base,  $DL_2$  with about 40–50 spinules, and  $DL_3$  with around 35–40 spinules [those spinules of  $DL_1$  from segment I to the  $DL_2$  of segment V are pointed posteriorly, while  $DL_3$  of segment V to  $DL_1$  of VII pointed anteriorly; spinules absent from  $DL_2$  of segment VII to VIII (Fig. 2D)].  $DL_2$  and  $DL_3$  from all segments (I–VIII) with 40–45 black setae posterior to row of spinules [with exception of  $DL_3$  of V and VI]. Lateral lobe (lateral view) from segments I–VIII formed with three lobes ( $LL_1$ ,  $LL_2$ , and  $LL_3$ ) covered by long black setae:  $LL_1$  with about 7–8 setae,  $LL_2$  with 15–17 setae, and  $LL_3$  with 15–20 setae (number of setae decreasing progressively from segments I–VIII). Segment IX without  $LL_3$  visible; lateral lobe of segment X without subdivisions. Segment X (raster) with broad band of black setae, interrupted just ventrally; palidium and tegillum absent. Anal opening Y-shaped, divided into three lobes, 1 dorsal and 2 lateroventral; glabrous.

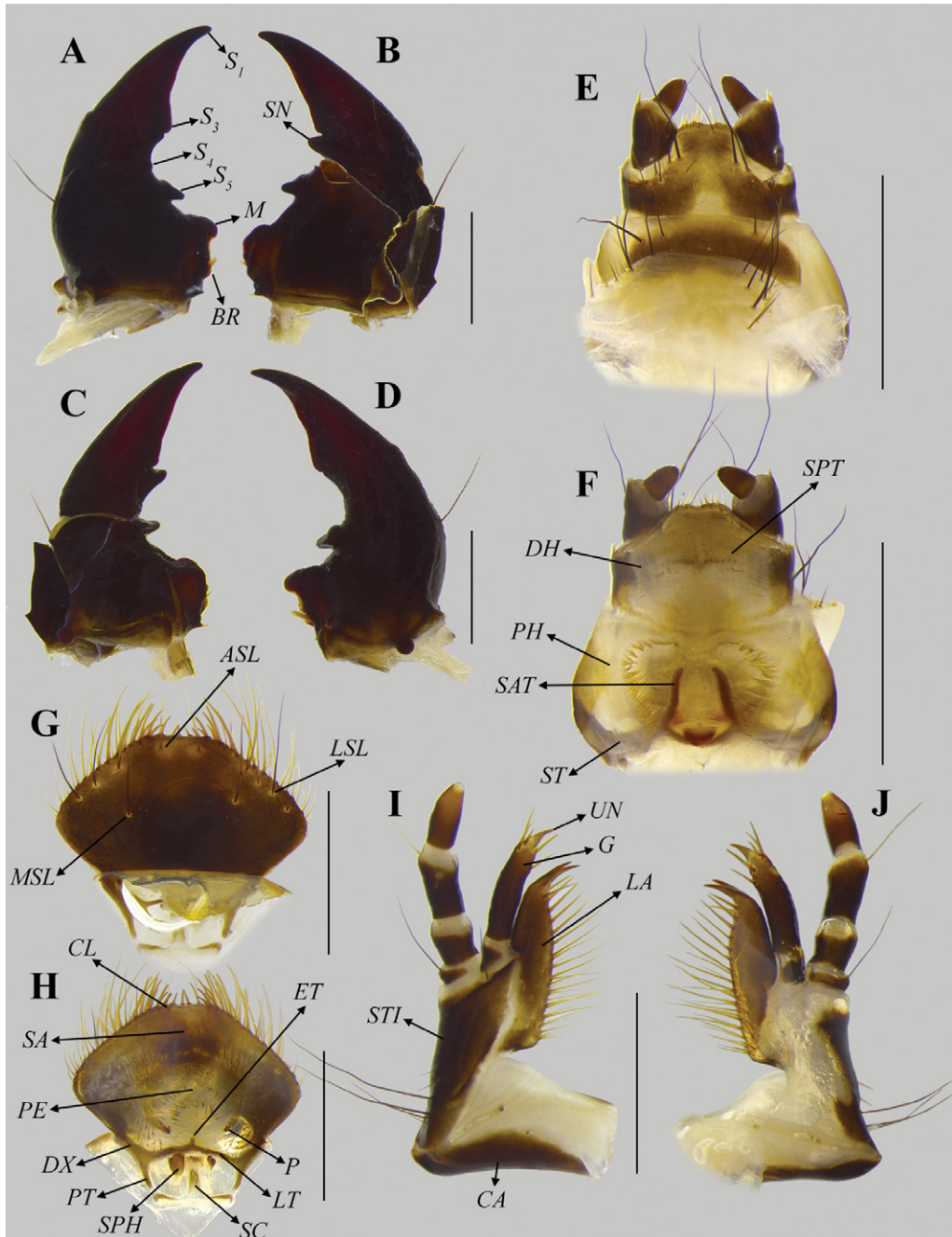
**Identification.** A DNA barcoding approach using CO1 was employed, confirming the larva to be a specimen of *P. hemisphaericus*. The larval specimen was a 100% match with one of the adult specimens collected in the same collecting event. The sequences are publicly available on the BOLD website (<https://boldsystems.org>) under the following sample ID numbers: adult = ASBTL525-05, larva = ASBTL526-05. The adult was identified using Scholtz (1990) and Costa-Silva *et al.* (2024).

**Natural History.** The larval specimen was found, along with five adults of the same species, underneath the partially desiccated body of a dead guano. Both the larva and adults were found in the area under the carcass where there was tight contact with the ground and some moisture. Diéguez (2008) suggested that *P. aricensis* third instars “burrow a few centimeters under the host, and form, with hair and remains of skin, a chamber within which the larva feeds and develops until its pupal period begins”. Based on the size of the *P. hemisphaericus* larva and the location between the carcass and the surface of the ground, we postulate that it is a second instar.

**Remarks.** After comparing our *P. hemisphaericus* larva with the drawings of *P. seymourensis* provided by Scholtz and Peck (1990), we noticed only a few divergences (*i.e.*, the arrangement of fobae in the epipharynx and hypopharynx and the arrangement of setae on the frons). Although these are two species derived from different evolutionary lineages within *Polynoncus* (Costa-Silva 2022), the morphological similarity between the species highlights the difficulty of studying Trogidae immatures. In addition, the features visualised in the larva are consistent with those used in the generic identification key in Scholtz (1993a), demonstrating that the features presented, although not very informative for species separation, serve as a basis of homology for supra-generic phylogenetic studies. Further efforts should be devoted to the description of *Polynoncus* larvae in order to have a better understanding of their biology and natural history in general.

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**Fig. 3.** *Polynoncus hemisphaericus* larval mouthparts. Left mandible: A) Dorsal, D) Ventral. Right mandible: B) Dorsal, C) Ventral. E) Labium, dorsal. F) Hypopharynx. G) Labrum, dorsal. H) Epipharynx. Left maxilla: I) Dorsal, J) Ventral. Legend: *ASL* = anterior setae of labrum; *BR* = brustia; *CA* = cardo; *CL* = clithrum; *DH* = distal area of hypopharynx; *DX* = dextortorma; *ET* = epitorma; *G* = galea; *LA* = lacinia; *LSL* = lateral setae of labrum; *LT* = lacotorma; *M* = mola; *MSL* = mediam setae of labrum; *P* = phobae; *PE* = pedium; *PH* = proximal area of hypopharynx; *PT* = pternotorma; *S<sub>1-5</sub>* = teeth of mandibles; *SA* = sensory area of haptomerum; *SAT* = subapotorma; *SC* = sense cone; *SN* = scissorial notch; *SPH* = sclerotized plate on haptolachus; *SPT* = sensory spots; *ST* = subtorma; *STI* = stipes; *UN* = uncus. Scale bars: 1 mm.

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