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Morphological and biological observations on the stick insect *Tithonophasma tithonus* (Gray, 1835) (Phasmida: Pseudophasmatidae: Pseudophasmatinae)

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American Pseudophasmatinae stick insects are often colorful, winged or apterous, with or without scale-shaped tegmina, with an area apicalis on all tibiae, and either with a ventromedian carina on the meso and metafemora, or with broad profemora, as long as head, pro- and mesonotum combined (Zompro, 2004). In the egg, micropylar plate is externally located in the middle of the dorsal surface, and internally appears of the open type. Among Pseudophasmatinae, the genus *Tithonophasma* Zompro, 2004 has a single species, *Tithonophasma tithonus* (Gray, 1835). Although this species is frequent in museum collections (Zompro, 2004), accurate morphological and biological information potentially useful in phylogenetic approaches are still missing.

Here we provide a detailed description of both adult sexes and egg capsule morphology, following terminologies of Bragg (1997) and Sellick (1997), respectively. Pictures and measurements were taken with a camera attached to Leica M205C and M125 stereomicroscopes, and with a digital caliper for the adult body length. We also present the *T. tithonus* biology studied in laboratory, which elucidate embryo and post-embryonic developments and aspects of its behavior. Ultimately, we make some considerations about *T. tithonus* distribution. All the material used is deposited in Coleções Taxonômicas da Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, Brazil (curator F. A. Silveira).

Tithonophasma tithonus (Gray, 1835)

Diagnosis. (Fig. 1) Colorful species; body and wings yellow, with a black dorsal median stripe on entire body; legs bluish green, black marked in ventral surface of tibia and tarsus and as a ring in apex of femora, tibia and each tarsomere. Head as wide as long; ocelli present; antennae not projecting beyond abdomen. Profemora curved and compressed basally. Both sexes with well-developed hind wing. Females' sternum VII swollen and hirsute near apex, black marked (Fig. 2B–C). Males' anal segment posterior margin distinctly truncate in dorsal view, bent down, forming a bilobed margin, each lobe with a conspicuous toothed region (Fig. 2D–E).

Redescription. Female. Head smooth, as long as wide (Fig. 2A), oval in cross-section and slightly flattened dorsally. Ocelli present, with a subcircular depression right in front of the median ocellus. Compound eyes circular, prominent, almost touching torulus; in dorsal view, 0.4x as long as head. Antennae slender and long, nearly reaching the anal segment; scape almost 1.5x as long as wide in dorsal view, slightly compressed dorsoventrally; pedicel longer than wide, about 0.7x as long as scapus; in lateral view, clearly inflate; wider than flagellomeres; first flagellomere about 2x as long as pedicel; second one slightly shorter, as long as pedicel; remaining flagellomeres increasing in length towards apex. Males head as in females. **Thorax** subcircular in cross-section. Pronotum slightly longer but narrower than head, 1.5x longer than wide, laterally wrinkled in its anterior third, longitudinally aciculate in the 0.1 distal portion, which is less evident in males; anterolateral angles with rounded notches, for the prothorax defensive glands opening (Fig. 2A); median line slightly impressed; transverse median depression displaced towards anterior third of segment, weakly impressed. Mesonotum as wide as and about 1.5x longer than pronotum; 2.5x longer than wide and slightly broadened towards the posterior end; bearing several, although sometimes almost indistinct, tubercles randomly arranged in the anterior half. Metanotum and median segment combined about 1.6x as long as and wider than mesonotum; 2.1x as long as wide, parallel-sided; metanotum 1.7x as long as wide and about 3x as long as median segment. Median segment separated from metanotum by a transverse depression (Fig. 1). Metaepisternum slightly striate diagonally. Mesoepisternum, pro-, meso- and metasternum simple and smooth. Tegmina small, convex, in dorsal view with an

apical notch at middle, and with a distinct dorsal raised median longitudinal line. Hind wing well developed, projecting beyond tergum VIII in females, but not exceeding tergum VI in males. **Legs** slender, partly shiny; entirely bristled, distinctly more densely covered on ventral surface. Femora somewhat squared in cross-section. Foreleg femora compressed and curved basally, 1.8–2x as long as mesothorax; basitarsus 2.25x as long as second tarsomere. Hind legs not projecting beyond apex of abdomen, with femora reaching to middle of abdominal tergum IV. **Female abdomen** 1.7–1.9x as long as head and complete thorax combined; gradually tapered towards the apex. Segments parallel-sided, with surface smooth and shiny. Median segment about 1.5x as wide as long; rectangular. Terga II–VII with two lateral longitudinal grooves each side. Terga II–VI of equal length, about 1.8–2x as long as median segment. Tergum VII 1.5x as long as median segment. Terga VIII–X narrowest, shortest than median segment, convex in cross-section. Sterna II–VI simple and smooth. Sternum VII swollen and hirsute near apex (Fig. 2B–C). Anal segment enlarging towards apex, posterior margin rounded, weakly concave mediodorsally. Supraanal plate very small and just visible in dorsal view by the extreme apex. Subgenital plate flat, not reaching to posterior margin of anal segment (Fig. 2B); minutely setose and apex pointed (Fig. 2C). Cerci finely bristled, about 0.7x as long as tergum X (Fig. 2C). **Male abdomen** as in female, in dorsal view with apex of anal segment truncate, bent down, forming a bilobed margin, each lobe with a conspicuous toothed plate (Fig. 2D–E) with irregularly distributed 10–23 acute teeth, down curved at apex; sternum VII unspecialized; sternum VIII 0.5x as long as tergum VIII; Poculum small and tightly convex in lateral view, with rounded apex almost reaching anterior margin of anal segment (Fig. 2D). Vomer curved in lateral view (Fig. 2D); in ventral view triangular, with apical 0.3 portion enlarged, with apical margin slightly convex, with two central asymmetric teeth (Fig. 2F). Paraprocts rounded at apex, with scattered bristles (Fig. 2E–F). **Measurements - length [mm]** (♀ / ♂): body: 62–68 / 35–40; head: 2.9–3.1 / 1.9–2.2; pronotum: 3.5–4 / 2.3–2.5; mesonotum: 6.2–6.5 / 3.4–4.4; metanotum: 8.2–9 / 4.2–4.6; median segment: 2.6–3.1 / 1.2–1.5; fore femur: 12.5–13.7 / 8–8.5; fore tibia: 12.3–13 / 7.3–7.4; mid femur: 8.8–10 / 5.5–6.2; mid tibia: 7.6–9.3 / 5–5.9; hind femur: 13.5–14.2 / 8–9.3; hind tibia: 12.3–13 / 7.6–8.8; tegmina: 7.5–8.5 / 3.5–4; hindwing 42–47.5 / 20–24.



FIGURE 1. *Tithonopasma tithonus* couple in dorsal view. Above, female; below, male.

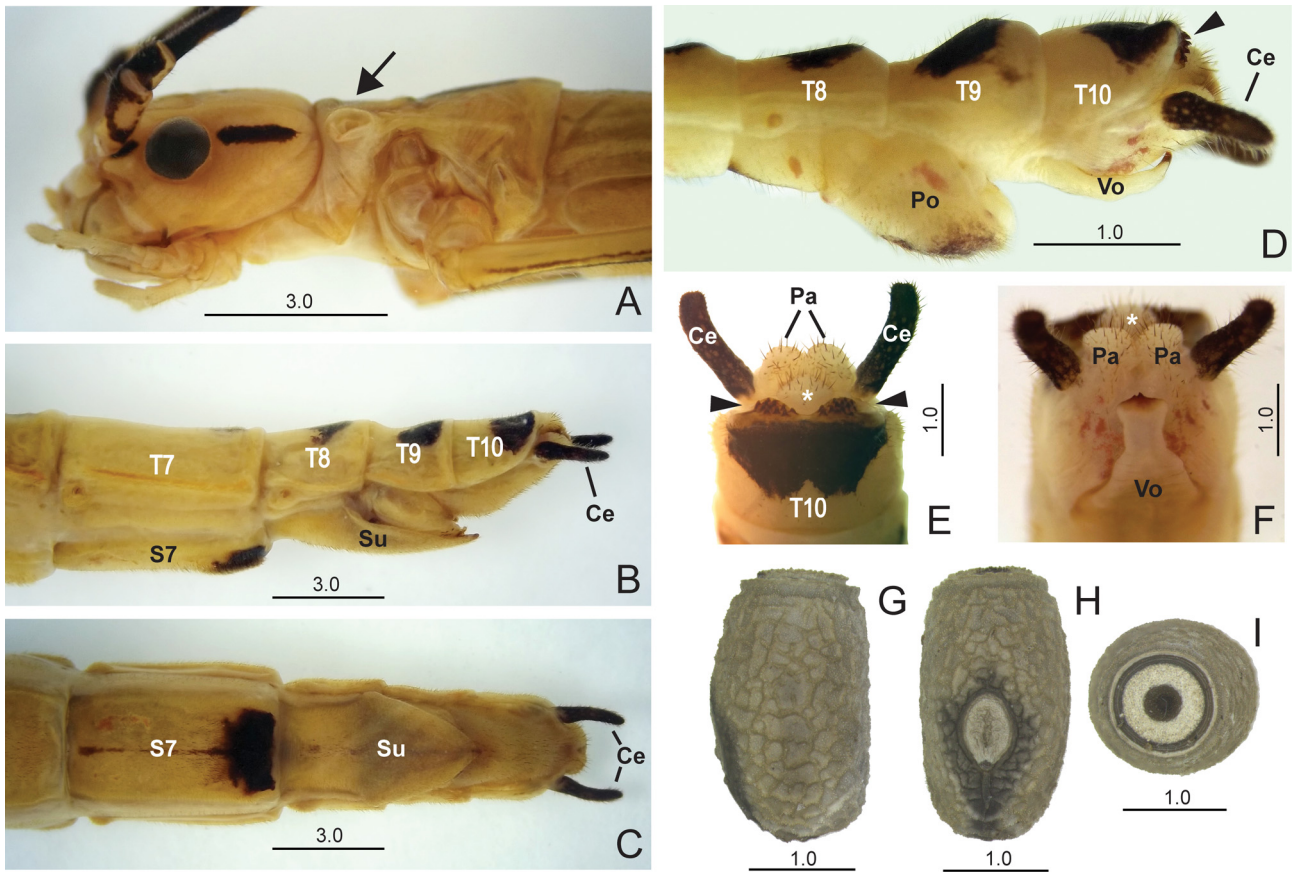


FIGURE 2. *Tithonophasma tithonus*. **A.** Head and prothorax in lateral view; opening of the defensive gland (arrow); **B–C.** Female, abdominal segments VII–X: **B.** lateral view; **C.** ventral view; **D.** Male, abdominal segments VII–X, lateral view; **E.** Male, anal segment in dorsal view; **F.** Male, vomer in ventral view. **G–I.** Capsule egg. **G.** Lateral view; **H.** Dorsal view; **I.** Anterior view. Abdominal sternum 7 (S7); abdominal terga 7–10 (T7–T10); cerci (Ce); paraprocts (Pa); poculum (Po); supra-anal plate (asterisk); subgenital plate (Su); vomer (Vo); thorn plates (arrowheads). Scale bar in millimeters [mm].

Color (female). Body and tegmina yellow with a dorsal median black stripe on entire body, present in terga VIII–X as posterior black marks. Head in lateral view, with a black line running through compound eye, from below torulus to the posterior of head. Antennae with scape and pedicel bluish green, dorsally black marked; flagellum black with irregular bluish green rings in the subbasal portion of the flagellomeres. Tegmina with a dorsal median black stripe. Wings from yellow to yellowish green. Legs bluish green, black marked in ventral surface of tibia and tarsus, and as an apical ring on femora, tibia and each tarsomere. Apex of sternum VII black marked. **Male's** color as in females, but with sternum VII yellow and with poculum black marked at apex.

Egg. Capsule covered with irregular ridges, uniformly gray green, darkened around the micropylar plate (Fig. 2H), with a circular black operculum inserted at the anterior pole, without inclination (Fig. 2G), and with a closed button-like capitulum (Fig. 2I). **Measurements** [mm]: Capsule length 2.6; width 1.1; height 1.6. Operculum width 1.1; height 1.15. Capitulum length 0.1; width 0.83; height 0.85. Micropylar plate length 0.7; width 0.45.

Material examined. (2♀, 2♂) **Brasil: Bahia: Prado.** 15.II.2010. F. C. Campos Neto col. (1♀, 1♂, UFMG) **Minas Gerais: Brumadinho,** Casa Branca, Serra do Rola Moça. 13.XI.2004. Collector name unreadable (1♀, 1♂, UFMG). (10♀, 10♂) Reared in laboratory from the couples collected in **Brumadinho** (Minas Gerais, Brazil).

Biology. *Tithonophasma tithonus* development is summarized in Table 1. It appears to be monophagous species, found in the field only on the woody vine *Chiococca alba* (L.) Hitchc. (Rubiaceae). The newly hatched nymphs, whose weight and length were 2.7 ± 0.6 mg and 9 ± 1 mm respectively, have a light-green color similar to that of *C. alba* young leaves, on which they feed. Males and females post-embryonic development have five and six nymphal instars respectively (Table 1). In last instar of both sexes the light green wing buds become turgid, and just five to four days before the final moult they acquired intense yellowish orange color. Mating began when the male found an adult female

and finished only with the male's death, two to three months later. No courtship behavior was observed. When adult male found a yellow orange wing buds last-instar female nymph, it climbed on her back and remained there until the final moult. Immediately after the adult female emergence the male began mating, sometimes even hindering the expansion of female's wings. Short daily interruptions occurred, during which the females oviposit 3–4 eggs. During oviposition, eggs were passively dropped to the ground, as in the first of three mechanisms recorded by Bedford (1978). The oviposition period took on average 137 days, in a net cage at room temperature (18–25°C), and finished only with the female's death. In the absence of mating, females reproduced by thelytokous parthenogenesis, similar to that observed in *Medauroidea extradentata* (= *Clitumnus extradentatus*) (Bergerard, 1962). Non-mating and mating females produced on average 513 and 453 eggs respectively. Just after oviposition, the egg weight was 3.6 ± 0.2 mg. The viability of fertilized and parthenogenetic eggs were 38% and 31.5% respectively.

TABLE 1. Life time of *Tithonophasma tithonus* (Gray, 1835) in days*.

	Embryonic development	Post-embryonic development			Adult life
Females	127–228 (174)	Instar	I	21–33 (26)	110–150 (118)
			II	20–25 (21)	
			III	20–39 (32)	
			IV	12–36 (21.5)	
			V	12–20 (15)	
			VI	20–20 (20)	
		123–137 (131)			
Males		Instar	I	21–33 (28)	65–97 (75)
			II	16–32 (22)	
			III	16–47 (32)	
			IV	12–56 (25)	
			V	16–20 (18)	
		104–131 (116)			

* Numbers represent the min. and max. values observed; numbers in parentheses represent the mean of 75 values for embryonic development, and 15 males /15 females for the post-embryonic phases.

When disturbed, both adults and nymphs secreted a milky fluid from the pair of glands opening at the anterior prothorax edge. This minty smell secretion accumulated just behind the head and was capable of inducing intense lacrimation. It was probably produced from the plant food, as the *C. alba* roots have a similar though weaker smell, and first instar nymphs were not able to produce it.

Distribution. When *T. tithonus* was first described, as *Phasma tithonus* (Gray, 1835), its habitat was defined as *Indiâ Orientali*. Serville (1838) considered that a mistake, and assigned *T. tithonus* habitat as *Brésil*. Redtenbacher (1906) reported its occurrence in Brazil (São Paulo, Bahia, Rio de Janeiro, Espírito Santo and Minas Gerais) and in French Guiana (Cayenne), though no one else has reported the species outside Brazil. A search for the food plant in a virtual Brazilian herbarium database (INPA, 2012) found records of *C. alba* in all but two States, Rondônia and Amapá, in Northern Brazil. A particularly interesting result is a voucher from French Guiana (Cayenne) (INPA, 2012), the same cited by Redtenbacher (1906).

Although its food plant is widely distributed in Brazil, we could confirm the occurrence of *T. tithonus* in only three localities: Prado - Bahia (17° 17' 33"S/ 39° 13' 31"W, alt. 37m), Casa Branca, Brumadinho - Minas Gerais (20° 07' 54"S/ 44° 05' 09"W, alt. 789m), and Parque Natural Municipal de Marapendi - Rio de Janeiro (23° 0' 34.69"S/43° 24' 37.26"W, alt. 4m). More studies are necessary to elucidate the real distribution of this species.

Note. A distinct boundary between the metanotum and the median segment is typically found in Timematodea, whilst in the remaining members of Phasmida this boundary is very indistinct due to fusion of the two terga (Tilgner *et al.*, 1999). However, recently a well-differentiated boundary between metanotum and median segment has been also reported in a species of Aschiphasmatae (Gottardo, 2011).

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References

- Bedford, G.O. (1978) Biology and ecology of the Phasmatodea. *Annual Review of Entomology*, 23, 125–149.
<http://dx.doi.org/10.1146/annurev.en.23.010178.001013>
- Bergerard, J. (1962) Parthenogenesis in the Phasmidae. *Edeavour*, 2, 137–143.
- Bragg, P.E. (1997) A glossary of terms used to describe Phasmids. *Phasmid Studies*, 6 (1 & 2), 24–33.
- Gottardo, M. (2011) A new genus and new species of Philippine stick insects (Insecta: Phasmatodea) and phylogenetic considerations. *Comptes Rendus Biologies*, 334, 555–563.
<http://dx.doi.org/10.1016/j.crv.2011.04.003>
- Gray, G.R. (1835) Synopsis of the species of insects belonging to the family of Phasmidae. Longman, Rees, Orme, Brown, Green and Longman, London, 48 pp.
- INPA (2012) Herbário Instituto Nacional de Pesquisas da Amazônia. (Accessed via the network INCT - Herbário Virtual da Flora e dos Fungos. Available from: <http://inct.splink.org.br> (Accessed 10 Mar. 2012)
- Redtenbacher, J. (1906) *Die Insektenfamilie der Phasmiden*. Vol. 1. Phasmidae Areolatae 1906. Wilhelm Engelmann, Leipzig, 108 pp.
- Sellick, J.T.C. (1997) Descriptive terminology of the phasmid egg capsule, with an extended key to the phasmid genera based on egg structure. *Systematic Entomology*, 22, 97–122.
<http://dx.doi.org/10.1046/j.1365-3113.1997.d01-30.x>
- Serville, M.A. (1838) *Histoire naturelle des Insectes. Orthoptères* Librairie encyclopédique de Roret, Paris, 722 pp.
- Tilgner, E.H., Kiselyova, T.G. & McHugh, J.V. (1999) A morphological study of *Timema cristinae* Vickery with implications for the phylogenetics of Phasmida. *Deutsche Entomologische Zeitschrift*, 46, 149–162.
<http://dx.doi.org/10.1002/mmnd.19990460203>
- Zompro, O. (2004) *Revision of the genera Areolatae, including the status of Timena and Agathemera (Insecta: Phasmatodea)*. *Abhandlungen des Naturwissenschaftlichen Vereins in Hamburg*, vol. 37, 327 pp.