ZOOLOGY | SHORT COMMUNICATION

First record of a *Leptus* Latreille mite (Trombidiformes, Erythraeidae) associated with a Neotropical trapdoor spider (Araneae: Mygalomorphae: Actinopodidae)

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Abstract: The first occurrence of a parasitic mite, *Leptus* Latreille (Trombidiformes, Erythraeidae) parasitizing an adult male of a trapdoor spider *Actinopus* Perty, 1833 (Araneae: Mygalomorphae: Actinopodidae) and the first occurrence of *Leptus* sp. larvae in the municipality of Manaus, Amazonas state, Brazil are reported.

Subjects: Environment & Agriculture; Zoology; Entomology & Acarology

Keywords: Acari; parasitism; mutualism; ectoparasite; Arachnida; Neotropical; Amazon

The cosmopolitan genus *Leptus* Latreille, 1796 (Prostigmata: Parasitengona: Erythraeidae) has a total of 10 species described for Brazil, 27 species for the Neotropical region, and more than 270 described species worldwide (Haitlinger, 2004; Mąkol & Wohltmann, 2012). *Leptus* mites have seven larval stages of which nymphs are ectoparasitic using a wide range of arthropods to feed and transport (Penney & Green, 2011).

After hatching from eggs, the mite larvae pierce the cuticle of the invertebrate host and gain access to the host’s hemolymph and interstitial fluids via a straw-like stylostome. After engorging, larvae drop off the host and transform into eight-legged nymphs and then adults (Penney & Green, 2011). Both adults and deutonymphs are free-living predators of small invertebrates. Most common hosts are insects (Flechtmann, 1980; Kamran, Afzal, Bashir, & Raza, 2009; Teixeira, 2011; Wilson, Rubink, & Collins, 1990; Wilson, Wooley, Nunamaker, & Rubink, 1987) and arachnids such as opilionids, scorpions, and spiders (Fain, Gummer, & Whitaker, 1987; Mohamed & Mohamed, 2011; Townsend, Mulholland, Bradford, Proud, & Parent, 2006; Welbourn & Young, 1988).

This work reports the first occurrence of larva of the genus *Leptus* parasitizing an adult male of a trapdoor spider *Actinopus* (Araneae: Mygalomorphae: Actinopodidae) and the first occurrence of

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PUBLIC INTEREST STATEMENT

Mites are among the most diverse and successful of all the invertebrate groups. Many mites are parasitic on plants and animals. Most host-parasitic association is poorly described and understood. Investigations of the host-parasitic association can elucidate the biology and animal behavior, the link between parasites and pathogens, and define the role of the mite in transmission and pathogenesis. This article reports the first occurrence of larva of the genus *Leptus* parasitizing an adult male of a trapdoor spider *Actinopus*. 
Leptus sp. larvae in the municipality of Manaus, Amazonas state. Specimens were collected near the “Universidade Federal do Amazonas,” Manaus, Amazonas, Brazil, and are deposited into the “Coleção de Invertebrados” located at the Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, Amazonas, Brazil. Photos were taken using a stereomicroscope Leica MZ16, equipped with Leica camera M205c.

Actinopus Perty, 1833, also commonly known as trapdoor spiders, are distributed throughout Central and South America (Brescovit, Bonaldo, Bertani, & Rheims, 2002; Ríos, 2014) and can be easily identified by the thoracic groove procurved and rastellum on distinct process (Brescovit et al., 2002; Raven, 1985). The biology and ecology of the species are still little known, females and young males have cryptic habits, living most of the time in excavated burrows, closed by a trap door made of soil particles and silk, making difficult to detect these spiders in their natural habitat (Brescovit et al., 2002; Coyle, Goloboff, & Samson, 1990; Miglio, 2009). Few works reported associations between mites and mygalomorph spiders (Ebermann & Goloboff, 2002; Mosan, Simpson, Peratti, & Braig, 2012; Welbourn & Young, 1988). The spider was identified as belonging to Actinopus cucutaensis Mello-Leitão, 1941 by the copulatory bulb with elongated and well-developed paraembolic apophysis.

The six-legged Leptus larva (body length 0.55 mm, width 0.18 mm) (Figure 1(A), (C–D)) was located near posterior margin on dorsal portion of the spider’s carapace (body length 22.6 mm; carapace long 11.7 mm, wide 11.1 mm) (Figure 1(B)). The specimen was firmly attached to the carapace by its chelicerae, and when it was removed, no injury caused by its mouthparts was visibly detected. The larva is an undescribed species of Leptus.

Figure 1. (A) Mite larva of Leptus sp., habitus, dorsal view; (B) spider of Actinopus sp., carapace, dorsal view (white arrow indicates where mite was attached); (C) details of larva’s gnathosoma and dorsal scutum; (D) dorsal idiosomal setae.
Currently, 79 arachnid species among mites (9 spp.), spiders (17 spp.), scorpions (11 spp.), harvestmen (39 spp.), pseudoscorpions (2 spp.), and tailless whip scorpions (1 sp.) were reported as host of *Leptus* spp. (Table 1).

| Host | Host species | Leptus species | Country | References |
|------|--------------|----------------|---------|------------|
| Subclass Acari | | | | |
| Order Trombidiformes | | | | |
| Family Erythraeidae | Abrolophus sp. | L. trimaculatus | Germany | Wendt, Olomski, Leimann, and Wohltmann (1992) |
| | Balaustium globigerum | L. ignotus | Netherlands | Oudemans (1912) |
| | Erythraeus sp. | L. echinopus | Denmark | Southcott (1992) |
| Family Anystidae | Anystis baccarum | L. killingtoni | UK | Turk (1945) |
| | A. baccarum | L. trimaculatus | Germany | Wendt et al. (1992) |
| Order Sarcoptiformes | | | | |
| Family Damaeidae | Damaeus grossmani | Leptus spp. | USA | Norton, Welbourn, and Cave (1988) |
| | Spatioidamaeus verticillipes | Leptus spp. | USA | Norton et al. (1988) (as *Damaeus verticillipes*) |
| Family Oribatellidae | Oribatella extensa | Leptus spp. | USA | Norton et al. (1988) |
| Family Xenilliidae | Xenillus occultus | Leptus spp. | USA | Norton et al. (1988) |
| Order Amblypygi | | | | |
| Family Charinidae | Phrynus kennidae | Leptus sp. | Dominican Republic | Armas and Trueba (2003) |
| Order Araneae | | | | |
| Family Actinopodidae | Actinopus cucutaensis | Leptus spp. | Brazil | This paper |
| Family Eutichuridae | Cheiracanthium sp. | L. hidakai | Japan | Kawashima (1958) |
| Family Sparassidae | Delena cancrinoides | L. charon | Australia | Southcott (1999) |
| | Isopeda frenchi | L. minno | Australia | Southcott (1999) |
| | Isopeda woodwardi | L. charon | Australia | Southcott (1999) |
| | Isopeda sp. | L. charon | Australia | Southcott (1999) |
| | Isopeda sp. | L. faini | Australia | Southcott (1999) |
| | Isopedella inola | L. orthrius | Australia | Southcott (1999) |
| | Ilea | L. orthrius | Australia | Southcott (1999) |
| Family Theridiidae | Enoplognatha avata | Leptus sp. | USA | Reillo (1989) |
| | Holconia insignis | L. faini | Australia | Southcott (1999) |
| Family Lycosidae | Lycosa sp. | L. gifuensis | Japan | Kawashima (1958) |
| | Pardosa sp. | Leptus sp. | USA | Sorkin (1982) |
| Family Uloboridae | Miagrammopes singaporensis | L. hidakai | Singapore | Baker and Selden (1997) |
| Family Tetragnathidae | Pachygnatha clerki | L. ignotus | UK | Parker (1962) |

(Continued)
| Host | Host species | Leptus species | Country | References |
|------|--------------|----------------|---------|------------|
| Family Philodromidae | Philodromus imbecillus | Leptus sp. | USA | Cokendolpher, Horner, and Jennings (1979) |
| Family Salticidae | Satis sp. | L. atticus | South Africa | Lawrence (1940) |
| Family Zodariidae | Systenoplacis sp. | L. rwanda | Rwanda | Fain and Jacqué (1996) |
| Undetermined spider | – | L. ignotus | France | Bruyant (1911) |

Order Opiliones

| Family Manaosbiinae | Cranellus montgomeryi | Leptus sp. | Trinidad | Townsend et al. (2008) |
| Family Cosmetidae | Cynorta sp. | L. gracilipes | Surinam | Oudemans (1910a) |
| | Cynorta sp. | Leptus sp. | Trinidad | Townsend et al. (2008) |
| | Paeciloema inglei | Leptus sp. | Trinidad | Townsend et al. (2008) |
| Family Gonyleptidae | Discocyrtus funestus | L. lomani | Chile | Oudemans (1902) |
| Family Sclerosomatidae | Gragellula niveata | L. phuketicus | Thailand | Southcott (1994) |
| | Gragellula sp. | L. phuketicus | Thailand | Southcott (1994) |
| | Gagrella sp. | L. gagrellae | Indonesia | Oudemans (1910b) |
| | Leiobunum calcar | L. indianensis | USA | Fain et al. (1987) |
| | L. formosum | L. indianensis | USA | Cokendolpher (1993) |
| | | Leptus sp. | USA | Townsend et al. (2006) |
| | L. longipes | L. indianensis | USA | Fain et al. (1987) |
| | L. nigripes | L. nearcticus | |
| | L. speciosum | L. indianensis | USA | Fain et al. (1987) |
| | L. ventricosum | |
| | L. vittatum | L. nearcticus | USA | Fain et al. (1987) |
| Prionostemma sp. | Leptus sp. | Trinidad | Townsend et al. (2008) |
| Trachyrhinus marmoratus | Leptus sp. | USA | Mackay, Grimsley, and Cokendolpher (1992) |

Family Phalangiidae

| Lacinius ephippius | L. halmae | Slovakia | Staisio (2003) |
| Lophopilia palpalis | L. halmae | Slovakia | Staisio (2003) |

| L. ignotus | Poland | Haitinger (1987) (as Odieius palpalis) |
| L. phalangii | Poland | Gabry's (1991) (as Odieius palpalis) |

Megabunus diadema

| L. berani | France | Fain and Amico (1997) |

Mitopus maria

| L. berani | Belgium | Fain (1991a) |

| France | Fain and Amico (1997) |
| Host       | Host species | Leptus species | Country  | References         |
|------------|--------------|----------------|----------|--------------------|
|            | L. holmiae   | Denmark        | Southcott (1992) |
|            | L. holmiae   | Iceland        |          |                    |
|            |              | Ireland        |          |                    |
|            |              | Poland         |          |                    |
|            | L. ignotus   | Bulgaria       | Beron (1975) |
|            | L. kalaallis | Greenland      | Southcott (1992) |
| Leptus spp.|              | Norway         | Ábra (1988) |
|            | L. holmiae   | Poland         | Hailinger (1991) |
|            |              | Poland         |          |                    |
|            |              | Slovakia       |          |                    |
|            |              | Japan          |          |                    |
|            |              | Kawashima (1958) |
|            | L. holmiae   | Poland         | Hailinger (1991) |
|            |              | Poland         |          |                    |
|            |              | Slovakia       |          |                    |
|            |              | Japan          |          |                    |
|            |              | Kawashima (1958) |
|            | L. ignotus   | Bulgaria       | Beron (1975) |
| Opilio     |              | Sweden         | Southcott (1992) |
| O. pentaspinulatus | L. holmiae | Sweden          | Southcott (1992) |
| O. ruzickai | L. ignotus   | Poland         | Hailinger (1987) |
| Opilio sp. |              | Sweden         | Oudemans (1912) |
|            | L. holmiae   | UK             | Southcott (1992) |
|            |              | Poland         | Hailinger (1987) |
|            |              | France         | Fain and Amico (1997) |
|            | L. mariæ     | Poland         |          |                    |
|            | L. molachinus| Poland         |          |                    |
|            | L. phalangi  | Poland         | Gabrys (1991) |
| Leptus spp.|              | UK             | Evans (1910)  |
|            |              | Norway         | Ábra (1988) |
| P. partietinum | L. ignotus | Netherlands    | Oudemans (1912) |
| Phalangium spp. | L. ignotus | France         | Bruyant (1911) |
| Riloena    |              | UK             | Southcott (1992) (as Phalangium triangularis) |
| triangularis | L. holmiae | UK             | Southcott (1992) (as Phalangium triangularis) |
|            | L. ignotus   | Poland         | Hailinger (1987) (as Phalangium triangularis) |
|            | L. phalangi  | Poland         | Gabrys (1991) (as Phalangium triangularis) |
| Rhamsinis  |              | L. rwandae     | Rwanda    | Fain and Jacqué (1996)|
| tis fissidens              |              |               |          |                    |
| Family Samoidea             |              |               |          |                    |
| Maracaynatum               | Leptus sp.   | Trinidad       | Townsend et al. (2008) |
| trinidadense                |              |               |          |                    |
| Pellobunus longipalpus      | Leptus sp.   | Trinidad       | Townsend et al. (2008) |
| Family Cranidae             |              |               |          |                    |
| Pharecranaus calcarniferus  | Leptus sp.   | Trinidad       | Townsend et al. (2008) |
| Santinezia serratotibialis  | Leptus sp.   | Trinidad       | Townsend et al. (2008) |

(Continued)
| Host | Host species | Leptus species | Country | References |
|------|--------------|----------------|---------|------------|
| Family Manaosbiidae | Rhopalocranaus abilineatus | Leptus sp. | Trinidad | Townsend et al. (2008) |
| Family Stygnidae | Stygnoplus clavotibialis | Leptus sp. | Trinidad | Townsend et al. (2008) |
| Family Agoristenidae | Avima sp. | Leptus sp. | Trinidad | Townsend et al. (2008) (as Trinella sp.) |
| Undetermined | | | | Fain and Elsen (1987) |
| | | | | | L. bicristatus |
| | | | Malawi | Fain and Elsen (1987) |
| | | | | L. locquei |
| | | | | L. puylaerti |
| | | | | L. polythrix |
| | | | | L. steigimayri |
| | | | Brazil | Oudemans (1905) |
| | | | | L. ignotus |
| | | | Poland | Haitlinger (1991) |
| | | | | L. sp. USA |
| | | | Welbourn (1983) |
| Order Pseudoscorpiones | Neobisium sp. | Leptus sp. | France | Judson and Mąkol (2011) |
| Undetermined | | | L. chelonethus | Womersley (1994) |
| Order Scorpionidae | Buthus occitanus | Leptus sp. | France | Andre (1953) |
| | Centruroides vittatus | Leptus sp. | USA | Welbourn (1983) |
| | Hemilychas alexandrinus | L. waldockae | Australia | Fain (1991b) (as Lychas alexandrinus) |
| | Lychas sp. | L. korematus | Australia | Southcott (1999) |
| Family Bothriuridae | Cercophonius squama | L. charon | Australia | Southcott (1999) |
| | | | Tasmania | Seeman and Miller (2002) |
| Family Scorpionidae | Urodacus manicatus | Leptus sp. | Australia | Southcott (1999) (as Urodacus abruptus) |
| | | | | | L. baudini |
| | | | | | Southcott (1999) |
| | | | | | L. urodaci |
| | | | | | Southcott (1999) |
| | | | | | L. smithi |
| | | | | | Southcott (1999) |
| | | | | | L. pistoris |
| | | | | | Southcott (1999) |
| | | | | | L. carduus |
| | | | | | Southcott (1999) |
| | | | | | U. armatus |
| | | | | | Southcott (1999) |
| | | | | | U. hoplurus |
| | | | | | Fain (1991b) |
| | | | | | U. yaschenkoi |
| | | | | | U. hartmeyeri |
| | | | | | Southcott (1999) |
| | | | | | U. varians |
| | | | | | Southcott (1999) |
| | | | | | Urodacus cf. yaschenkoi |
| | | | | | Southcott (1999) |
| Undetermined | | | Leptus sp. | Mexico | Welbourn (1983) |
| | | | | | Leptus sp. |
| | | | | | Costa Rica | Welbourn (1983) |

Source: Modified from Baker and Selden (1997).
Little is known about the impact of Leptus larva feeding on their host upon the survival, locomotion, or reproductive capacity of their spider hosts, but it is known that Leptus larvae are able to transmit Spiroplasma bacteria which can be mutualistic or pathogenic (DiBlasi et al., 2011). Although specific associations between deutonymphs of Astigmata and Heterostigmata mites, and larvae of Prostigmata mites, and spiders are well documented, little is known about the spider mite associations in Brazil and the implications for the host.

This paper revealed an unrecorded association between trapdoor Actinopus spider and a Leptus mite for Brazil, which indicated that similar interactions (parasitic and non-parasitic) are likely to be far more diverse. Additional field and laboratory studies of the life history and ecology of parasite and host species are required.

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Competing Interests

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