

***Macrophyes pacoti* n. sp. (Araneae: Anyphaenidae) from Brazilian Atlantic Forest, with notes on an araneopathogenic fungus**

ANTONIO D. BRESCOVIT^{1,6}, GERMAN A. VILLANUEVA-BONILLA⁵,
JULLYANA CRISTINA M. S. M. SOBCZAK⁴, FRANCISCO A. DE SOUSA NÓBREGA⁴,
LUIZ FERNANDO M. OLIVEIRA^{1,2}, ITALO DIEGO PAIVA ARRUDA³ & JOBER F. SOBCZAK^{3,4}

¹Instituto Butantan, Laboratório Especial de Coleções Zoológicas, Av. Vital Brasil 1500, CEP 05503-900, São Paulo, SP, Brazil,

²Programa de Pós-Graduação em Zoologia, Instituto de Biociências, Rua do Matão 14, 05508-090, Universidade de São Paulo, São Paulo, SP, Brazil.

³Programa de Pós-Graduação em Ecologia e Recursos Naturais, Departamento de Biologia, Universidade Federal do Ceará, CEP 60440-900, Fortaleza, CE, Brazil.

⁴Instituto de Ciências Exatas e da Natureza—Laboratório de Ecologia e Evolução, Universidade da Integração Internacional da Lusofonia Afro-Brasileira, Rod. CE 060, Acarape, CE, Brazil.

⁵Programa de Pós-graduação em Biologia Animal, Instituto de Biologia, Universidade Estadual de Campinas, CP 6109, CEP 13083-970, Campinas, SP, Brazil.

⁶Corresponding author. E-mail: antonio.brescovit@butantan.gov.br

The spider genus *Macrophyes* O. Pickard-Cambridge, 1893 includes five species from the Neotropical region (World Spider Catalog 2019). Two species were described from Central America, *M. attenuata*, the type species, by Pickard-Cambridge (1893), known until now only by the male, and *M. elongata* by Chickering (1937) known by both sexes. Three other species were described from South America, *M. silvae* Brescovit, 1992 and *M. manati* Brescovit, 1993 from Peru, and *M. jundiai* Brescovit, 1993 from Brazil (Brescovit 1992, 1993). Brescovit (1997) diagnosed this genus from other Anyphaeninae by the cylindrical abdomen, retrolateral margin of the chelicera with prominent distal tooth, close to the claw and by the tibia of the male palp almost twice longer than the cymbium. The females could be confused with *Mesilla* Simon by the long and cylindrical abdomen, but are distinguished by the epigynum with narrow, sinuous lateral borders and, internally, by the long copulatory ducts (see Brescovit, 1997: figs 146, 150–151).

Interactions between entomopathogenic fungi and spiders have been reported since the year 1856 (Cooke 1892, Evans 2013). Subsequently, Evans and Samson (1987) propose the term araneopathogenic fungi for those that specifically attack spiders. In subsequent years, different records have been included in several regions of the world reporting new species of fungi but without any taxonomic or biological data on the host spider (e.g. Kobayasi & Shimizu 1977; Humber & Rombach 1987; Samson & Evans 1992).

Among the araneopathogenic fungi, species of *Gibellula* Cavaletti attack exclusively spiders (Evans 2013). Currently, the genus presents 23 recognized species with a worldwide distribution (Samson & Evans 1992). Most host spiders are free-living adult spiders of the family Salticidae (Samson & Evans 1973; Evans & Samson 1987). However, few details are presented, and, in most records, the host appear as “unknown spider” (e.g. Sánchez-Peña 1990; Tzean et al. 1997), except in a study in Canada where the host spider was identified as *Neon nellii* Peckham & Peckham, 1888 (Salticidae) by Strongman (1991).

In this study we describe *Macrophyes pacoti* n. sp., recording the interaction between this species and araneopathogenic fungi *Gibellula* sp. The specimens with fungi were collected in a trail localized in a semi-deciduous montane tropical forest at Reserva Florestal Particular Empresa Arvoredo Floricultura, (4°18'40"S, 38°58'05"W, 840 m alt.), city of Pacoti, state of Ceará, Brazil, in June of 2017. This locality represents one of the few remnants of Atlantic Forest within a semi-arid region (Oliveira & Araújo 2007). This unusual feature results in a warm (mean annual temperature 20.8 °C) and humid (average precipitation 1221 mm) climate, with a very heterogeneous vegetation.

The specimens were deposited in the collection of the Instituto Butantan, São Paulo (IBSP, curator: A.D. Brescovit). Male palps were examined and illustrated immersed in 70% ethanol in a Leica M165C stereoscopic microscope with camera lucida. The female internal genitalia was dissected and illustrated immersed in clove oil in this same equipment. Digital multi-focal photos were taken using a Leica DFC 500 digital camera attached to a Leica MZ16A stereomicroscope.

Morphological terminology and abbreviations follow Brescovit (1997). All measurements of the morphological descriptions are in millimeters. The following abbreviations were used in the text and figures: A—atrium; ALE—anterior lateral eyes; AME—anterior median eyes; CD—copulatory ducts; FD—fertilization ducts; MA—median apophysis; PLE—posterior lateral eyes; PME—posterior median eyes; RTA—retrolateral tibial apophysis; S—spermathecae. The map was prepared in the software ArcGIS. Funding was provided in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, Brazil (CAPES), Code 001 to GAVB and IDPA; by Instituto Nacional de Ciência e Tecnologia dos Hymenoptera Parasitoides (HYMPAR-CNPq/FAPESP/CAPES), FUNCAP–BPI proc. BP3-00139-00186.01.00/18, to JFS, by CNPq grant PQ 301776/2004-0 to ADB; by Program postgraduate in Zoology-IB-USP, N° 9195209 and CNPq grant 142150/2017-7 to LFMO. We also would like to express our gratitude to Mrs. Cláudia Maria M.B. de Goes, from Sítio São Luiz, by granting access to the study area and to Dr. A.B. Bonaldo by the valuable suggestions on the manuscript.

Anyphaenidae Bertkau, 1878

Anyphaeninae Bertkau, 1878

Macrophyes O. Pickard-Cambridge, 1893

Macrophyes pacoti Brescovit, Oliveira, Sobczak & Sobczak, new species

(Figures. 1A–F, 2A–D, 3A–B, 4)

Types. Male holotype from Reserva Florestal Particular Empresa Arvoredo Floricultura (4°18'40"S, 38°58'05"W, 840 m alt.), Pacoti, Ceará, Brazil, V-VI/2017, J.F. Sobczak leg., sample 9.13, deposited in IBSP 213909; female paratype from same locality, sample 9.19, deposited in IBSP 213910.

Other material examined. Brazil. *Ceará*: Pacoti (04°13'03"S; 38°55'22"W), Reserva Florestal Particular Empresa Arvoredo Floricultura, *fungus covering spider's body*, 1♀ (IBSP 213905), 1♀ (IBSP 213908), 1♀ (IBSP 213904, photo), 1♀j (IBSP 213907), 1♀j (IBSP 213906), V-VI/2017, J.F. Sobczak leg.; *not covered by fungus*: 1♀, V-VI.2017, sample 9.20, J.F. Sobczak leg. (IBSP 213913, draw internal epigynum); 1♀, sample 9.15 (IBSP 213913); 1♀, sample 3.5 (IBSP 213914); 1♀, sample 5.9 (IBSP 213911, photo); 1♂, sample 9.16 (IBSP 213915; photo); V-VI/2017, J.F. Sobczak leg.; *Paraíba*: Areia (06°57'46"S; 35°41'31"W), Mata do Guarim, 1♂, 12/IV/1997, A.D. Brescovit leg. (IBSP 10280); Areia, Reserva da Mata do Pau Ferro, (06°57'28"S; 35°44'4"W), 1♂, 23-29/IX/1999, A.D. Brescovit et al. leg. (IBSP 138952); 1♀ (IBSP 138936); 1♀ (IBSP 138951); 1♀ (IBSP 138955); 1♀ (IBSP 139959); 1♂ (IBSP 138957); 1♂ (IBSP 138947); 1♂ (IBSP 138935); 1♂ (IBSP 138948), all same locality and collector; *Pernambuco*: Recife, (08°03'14"S; 34°52'51"W), Horto Dois Irmãos, 4♂, 4♀, 30/V-02/VI/2001, Equipe Biota leg. (IBSP 138511–138512; IBSP 138514–138519), all same locality and collector; *Alagoas*: Murici, Estação Ecológica de Murici (09°15'S, 35°51'W), 1♂, 13-22/IX/2003, Equipe Biota leg. (IBSP 139920); 1♀ (IBSP 139869); 1♂, 1♀ (IBSP 139875); 1♂ (IBSP 139901); 1♀ (IBSP 139916); 1♂ (IBSP 139866); 1♀ (IBSP 139906); 1♂ (IBSP 139885); 1♂ (IBSP 139896); 1♂ (IBSP 139922); 1♀ (IBSP 139878); 2♂ (IBSP 139912); 1♂ (IBSP 139891); 1♂ (IBSP 139889); 1♂, 1♀ (IBSP 139870); 1♂ (IBSP 139881); 1♂ (IBSP 139871); 1♀ (IBSP 139867); 1♂ (IBSP 139892); 1♂ (IBSP 139918); 1♀ (IBSP 139877); 1♂ (IBSP 139879); 1♀ (IBSP 139923); 1♂ (IBSP 139909), 1♂ (IBSP 139917); 1♂ (IBSP 139863), all same locality and collector; *Sergipe*: Santa Luzia do Itanhhy, Mata do Crasto (11°21'03"S 37°26'52"W), 1♂, 09-13/IX/1999, A.D. Brescovit et al. leg. (IBSP 138553); 1♀ (IBSP 138555); 1♀ (IBSP 138556); 1♂ (IBSP 138557); 1♀ (IBSP 138558); 1♀ (IBSP 138559); 1♂ (IBSP 138560); 1♂ (IBSP 138561); 1♀ (IBSP 138562); 1♀ (IBSP 138563), all same locality and collector; *Bahia*: Mata de São João (12°31'48"S, 38°17'56"W), Fazenda Camurujipe, 1♂, 2006, C. Machado leg. (IBSP 91317); 1♂ (IBSP 91318); 1♂ (IBSP 91319); 1♀ (IBSP 91320); 1♂ (IBSP 91321); 1♀ (IBSP 91322), all same locality and collector; Jussari, Reserva Natural da Fazenda Teimoso (15°09'S 39°31'W), 1♀, 21/XI/1998, F. Dias leg. (IBSP 35171); *Espírito Santo*: Conceição da Barra, Parque Estadual de Itaúnas (18°25.5'97"S; 39°42'25.68"W), 1♀, 15/XII/2002-06/III/2003, Equipe Biota leg. (IBSP 138696); *Rio de Janeiro*: Petrópolis (22°30'18"S; 43°10'44"W), Fazenda Ranchinho da Roça, 1♀, 08-15.II.2000, Equipe Biota leg. (IBSP 139959).

Etymology. The noun in apposition refers to the type locality.

Diagnosis. Males of *Macrophyes pacoti* n. sp. resembles those of *M. jundiai* (see Brescovit, 1993, figs. 1–2) by the long tibiae and vestigial tibial retrolateral apophysis but differ by the palp having a sinuous spermatic duct and elongated, bent embolus (Figs. 1C, D; 2A). Females are readily recognizable by the epigynum with triangular atrium and slightly sclerotized lateral borders (Fig. 1E, 2C).

Description. *Male* (IBSP 213909). Carapace yellow with gray cephalic area and paramedian bands. Chelicerae, endites and labium brown. Sternum white. Abdomen white with dorsal median gray band dorsally, ventrally white. Legs

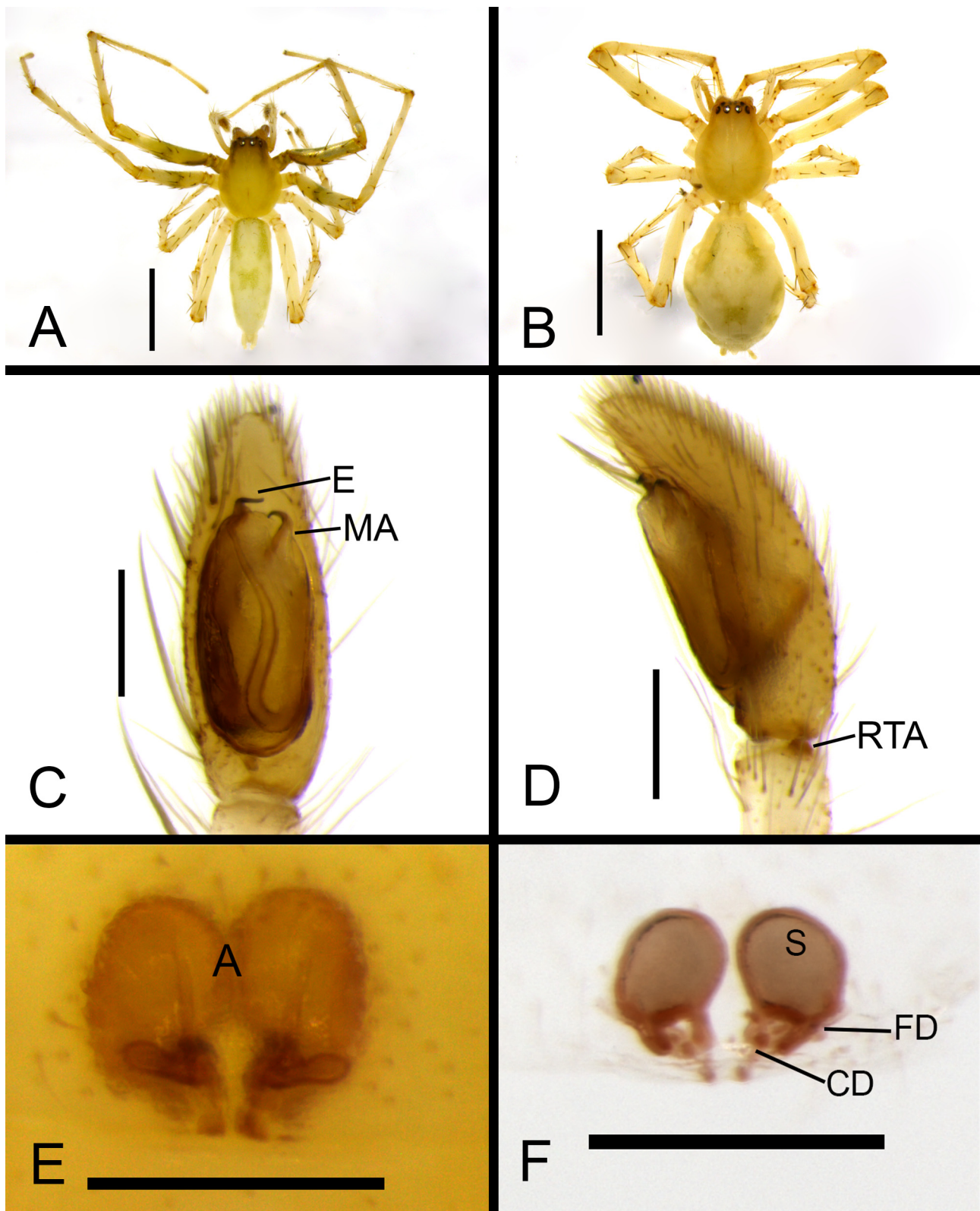


FIGURE 1A–F. *Macrophytes pacoti* n. sp., male (IBSP 213909): A, habitus, dorsal view; C, left palp, ventral view; D palp, retrolateral view; female (IBSP 213913): B, habitus, dorsal view; E epigynum, ventral view; F epigynum, dorsal view. Abbreviations: A, atrium; CD, copulatory ducts; E, embolus; FD, fertilization ducts; MA, median apophysis; RTA, retrolateral tibial apophysis; S, spermathecae. Scale bars: A–E 0.2mm; F 0.25mm.

I-II orange with green bands in the femora I, and other legs white (Fig. 1A, 3A). Total length 4.8, carapace length 1.8, width 1.6. Clypeus height 0.08. Eye diameters and interdistances: AME 0.08, ALE 0.16, PME 0.18, PLE 0.16; AME–AME 0.06, AME–ALE 0.06, PME–PME 0.10, PME–PLE 0.10, ALE–PLE 0.06. Chelicerae 1.0 long, with 5 promarginal teeth and 5 retromarginal denticles. Leg measurements: Leg I—femur 2.1/ patella 0.75/ tibia 2.4/ metatarsus 2.0/ tarsus 0.75/ total 8.0; II—2.0/ 0.7/ 2.0/ 1.8/ 0.8/ 7.3; III—1.5/ 0.45/ 1.1/ 1.4/ 0.5/ 4.95; IV—2.2/ 0.55/ 1.8/ 2.3/ 0.65/ 7.5. Leg spination: I–II—tibia v2-2-0, p0, r0, metatarsus v2-0-0, p0, r0; III—tibia v1p-2-0, p1-1-0, r1-1-0, metatarsus v2-2-2, p1-1-1, r1-1-1; IV—tibia v1p-1p-2, p1-1-0, r1-1-0, metatarsus v2-2-2, p1-1-1, r1-1-1. Palp: tibia almost as long as cymbium (Fig. 2A–B); short and rounded retrolateral tibial apophysis (Fig. 2B); median apophysis subapical, short, curved at tip (Figs. 1C, 2A). Abdomen: length 3.0, epigastric furrow 1.0 from tracheal spiracle, spiracle 1.0 from base of spinnerets.

Female (IBSP 213910). Coloration as in male, except carapace dorsally with inconspicuous bands and abdomen totally cream (Fig. 1B). Total length 4.8, carapace length 1.7, width 1.4. Clypeus height 0.06. Eye diameters and interdistances: AME 0.08, ALE 0.12, PME 0.12, PLE 0.12; AME–AME 0.06, AME–ALE 0.04, PME–PME 0.10, PME–PLE 0.4, ALE–PLE 0.06. Chelicerae 0.7 long, with 5 promarginal teeth and 7 retromarginal denticles. Leg measurements: Leg I—femur 2.1/ patella 0.75/ tibia 2.4/ metatarsus 2.0/ tarsus 0.75/ total 8.0; II—2.0/ 0.7/ 2.0/ 1.8/ 0.8/ 7.3; III—1.5/ 0.45/ 1.1/ 1.4/ 0.5/ 4.95; IV—2.2/ 0.55/ 1.8/ 2.3/ 0.65/ 7.5. Leg spination: I–III—tibia and metatarsus as in male; IV—tibia v1p-1p-2, p1-1-0, r1-1-0, metatarsus v2-2-2, p1-1-1, r1-1-1. Abdomen: length 3.1, epigastric furrow 1.0 from tracheal spiracle, spiracle 1.1 from base of spinnerets. Epigynum: oval spermathecae, short copulatory ducts between the spermathecae, with oval seminal receptacles in the basal third and elongate, posterior fertilization ducts (Figs. 1E, F; 2C–D).

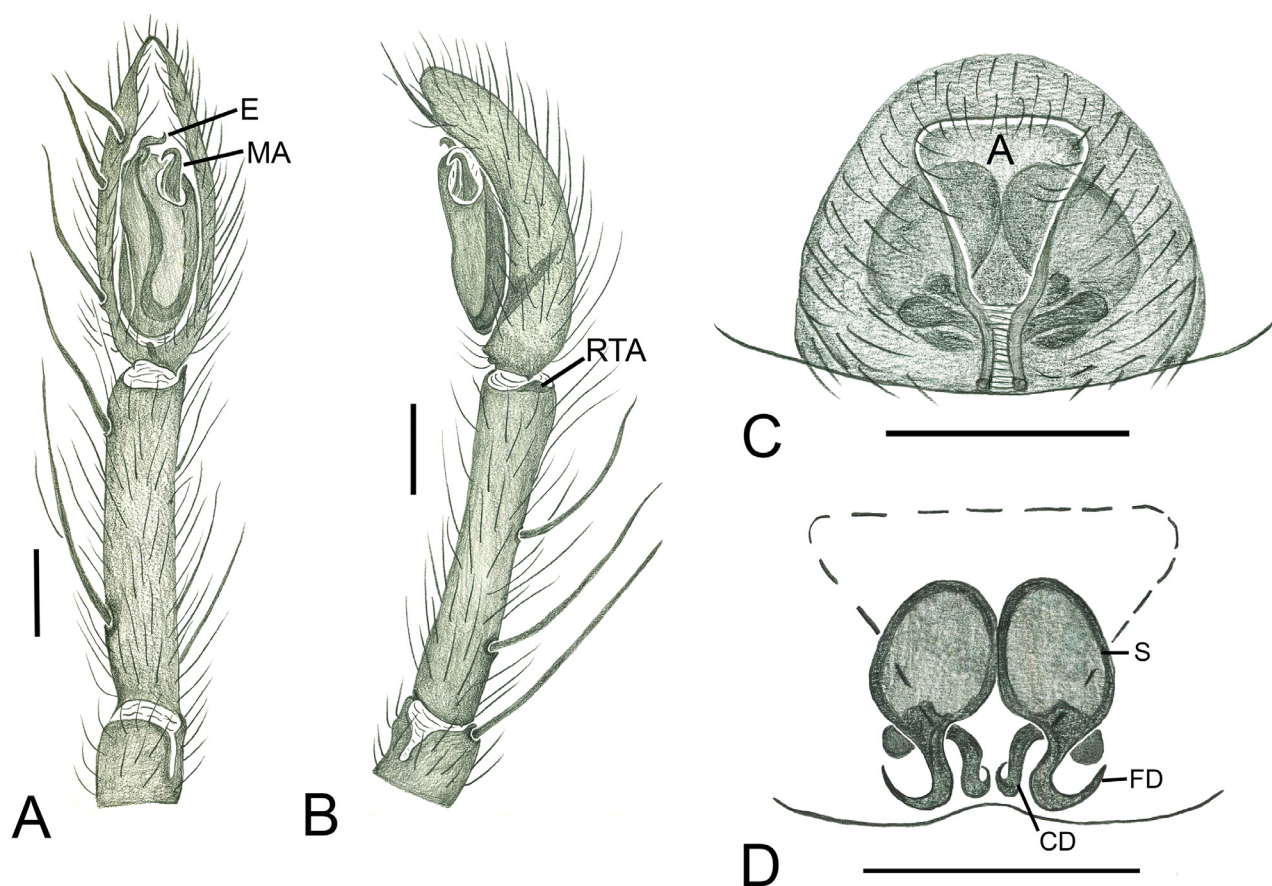


FIGURE 2A–D. *Macrophyes pacoti* n. sp., male (IBSP 213909): A, left palp, ventral view; B palp, retrolateral view; female (IBSP 213913): C, epigynum, ventral view; D, epigynum, dorsal view. Abbreviations: A, atrium; CD, copulatory ducts; E, embolus; FD, fertilization ducts; MA, median apophysis; RTA, retrolateral tibial apophysis; S, spermathecae. Scale bars: A–D 0.5mm.

Variation. Males (n = 10): total length 4.5–4.8; carapace 1.7–1.8; femur I 2.7–2.8; females (n = 10): total length 4.1–4.9; carapace 1.5–2.0; femur I 1.8–2.4.

Distribution. Known from the states of Ceará, Paraíba, Pernambuco, Alagoas, Sergipe and Bahia in northeast Brazil and state of Espírito Santo and Rio de Janeiro, in southeast Brazil (Fig. 4).

Remarks. In the area of the Reserva Florestal Particular Empresa Arvoredo Floricultura at least 10 specimens of *M.*

pacoti n. sp. were collected. Among these specimens, five individuals were infected with fungi (1 male and 4 females) and five were not infected. Infected specimens were attacked by a species of araneopathogenic fungus of the genus *Gibellula* sp. (Cordycipitaceae), which is the most common genus to infect spiders in South America (Evans 2013). Some specimens showed white coloration and others orange coloration (Fig. 3B), the latter being more abundant. The hyphae of the fungus attack the specimens from the exoskeleton into the hemocoel, ultimately covering the whole body of the spider. These infected spiders usually die on the abaxial surface of green leaves, with their legs stretched and fixed to leaf (Fig. 3B), which possibly helps in fixing the host to the plant. In addition, spiders, after killed by the parasitic fungus, have developed fungal reproductive structures in their bodies.



FIGURE 3A–B. *Macrophyes pacoti* n. sp. (IBSP 213915): A, live specimen not covered by fungus, dorsal view (IBSP 213904); B, dead specimen with fungus covering body, latero-dorsal view.

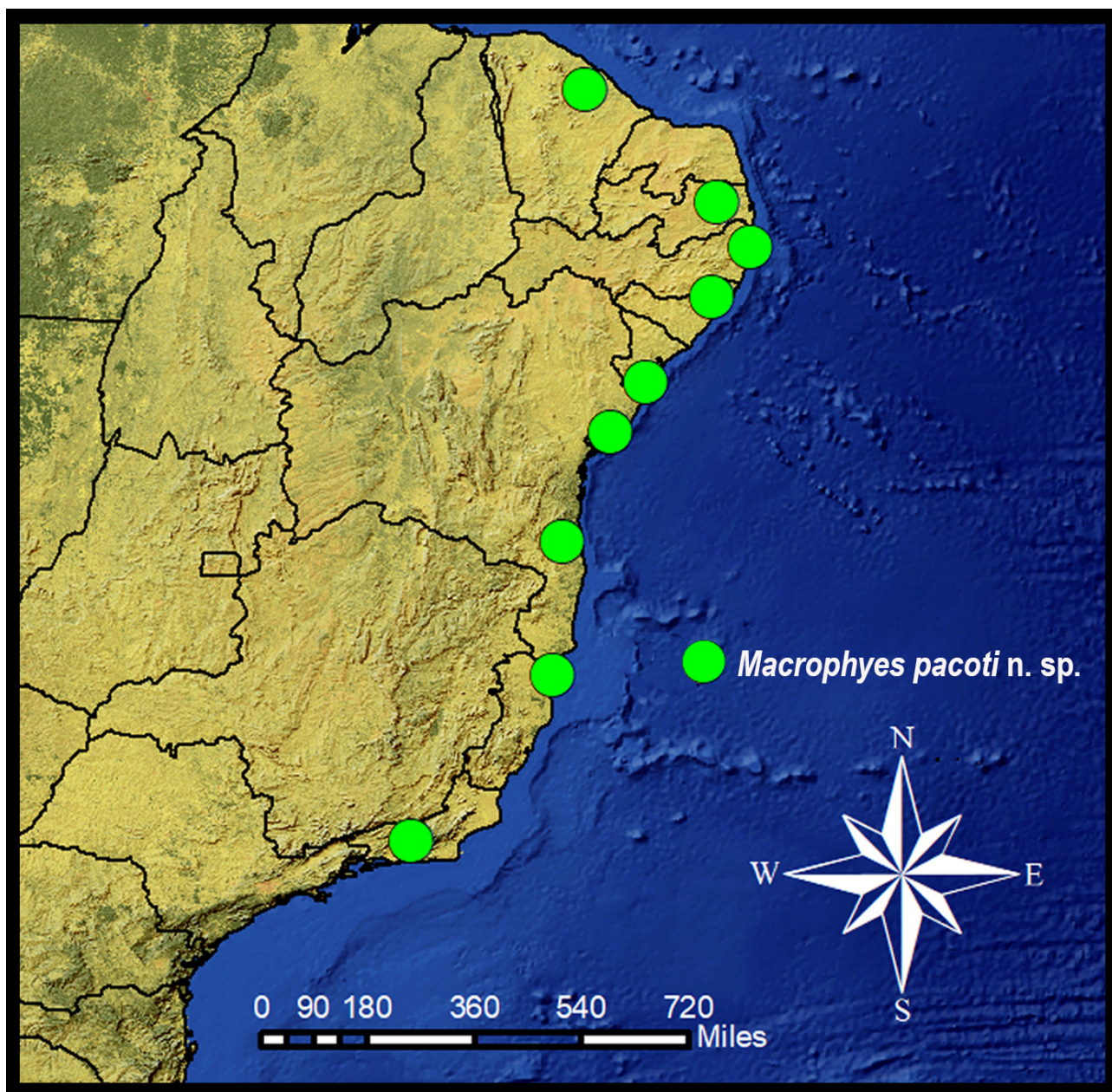


FIGURE 4. Records of *Macrophyes pacoti* n. sp.

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