

# A preliminary survey and range extension of millipedes species introduced in Brazil (Myriapoda, Diplopoda)

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**Abstract.** The present study provides historical and new records of the introduced millipedes species in Brazil, *Oxidus gracilis* (C.L. Koch, 1847), *Orthomorpha coarctata* (Saussure, 1860) (Paradoxosomatidae), *Prosopodesmus jacobsoni* Silvestri, 1910 (Haplodesmidae), *Trachyjulus calvus* (Pocock, 1893a), *Glyphiulus granulatus* (Gervais, 1847) (Cambalopsidae), *Trigonius corallinus* (Gervais, 1842), *Leptogoniulus sorornus* (Butler, 1876), *Epitrigoniulus cruentatus* (Brölemann, 1903) (Pachybolidae), *Paraspirobolus lucifugus* (Gervais, 1837) (Spirobolellidae), *Cylindroiulus britannicus* (Verhoeff, 1891), *Cylindroiulus truncorum* (Silvestri, 1896) (Julidae), and *Rhinotus purpureus* (Pocock, 1894) (Siphonotidae). Among the 27 federative units in Brazil, 21 states present at least one record of a non-native species. *Orthomorpha coarctata* was the most widely distributed species, occurring in 15 states. *Glyphiulus granulatus* (state of Rio Grande do Sul), *C. truncorum* (São Paulo), and *R. purpureus* (Amazonas) were recorded from only one Brazilian state. The Southeast region concentrates most of the compiled records (42,6%) and richness by grid (5-7 species), mainly in urban areas of the states of Rio de Janeiro and São Paulo.

**Keywords.** Invasive species; Synanthropic millipedes; Schubart; *Oxidus gracilis*; *Orthomorpha coarctata*.

## INTRODUCTION

Members of the class Diplopoda are distributed on all continents, excepting the Antarctica (Hoffman, 1980; Golovatch & Kime, 2009). Millipedes are commonly observed on tropical, subtropical, and temperate forests (Golovatch & Kime, 2009), performing important ecological roles as detritivorous and biogeographical indicators (Schubart, 1942b; Crawford, 1992; Golovatch & Kime, 2009; Suzuki *et al.*, 2013; Nsengimana *et al.*, 2018; Potapov *et al.*, 2019).

Introduced species are widely accepted as one of the main direct causes of biodiversity loss and habitat alteration (Didham *et al.*, 2005). In addition, non-native species have been reported as widely introduced around the world by human

activities such as gardening, cultivation of plants, and soil transport. Numerous studies have reported the presence of millipedes in man-made habitats (Vicente & Enghoff, 1999; Golovatch & Kime, 2009; Shelley & Golovatch, 2011), including well-established populations in urban and rural areas (Hopkin & Read, 1992; Korsós *et al.*, 2002; Bogyó *et al.*, 2015). Some millipedes have been reported as pests causing significant economic damage (Butcher, 1936; Kuria & Eijnatten, 1981; Brunke *et al.*, 2012). In Brazil, some introduced millipedes are considered agricultural pests in poly- or monocultures based on observations of immatures and adults feeding on seedlings, tubers, and fruits (Schubart, 1942b; Boock & Lordello, 1952; Lordello, 1954). Importantly, the identification of a given species as introduced depends on the

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**RESULTS**

**Order Polydesmida  
Family Paradoxosomatidae**

***Oxidus gracilis* (C.L. Koch, 1847)  
(Figs. 1A, 4B, 5A)**

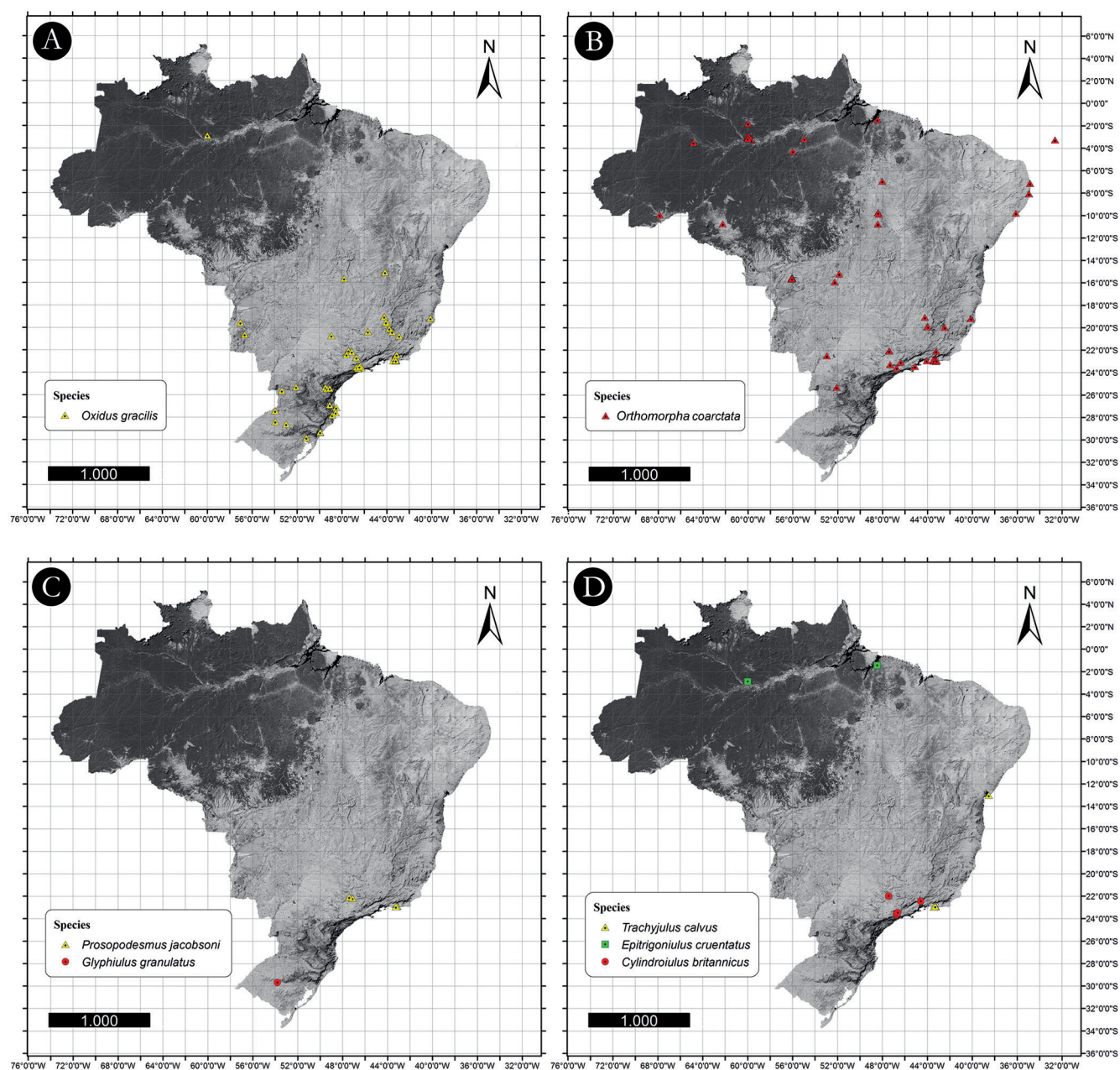
**Descriptive notes:** See Nguyen et al. (2017: 6, figs. 1-2).

**Note:** Based on examined material, immatures and females of *O. gracilis* cannot be identified and morphologically distinguished from those of *Orthomorpha coarctata*.

**Identification:** The species can be easily distinguished from autochthones Neotropical paradoxosomatids

mainly by gonopod features (Fig. 5A). Males of *O. gracilis* are recognized by femorite strongly expanded distally; postfemoral spine pointed tuberculiform; postfemoral process lamellar and bent upwards from midpart, serrated at distolateral portion; solenophere with mesal lobe well-developed (see Nguyen et al., 2017).

**Distribution:** *Oxidus* Cook, 1911 occurs in the SE Asia (Jeekel, 1968; Nguyen et al., 2017), while the species *O. gracilis* is widely distributed around the world due to commercial activities (Nguyen & Sierwald, 2013), occurring in USA and Hawaii (Shelley et al., 1998), Europe (Blower, 1985), and Asia (Korsós, 2004; Nguyen et al., 2017). The species is considered urban and agricultural pest (O'Neill & Reichle, 1970). In Brazil, the species presents a large distribution range, occurring in urban and



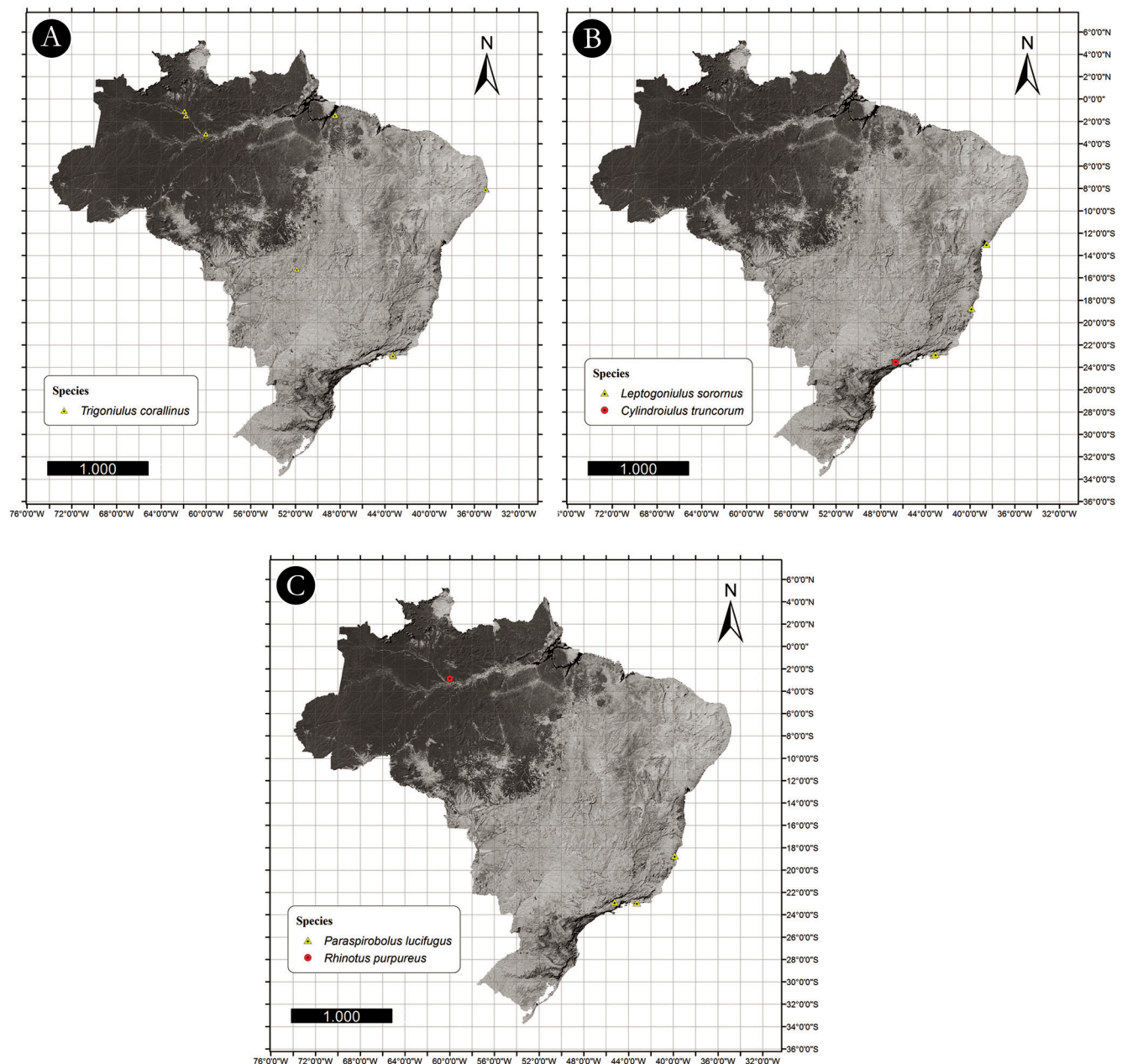
**Figure 1.** Distribution maps of *Oxidus gracilis*, *Orthomorpha coarctata* (Polydesmida, Paradoxosomatidae), *Prosopodesmus jacobsoni* (Polydesmida, Haplodesmidae), *Glyphiulus granulatus* (Spirostreptida, Cambalopsidae), *Trachyjulus calvus* (Spirostreptida, Cambalopsidae), *Epitrigoniulus cruentatus* (Spirobolida, Pachybolidae), and *Cylindroiulus britannicus* (Julida, Julidae).



rural areas, greenhouses, caves, and in forests partially preserved (Iniesta *et al.*, 2020).

**Material examined: Amazonas:** **Manaus** [-03.063877°S; -60.036493°W], Embrapa Amazônia Ocidental, banana plantation, near the Climatology laboratory, 28.iv.2016, T.M. Almeida & A.E.C. Silveira coll., 12♂ 8♀ 2 immatures (INPA); **Distrito Federal:** **Sobradinho** [-15.658554°S; -47.791846°W], cave Face Leste, 26.vi.2013, M.P. Bolfarini coll., 2♂ (IBSP 5509); **Mato Grosso do Sul:** **Corumbá** [-19.577553°S; -57.037810°W], Passo do Lontra, 2000, J. Raizer coll., ♂ (IBSP 1035); **Bodoquena** [-20.631661°S; -56.652781°W], cave Califórnia, 17.iii.2001, C.S. Escarpinati coll., ♂ (IBSP 4276); ♀ (IBSP 4282); ♀ (IBSP 4270); ♀ (IBSP 4271); ♀ (IBSP 4277); ♀ (IBSP 4280); **Minas Gerais:** **Pains** [-20.383591°S; -45.661936°W], cave Piriás, 30.i.2001, R. Ferreira coll., 2♂ 2♀ (IBSP 3602);

27.i.2000, Ferreira coll., 5♂ 2♀ (IBSP 3601); **Itacarambi** [-15.092057°S; -44.133344°W], Vilarejo Fabião II, 05.vii.2011, J.P.P. Pena-Barbosa coll., ♂ ♀ (IBSP 3726); **Cordisburgo** [-19.050250°S; -44.209663°W], Morena cave, 12-15.x.2007, ♂ ♀ (IBSP 3558); ♂ ♀ (IBSP 3556); ♀ (IBSP 3559); ♀ (IBSP 3557); **Lagoa Santa** [-19.635088°S; -43.898478°W], 21.x.1947, O. Schubart coll., 5♂ 3♀ 3 immatures (MZSP); **Viçosa** [-20.756373°S; -42.883016°W], ESAV, 14.x.1947, O. Schubart coll., 2♂ (MZSP); **Ouro Preto** [-20.395727°S; -43.502578°W], 17.x.1947, O. Schubart coll., 4♂ 6♀ 1 immature (MZSP); **Rio Acima** [-20.088882°S; -43.791390°W], cave 0020\_VG43, 02-10.viii.2011, R. Andrade coll., ♂ ♀ (IBSP 6622); 2♂ ♀ (IBSP 6671); cave SPD\_38, 25-27.vii.2013, Bessi *et al.*, coll., ♂ ♀ (IBSP 7150); ♀ (IBSP 7149); **Matozinhos** [-19.565584°S; -44.078665°W], cave LF\_22, 16.viii-14.ix.2017, Eq. Spelayon coll., 2♂ 2♀ (IBSP 7473); **Espírito**

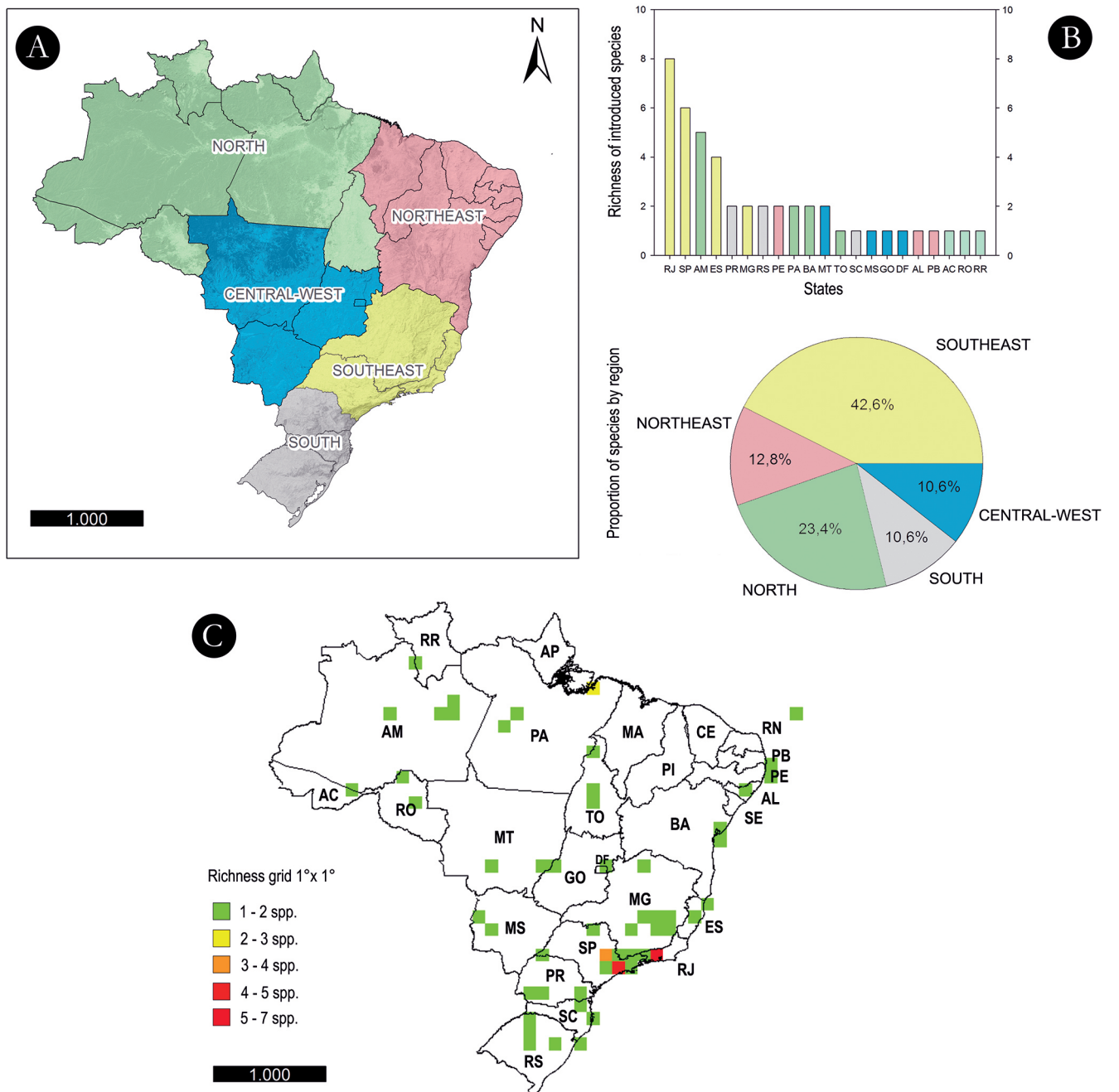


**Figure 2.** Distribution maps of *Trigoniuulus corallinus*, *Leptogoniulus sorornus* (Spirobolida, Pachybolidae), *Cyllindroiulus truncorum* (Julida, Julidae), *Paraspriobolus lucifugus* (Spirobolida, Spirobolellidae), and *Rhinotus purpureus* (Polyzoniida, Siphonotidae).



**Santo: Sooretama** [-19.1979°S; -40.0913°W], 24.ii.2011, A.F.R. Teixeira coll., 2♀ (MCN); **Rio de Janeiro: Rio de Janeiro** [-22.921765°S; -43.169510°W], O. Schubart coll., 18 immatures (MNRJ 11694); ♀ (MNRJ 11740); 71 immatures (MNRJ 11749); (MNRJ 11728); (MNRJ 11732); (MNRJ 11746); **Petrópolis** [-22.921765°S; -43.169510°W], O. Schubart coll., ♀ (MNRJ 11733); 22 immatures (MNRJ 11737); **São Paulo: Arujá** [-22.668644°S; -46.320865°W], 06.xii.1995, Vigilância Sanitária Guarulhos coll., ♂ ♀ (IBSP 944); **Guarulhos** [-23.678875°S; -46.543425°W], 28.ii.2002, Prefeitura Municipal de Guarulhos coll. (IBSP 903); **Olimpia** [-20.741815°S; -48.911570°W], xi.1916, E. Garb coll., ♂ (MZSP); **Santo André** [-23.678234°S; -46.543425°W], x.1939, B.L. Bastiani coll., 2♂ 3♀ (IBSP 28); **São Paulo** [-23.567300°S;

-46.633047°W], 01.i.1956, J. Becker coll., 2♂ 3♀ (MNRJ); 2♂ 2♀ (IBSP 34); iv.1939, F. Paes de Barros coll., 2♂ 5♀ (IBSP 34); vii.1940, W. Bücherl coll., 4♂ ♀ (IBSP 23); Tremembé [-23.464143°S; -46.625706°W], 10.x.2001, L. Goes & L. Silva coll., ♀ (MNRJ); Santana [-23.501011°S; -46.626233°W], 08.x.1998, Centro Zoonoses Prefeitura Municipal de São Paulo coll., ♂ 3♀ (IBSP 678); Vila Gomes [-23.576975°S; -46.732075°W], 26.viii.1998, F. Henrique coll., ♂ 2♀ (IBSP 683); Saúde [-23.619984°S; -46.635291°W], 14.xi.2000, P. Kitamoto coll., 10♂ 12♀ 1 immature (IBSP 825); Jardim Rizzo [-23.572008°S; -46.732739°W], 20.xi.1998, Equipe IBSP coll., ♂ (IBSP 673); ♂ ♀ (IBSP 672); ♀ (IBSP 675); **Mogi das Cruzes**, Parque São Martinho [-23.614280°S; -46.236089°W], 17.xi.2018, R.S. Bouzan coll., 3♂ 2♀ 2 immatures (IBSP 7757); **Paraná: Piraquara**



**Figure 3.** Introduced species in Brazil: (A) Brazilian regions; (B) Proportion of species by states and regions; (C) Richness by grid 1°x1°. See Table 1 for the abbreviations of the states.

[-25.454547°S; -49.062333°W], Banhado, 22.xii.2015, A. Chagas-Jr., M. Karam & A. Kury coll., ♂ 2♀ (UFMT); Nova Prata do Iguaçu [-25.640129°S; -53.345181°W], Salto Caxias, 24.ix.1990, R.S. Bérnils coll., ♂ (MHNCI); Campo Magro [-25.369783°S; -49.450466°W], cave Terra Boa, 27.vi.2015, W. Murguia coll., ♂ (IBSP 7405); Rio Grande do Sul: Selbach [-28.63129444°S; -52.95194444°W], xi.2016, C. Maldaner coll., ♀ (INPA); Morrinhos do Sul [-29.3569°S; -49.91812°W], 20.xii.2010, R. Ott coll., 3♂ 7♀ (MCN 938); Sapucaia do Sul [-29.840651°S; -51.147425°W], 07.xii.2012, E. Velinho coll., ♂ 4♀ (MCN 964); ♂ 50♀ (MCN 964); Três Passos [-27.453954°S; -53.929651°W], 14.ix.1947, A.C. Aguirre coll., ♂ (MZSP); Ijuí [-28.393218°S; -53.920602°W], 16.iv.1954, A.C. Aguirre coll., ♂ (MZSP).

**Historical records:** Rio de Janeiro: Petrópolis [-22.921765°S; -43.169510°W], O. Schubart coll. (Schubart, 1945b); São Paulo: Amparo, Fazenda São Bento [-22.668644°S; -46.737739°W], 08.iii.1943, F. Lane coll., 9♂ 13♀ 1 immature (Schubart, 1945a); Mogi Guaçu [-22.185269°S; -47.097326°W], 06.vii.1941, 6♂ 6♀ 9 immatures (Schubart, 1944); Monte Alegre [-22.691374°S; -46.682651°W], 12.iv.1944, ♂ 5♀ 7 immatures (Schubart, 1945a); Estação Experimental, 12.iv.1944, 13♂ 7♀ (Schubart, 1945a); Pirassununga [-22.067267°S; -47.395011°W], 17.i.1940, 10♂ 11♀ 5 immatures (Schubart, 1944); 03.iv.1940, 5♂ 7♀ 26 immatures (Schubart, 1944); 22.v.1940, ♂ ♀ 1 immature (Schubart, 1944); 30.vii.1940, 5♂ 5♀ (Schubart, 1944); 13.ii.1941, ♂ 4♀ 38 immatures (Schubart, 1945a); Fazenda São Domingos, 22.ix.1940, 16♂ 21♀ 63 immatures (Schubart, 1945a); Fazenda Graciosa, 25.x.1940, 52♂ 31♀ 21 immatures (Schubart, 1945a); Cachoeira, 23.xi.1940, ♀ (Schubart, 1944); 10.ii.1941, 2♂ 1 immature (Schubart, 1944); Fazenda Pedra Branca, 15.ii.1942, J. Gaspar coll., 2♂ ♀ (Schubart, 1944); Rio Claro [-22.429577°S; -22.429577°W], Fazenda São José, 26.ix.1941, 22♂ 13♀ 13 immatures (Schubart, 1944); Santa Rita [-23.513697°S; -46.414041°W], 03.xi.1940, ♀ (Schubart, 1944); Paraná: Curitiba [-25.495342°S; -49.303308°W], 318♂ 235♀ (Schubart, 1953); Piraquara [-25.454547°S; -49.062333°W], Banhado (Schubart, 1953); Santa Catarina: Florianópolis [-27.602630°S; -48.547169°W], iv.1946, Gofferjé coll. (Schubart, 1953); Rio Grande do Sul: São Francisco de Paula, Centro de Pesquisas e Conservação da Natureza Pró-Mata [-29.481206°S; -50.173833°W], 2016, P.E.S. Rodrigues et al. coll. (Rodrigues et al., 2017).

***Orthomorpha coarctata* (Saussure, 1860)**  
(Figs. 1B, 4A, 5B)

**Descriptive notes:** See Likhitrakarn et al. (2011: 12, figs. 4-8).

**Note:** Based on examined material, immatures and females of *O. coarctata* cannot be identified and morphologically distinguished from those of *Oxidus gracilis*. The species was placed in the genus *Asiomorpha* by Verhoeff (1939), and its taxonomic position is under discussion

(see Likhitrakarn et al., 2011, 2019; Nguyen & Sierwald, 2013). For a listing purpose, we maintained the species in *Orthomorpha* according to the latest taxonomic reviews (for more details, see Likhitrakarn et al., 2011, 2019).

**Identification:** The species can be easily separated from autochthones Neotropical paradoxosomatids mainly by gonopod features (Fig. 5B). Males of *O. coarctata* are recognized by a single terminal lobule on gonopod tip; spikes and denticles either missing or nearly missing (Likhitrakarn et al., 2011, 2019).

**Distribution:** The species is widely distributed in the tropics (Nguyen & Sierwald, 2013), occurring in USA, Hawaii (Shelley et al., 1998), Caribbean islands (Nguyen & Sierwald, 2013), and SE Asia (Korsós, 2004). *Orthomorpha coarctata* is distributed predominantly in the North and Southeast regions in Brazil, occurring in urban and rural areas, greenhouses, forests, and islands.

**Material examined:** Acre: Rio Branco [-09.95938889°S; -67.85665556°W], 09.x.2017, J.A. Rafael coll., ♀ (INPA); Amazonas: Boca do Tefé [-03.488378°S; -64.843366°W], mata rio Solimões, ix.1952, Equipe IBSP coll., 6♂ 2♀ (IBSP 106); Careiro da Várzea, Ilha do Careiro [-03.16607500°S; -59.73265278°W], 08.vii.1997, K. Vohland coll., ♂ (INPA); Manaus, Residencial Nascentes do Tarumã [-02.99222222°S; -60.03416667°W], 05.vii.2016, T. Mahlmann coll., 20♂ 61♀ (INPA); Igarapé Cururu [-03.12666667°S; -59.94055556°W], 22-24.ii.2007, N.O. Aguiar et al., coll., ♀ (INPA); Bosque da Ciência [-03.09743889°S; -59.98781389°W], 07.v.2017, T.M. Almeida coll., 31♂ 13♀ (INPA); Instituto Nacional de Pesquisas da Amazônia, campus II [-03.096214°S; -59.989578°W], 20.iv.2016, 2♂ (INPA); campus INPA, secondary forest [-03.13333333°S; -60.01666667°W], 03.viii.1995, J. Adis et al., coll., 21♀ 10♂ (INPA); campus of Universidade Federal do Amazonas (UFAM) [-03.10024444°S; -59.97850000°W], 07.x.2005, M.L. Custódio coll., ♂ 2♀ (INPA); 09.ii.2015, N.T.B. Antunes coll., ♀ (INPA); Embrapa Amazônia Ocidental, banana plantation, near the Climatology laboratory [-02.893680556°S; -59.9730667°W], 28.iv.2016, T.M. Almeida & A.E.C. Silveira coll., 3♂ ♀ (INPA); Reserva Florestal Adolpho Ducke [-02.96334444°S; -59.92283333°W], 17.v.2014, 7♂ 6♀ (INPA); 23.vii.2015, 2♂ (INPA); 20.xii.2018, T.M. Almeida coll., 6♂, 4♀ (INPA); 20♀ 20♂ (INPA); Presidente Figueiredo [-01.797656°S; -59.973303°W], 16.vii.1996, K. Vohland coll., ♀ ♂ (INPA); Rondônia: Porto Velho, Parque Municipal [-10.738177°S; -62.218467°W], 02.iii.2010, G. Miranda coll., ♂ 2♀ 1 immature (MNRJ); Porto Velho, campus Universidade Federal de Rondônia – UNIR [-08.76349167°S; -63.906575°W], tree trunk, 14.xi.2016, A. Andriolo coll., ♀ (INPA); Pará: Itaituba [-04.275500°S; -55.992846°W], 08.vii.2003, J. de Fronte coll., 5♂ 3♀ (MCTP 124); Belém, Campus MPEG [-01.451628°S; -48.446535°W], 10-30.vi.2010, R. Ott coll., ♂ ♀ (MPEG); Belterra, urban area [-03.161651°S; -54.965476°W], 26-29.x.2009, Equipe IBSP coll., ♂ (IBSP 7758); Paraíba: João Pessoa [-07.124538°S; -34.845187°W], O. Schubart



coll., ♂ (MNRJ 11721); x.1935, O. Schubart coll., 16 specimens (MNRJ 11707); 10.x.1935, L. Cordeiro coll., 2♂ (MNRJ 11692); **Pernambuco: Recife** [-08.056951°S;

-34.929493°W], O. Schubart coll., 2♂ 2♀ (MNRJ 11705); 2♀ (MNRJ 11690); ♂ (MNRJ 11687); ♀ (MNRJ 11712); O. Schubart coll., 2♂ 3♀ (MNRJ 11715); 29.i.1935, O. Schubart



**Figure 4.** Introduced species in Brazil, habitus: (A) *Orthomorpha coarctata*; (B) *Oxidus gracilis*; (C, D) *Glyphiulus granulatus*; (E) *Trioniulus corallinus*; (F) *Rhinotus purpureus*. Scale bars: 2 mm (A, B, E); 500 µm (C, D); 200 µm (F).



coll., ♂ (MNRJ 11709); Parque Estadual de Dois Irmãos, ix.1936, O. Schubart coll., ♂ (MNRJ 11688); Jiquiá, O. Schubart coll., 12♂ (MNRJ 11699); Tegipió [-08.056961°S; -34.929503°W], 06.i.1932, O. Schubart coll., ♀ 2 immatures (MNRJ 11718); Torres [-08.056958°S; -34.929500°W], O. Schubart coll., ♂ ♀ 1 immature (MNRJ 11720); Ilha Itamaracá [-08.056961°S; -34.929503°W], O. Schubart coll., 24♂ (MNRJ 11704); Ruínas do Engenho Amparo, O. Schubart coll., ♂ 2♀ (MNRJ 11713); **Fernando de Noronha** [-03.863123°S; -32.440625°W], Praia do Leão, 10.vi.2019, ♂ ♀ (INPA); Ilha Rata, 01-09.vi.2019, J.A. Rafael & D.M.M. Mendes coll., ♀ (INPA); Trilha do Capim-Açu, 01-09.vi.2019, J.A. Rafael, F. Limeira-de-Oliveira & D.M.M. Mende coll., 3♂ 2♀ (INPA); Mangue, southeast part of Ilha Rata mangue, 01-09.vi.2019, J.A. Rafael, F. Limeira-de-Oliveira & D.M.M. Mende coll., ♀ (INPA); **Tocantins: Araguaína** [-15.200975°S; -51.852218°W], São João, 05.xi.2016, K.S. Pacheco coll., 2♂ 1 immature (IBSP 7500); Setor Cimba, 22.x.2014, J. Pereira coll., ♂ (IBSP 7498); Lageado [-09.871592°S; -48.297346°W], Área urbana, 23.iv.2002, I. Knysak, R. Martins & G. Puerto coll., 19♂ 5♀ 6 immatures (IBSP 1556); **Palmas** [-09.760156°S; -48.378491°W], U.H.E. Luís Eduardo Magalhães, 22.xi.2000, I. Knysak, R. Martins & G. Puerto coll., ♂ (IBSP 857); 22.xi.2000, R. Martins & G. Puerto coll., 8♂ 14♀ 1 immature (IBSP 846); 21.iii.2001, R. Martins & G. Puerto coll., ♂ 2♀ 1 immature (IBSP 880); ♂ ♀ (IBSP 881); ♀ (IBSP 873); ♀ (IBSP 863); 4♂ 4♀ 1 immature (IBSP 883); **Porto Nacional** [-10.759459°S; -48.398068°W], Ribeirão Santa Luzia, U.H.E. Luís Eduardo Magalhães, 20.i.2000, I. Knysak, R. Martins & G. Puerto coll., 4♂ ♀ (IBSP 938); **Wanderlândia** [-06.929806°S; -48.006315°W], 30.ix.2014, ♂ (IBSP 7499). **Mato Grosso: Cuiabá** [-15.600776°S; -56.074270°W], 14.v.2015, Francisco coll., 3♂ (UFMT); Pedregal, 12.vii.2012, R. Pinto coll., ♂ (UFMT); campus UFMT, 17.viii.2016, B. Martins coll., ♂ (UFMT); 23.v.2017, T. Amorim coll., 2♂ 3♀ (UFMT); 26.vi.2017, G. Brunna coll., ♂ (UFMT); xii.2012, V.S. Falcio coll., ♂ (UFMT); 09.vii.2017, J.R. Silva coll., 2♂ (UFMT); 19.viii.2016, K. Fonseca & M. Martello coll., 2♂ ♀ (UFMT); CPA III, 17.ii.2011, C.C.L. Dias coll., ♂ (UFMT); 15.v.2011, A.F.S. Assis coll., ♂ (UFMT); Bairro Tijucal, 18.vii.2010, R. Moraes coll., ♂ (UFMT); **Várzea Grande** [-15.650197°S; -56.132670°W], 16.ix.2013, A.C. Santos coll., ♂ (UFMT); **Minas Gerais: Belo Horizonte** [-19.921015°S; -43.947253°W], 01.i.1999, A.J. Santos coll., ♂ ♀ (IBSP 1306); FAE UFMG [-19.873236°S; -43.966837°W], iv.2006, L. Bernardi coll., 4♂ ♀ (IBSP 2910); **Raul Soares**, São Vicente da Estrela [-19.960899°S; -42.438840°W], 06.i.2002, E.N. de Jesus coll., ♂ 2♀ (IBSP 961); **Cordisburgo** [-19.067019°S; -44.215763°W], 25.x.1947, O. Schubart coll., 2♂ 1 immature (MZSP); **Três Rios** [-22.110134°S; -43.208401°W], Road to Rio de Janeiro, 12.x.1947, O. Schubart coll., 5♂ ♀ 2 immatures (MZSP); 2♂ 7♀ 3 immatures (MZSP); **Espírito Santo: Sooretama** [-19.178587°S; -40.098118°W], plantação de café, 24.ii.2011, A.F.R. Teixeira coll., ♂ ♀ (MCN 1184); ♂ ♀ (MCN 1218); ♀ (MCN 1183); ♂ (MCN 1185); 2♂ ♀ (MCN 1210); 5♂ 8♀ (MCN 1199); 4♂ 7♀ (MCN 1188); 30.iii.2011, A.F.R. Teixeira coll., 27♂ 53♀ 18 immature (MCN); 24.iv.2011, A.F.R. Teixeira coll., 2♂ 3♀ 1 immature (MCN); 25.v.2011, A.F.R.

Teixeira coll., ♂ (MCN); **Rio de Janeiro: Mangaratiba**, Rio Junqueira [-22.930954°S; -44.038933°W], O. Schubart coll., 71♀ (MNRJ 11697); **Rio de Janeiro** [-22.921765°S; -43.169510°W], 28.iii.1951, J. Becker coll., 2♂ ♀ (MNRJ); O. Schubart coll., ♂ (MZSP); **São Paulo: Ubatuba** [-23.446317°S; -45.087149°W], 12-13.ix.1998, R. Martins coll., ♂ ♀ (IBSP 680); **Piracaia** [-23.059153°S; -46.360347°W], x.1996, S. Rocha coll., ♂ (IBSP 691); **Itu** [-23.272062°S; -47.299290°W], 11.iv.1985, R. D'Ávila coll., 13♂ 4♀ (IBSP 667); **São Paulo**, Jardim Rizzo [-23.572008°S; -46.732739°W], 20.xi.1998, Eq. IBSP coll., ♂ (IBSP 7759); **Paraná: Curitiba** [-25.495342°S; -49.303308°W], 2♂ ♀ (IBSP 7760).

**Historical records: Amazonas: Manaus** [-03.023045°S; -59.965390°W], Bicego coll. (Brölemann, 1904); Embrapa Amazônia Ocidental [-02.893744°S; -59.973109°W] (Hoffman et al., 2002); **Paraíba: João Pessoa** [-07.1150°S; -34.8631°W], 10.vii.1937, E. Cordeiro coll. (Schubart, 1939); **Pernambuco: Recife** [-08.0539°S; -34.8811°W], Bairro dos Afogados, 1935 (Schubart, 1942a); margin of Rio Capibaribe, 30.i.1935 (Schubart, 1942a); margin of Rio Beberibe, 31.iii.1935 (Schubart, 1942a); Madalena, 25.iv.1935 (Schubart, 1942a); Bairro Torre, 16.vii.1936 (Schubart, 1942a); Bairro Dois Irmãos, 1934 (Schubart, 1939); Bairro Tegipió, 1934 (Schubart, 1939); Bairro Várzea, 1934 (Schubart, 1939); **Olinda** [-08.0089°S; -34.8553°W], banana plantation, 07.iv.1935 (Schubart, 1939); Iguarassú [-07.8333°S; -34.9000°W], **Ilha Itamaracá** [-07.754660°S; -34.837309°W], 25.v.1935 (Schubart, 1939); **São Lourenço da Mata**, 14.vii.1937, (Schubar, 1939); **Alagoas: Jequiá da Praia** [-09.7811°S; -36.0936°W], Lagoa de Jequiá, Porta da Boca, 10.vii.1936, ♀ 1 immature (Schubart, 1939); **Goias: Aragarças** [-15.912823°S; -52.251231°W], x.1953, H. Sick coll., ♂ (Schubart, 1958a); **Rio de Janeiro: Rio de Janeiro**, Bairro Cachambí [-22.902038°S; -43.273901°W] (Schubart, 1945b); Bairro Deodoro [-22.857562°S; -43.384850°W] (Schubart, 1945b); Bairro do Encantado [-22.896400°S; -43.302050°W] (Schubart, 1945b); Bairro Jacarepaguá [-22.971732°S; -43.391675°W] (Schubart, 1945b); Lagoa Rodrigo de Freitas [-22.973385°S; -43.207108°W] (Schubart, 1945b); Bairro do Leblon [-22.984645°S; -43.223162°W] (Schubart, 1945b); Morro dos Dois Irmãos [-22.952544°S; -43.399345°W] (Schubart, 1945b); Serra de Bangú [-22.876050°S; -43.468651°W] (Schubart, 1945b); Bairro Tijuca [-22.935505°S; -43.243112°W] (Schubart, 1945b); **São Gonçalo**, Engenho Novo [-22.903896°S; -43.268490°W] (Schubart, 1945b); **São Paulo: Pirassununga** [-22.067267°S; -47.395011°W], 17.i.1940, ♂ ♀ 1 immature (Schubart, 1944); 03.iv.1940, 9♂ 6♀ (Schubart, 1944); 22.v.1940, 8♂ 3♀ 1 immature (Schubart, 1944); 23.vii.1940, 3♂ 7♀ 12 immatures (Schubart, 1944); 13.ii.1941, 4♂ 2♀ (Schubart, 1944); 02.iii.1940, 3♂ 2♀ 10 immatures (Schubart, 1944); 26.ix.1941, 7♂ 4♀ 2 immatures (Schubart, 1944); 12.iii.1940 (Schubart, 1944); 27.ii.1940, A. Aguirre coll., 11♂ 11♀ 14 immatures (Schubart, 1944); Fazenda Pedra Branca, 11.i.1942, J. Gaspar coll., ♀ 2 immatures (Schubart, 1944); Fazenda São Domingos, 22.ix.1940, 20♂ 14♀ (Schubart, 1944).

## Family Haplodesmidae

### *Prosopodesmus jacobsoni* Silvestri, 1910 (Figs. 1C, 6A)

**Descriptive notes:** See Brölemann (1920: 226, figs. 141-144).

**Identification:** *Prosopodesmus jacobsoni* can be separated from other species of Neotropical Haplodesmidae by having mushroom-shaped porosteles (see Enghoff, 1993: fig. 4); telopodite with large lateral lamella; two subapical dentiform processes (Silvestri, 1910: fig. 7; Fig. 11a; Mesibov, 2012: fig. 4).

**Distribution:** The species is widespread in the tropics and supposedly introduced by human activities (Hoffman, 1999). Some records have been made from USA and Hawaii, West Indies, Cape Verde, Tanzania, India, Indonesia, Fiji, and Taiwan (Loomis, 1950; Enghoff, 1993; Hoffman, 1999; Shelley & Golovatch, 2000; Akkari & Enghoff, 2011; Golovatch et al., 2011; Mesibov, 2012). Its native distribution is uncertain (Mesibov, 2012). In Brazil, the species has been recorded only in urban areas from states of Rio de Janeiro and São Paulo. All records were obtained from the literature.

**Historical records:** **Rio de Janeiro:** Niterói, Icaraí [-22.903431°S; -43.111570°W] (Schubart, 1947); Rio de Janeiro [-22.921765°S; -43.169510°W] (Schubart, 1947); Bairro Tijuca [-22.935505°S; -43.243112°W], 17.v.1938, O. Schubart coll., 3♂ ♀ 1 immature (Schubart, 1945b); 08.x.1938, ♂ (Schubart, 1945b); 29.x.1938, O. Schubart coll., 2♂ (Schubart, 1945b); 04.xi.1939, O. Schubart coll., ♀ (Schubart, 1945b); 06.xi.1939, O. Schubart coll., ♂ ♀ (Schubart, 1945b); 08.xi.1939, O. Schubart coll., 3♂ ♀ 1 immature (Schubart, 1945b); 09.xi.1939, O. Schubart coll., 2♂ 2♀ (Schubart, 1945b); 12.xi.1939, O. Schubart coll., ♂ (Schubart, 1945b); 13.xi.1939, O. Schubart coll., ♂ ♀ (Schubart, 1945b); 27.xi.1939, O. Schubart coll., 2♂ (Schubart, 1945b); 05.vi.1940, O. Schubart coll., ♂ (Schubart, 1945b); 23.ix.1939, O. Schubart coll., ♀ (Schubart, 1945b); **São Paulo:** Mogi Guaçu [-22.185269°S; -47.097326°W] (Schubart, 1947); Pirassununga [-22.067267°S; -47.395011°W], Fazenda São Domingos (Schubart, 1947).

## Order Spirostreptida Suborder Cambalidea Family Cambalopsidae

### *Trachyjulus calvus* (Pocock, 1893a) (Figs. 1D, 6C-D)

**Descriptive notes:** Male, see Golovatch et al. (2012: 114, figs. 8-9).

**Identification:** *T. calvus* is easily separated from Brazilian species of Spirostreptida by having tergites longitudinally crested (Golovatch et al., 2012: fig. 8) and the presence

of posterior gonopod. According to the diagnosis made by Golovatch et al. (2012), males are recognized by lateral coxal process of the anterior gonopod being very slender (Fig. 6C); slender and conical medial coxal process; posterior gonopod with axe-shaped flagellum extended and with microgranulate distal lobules (Fig. 6D).

**Distribution:** *T. calvus* presents a tropical distribution (Golovatch et al., 2012). In Brazil, the species has been recorded only in urban areas from states of Rio de Janeiro and Bahia (ca. 1,500 km).

**Material examined:** **Bahia:** Salvador, campus UFBA [-13.004364°S; -38.508978°W], 2013, C.M.P. Leite coll., ♂ (UFMT).

**Records:** **Rio de Janeiro:** Rio de Janeiro, Bairro Tijuca [-22.935505°S; -43.243112°W], 17.v.1938, A.C. Aguirre coll., 11♀ 1 immature (Schubart, 1946b); vi.1938, A.C. Aguirre coll., ♀ (Schubart, 1946b); 21.v.1939, A.C. Aguirre coll., 3♂ 9♀ 8 immatures (Schubart, 1946b); 12.ix.1939, A.C. Aguirre coll., ♂ 1 immature (Schubart, 1946b); 29.x.1939, A.C. Aguirre coll., 6 immatures (Schubart, 1946b); 27.xi.1939, A.C. Aguirre coll., 4 immatures (Schubart, 1946b); 30.i.1940, A.C. Aguirre coll., 3♂ 4♀ (Schubart, 1946b); 30.iv.1940, A.C. Aguirre coll., 5♀ 4 immatures (Schubart, 1946b); 05.vi.1940, A.C. Aguirre coll., ♀ (Schubart, 1946b); 11.vi.1940, A.C. Aguirre coll., 4♀ 3 immatures (Schubart, 1946b); 04.viii.1940, A.C. Aguirre coll., 2♂ 4♀ 2 immatures (Schubart, 1946b); 14.ix.1940, A.C. Aguirre coll., 5♂ 10♀ 1 immature (Schubart, 1946b); 30.vii.1939, A.C. Aguirre coll., ♀ (Schubart, 1946b); 15.ix.1939, A.C. Aguirre coll., 93♂ 133♀ 27 immatures (Schubart, 1946b); 13.iv.1946, A.C. Aguirre coll., 2♂ 4♀ 4 immatures (Schubart, 1946b).

### *Glyphiulus granulatus* (Gervais, 1847) (Figs. 1C, 4C-D, 6B)

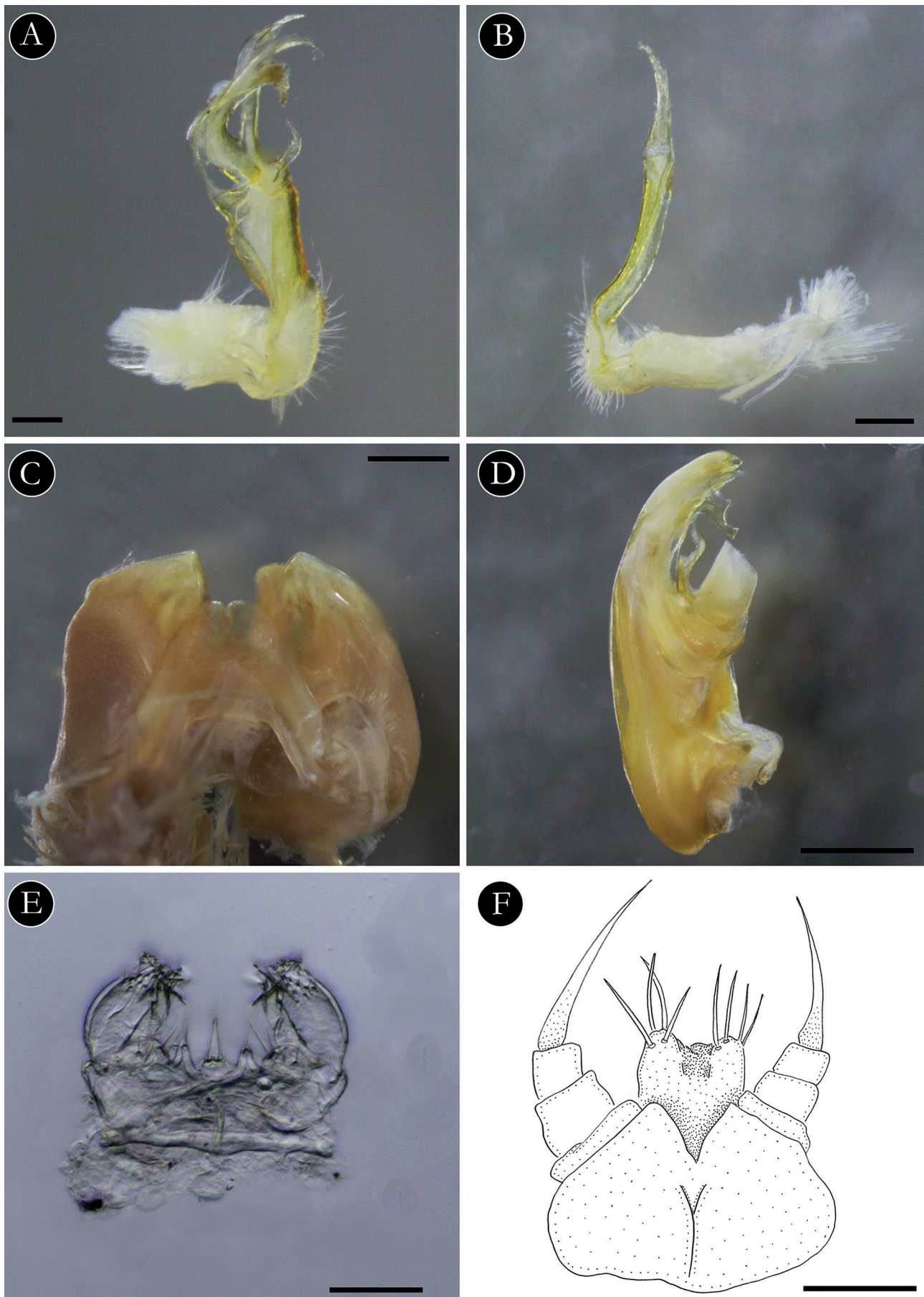
**Descriptive notes:** See Golovatch et al. (2007: 12, figs. 1-6).

**Identification:** Males of *G. granulatus* are recognized by a median outgrowth of the coxosternum in the anterior gonopods (Golovatch et al., 2007: fig. 5a, b; Fig. 6B) and the typical pattern of carinotaxy. As in *T. calvus*, the species is easily identified when compared with Brazilian species of Spirostreptida by having tergites longitudinally crested (Fig. 4C-D) and the presence of posterior gonopod (see Golovatch et al., 2007: 12).

**Distribution:** *G. granulatus* has been recorded in SE Asia and in islands in the Pacific and Indian oceans (Shelley, 1998a; Jeekel, 2004; Korsós, 2004; Enghoff et al., 2015). In Brazil, the species occurs only in urban areas in Santa Maria, state of Rio Grande do Sul.

**Material examined:** **Rio Grande do Sul:** Santa Maria [-29.6914°S; -53.8008°W], Universidade Federal de Santa Maria, 17.iv.2014, V.M. Silva coll., 8♂ 5♀ (MCN).





**Figure 5.** (A) *Oxidus gracilis*, gonopod in mesal view; (B) *Orthomorpha coarctata*, gonopod in mesal view; (C) *Trigoniulus corallinus*, anterior gonopods in anterior view; (D) *Trigoniulus corallinus*, telopodite of left posterior gonopod in anterior view; (E) *Rhinotus purpureus*, anterior gonopod in posterior view; (F) *Rhinotus purpureus*, posterior gonopod in posterior view. Scale bars: 100  $\mu$ m (A, B, E, F); 750  $\mu$ m (C); 1 mm (D).



**Order Spirobolida**  
**Family Pachybolidae**

***Trigoniulus corallinus* (Gervais, 1842)**  
**(Figs. 2A, 4E, 5C-D)**

**Descriptive notes:** See Shelley & Lehtinen (1999: 1389, figs. 8-14).

**Note:** An overview of its taxonomic status was made by Shelley & Lehtinen (1999).

**Identification:** The species is easily recognized by the strongly reddish color in life (Fig. 9e). According to the diagnosis made by Shelley & Lehtinen (1999, figs. 11-13), males of *T. corallinus* are recognized by the coxae of the anterior gonopods narrowly separated by subtriangular sternum indented in midline; telopodites subtriangular, extending directly mediad (Fig. 5C), telopodites of the posterior gonopods rounded and with broad medial lobe at midlength; two inner projections arising basally from lobe and directed distad; and outer projection with notch on inner margin, expanded distad (Fig. 5D).

**Distribution:** *Trigoniulus corallinus* presents a tropical distribution (Hoffman, 1999; Shelley, 1998b; Shelley & Lehtinen, 1999; Korsós, 2004; Enghoff et al., 2015). In Brazil, the species is distributed predominantly in the North and Northeast regions, occurring in urban and rural areas, greenhouses, and forests. Records from the state of Rio de Janeiro are due to its use for the production of organic compost for agriculture (Antunes et al., 2016, 2019). Species of Trigoniulinae distributed in the Neotropical region are supposedly introduced from SE Asia (see Hoffman, 1994; Hoffman et al., 1996).

**Material examined:** **Roraima:** Caracarái, Serra da Mocidade [01.491084°S; -61.78333333°W], 25.i.06.ii.2016, M. Oliveira, F.F. Xavier & T. Mahlmann coll., ♂ (INPA); Parque Nacional Serra da Mocidade, [01.074634°S; -61.90000001°W], 15-26.i.2016, F.F. Xavier, R. Boldrini & P. Barroso coll., 2♂ 2♀ (INPA); Igarapé Caicubi [00.560220°S; -62.168280°W], Pupunha, pitfall, 22.x.2008, Ana coll., ♂ ♀ (INPA); **Amazonas:** Manaus, campus INPA [-03.0960583°S; -59.9894389°W], 12.vii.2016, D.P. Cordeiro coll., ♂ (INPA); **Pará:** Belém, Bairro Terra Firme [-01.457070°S; -48.451254°W], 22-23.vi.2010, R. Ott coll., 4♂ 6♀ (MCN 659); 17♂ 11♀ 3 immatures (MPEG Myr-00048); **Tocantins:** Araguaína [-15.200975°S; -51.852218°W], campus UFT, 02.xi.2016, M. Lopes coll., ♂ ♀ (IBSP 7494); 13.xi.2016, M. Lopes coll., Quintal de Casa, 4♂ 3♀ (IBSP 7495); Bairro da Cimba, 08.viii.2015, F. Costa coll., ♂ ♀ (IBSP 7496); 16.ix.2014, V.S. Marinho coll., Urban area, ♀ (IBSP 7497); **Pernambuco:** Recife [-08.056951°S; -34.929493°W], 26.vi.1946, M.L. Siqueira coll., 2♂ (MZSP); campus Instituto Ricardo Brennand [-08.055537°S; -34.959112°W], 27.viii.2010, R. Ott coll., ♂ 8♀ (MCN 611); **Rio de Janeiro:** Rio de Janeiro

[-22.921765°S; -43.169510°W], 13.xii.1954, H. Lopes coll., ♂ (MZSP).

**Historical records:** **Amazonas:** Manaus [-03.023045°S; -59.965390°W], Bicego coll., 8♂ 2♀ (Brölemann, 1902); Embrapa Amazônia Ocidental [-02.893744°S; -59.973109°W] (Hoffman et al., 2002); **Pará:** Ananindeua, Aurá [-01.408310°S; -48.397542°W], 05.iii.1958, L. Travassos coll., 3♂ 10♀ (Schubart, 1958b); 04.iii.1958, ♀ (Schubart, 1958b); Entrada de Utinga [-01.42599°S; -48.444631°W], 12.iii.1958, L. Travassos coll., 2♂ 2♀ (Schubart, 1958b); **Pernambuco:** Recife [-08.0539°S; -34.8811°W], Bairro dos Afogados, 14.xiii.1934, O. Schubart coll. (Schubart, 1958b); Bairro do Paysandú, 26.iv.1946, M.L. Siqueira coll., 4♂ 6♀ 2♀ immature (Schubart, 1958b); **Rio de Janeiro:** Rio de Janeiro, Bairro Leblon [-22.985714°S; -43.222412°W], 25.xii.1941, A.C. Aguirre coll., 2♂ 4♀ (Schubart, 1958b); Bairro Brás de Pina [-22.831870°S; -43.296731°W], 25.iii.1947, A.C. Aguirre coll., 2♂ ♂ immature (Schubart, 1958b); Bairro do Andaraí [-22.927367°S; -43.251521°W], i.1953, J. Becker coll., 2♀ (Schubart, 1958b); campus Universidade Rural, km 47 [-22.768546°S; -43.687338°W], xii.1957, H.S. Lópes coll., ♂ 2♀ (Schubart, 1958b); Seropédica [-22.768582°S; -43.706134°W], 2017, L.F.S. Antunes et al. coll. (Antunes et al., 2019).

***Leptogoniulus sorornus* (Butler, 1876)**  
**(Figs. 2B, 6E-F)**

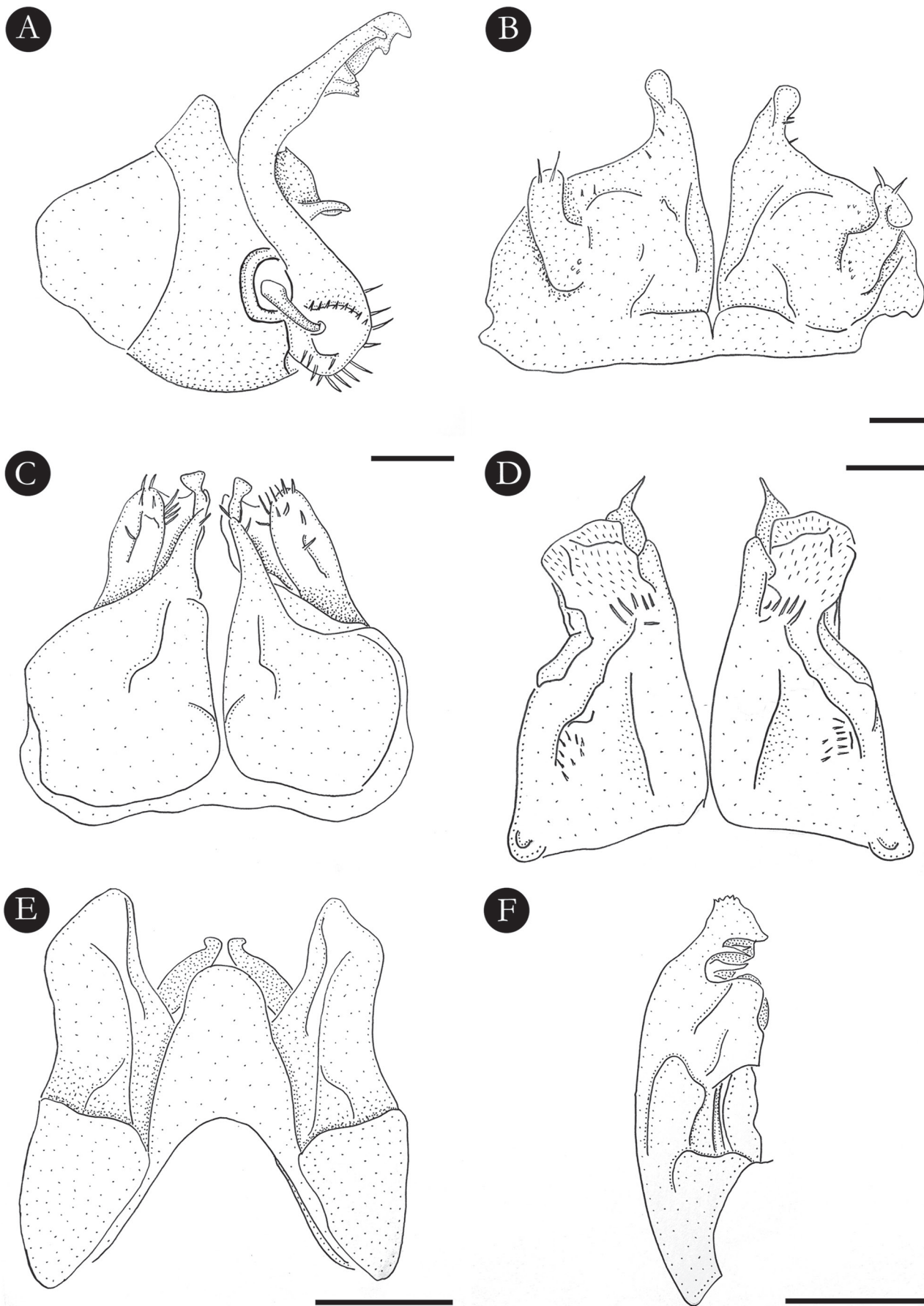
**Descriptive notes:** See Shelley & Lehtinen (1999: 1383, figs. 1-7).

**Note:** An overview of its taxonomic status was made by Shelley & Lehtinen (1999).

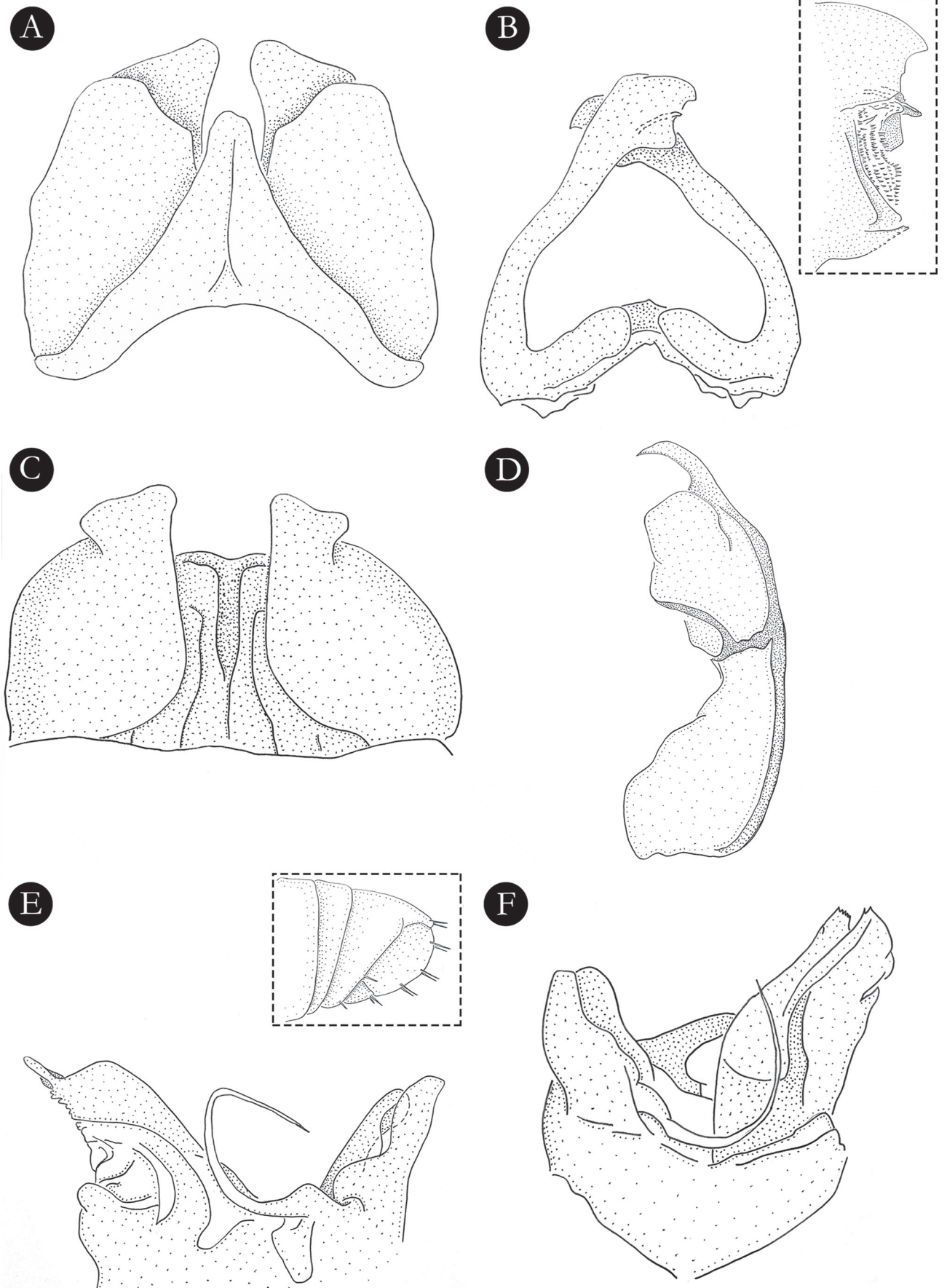
**Identification:** According to the diagnosis made by Shelley & Lehtinen (1999), males of *L. sorornus* are recognized by coxae of the anterior gonopods widely separated by apically broad and subtruncate sternum (Fig. 6E), and telopodites apically uncinated. Telopodites of the posterior gonopods with broad medial lobe, and apically rounded with notches along the distal margin (Fig. 6F).

**Distribution:** *Leptogoniulus sorornus* presents a tropical distribution (Hoffman, 1999; Shelley & Lehtinen, 1999; Korsós, 2004). In Brazil, the species has been recorded in the old-named state of Guanabara (now known as Rio de Janeiro), São Mateus, and Salvador (approximately 1,500 km from Rio de Janeiro) (Shelley & Lehtinen, 1999). All records were obtained from the literature.

**Historical records:** **Bahia:** Salvador [-12.9711°S; -38.5108°W], J. Becker coll. (Schubart, 1958b); **Espírito Santo:** São Mateus [-18.718937°S; -39.861257°W] (Schubart, 1947); **Rio de Janeiro:** Rio de Janeiro [-22.9028°S; -43.2075°W] (Schubart, 1958b); Corcovado, Jardim Botânico, Caullery coll. (Brölemann, 1929); São Gonçalo [-22.8269°S; -43.0539°W], Fazenda Engenho Novo, A.C. Aguirre coll. (Schubart, 1947).



**Figure 6.** (A) *Prosopodesmus jacobsoni*, gonopod in mesal view (after Silvestri, 1910); (B) *Glyphiulus granulatus*, anterior gonopods in posterior view; (C) *Trachyjulus calvus*, anterior gonopods in anterior view; (D) *Trachyjulus calvus*, posterior gonopods in anterior view (after Schubart, 1946); (E) *Leptogoniulus sorornus*, anterior gonopods in anterior view; (F) *Leptogoniulus sorornus*, telopodite of left posterior gonopod in anterior view (after Shelley & Lehtinen, 1999). Scale bars: 20  $\mu$ m (B); 100  $\mu$ m (C, D); 750  $\mu$ m (E); 1 mm (F). Image (A) not to scale.



**Figure 7.** (A) *Epitrigoniulus cruentatus*, anterior gonopods in posterior view (after Brölemann, 1903); (B) *Epitrigoniulus cruentatus*, posterior gonopods in anterior view (after Brölemann, 1903). Distal region in detail; (C) *Paraspirobolus lucifugus*, anterior gonopods in anterior view; (D) *Paraspirobolus lucifugus*, posterior gonopod in anterior view (after Attems, 1900); (E) *Cyldroiulus britannicus*, gonopod in anterior view. Detail of telson in lateral view (after Blower, 1985); (F) *Cyldroiulus truncorum*, gonopod in anterior view (after Blower, 1985). Images not to scale.



***Epitrigoniulus cruentatus* (Brölemann, 1903)  
(Figs. 1D, 7A-B)**

**Descriptive notes:** See Brölemann (1903: 250, figs. 5-9).

**Identification:** According to the description made by Brölemann (1903), males of *E. cruentatus* can be recognized by coxae of the anterior gonopods separated by subtriangular sternum (Fig. 7A); and telopodites subtriangular (Brölemann, 1903: fig. 5). Telopodites of the posterior gonopods rounded and expanded distad; and with notches along the mesal margin (Brölemann, 1903: figs. 6-8; Fig. 7B).

**Distribution:** *Epitrigoniulus cruentatus* occurs in the Indo-Malayan region (Brölemann, 1903; Schubart, 1947). In Brazil, the species has been recorded only in the Amazonian region (Brölemann, 1903, 1909).

**Historical records:** **Amazonas:** Manaus [-03.063877°S; -60.036493°W Embrapa Amazônia Ocidental [-02.893744°S; -59.973109°W] (Hoffman *et al.*, 2002); **Pará:** Belém [-01.451628°S; -48.446535°W] (Schubart, 1947).

**Family Spirobolellidae**

***Paraspirobolus lucifugus* (Gervais, 1837)  
(Figs. 2C, 7C-D)**

**Descriptive notes:** See Attems (1900: figs. 13-16) and Brölemann (1902: 184, figs. 223-227).

**Identification:** According to the descriptions made by Attems (1900) and Brölemann (1902), males of *P. lucifugus* can be recognized by the anterior and posterior gonopods. Coxae of the anterior gonopods separated by wide sternum slightly indented in midline (Attems, 1900: figs. 13-14; Brölemann, 1902: fig. 226; Fig. 7C). Telopodites of the posterior gonopods apically fusiform and with a broad lobe (Attems, 1900: fig. 16; Fig. 7D). An overview of its taxonomic status was made by Jeekel (2001).

**Distribution:** *Paraspirobolus lucifugus* is widespread in the tropics and in greenhouses from Europe (Jeekel, 2001; Enghoff *et al.*, 2004; Korsós, 2004). In Brazil, the species has been recorded only in the coastal region from the Atlantic Forest and in urban areas. All records of the species were obtained from the literature.

**Historical records:** **Espírito Santo:** São Mateus [-18.718937°S; -39.861257°W] (Schubart, 1947); **Rio de Janeiro:** Rio de Janeiro, Tijuca [-22.935505°S; -43.243112°W] (Schubart, 1947); Jacarepaguá [-22.953677°S; -43.408759°W] (Schubart, 1947). **São Paulo:** Aparecida do Norte [-22.867750°S; -45.228194°W] (Schubart, 1947); Ilhabela [-23.817663°S; -45.369504°W], xi.1896, 2♂ 5♀ (Brölemann, 1902); Santos [-23.974598°S; -46.307597°W], ix.1896, ♀ (Brölemann, 1902).

**Order Julida  
Family Julidae**

***Cylindroiulus britannicus* (Verhoeff, 1891)  
(Figs. 1D, 7E)**

**Descriptive notes:** See Schubart (1942c: 250, fig. 1) and Blower (1985: 158, fig. 49).

**Identification:** Members of Julida are easily recognized by stipites of gnathochilarium in contact in the midline in their basal part (symphyognathous condition). The species is recognized by three pairs of setae on the anal valves (Blower, 1985: fig. 49a); opisthomerite with finger-shaped projection (Blower, 1985: fig. 49b); promerite simple; mesomerite shorter than promerite (Fig. 7E).

**Distribution:** The order Julida is distributed in the Holarctic region, marginally also in SE Asia and Central America (Enghoff *et al.*, 2015). *Cylindroiulus britannicus* is widespread in Europe and predominantly distributed in the Northwest region (Blower, 1985). The species has been recorded in southern India, New Zealand, South Africa (Hoffman, 1999), Chile, and Argentina (Golovatch, 2014; Shelley *et al.*, 2014). In Brazil, the species has been recorded only in urban areas in the states of São Paulo and Rio de Janeiro. All records of the species were obtained from the literature.

**Historical records:** **São Paulo:** Pirassununga [-22.005841°S; -47.424516°W], 23.vii.1940-13.ii.1941, O. Schubart coll., 2♂ 2♀ 4 immatures (Schubart, 1942c); São Paulo, Bairro Santo Amaro [-23.654909°S; -46.703473°W], 1954, O. Schubart coll., ♂ ♀ 1 immature (Schubart, 1945a); Água Branca [-23.517304°S; -46.690714°W] (Schubart, 1944); Bairro do Tremembé [-23.468582°S; -46.624367°W] (Schubart, 1947); **Rio de Janeiro:** Itatiaia [-22.458524°S; -44.562840°W] (Schubart, 1947).

***Cylindroiulus truncorum* (Silvestri, 1896)  
(Figs. 2B, 7F)**

**Descriptive notes:** Male, see Blower (1985: 162, fig. 51) and Korsós & Enghoff (1990: 347, figs. 1, 5-8, 21, 30, 31).

**Identification:** According to the diagnosis made by Korsós & Enghoff (1990), males of *C. truncorum* are recognized by promerite of gonopods slightly longer than mesomerite, without a deep mesal incision; opisthomerite with laterad bent smooth brachit, without setae or protuberances; paracoxal process long, slender and pointed, almost reaching the end of solenomerite (Blower, 1985: fig. 51; Fig. 7F).

**Distribution:** It is widespread in Europe and North Africa, probably by several events of introduction (Blower, 1985; Korsós & Enghoff, 1990). The species has been reported in Hawaii, North and South America (Shelley *et al.*, 1998; Hoffman, 1999). *Cylindroiulus truncorum* occurs mainly

in synanthropic habitats such as greenhouses, gardens, and parks (Korsós & Enghoff, 1990). In Brazil, the species has been recorded only in urban areas in São Paulo. All records of the species were obtained from the literature.

**Historical records: São Paulo:** São Paulo, Bairro dos Campos Elíseos [-23.5475°S; -46.6361°W], 03.iii.1944, O. Schubart & J. Schubart coll. (Schubart, 1946a).

### Order Polyzoniida Family Siphonotidae

#### *Rhinotus purpureus* (Pocock, 1894) (Figs. 2C, 4F, 5E-F)

**Descriptive notes:** See Mauriès (1980: 1101, fig. 62) and Wesener (2014: 588, figs. 1-2, for the synonym *P. malagassum*).

**Identification:** Native species of Polyzoniida in Brazil belong to the genera *Siphonotus* Brandt, 1837 and *Burinia* Attems, 1926 (Hoffman, 1977, 1980; Enghoff *et al.*, 2015). Males of *R. purpureus* are recognized by having sternite of anterior gonopod with two lobes carrying long setae; coxae with trichostele carrying long setae; third podomere laterally with short setae and carrying mesally a protruding channel (Mauriès, 1980: fig. 62; Wesener, 2014: fig. 2a; Fig. 5E). Posterior gonopod sternite elongated into two lobes; each one with apical setae; remaining podemeres partly fused and difficult to distinguish; tarsus elongated and apically with short claw (Wesener, 2014: fig. 2b; Fig. 5F).

**Distribution:** The range extension of *R. purpureus* is not known and its native area is still uncertain (Hoffman, 1999). The species has been recorded in the Neotropical region (Shelley, 1998c), West Africa, Mauritius, East Indies (Hoffman, 1999), Madagascar (Wesener, 2014), and Asia (Hoffman, 1977; Korsós, 2004). In Brazil, the species has been recorded in urban areas from Manaus and from uncertain localities in the state of Amazonas (see Hoffman *et al.*, 1996, 2002).

**Material examined: Amazonas:** Manaus, sítio Vida Tropical, AM 010, km 35 [-02.759189°S; -59.920910°W], 11.xi.2017, T.M. Almeida & J.A. Rafael coll., 11♂ 22♀ (INPA).

**Historical records: Amazonas:** Manaus [-03.063877°S; -60.036493°W], Embrapa Amazônia Ocidental [-02.893744°S; -59.973109°W] (Hoffman *et al.*, 2002).

### DISCUSSION

According to our results, the species richness varies substantially among the federative units in Brazil, with the Southeast region concentrating 42, 6% of the compiled records and 5-7 species recorded by grid (Fig. 3A-C). Some hypotheses have been made to determine whether

the geographic expansion of some species in Brazil is a consequence of human-assisted introduction (Schubart, 1942b, 1946a, b). For instance, Schubart (1946b) suggested that the trade route of Portuguese colonies between South America and Asia indirectly influenced the spreading of *T. calvus* throughout the Neotropical region. Based on our results, *T. calvus* has been reported only in cities with maritime commercial facilities, including the new records from Salvador, Bahia.

Introduced millipedes in the Neotropical region tend to be synanthropic (Hoffman *et al.*, 2002). For the julidans species, some studies have reported their occurrences in synanthropic habitats in Europe and USA (Schubart, 1946a; Blower, 1985; Korsós, 1992; Proesmans & De Smedt, 2015). The proximity of the occurrence sites of introduced millipedes in Brazil reinforces this pattern since most of the species have been observed in urban areas (Schubart, 1946a, b, 1958a, b). Based on the collecting data and the species reported here, the oldest records of introduction would be those of *Paraspirobolus lucifugus* from the coast of the São Paulo state in the late 19<sup>th</sup> century (Brölemann, 1902), and posteriorly from the middle of the 20<sup>th</sup> century for the species *Prosopodesmus jacobsoni* and *Trachyjulus calvus* in 1940 (Schubart, 1945b, 1946b) and the paradoxosomatid species *Oxidus gracilis* and *Orthomorpha coarctata* (Schubart, 1939, 1944, 1945a).

Even if the consequences of the introduction of species are poorly discussed in Brazil, some reports have been made focused on possible economic damages to poly- monocultures (Schubart, 1942b; Boock & Lordello, 1952; Lordello, 1954; Corso, 1991; Hoffman-Campo *et al.*, 2012). The widespread species *Oxidus gracilis* has been reported attacking fern (Schubart, 1942b, 1945b), seedlings of coffee (*Coffea arabica* L.) and lettuce (*Lactuca sativa* L.), yellow mombin (*Spondias mombin* L.), and ornamental plants (Lordello, 1954), while *Orthomorpha coarctata* has been found attacking seedlings of coffee and ornamental plants (Lordello, 1954), cultivars of banana (*Musa* L.) and vegetable gardens (Schubart, 1947), and *Cylindroiulus britannicus* vegetable gardens (Schubart, 1947) and lettuce seedlings (Lordello, 1954). In addition, Hoffman *et al.* (2002) also recorded the presence of *R. purpureus* (Siphonotidae) in tree crop plantations in Manaus, Amazonas state.

### CONCLUSIONS

Although there are still gaps in knowledge about the millipede fauna in the Neotropical region, this study presents one of the first efforts for a survey of introduced species in Brazil. The findings presented here report 12 introduced species in 21 Brazilian states, with a significant portion of these records related to rural and urban areas. However, our results are far from complete since the number of known introduced species in Brazil is still incipient. In this perspective, additional studies should expand our list of millipede with the inclusion of possible other species.

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## AUTHORS' CONTRIBUTIONS

LFMI, RSB, and ADB planned the manuscript. All authors analyzed the data and contributed actively in the paper writing, editing and revisions.

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