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**REVISÃO TAXONÔMICA E ANÁLISE FILOGENÉTICA EM  
BATHYTROPIDAE VANDEL, 1952 (CRUSTACEA: ISOPODA:  
ONISCIDEA)**

Tese apresentada ao Programa de Pós-Graduação em Biologia Animal, Instituto de Biociências da Universidade Federal do Rio Grande do Sul, como requisito parcial à obtenção do título de Doutor em Biologia Animal.

Área de concentração: Biologia Comparada

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Apresentada em \_\_\_\_\_ de \_\_\_\_\_ de 2017.

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Dr. Filipe Michels Bianchi

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*“Somewhere, something incredible is waiting to be known.”*

*Carl Sagan*

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## PREFÁCIO

Os isópodos terrestres são popularmente conhecidos como “tatuzinhos de jardim”. São amplamente distribuídos pelos ambientes terrestres, podendo ser encontrados desde a zona litorânea até áreas desérticas. Várias adaptações foram necessárias para o domínio do ambiente terrestre, e foram reflexo de diferentes processos evolutivos que são responsáveis pela grande diversidade encontrada atualmente. Conhecer e compreender um pouco sobre a diversidade e a evolução deste grupo é um dos grandes objetivos desta tese. Ao longo deste trabalho foi possível estudar diversos grupos taxonômicos que auxiliaram na compreensão do grupo em destaque, e permitiram o desenvolvimento das análises morfológicas e filogenética.

A tese inicia com uma introdução geral, onde são abordadas algumas questões não inclusas nos artigos científicos, visando contextualizar o leitor acerca do tema abordado pelos capítulos subsequentes. Em seguida, cinco capítulos são apresentados na forma de artigos científicos. Os primeiros três capítulos são apresentados na íntegra conforme as normas dos periódicos onde foram publicados. Os últimos dois capítulos são apresentados conforme as normas dos periódicos aos quais serão submetidos.

O primeiro capítulo foi publicado no periódico *Zootaxa*, no ano de 2015, descreve um novo gênero pertencente à Trachelipodidae. Este gênero, *Levantoniscus* Cardoso, Taiti & Sfenthourakis, 2015, é composto duas novas espécies e uma nova combinação para a espécie *Bathytropa wahrmani* Strouhal, 1968, que devido à presença de pulmões pleopodais diferia das demais espécies de *Bathytropa*. O segundo capítulo foi publicado no periódico *Tropical Zoology*, no ano de 2016; neste artigo, as espécies de *Dubioniscus* Vandel, 1963 são revisadas, inclusive *Dubioniscus negrae* Vandel, 1973 que corresponde ao sinônimo sênior de *Cubanoscia romanorum* Vandel, 1981. O terceiro capítulo foi submetido ao periódico *Studies on Neotropical Fauna and Environment* e descreve duas novas espécies de *Neotroponiscus* Arcangeli, 1936. O quarto capítulo aborda a revisão do gênero *Neotroponiscus* e será submetido ao *Journal of Natural History*. O último capítulo será submetido ao *Zoologica Scripta*, tem por finalidade testar a monofilia de *Neotroponiscus* e investigar as relações do grupo dentro de Bathytropidae. Por fim, conclusões e perspectivas são abordadas nos Considerações Finais.

## RESUMO

A ordem Isopoda é um dos o grupo mais diverso dentre os crustáceos, sendo composta por dez subordens. Os representantes da subordem Oniscidea, conhecidos como “tatuzinhos de jardim”, obtiveram grande sucesso no domínio do ambiente terrestre. Para isso, foram necessárias várias adaptações morfológicas, fisiológicas e comportamentais, tais como comportamento gregário para diminuição da perda de água, presença de marsúpio fechado para reprodução e a presença de pulmões pleopodais. Apesar do grupo apresentar ampla uma distribuição geográfica, as espécies apresentam limitada capacidade de dispersão. Essa baixa dispersão resulta em isolamento de populações e alta diversidade genética. Dessa forma, o número de espécies dos isópodos é subestimado, sendo necessários mais esforços taxonômicos a fim de ampliar o conhecimento para o grupo. Frequentemente, revisões taxonômicas resultam em ampliação do número de espécies, reforçando a importância destes estudos para o grupo. Identificações usualmente se baseiam em pequenas variações morfológicas, o que muitas vezes dificulta a distinção entre espécies, sendo dados moleculares representam uma importante ferramenta para a delimitação das relações de parentesco entre espécies. O gênero *Neotroponiscus* ocorre na América do Sul e possui uma grande diversidade de espécies distribuídas ao longo da Mata Atlântica Brasileira. Oito espécies são conhecidas na literatura e foram revisadas para o levantamento de caracteres, necessários para os estudos filogenéticos. Além disso, neste trabalho, cinco novas espécies novas foram identificadas. Com base em dados morfológicos e moleculares a monofilia do gênero foi testada, e o grupo foi recuperado como monofilético. As relações de parentesco entre *Neotroponiscus* e os integrantes da família Bathytropidae foi testada e a família foi recuperada como um grupo parafilético, corroborando para hipóteses anteriores. Estudos futuros com uma abordagem biogeográfica serão importantes para elucidar os padrões de distribuição das espécies de *Neotroponiscus*.

**Palavras-chave:** isópodos terrestres, tatuzinhos, diversidade, Mata Atlântica.

**ABSTRACT**

The order Isopoda is one of the most diverse groups among crustaceans. Species from the suborder Oniscidea, commonly known as woodlice, were very successful in conquering the terrestrial environment. For that, many morphological, physiological and behavioral adaptations were necessary, such as, closed marsupium for reproduction, presence of pleopodal lungs, and gregarious behavior to diminish water losses. Although the group has large geographical distribution, species have limited dispersion capacity. This low dispersion results in population isolation and high genetic diversity. Therefore, the number of species of terrestrial isopods is greatly underestimated and more taxonomical studies are necessary in order to broaden the knowledge on the group. Taxonomical revisions on terrestrial isopods frequently result in higher number of species reinforcing the importance of these studies for the fore the mentioned group. Identification is usually based on subtle morphological differences, so molecular data is an important tool to elucidate the relationship within the group. The genus *Neotroponiscus* occurs in South America and has high species diversity throughout the Atlantic Forest. A total of eight species are known from the literature and were reviewed to identify characters that are necessary for phylogenetic studies. In this study, five new species were identified and described. Based on morphological and molecular data, the monophyly of the group was tested and the group was confirmed as monophyletic. The relationship between *Neotroponiscus* and the other species from the family Bathytropidae were also tested, showing that the family represents a paraphyletic group, which corroborates previous suggestions. Future studies with biogeographic approach will be important to elucidate the distribution pattern of the genus *Neotroponiscus*.

**Key-words:** terrestrial isopods, woodlice, diversity, Atlantic Forest.

## INTRODUÇÃO GERAL

### 1.1. Aspectos gerais

A ordem Isopoda é um dos o grupo mais diverso dentre os crustáceos (SCHMALFUSS, 2003), com mais de 10.000 espécies descritas. Ela é dividida em dez Subordens: Anthuroidea, Asellota, Calabozoidea, Cymothoidea, Flabellifera, Gnathiidea, Limnoriidea, Microcerberidea, Oniscidea, Phoratoidea, Phreatoidea, Sphaeromatidea, Tainisopidea e Valvifera (TAITI, 2016).

Diferente dos demais crustáceos, os isópodos possuem o corpo segmentado, sem carapaça, é achatado dorso ventralmente e divide-se em cabeça, pereon e pleon (VANDEL, 1960, SUTTON, 1980) (Figura 1). A cabeça (ou cefalotórax) é formada por cinco segmentos fusionados e um apêndice do tórax, o maxilípodo, além de dois pares de antenas e um par de olhos (JACKSON, 1926, 1928).

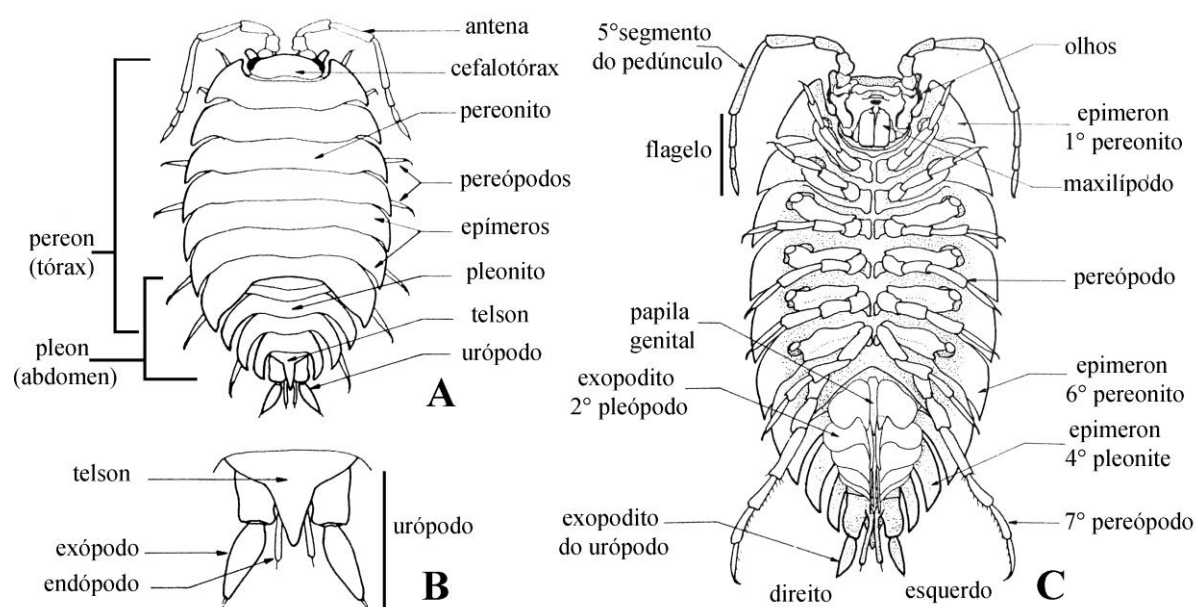


Figura 1. Morfologia geral de um isópodo terrestre, A. visão dorsal do *habitus*; B, visão dorsal do telson e urópodos; C, visão ventral do *habitus*. Fonte: SUTTON (1980), modificado.

Algumas características morfológicas da cabeça são utilizadas para definições de gêneros e espécies, como a linha supra-antenal, que se situa entre as inserções das antenas, dividindo a porção frontal em frons (abaixo da linha) e profrons (acima da linha); e a linha frontal que está entre as margens anteriores dos olhos, acima da linha supra-antenal, e pode formar lobos laterais (em frente aos olhos) e um lobo mediano (no meio desta linha) (JACKSON, 1926; 1928) (Figura 2). O pereon ou tórax possui sete pares de apêndices locomotores, os pereópodos (SUTTON, 1980). O pleon ou abdômen é composto por cinco

segmentos não fusionados e seus apêndices, os pleópodos; e o pleotelson que consiste na fusão de um ou mais pleonitos com o telson (SUTTON, 1980; ROMAN & DALENS 1999). Os pleópodos são birremes, e possuem um ramo externo (exópodo), onde podem estar presentes os pulmões pleopodais; e interno (endópodo). Os dois primeiros pares de pleópodos são modificados nos machos como genitália externa para transferência de esperma (SUTTON, 1980; ARAUJO, 1999).

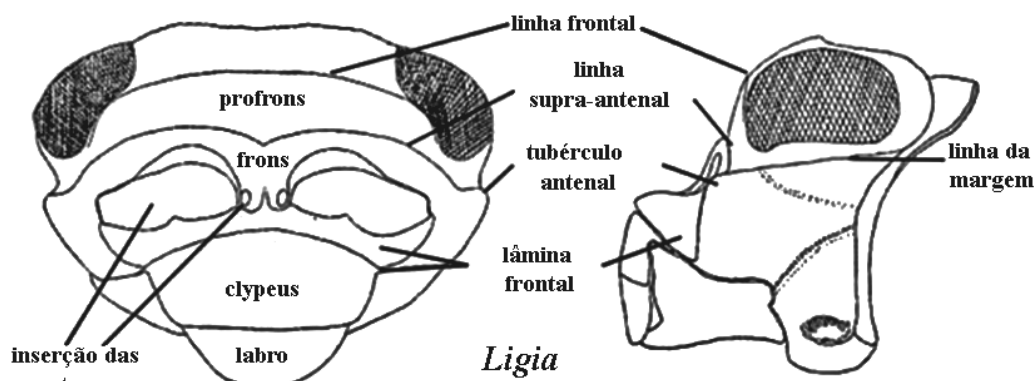


Figura 2. Morfologia geral da cabeça de um isópodo terrestre, A. visão frontal; B, visão lateral. Fonte: JACKSON (1928), modificado.

Os representantes terrestres pertencem à subordem Oniscidea e são popularmente conhecidos como “tatuzinhos de jardim”. Suas espécies ocorrem desde a zona litorânea até as regiões de altitude, incluindo ambientes desérticos e subterrâneos (SCHMIDT, 2002). O grande sucesso no domínio do ambiente terrestre está associado a algumas adaptações morfológicas, fisiológicas e comportamentais (ARAUJO, 1994; SCHMALFUSS, 1998). Entre algumas dessas estratégias comportamentais encontra-se a proteção contra predadores e a perda d’água, a capacidade volvacional e o hábito de agregação (WARBURG, 1987; HORNUNG, 2011). Entre as mudanças morfológicas e fisiológicas encontra-se a redução do tamanho corporal; a cutícula resistente a perde de água; o aumento de estruturas na superfície dorsal; o desenvolvimento de pulmões pleopodais; o sistema condutor de água; e o marsúpio fechado (HORNUNG, 2011).

A agregação é um comportamento adaptativo que proteger os animais contra a dessecação, além disso, a agregação promove a criação de abrigos que representam microclimas e micro-habitats tamponados, promove o crescimento da população ao estimular a reprodução das fêmeas e protege contra predação devido à saturação do predador e a somatória de secreções repulsivas (BROLY et al., 2013).

A umidade é um fator que afeta tanto a distribuição quanto a abundância dos isópodos (WARBURG & LINSENMAIR, 1984). Importantes setas sensoriais estão presentes nas antenas e antênulas, os estetascos (RISLER, 1977; 1978). Seu tamanho e posição foram importantes adaptações à sobrevivência em ambientes terrestres, uma vez que possuem importantes receptores de umidade (HAUG & ALTNER, 1984; SCHMALFUSS, 1998). A primeira antena é diminuta e seu tamanho é uma estratégia adaptativa, pois se mantém protegida de possíveis ataques de predadores, enquanto a segunda antena é usualmente perdida (SCHMALFUSS, 1998).

O exoesqueleto é a principal barreira entre os isópodos e o ambiente, sendo composto por quatro camadas: epicutícula, exocutícula, endocutícula e a camada membranosa, cuja espessura varia conforme a espécie (HILD et al., 2008). A calcita se concentra na porção da exocutícula e sua densidade pode contribuir para a redução de perda de água (HILD et al., 2008). Para seu crescimento, os isópodos realizam a muda, que ocorre em duas fases, a primeira ocorre na porção posterior, seguida pela metade anterior do exoesqueleto (HEELEY, 1941). O carbonato de cálcio é reabsorvido e mobilizado entre as cutículas e os tecidos internos, isto é, o cálcio é transportado da porção anterior para a mineralização da nova cutícula posterior durante a primeira fase da muda, seguido pela mobilização da porção posterior para a mineralização anterior durante a segunda fase da muda (GREENAWAY, 1985; STEEL, 1993; ZIEGLER et al., 2007). A epicutícula forma uma série de estruturas superficiais e estão presentes em todos os isópodos terrestres (SCHMALFUSS, 1978).

Uma grande variedade de ornamentos estão presentes na superfície dorsal, tais como papilas, setas, tricornes, microescalas, cavidades, placas, tubérculos e poros (HOLDICH & LINCOLN, 1974). Alguns ornamentos possuem inervações cuticulares e mediam informações sensoriais (JANS & ROSS, 1963). Estas setas sensoriais podem ser mecanorreceptoras e estimulam respostas tigmocinéticas, estimulando o movimento, ou não, em resposta ao contato (HOLDICH & LINCOLN, 1974). A seta tricorne é constituída por um eixo principal que surge de uma concavidade na superfície da cutícula, com uma aba livre suportada por duas abas laterais (SUTTON, 1972; HOLDICH & LINCOLN, 1974). A aba livre pode apresentar variação dependendo da sua localização (HOLDICH & LINCOLN 1974), ou dependendo da espécie (Figura 3), geralmente possui a forma de concha ou leque, onde a bainha é distalmente alargada com uma margem serrilhada (VANDEL, 1960). Outro tipo de seta sensorial é chamado de "*nodulus lateralis*" (VERHOEFF, 1907), e diferente da seta tricorne, tem uma longa porção livre que ultrapassa a bainha (SCHMIDT, 2002). Sua posição



relativa foi definida por VANDEL (1960) e é frequentemente utilizada como um caráter diagnóstico para algumas espécies.

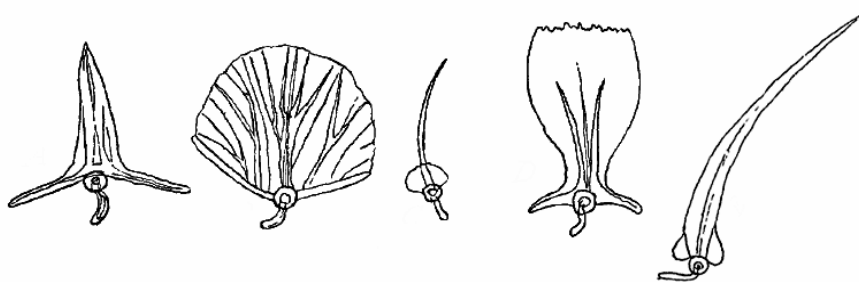


Figura 3. Diferentes tipos de setas. Fonte: VANDEL (1960), modificado.

Os tubérculos podem ser encontrados em diferentes famílias, e presume-se que evoluíram convergentemente devido a condições ecológicas semelhantes (SCHMALFUSS, 1977). O conjunto destas estruturas possui uma função anti-adesiva contra partículas e a tensão superficial da água, impedindo partículas de se aderirem a cutícula (Figura 4) (SCHMALFUSS, 1977; 1978; HOLDICH, 1984).

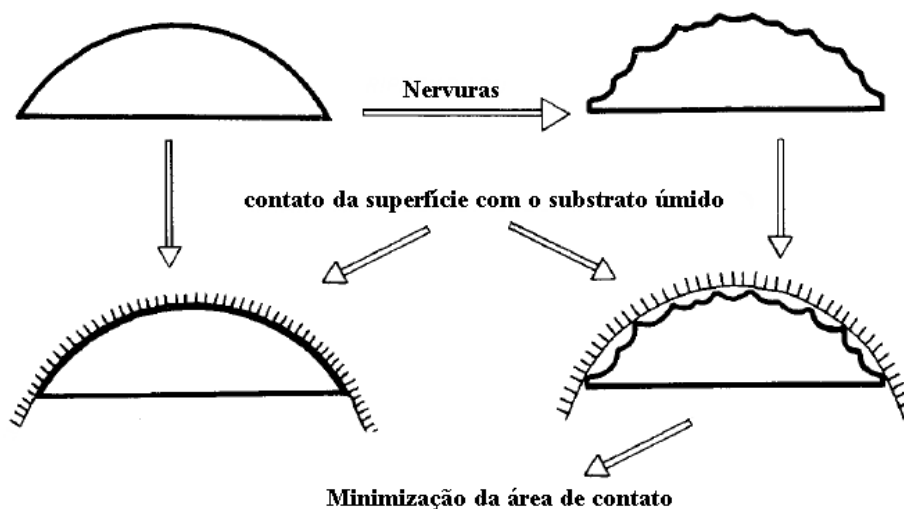


Figura 4. Tergitos em seções transversais. Representação da superfície dorsal e o contato com o substrato. Fonte: SCHMALFUSS (1977).

Em espécies marinhas, as trocas gasosas ocorrem na superfície dorsal dos pleópodos. A mudança para a posição ventral foi importante para o domínio terrestre, como pode ser vista em representantes de *Ligia* Fabricius, 1798, gênero que habita a região litorânea, é considerado ancestral entre Oniscidea (SCHMIDT & WAGELE 2001). O aumento da complexidade dos pulmões foi essencial para a colonização de habitats mais secos e evoluiu independentemente na Subordem Oniscidea (SCHMIDT & WAGELE, 2001). Os órgãos

respiratórios apresentam uma variação, podendo ser observado desde uma simples área respiratória com a cutícula delgada a pulmões fechados com a presença de espiráculos (LEISTIKOW & ARAUJO, 2001; PAOLI et al., 2002).

O marsúpio é um caráter diagnóstico da superordem Peracarida (POORE, 2005). Esta estrutura é formada pelo conjunto de oostegitos, apêndices reprodutivos temporários que se desenvolvem na superfície ventral dos apêndices, entre o segundo e quinto segmento torácico, formando uma bolsa incubadora onde oxigênio e água são fornecidos para o desenvolvimento dos ovos e embriões (HOESE, 1983). Os embriões apresentam desenvolvimento direto, independente de uma fonte externa de água, eclodindo dentro do marsúpio no estágio de manca, que pode ser diferenciado do juvenil pela ausência do sétimo pereópodo (HOESE, 1983; ARAUJO et al., 2004; POORE, 2005; APPEL et al., 2011).

SCHMALFUSS (1984) classificou os isópodos em grupos ecomorfológicos. Nessa classificação, a constituição corporal está diretamente correlacionada às estratégias adaptativas e comportamentais que reduzem a pressão de predação, sendo elas: (1) “runners” ou corredores – com pereópodos relativamente longos e fortes, tergitos planos; (2) “clingers” ou aderentes – com corpo achatado, tergitos expandidos lateralmente e pereópodos curtos que aderem ao substrato; (3) “rollers” ou volvacionais – com tergitos convexos e capacidade de enrolar-se em bola; (4) “spineforms” ou espiniformes – com espinhos proeminentes no tegumento, com capacidade volvacional; (5) “creepers” ou rastejadores – com tergitos providos de costelas longitudinais, pereópodos curtos e fracos, geralmente de habitats endógenos; e (6) não conformistas – é composto pelo restante das espécies que não se encaixam dentro das cinco categorias anteriores Figura 5.

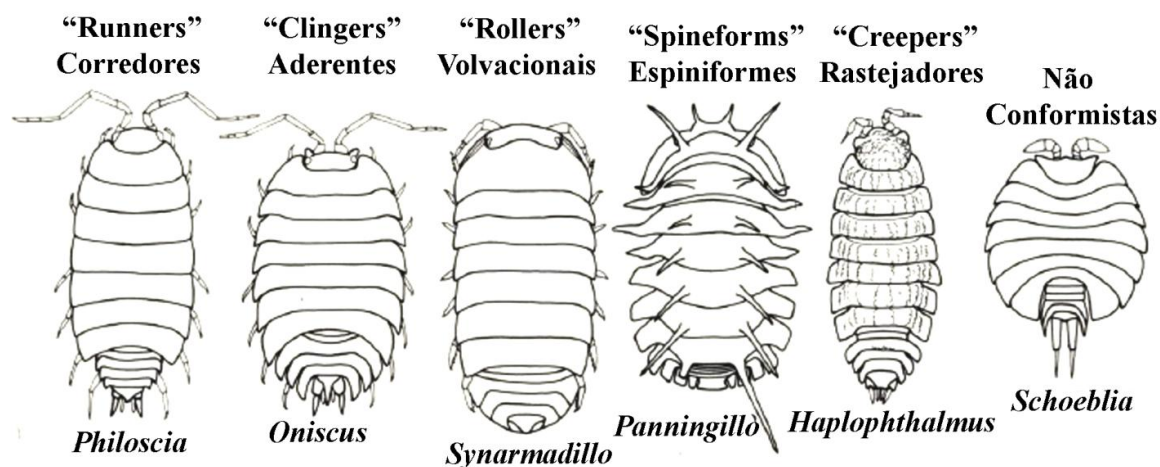


Figura 5. Grupos ecomorfológicos de isópodos terrestres. Fonte: SCHMALFUSS (1984), modificado.

A fauna de isópodos desempenha funções importantes nos ecossistemas terrestres, pois atua na ciclagem de nutrientes e na formação do solo (LAVELLE et al., 2006). Esses organismos são primariamente detritívoros, agindo na quebra mecânica e na fragmentação de folhas, matéria orgânica em decomposição, madeira, fungos e bactérias (ZIMMER, 2003). Além disso, atuam na degradação da celulose devido à presença de bactérias endossimbiontes no seu intestino e hepatopâncreas (ZIMMER et al., 2001). Esses crustáceos também servem de alimento para outros artrópodos como aranhas, escorpiões e insetos, além de vertebrados como anfíbios, répteis e mamíferos (ARAUJO, 1999; PAOLETTI & HASSAL 1999; REZÁČ et al., 2008).

## 1.2. Filogenia de Oniscidea

As relações filogenéticas em Oniscidea, e sua respectiva posição na Ordem Isopoda, foram analisadas por SCHMALFUSS (1989). As cinco linhagens, Ligiidae, Tylidae, Mesoniscus, Crinocheta e Synocheta foram consideradas como um grupo monofilético, com as seguintes sinapomorfias: (1) redução da primeira antena e da maxílula; (2) alteração no tamanho do maxilípodo; e (3) presença de um complexo sistema condutor de água. Ligiidae é o grupo irmão das demais linhagens, que por sua vez possuem uma retração do endópodo do urópodo, redução da antena 1 e alteração nas peças bucais; a próxima divisão separa Mesoniscidea de Synocheta e Crinocheta e considera esses dois últimos como grupos irmãos por partilharem o estado do caráter com a papila genital fusionada (Figura 6).

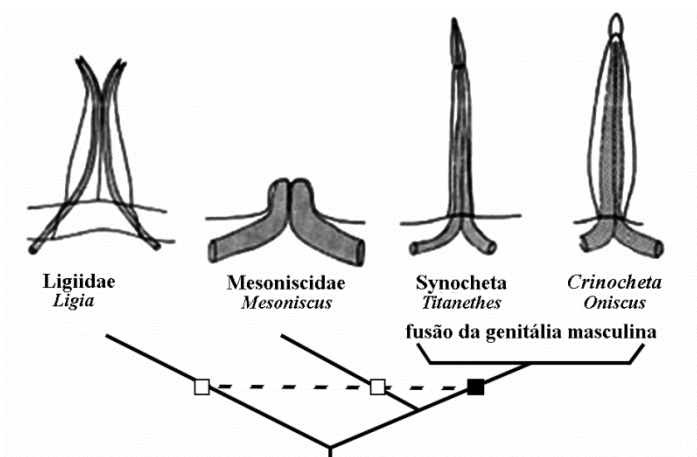


Figura 6. Cladograma apresentado por SCHMALFUSS (1989) para as relações em Oniscidea.

Outra análise morfológica envolvendo Oniscidea infere que Calabozoidea é um grupo irmão de Oniscidea, e Calabozoidea e Oniscidea são grupo irmão dos demais isópodos (BRUSCA & WILSON, 1991). ERHARD (1995, 1998) utilizando características

morfológicas e anatômicas do exoesqueleto e da musculatura do pleon suportam a monofilia do táxon. O autor estabeleceu o clado *Holoverticata* (composto por: *Tylidae*, *Mesoniscidae*, *Synocheta* e *Crinocheta*) sendo grupo irmão de *Ligiidae*; o clado *Orthogonopoda* incluindo *Mesoniscidae*, *Synocheta* e *Crinocheta*; e o clado *Euoniscoida* incluindo *Synocheta* e *Crinocheta*, corroborando com a configuração previamente obtida por SCHMALFUSS (1989) (Figura 7).

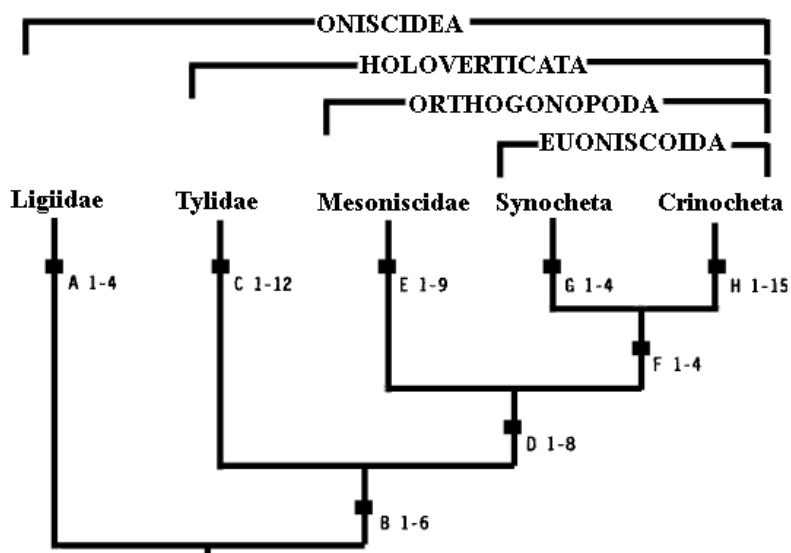


Figura 7. Cladograma apresentado por ERHARD (1998) para as relações em Oniscidea.

As primeiras análises realizadas para Oniscidea, onde foram utilizados dados moleculares, englobaram grupos taxonômicos mais elevados. *Crinocheta* e *Synocheta* foram recuperados como grupos monofiléticos (MICHEL-SALZAT & BOUCHON, 2000; MATTERN & SCHLEGEL, 2001), assim como Oniscidea (DREYER & WÄGELE, 2002).

As relações filogenéticas de *Crinocheta* foram avaliadas por SCHMIDT (2002, 2003) com base em dados morfológicos de 24 famílias, onde obteve as seguintes sinapomorfias: (1) mandíbula sem molares; (2) endópodo do pleópodo1 do macho com furo espermático; (3) redução do sistema condutor de água, (4) cotilédones e (5) tendência a formação da área respiratória na parte dorsal dos exópodos dos pleópodos.

Recentemente, o número de estudos utilizando dados moleculares vem aumentando e a maioria destes com o objetivo de elucidar as relações entre gêneros, espécies e populações (KLOSSA-KILIA et al., 2006; PARMAKELIS et al., 2008; POULAKAKIS & SFENTHOURAKIS, 2008; KARASAWA & HONDA, 2012; KAMILARI et al., 2014; LEE et al., 2014; RAUPACH et al., 2014). Uma grande diversidade genética e uma grande frequência de espécies crípticas vem sendo documentada (HELD, 2003; 2005; JUNG et al.,

2008; HURTADO et al., 2010) assim como a existência de complexo de espécies (BRÖKELAND & RAUPACH, 2008; LEE et al., 2014).

Alguns problemas taxonômicos se devem a identificações equivocadas de espécies, muitas vezes por falta de conhecimento ou até mesmo por falta de descrições detalhadas. Muitas vezes diferenças entre espécies são restritas a poucos caracteres, frequentemente inerente a morfologia dos machos e muitas destas características podem ser reflexo de variações intraespecífica (POULAKAKIS & SFENTHOURAKIS, 2008). Sendo assim a utilização de dados moleculares pode representar uma importante ferramenta para a determinação de espécies.

### 1.3. Bathytropidae Vandel, 1952

A família Bathytropidae por não ter sido bem definida sofreu várias alterações desde sua criação. Seu histórico é brevemente discutido abaixo.

O gênero tipo, *Bathytropa*, foi descrito por BUDDE-LUND (1885) para as espécies *B. meinertii* Budde-Lund, 1885 e *B. costata* Budde-Lund, 1885. As espécies com ocorrência na Argélia, norte da África, foram definidas pela forma do corpo convexa, ligeiramente contrátil, com nervuras ou granulação; olhos medianos; antenas expostas; cabeça com lobos; epímeros grandes e sub-retangulares; telson triangular ou trapezoidal e ausência de pulmões pleopodais. Oniscidea, neste trabalho, era composta por quatro famílias e o gênero foi alocado em ‘Onisci’.

O gênero *Neotroponiscus* e a espécie *Neotroponiscus carolii* foram estabelecidos por ARCANGELI (1936). A espécie foi registrada em Piraju, São Paulo (Brasil) e caracterizada pelos lobos cefálicos, tubérculos dorsais e ausência pulmões pleopodais. No momento, Oniscidea era composta por 10 famílias (VERHOEFF, 1920) e *Neotroponiscus* foi alocado na família Porcellionidae.

GIAMBIAGI DE CALABRESE (1939) descreveu *Porcellio argentinus* de Punta Lara e *P. daguerrii* da Ilha Delta do Paraná, ambos de Buenos Aires, Argentina. O autor observou que, em particular, a forma não triangular do telson e o tamanho reduzido das antenas destas espécies poderiam indicar seu posicionamento incorreto e sugeriu que pertenciam a outro gênero.

*Brasilocellio* VERHOEFF (1941) foi proposto para acomodar *B. nodulosus*, também na família Porcellionidae, com material provindo de Nova Teutônia, Santa Catarina (Brasil). Este gênero apresentava algumas semelhanças corporais a *Neotroponiscus* como a forma do *habitus*, as antenas e a ausência pulmões pleopodais. No entanto os gêneros eram distintos na

forma do lobo frontal e o tipo de tubérculos. Contudo, a ausência de caracteres masculinos para *Neotroponiscus* limitou as comparações entre os táxons.

A subfamília Bathytropinae VANDEL, 1952 foi estabelecida para incluir os gêneros *Bathytropa* Budde-Lund, 1885, *Neotroponiscus* Arcangeli, 1936, *Brasilocellio* Verhoeff, 1941, *Myrmekiocellio* Verhoeff, 1936 [atualmente em Squamiferidae (SCHMOLZER, 1965)] e *Dubioniscus* Vandel, 1963 [atualmente em Dubioniscidae (SCHULTZ, 1995)] (VANDEL, 1963).

*Neotroponiscus* foi revisado por LEMOS DE CASTRO (1970a), quem sinonimizou *Brasilocellio* com *Neotroponiscus* e forneceu a redescrição de *N. carolii* juntamente com novos caracteres diagnósticos para o gênero. As espécies *N. argentinus* (Giambiagi de Calabrese, 1939), *N. plaumanni* (Andersson, 1960), *N. daguerrii* (Giambiagi de Calabrese, 1939) e *N. vedadoensis* (Boone, 1918) [atualmente *Porcellio lamelatus* Budde-Lund, 1885 (SCHULTZ, 1972)] foram incluídas no gênero. Em um estudo consecutivo, Lemos de Castro (1970b) descreveu quatro novas espécies: *N. littoralis* Lemos de Castro, 1970; *N. lobatus* Lemos de Castro, 1970; *N. lenkoi* Lemos de Castro, 1970; *N. perlatus* Lemos de Castro, 1970 (LEMOS DE CASTRO, 1970b).

Algumas espécies foram descritas e transferidas para *Bathytropa*. O gênero atualmente é composto por *B. colasi* Vandel, 1954 da província de Málaga (Sul da Espanha); *B. dollfusi* Strouhal, 1936 da Grécia e Sicília (Itália), *B. graevei* (Verhoeff, 1940) da Ilha de Ischia (Itália); *B. patanei* Caruso, 1973 e *B. ruffoi* Caruso, 1973 da Sicília (Itália); *B. schembrii* Caruso & Lombardo, 1982 de Malta; *B. granulata* Aubert & Dollfus, 1890 de Marseille; *B. meinertii* Budde-Lund, 1885, *B. costata* (Budde-Lund, 1885), *B. tuberculata* Racovitza, 1908 do Norte da Argélia; e *B. rifensis* Taiti & Rossano, 2015 de Rif (Marrocos) (SCHMIDT, 2003; TAITI & ROSSANO, 2015).

STROUHAL (1968) descreveu *Bathytropa wahrmani* com ocorrência em Israel e Turquia. A espécie foi caracterizada pelos espinhos dorsais, pulmões pleopodais esponjosos e telson largo, características diversas das demais espécies do gênero, o que levou a suposição de que seu posicionamento neste gênero estava incorreto ou que havia a probabilidade de uma perda secundária dos pulmões pelos outros integrantes da família (SCHMIDT, 2003). Esta espécie foi examinada e seu posicionamento e características serão discutidos no capítulo 1.

*Mauritaniscus* Vandel, 1959 era composto pela espécie *Mauritaniscus pierrei* (Vandel, 1950), e *Mauritaniscus littorinus* (Miller, 1936) [atualmente *Niambia capensis* (Dollfus, 1895), pertencente a Platyarthridae]. O gênero foi transferido de Oniscidea para Bathytropidae por SCHULTZ (1982), já que as espécies possuíam antena biarticulada e pleópodos sem área

respiratória. Devido ao fato que a família Platyarthridae também é definida pelo flagelo de antena com duas articulações, ausência de pulmões pleopodais e baixa capacidade volvocional, foi levantada a hipótese que ambas as famílias representassem o mesmo táxon (FERRARA & TAITI, 1989).

Em 1973, três novos gêneros foram estabelecidos, entre eles: *Australoniscus* Vandel, 1973 composto por duas espécies *A. alticolus* Vandel, 1973 do Nepal e *A. springetti* Vandel, 1973 da Austrália; *Papuasoniscus* Vandel, 1973 para *Papuasoniscus holthuisi* Vandel, 1973 da Oceania; e *Laninoniscus* Reca, 1973 para *Laninoniscus giambiagiae* Reca, 1973 da Argentina (VANDEL, 1973a, b; RECA, 1973).

*Laninoniscus giambiagiae* diferencia-se das demais espécies de Bathytropidae por apresentar os lobos cefálicos pouco desenvolvidos, sendo assim pode ser considerado um gênero mais ancestral dentre os integrantes da família (RECA, 1973).

SCHMALFUSS (1983) reexaminou *Australoniscus alticolus* encontrada no Nepal e sinonimizou o gênero a *Nagurus* Holthuis, 1949 devido à presença de uma área respiratória nos exópodos dos pleópodos. No entanto, destacou que *A. springetti* não se insere em *Nagurus* e que certamente pertence a um gênero diferente, enfatizando a necessidade de revisão do gênero.

*Papuasoniscus* atualmente é composto por três espécies: *Papuasoniscus golovatchi* Dalens, 1988, *Papuasoniscus holthuisi* Vandel, 1973 e *Papuasoniscus lutaoensis* Jeon & Kwon, 1996. O gênero se distribui pela região tropical da Austrália nas Ilhas Salomão, Bismarck, Togian e Nova Guiné, e na região Oriental, em Taiwan, China (JEON & KWON, 1996).

VANDEL (1981) em um trabalho de descrição dos isópodos terrestres de cavernas de Cuba descreveu o gênero *Cubanoscia* com três espécies: *C. primitiva* Vandel, 1981, *C. romanorum* Vandel, 1981 e *C. próxima* Vandel, 1981. Como na descrição do gênero e das espécies o material tipo não foi designado, o nome é considerado um nome não válido ou não disponível pelo Código Internacional de Nomenclatura Zoológica (ICZN, Art. 13.3). As espécies de *Cubanoscia* presentes na coleção de Vandel no Museu Nacional de História Natural (França) foram examinadas e são discutidas no capítulo 2.

A hipótese de sinonímia de Bathytropidae e Platyarthridae é mencionada por FERRARA & TAITI (1989) e TAITI et al. (1992). No entanto, LEWIS (1998) argumenta contra a sugestão de ambos os trabalhos, pois as famílias apresentam morfologia distinta. Ainda neste trabalho, descreveu *Monitus*, gênero monotípico para a espécie *Monitus testudinatus* Lewis, 1998, encontrado na Austrália, que apresenta uma grande semelhança

morfológica com os exemplares de *Neotroponiscus*. Entretanto possui três artículos no flagelo da antena.

*Dumetoniscus* foi o gênero mais recente descrito para Bathytropidae, ocorrendo em Socotra, Iêmen. *Dumetoniscus graniticus* Taiti & Checcucci, 2009 são isópodos do tipo “runner”, sem capacidade volvocional, cujo tegumento possui tubérculos superficiais e lobos cefálicos bem desenvolvidos, com o lobo frontal triangular (TAITI & CHECCUCCI, 2009).

A posição taxonômica da família Bathytropidae foi analisada por SCHMIDT (2003) que recuperou as famílias Bathytropidae e Platyarthridae independentemente, discordando com a hipótese anterior de sinonímia de FERRARA & TAITI (1989) e TAITI et al. (1992). No entanto, sugeriu que Bathytropidae forma um agrupamento artificial, e que necessita de uma revisão taxonômica e uma análise filogenética mais detalhada para elucidar as relações entre seus membros.

#### **1.4. *Neotroponiscus* Arcangeli, 1936**

O gênero possui oito espécies descritas. Algumas espécies foram re-descritas, entre elas, *N. carolii* por LEMOS DE CASTRO (1970a), *N. daguerrii* por RECA (1973) com material da localidade tipo, da Argentina e por ARAUJO et al. (1996), com o primeiro registro para o Rio Grande do Sul, Brasil. Além disso, a disposição do marsúpio das fêmeas de *N. daguerrii* e *N. carolii* foi descrita por APPEL et al. (2011).

O conhecimento da distribuição de algumas espécies foi ampliado, entre elas, *N. daguerrii* e *N. argentinus*, ambas originalmente descritas da Argentina e atualmente possuem registros de distribuição para a região Sul do Brasil (ARAUJO et al., 1996; ALMERÃO et al., 2006; BOOS et al., 2012); *N. lenkoi*, anteriormente conhecida apenas no estado de São Paulo, foi registrada no estado do Rio de Janeiro no Parque Nacional da Tijuca (MUGNAI et al., 2013).

O gênero ocorre nas regiões de Mata Atlântica ao longo da América do Sul (LEMOS DE CASTRO, 1970a). No Brasil, as espécies podem ser encontradas em áreas de mata primária ou secundária, em áreas de encosta ou na região costeira (LOPES et al., 2005), geralmente associadas a bromélias (ARAUJO et al., 1996), em ninhos de formigas (LENKO, 1971) ou cupins (LISBOA et al., 2013). As espécies apresentam baixa capacidade volvocional e tegumento pigmentado; a superfície dorsal geralmente é coberta por espinhos ou tubérculos; a cabeça possui lobos medianos e laterais bem desenvolvidos; e o telson possui as laterais convergentes geralmente com carena na linha mediana (LEMOS DE CASTRO, 1970a).



## **OBJETIVOS**

### **OBJETIVO GERAL**

Revisar a taxonomia e investigar as relações filogenéticas das espécies de *Neotroponiscus*, e esclarecer seu posicionamento em Oniscidea.

### **OBJETIVOS ESPECÍFICOS**

- Analisar o material proveniente de coleções científicas e de coletas, para a identificação das espécies.
- Redescrever e/ou descrever espécies, para o levantamento dos caracteres morfológicos.
- Confirmar e ampliar o conhecimento sobre a distribuição das espécies de *Neotroponiscus* e dos demais gêneros de Bathytropidae, quando possível solucionar os problemas taxonômicos da família.
- Testar a monofilia da família e do gênero, estabelecendo relações de parentesco entre seus integrantes, com base em dados morfológicos e moleculares.

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## Capítulo I

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### **A new genus of Trachelipodidae Strouhal, 1953 (Crustacea, Isopoda, Oniscidea) from the eastern Mediterranean**

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#### **Abstract**

*Levantoniscus* n. gen. is erected for two new species from Cyprus: *Levantoniscus bicostulatus* n. sp. and *Levantoniscus makrisi* n. sp. *Levantoniscus wahrmani* (Strouhal, 1968) n. comb. from Israel and southern Turkey is transferred from the genus *Bathytropa* Budde-Lund, 1885 and family Bathytropidae. The new genus is included in the family Trachelipodidae and is characterized by distinct dorsal ornamentation, interlocking pleopods and uncovered pleopodal lungs which are located in invaginations on pleopod 3–5 exopodites.

**Key words:** Oniscidea, *Levantoniscus*, new species, Cyprus, Near East





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## A new genus of Trachelipodidae Strouhal, 1953 (Crustacea, Isopoda, Oniscidea) from the eastern Mediterranean

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### Abstract

*Levantoniscus* n. gen. is erected for two new species from Cyprus: *Levantoniscus bicostulatus* n. sp. and *Levantoniscus makrisi* n. sp. *Levantoniscus wahrmani* (Strouhal, 1968) n. comb. from Israel and southern Turkey is transferred from the genus *Bathytropa* Budde-Lund, 1885 and family Bathytropidae. The new genus is included in the family Trachelipodidae and is characterized by distinct dorsal ornamentation, interlocking pleopods and uncovered pleopodal lungs which are located in invaginations on pleopod 3–5 exopodites.

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### Introduction

The terrestrial isopod (Oniscidea) fauna of the eastern Mediterranean countries has not been studied in detail, with the only exception of Israel (Strouhal & Pretzmann 1975; Warburg & Hornung 1999). Furthermore, the taxonomy of several groups of Oniscidea needs a sound revision, as evinced also by the few recent molecular phylogenies produced for some taxa (e.g., Klossa-Kilia *et al.* 2006; Parmakelis *et al.* 2008; Kamilari *et al.* 2014) that revealed very high genetic variation even within neighbouring conspecific populations.

In the past few years we have undertaken a detailed study on the oniscidean fauna of Cyprus, during which we have collected material that includes new taxa and helps to elucidate the taxonomic status of other known taxa from the region. In this paper we describe two new species from Cyprus which share characters with a previously described species from the Near East assigned to the genus *Bathytropa* Budde-Lund, 1885 in the family Bathytropidae. The unique characters of these three species justify the establishment of a new genus which we consider to belong to the family Trachelipodidae.

### Materials and methods

The specimens of the two new species described herein were collected on Cyprus and stored in 95% ethanol. The specimens of *Bathytropa wahrmani* Strouhal, 1968 were borrowed from the Steinhardt Museum of Natural History, Tel Aviv University, Israel, and had been identified by H. Schmalfuss, Stuttgart. The species were illustrated from the entire animals and micropreparations of body parts; figures were prepared with the aid of a camera lucida mounted on Wild M5 and M20 microscopes. For one species, some pictures were taken with a scanning electron microscope using a FEI ESEM QUANTA 200. Samples were dried and introduced in the measuring chamber with no pretreatments.

The material is deposited in the collections of the Museo di Storia Naturale dell'Università, Sezione di Zoologia "La Specola", Florence, Italy (MZUF), and the Steinhardt Museum of Natural History, Tel Aviv University, Tel Aviv, Israel (TAU).

## Systematic account

### Family Trachelipodidae Strouhal, 1953

#### Genus *Levantoniscus* n. gen.

Type species: *Levantoniscus bicostulatus* n. sp., here designated; gender masculine.

**Diagnosis.** Oval body shape, outline not interrupted between pereon and pleon. Body with conspicuous lamellar or acute dorsal tubercles covered with piliform setae. One line of noduli laterales inserted far from lateral margins of pereonites 1–4 and near posterolateral corners on pereonites 5–7; no gland pores on pereon epimera. Head with prominent frontal lateral and middle lobes. Eyes reduced to five or less ommatidia. Pereonite 1 with posterior margin concave at sides. Pereon epimera and pleon epimera 3–5 quadrangular. Telson hourglass-shaped, with more or less concave posterior margin. Mandibles with dichotomized molar penicils. Outer branch of maxillula with teeth apically entire. Pereopods with dactylar and unguis setae flagelliform. Pleopod 2–5 exopodites interlocking, with deep groove on medial and proximal margin to receive distal part of previous pleopod exopodites. Pleopod exopodites with uncovered lungs, consisting of ridges and folds on dorsal surface of pleopod 1 and 2 exopodites, and in invaginations on pleopod 3–5 exopodites.

**Etymology.** The name of the genus refers to the Levant Region, where the species occur + *oniscus*.

**Remarks.** The family Trachelipodidae has six genera (Schmalfuss 2003; Taiti & Ferrara 2004): *Trachelipus* Budde-Lund, 1908, *Porcellium* Dahl, 1916, *Pagana* Budde-Lund, 1908, *Nagurus* Holthuis, 1949, *Panchaia* Taiti & Ferrara, 2004, and *Tamarida* Taiti & Ferrara, 2004. The new genus is included in Trachelipodidae as it has a two-segmented antennal flagellum and uncovered lungs on all pleopod exopodites. *Levantoniscus* differs from all the other genera in the family in having distinct dorsal ornamentation, interlocking pleopods and different morphology of lungs on pleopods 3–5, i.e. with the respiratory surface inside invaginations of the exopodites. These characters are unique in the family Trachelipodidae and certainly derived since the plesiomorphic states present in lower taxa are: smooth dorsum, pleopods overlapping and not interlocking, uncovered lungs with respiratory surface mostly exposed and not included in invaginations. These characters can be considered as autapomorphies of the new genus.

*Levantoniscus* includes the two new species from Cyprus described below and *L. wahrmani* (Strouhal, 1968) from Israel and the Hatay region of southeastern Turkey which was originally assigned to the genus *Bathytropa*. As pointed out by Schmidt (2003) in his attempt to re-define the family Bathytropidae, the monophyly of the genus *Bathytropa* was questioned by the inclusion of this species since, according to the original description by Strouhal (1968), it has lungs or respiratory fields of *Trachelipus*-type in the exopodites of pleopods 1–5. Moreover, this species has an hourglass-shaped telson and interlocking pleopod exopodites which are not present in any of the other 10 species of *Bathytropa* (for bibliographic references of this genus see Schmalfuss 2003 and Taiti & Rossano 2015). The transfer of this species to the new genus restores the purported monophyly of *Bathytropa*.

According to our knowledge interlocking pleopod exopodites are present only in species of Stenoniscidae (see Vandel 1962; Taiti & Ferrara 1982) and three genera of Armadillidae from Australia (*Buddelundia* Michaelsen, 1912, *Barrowdillo* Dalens, 1993, and *Stigmops* Lillemet & Wilson, 2002) (see Dalens 1992, 1993; Lillemet & Wilson 2002; Taiti 2014). This derived character in phylogenetically distant families suggests that its presence is due to convergence.

In *Levantoniscus* the lungs on the exopodites of pleopods 1 and 2 are typically uncovered, i.e. consisting of ridges and folds with the respiratory surface almost entirely exposed like in the genus *Trachelipus* Budde-Lund, 1908 (Trachelipodidae) (see Hoese 1982; Schmidt & Wägele 2001), in the genus *Atracheodillo* Arcangeli, 1950 (Eubelidae) (see Paoli *et al.* 2002) or in the genus *Sinodillo* Kwon & Taiti, 1993 (Armadillidae) (see Kwon & Taiti 1993; Taiti *et al.* 1998). The lungs on exopodites of pleopods 3–5 have the same structure of ridges and folds but the respiratory surface is allocated inside an invagination near the lateral margin of the exopodites and not visible

in dorsal view. This special kind of lung can still be considered as uncovered due to the same kind of respiratory surface. Its position inside an invagination, instead of being exposed as in all the other species of Trachelipodidae, could be due to the interlocking structure of the pleopods.

As pointed out by Schmidt (2003: 131) the phylogenetic relationships within the family Trachelipodidae, but also with related taxa (e.g., Agnaridae, Porcellionidae, Cylisticidae etc.), still remain unclear and should be examined also by means of molecular analyses.

### ***Levantoniciscus bicostulatus* n. sp.**

Figures 1–6

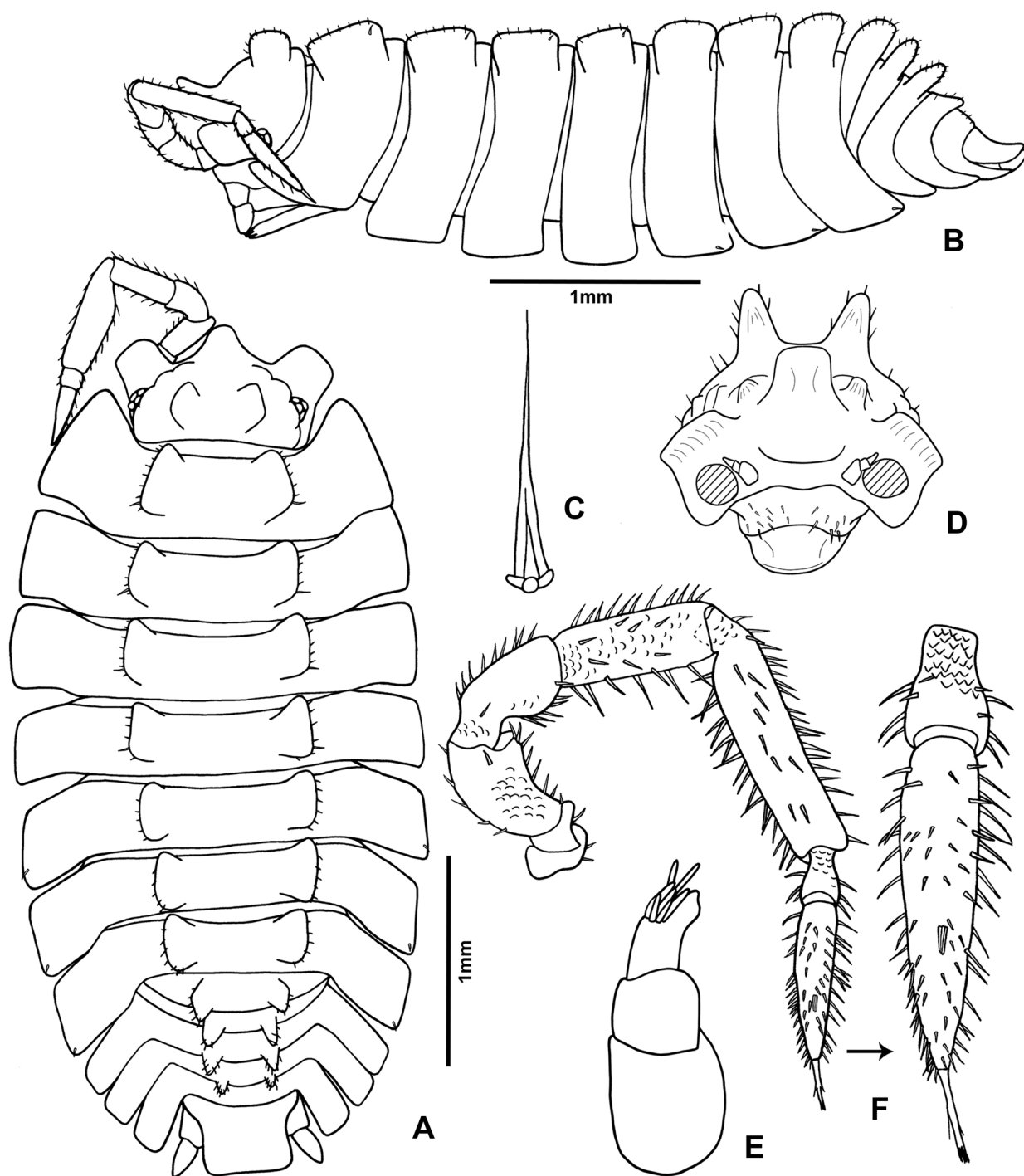
**Material examined.** Cyprus: 1 ♂ Holotype (MZUF 9609), Kampos Potamos, northern slopes of Troodos Mt., 35°04'44.80"N 32°44'06.15"E, 430 m, 29.XI.2012, leg. S. Sfenthourakis; 5 ♀ Paratypes (MZUF 9609), same data as Holotype; 6 ♂, 6 ♀ Paratypes (MZUF 9610), same locality, 25.III.2015, leg. S. Sfenthourakis; 1 ♀ Paratype (MZUF 9611), Chalefka, Pentadaktylos Mt., 35°17'09.03"N 33°32'08.28"E, 520 m, 5.XII.2012, leg. S. Sfenthourakis; 2 ♂, 3 ♀ Paratypes (MZUF 9612), Akanthou, northern slopes of Pentadaktylos Mt., 35°22'09.73"N 33°45'18.10"E, 120 m, 5.XII.2012, leg. S. Sfenthourakis.

**Description.** Maximum size: ♂: 4.0 x 2.7 mm, ♀: 4.2 x 2.0 mm. Colour in ethanol: head with brown lobes and pale vertex; pereonites brown in median part, two pale stripes between tubercles and epimera; pereon and pleon epimera brown; tergites of pleonite 4 and 5 pale; antennae, pereopods, pleopods, telson and uropods pale. Body with distinct dorsal ornamentation (Figs 1A, B, 5A–C, E) disposed as follows: two quadrangular lamellar tubercles on posterior part of cephalon and an oblique line of four low rounded tubercles on each side next to eyes; two quadrangular lamellar tubercles on each pereonite, and two on pleonite 1; two, progressively more pointed tubercles on pleonites 2–4; no tubercles on pleonite 5 and telson. Dorsum with cuticular structure consisting of hexagonal or pentagonal cells and small wart-like protuberances (Fig. 5D), whole surface covered with long piliform setae (Fig. 1C), which are longer and denser on tubercles; noduli laterales (Fig 1A, B) on pereonites 1–4 inserted on outer surface of tubercles near tubercle posterior corner, and on pereonites 5 to 7 on postero-lateral corner of pereonites, progressively closer to posterior margin. Cephalon (Figs 1D, 5B) with quadrangular frontal lateral lobes, obliquely directed outwards, and rectangular median lobe more protruding than lateral lobes and directed upwards. Eyes small with five ommatidia. Epimera (Figs 1A, B, 5A) of pereonite 1–3 quadrangular with posterior margins slightly concave; epimera of pereonites 4–7 progressively more acute and backwards directed. Telson (Fig. 5C) almost twice as broad as long, distal part with rounded corners and very slightly concave distal margin. Antennula (Fig. 1E) with second article shorter than first and third; distal articles with two apical and five subapical aesthetascs. Antenna (Fig. 1F) short, reaching posterior margin of pereonite 1; flagellum slightly shorter than fifth segment of peduncle, first flagellar article 3 times shorter than second, second flagellar article with row of three aesthetascs. Right mandible (Fig. 2A) with 1+1 and left mandible (Fig. 2B) with 2+1 free penicils. Maxillula (Fig. 2C) outer branch with 4+6 teeth; inner branch with distinct triangular posterior point and two subequal penicils. Maxilla (Fig. 2D) with inner lobe 1.5 times larger than outer lobe, covered with thick apical setae; three large setae between two lobes. Maxilliped (Fig. 2E) endite with broad and rounded distal margin bearing three triangular teeth and long seta; pulp short with proximal article bearing two thick setae. Pereopod 1 (Fig. 3A) carpus with antennal brush consisting of large area of short setae obliquely directed. Pleopods with uncovered lungs largely exposed on exopodites 1 and 2 (Fig. 6A, B), and in invaginations on exopodites 3–5 (Fig. 6C, D). Uropod (Fig. 2F) protopodite with concave outer margin, not grooved; exopodite ventrally grooved, slightly longer than endopodite and reaching distal margin of telson.

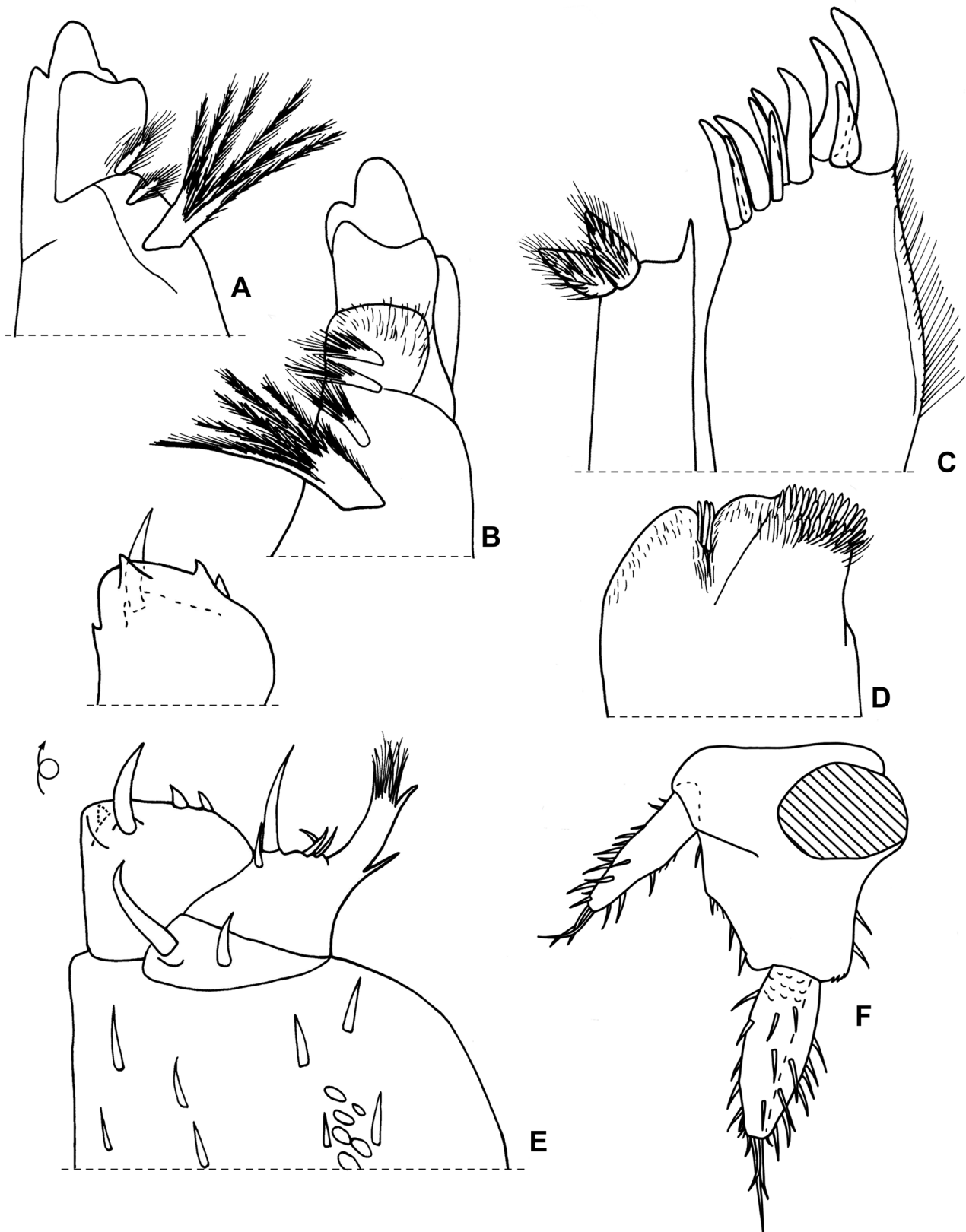
Male. Pereopod 1 (Fig. 3A) merus and carpus with line of strong setae on sternal margin. Pereopod 7 (Fig. 3B) with enlarged basis, ischium with straight sternal margin, merus and carpus with slightly concave sternal margins. Pleopod 1 (Fig. 3C, D) exopodite small, subrectangular, about 2.5 times as wide as long; endopodite with thickset distal part and pointed apex. Pleopod 2 (Fig. 3E, F) exopodite triangular distinctly shorter than endopodite. Pleopod 3 (Fig. 4A, B) and 4 (Fig. 4C, D) trapezoidal with distinctly concave distal margin; pleopod 5 (Fig. 4E, F) trapezoidal with distal margin oblique and almost straight.

**Etymology.** Latin: *bi* = double + *costulatus* = with ribs. The name of the species refers to the double line of lamellar tubercles on the cephalon, pereon and pleon.

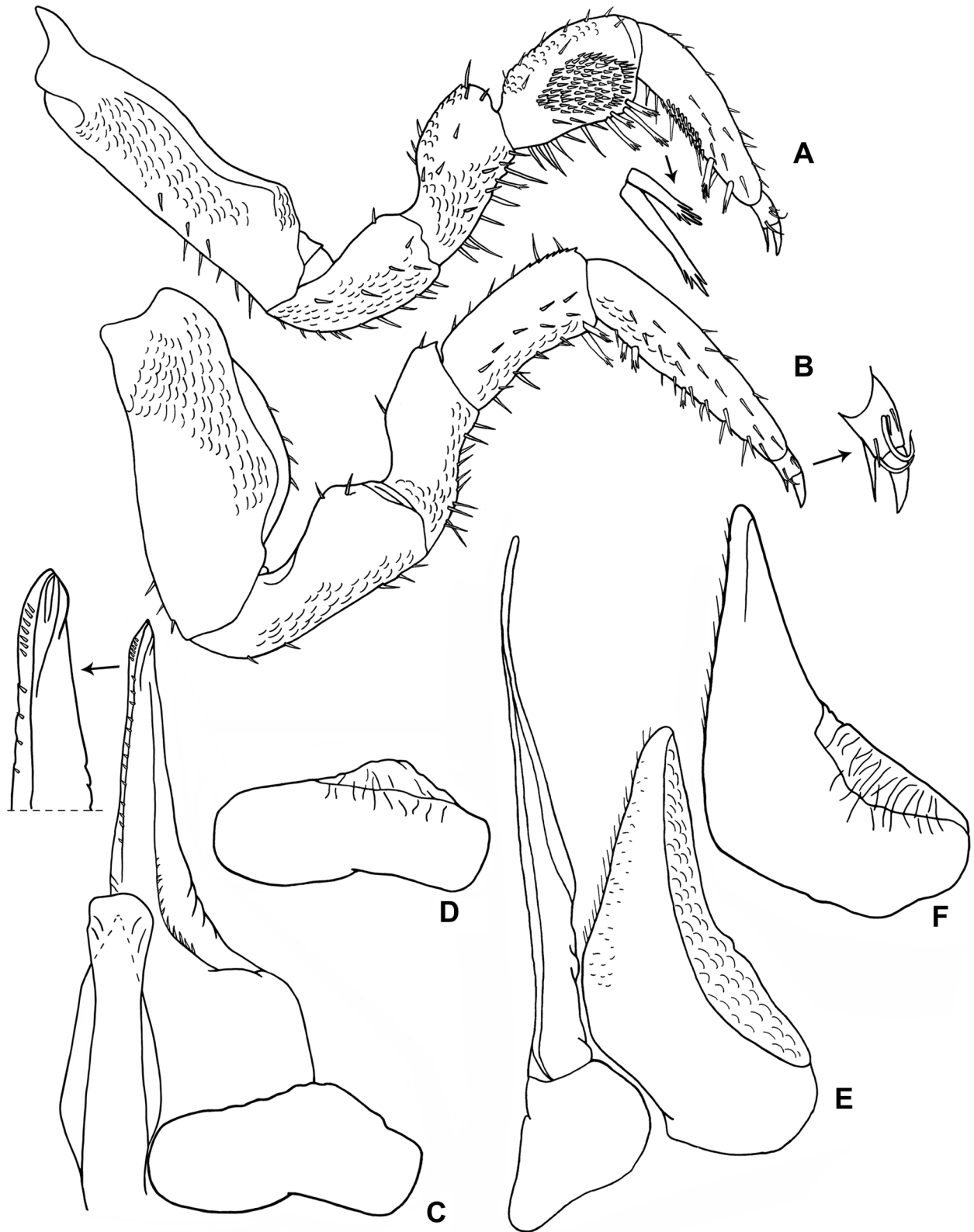
**Remarks.** The species has been found only at the close vicinity of running water, under leaves and stones hidden inside the wet litter layer of hygrophilic plants. Taking into account its dorsal ornamentation, the species should be considered rather as an endogean species, coming to the surface only in locations with very high humidity.



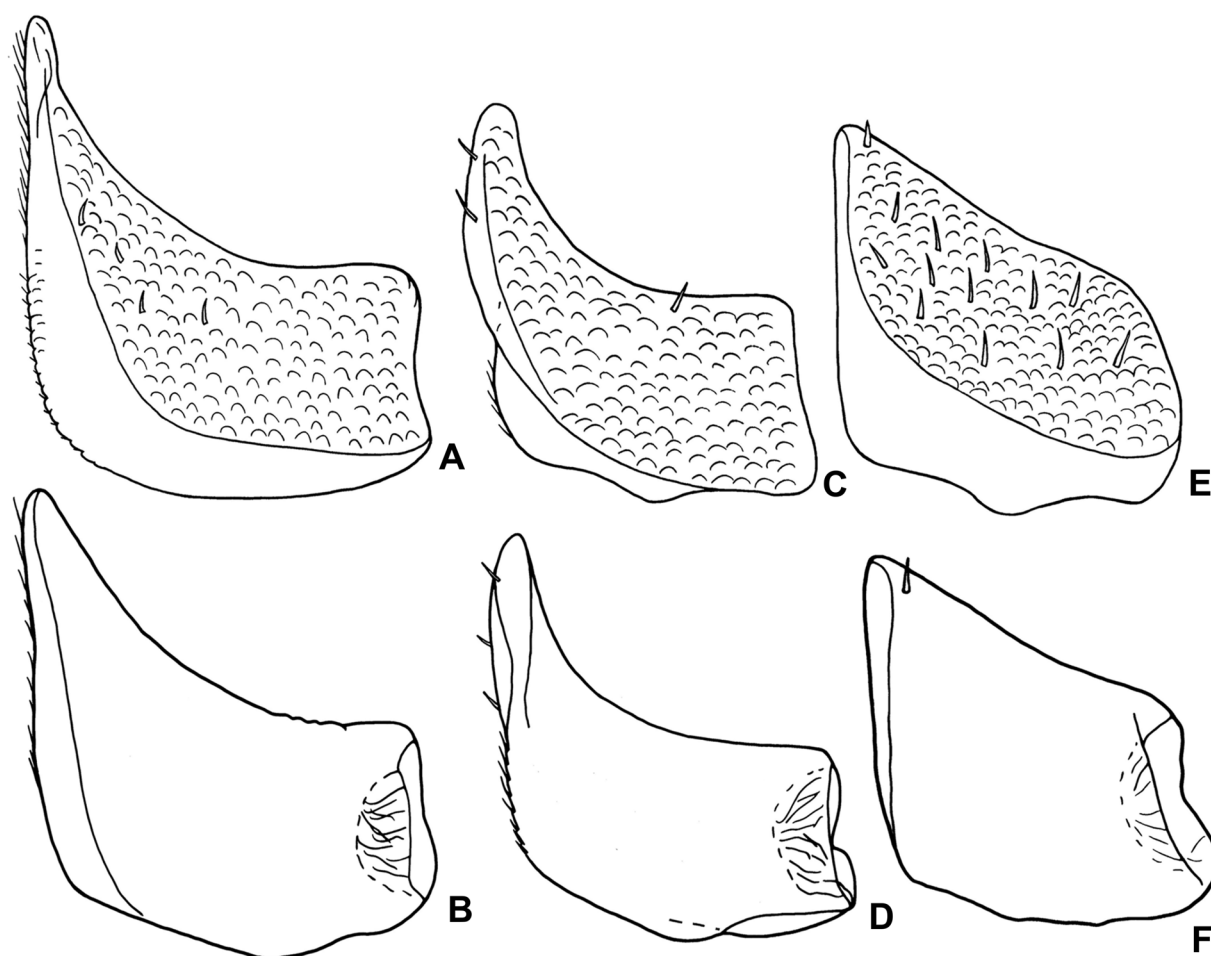
**FIGURE 1.** *Levantoniscus bicostulatus* n. sp. Paratype ♀: A, adult specimen, dorsal view; B, adult specimen, lateral view; C, dorsal scale-seta; D, cephalon, frontal view. Paratype ♂: E, antennula; F, antenna.



**FIGURE 2.** *Levantoniscus bicostulatus* n. sp. Paratype ♀: A, right mandible; B, left mandible; C, maxillula; D, maxilla; E, maxilliped; F, uropod.



**FIGURE 3.** *Levantoniscus bicostulatus* n. sp. Holotype ♂: A, pereopod 1; B, pereopod 7; C, pleopod 1, ventral view; D, pleopod 1 exopodite, dorsal view; E, pleopod 2, ventral view; F, pleopod 2 exopodite, dorsal view.



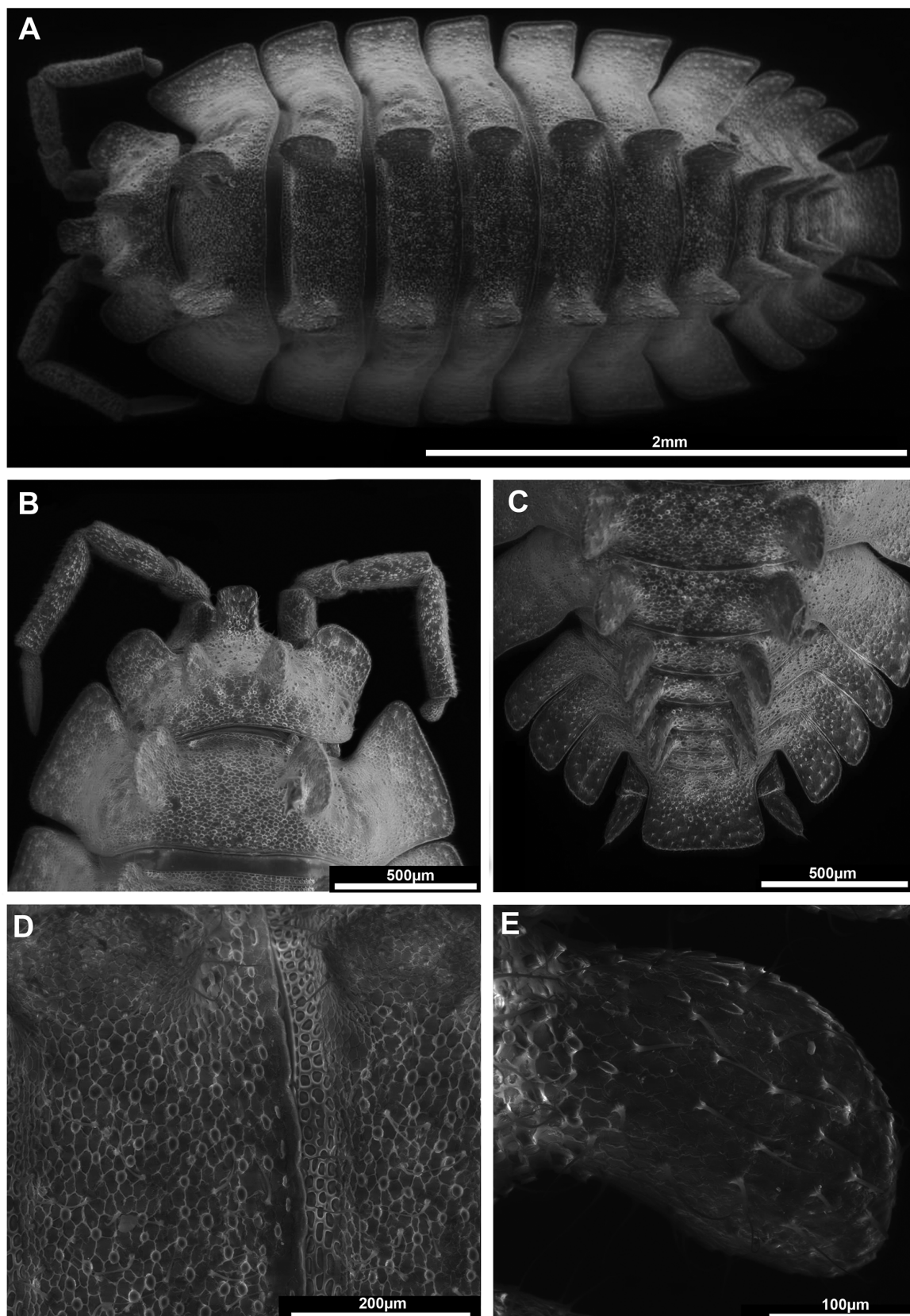
**FIGURE 4.** *Levantoniscus bicostulatus* n. sp. Holotype ♂: A, pleopod 3 exopodite, ventral view, B, pleopod 3 exopodite, dorsal view; C, pleopod 4 exopodite, ventral view, D, pleopod 4 exopodite, dorsal view; E, pleopod 5 exopodite, ventral view, F, pleopod 5 exopodite, dorsal view.

***Levantoniscus makrisi* n. sp.**

Figures 7, 8

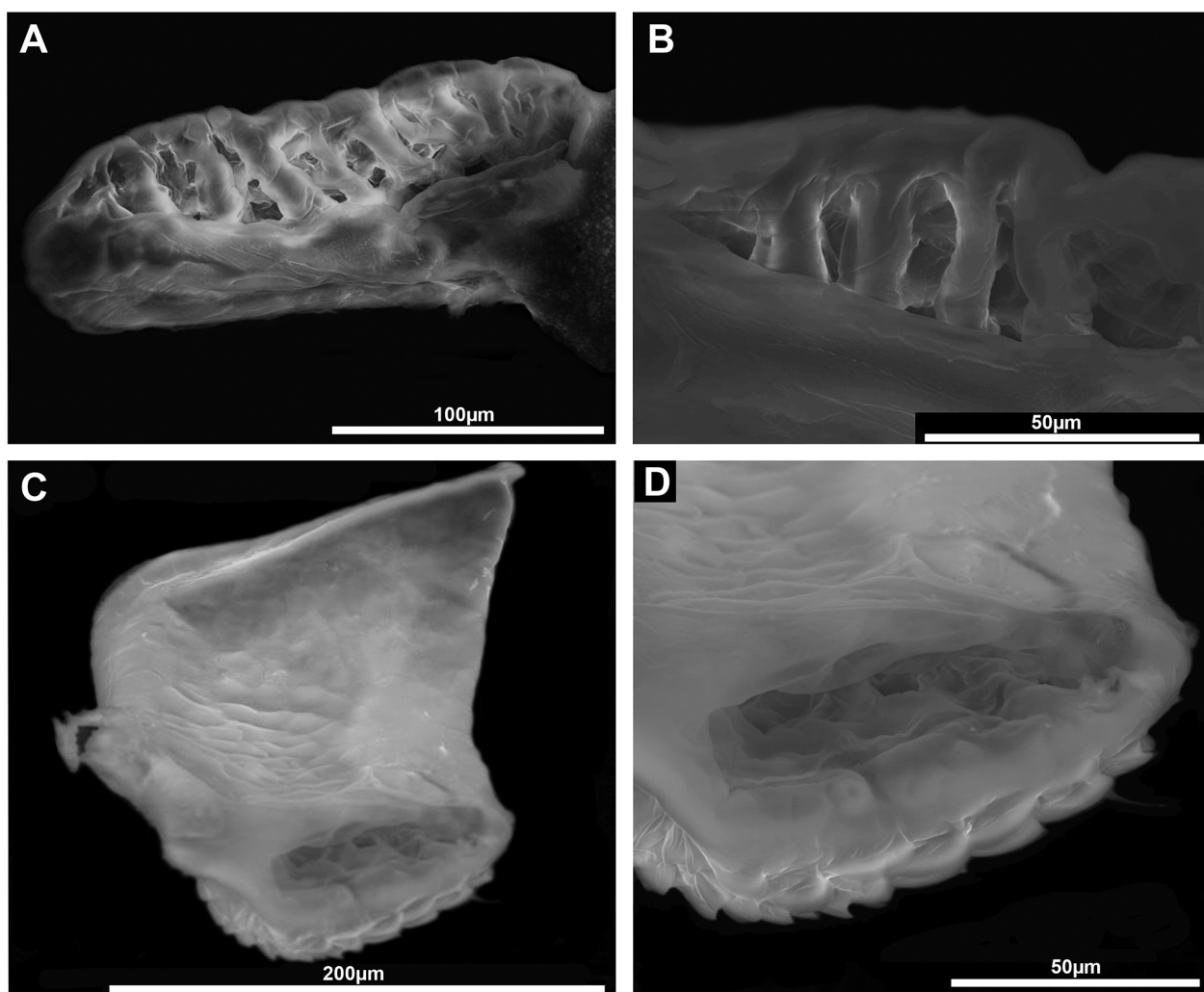
**Material examined.** Cyprus: 1 ♂ Holotype (MZUF 9613), Stavros tis Psokas, Troodos Mt., 35°01'06.04''N 32°37'08.59''E, 800 m, 1.II.2012, leg. S. Sfenthourakis.

**Description.** Size: 3.5 x 1.9 mm. Colour in ethanol: whole body pale. Body with dorsal ornamentation (Fig. 7A, B) with same disposition as in previous species, but with longer and narrower lamellar tubercles. Dorsum with similar cuticular structure, setae and disposition of noduli laterales. Cephalon (Fig. 7C, D) with quadrangular frontal lateral lobes, obliquely directed outwards with widely rounded distal margin, triangular median lobe dorsally concave, not protruding frontwards compared with lateral lobes. Eyes reduced, visible only as dot of dark pigment. Epimera of pereonites quadrangular, with posterior margin straight. Telson (Fig. 7E) slightly broader than long, distal part with rounded corners and distinctly concave distal margin. Antennula (Fig. 7F) with second article shorter than first and third; distal articles with five superimposed aesthetascs. Antenna (Fig. 7G) short, almost reaching posterior margin of pereonite 2; flagellum as long as fifth segment of peduncle, first flagellar article 4 times shorter than second, second flagellar article with row of three aesthetascs. Buccal pieces and uropods as in *L. bicostulatus*. Pereopod 1 (Fig. 8A) carpus with some strong setae on sternal margin. Pereopod 7 (Fig. 8B) ischium, merus and carpus with straight sternal margin. Pleopod 1 (Fig. 8C, D) exopodite small, subrectangular, about twice as wide as long; endopodite with straight distal part and triangular apical part. Pleopod 2 (Fig. 8E, F) exopodite triangular distinctly shorter than endopodite. Pleopod 3 (Fig. 8G) and 4 (Fig. 8H) trapezoidal with concave distal margin; pleopod 5 (Fig. 8I) trapezoidal with distal margin oblique and straight.



**FIGURE 5.** *Levantoniscus bicostulatus* n. sp. Paratype ♀: A, adult specimen, dorsal view; B, cephalon and pereonite 1, dorsal view; C, pereonites 6 and 7, pleon, telson and uropods, dorsal view; D, pereonites 2 and 3, details of the cuticular structure; E, tubercle on pereonite 7, medial surface.





**FIGURE 6.** *Levantoniscus bicostulatus* n. sp. Paratype ♀: A, pleopod 1 exopodite; B, pleopod 2 exopodite, detail of respiratory surface; C, pleopod 4 exopodite, dorsal view; D, detail of respiratory surface on pleopod 4 exopodite.

**Etymology.** The species is named after Christodoulos Makris, for his outstanding contribution to the study of Cyprus biodiversity.

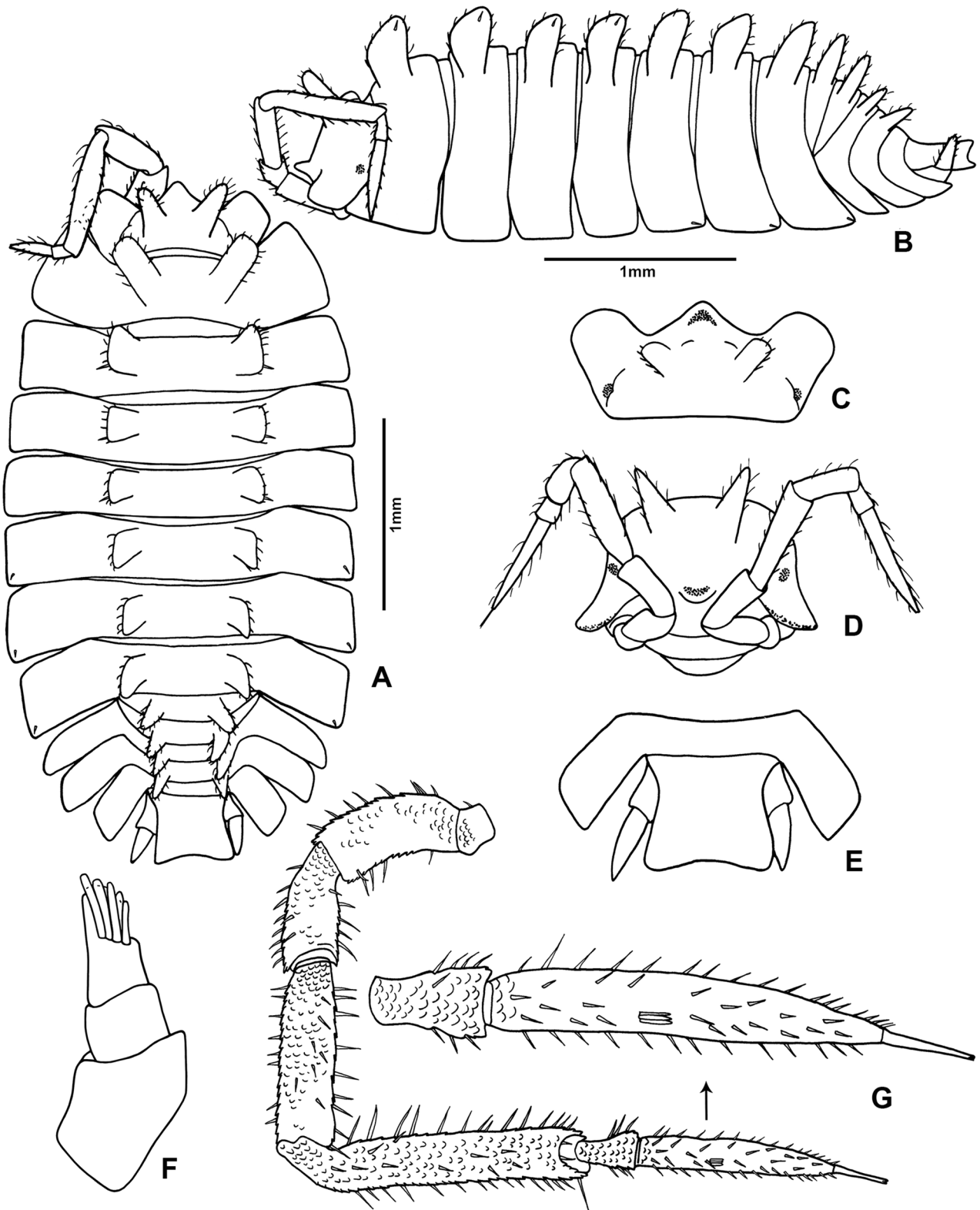
**Remarks.** The new species is morphologically very close to *L. bicostulatus* in the disposition of dorsal ornamentation. It differs from this species in having paler coloration of the whole body, longer dorsal tubercles with more rounded apex, reduced eyes, telson with more concave distal margin, relatively longer articles of antenna, and longer male pleopod 1 exopodite (compare Figs 8C and 1D). It differs from *L. wahrmani* (see below) in the number, disposition and shape of the dorsal tubercles, the reduced eye, and the longer male pleopod 1 exopodite.

This species has been found in the wet debris accumulated inside dead and decaying wood. Similarly to *L. bicostulatus*, it should be considered as an endogean species coming to the surface in localities with increased humidity. Since only one specimen has been found so far, it remains to be seen whether it also occurs near water or in other habitat types.

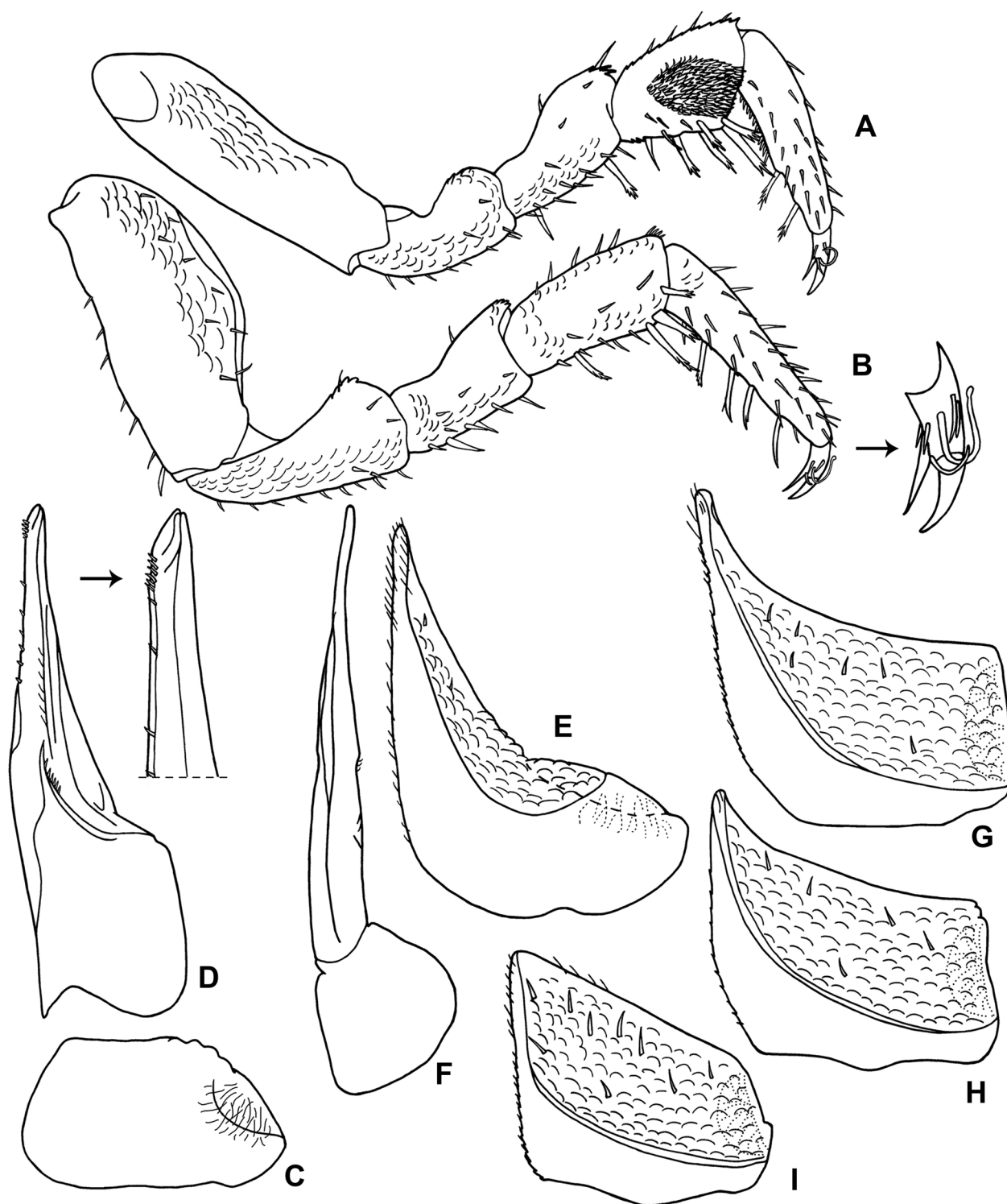
#### ***Levantoniscus wahrmani* (Strouhal, 1968)**

Figures 9, 10

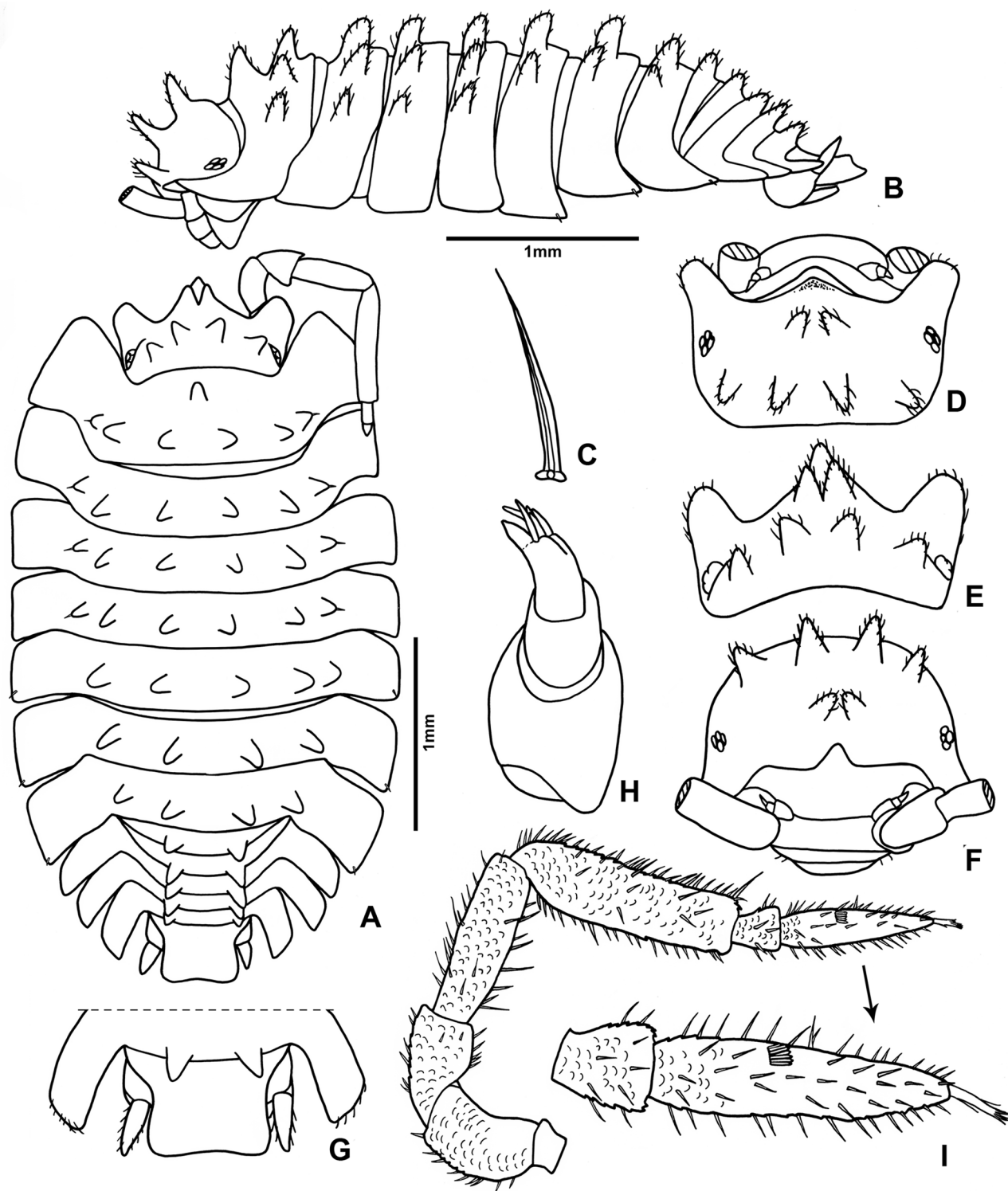
*Bathytropa wahrmani* Strouhal 1968: 69, Figs 1–25; Caruso 1973: 96, Fig. 1; Warburg *et al.* 1978: 159, 159, 162; Hornung & Warburg 1996: 181; Warburg 1993: 82, Figs 1, 2.1, 2.2, 2.8, 9.7, 9.8, 9.12; Warburg & Hornung 1999: 1473; Schmalfluss 2003: 61; Warburg 2007: 1228, 1230, 1233, 1235, 1248, Fig. 5.



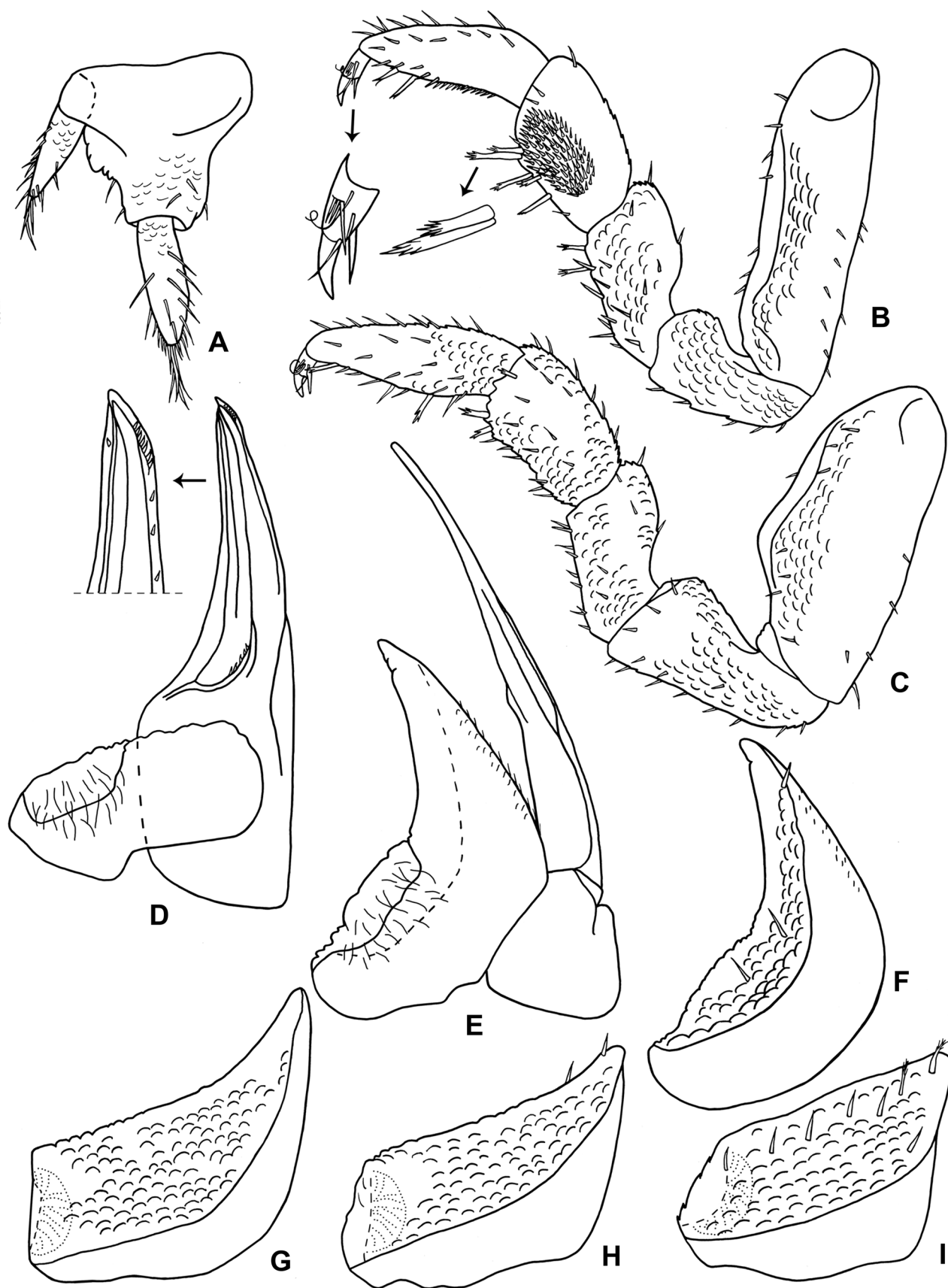
**FIGURE 7.** *Levantoniscus makrisi* n. sp. Holotype: A, specimen, dorsal view; B, lateral view; C, cephalon, dorsal view; D, cephalon, frontal view; E, pleonite 5, telson and uropods, dorsal view; E, antennula; F, antenna.



**FIGURE 8.** *Levantoniscus makrisi* n. sp. Holotype: A, pereopod 1; B, pereopod 7; C, pleopod 1 exopodite, dorsal view; D, pleopod 1 endopodite; E, pleopod 2 exopodite, ventral view; F, pleopod 2 endopodite; G, pleopod 3 exopodite, ventral view; H, pleopod 4 exopodite, ventral view; I, pleopod 5 exopodite, ventral view.



**FIGURE 9.** *Levantoniscus wahrmani*. ♀: A, adult specimen, dorsal view; B, lateral view; C, dorsal scale-seta; D, cephalon, dorsal view; E, cephalon, posterior view; F, cephalon, frontal view; G, pleonite 5, telson and uropods, dorsal view. ♂: H, antennula; I, antenna.



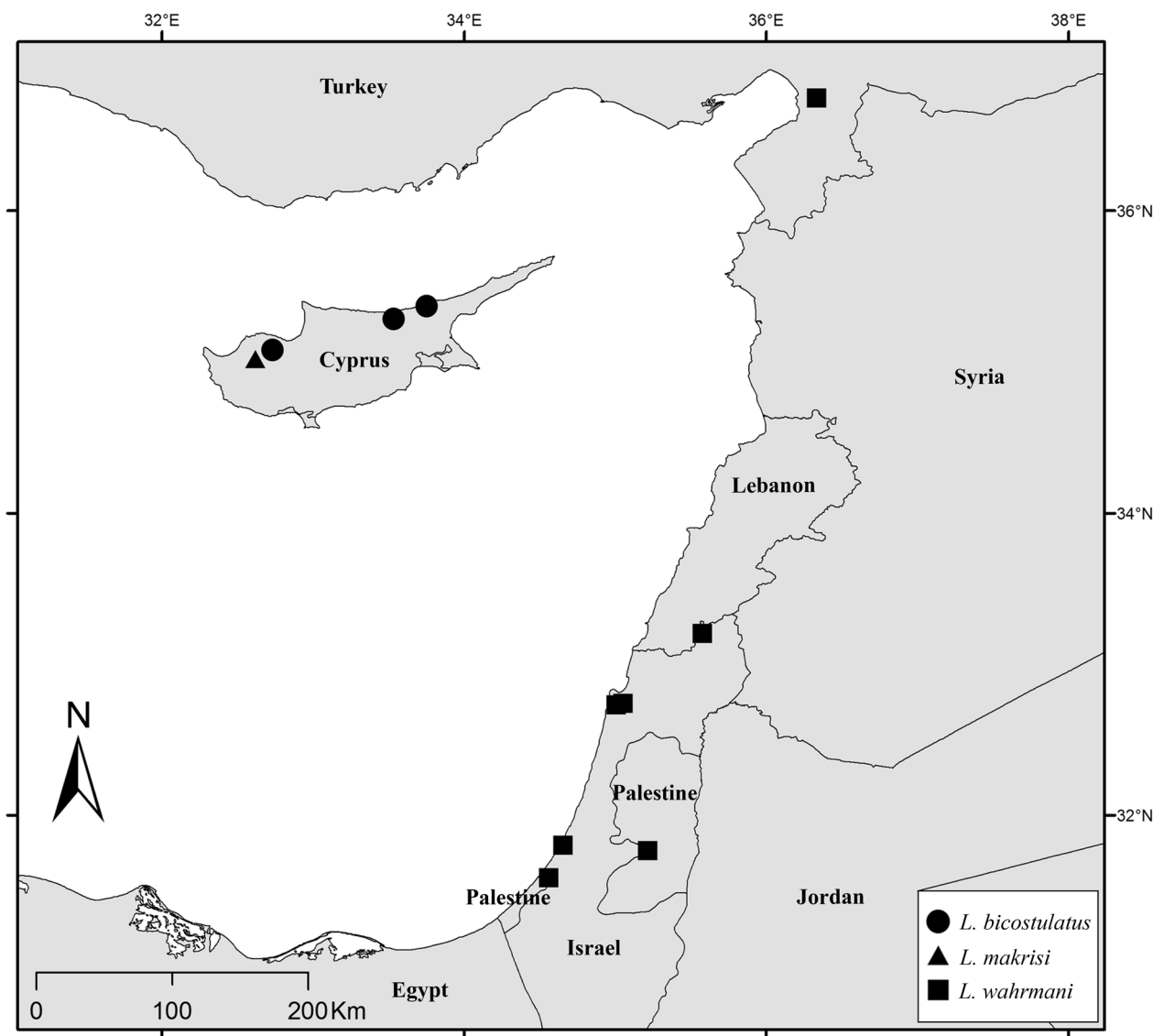
**FIGURE 10.** *Levantoniscus wahrmani*. ♂: A, uropod; B, pereopod 1; C, pereopod 7; D, pleopod 1, dorsal view; E, pleopod 2, dorsal view; F, pleopod 2 exopodite, ventral view; G, pleopod 3 exopodite, ventral view; H, pleopod 4 exopodite, ventral view; I, pleopod 5 exopodite, ventral view.

**Material examined.** Israel: 1 ♂, 1 ♀ (TAU 2406), Jerusalem, 24.V.1943, det. H. Schmalfuss 1987; 2 ♀ (TAU 1985), no locality, date and collector, det. H. Schmalfuss 1987; 1 ♀ (TAU 3118), no locality and collector, 21.IV.1974, det. H. Schmalfuss 1987; 1 ♀ (TAU 1924), no locality and collector, 20.XII.1973, det. H. Schmalfuss 1987.

**Previous records.** Turkey: Vilayet Hatay (Amanus, Bitiyas cave); Israel: Geiah stream, south of Yad Mordechai; Lachish stream, south of Ashdod; Juda Mt.; Aqua Bella (Strouhal 1968); Mt. Carmel (Strouhal 1968; Warburg & Hornung 1999; Warburg 2007); Bet Oren; Muhraqa (Warburg *et al.* 1978); Segev, Lower Galilee Mts (Hornung & Warburg 1996); Galilee Mts; Golan Heights; Judean Mts (Warburg 2007).

**Distribution.** Southern Turkey and northern Israel (Fig. 11).

**Remarks.** Strouhal (1968) had described this species as *Bathytropa wahrmani* and included it in the family Bathytropidae, which is definitely not correct because a diagnostic feature of this family is the absence of lungs from all pleopods (see Schmidt 2003), while this species has distinct uncovered lungs on pleopod exopodites. Also the hour-glass-shaped telson is a distinguishing character from all the other species of *Bathytropa*. This species is similar to the two new species from Cyprus described above, especially in the interlocking pleopods and in the same structure of the pleopodal lungs. It is therefore transferred to the new genus *Levantoniscus* and family Trachelipodidae.



**FIGURE 11.** Distribution of *Levantoniscus* species.

The species is here fully illustrated (Figs 9, 10) for comparison with *Levantoniscus bicostulatus* and *L. makrisi*, from which it is readily distinguished by the pattern of dorsal ornamentation (Fig. 9A, B). In particular, it has a row of four pointed tubercles at the back of the head instead of two in the new species, a couple of forward-pointed tubercles on the front of the head which are lacking in the new species, plus a narrower and acuter middle frontal lobe on the cephalon (Fig. 9D–F). Seven pointed tubercles are present on the pereonite 1, six on pereonites 2–4 and four on pereonites 5–7, while the two new species only have two lamellar tubercles on all pereonites. Finally, it has two tubercles on pleonites 1–5, while the new species have two tubercles on pleonites 1–4.

In the detailed description provided by Strouhal (1968) there is no mention on the position of the noduli laterales. They are located on the tip of the external tubercle on the pereonites 1–4 and on the postero-lateral corners of the pereonites 5–7 (see Fig. 9A, B).

## Acknowledgements

We would like to thank Katerina Balanika, Emmanouela Karameta and Christina Kassara for assistance in the field, Dr. Revital Ben David Zaslav (TAU) for the loan of specimens of *Bathytropa wahrmani*, and Dr. Cristina Salvatici (CeME-CNR, Florence) for assistance with SEM analysis. A particular acknowledgement goes to CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico: Doutorado Sanduíche no Exterior – SWE: 201713/2014-4) for a scholarship to G.M.C., and to Consiglio Nazionale delle Ricerche, Istituto per lo Studio degli Ecosistemi, Florence, Italy, for hosting G.M.C. during her PhD.

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## **The genus *Dubioniscus* Vandel, 1963 (Oniscidea, Dubioniscidae) with descriptions of two new species from Brazil**

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<http://zoobank.org/urn:lsid:zoobank.org:pub:1D2B9F44-96EE-48A6-A8DE-D24F-190F9AF3>.

### **Abstract**

Before the present study, the genus *Dubioniscus* included four species occurring in Central and South Americas. The examination of *Dubioniscus delamarei*, *D. marmoratus* and *D. negrae* allowed us to revise the genus and to move *D. goeldii* to *Calycuoniscus*. Moreover, two new species are described, *D. depressus* **n. sp.** from the state of São Paulo, and *D. elongatus* **n. sp.** from the state of Rio de Janeiro, Brazil.

**Keywords:** terrestrial isopods; neotropical; Amazon rainforest; Atlantic forest

## The genus *Dubioniscus* Vandel, 1963 (Oniscidea, Dubioniscidae) with descriptions of two new species from Brazil

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Before the present study, the genus *Dubioniscus* included four species occurring in Central and South Americas. The examination of *Dubioniscus delamarei*, *D. marmoratus* and *D. negreae* allowed us to revise the genus and to move *D. goeldii* to *Calycuoniscus*. Moreover, two new species are described, *D. depressus* n. sp. from the state of São Paulo, and *D. elongatus* n. sp. from the state of Rio de Janeiro, Brazil.

<http://zoobank.org/urn:lsid:zoobank.org:pub:1D2B9F44-96EE-48A6-A8DE-D24F-190F9AF3>.

**Keywords:** terrestrial isopods; neotropical; Amazon rainforest; Atlantic forest

### Introduction

The genus *Dubioniscus* was erected by Vandel (1963) to include *Dubioniscus delamarei* Vandel, 1963 from Punta Lara, La Plata, Argentina. Lemos de Castro (1970) described *D. marmoratus* from the state of Rio de Janeiro, Brazil and recorded *D. delamarei* from the states of Espírito Santo and São Paulo, Brazil. Vandel (1963) described *D. negreae* from Cueva de Pio Domingo, Provincia de Pinar del Rio, Sierra de los Órganos, Cuba. At that moment, all these species were included in the family Oniscidae and subfamily Bathytropinae (currently Bathytropidae) based on the general body shape, antennal flagellum of two articles and absence of pseudotracheae on pleopod exopods, typical of Bathytropidae (see Bathytropidae section in Schmidt 2003). Schultz (1995) points out that the authors who previously examined *Dubioniscus* did not observe the third article of the flagellum and for that reason erroneously allocated the genus in Bathytropinae. Schultz (1995) erected Dubioniscidae to include the genera *Calycuoniscus* Collinge, 1915, *Dubioniscus* and the new genus *Novamundoniscus* (for the New World species of *Phalloniscus* Budde-Lund, 1908). The author defined the family by having the dorsum covered with tiny scale-setae, cephalothorax with central-frontal depression and well-developed lateral lobes, antennal flagellum of three articles, pleon as broad as pereon with well-developed neopleurae, male and females pleopod exopods with similar shape and without pseudotracheae, and uropod exopod surpassing the tip of pleotelson. Moreover, the author included *Calycuoniscus goeldii* (Lemos de Castro, 1967) from Brazil in *Dubioniscus*.

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Currently, the family Dubioniscidae includes 17 described species distributed in Central and South Americas allocated in 3 genera: *Calycuoniscus* (4 spp.), *Dubioniscus* (4 spp.), and *Novamundoniscus* (9 spp.) (Schmalfuss 2003).

The examination of the type material of *D. delamarei* deposited in the Muséum National d'Histoire Naturelle (MNHN), Paris, France, and of *D. marmoratus* deposited in Museu Nacional do Rio de Janeiro (MNRJ), Universidade Federal do Rio de Janeiro, Brazil, together with specimens of *D. negreae* deposited in the Museo di Storia Naturale di Firenze – La Specola (MZUF), Florence, Italy, enabled us to revise the genus and redescribe these species. In addition, two new species are described, one from the state of São Paulo and the other from the state of Rio de Janeiro, recently collected in the Serra da Mantiqueira mountain range, Brazil.

### Material and methods

Specimens are stored in 70% ethanol and descriptions are based on morphological characters. The specimens were dissected, and the appendages and pereonites were mounted in micropreparations. Drawings were prepared using a camera lucida. The *noduli laterales* were measured and illustrated as in Vandel (1962).

The cuticular structures were studied in a JSM 6060 scanning electron microscope (SEM) at the Centro de Microscopia Eletrônica of Universidade Federal do Rio Grande do Sul (UFRGS). The type material is deposited at the Museu de Zoologia, Universidade de São Paulo, Brazil; in Coleção de Carcinologia do Departamento de Zoologia, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; and in the Museo di Storia Naturale di Firenze – La Specola, Florence, Italy.

### Systematic account

#### Dubioniscidae Schultz, 1995

##### *Dubioniscus* Vandel, 1963

*Hileioniscus* Lemos de Castro, 1967: 317.

*Dubioniscus* Vandel 1962: 2697 (*nomen nudum*).

*Dubioniscus* Vandel, 1963: 78; 1972: 40; 1973: 158; 1981: 43; Lemos de Castro 1968: 408; 1970: 1; Schultz 1995: 400; Souza-Kury 1998: 656; Leistikow & Wägele 1999: 24; Schmalfuss 2003: 98; Campos-Filho et al. 2014: 401.

Type species: *Dubioniscus delamarei* Vandel, 1963 by monotypy.

### Diagnosis

Maximum body length 8 mm; dorsum covered with fan-shaped scale-setae; cephalothorax with V-shaped depression on central part of profrons and frontal part of vertex, lateral lobes well developed, frontal and suprantennal lines absent; epimera of pereonites well developed; pleon as broad as pereon with neopleurae well developed; pleotelson triangular, lateral margins slightly concave; antennal flagellum of three articles with distal article reduced; mandible with molar penicils dichotomized, left mandible with 2 + 1 penicils, right mandible with 1 + 1; maxillula inner endite with two penicils, outer endite with simple teeth; maxilla of two lobes covered with setae, outer lobe wider than inner lobe; maxilliped endite rectangular, distal margin rounded, medial seta surpassing distal margin; pereopods 1 – 7 stout, male carpus 1 with longitudinal antennal grooming brush;

dactylus with dactylar organ and unguis seta simple; uropod protopod subrectangular, endopod inserted proximally, exopod twice as long as endopod; pleopod exopods with respiratory area *annulicornis*-type, bearing setae on outer margin.

#### Remarks

The genus *Dubioniscus* is morphologically similar to the genera *Calycuoniscus* and *Novamundoniscus* in having the dorsal surface densely covered with fan-shaped scale-setae, cephalothorax with well-developed lateral lobes and pleon as broad as pereon with well-developed neopleurae; it can be distinguished by the cephalothorax with a V-shaped depression on the cephalothorax (absent in *Calycuoniscus* and *Novamundoniscus*), antennal flagellum with reduced distal article (all articles subequal in *Calycuoniscus* and *Novamundoniscus*), maxillula outer endite with outer set bearing simple teeth (cleft in *Novamundoniscus*), pleopod exopods with respiratory area (absent in *Calycuoniscus* and *Novamundoniscus*, to be confirmed).

In all previous works, authors mentioned the pleopod exopods without any type of respiratory structures; even though in some illustrations it is possible to observe some kind of delimited area near the outer margin (Vandel 1963, Lemos de Castro 1970, Schultz 1995). The presence of a respiratory area observed in the species *D. delamarei* and *D. negrae* is very clear and similar to those founded in *Benthana* Budde-Lund, 1908 and *Atlantoscia* Ferrara & Taiti, 1981 (see Campos-Filho et al. 2013, 2015). This type of area was classified as *annulicornis*-type by Ferrara et al. (1994), and demonstrated to be a functional respiratory organ by Leistikow & Araujo (2001).

Lemos de Castro (1967) erected the genus *Hileioniscus* to allocate the new species *Hileioniscus goeldii* from Pará, Brazil. Later, Lemos de Castro (1968) noticed that the antennal flagellum of *H. goeldii* was composed of three articles, instead of two, and he moved the species to the genus *Calycuoniscus*. *Calycuoniscus goeldii* was described by Lemos de Castro (1968) with antennal flagellum composed of three articles subequal in length, cephalothorax without frontal depression and subtriangular lateral lobes, maxillula outer endite with inner set of simple teeth, and broad pleotelson with rounded distal margin, typical of *Calycuoniscus* (see Schmidt 2003). Schultz (1995) did not take into consideration these characters and placed *C. goeldii* in the genus *Dubioniscus*. According to Schmidt (2003) these characters are considered to be diagnostic for *Calycuoniscus* (see his re-description of *Calycuoniscus ambiguous* (Budde-Lund, 1893)). Therefore, we suggest that *D. goeldii* should be included in the genus *Calycuoniscus*.

#### ***Dubioniscus delamarei* Vandel, 1963**

(Figures 1, 2, 13)

*Dubioniscus delamarei* Vandel, 1963: 78, Figs. 9–11; 1972: 40; 1973: 158; 1981: 43; Lemos de Castro 1970: 2; Lenko 1971: 7; Schultz 1995: 401, Figs. 5–7; Souza-Kury 1998: 656; Leistikow and Wägele 1999: 24; Schmalfuss 2003: 92.

#### *Type material re-examined*

Syntypes: Argentina, 1 ♂, 1 ♀ (Vandel Collection, MNHN), Punta-Lara, north of La Plata, border of La Plata River, 3/V/1959.

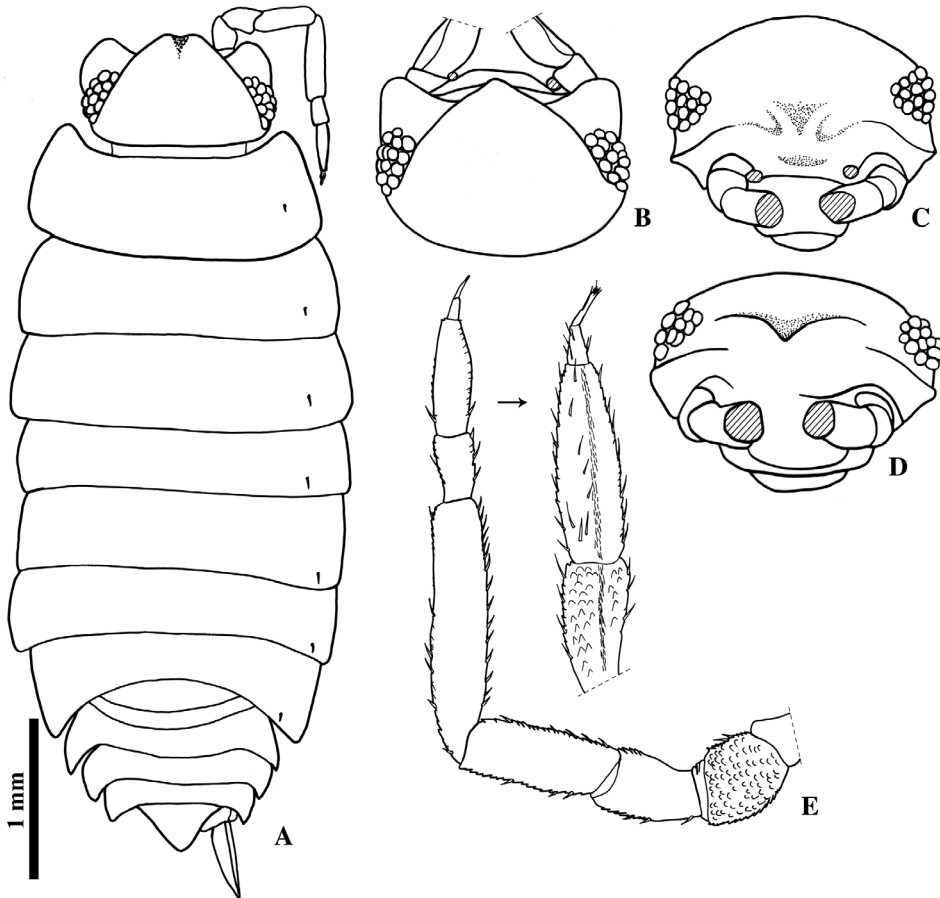


Figure 1. *Dubioniscus delamarei* Vandel, 1963, male, MNHN. A, habitus; B, cephalothorax, dorsal view; C, D, cephalothorax, frontal view; E, antenna.

### Re-description

Maximum body length 5 mm. Body outline as in Figure 1A. Specimens depigmented due to long preservation in ethanol 70%. Pereonite 1 anterior corners directed frontwards not surpassing eyes, pereonites 2–5 with posterior margins almost straight, pereonite 7 with posterior margin concave (Figure 1A). Cephalothorax as in Figure 1B–D; eyes with 14–16 ommatidia arranged in rows. Pleotelson (Figure 1A) with lateral margins slightly sinuous, apex right-angled. *Noduli laterales* inserted almost at same position from lateral margins, gradually positioned closer to posterior margin from pereonite 1–7 (Figure 1A). Antenna (Figure 1E) when extended posteriorly reaching posterior margin of pereonite 1, second article of flagellum longest bearing two aesthetascs, third article 1/5 length of second article. Pereopods (Figure 2A, B) scaled, bearing sparse setae along sternal margin of merus and carpus, dactylus inner claw reaching distal margin of outer claw. Buccal pieces and uropod as in Schultz (1995).

Male: Pleopod 1 (Figure 2C) exopod ovoid; endopod about three times as long as exopod. Pleopod 2 exopod subtriangular (Figure 2D). Pleopod 3 and 4 exopods as in Figure 2E, F. Pleopod 5 exopod (Figure 2G) rhomboid, outer margin slightly convex bearing 4–6 setae.

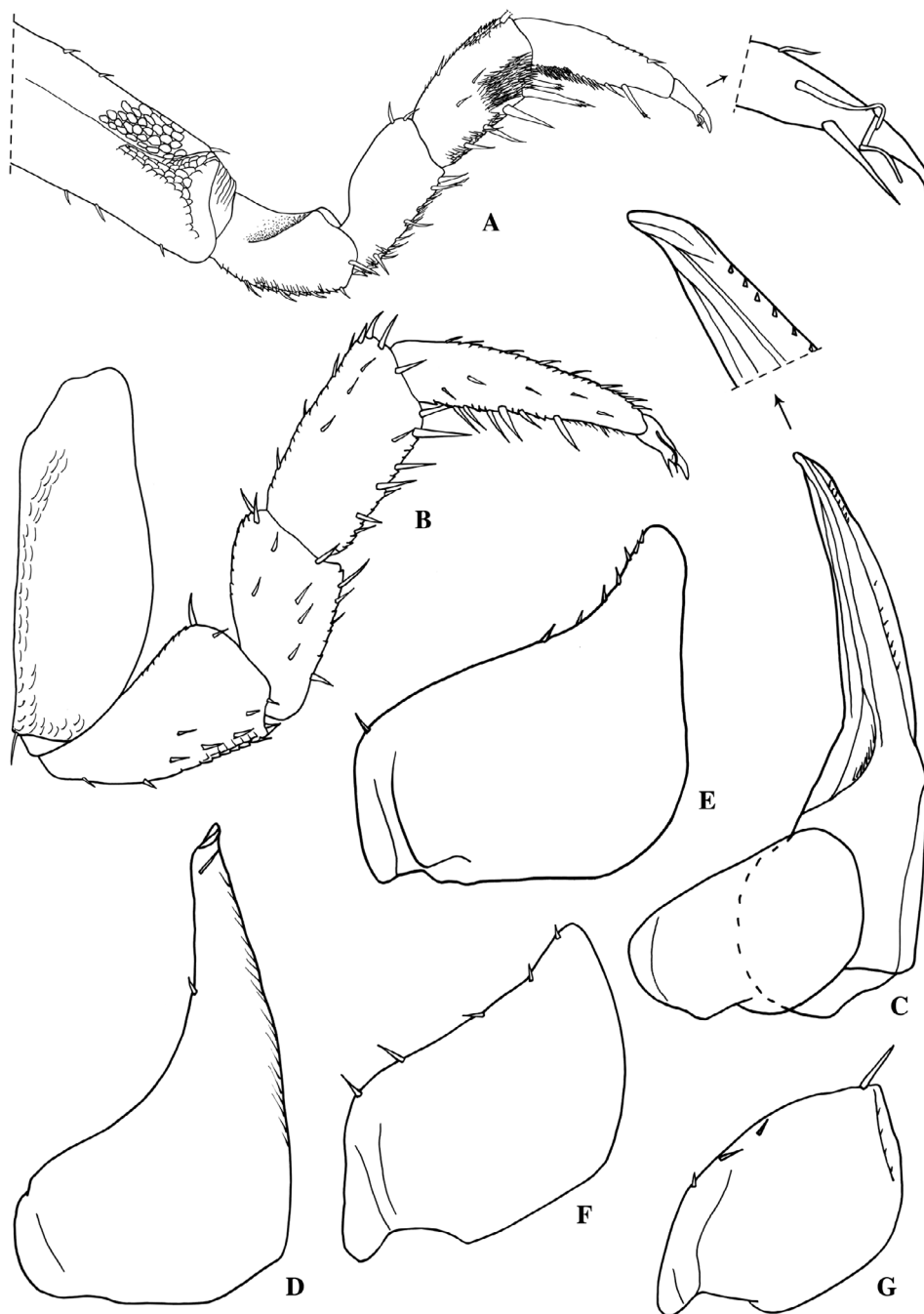


Figure 2. *Dubioniscus delamarei* Vandel, 1963, male, MNHN. A, pereopod 1; B, pereopod 7; C, pleopod 1; D, pleopod 2 exopod; E, pleopod 3 exopod; F, pleopod 4 exopod; G, pleopod 5 exopod.

## Remarks

*Dubioniscus delamarei* resembles *D. marmoratus* in having the pereonite 1 directed frontwards and reaching eyes; it can be readily distinguished by the shape of the male pleopod 1 exopod.

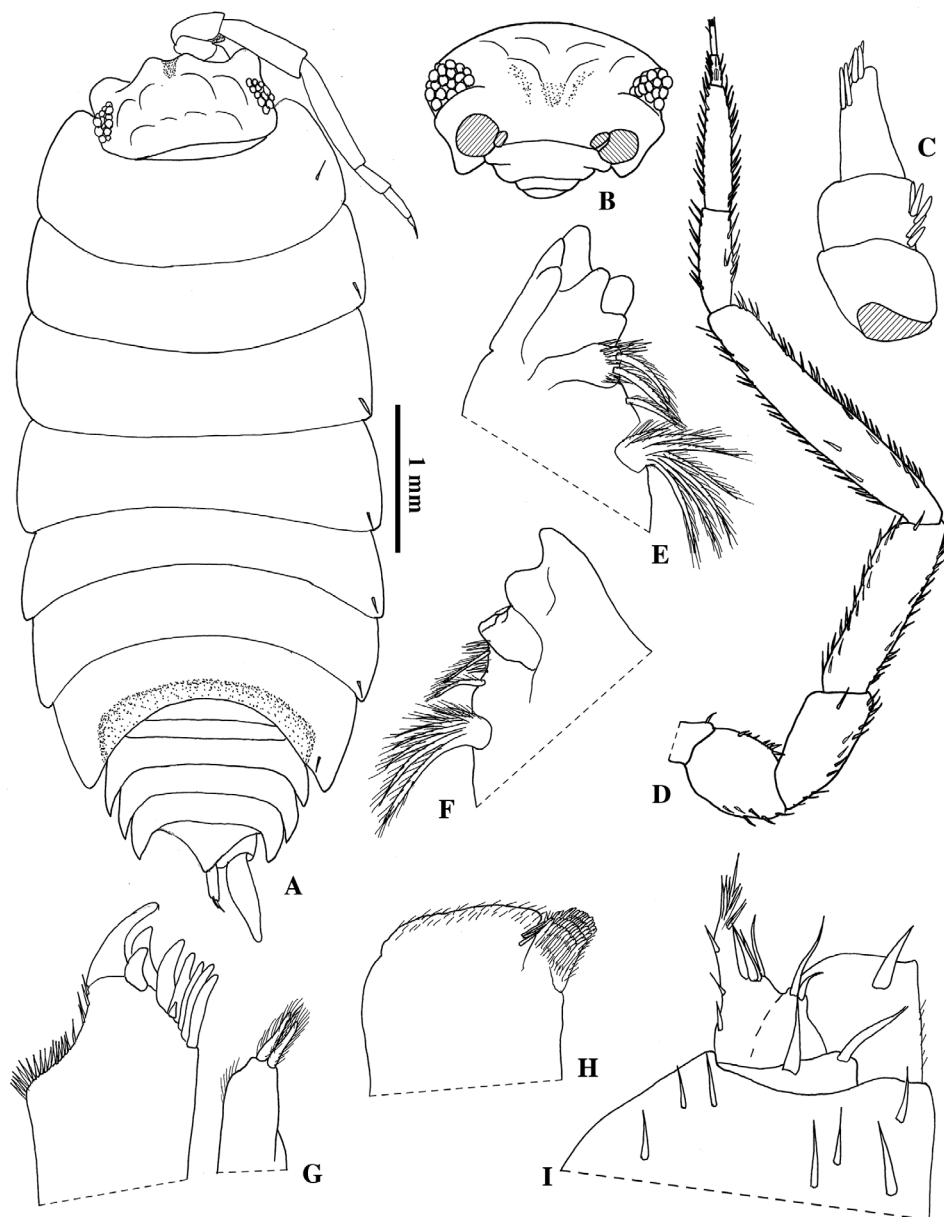


Figure 3. *Dubioniscus marmoratus* Lemos de Castro, 1970, male MNRJ. A, habitus; B, cephalothorax, frontal view; C, antennula; D, antenna; E, left mandible; F, right mandible; G, maxillula; H, maxilla; I, maxilliped.



*Distribution*

*Dubioniscus delamarei* is recorded from the Border of La Plata River, Punta Lara, La Plata, Argentina (Vandel 1963); Punta Lara, La Plata, Province of Buenos Aires, Argentina Pilar city, Neembucu, Paraguay (Schultz 1995); Ibiti and Monte Alegre, state of Espírito Santo, Barueri, Boa Esperança do Sul, Campos do Jordão, Pirassununga and São Paulo city, state of São Paulo, Brazil (Lemos de Castro 1970); Barueri, Cabreúva, Ilha da Vitória and São Paulo city, state of São Paulo, Brazil (Lenko 1971) (Figure 13).

***Dubioniscus marmoratus* Lemos de Castro, 1970**  
(Figures 3, 4, 13)

*Dubioniscus marmoratus* Lemos de Castro, 1970: 3, Figs. 1–10; Schultz 1995: 401; Souza-Kury 1998: 656; Leistikow and Wägele 1999: 25; Schmalfuss 2003: 92; Campos-Filho et al. 2014: 401, Fig. 40.

*Type material re-examined*

Paratypes: Brazil, Rio de Janeiro, 1 ♂ (MNRJ 6190), Tijuca, Morro Dois Irmãos, 18/X/1938, leg. O. Schubart, in tree barks; 1 ♂, 2 ♀♀ (MNRJ 6201), 3 ♂♂, 5 ♀♀ (MNRJ 6185), Bom Retiro, Floresta da Tijuca, 12/V/1963, leg. J. Becker; 4 ♂♂, 2 ♀♀ (MNRJ 6186), Parada da Ribeira, 13/IV/1952, leg. A. Lemos de Castro; 2 ♂♂ (MNRJ 6187), Petrópolis, II/1950, leg. J.C.M. Carvalho; 1 ♀ (MNRJ 6189), Fazenda Areal, 09/II/1969, leg. J. Machado Filho; 1 ♂ (MNRJ 6191), Alto da Boa Vista, Floresta da Tijuca, Açude Solidão, 07/X/1939, leg. O. Schubart; 1 ♂, 2 ♀♀ (MNRJ 6200), Cascatinha, Floresta da Tijuca, 13/I/1950, leg. A.L. de Castro, in tree barks; São Paulo: Sumaré, V/1951, leg. J. Becker; 2 ♀♀ (MNRJ 6202), São Vicente, Porchat, 12/II/1958, leg. O. Schubart.

*Re-description*

Maximum body length 6 mm. Body outline as in Figure 3A. Specimens depigmented due to long preservation in ethanol 70%. Pereonites 1 and 2 anterior corners directed frontwards, pereonite 1 anterior corner not surpassing eyes, pereonites 2–4 with posterior margins straight, 5–7 gradually more concave (Figure 3A). Cephalothorax (Figure 3A, B) with irregular depressions on vertex; eyes with 14–16 ommatidia arranged in rows. Pleotelson (Figure 3A) with apex triangular. *Noduli laterales* (Figure 3A) inserted almost at same position from lateral margins, gradually closer to posterior margins from pereonites 1–7. Antennula (Figure 3C) with distal article longest, second article with five lateral aesthetascs, distal article bearing five distal aesthetascs. Antenna (Figure 3D) when extended posteriorly reaching anterior margin of pereonite 2, second article of flagellum longest, third article 1/5 length of second article and bearing two aesthetascs. Mandible (Figure 3E, F) with molar penicil of 7–8 branches; maxillula (Figure 3G) outer endite with 4 + 5 simple teeth, one of them shortest; maxilla (Figure 3H) and maxilliped (Figure 3H) as in diagnosis. Uropod as in Figure 4A. Pereopods (Figure 4B, C) scaled; dactylus inner claw reaching distal margin of outer claw.

Male: Pereopod 1 (Figure 4B) bearing sparse setae along sternal margin of merus and carpus. Pleopod 1 (Figure 4D) exopod sub-ovoid, outer margin distally concave, distal portion elongated bearing three setae; endopod about twice as long as exopod, distal part tapering. Pleopod 2 (Figure 4E) exopod bearing setae; endopod slender, longer than



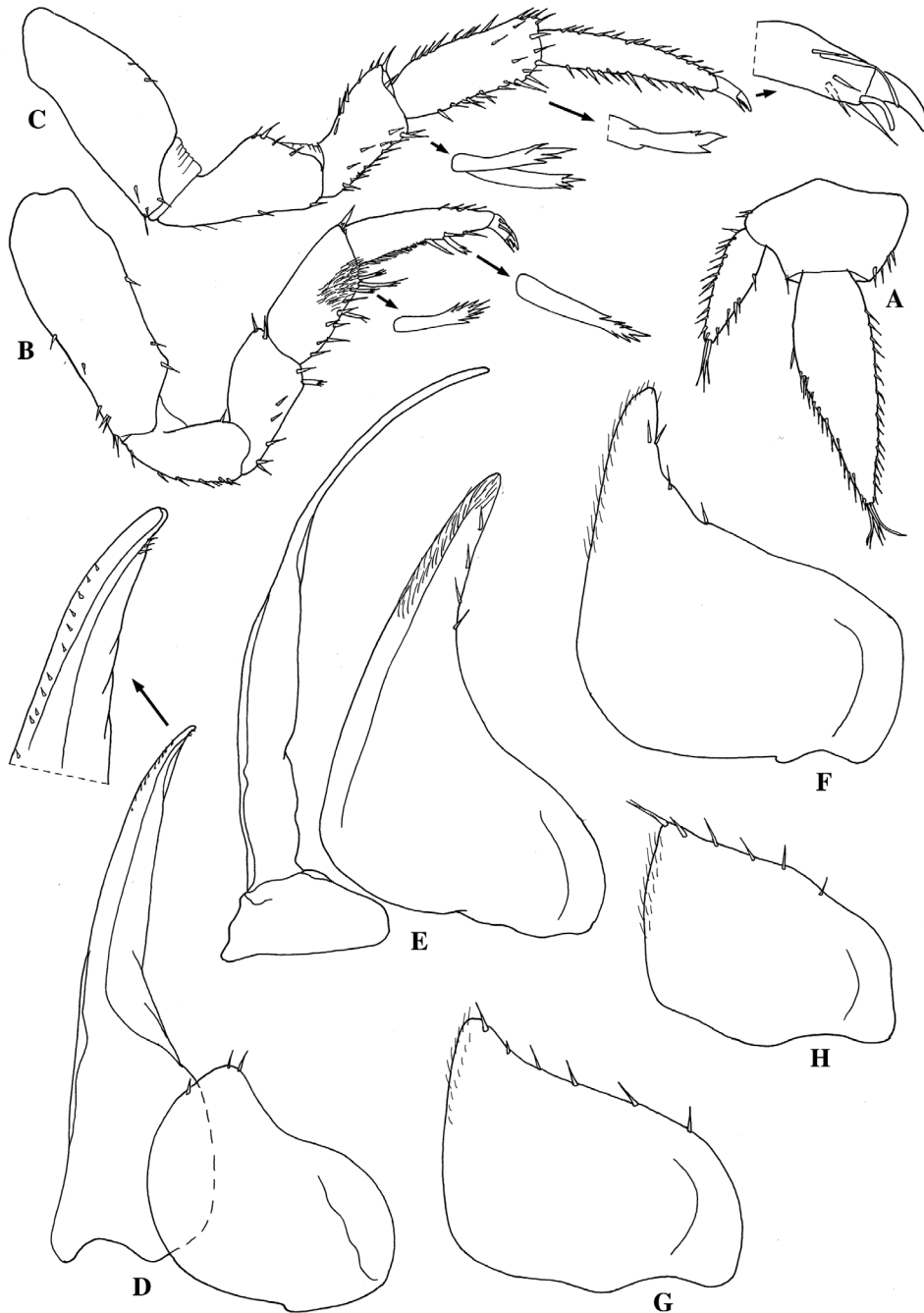


Figure 4. *Dubioniscus marmoratus* Lemos de Castro, 1970, male MNRJ. A, uropod; B, pereopod 1; C, pereopod 7; D, pleopod 1; E, pleopod 2; F, pleopod 3 exopod; G, pleopod 4 exopod; H, pleopod 5 exopod.

exopod. Pleopod 3 exopod (Figure 4F) triangular, outer margin concave bearing four setae. Pleopod 4 exopod as in Figure 4G. Pleopod 5 exopod (Figure 4H) rhomboid, outer margin slightly sinuous bearing six setae.

*Remarks*

*Dubioniscus marmoratus* resembles *D. negreae* in the shape of the male pleopod 1 exopod; it is distinguished by the antennula with aesthetascs on the second article (vs. absent), male pereopod 1 merus and carpus with sparse setae on sternal margin (vs. dense), male pleopod 1 exopod with outer margin slightly concave (vs. strongly), and male pleopod 5 exopod rhomboid (vs. triangular).

*Distribution*

Areal, Itaipuaçu, Mangaratiba, Petrópolis, Rio de Janeiro city (Floresta da Tijuca, including Açude da Solidão, Cascatinha, Morro Dois Irmãos, Pedra do Conde, Represa dos Ciganos), and Sumaré, in the state of Rio de Janeiro, Brazil (Lemos de Castro 1970) (Figure 13).

***Dubioniscus negreae* Vandel, 1973**  
(Figures 5, 6, 13)

*Dubioniscus negreae* Vandel, 1973: 158, Figs. 4, 5, 1981: 43; Schultz 1995: 401; Leistikow and Wägele 1999: 25; Schmalfuss 2003: 92.

*Cubanoscia romanorum* Vandel, 1981: 44, Figs. 6–8; Leistikow and Wägele 1999: 26; Schmalfuss 2003: 81. **n. syn.**

*Type material re-examined*

Syntypes of *Cubanoscia romanorum*: Cuba, 1 ♂ (Vandel Collection, MNHN), Cueva del Jaguey, Provincia de Oriente, 28/II/1973, leg. Decou and Negrea, on guano; 1 ♂ (Vandel Collection, MNHN), Hoyo de Fanía, 13/IV/1973, leg. Decou and Negrea, leaf litter; 1 ♂ (Vandel Collection, MNHN), Pinar del Rio, Gran Caverna de Santo Tomás, Cueva de las Represas, 12/IV/1973, leg. Decou and Negrea.

*Material examined*

Cuba, 7 ♂♂, 15 ♀♀, 1 juv. (MZUF 8664), Pinar del Rio, Peninsula de Guanahacabibes, Cueva Perjuicio, 8/IV/2002, leg. S. Taiti; 8 ♂♂, 3 ♀♀ (MZUF 8665), Pinar del Rio, Peninsula de Guanahacabibes, 3 km south of La Bajada, 7/IV/2002, leg. S. Taiti; 7 ♂♂, 6 ♀♀ (MZUF 8666), Matanzas, Parque Natural Ciénaga de Zapata, along road to La Salina, 11/IV/2002, leg. S. Taiti, under stones, lagune margin; 12 ♂♂, 9 ♀♀ (MZUF 8667), Pinar del Rio, Peninsula de Guanahacabibes, Cueva La Barca, 8/IV/2002, leg. S. Taiti;

*Re-description*

Maximum body length 8 mm. Color light brown; frontal portion and lateral lobes of cephalothorax; Antenna, epimera 1–7, pleon, and pleotelson strongly pigmented; vertex of cephalothorax with irregular unpigmented spots; pereon with longitudinal unpigmented spots on paramedian portion; pereonites 1–7 medial and posterior portions strongly pigmented; pereonites 2–5 medially with triangular unpigmented area; pleonites 1–5 with transversal unpigmented row; uropod protopod slightly pigmented, exopod and endopod strongly pigmented; pereopods with sparse pigmented spots. Body outline as in Figure 5A. Dorsum covered with fan-shaped scale-setae (Figure 5B). Pereonite 1 anterior corners directed frontwards

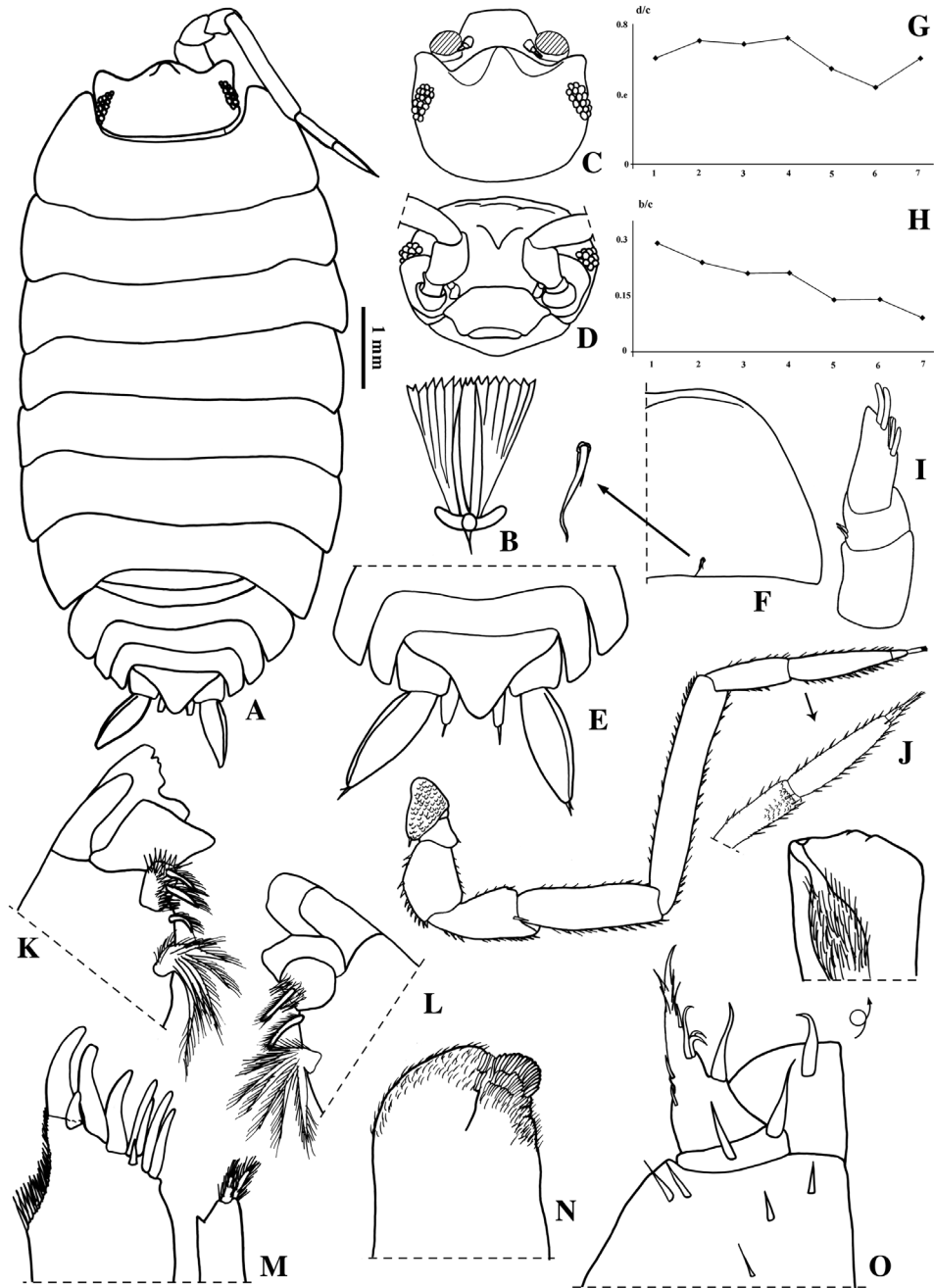


Figure 5. *Dubioniscus negreae* Vandel, 1973, male MZUF. A, habitus; B, scale-seta; C, cephalothorax, dorsal view; D, cephalothorax, frontal view; D, d/c *noduli laterales* coordinates; E, b/c *noduli laterales* coordinates; F, epimeron 7; H, pleonites 4, 5, pleotelson and uropods; I, antennula; J, antenna, K, left mandible; L, right mandible; M, maxillula; N, maxilla; O, maxilliped.

slightly surpassing eyes, epimera 1–6 with posterior margins slightly concave, pereonite 7 with posterior margin concave (Figure 5A). Cephalothorax as in Figure 5C, D; eyes with 16 ommatidia arranged in rows. Pleotelson (Figure 5E) with lateral margins slightly concave,

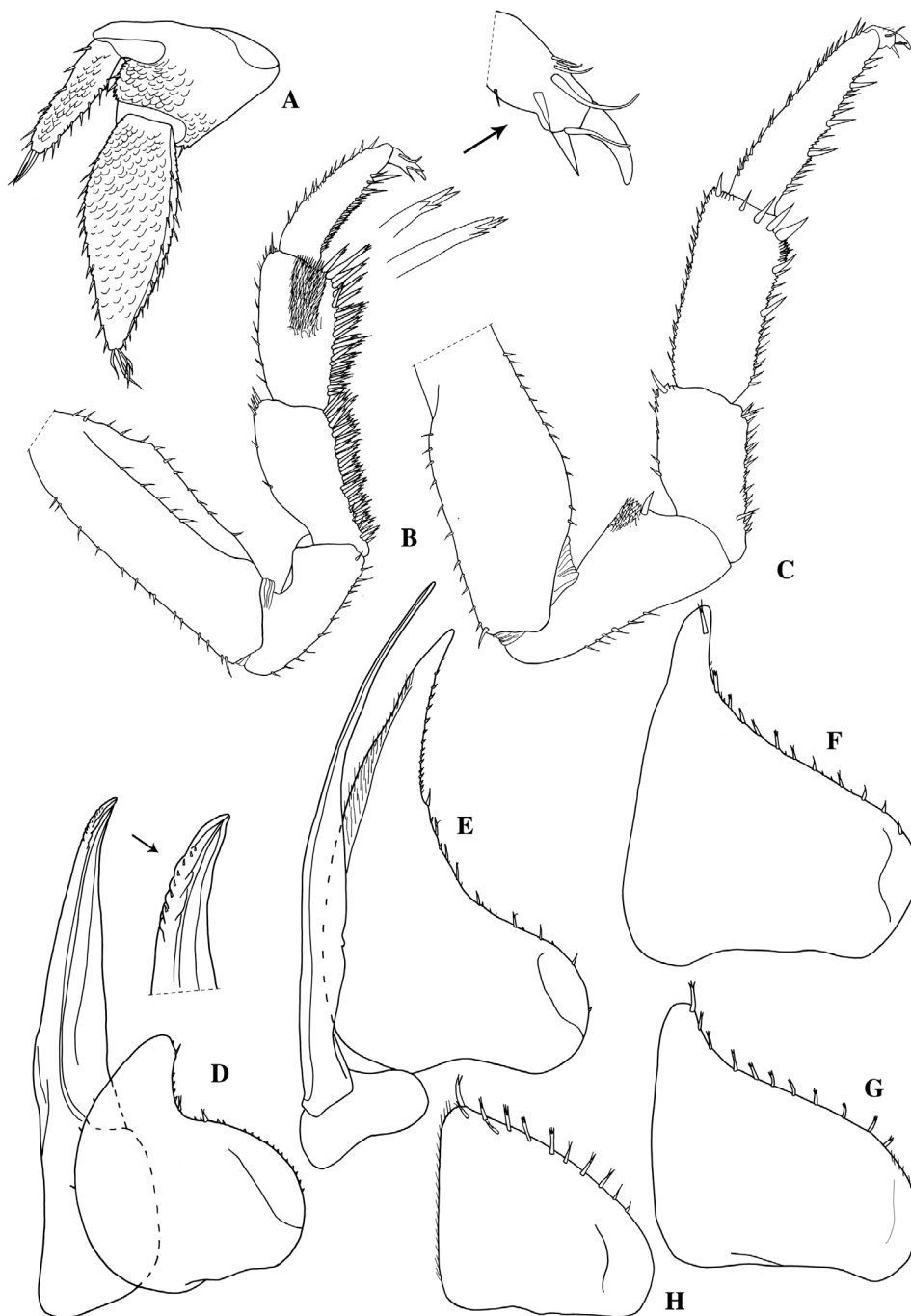


Figure 6. *Dubioniscus negreae* Vandel, 1973, male MZUF. A, uropod; B, pereopod 1; C, pereopod 7; D, pleopod 1; E, pleopod 2; F, pleopod 3 exopod; G, pleopod 4 exopod; H, pleopod 5 exopod.

apex acute. *Noduli laterales* (Figure 5F–H) inserted almost at same position from lateral margins, gradually closer to posterior margins from pereonites 1–7. Antennula (Figure 5I) with proximal and distal articles subequal in length, distal article bearing aesthetascs. Antenna

(Figure 5J) when extended posteriorly reaching pereonite 3, second and third articles of flagellum bearing aesthetascs, third article 1/5 length of second article. Mandible (Figure 5K, L) with molar pencil of nine branches; maxillula (Figure 5M) inner endite with lateral tip, outer endite with 4 + 5 simple teeth, one of them short; maxilla (Figure 5N) outer lobe twice as wide as inner lobe; maxilliped as in Figure 5O. Uropod (Figure 6A) as in diagnosis.

Male: Pereopods (Figure 6B, C) with brush of setae on sternal margin of merus and carpus, stronger on pereopods 1 and 2. Pleopod 1 (Figure 6D) exopod falciform, outer margin strongly sinuous, distal part with rounded apex and slightly directed outwards; endopod about twice as long as exopod, distal portion tapering. Pleopod 2 (Figure 6E) exopod triangular, distal portion tapering; endopod slightly longer than exopod. Pleopod 3 and 4 exopods (Figure 6F, G) triangular, outer margin concave bearing setae, distal portion tapering. Pleopod 5 exopod (Figure 6H) triangular, outer margin slightly convex bearing setae.

#### Remarks

Vandel (1981) erected the genus *Cubanoscia* to allocate three new species *C. primitiva*, *C. romanorum* and *C. proxima* from Cuba. After re-examination of the type material of *Cubanoscia romanorum*, this species corresponds to *Dubioniscus negreae*.

#### Distribution

This species is recorded only from Cuba (Figure 13).

### ***Dubioniscus depressus* n. sp.**

(Figures 7–9, 13)

#### Type material examined

Holotype: Brazil, São Paulo, 1 ♂ (MZUSP 34313), São Bento do Sapucaí, 22°41'09"S 45°44'13"W, alt. 908 m, 08/VI/2013, leg. I.S. Campos-Filho & G.M. Cardoso. Paratypes: 1 ♂, 1 ♀, 1 juv. (MZUSP 34314), same data as holotype; 1 ♂, 1 ♀ (on micropreparations) (MZUSP 34315), Santo Antônio do Pinhal, Serra da Mantiqueira, 22°49'39"S 45°38'09"W, alt. 1126 m, 08/VI/2013, leg. G.M. Cardoso & I.S. Campos-Filho, under stones, in bromeliads and leaf litter; many ♂♂ and ♀♀ (MZUSP 34316), Santo Antônio do Pinhal, Serra da Mantiqueira, 22°49'39"S 45°38'09"W, alt. 1126 m, 08/VI/2013, leg. G.M. Cardoso & I.S. Campos-Filho, under stones, in bromeliads and leaf litter; 2 ♂♂, 2 ♀♀, same data (UFRGS 6381).

#### Description

Maximum body length 5 mm. Color brown; antenna with first and second articles and distal portion of third article of peduncle unpigmented, flagellum completely pigmented; vertex of cephalothorax with irregular pigmented areas, lateral lobes strongly pigmented; pereon strongly pigmented on lateral and medial portions, pereonites 1–7 with paramedian portion unpigmented, pereonites 1–4 epimera and medial portion of pereonites 5–7 exhibiting a continuous pigmented V-shaped area; pereonite 1 epimeron with a rounded unpigmented area on posterior margin, pereonites 2–7 epimera with two unpigmented spots; neopleurae

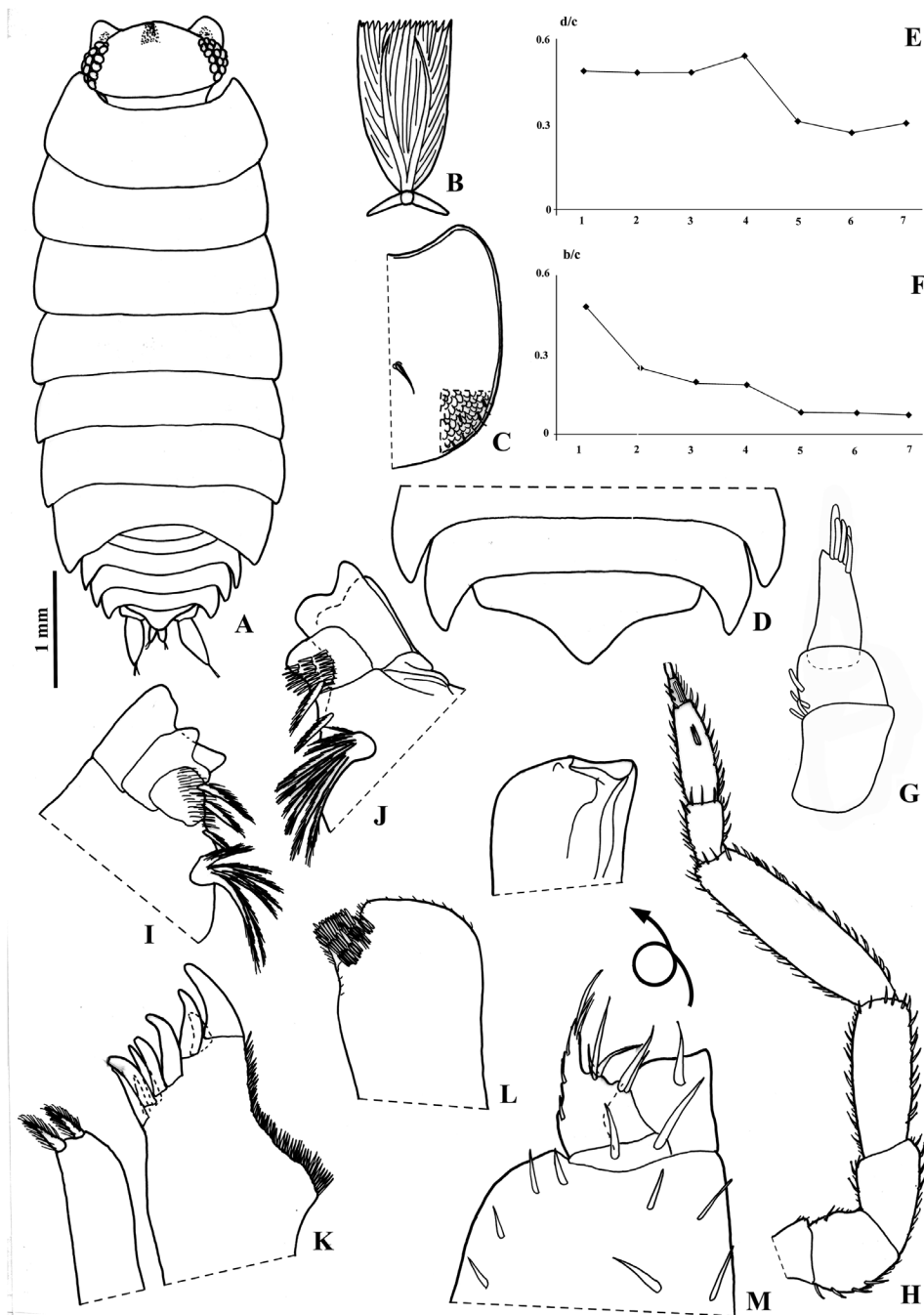


Figure 7. *Dubioniscus depressus* n. sp., male, MZUSP 34315. A, habitus; B, scale-seta; C, pereonite 1; D, pleonites 4, 5 and pleotelson; E, d/c noduli laterales coordinates; F, b/c noduli laterales coordinates; G, antennula; H, antenna; I, left mandible; J, right mandible; K, maxillula; L, maxilla; M, maxilliped.



Figure 8. *Dubioniscus depressus* n. sp., male, MZUSP 34315. A, uropod; B, pereopod 1; C, pereopod 7; D, pleopod 1 and genital papilla; E, pleopod 2; F, pleopod 3 exopod; G, pleopod 4 exopod; H, pleopod 5 exopod.

strongly pigmented, pleonites 3–5 slightly pigmented on paramedian area; pleotelson with medial portion pigmented; uropods with irregular pigmented areas. Body outline as in Figure 7A. Dorsum covered with fan-shaped scale-setae (Figures 7B, C, 9D, F). Pereonites 1–7 depressed on posterior portions, pereonite 7 posterior margins slightly sinuous at



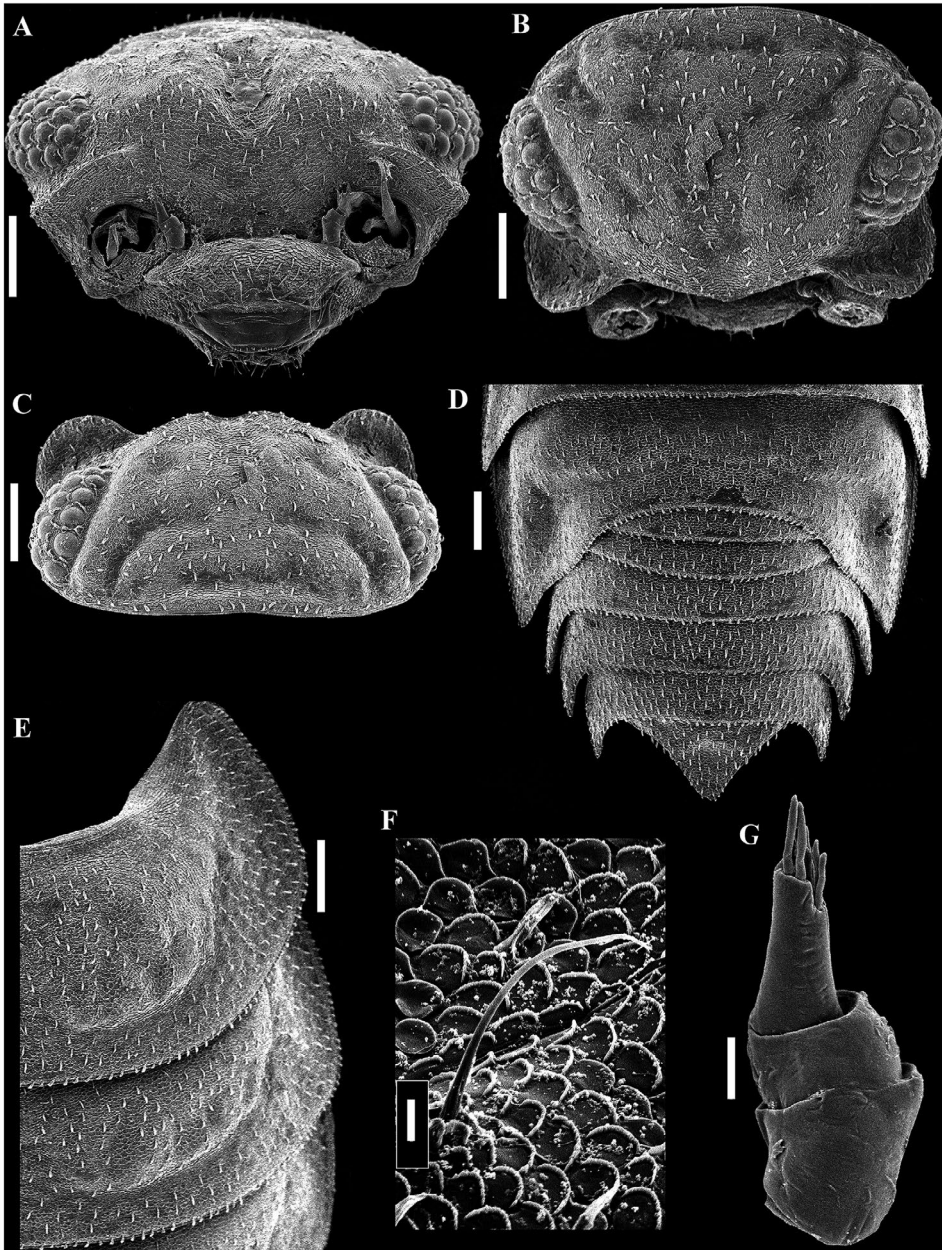


Figure 9. *Dubioniscus depressus* n. sp., SCAM SEM photographs. A, cephalothorax, frontal view; B, C, cephalothorax, dorsal view; D, pereonites 6 and 7, pleonites 1–5 and pleotelson; E, epimera 1–3; F, *nodulus lateralis*, G, antennula. Scale bars: A–E 200  $\mu$ m, F 10  $\mu$ m, G 20  $\mu$ m.

sides (Figure 9D, E). Cephalothorax (Figures 7A, 9A–C) with vertex bearing irregular depressions; eyes of 14–20 ommatidia arranged in rows. Pleotelson (Figures 7D, 9D) with lateral margins slightly concave, apex right-angled. Epimera (Figures 7C, 9D–F) with sulcus marginalis, *noduli laterales* flagelliform; glandular pores not visible. Coordinates of *noduli laterales* as in Figure 7E, F. Antennula (Figures 7G, 9G) with distal article longest, apical tip, and aesthetascs inserted distally. Antenna (Figure 7H) when extended posteriorly



reaching posterior margin of pereonite 1, second and third articles of flagellum bearing two aesthetascs, third article 1/4 length of second article; apical organ broken in all specimens. Mandible (Figure 7I, J) with molar pencil of nine branches; maxillula (Figure 7K) outer endite with 4 + 5 simple teeth, one of them short; maxilla (Figure 7L) outer lobe twice as wide as inner lobe; maxilliped as in Figure 7M. Uropod as in Figure 8A.

Male: Pereopod 1 (Figure 8B) bearing slightly sparse setae on sternal margin of merus and carpus, setae with simple and cleft apex; carpus 1 with two distal setae having double-serrate apex. Pereopods 2–7 (Figure 8C) bearing sparse setae on sternal margin of merus and carpus. Genital papilla (Figure 8D) with stout triangular shield and two subapical orifices. Pleopod 1 (Figure 8D) exopod falciform, distal margin rounded, outer margin slightly concave bearing three setae; endopod enlarged on basal portion, medial margin bearing minute setae, distal part stout with apex slightly bent outwards. Pleopod 2 (Figure 8E) exopod triangular, outer margin concave bearing five setae; endopod longer and slender. Pleopod 3 and 4 exopods (Figure 8F, G) rhomboid, with short posterior points, outer margin bearing setae. Pleopod 5 (Figure 8H) exopod with outer margin slightly convex bearing five setae, one long seta inserted at apex.

### Etymology

The specific name refers to the dorsal depressions of cephalothorax and dorsal surface.

### Remarks

*Dubioniscus depressus* n. sp. resembles *D. marmoratus* in having the cephalothorax with irregular depressions on the vertex and, a large V-shaped frontal depression, and in the shape of the male pleopod 1 exopod; it is easily distinguished by the less setose sternal margin of the male pereopod 1 merus and carpus, and the shape of the distal part of the male pleopod 1 endopod.

*Dubioniscus depressus* n. sp. was collected in the west area of the Serra da Mantiqueira mountain range (Figure 13). This mountain range has about 500 km of extension, with mountain altitude ranging between 1200 and 2800 meters and comprises the Brazilian states of Minas Gerais, São Paulo, and Rio de Janeiro. The Köppen–Geiger climate classification defined the region as subtropical humid (Cfa) (Kottek et al. 2006). The region is inserted in the Atlantic Forest domain and it is known to harbor a consistent number of endemic species of plants and vertebrates (Myers et al. 2000). The region is also inserted at the Mantiqueira Province with ca. 3000 km extension and highly complex structural province deformed by the Brasiliano “Orogenic Cycle” in South America, during the Neoproterozoic/Early Paleozoic (900–480 Ma) (Delgado et al. 2003, Silva et al. 2005).

### *Dubioniscus elongatus* n. sp.

(Figures 10–13)

### Type material examined

Holotype: Brazil, Rio de Janeiro, 1 ♂ (MZUSP 34317), Parque Nacional do Itatiaia, 22°27'45"S 44°35'32"W, alt. 586 m, 09/VI/2013, leg. G.M. Cardoso & I.S. Campos-Filho, under tree barks. Paratypes: 1 ♂, 1 ♀ (in micropreparations) (MZUSP 34318); 6 ♂♂, 2 ♀♀ (MZUSP 34319), many ♂♂ and ♀♀ (MZUSP 34320), 5 ♂♂, 5 ♀♀ (UFRGS 6382), same data as holotype.

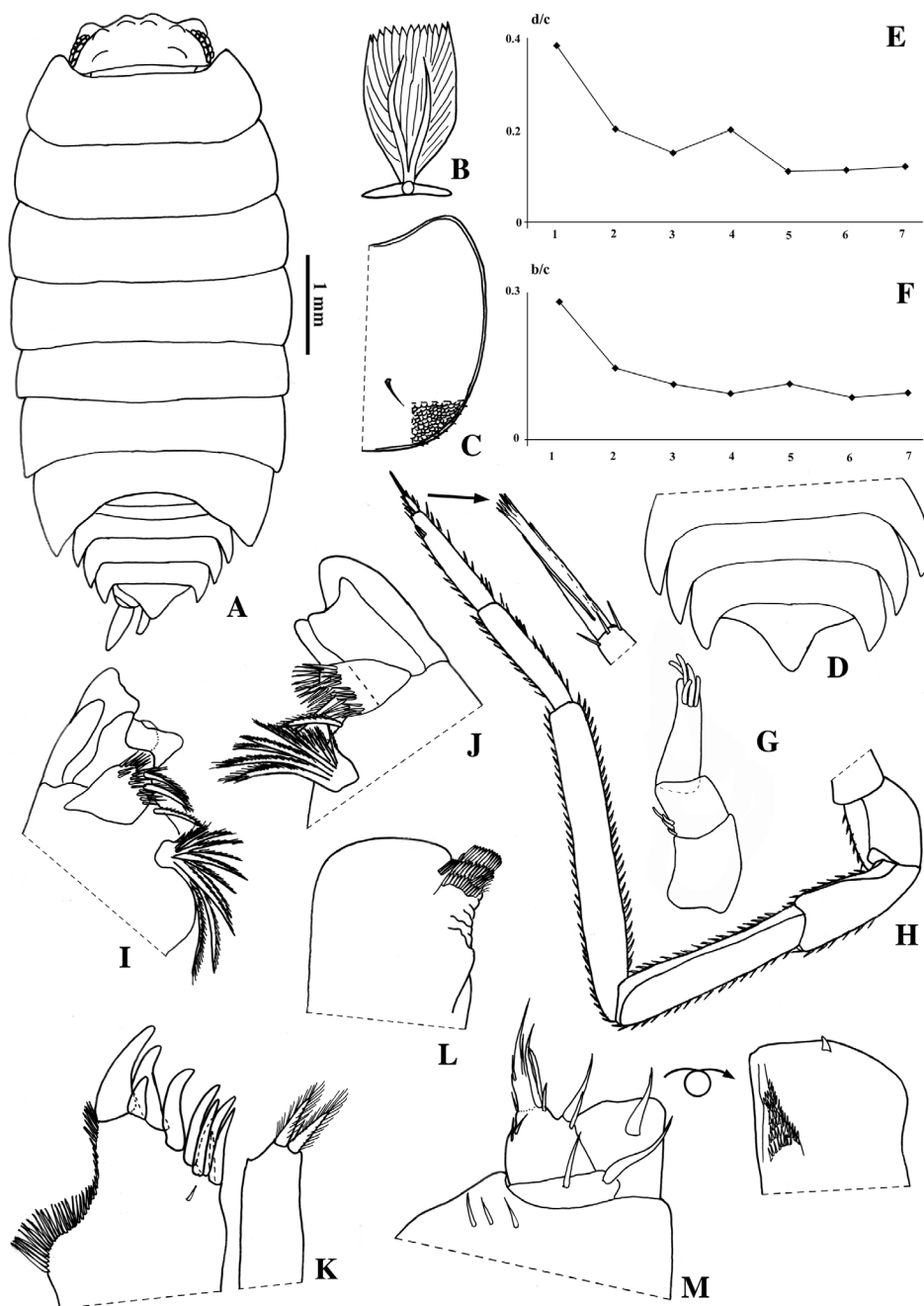


Figure 10. *Dubioniscus elongatus* n. sp., male, MZUSP 34318. A, habitus; B, scale-seta; C, pereonite 1; D, pleonites 3–5 and pleotelson; E, d/c noduli laterales coordinates; F, b/c noduli laterales coordinates; G, antennula; H, antenna; I, left mandible; J, right mandible; K, maxillula; L, maxilla; M, maxilliped.

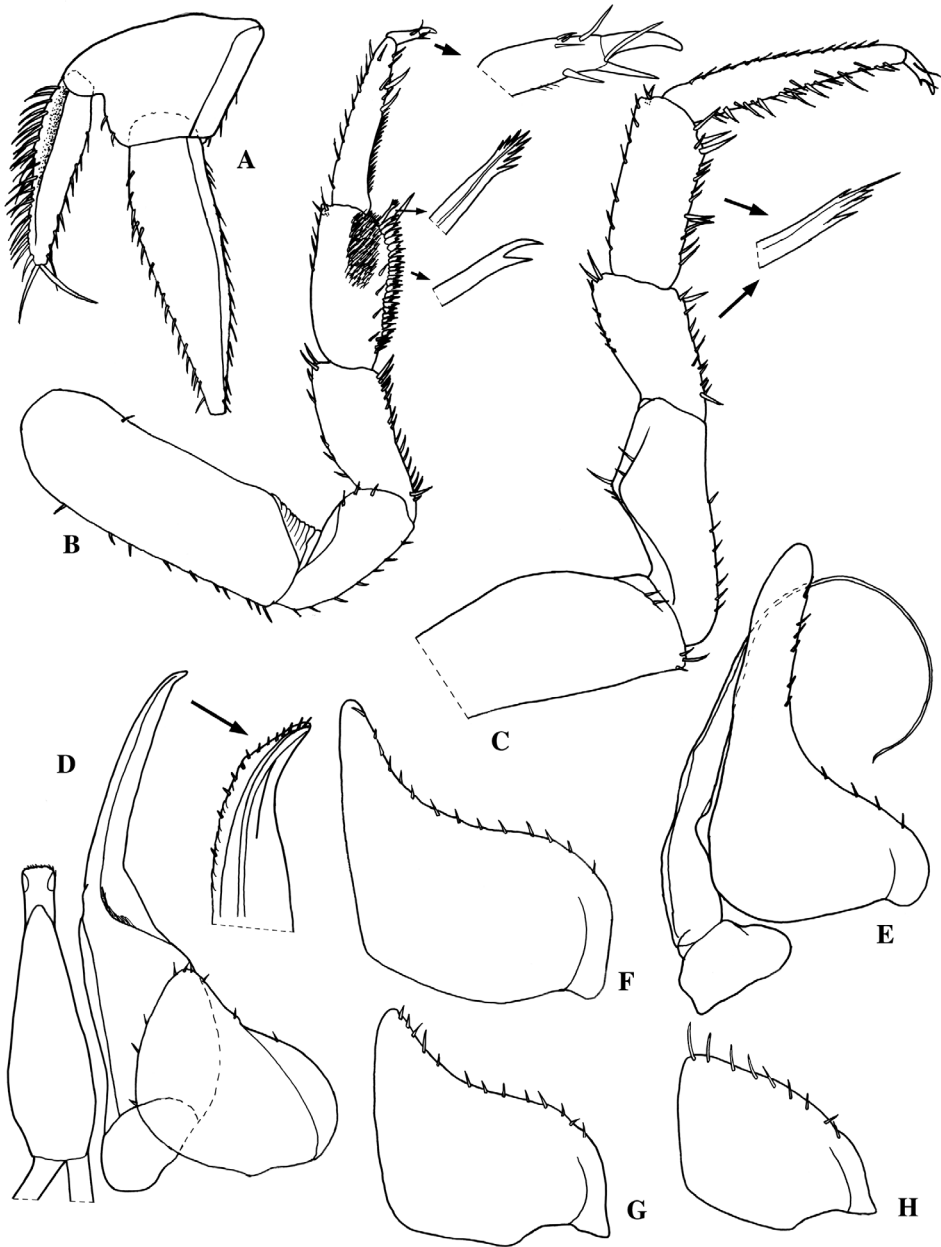


Figure 11. *Dubioniscus elongatus* n. sp., male, MZUSP 34318. A, uropod; B, pereopod 1; C, pereopod 7; D, pleopod 1 and genital papilla; E, pleopod 2; F, pleopod 3 exopod; G, pleopod 4 exopod; H, pleopod 5 exopod.

### Description

Maximum body length 6 mm. Color brown; antenna with articles 1–3 of peduncle and flagellum unpigmented; cephalothorax with irregular pigmented areas and lateral lobes strongly pigmented; pereonite 1 unpigmented, paramedian areas and epimera gradually more pigmented from pereonites 2–6, one pigmented spot on median portion of pereonites 1–6, pereonite 7 more pigmented; pleon strongly pigmented on lateral portion and medial

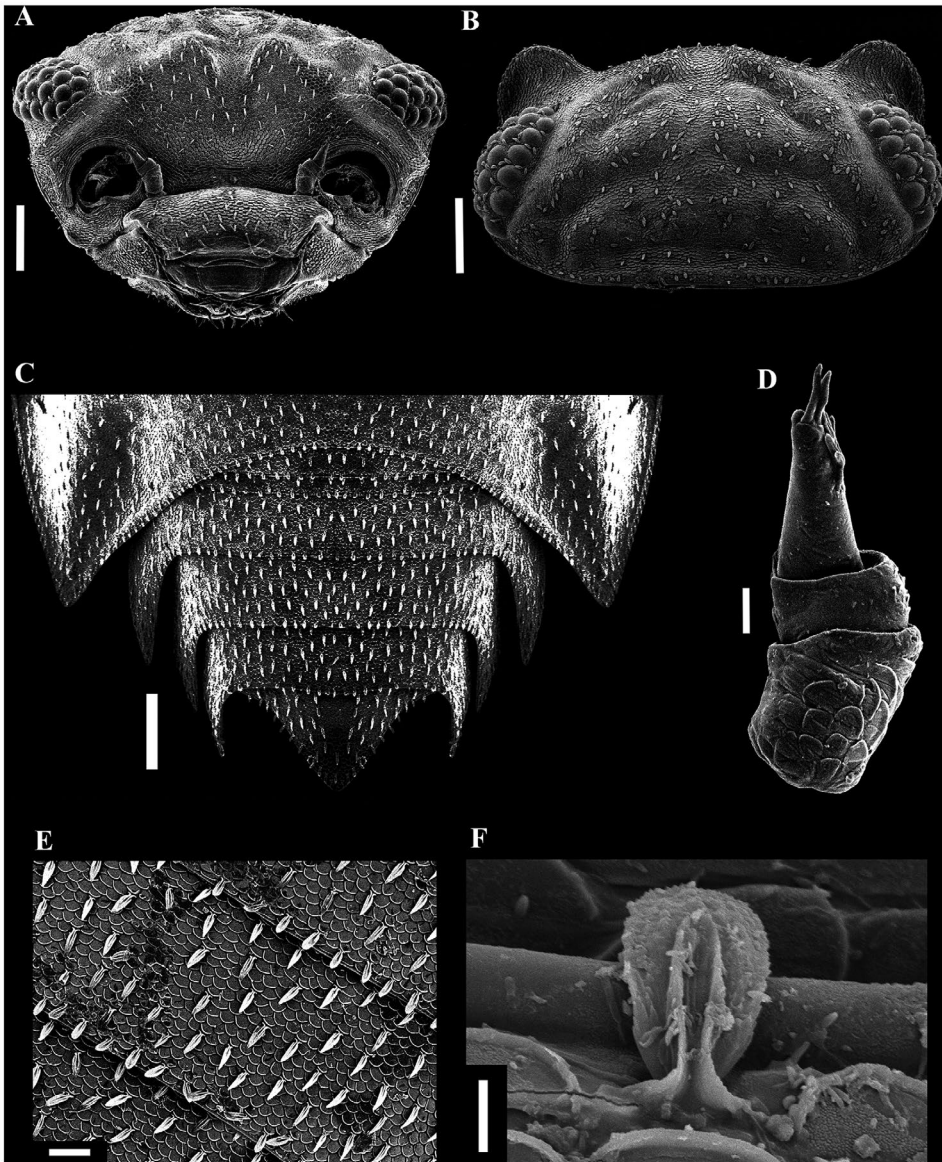


Figure 12. *Dubioniscus elongatus* n. sp., SCAM SEM photographs. A, Cephalothorax, frontal view; B cephalothorax, dorsal view; C, pereonite 7, pleonites 1–5 and pleotelson; D, antennula; E, cuticle and dorsal surface; F, scale-seta. Scale bars: A–C 200  $\mu$ m, D 20  $\mu$ m, E 50  $\mu$ m, F 5  $\mu$ m.

portion unpigmented, pleonite 1 with large pigmented area on medial portion and pleonites 2–5 slightly pigmented; pleotelson pigmented on median area; uropods with irregular pigmented areas. Body outline as in Figure 10A. Dorsum covered with fan-shaped scale-setae (Figures 10B, C and 12E, F). Pereonites 1–7 depressed on posterior portions, pereonite 7 with posterior margin arched, not sinuous at sides (Figure 10C). Cephalothorax (Figure 12A, B) vertex with irregular depressions; eyes of 14–20 ommatidia arranged in rows. Pleotelson (Figures 10D, 12C) with lateral margins slightly concave, apex acute. Epimera (Figure 10C) with flagelliform noduli laterales, glandular pores not visible. Coordinates

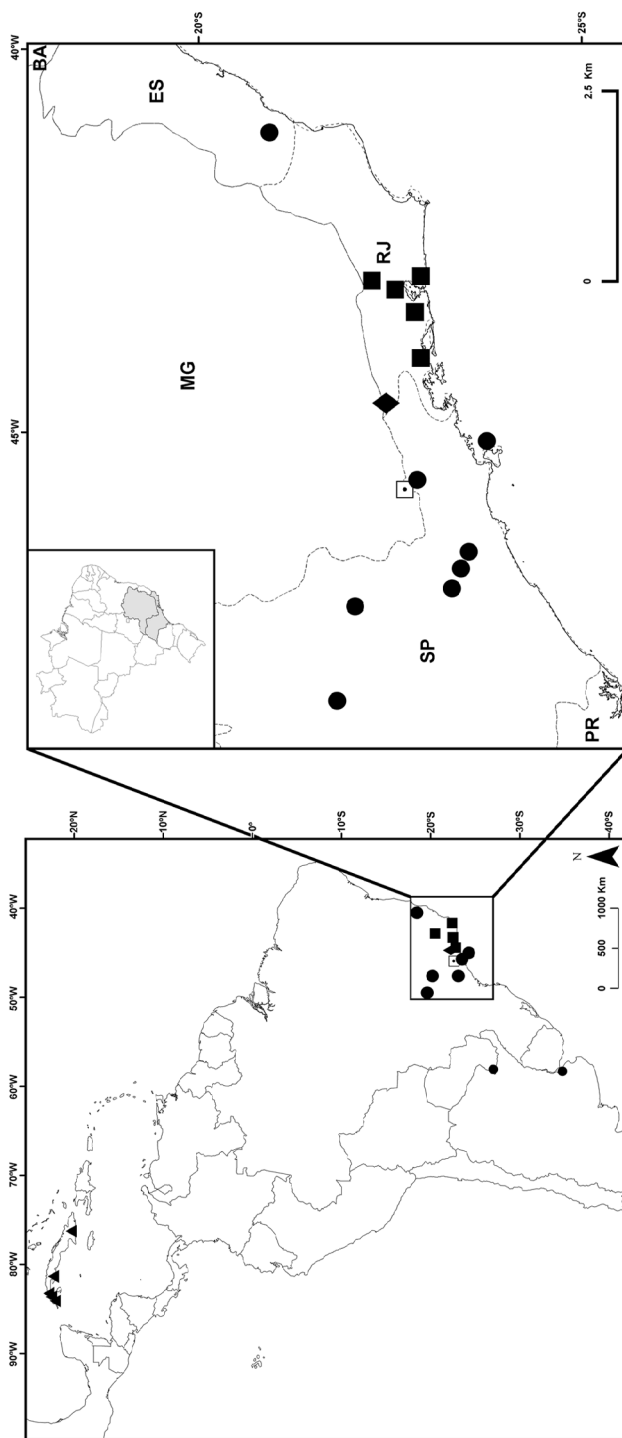


Figure 13. A distribution map of *Dubioniscus* Vandel, 1963: (●) *D. marmoratus*, (▲) *D. negreae*, (◆) *D. depressus n. sp.*, and (◻) *D. elongatus n. sp.*



of *noduli laterales* as in Figure 10E, F. Antennula (Figures 10G, 12D) with distal article longest, four subapical and two apical aesthetascs. Antenna (Figure 10H) when extended posteriorly reaching posterior margin of pereonite 2, first and second articles of flagellum subequal in length, second and third articles bearing two aesthetascs, third article 1/6 length of second article. Mandible (Figure 10I, J) with molar pencil consisting of about 11–13 branches, maxillula (Figure 10K) inner endite with apical tip on distal margin. Maxilla and maxilliped as in Figure 10L, M, respectively. Uropod (Figure 11A) as in diagnosis, endopod bearing inner fringe of setae.

Male: Pereopod 1 (Figure 11B) carpus bearing brush of setae with cleft apex on sternal margin, distal seta with double-serrate apex and longitudinal antennal-grooming brush. Pereopods 2–7 (Figure 11C) merus and carpus with slightly sparse setae on sternal margin. Genital papilla (Figure 11D) with triangular shield and two subapical orifices: Pleopod 1 (Figure 11D) exopod triangular, outer margin slightly concave, outer and inner margin bearing nine setae; endopod elongated, more than twice as long as exopod, proximal portion stout, distal portion tapering, bearing minute setae, apex slightly bent outwards. Pleopod 2 (Figure 11E) exopod triangular, distal portion elongated, outer margin concave bearing 10 setae; endopod very long, distal part flagelliform, reaching distal portion of pleopod 5 exopod. Pleopod 3,4 exopod (Figure 11F, G) rhomboid, outer margin concave bearing setae. Pleopod 5 exopod (Figure 11H) outer margin convex bearing nine setae.

### Etymology

The new species is named in reference to the very long male pleopod 2 endopod.

### Remarks

*Dubioniscus elongatus* **n. sp.** resembles *D. depressus* **n. sp.** and *D. marmoratus* in having the cephalothorax with irregular depressions on the vertex and a large V-shaped frontal depression, and in the shape of the male pleopod 1 exopod; it is distinguished by the more setose sternal margin of the male pereopod 1 merus and carpus, the shape of the distal part of male pleopod 1 endopod, the flagelliform male pleopod 2 endopod, and the uropod endopod with brush of long setae on the inner margin. Unlike *D. depressus* **n. sp.** that was collected in the western area of the Serra da Mantiqueira mountain range, *D. elongatus* **n. sp.** was collected in the eastern area (Figure 13).

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### Disclosure statement

No potential conflict of interest was reported by the authors.

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### Capítulo III

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## **Two new species of *Neotroponiscus* Arcangeli, 1936 (Crustacea, Isopoda, Oniscidea) from Brazilian caves**

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### **Abstract**

*Neotroponiscus* comprises eight species. In this study, two new species of this genus of terrestrial isopods are described. *Neotroponiscus iporangaensis* sp. nov. was collected in limestone caves located in Parque Estadual Turístico do Alto Ribeira (PETAR). *Neotroponiscus tuberculatus* sp. nov. occurs in iron ore caves of the Iron Quadrangle (local name Quadrilátero Ferrífero) and represents the first species of the genus recorded in iron caves. As tourism and mining are common activities in PETAR and in the caves of the Iron Quadrangle, respectively, both species' occurrence is threatened.

**Keywords:** Terrestrial isopods; woodlice; neotropics.

## ORIGINAL ARTICLE



## Two new species of *Neotroponiscus* Arcangeli, 1936 (Crustacea, Isopoda, Oniscidea) from Brazilian caves

G. M. Cardoso <sup>a</sup>, P. B. Araujo <sup>a</sup> and M. E. Bichuette <sup>b</sup><sup>a</sup>Programa de Pós-Graduação em Biologia Animal, Departamento de Zoologia, Laboratório de Carcinologia, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; <sup>b</sup>Departamento de Ecologia e Biologia Evolutiva, Universidade Federal de São Carlos, São Carlos, Brazil**ABSTRACT**

Currently *Neotroponiscus* comprises eight species. In this study, two new species of this genus of terrestrial isopods are described. *Neotroponiscus iporangaensis* sp. nov. was collected in limestone caves located in Parque Estadual Turístico do Alto Ribeira (PETAR). *Neotroponiscus tuberculatus* sp. nov. occurs in iron ore caves of the Iron Quadrangle (local name Quadrilátero Ferrífero) and represents the first species of the genus recorded in iron caves. As tourism and mining are common activities in PETAR and in the caves of the Iron Quadrangle, respectively, both species' occurrence is threatened.

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**KEYWORDS**

Terrestrial isopods; woodlice; neotropics

**Introduction**

The genus *Neotroponiscus* was erected by Arcangeli (1936) to include *N. carolii* Arcangeli, 1936, from São Paulo state (Brazil). The description was based solely on a female specimen. Lemos de Castro (1970a) revised the genus and provided the male description. Currently, the genus includes eight species: *N. carolii*, *N. argentinus* (Giambiagi de Calabrese 1939), *N. plaumanni* (Andersson 1960), *N. daguerrii* (Giambiagi de Calabrese 1939), *N. littoralis* Lemos de Castro, 1970, *N. lobatus* Lemos de Castro, 1970, *N. lenkoi* Lemos de Castro, 1970, and *N. perlatus* Lemos de Castro, 1970 (Giambiagi de Calabrese 1939; Andersson 1960; Lemos de Castro 1970a; 1970b). Schultz (1972) revised the material used by Boone (1918) and synonymized *N. vedadoensis* (Boone 1918) with *Porcellio lamelatus* Budde-Lund (1885).

Most *Neotroponiscus* species occur in the Brazilian Atlantic Forest and can be found on banana and bromeliad leaves, decaying wood, and in ant and termite nests (Lemos de Castro 1970a, 1970b; Lenko 1971; Lisboa et al. 2013). Some species also occur in Argentina (*N. argentinus* and *N. daguerrii*) and Uruguay (*N. plaumanni*). Although there have been new records expanding the known distribution of some species (Araujo et al. 1996; Mugnai et al. 2013), new species have not been described since 1970. The present study describes two new species of *Neotroponiscus* from the Brazilian states of Minas

Gerais and São Paulo. Both species were collected in subterranean environments (caves), associated with organic matter such as guano piles and litter.

**Material and methods**

Specimens were stored in 75% ethanol and identifications were based on morphological characters. The species were illustrated with the aid of a camera lucida on an Olympus CX31 microscope (Tokyo, Japan) and pictures were obtained with Nikon AZ100 (Tokyo, Japan). Illustrations were prepared according to Montesanto (2015, 2016).

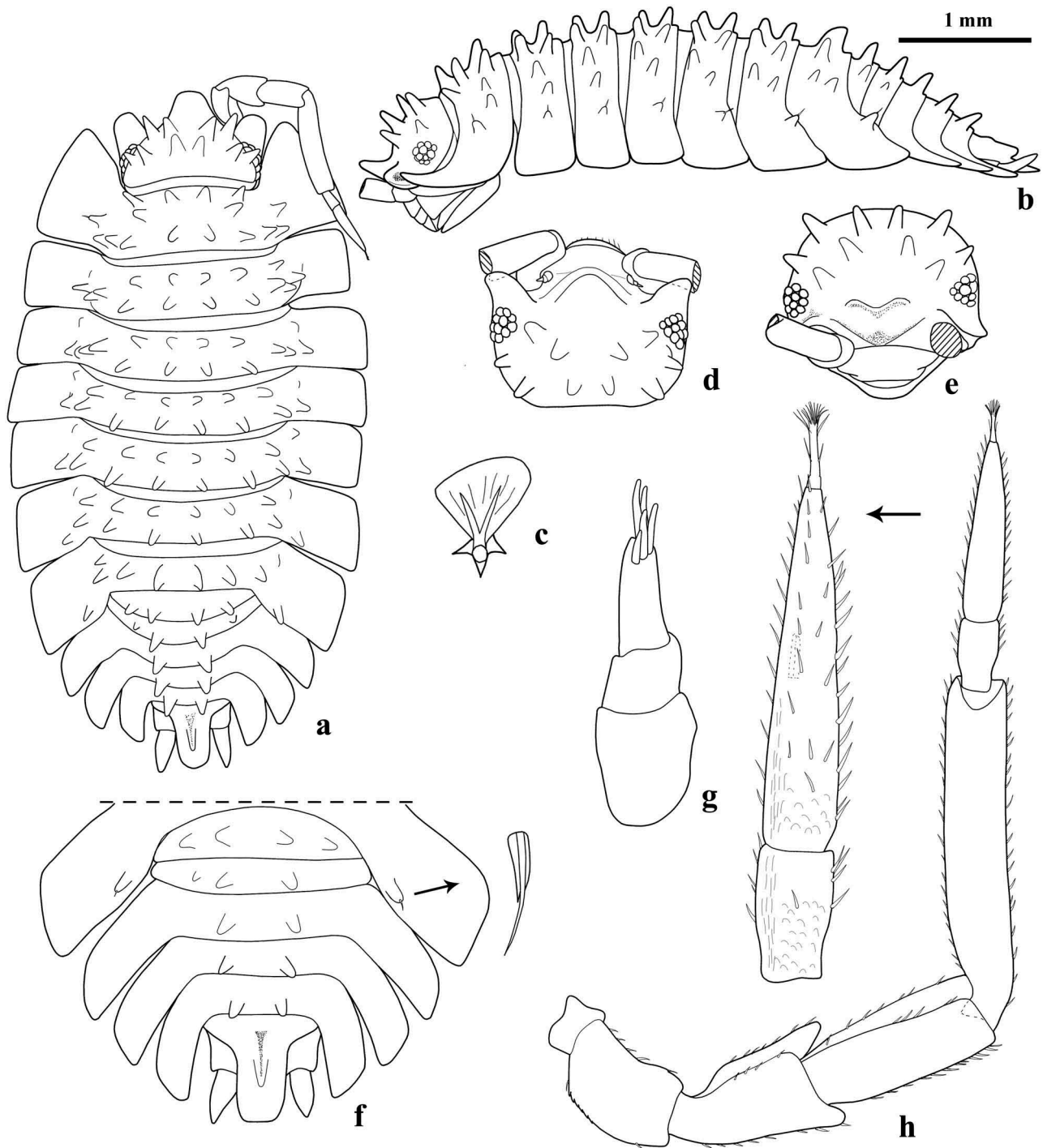
The material used for this study is deposited in the Museu de Zoologia (MZUSP), Universidade de São Paulo, São Paulo, Brazil; in the Laboratório de Estudos Subterrâneos, Universidade Federal de São Carlos (LES/UFSCar); and in the Coleção de Crustáceos do Departamento de Zoologia (UFRGS), Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil.

**Results**

Genus *Neotroponiscus* Arcangeli, 1936

Type species *Neotroponiscus carolii* Arcangeli, 1936  
*Neotroponiscus iporangaensis* sp. nov. Cardoso & Araujo

(Figures 1–3, 6(A), 7(A–D))



**Figure 1.** *Neotroponiscus iporangaensis* sp. nov. ♂ holotype MZUSP 35061. (A) habitus, dorsal view; (B) habitus, lateral view; (C) scale-seta; (D) cephalon, dorsal view; (E) cephalon, frontal view; (F) pereonite 7, pleon, telson and uropods, dorsal view; (G) antennule; (H) antenna.

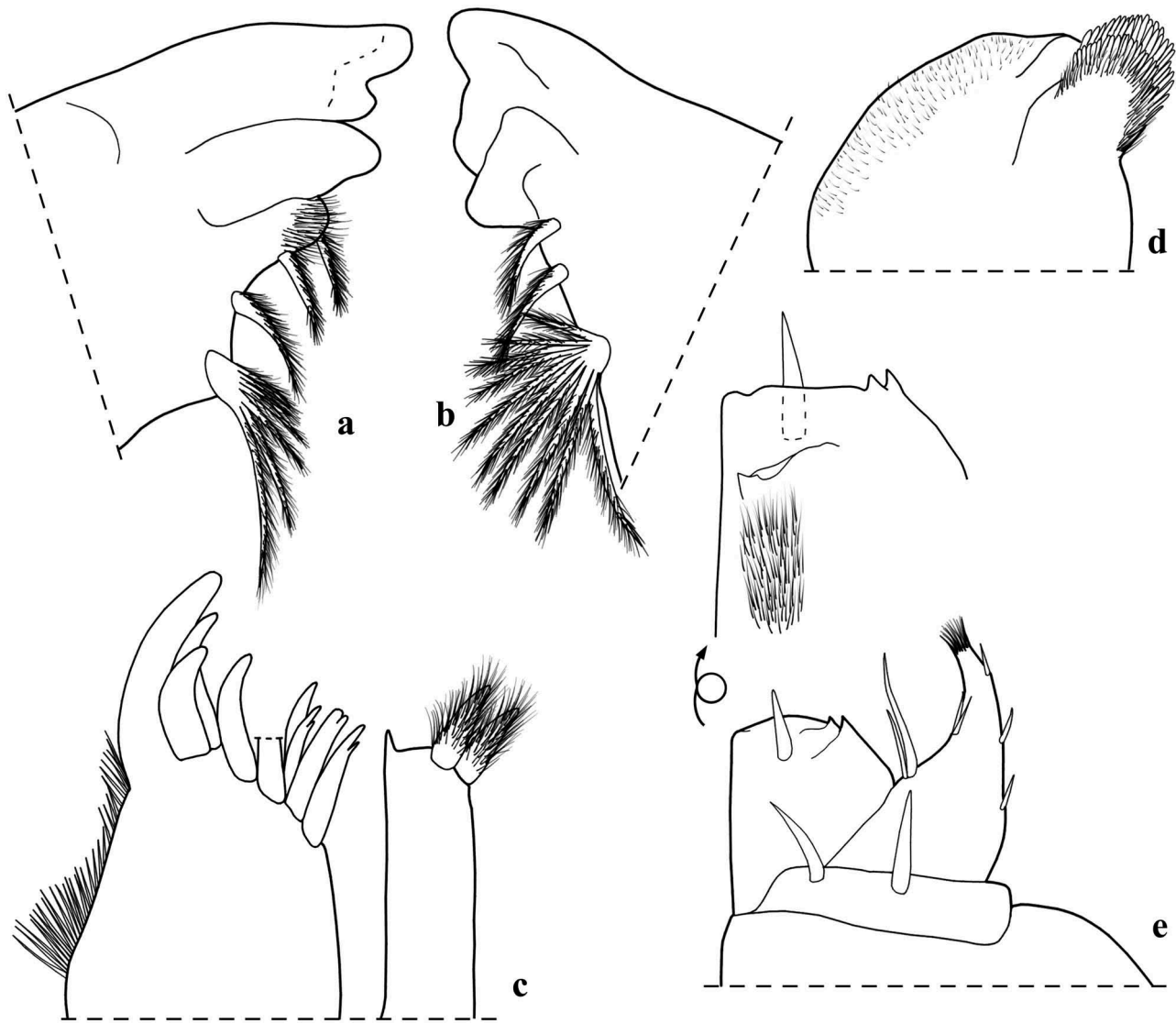
#### **Type material**

São Paulo state, Iporanga: 1 ♂ Holotype (MZUSP 35061), Cafezal cave, Parque Estadual Turístico do Alto Ribeira (PETAR), 16–20 September 2009, leg. Pellegatti-Franco (col.); 2 ♀♀ 2 ♂♂ Paratypes (MZUSP 35062), Lage Branca, Parque Estadual

Turístico do Alto Ribeira (PETAR), 1 October 2012, leg. M. E. Bichuette (col.).

#### **Additional material**

1 ♀ (LES/UFSCar 1774), Santana cave, Parque Estadual Turístico do Alto Ribeira (PETAR), 16–20 September



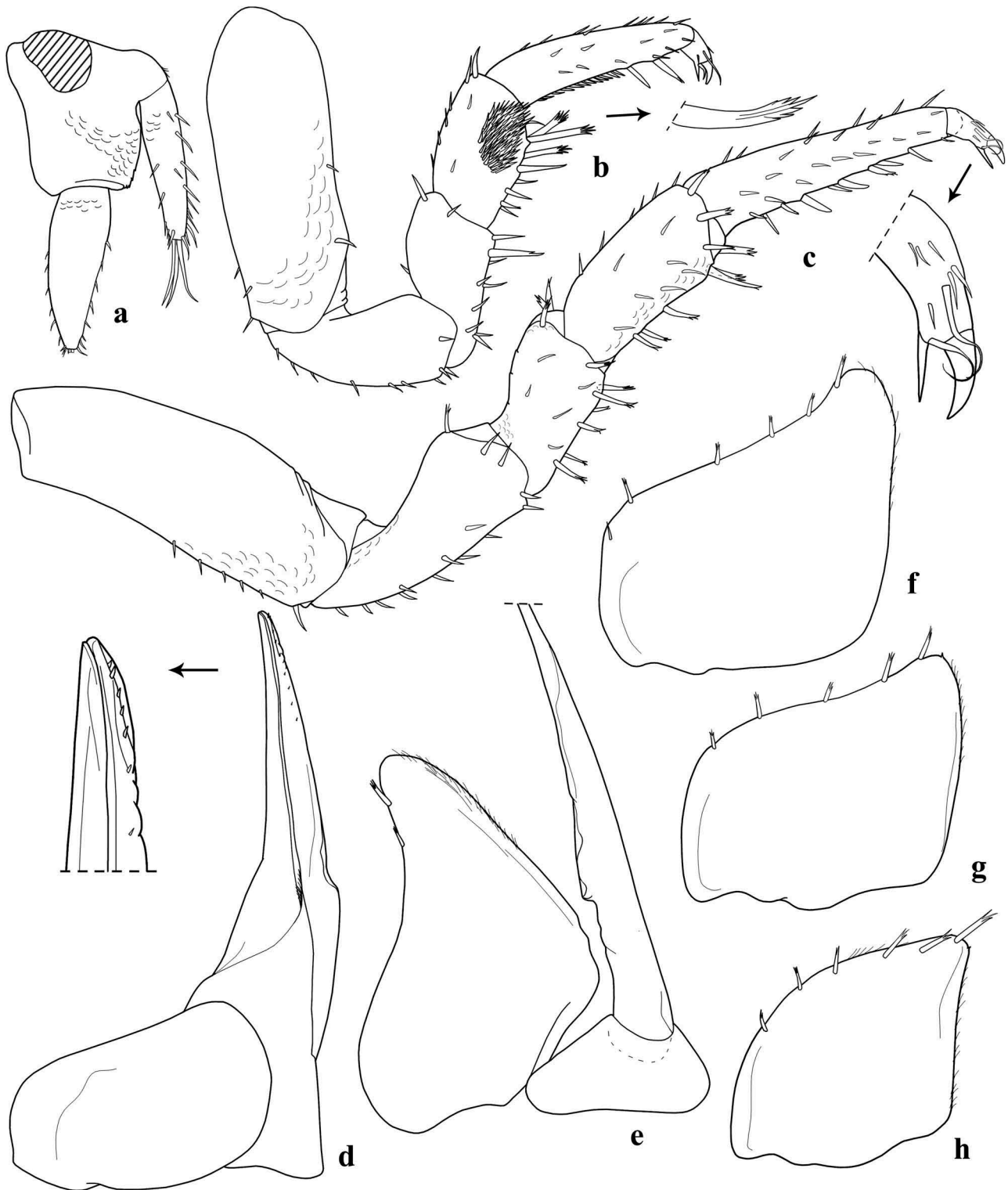
**Figure 2.** *Neotroponiscus iporangaensis* sp. nov. ♂ paratype MZUSP 35062. (A) left mandible; (B) right mandible; (C) maxillula; (D) maxilla; (E) maxilliped.

2009, leg. Pellegatti-Franco (col.); 1 ♂ (UFRGS 6070), Alambari de Baixo cave, Parque Estadual Turístico do Alto Ribeira (PETAR), 13–20 September 2009, leg. Pellegatti-Franco (col.); 1 ♀ (UFRGS 6093), Cafetal cave, Parque Estadual Turístico do Alto Ribeira (PETAR), 16–20 September 2009, leg. M. E. Bichuette (col.).

### Description

Maximum body length 8 mm. Specimens of brown color with yellow spots, antenna pigmented; cephalon lobes strongly pigmented, posterior part yellowish; epimera less pigmented than body, with median unpigmented area; pleon epimera, uropods, and telson strongly pigmented (Figure 6(A)). Dorsal tubercles conical with rounded apex located as follows: two lines on cephalon, three lines on pereonite 1, two lines on pereonites 2–6,

two or one line on pereonite 7, four tubercles on pleonite 1, sometimes two on pleonite 2, two tubercles on pleonites 3–5; telson with one carinated tubercle (Figure 1(A), 1(B)). Dorsum covered with fan-shaped scale-setae (Figure 1(C)); one line of *noduli laterales* per side, arranged on top of outmost tubercle (Figure 1(B), 1(F)). Pereon and pleon epimera enlarged; pereon 1 epimeron directed frontwards, other epimera progressively directed backwards (Figure 1(A), 1(B)); pleon epimera falciform directed backwards (Figure 1(F)). Cephalon (Figure 1(D), 1(E)) with rounded lateral lobes, directed outwards, and triangular median lobe directed upwards; eyes with 16 ommatidia. Telson (Figure 1(F)) as wide as long; convex lateral margins with rectangular distal part. Antennula (Figure 1(G)) with second article shortest; distal articles with two apical and three subapical



**Figure 3.** *Neotroponiscus iporangaensis* sp. nov. ♂ paratype MZUSP 35062. (A) uropod; (B) pereopod 1; (C) pereopod 7; (D) pleopod 1; (E) pleopod 2; (F) pleopod 3 exopod; (G) pleopod 4 exopod; (H) pleopod 5 exopod.

aesthetascs. Antenna (Figure 1(H)) reaching posterior margin of pereonite 2; flagellum shorter than fifth segment of peduncle, second flagellar article almost 3 times as long as first article, with two aesthetascs. Mandible with molar penicil with about 10 branches, left mandible

(Figure 2(A)) with 2 + 1 penicils, right mandible (Figure 2(B)) with 1 + 1 penicils. Maxillula (Figure 2(C)) inner endite bearing two hairy penicils, distal margin with lateral tip; outer endite with 4 + 5 teeth, inner set with cleft apex. Maxilla (Figure 2(D)) outer lobe



wider than inner lobe. Maxilliped (Figure 2(E)) palp with two long setae on proximal article; endite subrectangular, median seta surpassing distal margin, distal margin with two hooks. Pereopods with simple dactylar organ and unguis seta. Uropod (Figure 3(A)) protopod as wide as long; endopod inserted proximally; exopod as long as endopod, surpassing distal margin of telson.

**Male.** Pereopod 1 (Figure 3(B)) bearing sparse setae on sternal margin of merus and carpus; carpus with longitudinal antennal brush. Pereopod 7 (Figure 3(C)) bearing sparse setae on sternal margin of ischium, merus, and carpus. Pleopod 1 (Figure 3(D)) exopod small (one third of endopod length), rectangular, about twice as wide as long; endopod with setules on distal inner margin, straight distal part. Pleopod 2 (Figure 3(E)) exopod triangular, shorter than endopod. Pleopods 3–5 (Figure 3(F–H)) trapezoidal.

### Etymology

The name *iporangaensis* refers to the locality where the species was found.

### Remarks

The general body shape of *Neotroponiscus iporangaensis* sp. nov., with lateral epimera strongly developed, resembles *N. littoralis*. The type of tubercle, conical and rounded (as opposed to small boss in *N. perlatus* and *N. lobatus*, or ribs in *N. daguerrii* and *N. plaumanni*), resembles the tubercles of *N. carolii* and *N. littoralis*, but differs in number and position. On the pereon, the tubercles occur in five pairs, while in *N. carolii* they occur in four pairs. The rectangular shape of pleopod 1 exopod can also distinguish *N. iporangaensis* sp. nov. from *N. carolii* as the latter shows a quadrangular shape.

*Neotroponiscus iporangaensis* sp. nov. was recorded in touristic limestone caves located at Parque Estadual Turístico do Alto Ribeira (PETAR) in Southeastern Brazil (Figure 7(A–D)). The caves are under legal protection (State Conservation Unit), but their legal management allows a high number of visitors throughout the year. The specimens have been observed on and nearby guano piles, indicating a possible preference for this microhabitat, which implies that the species is vulnerable, since is dependent of a specific trophic resource. Despite having been collected only in a cave environment, the specimens did not show any troglomorphic character-states, but instead showed strong pigmentation and a regular number of ommatidia, similar to epigeic species. More samplings in epigeic habitats of PETAR and its surroundings are necessary to confirm if this species is troglomorphic.

***Neotroponiscus tuberculatus* sp. nov.** Cardoso & Araujo (Figures 4, 5, 6(B), 7(E), 7(F))

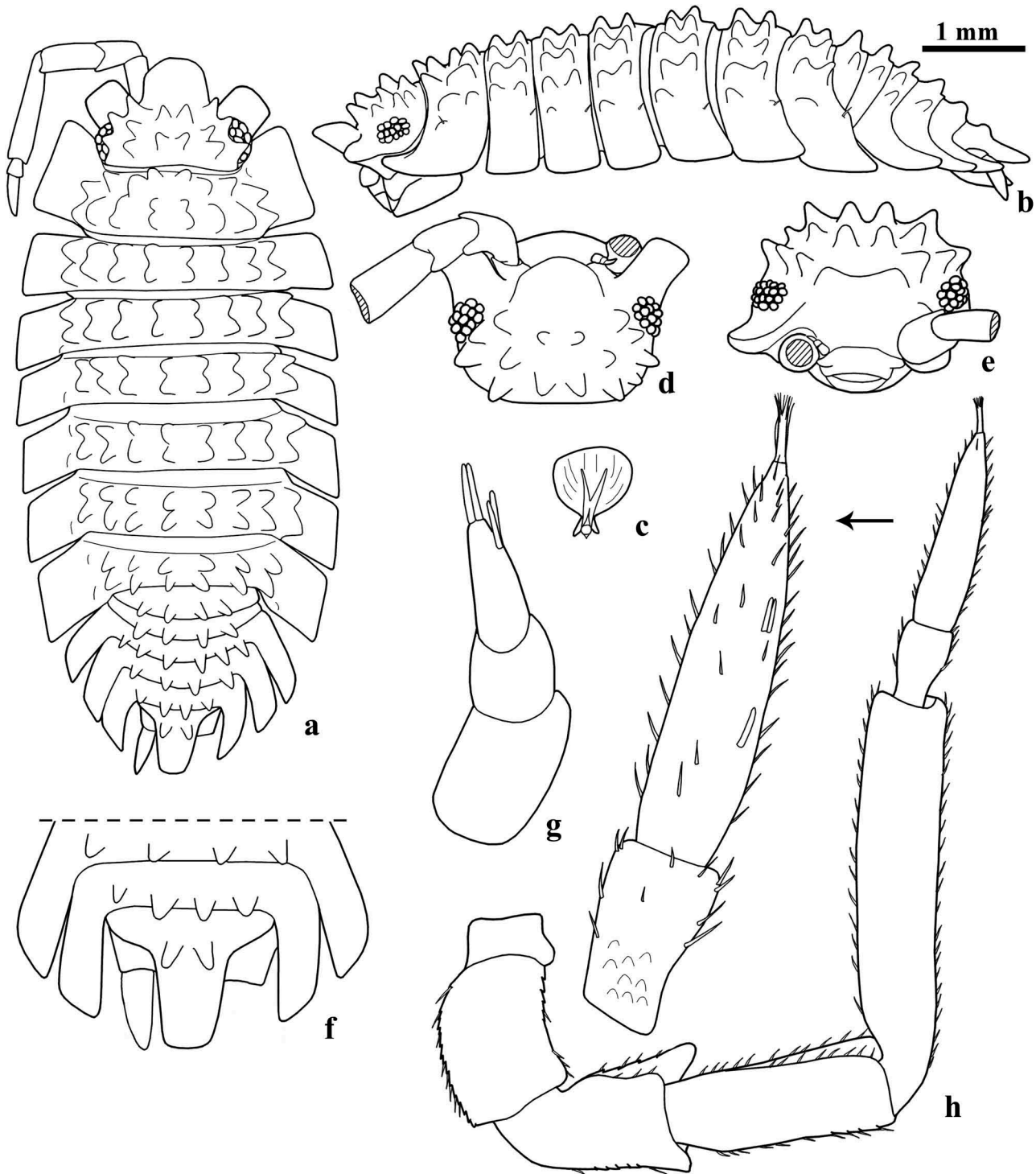
### Type material

Minas Gerais State, Brumadinho: 1 ♂ Holotype (MZUSP 35063) cave PBR23, 607479mE/7771357mN SAD'69 (20°09'07.2"S, 43°58'17.7"W), 28 September–3 October 2009, leg. Bessi (col.); 1 ♂ Paratype (MZUSP 35064) cave PBR03, 607729mE 7770560mN (20°09'33.1"S, 43°58'08.9"W) 15–20 March 2010, leg. Bessi (col.); 1 ♀ (UFRGS 5592) same data as holotype.

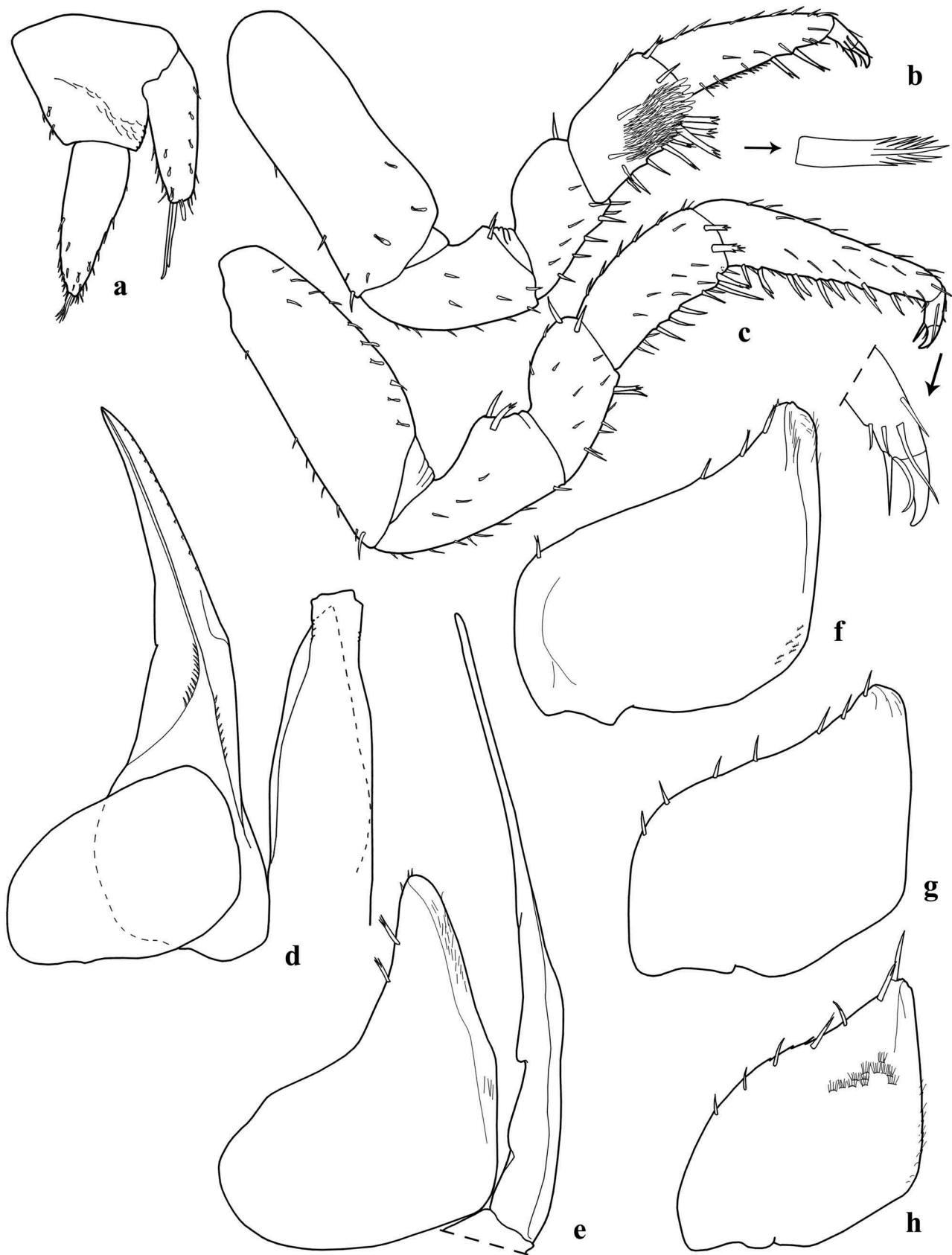
### Description

Maximum body length 5 mm. Brown color with unpigmented spots; antenna with first and second articles of peduncle yellowish, flagellum strongly pigmented; pereonite 1 epimeron weakly pigmented, pereonites 2–7 epimera with one unpigmented spot (Figure 6(B)). Dorsal conical tubercles (Figure 4(A), 4(B)) positioned as follows: three lines on cephalon and pereonite 1, two lines of fused tubercles on pereonites 2–7, four tubercles on pleonites 1–5, pleonite 3 with six tubercles, two tubercles on telson. Dorsum covered with fan-shaped scale-setae (Figure 4(C)); one line of *noduli laterales* per side, far from lateral margin and near outmost tubercle. Epimera of pereon and pleon enlarged; pereonite 1 epimeron directed frontwards, pereonite 2–7 epimera quadrangular with posterior margins progressively more acute and directed backwards (Figure 4(A), 4(B)). Cephalon (Figure 4(D), 4(E)) with quadrangular lateral lobes and directed outwards, median lobe rounded, directed upwards and larger than lateral lobes. Eyes small with 16 ommatidia. Telson (Figure 4(F)) wider than long, convex lateral margins with quadrangular distal part. Antennula (Figure 4(G)) with second article shortest; distal article with two apical and two lateral aesthetascs. Antenna (Figure 4(H)) reaching posterior margin of pereonite 2; flagellum with two articles, shorter than fifth article of peduncle, second flagellar article with two rows of aesthetascs. Pereopod with simple dactylar organ and unguis seta. Uropod (Figure 5(A)) protopod wider than long; exopod as long as endopod, surpassing distal margin of telson.

**Male.** Pereopod 1 (Figure 5(B)) bearing sparse setae on sternal margin of merus and carpus; carpus with antennal brush obliquely directed. Pereopod 7 (Figure 5(C)) bearing sparse setae on sternal margin of merus and carpus. Pleopod 1 (Figure 5(D)) exopod small (one third of endopod length), subrectangular, about twice as wide as long; endopod with straight distal part and triangular apical part. Pleopod 2 (Figure 5(E)) exopod triangular,

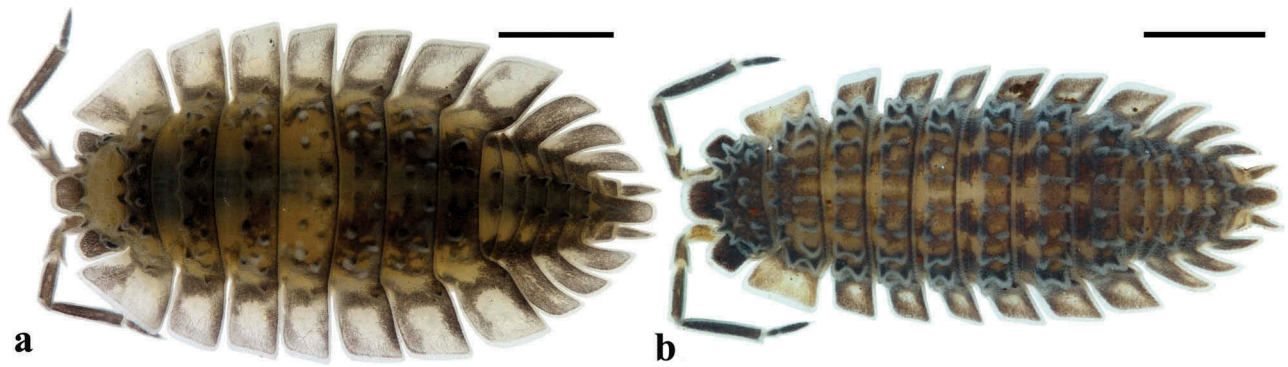


**Figure 4.** *Neotroponiscus tuberculatus* sp. nov. ♂ paratype MZUSP 35064. (A) habitus, dorsal view; (B) habitus, lateral view; (C) scale-seta; (D) cephalon, dorsal view; (E) cephalon, frontal view; (F) pleonites 4 and 5, telson and uropods, dorsal view; (G) antennule; (H) antenna.

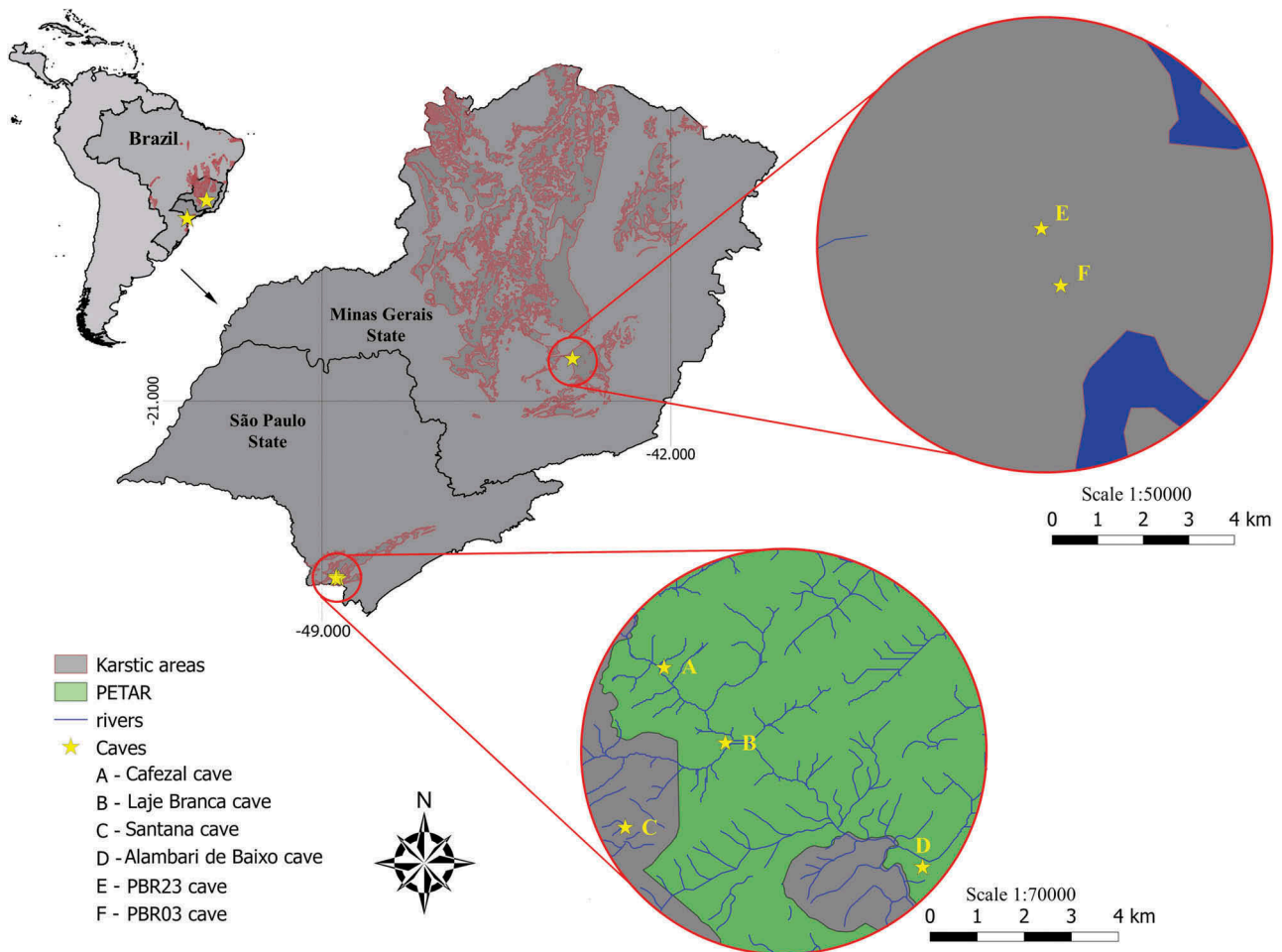


**Figure 5.** *Neotroponiscus tuberculatus* sp. nov. ♂ paratype MZUSP 35064. (A) uropod; (B) pereopod 1; (C) pereopod 7; (D) pleopod 1; (E) pleopod 2; (F) pleopod 3 exopod; (G) pleopod 4 exopod; (H) pleopod 5 exopod.





**Figure 6.** (A) *Neotroponiscus iporangaensis* sp. nov. ♀ paratype MZUSP 35062 in dorsal view; (B) *Neotroponiscus tuberculatus* sp. nov. ♂ paratype MZUSP 35064 in dorsal view. Scale: 1 mm.



**Figure 7.** Distribution of *Neotroponiscus iporangaensis* sp. nov. (A-D) and *Neotroponiscus tuberculatus* sp. nov. (E, F). By: Diego M. von Schimonsky.

shorter than endopod. Pleopods 3–5 (Figure 5(F-H)) trapezoidal.

### Etymology

The name *tuberculatus* refers to tubercles present on telson.

### Remarks

*Neotroponiscus tuberculatus* sp. nov. resembles *N. iporangaensis* sp. nov., *N. carolii*, and *N. littoralis* in the conical shape of the dorsal tubercles. In *N. tuberculatus* sp. nov., the tubercles occur in four pairs on pereon, as in *N. carolii*. However, the presence of six

tubercles on pleonite 3 and two tubercles on telson distinguish *N. tuberculatus* sp. nov. from the other species.

*Neotroponiscus tuberculatus* sp. nov. occurs in caves in Brumadinho municipality, in the central region of Minas Gerais state, Southeast Brazil (Figure 7(E), 7(F)). The caves are of iron ore lithology, located in the Iron Quadrangle (local name Quadrilátero Ferrífero) and are not included in conservation areas, i.e. are not under legal protection. These caves are severely threatened since they are located in and/or nearby mining operations; therefore, the new species is also threatened. Iron ore caves are commonly small cavities with many interposed channels and high humidity (Bichuette et al. 2015). The isopods were observed in the unconsolidated substrate, always exposed. The genus is usually distributed near the coastal region of the Atlantic Forest; therefore, this study represents the first record of the genus in the transition between Cerrado and Rainforest. Due to the occurrence site, this species must be considered in conservation initiatives as its occurrence in a mining region indicates its vulnerability.

### Acknowledgments

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### Disclosure statement

No potential conflict of interest was reported by the authors.

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## Capítulo IV

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### **Taxonomic revision of *Neotroponiscus* Arcangeli, 1936 (Isopoda: Bathytropidae)**

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#### **Abstract**

The terrestrial isopods from the genus *Neotroponiscus* occur in the Brazilian Atlantic forest. Eight out of the species are re-described: *N. carolii*, *N. argentinus*, *N. daguerrii*, *N. plaumanni*, *N. littoralis*, *N. lobatus*, *N. lenkoi*, *N. perlatus*. New characters to better define the species and new distribution record are provided.

**Keywords:** Terrestrial isopods, woodlice, neotropics.

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### **Abstract**

The terrestrial isopods from the genus *Neotroponiscus* occur in the Brazilian Atlantic forest. Eight species are re-described: *N. carolii*, *N. argentinus*, *N. daguerrii*, *N. plaumanni*, *N. littoralis*, *N. lobatus*, *N. lenkoi*, *N. perlatus*. New characters to better define the species and new distribution record are provided.

**Keywords:** Terrestrial isopods, woodlice, neotropics.

### **Introduction**

Bathytropidae includes 24 species distributed in the genera *Australoniscus* Vandel, 1973, *Bathytropa* Budde-Lund, 1885, *Cubanoscia* Vandel, 1981, *Dumetoniscus* Taiti and Checcucci, 2009, *Laninoniscus* Reça, 1973, *Monitus* Lewis, 1998, and *Neotroponiscus* Arcangeli, 1936 (Taiti and Schotte 2016). The genus *Neotroponiscus* comprises ten species

distributed in Argentina, Brazil and Uruguay (Schmalfuss 2003, Taiti and Schotte 2016). In Brazil, the genus is recorded along the Brazilian Atlantic forest and is mainly characterized by the shape and distribution of dorsal tubercles, the cephalic lobes and the pereonite epimera well-development (Lemos de Castro 1970a, 1970b, Mugnai et al. 2013, Lisboa et al. 2014).

*Neotroponiscus* was proposed to the monotypical *N. carolli* Arcangeli, 1936 from Piraju, state of São Paulo, Brazil. At that moment, the genus was placed in the family Porcellionidae Brandt, 1831 based on the cephalic lobes, dorsal tuberculation and pleopod exopods without pleopodal lungs.

Giambiagi de Calabrese (1939) described *Porcellio argentinus* Giambiagi de Calabrese, 1939 from Punta Lara, and *P. daguerrii* Giambiagi de Calabrese, 1939 from the Delta del Paraná Island, both from Buenos Aires, Argentina. Based on the non-triangular shape of telson with lateral sides straight and small size of antennae, the author suggested that both species could belong to a different genus. Verhoeff (1941) created *Brasilocellio* to allocate *B. nodulosus* Verhoeff, 1941 from Nova Teutônia, state of Santa Catarina, Brazil. According to the author, this genus shows similarities to *Neotroponiscus*, such as the habitus, the number of articles in the antennal flagellum and the absence of pleopodal lungs on pleopod exopods, but bears distinguishable characters as the shape of the frontal lobe and the type of tubercles. However, the absence of male specimens of *Neotroponiscus* limited the comparisons to *Brasilocellio*.

Bathytropinae was established by Vandel (1952) to include the genera *Myrmekiocello* Verhoeff, 1936 [currently considered as *incertae sedis*, according to Taiti and Schotte, 2016], *Bathytropa*, *Neotroponiscus*, *Brasilocellio*, and *Dubioniscus* Vandel, 1963 [currently in Dubioniscidae, according to Schultz, 1995] (Vandel 1963). The author characterized the subfamily by having: body length of 3-5 mm; dorsum pigmented, granulated, with round plaques and triangular scale-setae; large or medium eyes; neopleura 3-5 well-developed, with outline continuous with that of pereonite 7; telson triangular or trapezoidal; and pleopod exopod without pleopodal lungs.

Andersson (1960) described *Brasilocellio plaumanni* Andersson, 1960 from Nova Teutônia, state of Santa Catarina, Brazil. Lemos de Castro (1970a) revised the genus *Neotroponiscus* providing new diagnostic features. In this study *N. carolli*, was re-described, *P. argentinus*, *P. daguerrii*, *B. plaumanni*, and *Leptotrichus vedadoensis* Boone, 1918 [actually accepted as *Porcellio lamellatus* Budde-Lund, 1885] were transferred to *Neotroponiscus* and four species were described: *N. littoralis* Lemos de Castro, 1970 from Cabo Frio, state of Rio de Janeiro, *N. lobatus* Lemos de Castro, 1970 from Sooretama, state of

Espírito Santo, *N. lenkoi* Lemos de Castro, 1970 from Ilha da Vitória, state of São Paulo and *N. perlatus* Lemos de Castro, 1970 from Santa Tereza, state of Espírito Santo (Lemos de Castro 1970b). Recently, Cardoso et al. (2017) described two new species: *N. iporangaensis* Cardoso and Araujo, 2017 in limestone caves from Parque Estadual Turístico do Alto Ribeira (PETAR), state of São Paulo, and *N. tuberculatus* Cardoso and Araujo, 2017 in iron ore caves from Quadrilátero Ferrífero, state of Minas Gerais.

The aim of this study is to review the taxonomy of *Neotroponiscus*, providing detailed descriptions of the species of the genus required to determine the species limits, essential in phylogenetic studies and to understand the dynamics of symbiotic relationships. In addition, new distribution records are provided, increasing the knowledge of the distribution for some species in Brazil.

### Material and methods

Specimens were stored in 70% (museum) and absolute ethanol (recent material). Field surveys were conducted along the Atlantic forest in the Brazilian states from Bahia to Rio Grande do Sul. The identifications were based on morphological characters. The species were illustrated with the aid of a *camera lucida* on Olympus CX31 microscope and pictures were obtained with Nikon AZ100. The cuticular structures were studied in a JSM 6060 scanning electron microscope (SEM) at the Centro de Microscopia Eletrônica of UFRGS. The final illustrations were prepared according to Montesanto (2015, 2016).

The specimens used in this study were deposited in the Museu Nacional do Rio de Janeiro (MNRJ); Museu de Zoologia da Universidade de São Paulo (MZUSP); Coleção de Crustáceos do Departamento de Zoologia (UFRGS), Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; and Museo Argentino de Ciencias Naturales “Bernardino Rivadavia” (MACN), Buenos Aires, Argentina.

### Systematic account

Family **Bathytropidae** Vandel, 1952

Genus *Neotroponiscus* Arcangeli, 1936

Type species *Neotroponiscus carolii* Arcangeli, 1936

*Brasilocellio* Verhoeff, 1941:122;

*Neotroponiscus* Arcangeli, 1936: 201; Lemos de Castro 1970:89; Souza-Kury 1998: 654; Leistikow and Wägele 1999: 26; Schmalfuss 2003: 162; Schmidt and Leistikow 2004: 59.

*Neotropinoscus*: Vandel 1952: 145 [erroneous spelling]

*Nesiotroponiscus*: Vandel 1963: 78 [erroneous spelling]

### *Diagnosis*

Dorsum tuberculated, surface with circular plaques and covered with fan-shaped scale-setae. Pereon and pleon epimera enlarged; pereonite 1 epimeron directed frontwards and surpassing eyes, pereonites 2-7 epimera progressively directed backwards; neopleurae 3-5 outline continuous with that of pereonite 7, falciform, and directed backwards. Cephalon with frontal line delimiting frontal and lateral lobes on upper portion; suprantennal line absent. Telson with convex margins, not covering uropod protopods. Antennal flagellum of two articles, shorter than fifth segment of peduncle, second article almost three times as long as first article. Mandible with molar penicil dichotomized, left mandible with 2+1 penicils, right mandible with 1+1. Maxillula inner endite bearing two hairy penicils, outer distal margin with lateral tip; outer endite of 4+6 teeth, 5 or 4 teeth cleft at apex. Maxilla outer lobe wider than inner lobe. Maxilliped palp with two setae on proximal article; endite subrectangular, median seta surpassing distal margin, distal outer margin with two hooks. Pleopod exopods without respiratory areas. Uropod endopod inserted proximally.

### *Remarks*

*Neotropinoscus* is characterized by the frontal and lateral lobes in cephalon, pereonites and pleonites epimera expanded laterally, and distinct dorsal ornamentation. It is distinguishable from *Bathytropa* in the convex shape of telson instead of concave, and maxilla outer lobe wider than inner lobe instead slender; from *Monitus* in the antennal flagellum of two articles; from *Papuasoniscus* in the development of frontal lobes; from *Laninoniscus* in the development of frontal lobes, in the absence of suprantennal line, in the tuberculated dorsum instead of smooth and in the shape of telson with convex lateral margins instead of straight; from *Dumetoniscus* in the development of the medial frontal lobe, in the absence of suprantennal line and in the shape of telson with convex lateral margins instead of straight.

### *Neotropinoscus carolii* Arcangeli, 1936

(Figures 1-3, 18A, 19)

*Neotropinoscus carolii* Arcangeli, 1936: 201, figs 1-4; Van Name 1940: 115, fig 7; Lemos de Castro 1970a: 90, figs 1-2; Lenko 1971: 8; Souza-Kury 1998: 655; Leistikow and

Wägele 1999: 27; Schmalzfuss 2003: 162; Appel et al. 2011: table 1; Lisboa et al. 2013: 394, fig 1.

### *Material examined*

Brazil, Bahia: Candeias: 3 ♂♂, 2 ♀♀ (UFRGS 6457) RPPN Grande Moinho Aratu (-12.7925°, -38.4711°), May 2007, leg. J. Lisboa; 2 ♂♂, 2 ♀♀ (UFRGS 6458) (-12.7925°, -38.4711°), May 2007, leg. J. Lisboa; 2 ♂♂, 1 ♀ (UFRGS 6459) Baía de Aratu (-12.7925°, -38.47111°), November 2006, leg. J. Lisboa; 1 ♀ (UFRGS 6460) Região MT, between Candeias and Salvador (-12.7977°, -38.4763°), September 2007, leg. J. Lisboa. Salvador: 6 ♂♂, 9 ♀♀ (UFRGS 6462) Baía de Aratu, December 2007, leg. J. Lisboa; 3 ♂♂, 7 ♀♀ (UFRGS 4230) Baía de Aratu, November 2006, leg. J. Lisboa; 1 ♀ (UFRGS 4547) Baía de Aratu, leg. J. Lisboa; 1 ♀ (UFRGS 4548) Baía de Aratu, leg. J. Lisboa. Ilheus: 10 ♂♂, 8 ♀♀ (UFRGS 4731) Reserva Experimental da CEPLAC (-14.7990°, -39.1723°), 28 April 2010, leg. J. Lisboa and P.B. Araujo; 1 ♂, 2 ♀♀ (UFRGS 4735) Reserva Experimental da CEPLAC, 12 November 2010, leg. J. Lisboa and IS Campos-Filho; 1 ♂ (UFRGS 6456) CEPLAC, Cocoa plantation (-14.7572°, -39.2332°), 2007, leg. J. Lisboa; 2 ♀♀ (UFRGS 6461) CEPLAC, termite nest (-14.7544°, -39.2305°), 2007, leg. J. Lisboa. Una: 1 ♀ (UFRGS 6467) in bromeliads in the canopy of trees, 27 May 2014, leg. W. da Rocha and col. (E 5.5); 3 ♂♂, 4 ♀♀ (UFRGS 6468) same data (E 5.2); 2 ♂♂, 3 ♀♀ (UFRGS 6469) same data (E 5.6); 4 ♂♂, 2 ♀♀ (UFRGS 6471) 23 September 2013 (S 1.2); 2 ♂♂, 6 ♀♀ (UFRGS 6472) same data (S 1.1); 4 ♀♀ (UFRGS 6473) same data, 15 October 2013 (E 2.1). Itajú do Colonia: 1 ♀, 1 ♂ in slide (UFRGS 6453) road BA-120, between Itajú do Colonia and Itapé (-15.0327°, -39.6041°), 17 September 2013, leg. I.S. Campos-Filho and J. Lisboa.

### *Re-description*

Male body length 5 mm. Brown color with unpigmented spots, antenna fifth segment of peduncle and flagellum pigmented; cephalon with lobes strongly pigmented; epimeron I with unpigmented spots; neopleurae 3-5, uropods, and telson strongly pigmented (Figure 18A). Dorsum with spine-shaped tubercles placed as follows: three transversal lines on cephalon and pereonite 1, two transversal lines on pereonites 2–6, two or one transversal line on pereonite 7, four tubercles on pleonite 1 and 2, two tubercles on pleonites 3–5 (Figures 1A, B). Dorsum with fan-shaped scale-setae (Figure 1C); one *nodulus lateralis* per side, on top of outmost tubercle (Figures 1B, F). Pereonite 1 epimeron developed frontwards, surpassing eyes (Figures 1A, B). Cephalon (Figures 1D, E) with rounded lateral lobes, directed outwards; median lobe with quadrangular shape directed upwards; eyes with 14 ommatidia. Telson (Figure 1G) as wide as long, rounded distal apex and medial carena. Antennula (Figure 1H) distal articles with two apical and two subapical aesthetascs. Antenna (Figures 1I, 18A) when extended back, reaches posterior margin of pereonite 2; flagellum with two sets of



aesthetascs. Mandible (Figure 2A, B) as in generic diagnosis. Maxillula (Figure 2C) outer endite with 4+6 teeth, inner set with 4 cleft setae. Maxilla (Figure 2D) as in generic diagnosis. Maxilliped as in Figure 2E. Pereopods with sparse setae on sternal margin of merus and carpus; dactylar organ and unguis simple. Uropod (Figure 3A) protopod longer than wide; exopod longer than endopod, surpassing distal margin of telson.

Male: Pereopods (Figure 3 B – D) without modifications. Pleopod 1 (Figure 3E) exopod small (one third of endopod length), rectangular; endopod directed outwards with setules on distal inner margin. Pleopod 2 (Figure 3F) exopod triangular, shorter than endopod. Pleopods 3–5 as in Fig. 3G–I.

#### *Remarks*

This species is mainly characterized by the shape and distribution of dorsal tubercles. Here we provide the pattern of the *noduli laterales*, which remained undescribed since the Lemos de Castro's (1970) description of male specimens.

#### *Distribution*

*Neotroponiscus carolii* is recorded in the states of Bahia (Lemos de Castro 1970a, Lisboa et al. 2013, present work), Espírito Santo (Lemos de Castro 1970a) and São Paulo (Arcangeli 1936, Lenko 1971), Brazil (Figure 19).

### ***Neotroponiscus argentinus* (Giambiagi de Calabrese, 1939)**

(Figures 4-5, 18B, 19)

*Porcellio argentinus* Giambiagi de Calabrese, 1939: 634, plate I;

*Brasilocellio nodulosus* Verhoeff, 1941: 122, figs 8-15; Van Name, 1942: 308, fig 11; Andersson, 1960: 560, fig 11.

*Neotroponiscus argentinus* Lemos de Castro, 1970a: 93, fig 3; Souza-Kury 1998: 654; Leistikow and Wägele 1999: 26; Schmalfuss 2003: 162; Boss et al. 2012: 1035; Mugnai et al. 2013: 855, map 1.

#### *Material examined*

Brazil, Santa Catarina: 1 ♀ (UFRGS 6444) Joinville (-26.3219°, -48.8636°), 3 September 2013, leg. G.M. Cardoso; 1 ♂ (UFRGS 5470) Corupá (26°25'23"S, 49°14'46"W), 27 June 2012, leg. P.B. Araujo; 1 ♂, 1 ♂ in slide, 2 ♀♀ (UFRGS 5468) São João Batista (-27.2644°, -48.8533°), 26 June 2012, leg. P.B. Araujo; 1 ♂, 1 ♀, 1 ♂ in slide (UFRGS 6442) Florianópolis, Trilha do Poção (-27.6107°, -48.5057°), 22 September 2013, leg. F.B. Ribeiro and P.B. Araujo; 2 ♂♂, 2 ♀♀ (UFRGS

6443) Florianópolis, Banhado Ressaca (-27.6848°, -48.5382°), 23 September 2013, leg. F.B. Ribeiro and P.B. Araujo; Rio Grande do Sul: 1 ♀ (UFRGS 4866) Alta Igrejinha (29°34'44.23"S, 50°46'47.10"W), undated, leg. not identified; 1 ♀ (UFRGS 6445) Matinhos (-25.8355°, -48.5706°), 1 December 2013, leg. G.M. Cardoso. Argentina, Buenos Aires: 2 ♂♂, 2 ♀♀ (MACN 34334) Punta Lara (-34.8254°, -57.9684°), 08 December 1968, leg. A Reca (Colección Roberto Taberner); 3 ♂♂, 15 ♀♀ (MACN 34339) INTA Delta, 15 July 1968, leg. A.O. Bachmann (Colección Roberto Taberner).

### *Re-description*

Male body length 5 mm. Light brown color; antenna and cephalon pigmented; pereonite 1 epimeron with unpigmented spot on anterior portion; neoplaurae 3-5 with unpigmented spots on anterior portion; uropods and telson strongly pigmented (Figure 18B). Dorsum with rounded tubercles, placed as follows: three transversal lines on cephalon, two transversal lines on pereonite 1, one transversal line on pereonites 2–7, pleon smooth (Figures 4A, B). Dorsum covered with fan-shaped scale-setae (Figure 4C); one *nodulus lateralis* per side, inserted on outmost tubercle, first *nodulus* placed farther away from lateral and distal margins (Figures 4A, B, F). Pereonite 1 epimeron developed frontwards, reaching eyes (Figures 4A, B). Cephalon (Figures 4D, E) with rounded lateral lobes, directed outwards; median lobe rectangular with round distal margin and directed upwards; eyes with 16 ommatidia. Telson (Figure 4G) wider than long; distal portion rounded. Antennula (Figure 4H) with distal article bearing two apical and two subapical aesthetascs. Antenna (Figures 4I, 18B) when extended back reaches posterior margin of pereonite 1; flagellum with two aesthetascs. Pereopods with sparse setae on sternal margin of merus and carpus; dactylar organ simple and unguis seta spatuliform. Uropod (Figure 5A) protopod wider than long; exopod smaller than endopod, surpassing distal margin of telson.

Male: Pereopods 1 and 7 (Figures 5B, D) without modifications. Pereopod 2 (Figure 5C) with brush of setae on sternal margin of merus and carpus. Pleopod 1 (Figure 5E) exopod sub-circular, wider than long; endopod slightly bent outwards, twice as long as exopod bearing setules on distal inner margin. Pleopod 2 (Figure 5F) exopod triangular; endopod longer than exopod. Pleopods 3–5 as in Figs. 5G-I.

### *Remarks*

The type material of Giambiagi de Calabrese (1939) could not be found in the collection of MACN. *Neotroponiscus argentinus* is characterized by the rounded shape of telson and male pereopod 2 merus and carpus with brush of setae on sternal margin. The *noduli laterales* coordinates matches with the description provided by Andersson (1960). This species clearly

differs from *N. carolli* in the round-shaped tubercles, pleon without tubercles, and in the shape of telson, uropods and male pleopod 1 exopod.

#### *Distribution*

*Neotroponiscus argentinus* is recorded from Brazil (states of Espírito Santo, Rio de Janeiro, São Paulo, Paraná and Santa Catarina), and Argentina (Buenos Aires province) (Giambiagi de Calabrese 1939, Verhoeff 1941, Van Name 1942, Andersson 1960, Lemos de Castro 1970a, Mugnai et al. 2013) (Figure 19).

#### *Neotroponiscus daguerrii* (Giambiagi de Calabrese, 1939)

(Figures 6-8, 18C, 19)

*Porcellio daguerrii* Giambiagi de Calabrese, 1939: 635, plate 2; Van Name, 1942: 308, fig 12.

*Neotroponiscus daguerrii* Lemos de Castro, 1970a: 99, fig 5; Reça 1973: 93, plate 1; Araujo et al. 1996: 122, figs 29-38; Souza-Kury 1998: 655; Leistikow and Wägele 1999: 27; Schmalzfuss 2003: 162; Lopes et al. 2005: 101 table I; Almerão et al. 2006: 474; Appel et al. 2011: table 1.

#### *Material examined*

Brazil, Rio Grande do Sul: 24 ♂♂, 29 ♀♀ (UFRGS 6448) Eldorado do Sul, Estação Agronômica UFRGS (-30.1003°, -51.6945°), 16 April 2013, leg. G.M. Cardoso; 25 ♂♂, 50 ♀♀ (UFRGS 6447) Porto Alegre, Estrada dos Alpes (-30.0967°, -51.1860°), 06 April 2013, leg. G.M. Cardoso; 1 ♀ (UFRGS 6454) Viamão, Parque do Itapuã (-30.3837°, -51.0205°), 13 August 2013, leg. G.M. Cardoso; 53 ♂♂, 64 ♀♀ (UFRGS 1246) Porto Alegre, Ilha da Pintada (-30.0278°, -52.2594°), 06 July 1989, leg. L.A.M. Schmitt; 8 ♂♂, 18 ♀♀ (UFRGS 1515) Rio Grande, Reserva Ecológica do Taim (-32.5844°, -52.5692°), 17 February 1991, leg. P.B. Araujo. Argentina, Buenos Aires: 7 ♂♂, 18 ♀♀ (MACN 34335) Mocoretá, 17.II.1982, leg. R. Taberner (Colección Roberto Taberner); 4 ♂♂ (MACN 34343) Punta Lara (-34.8254°, -57.9684°), 12 November 1966, leg. A.O. Bachmann (Colección Roberto Taberner); 2 ♀♀ (MACN 34344) Delta del Paraná, 12 December 1976, leg. A.O. Bachmann (Colección Roberto Taberner); 1 ♂, 7 ♀♀ (MACN 34347) INTA Delta, 23 September 1978, E. Angrisano (Colección Roberto Taberner); 10 ♂♂, 38 ♀♀ (MACN 34400) Río Carapachay, Tigre, 31 May 1981, leg. R. Taberner (Colección Roberto Taberner).

#### *Re-description*

Male body length 6 mm. Brown color and unpigmented spots, antennae and cephalon pigmented; pereonite 1 epimeron with unpigmented spots on anterior portion; epimera with transversal unpigmented line; neopleurae 3-5 with medial unpigmented spots; uropods slightly pigmented, telson strongly pigmented (Figure 18C). Dorsum with rounded and rectangular tubercles, placed as follows: three transversal lines on cephalon, two transversal lines on pereonite 1, one transversal line on pereonites 2–7; pleon smooth (Figures 6A, B, 8A, B). Dorsum covered with fan-shaped scale-setae (Figures 6C, 8C); one *nodulus lateralis* per side, inserted on outmost tubercle, first *nodulus* placed farther away from distal margin (Figures 6B, F). Pereonite 1 epimeron developed frontward eyes (Figures 6A, B, 8A). Cephalon (Figures 6D, E, 8A) with lateral lobes directed outwards, rectangular, distal margin rounded, smaller than median lobe; median lobe directed upwards, rectangular and distal margin triangular; eyes with 20 ommatidia. Telson (Figures 6G, 8B) wider than long, distal margin quadrangular. Antennula (Figure 6H) with distal article bearing two apical and two subapical aesthetascs. Antenna (Figures 6I, 8E, 18C) when extended back reaches posterior margin of pereonite 1; flagellum with one aesthetasc. Pereopods bearing sparse setae on sternal margin of ischium, merus, and carpus; dactylar organ and unguis simple. Uropod (Figure 7A) protopod wider than long; exopod smaller than endopod, surpassing distal margin of telson.

Male: Pereopods 1 and 7 (Figures 7B, D) without modifications. Pereopod 2 (Figure 7C) with dense setae on sternal margin of merus and carpus. Pleopod 1 (Figure 7E) exopod sub-circular, wider than long, distal outer margin straight; endopod bent outwards, twice as long as exopod, bearing setules on distal inner margin. Pleopod 2 (Figure 7F) exopod triangular bearing three setae on the outer margin; endopod longer than exopod. Pleopods 3–5 exopods as in Fig. 7G-I.

#### *Remarks*

This species was re-described by Reça (1973) and Araujo et al. (1996). Here we provide illustrations with new information about cuticular surface structures.

*Neotroponiscus daguerrii* is characterized by the shape of the cephalic lobes, the quadrangular shape of telson and male pereopod 2 with brush of setae on sternal margin of merus and carpus. In lacking tubercles on pleon *N. daguerrii* is similar to *N. argentinus* and *N. plaumanni*; in having the male pereopod 2 bearing a brush of setae on sternal margin of the merus and carpus, the species is similar to *N. argentinus*.

#### *Distribution*

*Neotroponiscus daguerrii* is recorded from Buenos Aires province, Argentina (Giambiagi de Calabrese 1939, Lemos de Castro, 1970a, Reça 1973) and from state Rio Grande do Sul, Brazil (Araujo et al. 1996, present work) (Figure 19).

*Neotroponiscus plaumanni* (Andersson, 1960)

(Figures 9-10, 19)

*Brasilocellio plaumanni* Andersson, 1960: 563, figs 12.

*Neotroponiscus plaumanni* Lemos de Castro, 1970b: 93, fig 4; Souza-Kury 1998: 655; Leistikow and Wägele 1999: 27; Schmalfuss 2003: 162; Boss et al. 2012: 1035;

*Material examined*

Brazil, Santa Catarina: 1 ♂ (UFRGS 6281) Itajaí, Morro do Baú, 12-17 May 1996; 6 ♂♂, 11 ♀♀ (UFRGS 6284) Itajaí, Morro do Baú, 12-17 May 1996.

*Re-description*

Male body length 5 mm. Specimens unpigmented due to long preservation in ethanol. Dorsum with rounded tubercles, more elongated or rectangular on pereon, placed as follows: three transversal lines on cephalon, two transversal lines on pereonite 1, one transversal line on pereonites 2–7, pleon smooth (Figures 9A, B). Dorsum with one *nodulus lateralis* per side, inserted on outmost tubercle (Figures 9A, B, F). Pereonite 1 epimeron developed frontwards reaching eyes (Figures 9A, B); pleon epimera falciform directed backwards, in continuous line with that of pereon, (Figures 9A). Cephalon (Figures 9C, D) with rectangular lateral lobes and median lobe; eyes with 16 ommatidia. Telson (Figure 9E) wider than long; convex lateral margins with quadrangular distal part. Antennula (Figure 9F) distal article bearing two apical and two subapical aesthetascs. Antenna (Figures 9G) reaching posterior margin of pereonite 1; flagellum shorter than fifth segment of peduncle with two aesthetascs. Pereopods bearing sparse setae on sternal margin of ischium, merus, and carpus; unguis and dactylar organ simple. Uropod (Figure 10A) protopod wider than long; exopod smaller than endopod, surpassing distal margin of telson.

Male: Pereopods (Figure 10B – D) without modifications. Pleopod 1 (Figure 10E) exopod wider than long, with rounded distal projection; endopod with setules on distal internal margin, slightly bent outward. Pleopod 2 (Figure 10E) exopod triangular, shorter than endopod. Pleopods 3–5 (Figure 10F–H) trapezoidal.

*Remarks*

*Neotroponiscus plaumanni* is easily recognized by the shape of the cephalic lobes, dorsal tubercles, telson and male pleopod 1 exopod (see also Andersson 1960, Lemos de Castro 1970a). In the absence of tubercles on pleon *N. plaumanni* is similar to *N. daguerrii* and *N. argentinus* but it can be distinguished by the male pereopod 2 merus and carpus with sparse number of setae on sternal margin (vs. dense in *N. daguerrii* and *N. argentinus*). Here we provide the pattern of the *noduli laterales* and additional illustrations of pereopods and male appendages.

#### *Distribution*

*Neotroponiscus plaumanni* is recorded from the state of Santa Catarina, Brazil (Andersson 1960, present work) and from Rocha and Florida department, Uruguay (Lemos de Castro 1970a) (Figure 19).

#### *Neotroponiscus littoralis* Lemos de Castro, 1970

(Figure 11, 18D, 19)

*Neotroponiscus littoralis* Lemos de Castro, 1970b: 1, figs 1,2; Souza-Kury 1998: 655; Leistikow and Wägele 1999: 27; Schmalfuss 2003: 162.

#### *Type material examined*

Holotype: 1 ♂ (MNRJ 6171) Brazil, Rio de Janeiro, Ilha de Cabo Frio, 16 December 1965, leg. A. Lemos de Castro and A. Coelho, in bromeliads. Allotype: 1 ♀ (MNRJ 6172) same data as holotype. Paratypes: 3 ♂♂, 6 ♀♀ (MNRJ 6489) same data as holotype; 1 ♀ (MNRJ 6173) Rio de Janeiro, Cabo Frio, Praia do Perú, in bromeliads; January 1960, leg. A. Coelho and S. Ypiranga; 1 ♂, 2 ♀ (MNRJ 6488) Rio de Janeiro, Cabo Frio, Praia João Fernandes, in bromeliads, January 1960, leg. A. Coelho and S. Ypiranga.

#### *Re-description*

Male body length approximately 4 mm. Specimens unpigmented due to long preservation in ethanol (Figure 18D). Dorsum with rounded tubercles, placed as follows: three transversal lines on cephalon, three transversal lines on pereonite 1, two transversal lines on pereonites 2–7, tubercles can be fused, and less pronounced; two tubercles on pleonites 1-5 (Figures 11A, B); one *nodulus lateralis* per side, inserted on outmost tubercle (Figures 11A, B). Pereonite 1 epimeron developed frontwards surpassing eyes (Figures 11A). Cephalon (Figure 11C) with round lateral lobes directed outwards; triangular median lobe directed upwards; eyes with 20 ommatidia. Telson as wide as long, with medial carena (Figure 11A); distal margin rounded.

Pereopods bearing sparse setae on sternal margin of merus and carpus; unguis and dactylar organ simple.

Male: Pereopods (Figure 11D - F) without modifications. Pleopod 1 (Figure 11G) exopod rounded, wider than long; endopod with setules on distal internal margin. Pleopod 2 (Figure 11H) exopod triangular, shorter than endopod. Pleopods 3 and 4 as in Fig. 11I, J.

#### *Remarks*

This species is characterized by the shape of cephalic lobes, dorsal tubercles arrangement and shape of telson. *Neotroponiscus littoralis* resembles *N. carolii* in the shape of dorsal tubercles and uropod protopod longer than wide; but it differs by having tubercles on median portion of pleon (vs. paramedian tubercles in *N. carolii*). Here we provide the pattern of the *noduli laterales* and illustrations of pereopods.

#### *Distribution*

*Neotroponiscus littoralis* is recorded only in the state of Rio de Janeiro, Brazil (Lemos de Castro 1970b) (Figure 19).

### *Neotroponiscus lobatus* Lemos de Castro, 1970

(Figures 12-13, 18E, 19)

*Neotroponiscus lobatus* Lemos de Castro, 1970b: 5, figs 3-4; Souza-Kury 1998: 655; Leistikow and Wägele 1999: 27; Schmalfuss 2003: 162; Mugnai et al. 2013: 857, map 1.

#### *Type material examined*

Holotype: 1 ♂ (MNRJ 6174) Brazil, Espírito Santo, Sooretama, 12 October 1957, leg. O Schubart.

#### *Material examined*

Brazil: Minas Gerais: 1 ♂, 1 ♀ (UFRGS 5127) Matozinhos, Gruta MOC N8 (-19.5646°, -44.0598°) 4.-15 April 2011, leg. F. Franco and col. Espírito Santo: 1 ♀ (UFRGS 4232) Cariacica, Reserva Biológica Duas Bocas, 09 November 2006, leg. P.B. Araujo and J. Anza.

#### *Redescription*

Male body length 5 mm. Specimens unpigmented due to long preservation in ethanol (Figure 18E). Dorsum with round and rectangular tubercles, placed as follows: three lines on cephalon, two lines on pereonite 1, one line on pereonites 2-7, pleon smooth (Figures 12A, B). One *nodulus lateralis* per side, inserted on outmost tubercle (Figures 12A, B). Pereonite 1 epimeron developed frontwards, reaching eyes (Figures 12A, B). Cephalon (Figure 12C) with

rectangular lateral lobes, directed outwards; median lobe directed upwards with rounded distal margin; eyes with 14 ommatidia. Telson (Figure 12D) wider than long; distal margin quadrangular. Antennula (Figure 12E) distal articles with two apical and two subapical aesthetascs. Antenna (Figures 12F) when extended back reaches posterior margin of pereonite 2. Pereopods bearing sparse setae on sternal margin of merus and carpus; unguis and dactylar organ simple. Uropod (Figure 13A) protopod wider than long; endopod smaller than exopod. Male: Pereopods 1 (Figure 13B – C) without modification. Pleopod 1 (Figure 13D) exopod rectangular, wider than long; endopod with setules on distal internal margin. Pleopod 2 (Figure 13E) endopod longer than pleopod 1. Pleopods 4 and 5 as in Fig. 13G, F.

#### *Remarks*

*Neotroponiscus lobatus* was described based on only one male specimen. One additional record of one female specimen was made by Mugnai et al. (2013) after the description. Here we present one more record of two specimens, totaling the third record for the species. New characters not mentioned by Lemos de Castro (1970b) as position of *noduli lateralis*, antennula and illustration for pereopods and antenna were added in the present work. *Neotroponiscus lobatus* is characterized by the shape of the cephalic lobes and dorsal tubercles, and the well-developed pereonite epimera.

#### *Distribution*

*Neotroponiscus lobatus* is recorded in the state of Espírito Santo (Lemos de Castro 1970b, Mugnai et al. 2013) and Minas Gerais (present work), Brazil (Figure 19).

### *Neotroponiscus lenkoi* Lemos de Castro, 1970

(Figures 14-15, 18E)

*Neotroponiscus lenkoi* Lemos de Castro, 1970b: 8, fig 6; Souza-Kury 1998: 655; Leistikow and Wägele 1999: 27; Schmalfuss 2003: 162; Mugnai et al. 2013: 856, fig 2, map 1.

#### *Type material examined*

Holotype: 1 ♂ (MNRJ 6175) Brazil, São Paulo, Ilha da Vitória, Caraguatatuba, 27 March 1964, leg. K. Lenko. Alotype: 1 ♀ (MNRJ 6175) same data as holotype. Paratypes: 3 ♂♂, 7 ♀♀ (MNRJ 6177) same data as holotype.

#### *Material examined*

Brazil, São Paulo: 1 ♂ in slide (UFRGS 6474) Maresias (-23.8247°, -45.5285°), 04 December 2013, leg. G.M. Cardoso; 1 ♂ (UFRGS 6450) Iguape (-24.7635°, -47.7859°), 02 December 2013, leg. G.M.



Cardoso; 1 ♂, 2 ♀♀ (MZUSP 24295) Cananéia, Ilha do Cardoso (-25.0966°, -47.9297°), 24-28 November 2002, leg. Paraná: ♂♂, ♀♀ (MZUSP 24300) Morretes, Parque Estadual do Pau Oco (-24.4166° -48.9333°), 6-11 May 2002, leg. R.R. Silva and B.H. Riete.

### *Redescription*

Male body length approximately 2.5 mm. Specimens with dark brown unpigmented areas; cephalon and antenna strongly pigmented; pereonite 1 epimera and neopleura 3 pigmentless, pereonite 4 epimera slightly pigmented; telson pigmented, uropods light brown (Figure 18E). Dorsum with rounded and rectangular tubercles, placed as follows: two transversal lines round tubercles on cephalon and pereonite 1, one transversal line on pereonites 2–7, tuberculation on pereon is progressively weak, being hardly noticed on pereonites 6 and 7; pleon and telson smooth (Figures 14A, B). Dorsum covered with fan-shaped scale-setae (Figure 14C); one *nodulus lateralis* per side (Figures 14A, B, E). Pereonite 1 epimeron developed frontwards surpassing eyes (Figures 14A), pereonites and neopleura with well-developed epimera, distal margin quadrangular (Figures 14A, F). Cephalon (Figure 14D) with rectangular lateral lobes, directed outwards; pentagonal median lobe, distal margin rounded, directed upwards; eyes with 16 ommatidia. Telson (Figure 14F) wider than long; distal margin quadrangular. Antennula (Figure 14G) distal article with three apical aesthetascs. Antenna (Figure 14H) when extended back reaches posterior margin of pereonite 1. Buccal pieces as in the generic diagnosis. Pereopods bearing sparse setae on sternal margin of ischium, merus, and carpus; unguual setae simple and dactylar organ spatuliform. Uropod (Figure 15A) protopod wider than long; endopod longer than exopod.

Male: Pereopods (Figure 15B – D) without modifications. Pleopod 1 (Figure 15E) exopod rectangular, wider than long; endopod with setules on distal internal margin, bent outward. Pleopod 2 (Figure 15F) exopod triangular, shorter than endopod. Pleopods 3–5 as in Fig. 15G-I.

### *Remarks*

Additional characters not mentioned by Lemos de Castro (1970b) are position of *noduli lateralis*, the antennula, the pereopods bearing sparse setae on sternal margin, unguual setae simple and dactylar organ spatuliform.

*Neotroponiscus lenkoi* is characterized by the wide body size, cephalon with large median lobe, shallow tuberculation and color pattern. In the absence of tubercles on pleon *N. lenkoi* resembles *N. argentinus*, *N. daguerrii* and *N. plaumanni*; but differs in the quadrangular shape

of telson; in having the frontal lobe pentagonal-shaped and the distal margin of telson quadrangular is similar to *N. daguerrii*, but differs in the faint development of tubercles.

#### *Distribution*

*Neotroponiscus lenkoi* is recorded in the states of São Paulo (Lemos de Castro 1970b), Rio de Janeiro (Mugnai et al. 2013) and Paraná (present work), Brazil (Figure 19).

#### ***Neotroponiscus perlatus* Lemos de Castro, 1970**

(Figures 16-17, 18G, 19)

*Neotroponiscus perlatus* Lemos de Castro, 1970b: 11, figs 7-8; Souza-Kury 1998: 655; Leistikow and Wägele 1999: 27; Schmalfuss 2003: 162.

#### *Type material examined*

Holotype: 1 ♂ (MNRJ 6180) Brazil, Espírito Santo, Santa Teresa, 2 November 1944, leg. O. Schubart. Paratype: 1 ♂, 3 ♀♀ (MNRJ 6181) Brazil, Espírito Santo, Domingos Martins, 22 September 1953, leg. O. Schubart.

#### *Material examined*

Brazil, Espírito Santo: 1 ♂ in slide, 2 ♀♀, Juv (UFRGS 6451) Santa Tereza (-19.9415°, -40.5824°), 12 March 2014, leg. G.M. Cardoso; 1 ♂ (UFRGS 6452) Cariacica (-20.2414°, -40.4172°), 13 March 2014, leg. G.M. Cardoso.

#### *Re-description*

Male body length 3.5 mm. Specimens with brown with yellow unpigmented spots; cephalon, fifth segment and flagellum of antenna strongly pigmented; pereonites 1-7 epimera with unpigmented spots; pleonites 1 and 2 yellowish; telson and uropods pigmented (Figure 18G). Dorsum with rounded tubercles, some specimens with spine tubercles, placed as follows: three transversal lines on cephalon, three transversal lines on pereonite 1, two transversal lines on pereonites 2–7; four tubercles on pleonites 1-3, two tubercles on pleonites 4 and 5 (Figures 16A, B). Dorsum covered with circular plaques and fan-shaped scale-setae (Figure 16C, F); one *nodulus lateralis* per side (Figures 16A, B, F). Pereonite 1 epimeron developed frontwards surpassing eyes (Figures 16A, B). Cephalon (Figures 16D, E) with rectangular lateral lobes, directed outwards; rounded median lobe; eyes with 14 ommatidia. Telson wider than long, medial carena; distal margin rounded (Figure 16G). Antennula (Figure 16H) distal article with two apical and two subapical aesthetascs. Antenna (Figures 16I, 18G) when

extended back reaches posterior margin of pereonite 2; flagellum with two aesthetascs. Buccal pieces as in the generic diagnosis. Pereopods bearing sparse setae on sternal margin of merus and carpus; unguis and dactylar organ simple. Uropod (Figure 17A) protopod wider than long; endopod not reaching half length of exopod; exopod longer than endopod, surpassing distal margin of telson.

Male: Pereopods (Figure 17B – D) without modifications. Pleopod 1 (Figure 17E) exopod rectangular, wider than long; endopod with setules on distal internal margin. Pleopod 2 (Figure 17F) exopod triangular, shorter than endopod. Pleopods 3–5 as in Figs. 17G-I.

### *Remarks*

Additional characters not mentioned by Lemos de Castro (1970b) are the position of *noduli laterales*, the antennula, the pereopods bearing sparse setae on sternal margin, unguis and dactylar organ simple, uropod endopod inserted proximally, exopod longer than endopod. *Neotroponiscus perlatus* is characterized by the shape of tubercles and cephalic lobes. This species resembles *N. carolii* and *N. littoralis* in having tubercles on pleon and carena on telson.

### *Distribution*

*Neotroponiscus perlatus* is recorded in the state of Espírito Santo, southeastern of Brazil (Lemos de Castro 1970b and present work) (Figure 19).

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## Figure Captions

Figure 1. *Neotroponiscus carolii*. ♂ UFRGS 6453. A, habitus, dorsal view; B, habitus, lateral view; C, scale-seta; D, cephalon, dorsal view; E, cephalon, frontal view; F, pereonite 7; G, pleonite 5, telson and uropod, dorsal view; H, antennule; I, antenna.

Figure 2. *Neotroponiscus carolii*. ♂ UFRGS 6453. A, left mandible; B, right mandible; C, maxillula; D, maxilla; E, maxilliped.

Figure 3. *Neotroponiscus carolii*. ♂ UFRGS 6453. A, uropod; B, pereopod 1; C, pereopod 2; D, pereopod 7; E, pleopod 1; F, pleopod 2; G, pleopod 3 exopod; H, pleopod 4 exopod; I, pleopod 5 exopod.

Figure 4. *Neotroponiscus argentinus*. ♀ UFRGS 6445. A, habitus, dorsal view; B, habitus, lateral view; C, scale-seta; D, cephalon, dorsal view; E, cephalon, frontal view; F, pereonite 7; G, pleonites 4 and 5, telson and uropods, dorsal view; ♂ UFRGS 6442. H, antennule; I, antenna.

Figure 5. *Neotroponiscus argentinus*. ♂ UFRGS 6442. A, uropod; B, pereopod 1; C, pereopod 2; D, pereopod 7; E, pleopod 1; F, pleopod 2; G, pleopod 3 exopod; H, pleopod 4 exopod; I, pleopod 5 exopod.

Figure 6. *Neotroponiscus daguerrii*. ♂ UFRGS 6447. A, habitus, dorsal view; B, habitus, lateral view; C, scale-seta; D, cephalon, dorsal view; E, cephalon, frontal view; F, pereonite 7; G, pleonite 5, telson and uropods, dorsal view; H, antennule; I, antenna.

Figure 7. *Neotroponiscus daguerrii*. ♂ UFRGS 6447. A, uropod; B, pereopod 1; C, pereopod 2; D, pereopod 7; E, pleopod 1; F, pleopod 2; G, pleopod 3 exopod; H, pleopod 4 exopod; I, pleopod 5 exopod.

Figure 8. *Neotroponiscus daguerrii*. ♂ UFRGS 6447. A, cephalon and pereonite 1, dorsal view; B, pereonite 7, pleon, telson and uropods, dorsal view; C, tubercle on pereonite 7; D, pereonite 7 outmost tubercle; E, flagellum of antenna; F, pereopod 1, setae on carpus; G, pereopod 1, dactylus. Scale bars: A, B 200  $\mu$  m, C 50  $\mu$  m, D, G 20  $\mu$  m, E 100  $\mu$  m, F 10  $\mu$  m.

Figure 9. *Neotroponiscus plaumanni*. ♂ UFRGS 6281. A, habitus, dorsal view; B, habitus, lateral view; C, cephalon and pereonite 1, dorsal view; D, cephalon, frontal view; E, pleonites 3-5, telson and uropods, dorsal view; F, antennule; G, antenna.

Figure 10. *Neotroponiscus plaumanni*. ♂ UFRGS 6281. A, uropod; B, pereopod 1; C, pereopod 2; D, pereopod 7; E, pleopod 1; F, pleopod 2; G, pleopod 3 exopod; H, pleopod 4 exopod; I, pleopod 5 exopod.

Figure 11. *Neotroponiscus littoralis*. ♂ MNRJ 6489. A, habitus, dorsal view; B, habitus, lateral view; C, cephalon and pereonite 1, frontal view; D, pereopod 1; E, pereopod 2; F, pereopod 7; G, pleopod 1; H, pleopod 2; I, pleopod 3 exopod; J, pleopod 4 exopod.

Figure 12. *Neotroponiscus lobatus*. ♂ UFRGS 5127. A, habitus, dorsal view; B, habitus, lateral view; C, cephalon, frontal view; D, pleonites 4 and 5, telson and uropods, dorsal view; E, antennule; F, antenna.

Figure 13. *Neotroponiscus lobatus*. ♂ UFRGS 5127. A, uropod; B, pereopod 1; C, pereopod 2; D, pleopod 1; E, pleopod 2; F, pleopod 4 exopod; G, pleopod 5 exopod.

Figure 14. *Neotroponiscus lenkoi*. ♂ MZUSP 24295 A, habitus, dorsal view; B, habitus, lateral view; UFRGS 6474 C, scale-seta; D, cephalon, dorsal view; E, pereonite 7; F, pleonites 3–5, telson and uropods, dorsal view; G, antennule; H, antenna.

Figure 15. *Neotroponiscus lenkoi*. ♂ MZUSP 24295. A, uropod; B, pereopod 1; C, pereopod 2; D, pereopod 7; E, pleopod 1; F, pleopod 2; G, pleopod 3 exopod; H, pleopod 4 exopod; I, pleopod 5 exopod.

Figure 16. *Neotroponiscus perlatus*. ♂ UFRGS 6451. A, habitus, dorsal view; B, habitus, lateral view; C, scale-seta; D, cephalon, dorsal view; E, cephalon, frontal view; F, pereonite 7; G, pleonites 4 and 5, telson and uropods, dorsal view; H, antennule; I, antenna.

Figure 17. *Neotroponiscus perlatus*. ♂ UFRGS 6451. A, uropod; B, pereopod 1; C, pereopod 2; D, pereopod 7; E, pleopod 1; F, pleopod 2; G, pleopod 3 exopod; H, pleopod 4 exopod; I, pleopod 5 exopod.

Figure 18. Species of *Neotroponiscus* in dorsal view. A, *N. carolii* ♂ (UFRGS 6453); B, *N. argentinus* ♀ (UFRGS 6442); C, *N. daguerrii* ♂ (UFRGS 6447); D, *N. littoralis* ♂ (MNRJ 6489); E, *N. lobatus* ♂ (UFRGS 5127); F, *N. lenkoi* ♂ (UFRGS 6474); G, *N. perlatus* ♂ (UFRGS 6451). Scale-bar: 1mm.

Figure 19. Distribution map of *Neotroponiscus* species. Type localities are numbered, followed by the distributional records. Brazilian Atlantic Forest in green.



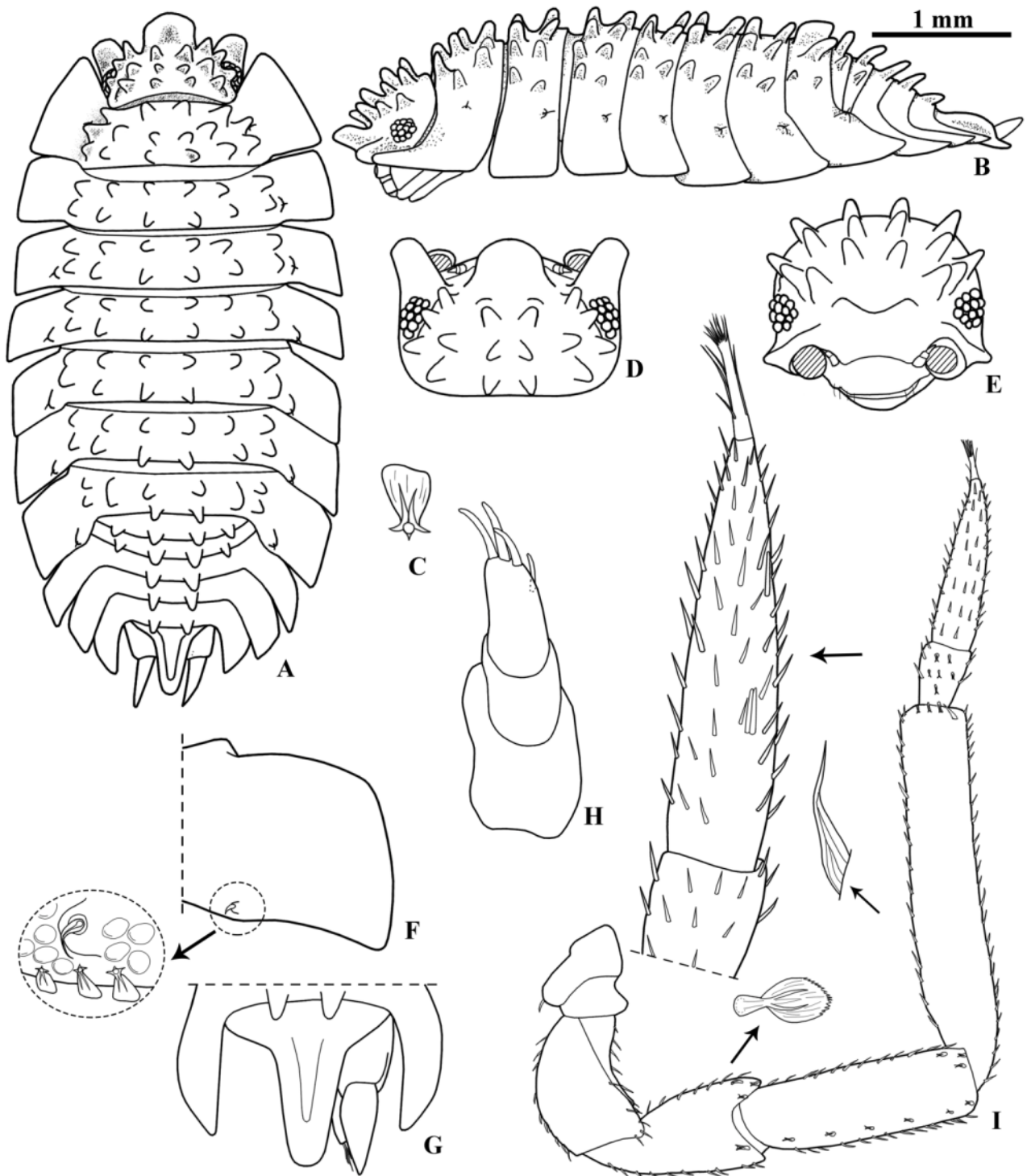


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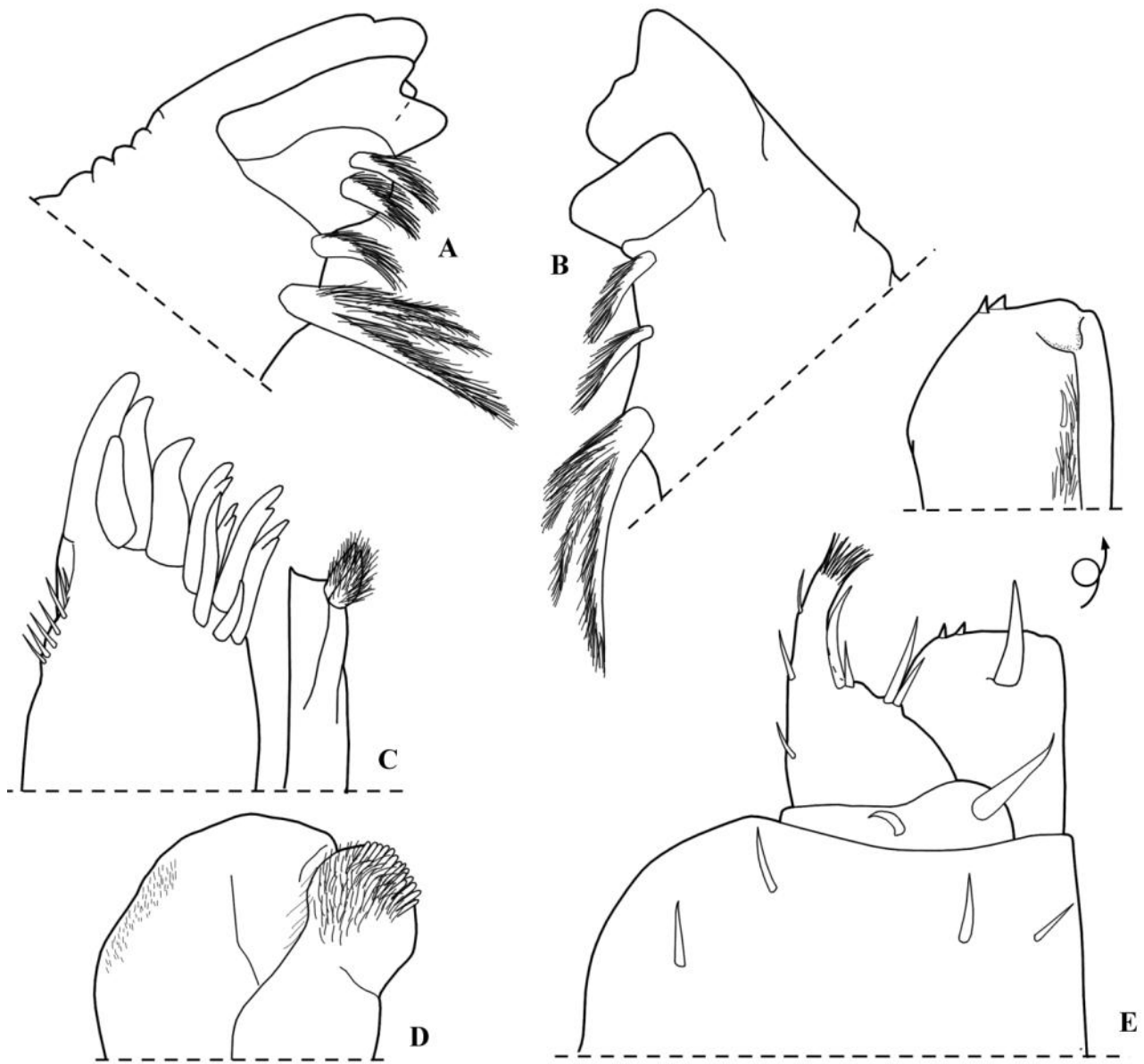


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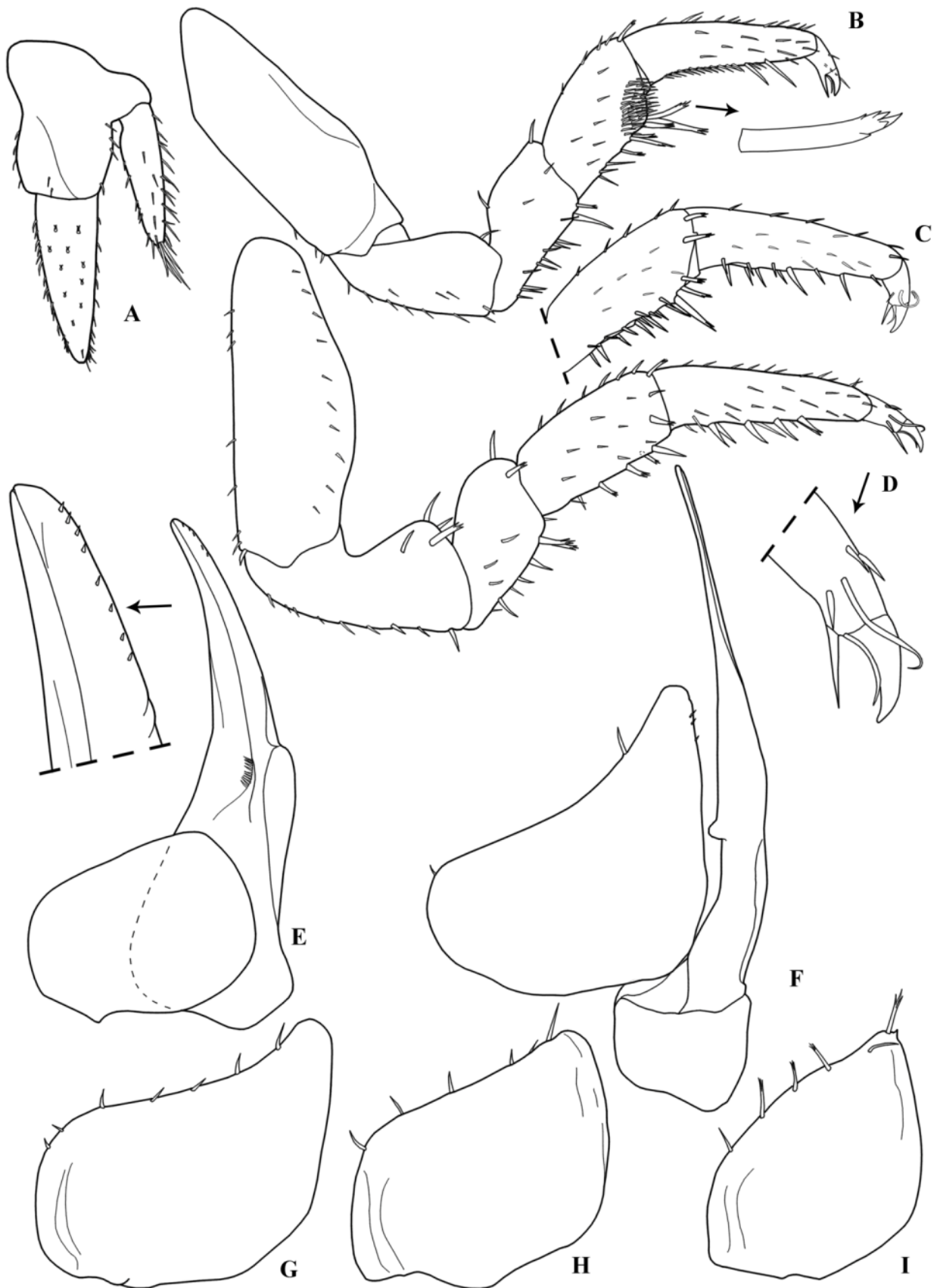


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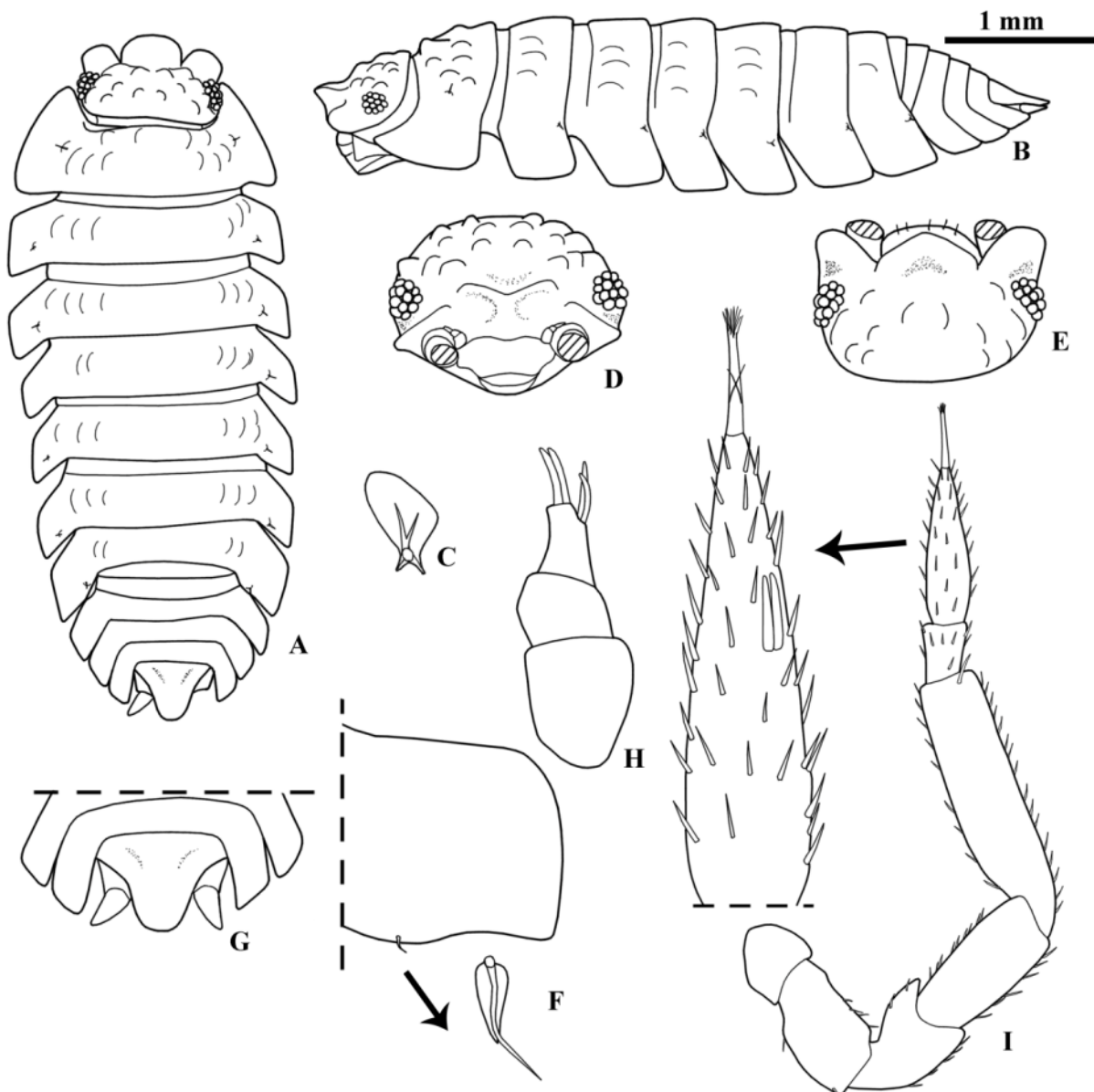


Figure 4. *Neotroponiscus argentinus*. ♀ UFRGS 6445. A, habitus, dorsal view; B, habitus, lateral view; C, scale-seta; D, cephalon, dorsal view; E, cephalon, frontal view; F, pereonite 7; G, pleonites 4 and 5, telson and uropods, dorsal view; ♂ UFRGS 6442. H, antennule; I, antenna.



Figure 5. *Neotroponiscus argentinus*. ♂ UFRGS 6442. A, uropod; B, pereopod 1; C, pereopod 2; D, pereopod 7; E, pleopod 1; F, pleopod 2; G, pleopod 3 exopod; H, pleopod 4 exopod; I, pleopod 5 exopod.

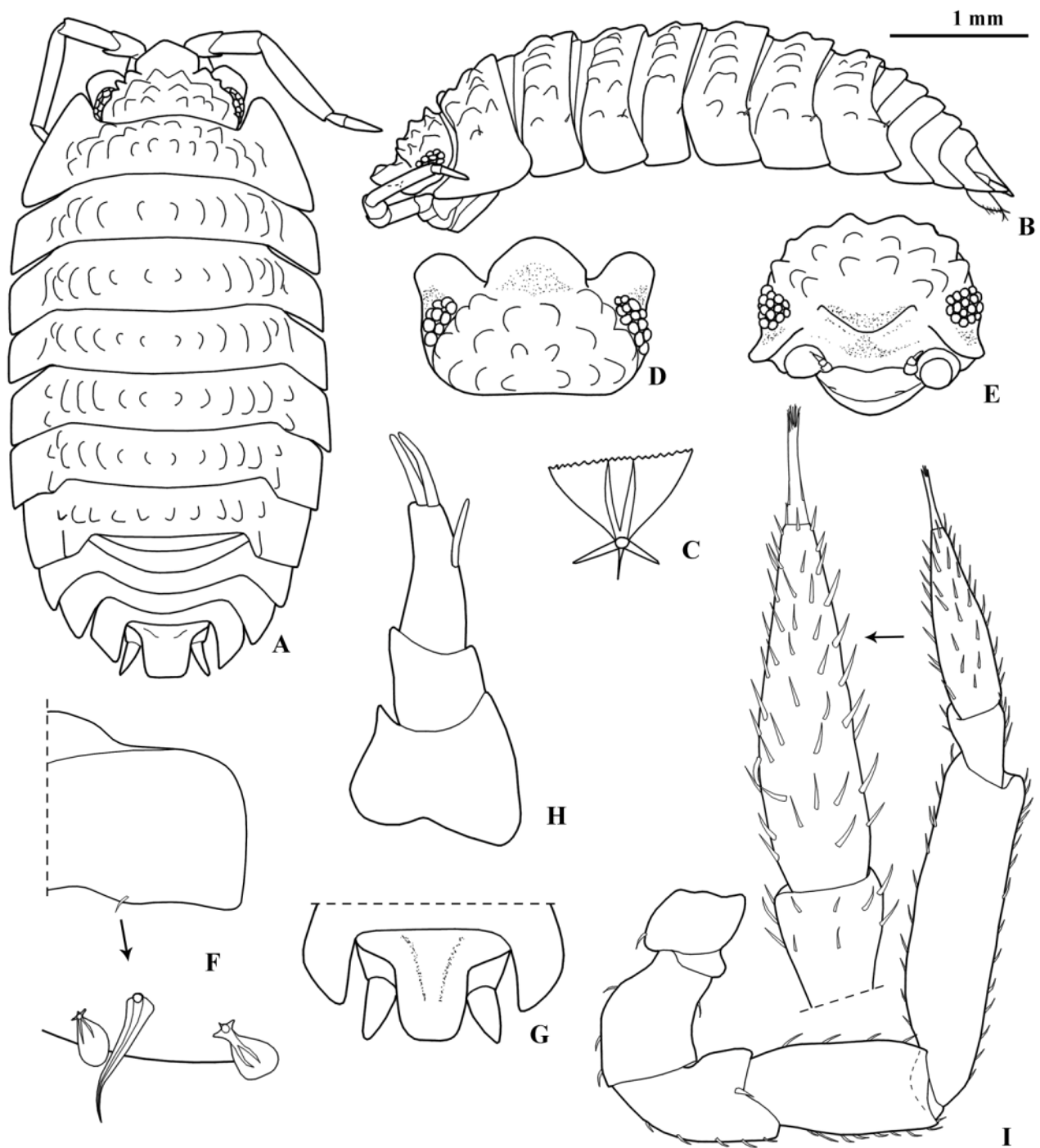


Figure 6. *Neotroponiscus daguerrii*. ♂ UFRGS 6447. A, habitus, dorsal view; B, habitus, lateral view; C, scale-seta; D, cephalon, dorsal view; E, cephalon, frontal view; F, pereonite 7; G, pleonite 5, telson and uropods, dorsal view; H, antennule; I, antenna.

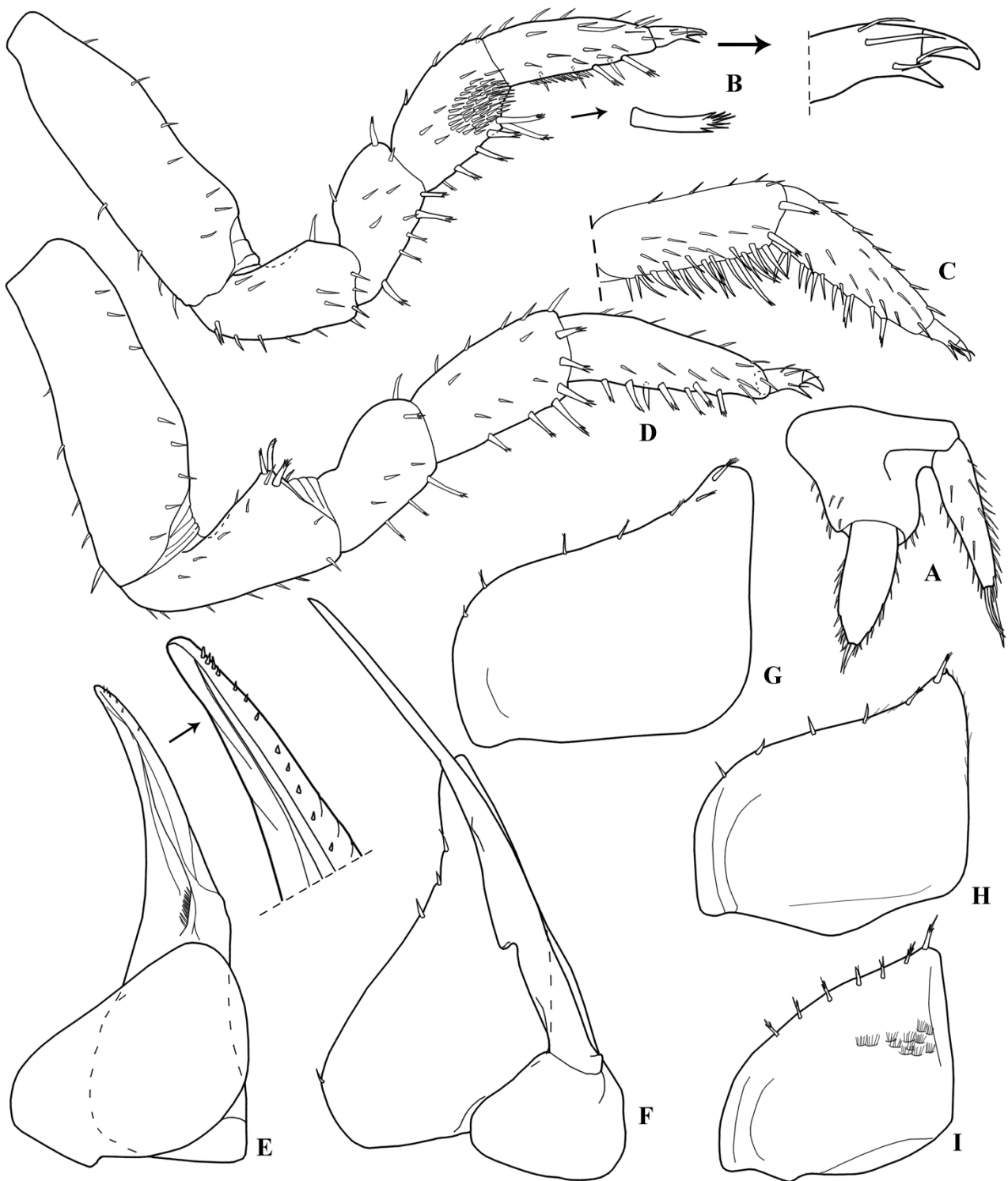


Figure 7. *Neotroponiscus daguerrii*. ♂ UFRGS 6447. A, uropod; B, pereopod 1; C, pereopod 2; D, pereopod 7; E, pleopod 1; F, pleopod 2; G, pleopod 3 exopod; H, pleopod 4 exopod; I, pleopod 5 exopod.



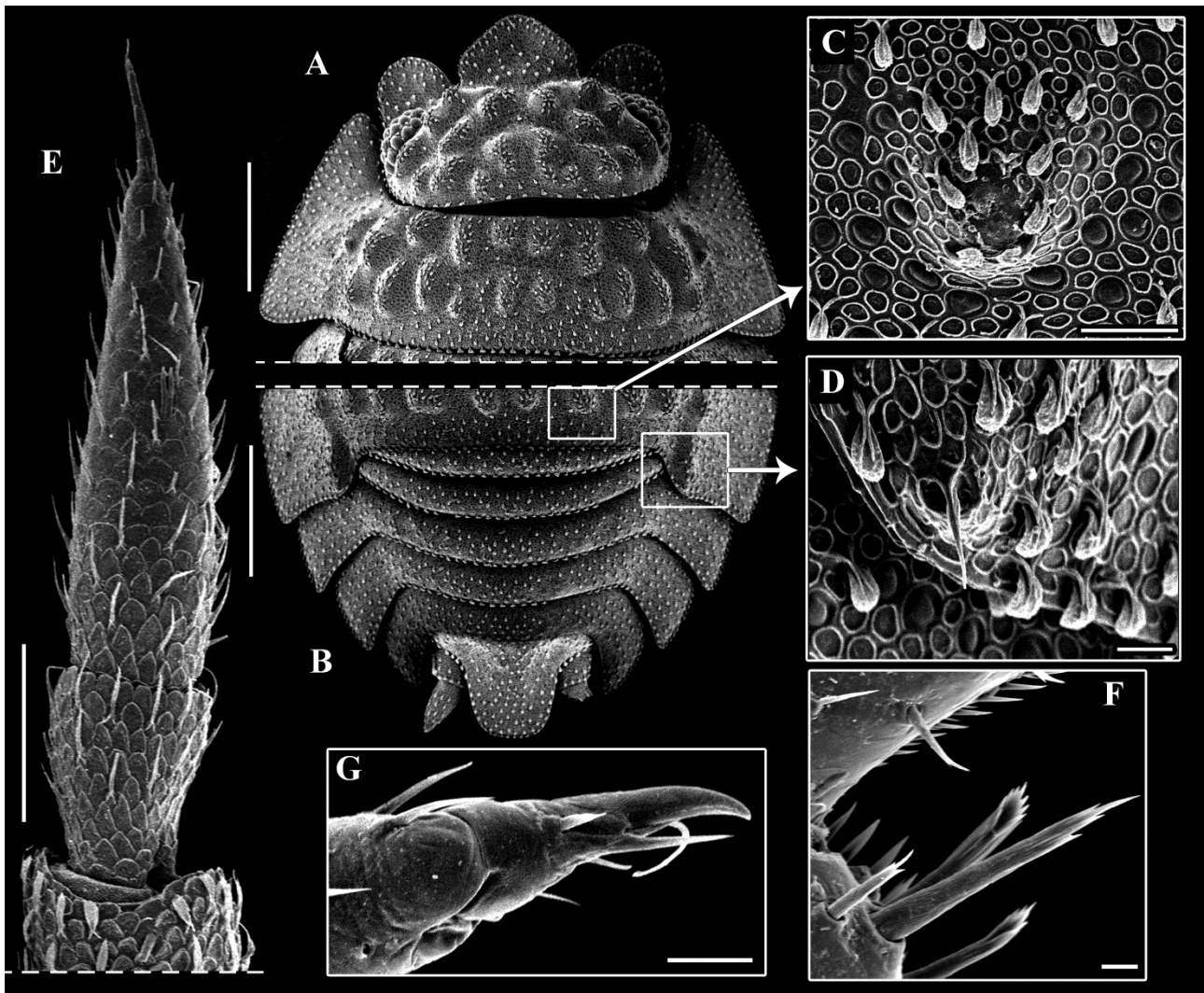


Figure 8. *Neotroponiscus daguerrii*. ♂ UFRGS 6447. A, cephalon and pereonite 1, dorsal view; B, pereonite 7, pleon, telson and uropods, dorsal view; C, tubercle on pereonite 7; D, pereonite 7 outmost tubercle; E, flagellum of antenna; F, pereopod 1, setae on carpus; G, pereopod 1, dactylus. Scale bars: A, B 200  $\mu$  m, C 50  $\mu$  m, D, G 20  $\mu$  m, E 100  $\mu$  m, F 10  $\mu$  m.



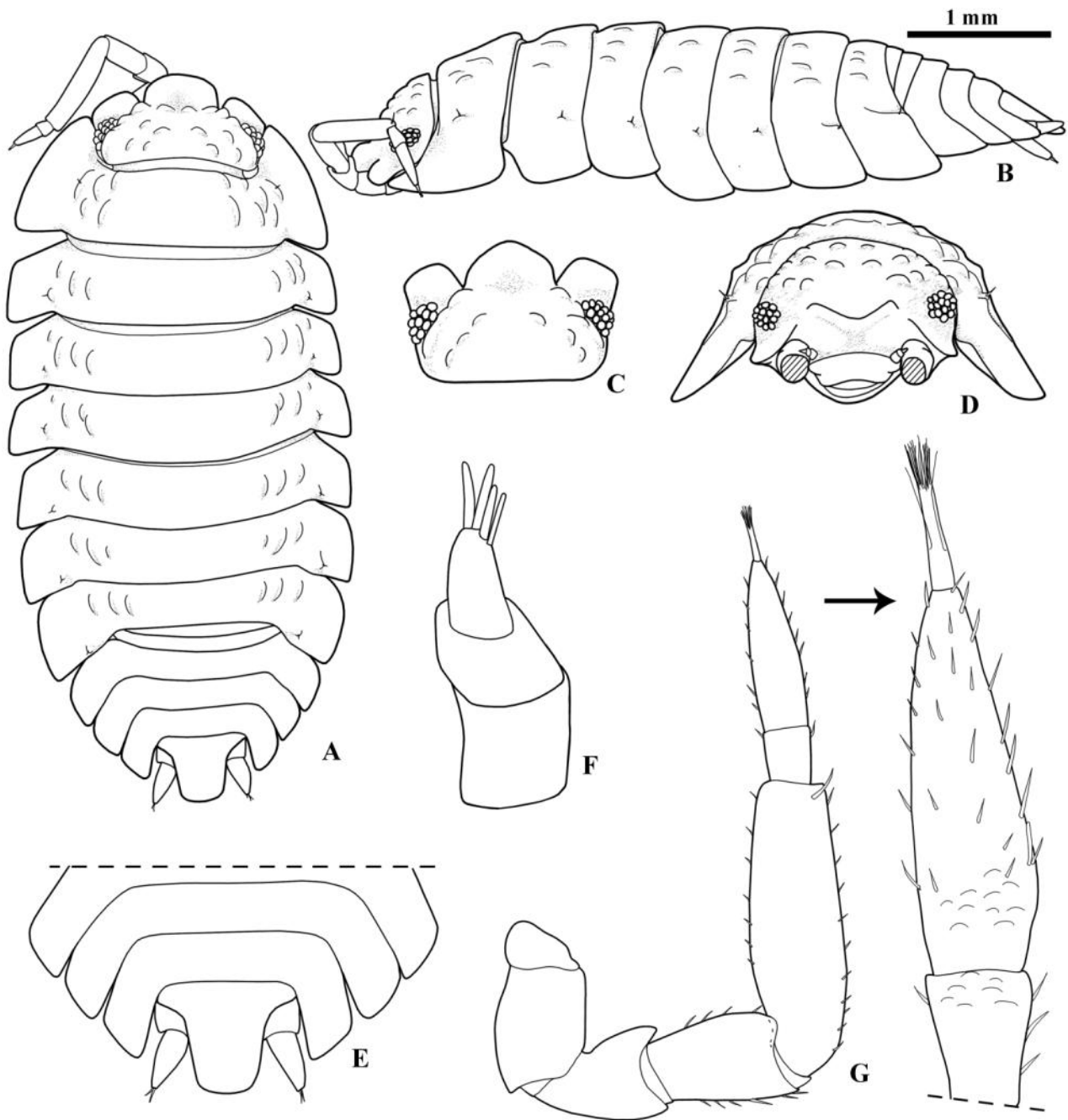


Figure 9. *Neotroponiscus plaumanni*. ♂ UFRGS 6281. A, habitus, dorsal view; B, habitus, lateral view; C, cephalon and pereonite 1, dorsal view; D, cephalon, frontal view; E, pleonites 3-5, telson and uropods, dorsal view; F, antennule; G, antenna.

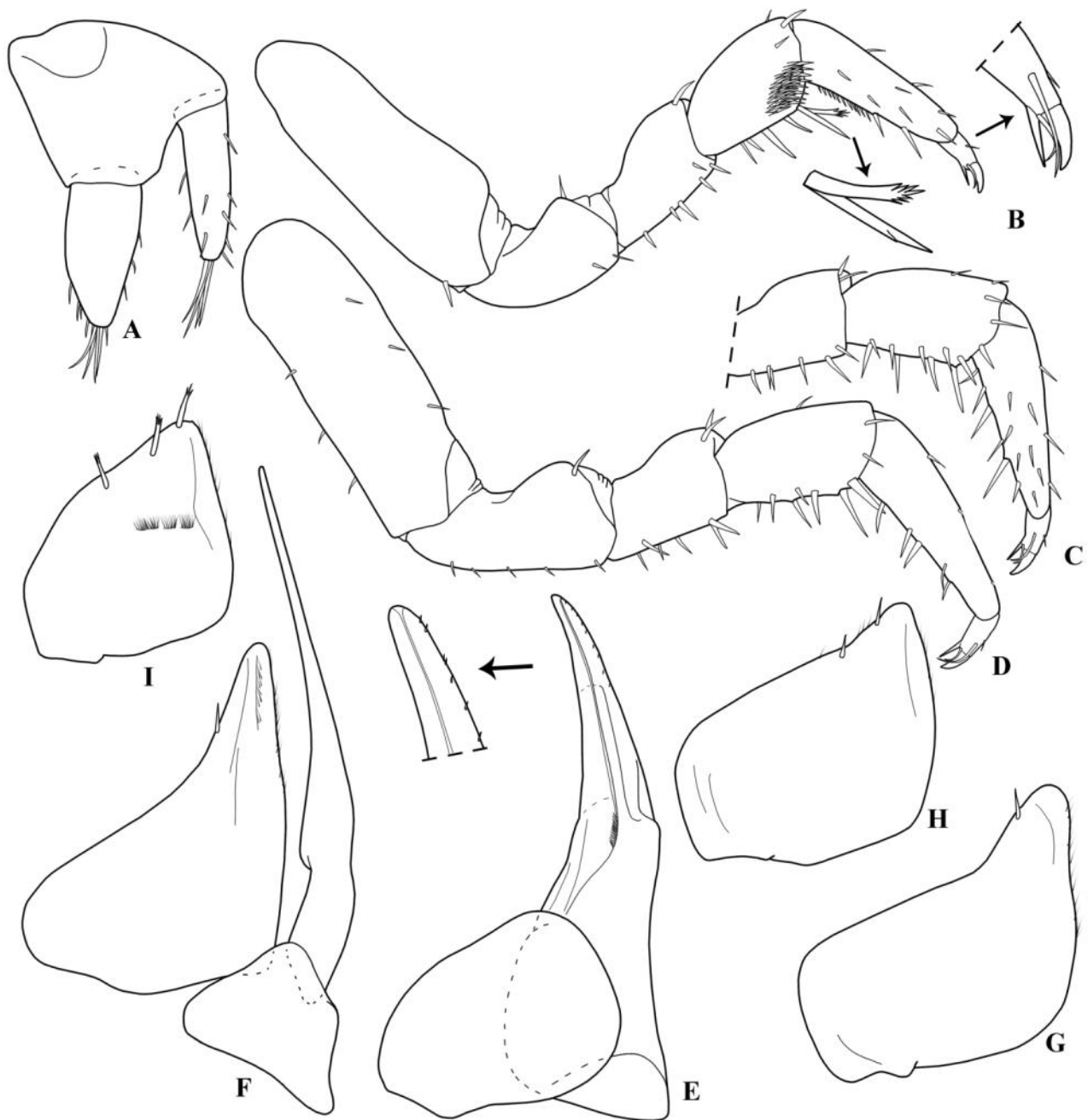


Figure 10. *Neotroponiscus plaumanni*. ♂ UFRGS 6281. A, uropod; B, pereopod 1; C, pereopod 2; D, pereopod 7; E, pleopod 1; F, pleopod 2; G, pleopod 3 exopod; H, pleopod 4 exopod; I, pleopod 5 exopod.

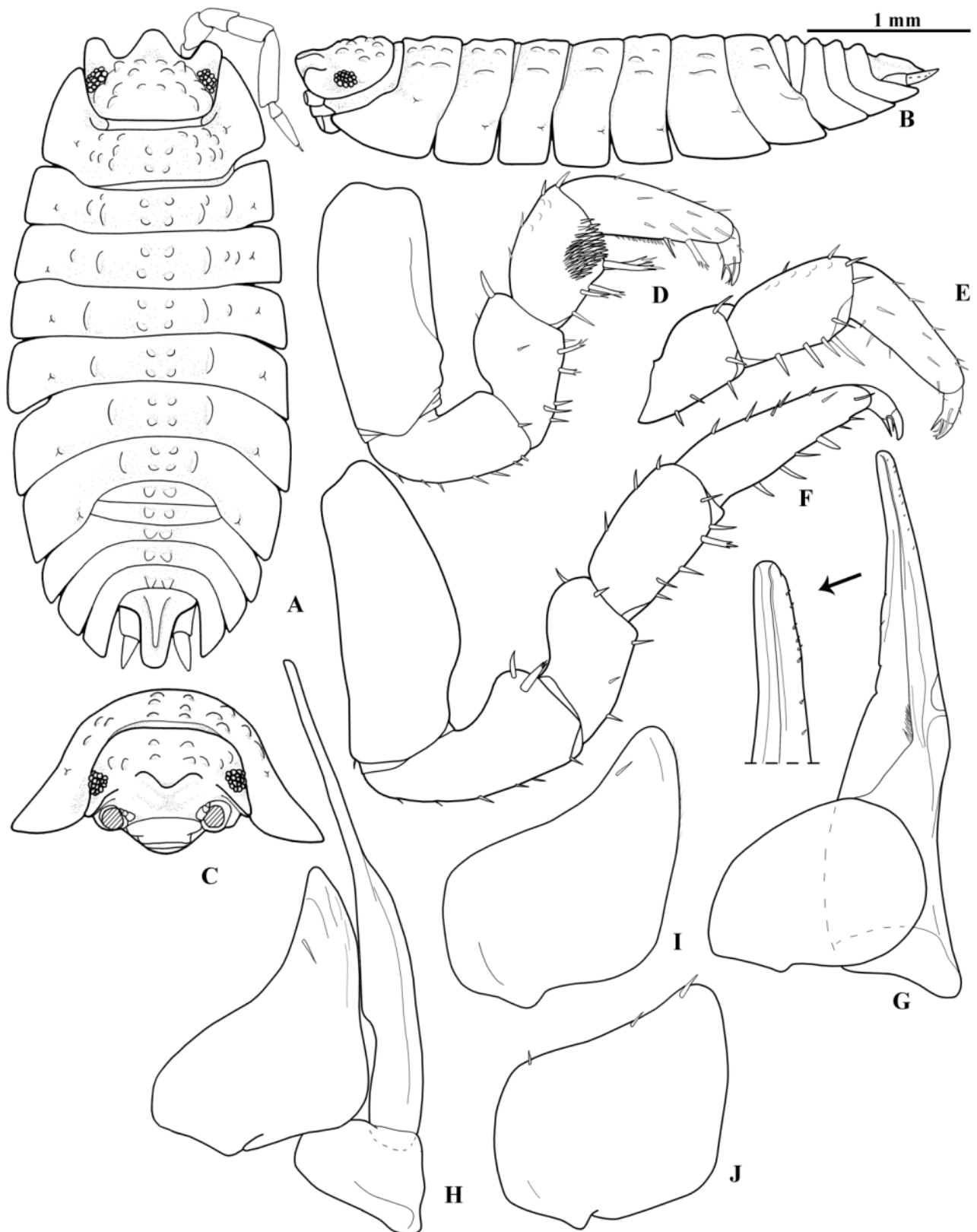


Figure 11. *Neotroponiscus littoralis*. ♂ MNRJ 6489. A, habitus, dorsal view; B, habitus, lateral view; C, cephalon and pereonite 1, frontal view; D, pereopod 1; E, pereopod 2; F, pereopod 7; G, pleopod 1; H, pleopod 2; I, pleopod 3 exopod; J, pleopod 4 exopod.

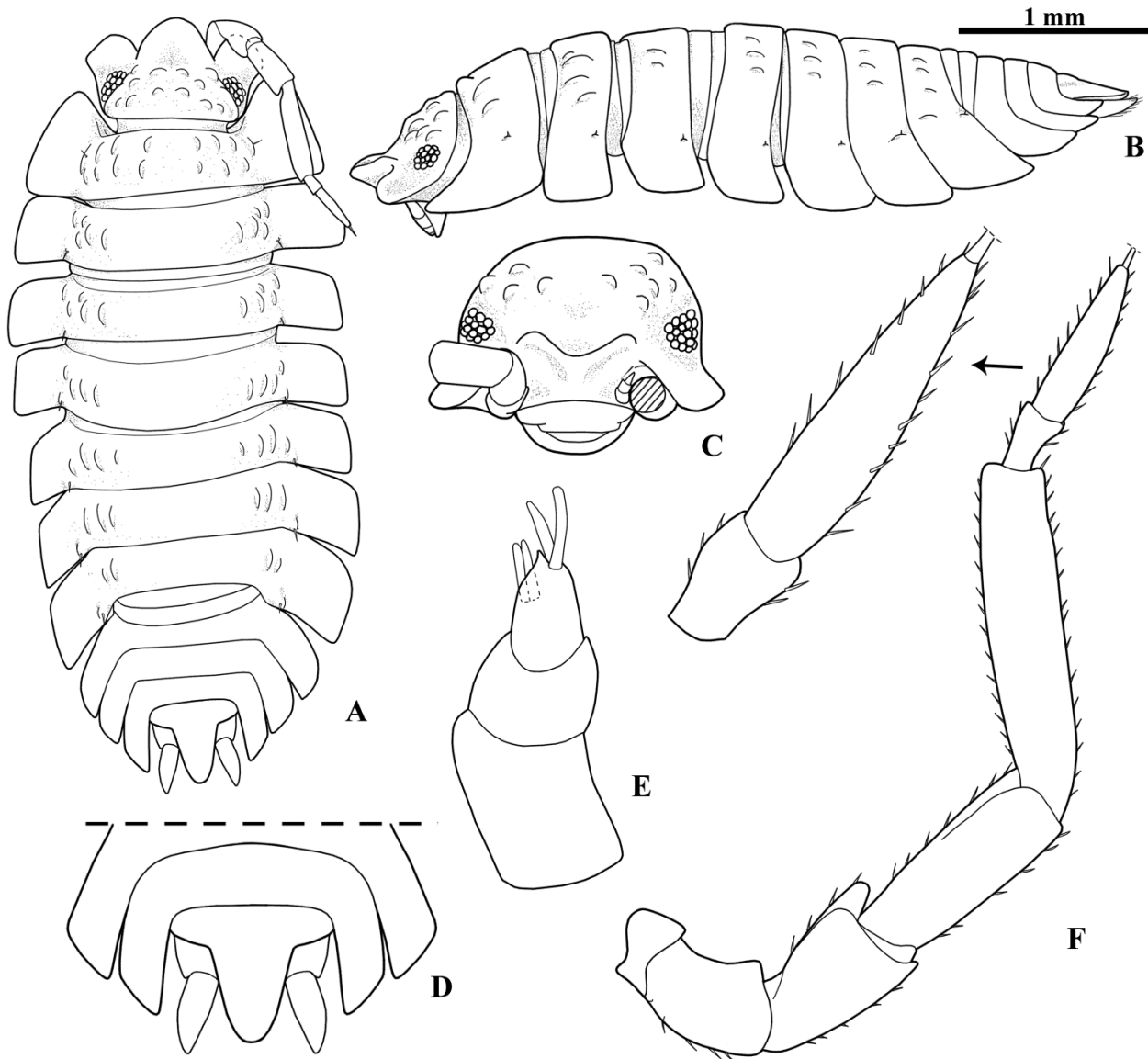


Figure 12. *Neotroponiscus lobatus*. ♂ UFRGS 5127. A, habitus, dorsal view; B, habitus, lateral view; C, cephalon, frontal view; D, pleonites 4 and 5, telson and uropods, dorsal view; E, antennule; F, antenna.

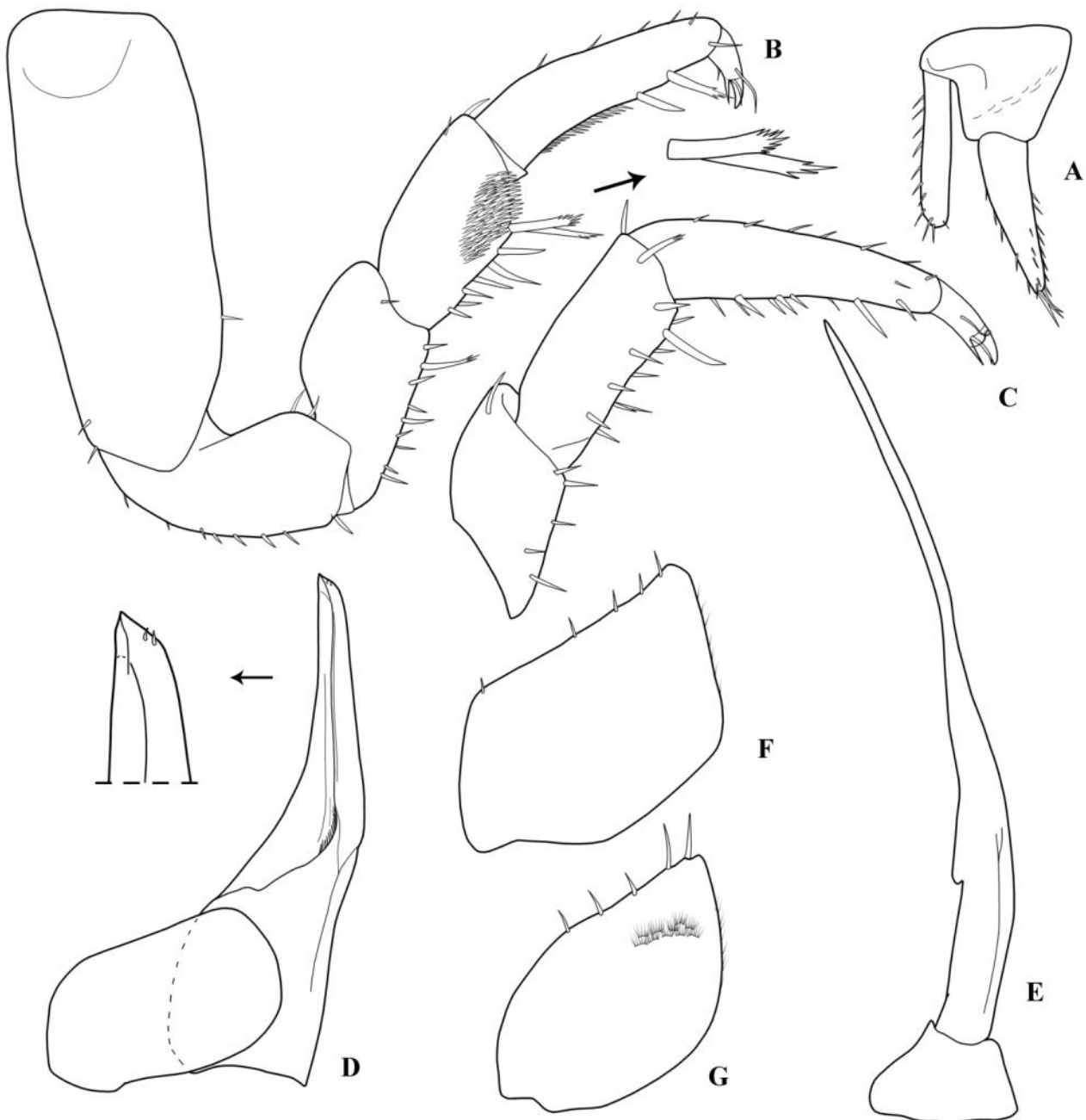


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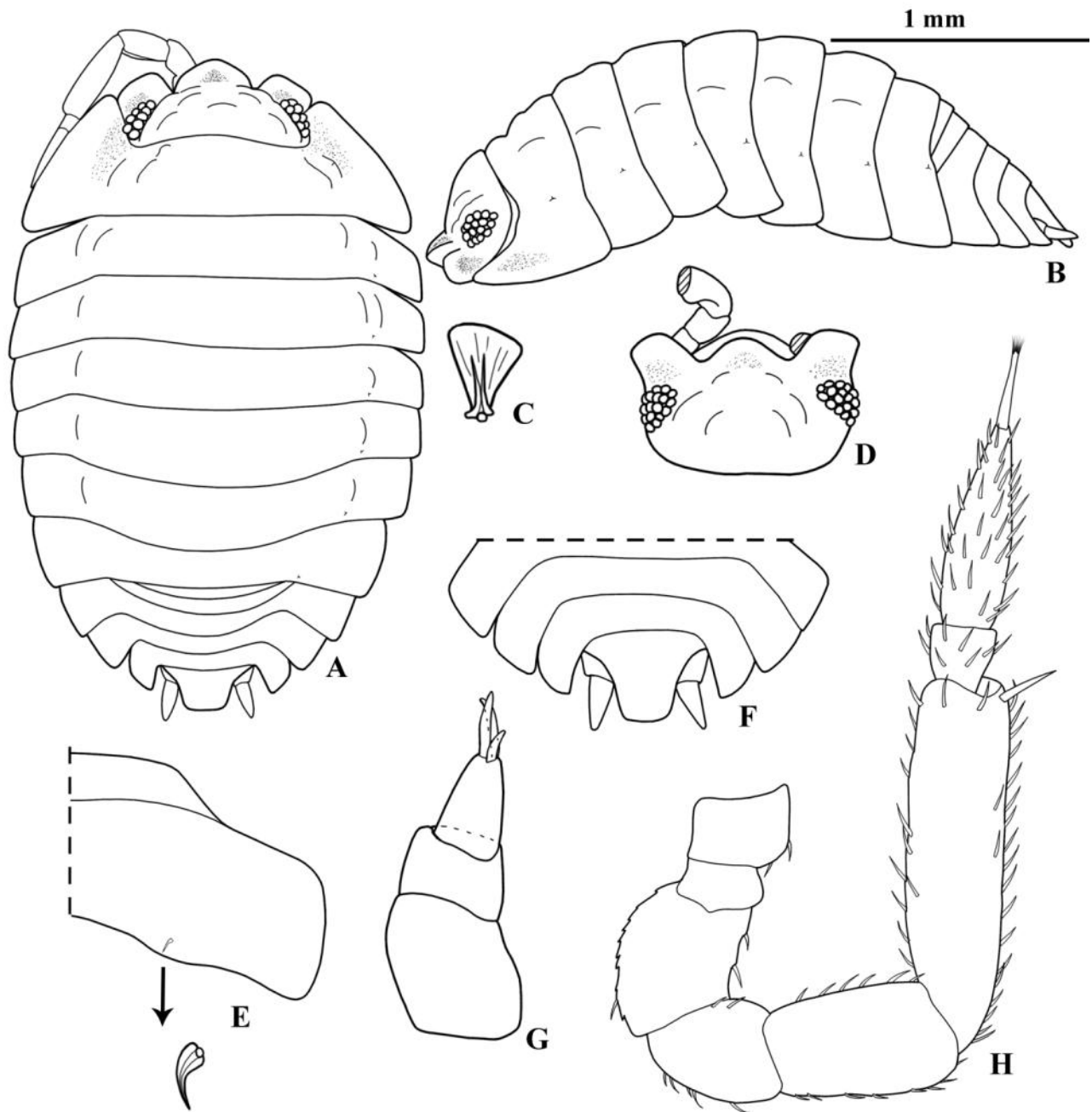


Figure 14. *Neotroponiscus lenkoi*. ♂ MZUSP 24295 A, habitus, dorsal view; B, habitus, lateral view; UFRGS 6474 C, scale-seta; D, cephalon, dorsal view; E, pereonite 7; F, pleonites 3–5, telson and uropods, dorsal view; G, antennule; H, antenna.

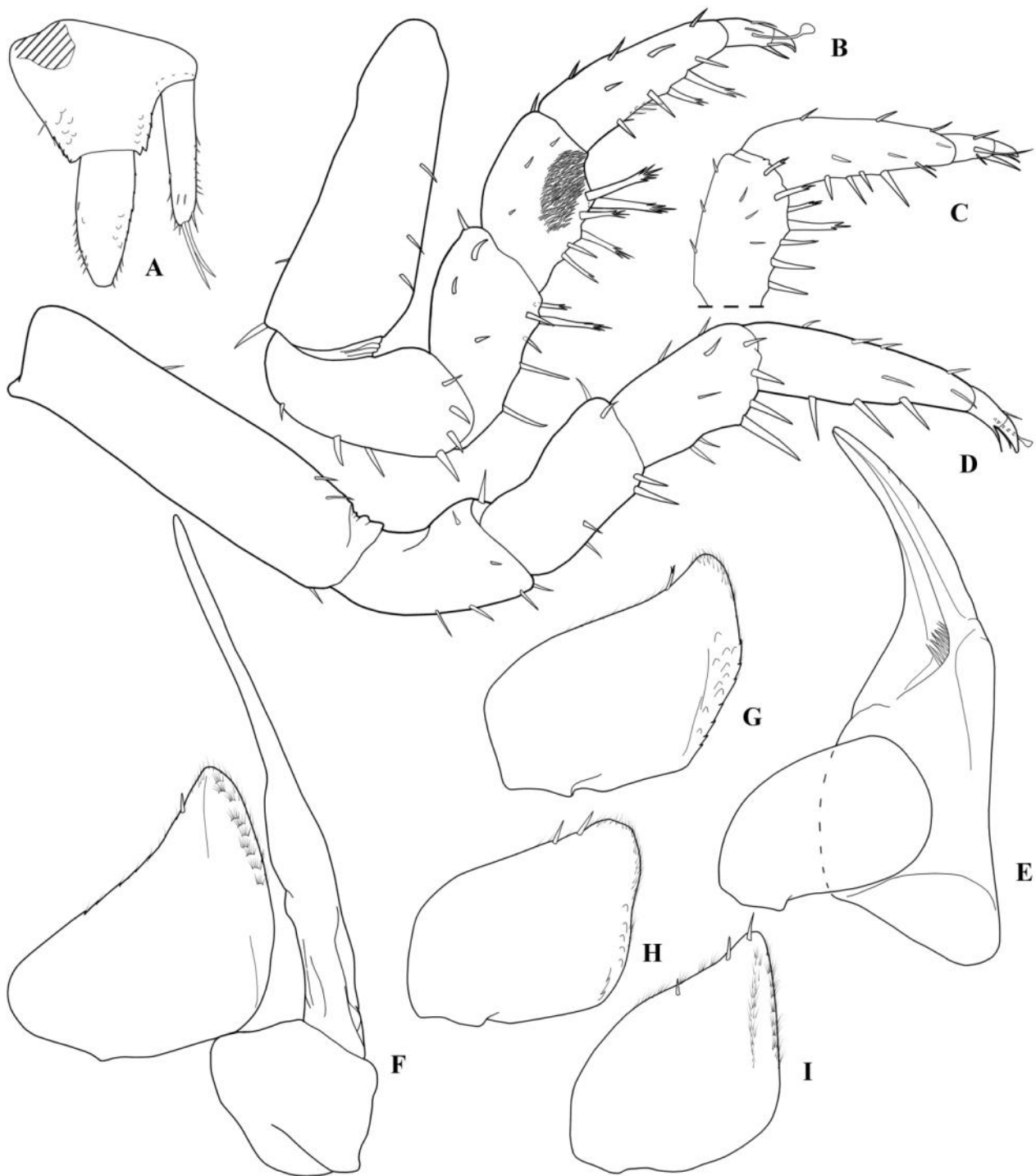


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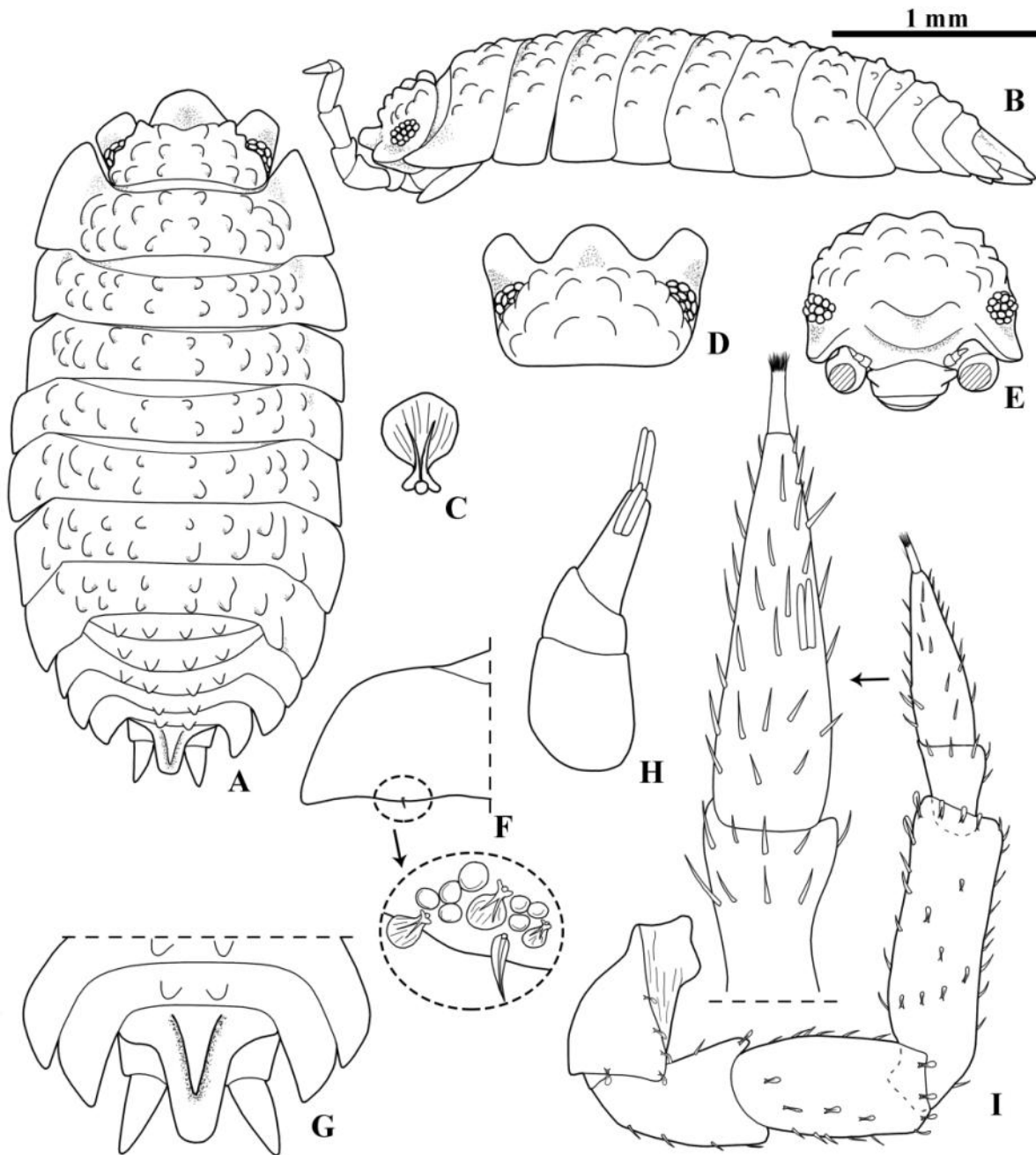


Figure 16. *Neotroponiscus perlatus*. ♂ UFRGS 6451. A, habitus, dorsal view; B, habitus, lateral view; C, scale-seta; D, cephalon, dorsal view; E, cephalon, frontal view; F, pereonite 7; G, pleonites 4 and 5, telson and uropods, dorsal view; H, antennule; I, antenna.



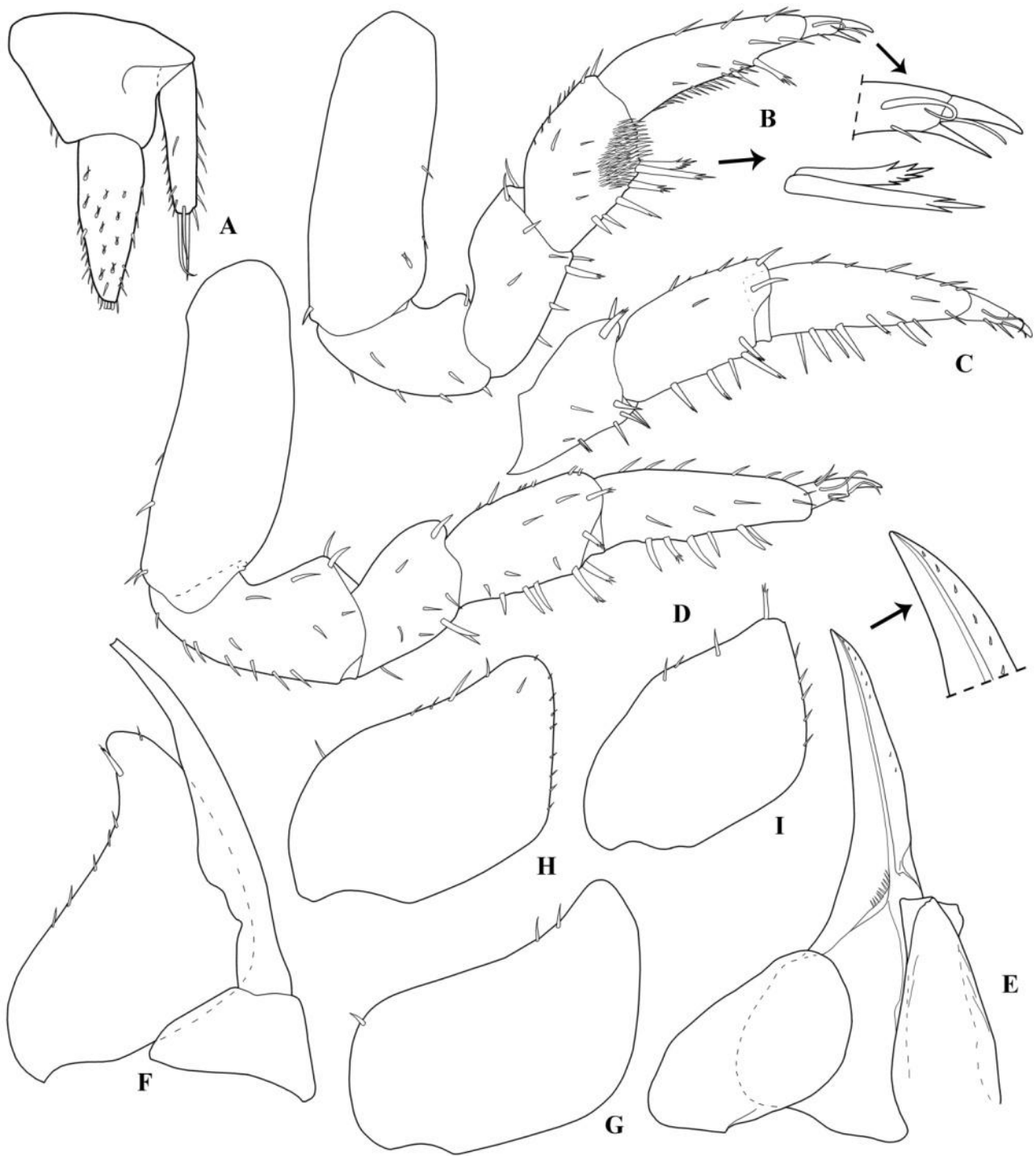


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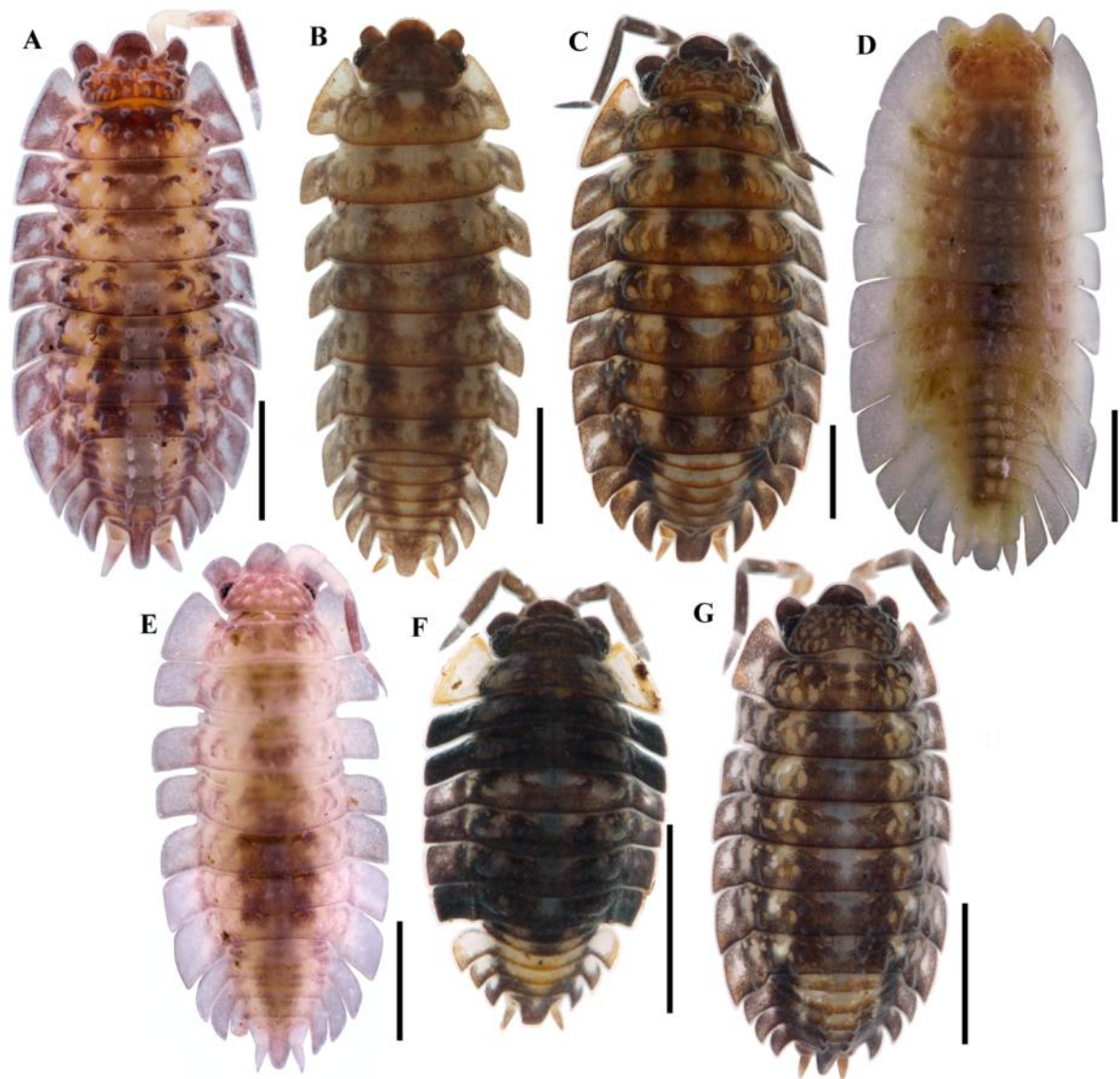


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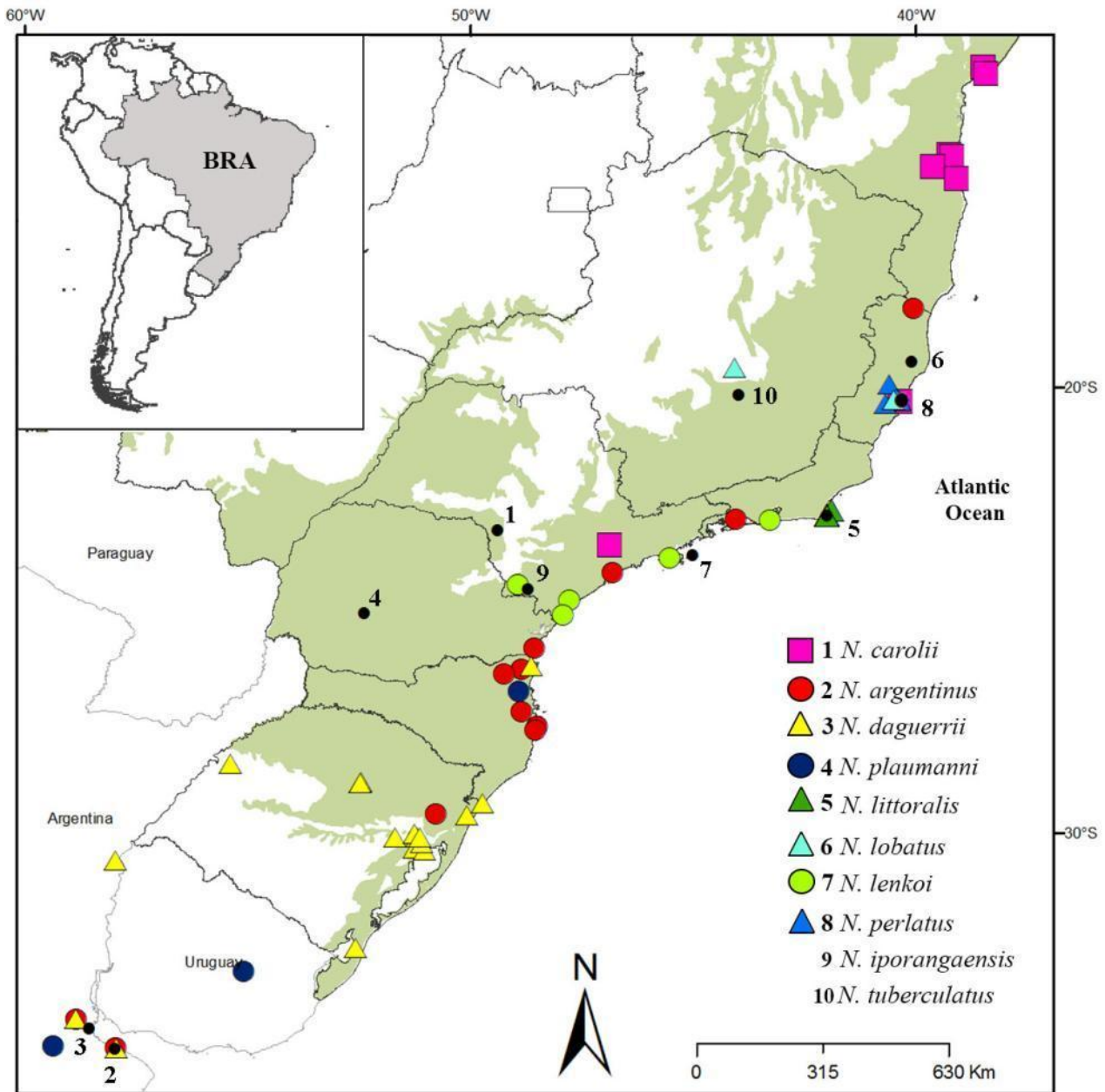


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**Phylogenetic relationships of the terrestrial isopod *Neotroponiscus* Arcangeli, 1936 based on Total evidence analysis (Isopoda, Oniscidea, Bathytropidae), with description of new species**

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**Abstract**

The phylogenetic relationships of the genus *Neotroponiscus* is addressed for the first time with the use of molecular and morphological data. The monophyly of the genus was tested and our results show that *Neotroponiscus* can be considerate monophyletic, and indicate that the family is composed by the genera *Bathytropa* and *Neotroponiscus*. With the aim of this approach three new species of *Neotroponiscus* could be identified. Further analyses with additional data are needed to infer the position of the other taxa placed in this family.

**Keywords:** Terrestrial isopods, woodlice, neotropics.

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**Abstract**

The phylogenetic relationships of the genus *Neotroponiscus* is addressed for the first time with the use of molecular and morphological data. The monophyly of the genus was tested and our results show that *Neotroponiscus* can be considerate monophyletic, and indicate that the family is composed by the genera *Bathytropa* and *Neotroponiscus*. With the aim of this approach three new species of *Neotroponiscus* could be identified. Further analyses with additional data are needed to infer the position of the other taxa placed in this family.

**Keywords:** Terrestrial isopods, woodlice, Neotropics.

## Introduction

The genus *Neotroponiscus* Arcangeli, 1936 includes ten species occurring in Brazil, Argentina and Uruguay (Lemos de Castro 1970a,b, Cardoso *et al.* 2017 *in press*, Cardoso & Araujo *in prep*). The genus is mainly recognized by the presence of cephalic lobes, antenna with bi-articulated flagellum, shape and disposal of dorsal tubercles, and well-developed epimera (Lemos de Castro 1970a, b). However, as usual for isopods, the differences between species rely on subtle morphological characteristics, often from male morphology and many of these characteristics may be a reflex of intraspecific variations (Poulakakis & Sfenthourakis 2008).

In the last years, molecular studies in a phylogenetic context within terrestrial isopods have increased in order to elucidate the relationships between genera, species and populations (Klossa-Kilia *et al.* 2006, Parmakelis *et al.* 2008, Poulakakis & Sfenthourakis 2008, Karasawa & Honda 2012, Kamilari *et al.* 2014, Lee *et al.* 2014; Raupach *et al.* 2014, Javidkar *et al.* 2015, Zimmermann *et al.* 2015, Karasawa 2016).

Studies regarding the phylogenetic relationships of terrestrial isopods from the Neotropics addressed mainly the families Philosciidae and Scleropactidae (Leistikow 1999, 2000, 2001a, 2001b, 2001c, Leistikow & Schmidt 2002, Schmidt 2002, 2003, 2008). The work of Zimmermann *et al.* (2015) used molecular data to reveal the phylogenetic relationships within the genus *Atlantoscia* Ferrara & Taiti, 1981.

This work aims to address for the first time the phylogenetic relationship within the genus *Neotroponiscus* into an integrative view, with the use of molecular and morphological data. Also, it will provide the first approach of the relationships within the family, testing the monophyly of other genera placed in the family until the moment. In addition, *Neotroponiscus* sp. n. from the states of Bahia, Rio de Janeiro and Rio Grande do Sul, resulted from this analysis, are described.

## Material and methods

### Taxon sampling

The specimens were collected between March 2013 and February 2014, along the Brazilian Atlantic forest from the states of Bahia to Rio Grande do Sul, and stored in 100% ethanol.

The material is deposited at the Coleção de Crustáceos do Departamento de Zoologia (UFRGS). Other material examined in this study are deposited in the Museo Argentino de Ciencias Naturales “Bernardino Rivadavia” (MACN), Buenos Aires, Argentina; Muséum

National d' Histoire Naturelle (MNHN), Paris, France and Museo di Storia Naturale dell' Università di Firenze, 'La Specola' (MZUF), Florence, Italy (Table 1).

For the phylogenetic analyses, the ingroup includes all species of *Neotroponiscus*. The outgroups used to polarize the character states and to test the monophyly of *Neotroponiscus* (sensu Nixon & Carpenter 1993), included the other genera of Bathytropidae (*Laninoniscus* Reca, 1973, *Dumetoniscus* Taiti & Checcucci, 2009, *Papuasoniscus* Vandel, 1973, *Monitus* Lewis, 1998, *Bathytropa* Vandel, 1954), and representatives of the families Scleropactidae (1 sp.), Armadillidiidae (2 spp.), Dubioniscidae (2 spp.), Platyarthridae (3 spp.), Pudeoniscidae (5 spp.), Trachelipodidae (3 spp.), Porcellionidae (2 spp.) and Oniscidae (1 sp.) (Table 1).

Some molecular data could not be obtained for four species whose specimens were obtained solely from scientific collections (*N. plaumanni* (Andersson, 1960), *N. littoralis* Lemos de Castro, 1970, *N. lobatus* Lemos de Castro, 1970 and *N. tuberculatus* Cardoso & Araujo, 2017). Also, since it was not possible to obtain DNA sequence of *Bathytropa* nor for the other genera of the family, the taxa are presented only in the complete dataset for the total evidence analyses. The total evidence matrix with complete taxon sampling includes 63 terminals with root at *Circoniscus bezzi* Arcangeli, 1931 (Scleropactidae). A reduced matrix was tested with the species with at least one DNA marker (41 taxa). Some sequences of the outgroup are available in GenBank (NCBI) and were combined hereto build the phylogenetic tree (see Table 1).

### **Morphological analysis**

The specimens were dissected (appendages and pereonites) and mounted on semi-permanent slides in Hoyer medium. The illustrations were made with the aid of a *camera lucida* on Olympus CX31 microscope and pictures were obtained with Nikon AZ100. The cuticular structures were studied in a JSM 6060 scanning electron microscope (SEM) at the Centro de Microscopia Eletrônica at UFRGS. The final illustrations were prepared according to Montesanto (2015, 2016).

The character matrix was built using Mesquite 3.2 (Maddison & Maddison 2017). Characters were coded to include most of the morphological variations. Some characters were adapted from Leistikow (2001a) and Schmidt (2002, 2007) and some new characters are proposed here, most from dorsal cuticular structures, whose definition were based on Holdich & Lincoln (1974) and Vandel (1960). The characters were coded as proposed by Sereno (2007), and treated as unordered (Fitch 1971, Swofford & Maddison 1992). The characters

list and states are available in Table 2 (see Appendix S1 for matrix). Missing data were coded as '?' and inapplicable characters as '-'.

The search for the most parsimonious tree was performed on TNT 1.1 (Goloboff *et al.* 2008), and the characters were treated as equally weighted (EW). The EW search was conducted with New Technology Search, with random seed=1 and 100 hits (replications). The parameters were adjusted as follow: Ratch parsimony (Nixon 1999) with 25 up and 5 down-weighting with 20 interactions, trying to explore a wide range of most parsimonious tree in the tree space, increasing accuracy and reducing search time; Tree Drifting (Goloboff 1999) with 20 cycles, and Tree fusing (Goloboff 1999) with 100 interactions, in order to increase the congruence (see also Paladini *et al.* 2014). The Jackknife symmetrical resampling (SR) adopted here as support measure, with the parameters adjusted as follow: 5000 replicates, with 100 additional replicates and 10 trees saved per replicate with SPR+TBR swapping, performed with Traditional Search in TNT (Felsenstein 1985).

#### **DNA extraction, amplification and sequencing**

Specimens were dissected before the extraction. DNA was extracted with PureLink® Genomic DNA (Invitrogen/K1820-01) according to the manufacturer's instructions. For the *COI* gene, the primers LCO (5'-GGTCAACAAATCATAAAGATATTGG-3') and HCO (5'-TAAACTTCAGGGTGACCAAAAAATCA-3) were used (Folmer *et al.*, 1994); and for *18s*, the primers SSU04 (3'-GCTTGTCTCAAAGATTAAGCC-5') and SSU22 (3'-GCCTGCTGCCTTCCTTGGA-5') were used (Blaxter *et al.* 1998). PCR reactions were performed with a final volume of 25 µl, using 1.0 µl DNA, 0.16 µl Taq Platinum (5U/µl), 2.5 µl 10X buffer, 1.66 µl MgCl<sub>2</sub> (50 mM), 0.5 µl of each forward and reverse primer (20 µM), 0.5 µl dNTPs (10 mM) and 18.1 µl ultrapure water. For the amplification of *COI*, the program was used with denaturation step temperature of 95 °C for 5"; annealing with 35 cycles (95 °C for 50', 52 °C for 50' and 72 °C for 50') and extension of 72 °C for 5"; and for *18s* the program was used with denaturation step temperature of 94 °C for 5"; annealing with 35 cycles (94 °C for 30', 52 °C for 50' and 72 °C for 2" 30') and extension of 72 °C for 10". PCR products were purified and sequenced by Macrogen, Inc. (Seoul, South Korea).

The sequences were verified using BLAST (<http://blast.ncbi.nlm.nih.gov/Blast.cgi>) to confirm their validity with the terrestrial isopods species. The sequences were visually inspected and manually edited using MEGA 6 (Tamura *et al.* 2013). All gene sequences generated in this study will be deposited in the GenBank database (<http://www.ncbi.nlm.nih.gov/>), accession numbers (XXXXXX to XXXXXX), shown in Table 1.



## Sequence alignment and genetic divergence analysis

Individual gene alignments were performed using the Clustal W algorithm (Thompson *et al.* 1994), implemented in MEGA 6. The pairwise genetic divergences of sequences were calculated using the Kimura two-parameter (K2P) substitution model (Kimura, 1980) in MEGA 6, with 10 000 bootstrap replicates (Hebert *et al.* 2003).

The concatenated alignment were exported as fasta files, then merged with the morphological dataset on Mesquite (Maddison & Maddison 2017), and the final matrix was exported as NEXUS format to conduce the Bayesian analysis.

## Phylogenetic analyses

The Bayesian inferences were performed using MrBayes 3.2.6 (Ronquist & Huelsenbeck 2003) on the CIPRES science gateway (Miller *et al.* 2010). The inferences were constructed for each gene, for the concatenated gene dataset, and for total evidence dataset.

The best substitution model was tested on jModelTest 2.1.3 (Darriba *et al.* 2012) under the Akaike Information Criterion (AIC - Akaike 1974) for each gene and GTR+I+G was selected for both data. The morphological data was analyzed under Mk model (Lewis 2001), implemented in MrBayes v3.2.6, based on unordered characters and assuming a gamma-distributed rate generations of the Markov chain Monte Carlo (MCMC). It was used two runs of four million MCMC generations and four chains, sampling every 1,000 generations. The first 25% of the recovered topologies were discarded as burn-in, and the efficiency of the chain was assessed using Tracer v1.6 (Rambaut *et al.* 2015). Final topologies were visualized and edited on Figtree 1.4.0 (Rambaut *et al.* 2014).

## Results

### Morphological analyses

In the morphological analysis 87 characters were codified, 20 of them proposed here (see Table 2). The missing data had the percentage ratio of 4.9% and the inapplicable characters of 3.3%. The EW parsimony analyses produced 38 equally parsimonious trees, with length of 488 steps (CI = 0.32; RI = 0.60), and the *strictus consensus* resulted in a tree with length 503 steps (CI = 0.31; RI = 0.58), forming a polytomic clade (Appendix S2).

The genus *Neotroponiscus* was recovered with one main clade, including almost all species of the genus, and only *N. lobatus* and *N. lenkoi* were recovered out of this clade. The main clade and these two species of the genus were recovered with unsolved relations with

the genus *Bathytropa* and the family Platyarthridae. Sinapomorphic characters for this analysis can be seen in the supplementary material (Appendix S2).

Regarding Bathytropidae, in none of the most parsimonious trees the other genera of the family showed relationships with *Bathytropa* and/or *Neotroponiscus*.

Other important result observed here was the monophyly of the families Pudeoniscidae and Platyarthridae, recovered in the most parsimonious trees.

### **Molecular phylogenies results**

A total of 47 sequences (from *COI* and *18s*) were generated from 29 individuals of *Neotroponiscus* collected in the Brazilian Atlantic forest (Fig 1). All sequences were reduced to the length of the shortest sequence to eliminate spurious values due to unequal sequence length. The final alignment consisted of sequences with 965 bp (being 492 bp for *18s* from 41 species and 472 bp for *COI* from 30 species).

Sequences of the *18s* nucleotide showed 207 variable sites (44.2%), and 155 parsimony informative (33.1%); and of *COI* nucleotide showed 258 variable sites (54.6%), and 225 parsimony informative (47.6%). Within *Neotroponiscus* the sequence divergence of *18s* nucleotide ranged from 0 to 12.4% (average of 6.2%) and *COI* nucleotide from 0 to 24.2% (average of 18.8%) (Appendix S3). Base frequencies for *COI* were composed by A: 25, C: 16.1, G: 21, T 37.9; while *18s* were composed by A: 21.9, C: 23.7, G: 27.9, T 26.6. The average AT content (%AT = 62.9) was higher for *COI* sequences than *18s* (%AT = 48.5). The results for molecular analyses (genes and concatenated dataset) were congruent (Fig 2; Appendix S2) and supported the monophyly of the *Neotroponiscus*.

The Bayesian analyses with the concatenated genes recovered the *Neotroponiscus* clade with *N. lenkoi* as basal taxon and relatively low supported (pp=0.8). *Neotroponiscus lenkoi* showed the highest diversity in relation to the other species, in which the *18s* sequences estimated divergence with *Neotroponiscus* sp. 2 was 12%; in the *COI* sequences the divergence was 24% between *Neotroponiscus* sp. 3 and *Neotroponiscus* sp. 1 (Appendix S3). The clade further divides into two groups, clade A and B, both strongly supported (pp= 0.9 and 1, respectively) (Appendix S2). The Clade A comprises *N. daguerrii*, *N. argentinus* and *Neotroponiscus* sp. 1. The Clade B includes *N. perlatus*, *N. carolii*, *N. iporangaensis*, *Neotroponiscus* sp. 2 and *Neotroponiscus* sp. 3. An unresolved clade was recovered with *N. carolii* and *N. iporangaensis*; however this result might be related with the absence of *COI* sequence for *N. iporangaensis* and the insufficient information from the *18s* marker to resolve the relationship between them, with only 0.3% of divergence (Appendix S3).

### Total evidence analyses

The total evidence reconstruction (Fig. 2) recovered *Neotroponiscus* in an unsolved clade with *Bathytropa* (pp=0.72). The main difference between the topology obtained from the reduced matrix and the full matrix is the well-resolved clade of *Neotroponiscus*, which is strongly supported with the reduced data (pp=0.98). *Neotroponiscus lobatus* was recovered with low support (pp=0.61) in an unsolved clade with clades A and B. In the Clade A, *N. plaumanni* was reconstructed as sister group of the clade with *N. daguerrii*, *N. argentinus* and *Neotroponiscus* sp. 1. In the clade B, the species *N. littoralis*, *N. tuberculatus*, *N. carolii*, *N. perlatus* and *N. iporangaensis* were recovered in an unsolved clade.

Regarding Bathytropidae, our results do not support the monophyly of the family with all genera placed in the family until the moment. The results found here indicate that the family is composed by the genera *Bathytropa* and *Neotroponiscus* (see discussion).

Only a few members of Trachelipodidae, Oniscidae, Armadillidae and Porcellionidae were sampled and some inferences can be made here. The family Pudeoniscidae was strongly recovered as a monophyletic unit (pp=0.95). The monophyly of the family Dubioniscidae was also supported here (pp=0.99). Regarding Platyarthridae represented by *Platyarthrus* and *Trichorhina*, the family was not recovered as monophyletic, contradicting the morphological results. Also, the family Trachelipodidae, represented by *Trachelipus* and *Nagurus*, was recovered as paraphyletic.

### Systematic account

Genus *Neotroponiscus* Arcangeli, 1936

#### *Neotroponiscus* sp. 1 (Figs. 3-4)

Holotype. m, Brazil, Santa Catarina, Blumenau, Parque das Nascentes (-27.0575°, -49.0861°), 27 June 2012, leg. BL Zimmerman & PB Araujo (UFRGS 5587).

Paratypes. Same data as for holotype 4 mm 3 ff (UFRGS 5587). Santa Catarina, Blumenau, Parque das Nascentes (-27.0575°, -49.0861°) 4 mm 3 ff, 27 June 2012, leg. B.L. Zimmerman & P.B. Araujo (UFRGS 6446). Santa Catarina, Blumenau (27°01'44"S 49°05'39"W) 1 m, 27 June 2012, leg. P.B. Araujo (UFRGS 5469). Santa Catarina, Imbituba, Morro Mirim (-28.2444°, -48.6983°), 12-17 May 1996.

*Etymology.*

*Diagnosis.* This species is characterized by the shape of dorsal tubercles, the shape of telson, uropod exopod longer than endopod.

### *Description*

Male body length 6.2 mm. Specimens with light brown with unpigmented spots; cephalic lobes and telson pigmented, uropods light brown. Dorsum with rectangular tubercles, placed as follows: three transversal lines on cephalon, two transversal lines on pereonite 1, one transversal line on pereonites 2–7, pleon smooth (Fig 3A, B). Dorsum covered with circular plaques and fan-shaped scale-setae (Fig 3C); one *nodulus lateralis* per side (Fig 3A, B). Pereonite 1 epimeron developed frontwards, surpassing eyes (Fig 3A, B). Cephalon (Fig 3D, E) with rectangular lateral lobes, directed outwards; median lobe pentagonal and directed upwards; eyes with 16 ommatidia. Telson (Fig 3G) wider than long, distal part rounded. Antennula (Fig 3H) distal articles with two apical and two subapical aesthetascs. Antenna (Fig 3I) when extended back, reaching posterior margin of pereonite 1; flagellum of two aesthetascs. Pereopods bearing sparse setae on sternal margin of merus and carpus; carpus with longitudinal antennal brush; unguis and dactylar organ simple. Uropod (Fig 4A) protopod wider than long; exopod longer than endopod, surpassing distal margin of telson.

Male: Pereopods 1 and 7 (Fig 4B, D) without modifications. Pereopod 2 (Fig 4C) bearing dense setae on sternal margin of merus and carpus. Pleopod 1 (Fig 4E) exopod small, wider than long and one third of endopod length; endopod slightly bent outwards. Pleopod 2 (Fig 4F) exopod triangular, shorter than endopod. Pleopods 3–5 as in Fig 4G–I.

*Remarks.* *Neotroponiscus* sp. 1 resembles *N. daguerrii*, *N. argentinus* and *N. plaumanni* by the presence of dense setae on pereopod 2 sternal margin, resembles *N. argentinus* by the distal part of telson rounded, but can be distinguished by the shape of male pleopod 1 exopod and uropod exopod longer than endopod. While from *N. daguerrii* is similar by the shape of male pleopod 1 exopod and distinguished by the distal part of telson rounded (vs. quadrangular in *N. daguerrii*) and uropod exopod longer than endopod.

### ***Neotroponiscus* sp. 2**

Material examined. Brazil, Bahia, Maraúvis: 2ff (UFRGS), Ba 16 (-14.167° -39.0936°), 18 November 2013, leg. I. Campos-Filho & J. Lisboa.

*Observation.* This species is characterized by the rounded frontal lobe, dorsal tubercles weakly developed, pleon with two tubercles medially and telson with distal part rounded. The lack of male specimens prevents a detailed the description.

***Neotroponiscus* sp. 3** (Figs 5-7)

Holotype. m, Brazil, Rio de Janeiro, Cabo Frio, Praia do Peró (-22.8670°S, -41.9850°), 08 March 2014, leg. GM Cardoso (MZUSPXXX).

Paratypes. Same data as for holotype 3 mm 5 ff (MZUSP XXX).

Other material. Búzios, Praia João Fernandes (-22.7394°, -41.8748°) 1 f, 09 March 2014, leg. GM Cardoso (MZUSP XXX).

*Etymology.*

*Diagnosis.* This species is characterized by the patterns of coloration, the shape of the cephalic lobes, the development of pereonite epimera and the position of the *noduli laterales*.

*Description*

Male body length 5.8 mm. Specimens with light brown to yellow color and unpigmented spots; cephalic lobes, fifth segment and flagellum of antenna strongly pigmented; epimera 1, 4 and neopleura 3 less pigmented; telson pigmented, uropods light brown. Dorsum with spine tubercles, placed as follows: three transversal lines on cephalon and pereonite 1, two transversal lines on pereonites 2–7, tubercles can be fused on pereonites 3-7, and less pronounced; two tubercles on pleonites 1-5 (Fig 5A, B). Dorsum covered with circular plaques and fan-shaped scale-setae (Fig 5C, 6B,C); one *nodulus lateralis* per side, first *nodulus* placed farther from lateral and distal margin, *noduli* on pereonites 2-7 near lateral margins (Figs 5A, B, 6A). Pereonite 1 epimeron developed frontwards, surpassing eyes (Fig 5A, B). Cephalon (Fig 5D, E) with rectangular lateral lobes, directed outwards; triangular median lobe, well-developed with round distal margin, directed upwards; eyes with 16 ommatidia. Telson (Fig 5G) wider than long, with medial carena, distal part quadrangular. Antennula (Fig 5H) distal articles with two apical and one subapical aesthetasc. Antenna (Figs 5I) when extended back, reaches posterior margin of pereonite 2; flagellum of two aesthetascs. Pereopods bearing sparse setae on sternal margin of merus and carpus; carpus with longitudinal antennal brush; unguis and dactylar organ simple. Uropod (Fig 6A) protopod longer than wide; exopod longer than endopod, surpassing distal margin of telson. Male: Pereopods 1, 2 and 7 (Fig 6 B – D) without modifications. Pleopod 1 (Fig 6E) exopod small (almost one third of endopod length), wider than long; endopod straight. Pleopod 2 (Fig 6F) exopod triangular, shorter than endopod. Pleopods 3–5 as in Figs 6G-I.

*Remarks.* *Neotroponiscus* sp. 3 was collected for this study in the same locality as *N. littoralis*, however the shape of the cephalic lobes and the position of the *noduli laterales* are unique characters for this species. In the pattern of coloration the pattern seen in *N. lenkoi* but

differs in the well developed tubercles (vs. weakly developed in *N. lenkoi*). In having the carena on telson is similar to *N. carolii*, *N. littoralis* and *N. perlatus*, but differs in the quadrangular distal margin of telson (vs. round in *N. carolii* and *N. perlatus*) and the oval shape of frontal lobe (vs. round in *N. littoralis* and *N. perlatus*, and quadrangular in *N. carolii*). The oval shape of frontal lobe resembles *N. lobatus*, which differs in the round shape of tubercles (vs. rectangular in *N. lobatus*).

## Discussion

Our results show *Neotroponiscus* can be considered a monophyletic unit. Despite the Parsimony and Bayesian analyses show partial incongruence, the concatenated molecular data strongly supports the monophyly of the genus. These inconsistencies can be attributed to the missing or inapplicable data on both matrices, and the nature of the segment that evolved differently resulting in some spurious results (see also Wiens 2006).

The genetic divergence values of the mitochondrial sequence (*COI*) were more variable than the nuclear sequence (*18s*), which is caused by the higher metabolic rate of the mitochondria (Brokeland & Rauspach 2008). This pattern is usually observed among crustaceans (Wetzer 2001) and among terrestrial isopods (Lee *et al.* 2014, Zimmermann *et al.* 2015). This high divergence values are usually associated with the restricted dispersal ability of isopods and its dependence to the habitat humidity (Warburg & Linsenmair 1984; Klossa-Kilia *et al.* 2006; Lee *et al.* 2014, Zimmermann *et al.* 2015).

The divergence for *COI* gene previously reported in some studies, ranged from 20 to 32% between *Tylos* species (Hurtado *et al.* 2014), 0 to 18.4% between *Orthometopon* species (Poulakakis & Sfenthourakis 2008), and 14.9% to 30.3% between *Ligia* species (Markow & Pfeiler 2010). In nuclear sequences the divergence was reported with 0.7% between *Spherillo grossus*' populations (Lee *et al.* 2014) and 1.4% to 3.4% divergence between *Haploniscus* species (Brokeland & Rauspach 2008). Nuclear sequences have been used successfully to reconstruct crustacean phylogeny; however our results provided by the 18S phylogeny showed low resolution for *Neotroponiscus* species. Other studies noticed similar results with groups unresolved by *18s* (Lee *et al.* 2014) which suggest that this gene can be used more properly in identifying older processes of divergence (Hillis & Dixon 1991, Spears & Abele 1998, Dreyer & Wägele 2002).

The unresolved relationship between *Neotroponiscus* could be due the limited molecular information and the small divergence rate of the genes used. Differences between *Neotroponiscus* species are small and usually determined by the shape of cephalic lobe and

tubercles. Some species such as *N. daguerrii*, *N. argentinus* and *N. plaumanni* are determined by the shape of telson and density of setae on pereopod 2, the latter character is only seen in males, so the identification is not always possible if no male is sampled. Therefore, an integrative approach combining morphological and molecular information seems to be necessary to establish the phylogenetic relationships among the species.

Our results strongly support the classification of the family Bathytropidae composed by *Neotroponiscus* and *Bathytropa*. The other Bathytropidae genera, *Laninoniscus*, *Papuasoniscus*, *Monitus* and *Dumetoniscus*, could be analyzed only under morphological aspects, and the topologies constructed here corroborates with the supposition that the family form a paraphyletic taxon sensu Schmidt (2003). Further data, including morphological and molecular, besides more additional taxa are needed to infer the positioning and relationship of this group.

The lack of resolution in the current higher-level classification of Oniscidea is known (Schmalfuss 2003, Schmidt 2003, 2008) and the uncertainty of the composition of the families Platyarthridae and Trachelipodidae were previously addressed by other studies (Schmidt 2003, Javidkar *et al.* 2015). The results presented here are congruent with them, with both families being recovered in paraphyly.

Some phylogenetic hypothesis presented in this study still has low support values in a few clades, showing that a more comprehensive taxon sampling is needed to address these clades. To conclude, our study presented the first hypothesis of internal relationships among *Neotroponiscus* species based on morphological and molecular data simultaneously.

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### Supporting Information

Appendix S1 Complete morphological data matrix.

Appendix S2 Phylogenetic reconstruction for each partition separately [*cytochrome oxidase subunit I* (COI), *18S* rRNA (18S)], DNA concatenated, morphological and total evidence reduced datasets.

Appendix S3 Additional tables:

Table 3: Sequence divergence on citocromo c oxidase subunidade I (*COI*) gene between species, including outgroup.

Table 4: Sequence divergence on citocromo c oxidase subunidade I (*COI*) gene between congeneric species of the *Neotroponiscus*

Table 5: Sequence divergence on 18S ribosomal RNA (*18S*) gene between species, including outgroup.

Table 6: Sequence divergence on 18S ribosomal RNA (*18S*) gene between congeneric species of the *Neotroponiscus*.

## Figure captions.

Figure 1. Sample species of *Neotroponiscus* along the Brazilian Atlantic Forest (in green). Brazil: BA, Bahia; ES, Espírito Santo; RJ, Rio de Janeiro; MG, Minas Gerais; SP, São Paulo; PR, Paraná; SC, Santa Catarina; RS, Rio Grande do Sul.

Figure 2. Bayesian inference consensus tree based on molecular markers and morphological characters for the complete taxon analyses with 63 terminals. Numbers close to nodes are Bayesian posterior probabilities (PP).

Figure 3. *Neotroponiscus* sp. 1. ♂ UFRGS 5587. A, habitus, dorsal view; B, habitus, lateral view; C, scale-seta; D, cephalon, frontal view; E, cephalon, dorsal view; F, pereonite 7; G, pleonite 5, telson and uropod, dorsal view; H, antennule; I, antenna.

Figure 4. *Neotroponiscus* sp. 1. ♂ UFRGS 5587. A, uropod; B, pereopod 1; C, pereopod 2; D, pereopod 7; E, pleopod 1; F, pleopod 2; G, pleopod 3 exopod; H, pleopod 4 exopod; I, pleopod 5 exopod.

Figure 5. *Neotroponiscus* sp. 3. ♂ (MZUSP XXX). A, habitus, dorsal view; B, habitus, lateral view; C, scale-seta; D, cephalon, frontal view; E, cephalon, dorsal view; F, pereonite 7; G, pleonite 5, telson and uropod, dorsal view; H, antennule; I, antenna.

Figure 6. *Neotroponiscus* sp. 3 ♂ (MZUSP XXX). A, uropod; B, pereopod 1; C, pereopod 2; D, pereopod 7; E, pleopod 1; F, pleopod 2; G, pleopod 3 exopod; H, pleopod 4 exopod; I, pleopod 5 exopod.

Figure 7. *Neotroponiscus* sp. 3 ♂ (MZUSP XXX). A, habitus, dorsal view; B, cephalon, dorsal view; C, dorsal surface on pereonite 7; D, pleon, telson and uropods, dorsal view. Scale bars: A 1mm, B, D 200  $\mu$  m, C 50  $\mu$  m.

Table 1. Taxon sampling for the phylogenetic analysis of *Neotroponiscus* and related isopods, with species codes, taxon name, geographical origins, and accession numbers. Brazil: BA, Bahia; ES, Espírito Santo; RJ, Rio de Janeiro; MG, Minas Gerais; SP, São Paulo; PR, Paraná; SC, Santa Catarina; RS, Rio Grande do Sul.

Code	Species	Collection number	Location	Latitude	Longitude	COI	18S
Outgroup	<i>Trachelipus rathkii</i> (Brandt, 1833)	retrieved from GenBank				KT708241.1	AF279605.1
Outgroup	<i>Armadillidium vulgare</i> (Latreille, 1804)	retrieved from GenBank				AF255779.1	AJ287061.1
Outgroup	<i>Cubaris murina</i> Brandt, 1833	retrieved from GenBank				AB861533.1	AJ287064.1
Outgroup	<i>Platyarthus hoffmannseggii</i> Brandt, 1833	retrieved from GenBank				KY020402.1	JN232927.1
Outgroup	<i>Porcellio scaber</i> Latreille, 1804	retrieved from GenBank				HQ978726.1	AJ287062.1
Outgroup	<i>Porcellionides pruinosus</i> (Brandt, 1833)	retrieved from GenBank				FN824140.1	KR424622.1
Outgroup	<i>Oniscus asellus</i> Linné, 1758	retrieved from GenBank				KU955994.1	AF255699.1
Outgroup	<i>Circoniscus bezzii</i> Arcangeli, 1931	UFRGS 5720	MG, São Roque de Minas	-20.3131	-46.5297	KJ814236.1	(X)
Outgroup	<i>Dubioniscus depressus</i> Cardoso et al 2016	UFRGS 6381	SP, Santo Antônio do Pinhal	-22.8276	-45.6359	(X)	(X)
Outgroup	<i>Trichorhina tomentosa</i> (Budde-Lund, 1893)		RS, Porto Alegre	-30.0680	-51.1212	KR424600.1	(X)
Outgroup	<i>Trichorhina bicolor</i> Araujo & Buckup, 1996		PR, Morretes	-25.5266	-48.7880	_	(X)
Outgroup	<i>Pudeoniscus birabeni</i> Vandel, 1963		SC, Itapoá	-25.9690	-48.6392	_	(X)
Outgroup	<i>Brasiloniscus</i> sp.		RJ, Trindade	-23.3299	-44.7057	_	(X)
Outgroup	<i>Nagurus cristatus</i> (Dollfus, 1889)		SC, Joinville	-26.3219	-48.8636	_	(X)
N_RS1	<i>N. daguerrii</i> (Giambiagi de Calabrese, 1939)	UFRGS 6447	RS, Porto Alegre	-30.0967	-51.1858	(X)	(X)
N_RS1F	<i>N. daguerrii</i> (Giambiagi de Calabrese, 1939)	UFRGS 6447	RS, Porto Alegre	-30.0967	-51.1858	(X)	(X)
N_RS2	<i>N. daguerrii</i> (Giambiagi de Calabrese, 1939)	UFRGS 6448	RS, Eldorado do Sul	-30.1003	-51.6944	(X)	(X)
N_RS2F	<i>N. daguerrii</i> (Giambiagi de Calabrese, 1939)	UFRGS 6448	RS, Eldorado do Sul	-30.1003	-51.6944	_	(X)
N_RS2F	<i>N. daguerrii</i> (Giambiagi de Calabrese, 1939)	UFRGS 6454	RS, Viamão	-30.3836	-51.0206	(X)	(X)
N_RS5	<i>N. daguerrii</i> (Giambiagi de Calabrese, 1939)	UFRGS 6448	RS, Eldorado do Sul	-30.1003	-51.6944	(X)	(X)
N_SC1	<i>N. argentinus</i> (Giambiagi de Calabrese, 1939)	UFRGS 6442	SC, Florianópolis	-27.6107	-48.5057	(X)	(X)
N_SC2	<i>N. argentinus</i> (Giambiagi de Calabrese, 1939)	UFRGS 6443	SC, Florianópolis	-27.6848	-48.5383	_	(X)
N_SC3	<i>Neotroponiscus</i> sp. 1	UFRGS 5587	SC, Blumenau	-27.0575	-49.0861	(X)	_
N_SC3M	<i>Neotroponiscus</i> sp. 1	UFRGS 5587	SC, Blumenau	-27.0575	-49.0861	(X)	(X)
N_SC3B	<i>Neotroponiscus</i> sp. 1	UFRGS 5587	SC, Blumenau	-27.0575	-49.0861	(X)	(X)
N_SC4	<i>N. argentinus</i> (Giambiagi de Calabrese, 1939)	UFRGS 6444	SC, Joinville	-26.3219	-48.8636	(X)	(X)
N_SC8	<i>N. argentinus</i> (Giambiagi de Calabrese, 1939)	UFRGS 5468	SC, São João Batista	-28.2644	-49.8533	(X)	(X)
N_SC9	<i>N. argentinus</i> (Giambiagi de Calabrese, 1939)		SC, Imbituba, Morro Mirim	-28.2445	-48.6983	_	(X)
N_SC10	<i>N. plaumanni</i> (Andersson, 1960)	UFRGS 6281	SC, Itajaí, Morro do Baú	_	_	_	_
N_PR1	<i>N. argentinus</i> (Giambiagi de Calabrese, 1939)		PR, Matinhos	-25.8356	-48.5707	_	(X)
N_MG8	<i>N. lobatus</i> Lemos de Castro, 1970	UFRGS 5127	MG, Matozinhos	-20.1520	-43.9716	_	_
N_SP4	<i>N. lenkoi</i> Lemos de Castro, 1970	UFRGS 6474	SP, Maresias	-23.8247	-45.5286	(X)	(X)
N_BA14	<i>Neotroponiscus carolii</i> Arcangeli, 1936	UFRGS 6462	BA, Salvador	-12.7925	-38.4711	_	(X)
N_BA15	<i>Neotroponiscus carolii</i> Arcangeli, 1936	UFRGS 6453	BA, Itajú	-15.0328	-38.9992	(X)	(X)
N_BA16	<i>Neotroponiscus</i> sp. 2		BA, Marauívis	-14.1672	-38.9967	(X)	(X)
N_BA20	<i>Neotroponiscus carolii</i> Arcangeli, 1936		BA, Ilheus, UESC	-14.7991	-39.1723	(X)	(X)
N_cilheus	<i>Neotroponiscus carolii</i> Arcangeli, 1936	UFRGS 6461	BA, Ilheus, CEPLAC	-14.7573	-39.2332	_	(X)
N_F2BA	<i>Neotroponiscus carolii</i> Arcangeli, 1936		BA, Ilheus, CEPLAC	-14.7573	-39.2332	KM200866	(X)
N_BAuna	<i>Neotroponiscus carolii</i> Arcangeli, 1936	UFRGS 6468	BA, Una	_	_	(X)	(X)
N_RJ4A	<i>Neotroponiscus</i> sp. 3		RJ, Cabo Frio, Praia do Perú	-22.8671	-41.9850	(X)	(X)
N_RJ4B	<i>Neotroponiscus</i> sp. 3		RJ, Cabo Frio, Praia do Perú	-22.8671	-41.9850	(X)	(X)
N_RJ4M	<i>Neotroponiscus</i> sp. 3		RJ, Cabo Frio, Praia do Perú	-22.8671	-41.9850	(X)	_
N_RJ11	<i>Neotroponiscus</i> sp. 3		RJ, Buzius, Praia João Fernandes	-22.7394	-41.9850	_	(X)
N_ES1	<i>N. perlatus</i> Lemos de Castro, 1970	UFRGS 6180	ES, Santa Tereza	-19.9416	-40.5824	_	(X)
N_IP	<i>N. iporangaensis</i> Cardoso & Araujo, 2017	MZUSP 35062	SP, Iporanga	_	_	_	(X)
N_TU	<i>N. tuberculatus</i> Cardoso & Araujo, 2017	MZUSP 35063	MG, Brumadinho	-20.1520	-43.9716	_	_

Table 2. List of morphological characters, their states and origins.

Character (+ states)	Derivation of character
1 Dorsum, dorsal cuticular surface, plaques type: 0, low profile plaques; 1, semicircular with raised walls; 2, circular with raised walls (individualized); 3, circular with raised walls with polygonal pattern	New character
2 Dorsum, dorsal cuticular surface, scale-setae type: 0, piliform; 1, tricornis; 2, fan-shape; 3, tooth-shape	Adapted from Leistikow 2001, Schmidt 2002
3 Dorsum, noduli lateralis: 0, small, not discernible; 1, discernible	Adapted from Schmidt 2007
4 Dorsum, noduli lateralis, disposition, lateral margin: 0, 7 near lateral margin; 1, 6 near lateral margin (1 distant); 2, 5 near lateral margin (2 distant); 3, 4 near lateral margin (3 distant); 4, 3 near lateral margin (4 distant); 5, 2 near lateral margin (5 distant); 6, 1 near lateral margin (6 distant); 7, 0 near lateral margin (7 distant)	Adapted from Leistikow 2001
5 Dorsum, nodulus laterales 7, quantity: 0, one; 1, two	Adapted from Schmidt 2007
6 Dorsum, cephalothorax tuberculation: 0, absent; 1, present	Adapted from Schmidt 2002, Schmidt 2007
7 Dorsum, tegument tuberculation: 0, absent; 1, present	Adapted from Schmidt 2002, Schmidt 2007
8 Dorsum, tegument tubercle type: 0, granulation; 1, round; 2, spine; 3, rectangular (high); 4, rectangular (long); 5, stripes	Adapted from Schmidt 2002, Schmidt 2007
9 Dorsum, pleon median tuberculation: 0, absent; 1, present	Adapted from Schmidt 2002, Schmidt 2007
10 Dorsum, pleonite 1 paramedian ornamentation: 0, absent; 1, present	New character
11 Dorsum, pleonite 1 paramedian ornamentation: 0, absent; 1, present	New character
12 Dorsum, pleonite 3 paramedian ornamentation: 0, absent; 1, present	New character
13 Dorsum, pleonite 4 paramedian ornamentation: 0, absent; 1, present	New character
14 Dorsum, pleonite 5 paramedian ornamentation: 0, absent; 1, present	New character
15 Dorsum, pleotelson: 0, smooth; 1, vestigial carena; 2, carena; 3, tubercle	New character
16 Dorsum, pleotelson depression: 0, absent; 1, present	New character
17 Pereon, epimeron 1, development of anterior portion: 0, not reaching eyes; 1, reaching eyes; 2, surpassing eyes	New character
18 Pereon, epimeron 7, development of posterior corners relative to the pleon: 0, surpassing pleonite 2 but not surpassing pleonite 3; 1, surpassing pleonite 3 but not surpassing pleonite 4; 2, surpassing pleonite 4 but not surpassing pleonite 5	New character
19 Pereon, pereonite 1 epimeron, lateral groove: 0, absent; 1, present	Adapted from Schmidt 2007
20 Pereon, pereonite 1 epimeron, schisma: 0, absent; 1, present	Adapted from Schmidt 2007
21 Pereon, epimera, ventral lobe: 0, absent; 1, present	Adapted from Schmidt 2007
22 Pleonites, neopleura, shape: 0, triangular; 1, rectangular	Adapted from Leistikow 2001
23 Pleonite 5, neopleura, relative length with pleotelson: 0, shorter than distal margin; 1, reaching distal margin; 2, surpassing distal margin	Adapted from Leistikow 2001
24 Pleotelson, lateral margins, shape: 0, concave; 1, straight; 2, convex	Adapted from Leistikow 2001, Schmidt 2002
25 Pleotelson, lateral margins, orientation: 0, convergent; 1, parallel; 2, divergent	Adapted from Leistikow 2001, Schmidt 2002
26 Pleotelson, distal margin, shape: 0, rounded; 1, quadrangular (truncated); 2, acute	Adapted from Leistikow 2001, Schmidt 2002
27 Pleotelson, relative development (% width x length ): 0, 30>60; 1, 60>90; 2, 90>120; 3, 120>	New character
28 Pleotelson, cover uropod protopod: 0, not covering; 1, covering	Adapted from Schmidt 2002
29 Pleotelson, length relative with uropod protopod: 0, shorter than protopod; 1, reaching protopod distal portion; 2, surpassing protopod; 3, surpassing protopod and reaching the tip o uropod exopod	Adapted from Schmidt 2002
30 Cephalothorax, frontal depression: 0, absent; 1, present	Adapted from Schmidt 2002
31 Cephalothorax, frontal line: 0, absent; 1, present	Adapted from Leistikow 2001, Schmidt 2002
32 Cephalothorax, frontal line, frontal lobe: 0, not developed; 1, developed	Adapted from Leistikow 2001, Schmidt 2002
33 Cephalothorax, frontal lobe, development relative to lateral lobes: 0, not reaching; 1, as long as lateral lobes; 2, surpassing	Adapted from Schmidt 2002
34 Cephalothorax, frontal lobe, shape: 0, triangular; 1, round; 2, oval; 3, ellipsoidal; 4, quadrangular; 5, trapezoidal; 6, pentagonal	Adapted from Schmidt 2002
35 Cephalothorax, dorsal view, frontal line, lateral lobes: 0, not developed; 1, developed	Adapted from Schmidt 2002
36 Cephalothorax, developed lateral lobes, shape: 0, rounded; 1, subquadrangular; 2, subtriangular	Adapted from Schmidt 2002
37 Cephalothorax, frontal shield: 0, absent; 1, present	Adapted from Schmidt 2002
38 Cephalothorax, suprantennal line: 0, absent; 1, present	Adapted from Leistikow 2001, Schmidt 2002
39 Antennula, aesthetascs arrangement: 0, in pairs, forming a stepped row; 1, tuft gathered apically; 2, medial tuft separated from an apical pair; 3, medial tuft; 4, in line	Adapted from Leistikow 2001, Schmidt 2007
40 Antennula, distal article, tip: 0, absent; 1, present	Adapted from Leistikow 2001, Schmidt 2007
41 Antennula, medial article dimension (width %): 0, 0-40; 1, 40-70; 2, 70-100; 3, 100-130; 4, 130>	Adapted from Leistikow 2001, Schmidt 2002
42 Antenna, 5° peduncle article, width in relation to length (%): 0, 0-20; 1, 20-40; 2, 40-60	New character
43 Antenna, flagellum, articles: 0, two; 1, three	Adapted from Leistikow 2001, Schmidt 2002
44 Antenna, flagellum triarticulated, articles relative length: 0, subequal; 1, distincts	New character
45 Antenna, flagellum biarticulated, articles relative length: 0, distal < proximal; 1, distal = proximal; 2, distal > 1x proximal; 3, distal > 2x proximal; 4, distal > 3x proximal; 5, distal > 4x proximal; 6, distal > 5x proximal	New character
46 Antenna, flagellum, relative legth x 5° peduncle article: 0, shorter; 1, subequal; 2, longer	New character
47 Mandibles, molar penicil composition: 0, single plumose seta; 1, tuft with 3-6 plumose setae; 2, tuft with 6-12 plumose setae; 3, tuft with more than 12 plumose setae	Adapted from Leistikow 2001
48 Maxillula, inner branch, distal tip: 0, absent; 1, present	Adapted from Leistikow 2001, Schmidt 2002
49 Maxillula, outer branch, outer set of teeth, number: 0, three; 1, four	Adapted from Leistikow 2001, Schmidt 2002
50 Maxillula, outer branch, inner set % of cleft teeth: 0, 100; 1, 75>; 2, 50>; 3, 25>; 4, 0	Adapted from Leistikow 2001

51	Maxillula, outer branch, inner set cleft type: 0, simple cleft; 1, trifurcate; 2, pectinate	Adapted from Leistikow 2001, Schmidt 2002
52	Maxilla, outer lobe, relative width with inner lobe: 0, wider; 1, subequal; 2, slender	Adapted from Leistikow 2001, Schmidt 2002
53	Maxilliped, palp, number of setae on first article: 0, one; 1, two	Adapted from Schmidt 2007
54	Maxilliped, endite, outer corner, lobes: 0, absent; 1, present	Adapted from Schmidt 2002
55	Maxilliped, endite, frontal face, penicil: 0, absent; 1, present	Adapted from Leistikow 2001, Schmidt 2002
56	Pereopod 1, Carpus, antennal brush, disposition: 0, transverse; 1, longitudinal	Adapted from Leistikow 2001, Schmidt 2002
57	Pereopod 1, Carpus, antennal brush, proportion in length: 0, 30-40; 1, 40-50; 2, 50-60; 3, 60-70; 4, 70-80; 5, 80-90	New character
58	Pereopod 1, carpus, width in relation to length (%): 0, 40-50; 1, 50-60; 2, 60-70; 3, 70-80; 4, 80-90	Adapted from Leistikow 2001
59	Pereopod 1, Carpus, distal seta, apex type: 0, double-fringe (2-1-2); 1, triple-fringe (3-1-3); 2, multiple-fringe	Adapted from Leistikow 2001
60	Pereopod 1 (males), Carpus, dense setae on sternal margin: 0, absent; 1, present	Adapted from Leistikow 2001, Schmidt 2002
61	Pereopod 2 (males), Carpus, dense setae on sternal margin: 0, absent; 1, present	Adapted from Leistikow 2001, Schmidt 2002, Schmidt 2007
62	Pereopod 3 (males), Carpus, dense setae on sternal margin: 0, absent; 1, present	Adapted from Leistikow 2001, Schmidt 2002, Schmidt 2007
63	Pereopod 4 (males), Carpus, dense setae on sternal margin: 0, absent; 1, present	Adapted from Leistikow 2001, Schmidt 2002
64	Pereopod 7 (males), base, distal margin, lateral depression: 0, absent; 1, present	Adapted from Schmidt 2007
65	Pereopod 7 (males), Ischium, concavity on sternal margin: 0, absent; 1, present	Adapted from Schmidt 2007
66	Pereopod 7 (males), Ischium, frontal view depression: 0, absent; 1, present	Adapted from Schmidt 2007
67	Pereopod 7, Dactylus, dactylar seta length versus outer claw: 0, dactylar seta > outer claw; 1, dactylar seta = outer claw; 2, dactylar seta < outer claw	Adapted from Leistikow 2001, Schmidt 2002
68	Pereopod 7, Dactylus, dactylar seta, shape: 0, simple; 1, enlarged; 2, with setules	Adapted from Leistikow 2001, Schmidt 2002
69	Pleopod 1 exopod (males), outer marginal setae: 0, absent; 1, present	Adapted from Schmidt 2002, Schmidt 2007
70	Pleopod 1 exopod (males), distal projection: 0, absent; 1, present	Adapted from Leistikow 2001
71	Pleopod 1 exopod (males), distal projection shape: 0, small projection; 1, round projection; 2, acute projection; 3, triangular projection; 4, quadrangular projection	Adapted from Leistikow 2001
72	Pleopod 1 exopod (males), lateral incision: 0, absent; 1, present	Adapted from Leistikow 2001
73	Pleopod endopod 1 (males), length relative to exopod: 0, short (less than twice of exopod length); 1, medium (2x exopod length); 2, long (3x exopod length); 3, very long (>3x exopod length)	Adapted from Leistikow 2001
74	Pleopod 1 endopod (males), distal portion, lobe: 0, absent; 1, present	Adapted from Leistikow 2001
75	Pleopod 1 endopod (males), apex ornamentation: 0, absent; 1, present	Adapted from Leistikow 2001
76	Pleopod 1 endopod (males), twisted distal apex: 0, absent; 1, present	Adapted from Leistikow 2001
77	Pleopod 2 endopod (males), length relative to the exopod: 0, short (as long as exopod); 1, medium (<2x exopod length); 2, elongated (>2x the exopod length)	Adapted from Leistikow 2001
78	Pleopod 5 exopod, dimension (relative length); 0, longer than wide; 1, as long as wide; 2, wider than long	Adapted from Leistikow 2001
79	Pleopods exopods, respiratory fields: 0, absent; 1, present	Adapted from Leistikow 2001, Schmidt 2002
80	Pleopods exopods, respiratory fields, type: 0, absent; 1, present	Adapted from Leistikow 2001, Schmidt 2002
81	Uropod, protopod, dimension (relative length): 0, longer than wide; 1, as long as wide; 2, wider than long	New character
82	Uropod, protopod, distal margin development: 0, absent; 1, present	Adapted from Schmidt 2002
83	Uropod, protopod, insertion of the endopod branch, relative to the exopod base: 0, proximal; 1, medial; 2, distal	New character
84	Uropod, exopod shape: 0, lanceolate; 1, plate-like	Adapted from Schmidt 2007
85	Uropod, exopod length, relative to the endopod: 0, 0-50; 1, 50-100; 2, 100-150; 3, 150-200; 4, 200-250	New character
86	Uropod, exopod length, relative to protopod: 0, 0-50; 1, 50-100; 2, 100-150; 3, 150-200; 4, 200-250; 5, 250-300	New character
87	Uropod, endopod branch, setae on margin, quantity: 0, sparse; 1, dense	Adapted from Schmidt 2002

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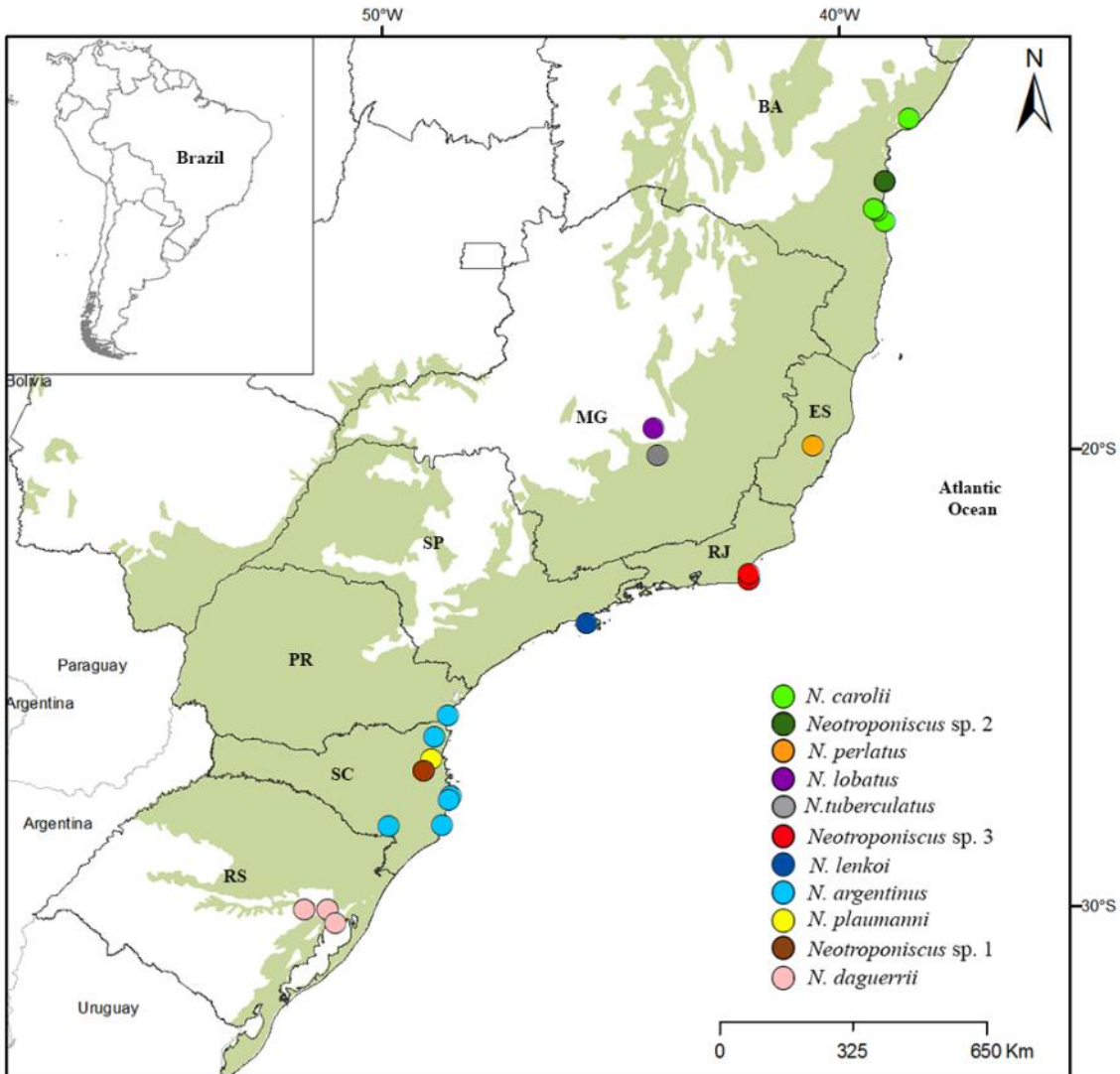


Figure 1. Sample species of *Neotroponiscus* along the Brazilian Atlantic Forest (in green). Brazil: BA, Bahia; ES, Espírito Santo; RJ, Rio de Janeiro; MG, Minas Gerais; SP, São Paulo; PR, Paraná; SC, Santa Catarina; RS, Rio Grande do Sul.

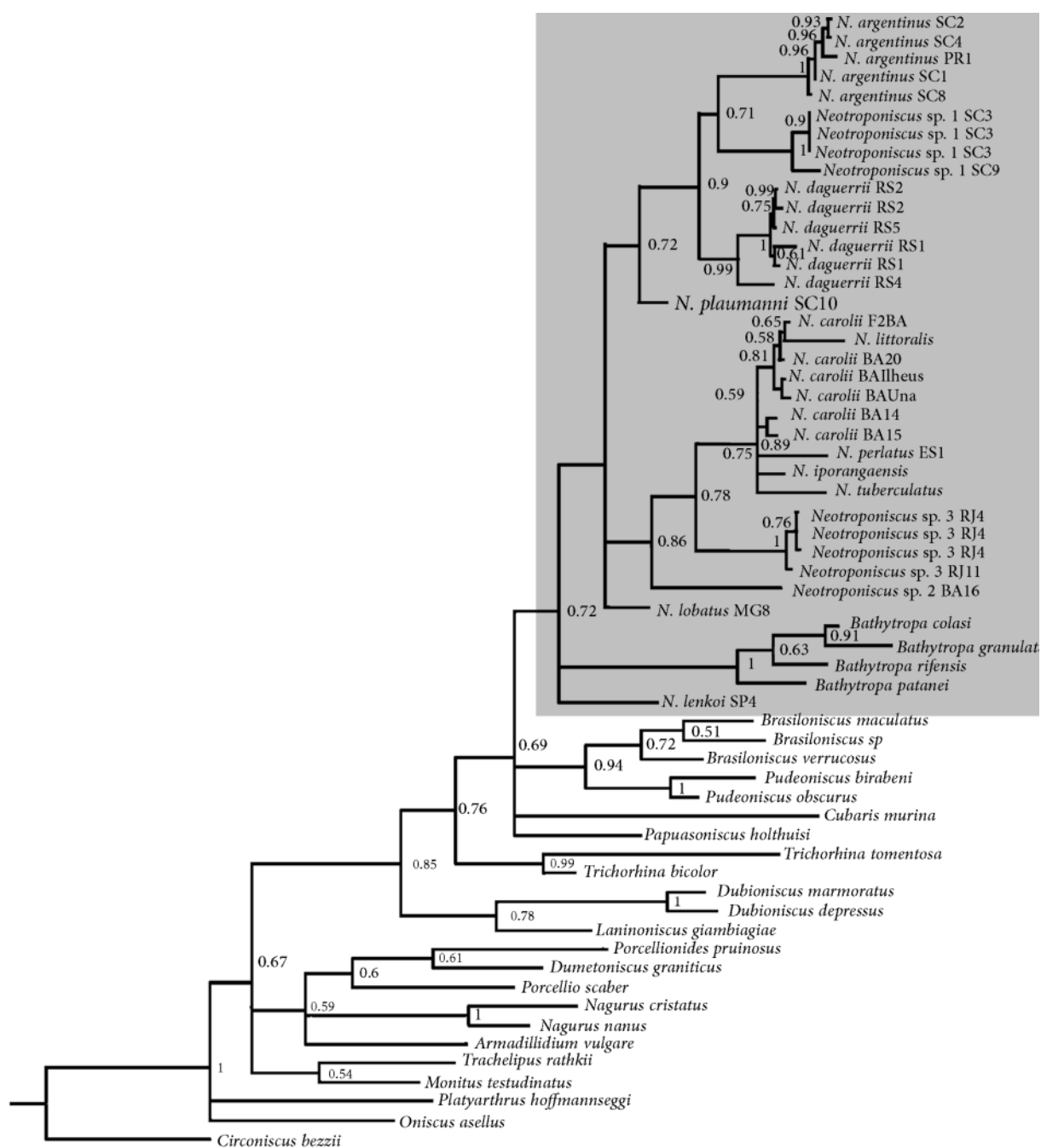


Figure 2. Bayesian inference consensus tree based on molecular markers and morphological characters for the complete taxon analyses with 63 terminals. Numbers close to nodes are Bayesian posterior probabilities (pp).

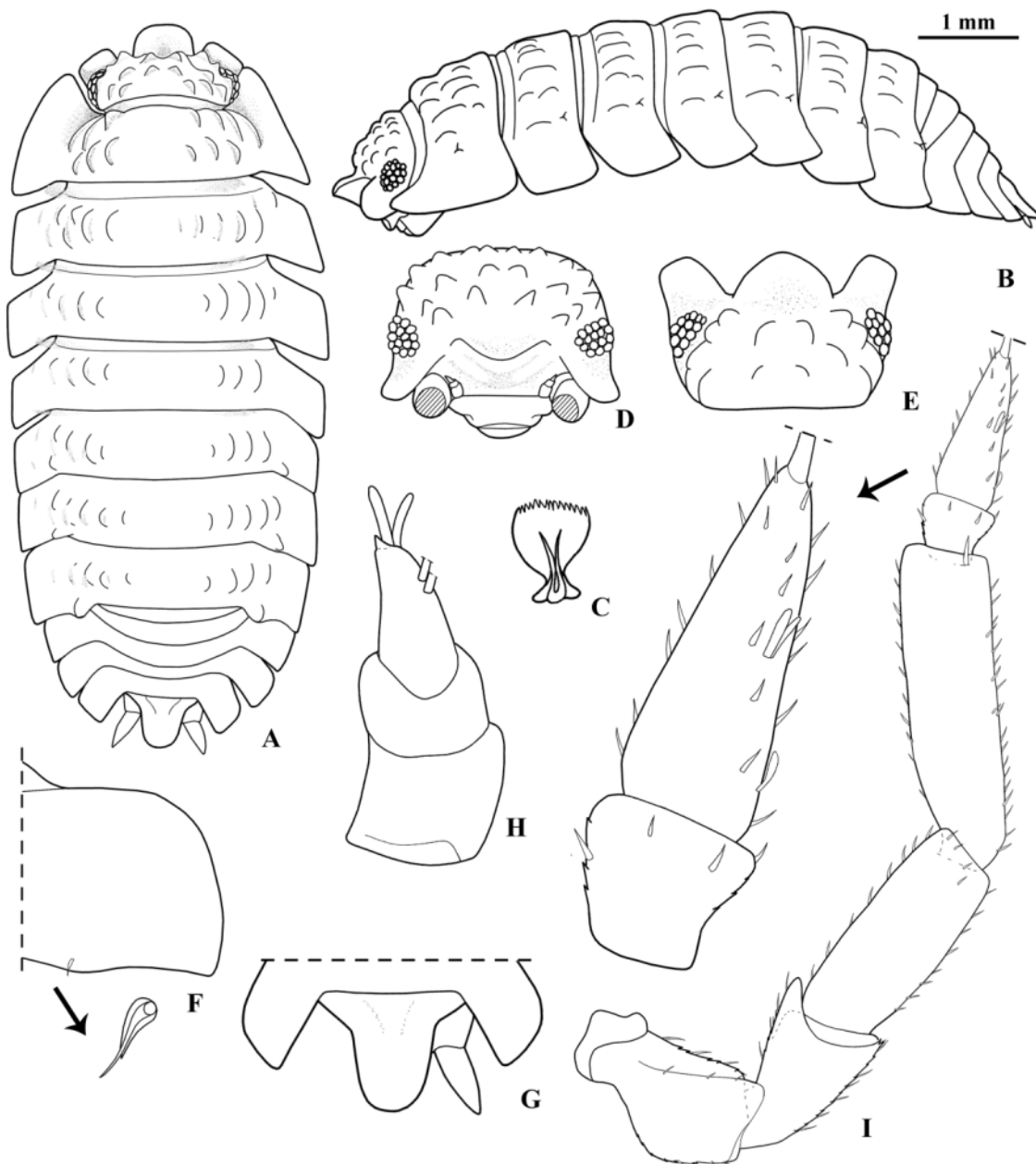


Figure 3. *Neotroponiscus* sp. 1. ♂ UFRGS 5587. A, habitus, dorsal view; B, habitus, lateral view; C, scale-seta; D, cephalon, frontal view; E, cephalon, dorsal view; F, pereonite 7; G, pleonite 5, telson and uropod, dorsal view; H, antennule; I, antenna.

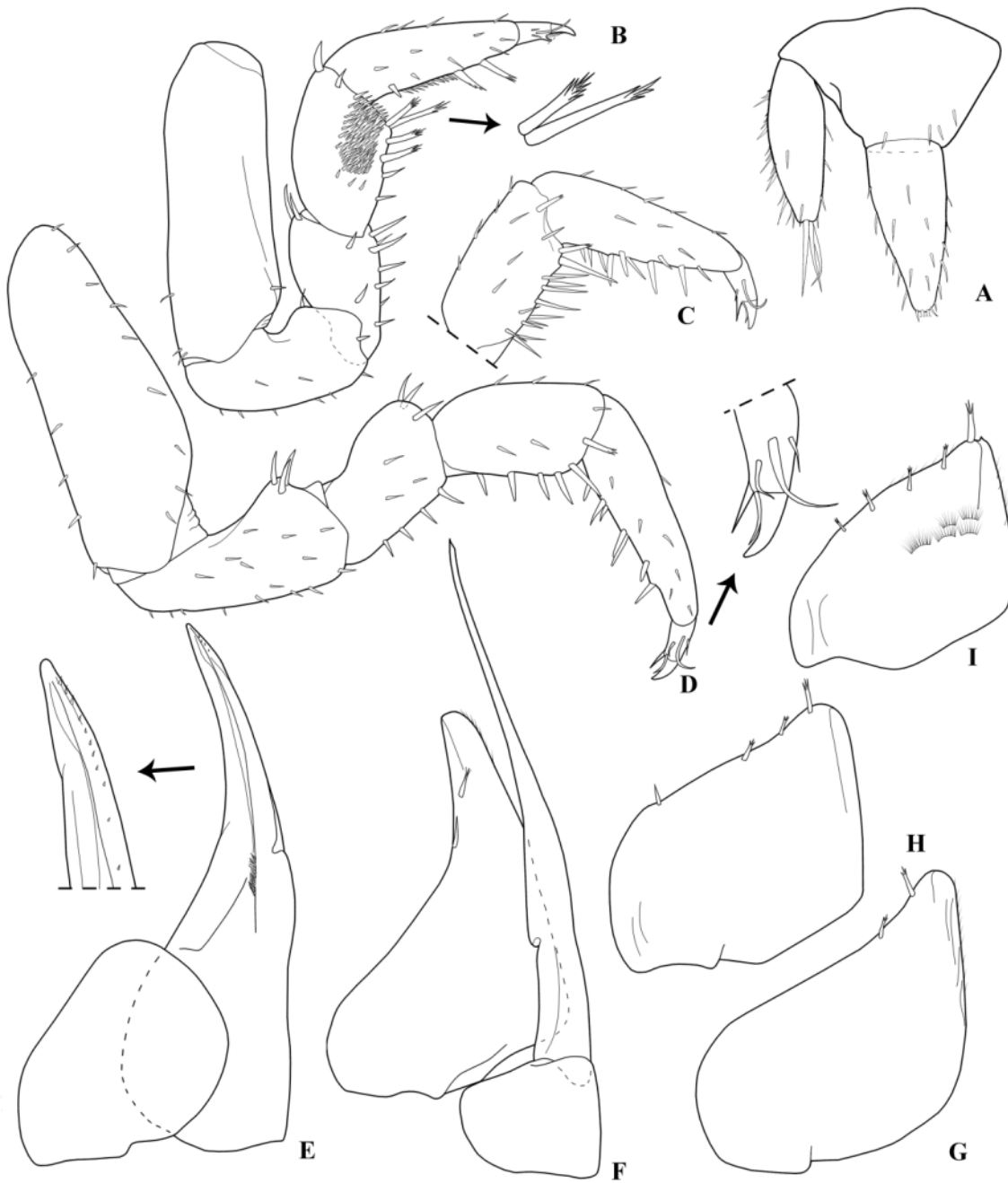


Figure 4. *Neotroponiscus* sp. 1. ♂ UFRGS 5587. A, uropod; B, pereopod 1; C, pereopod 2; D, pereopod 7; E, pleopod 1; F, pleopod 2; G, pleopod 3 exopod; H, pleopod 4 exopod; I, pleopod 5 exopod.

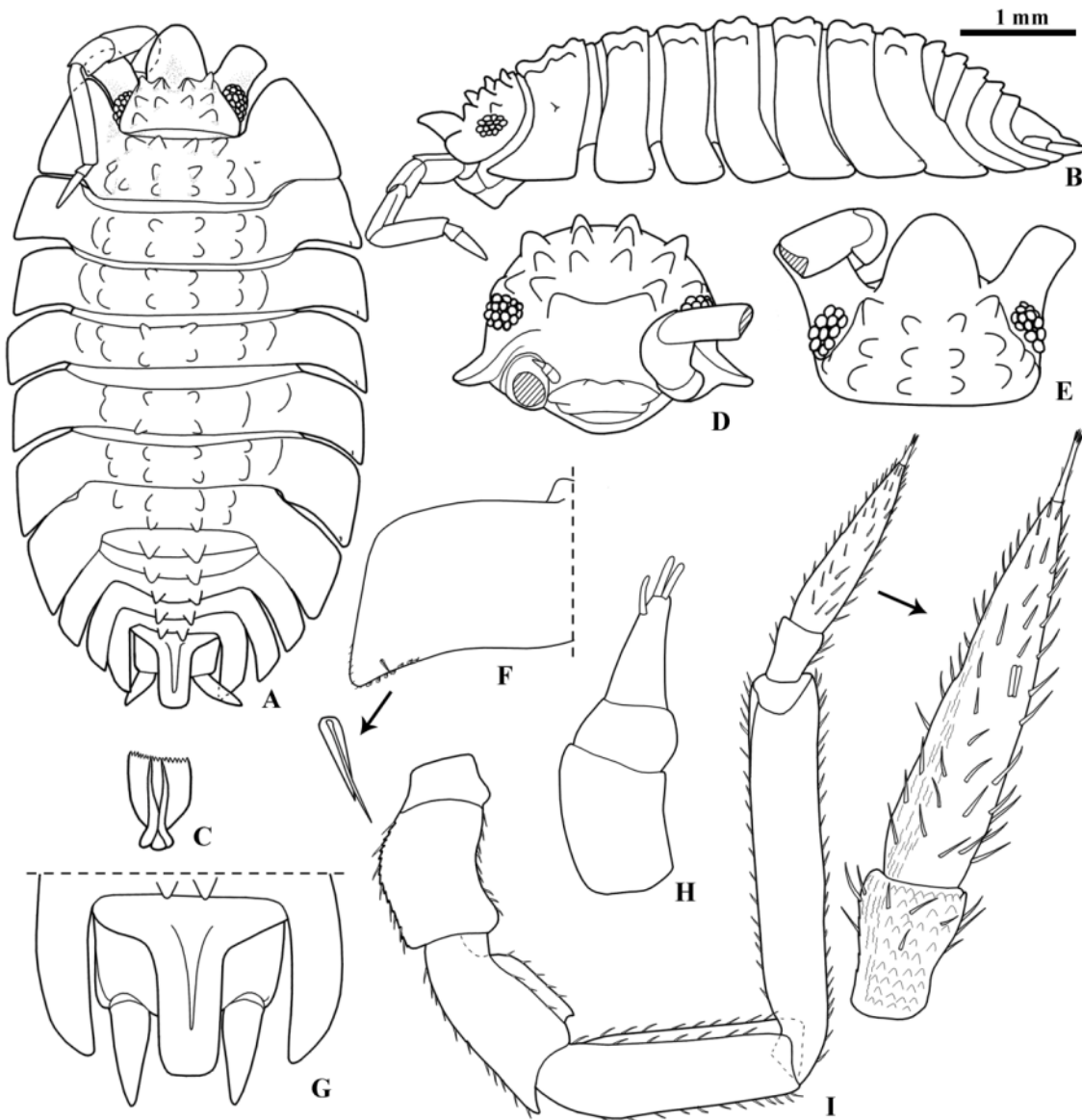


Figure 5. *Neotroponiscus* sp. 3. ♂ (MZUSP XXX). A, habitus, dorsal view; B, habitus, lateral view; C, scale-seta; D, cephalon, frontal view; E, cephalon, dorsal view;; F, pereonite 7; G, pleonite 5, telson and uropod, dorsal view; H, antennule; I, antenna.

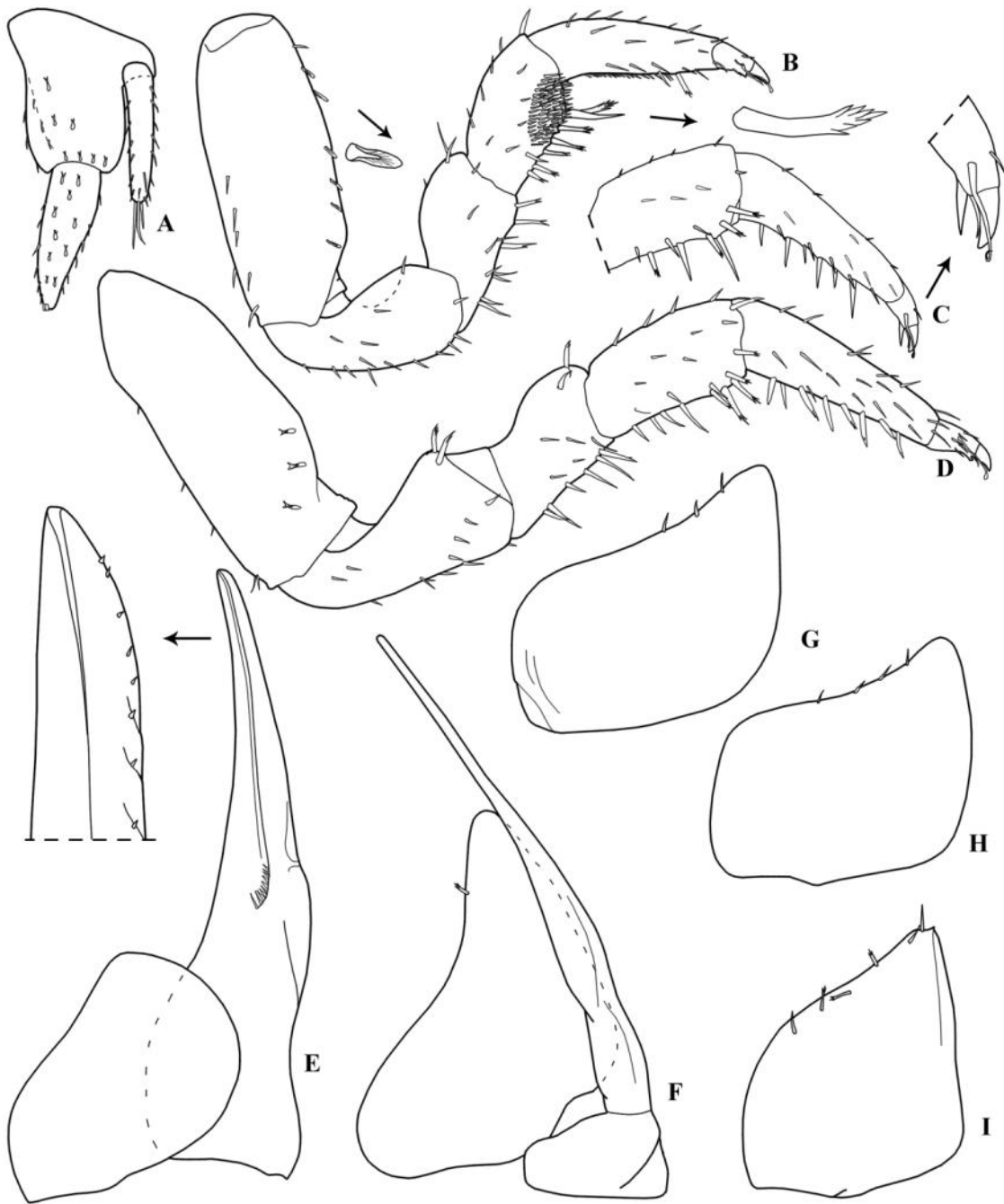


Figure 6. *Neotroponiscus* sp. 3 ♂ (MZUSP XXX). A, uropod; B, pereopod 1; C, pereopod 2; D, pereopod 7; E, pleopod 1; F, pleopod 2; G, pleopod 3 exopod; H, pleopod 4 exopod; I, pleopod 5 exopod.



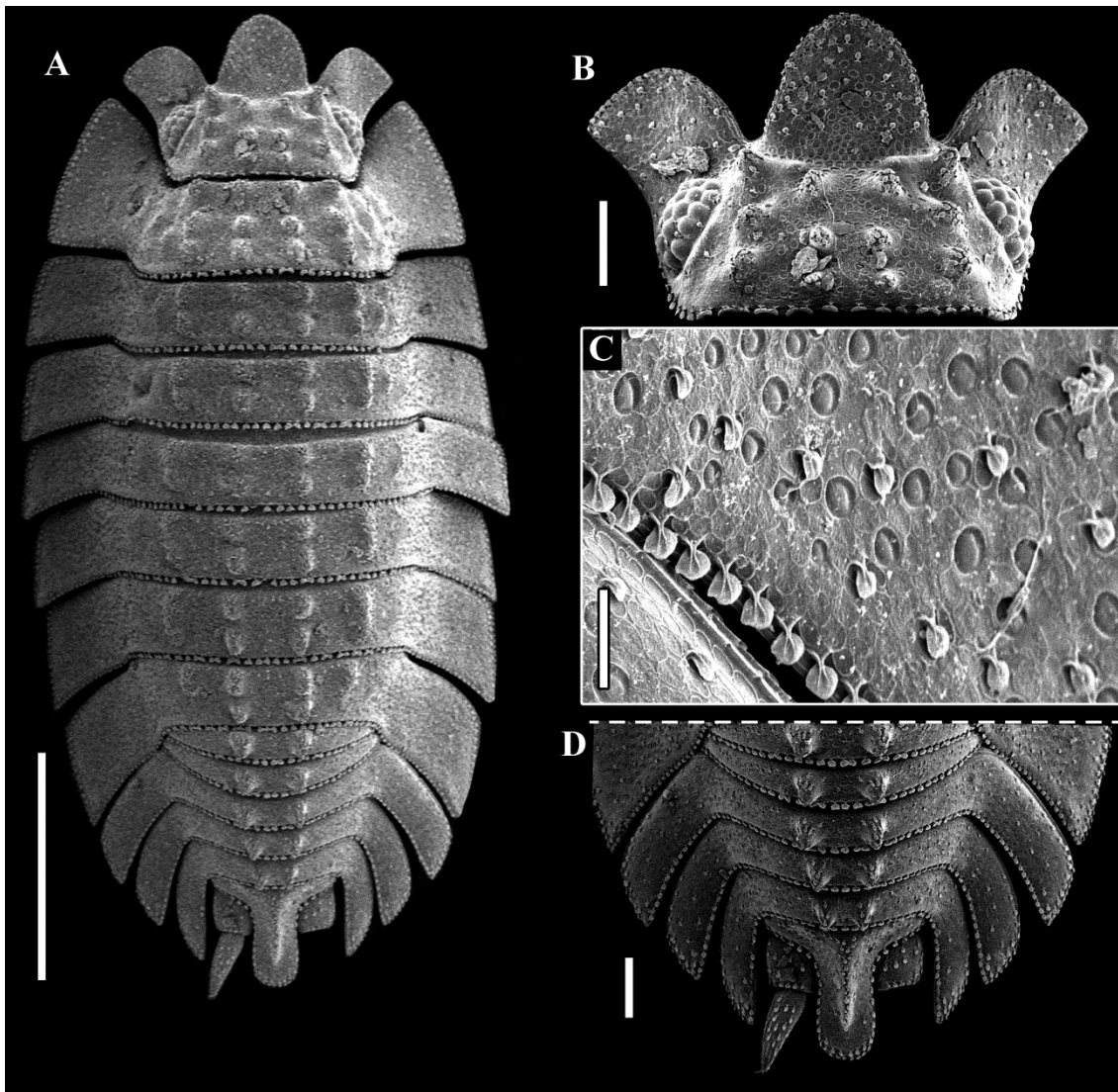


Figure 7. *Neotroponiscus* sp. 3 ♂ (MZUSP XXX). A, habitus, dorsal view; B, cephalon, dorsal view; C, dorsal surface on pereonite 7; D, pleon, telson and uropods, dorsal view. Scale bars: A 1mm, B, D 200  $\mu$  m, C 50  $\mu$  m.

### Supporting Information

#### Appendix S1. Complete morphological data matrix.

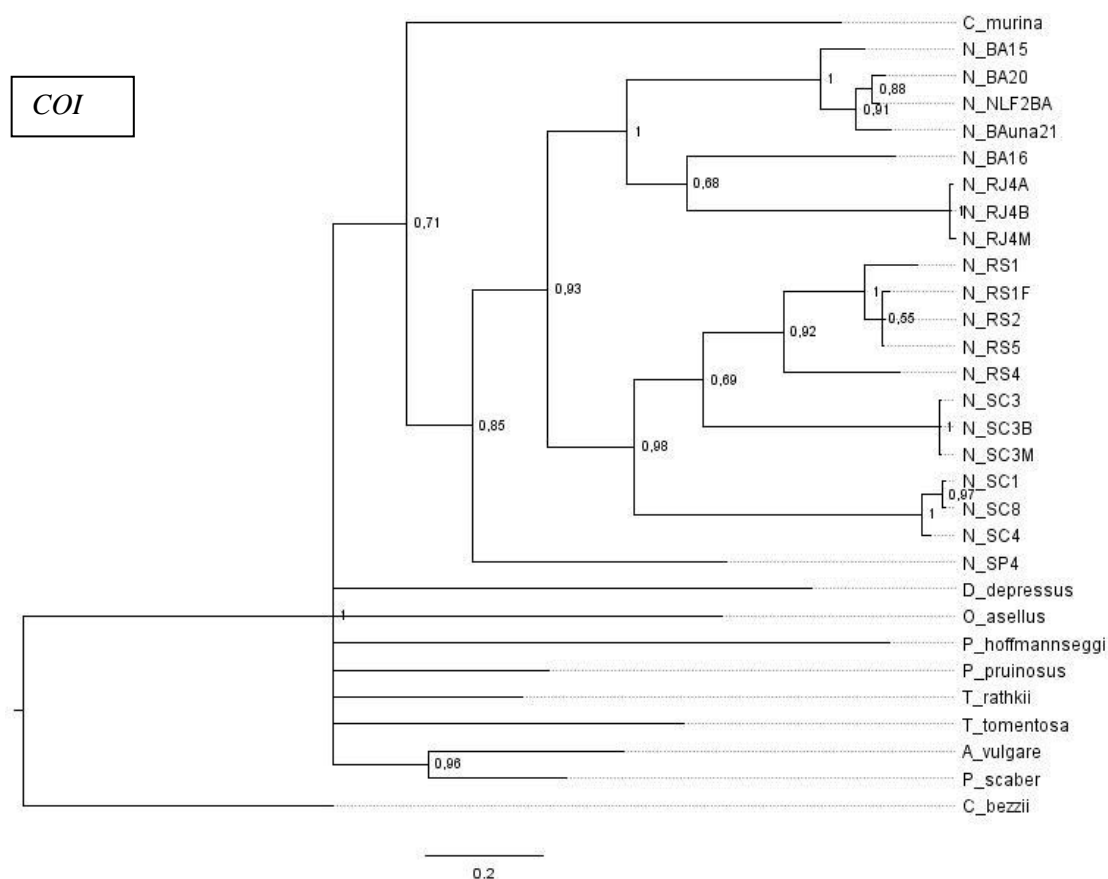
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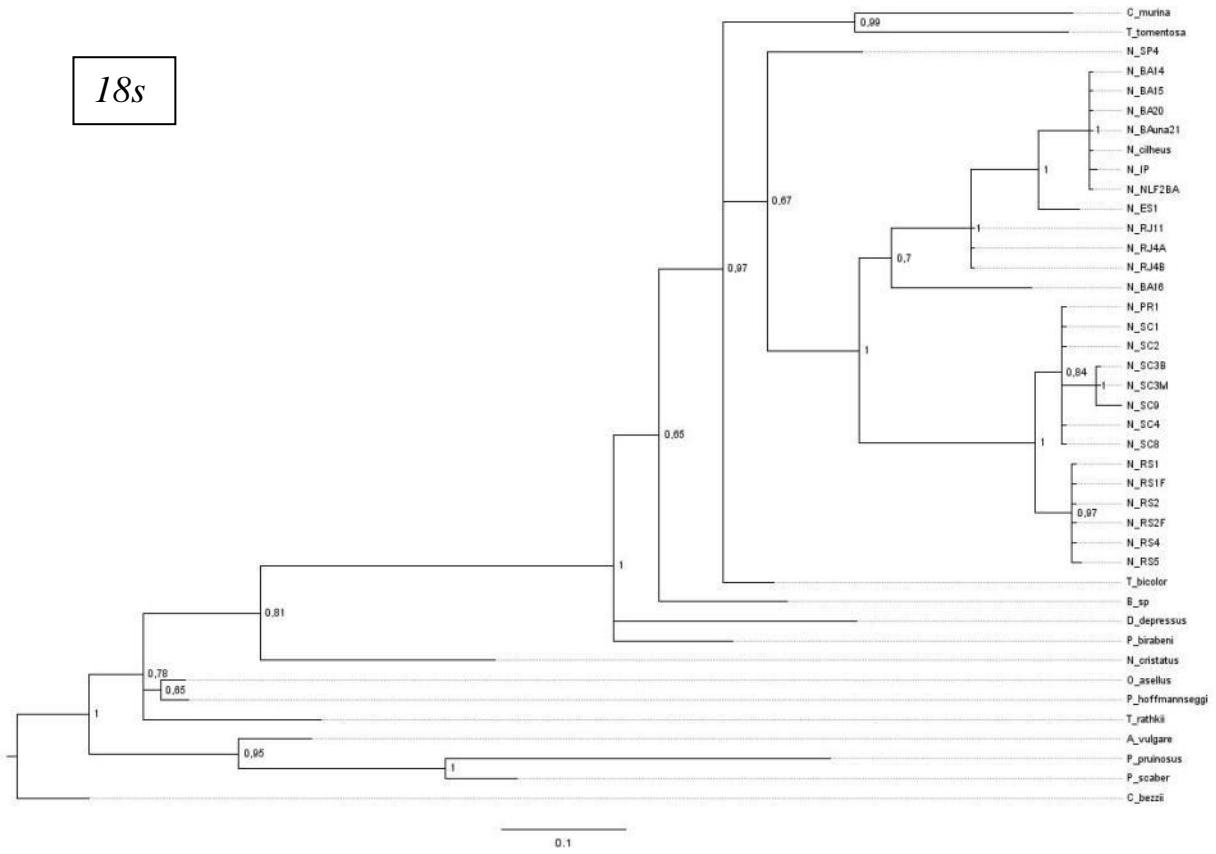


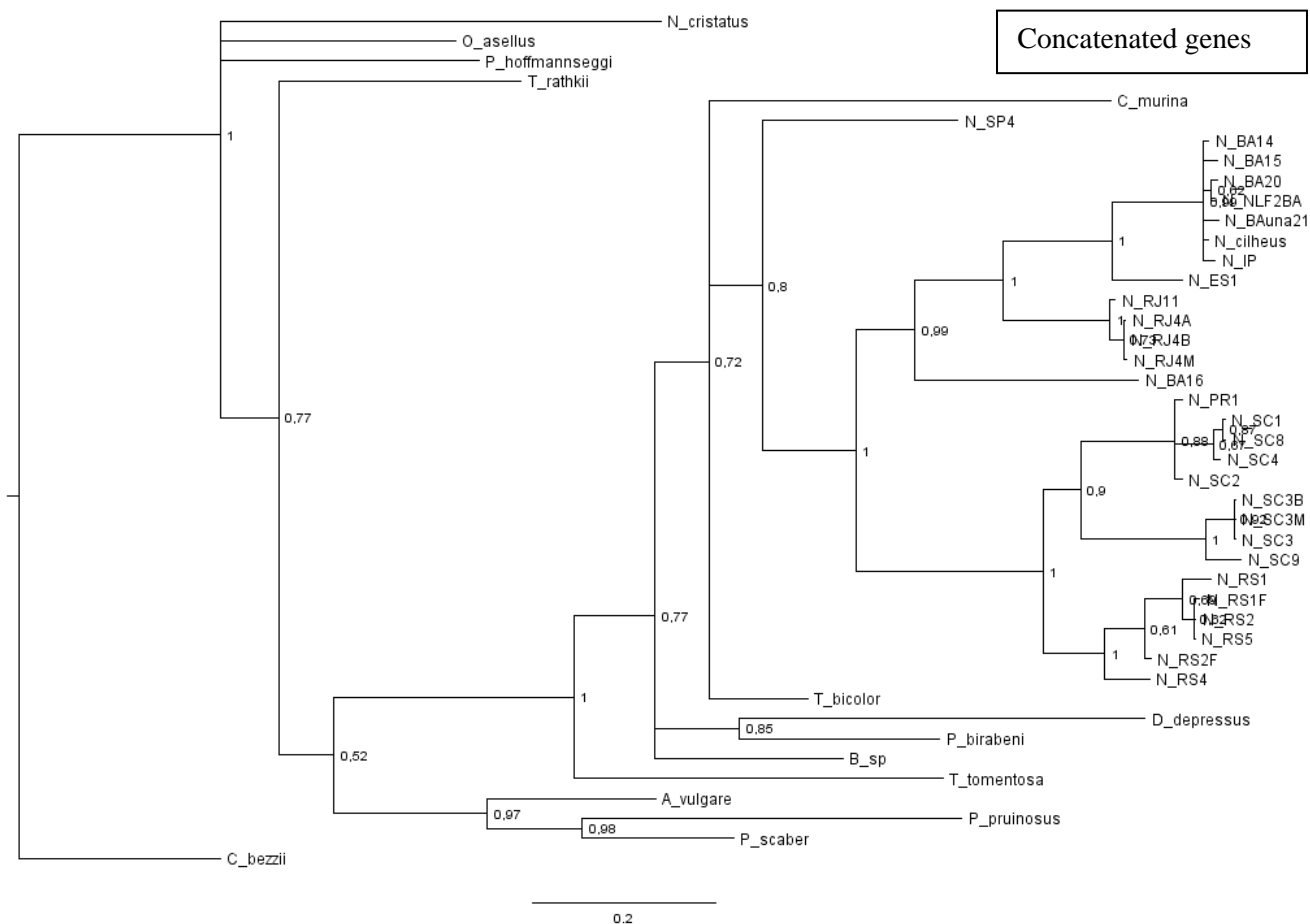
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Appendix S2. Phylogenetic reconstruction for each partition separately [*cytochrome oxidase subunit I* (*COI*), *18s* rRNA (*18s*)], DNA concatenated, morphological and total evidence reduced datasets. In *COI*, *18S*, DNA concatenated and total evidence the numbers close to nodes are Bayesian posterior probabilities (pp). In the topology of the strict consensus tree for morphological data the values in nodes are Jackknife symmetrical resampling (SR) support. The second tree with morphological data show character changes: black circles indicate non-homoplastic synapomorphies; white circles indicate homoplastic synapomorphies.

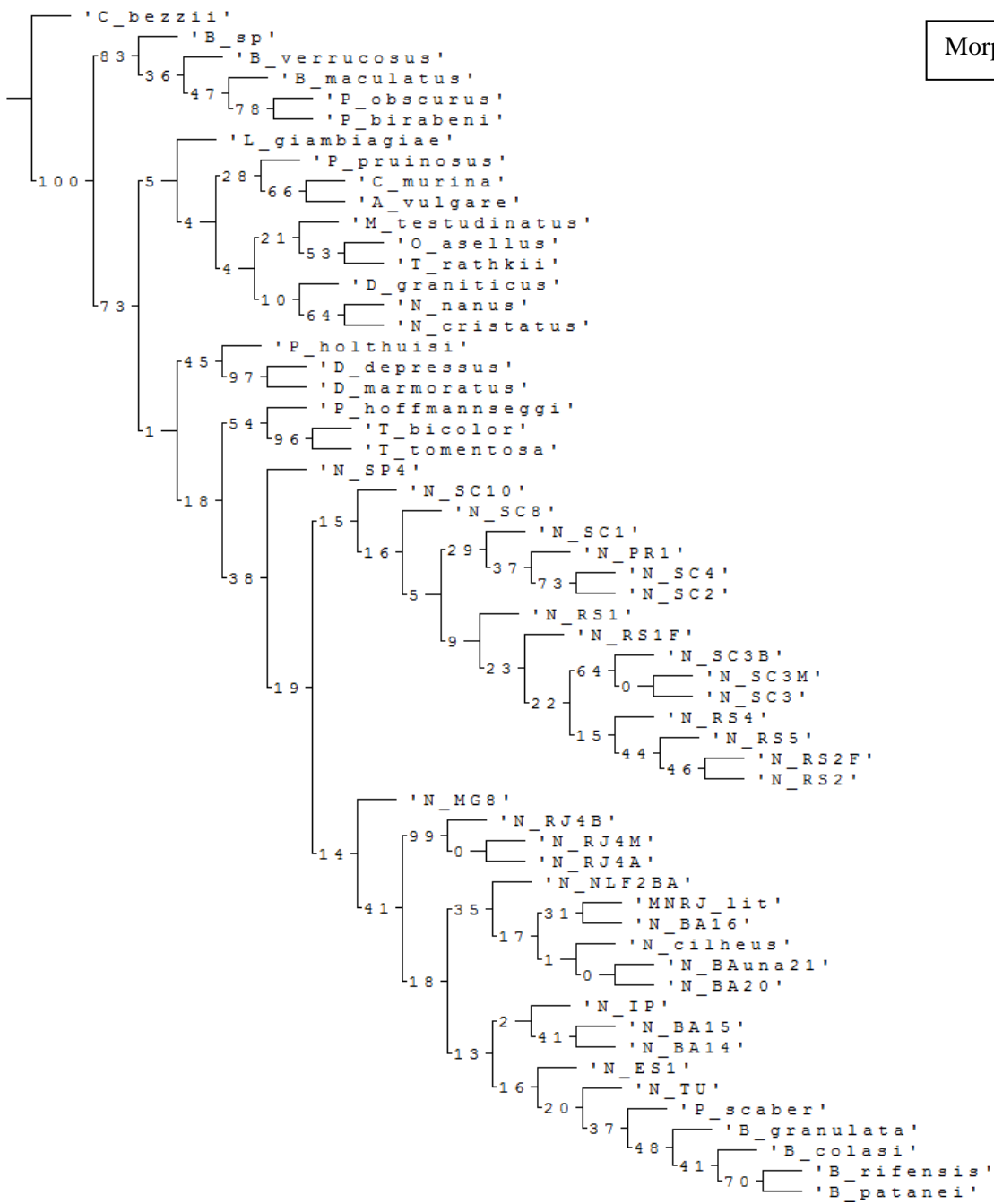


18s

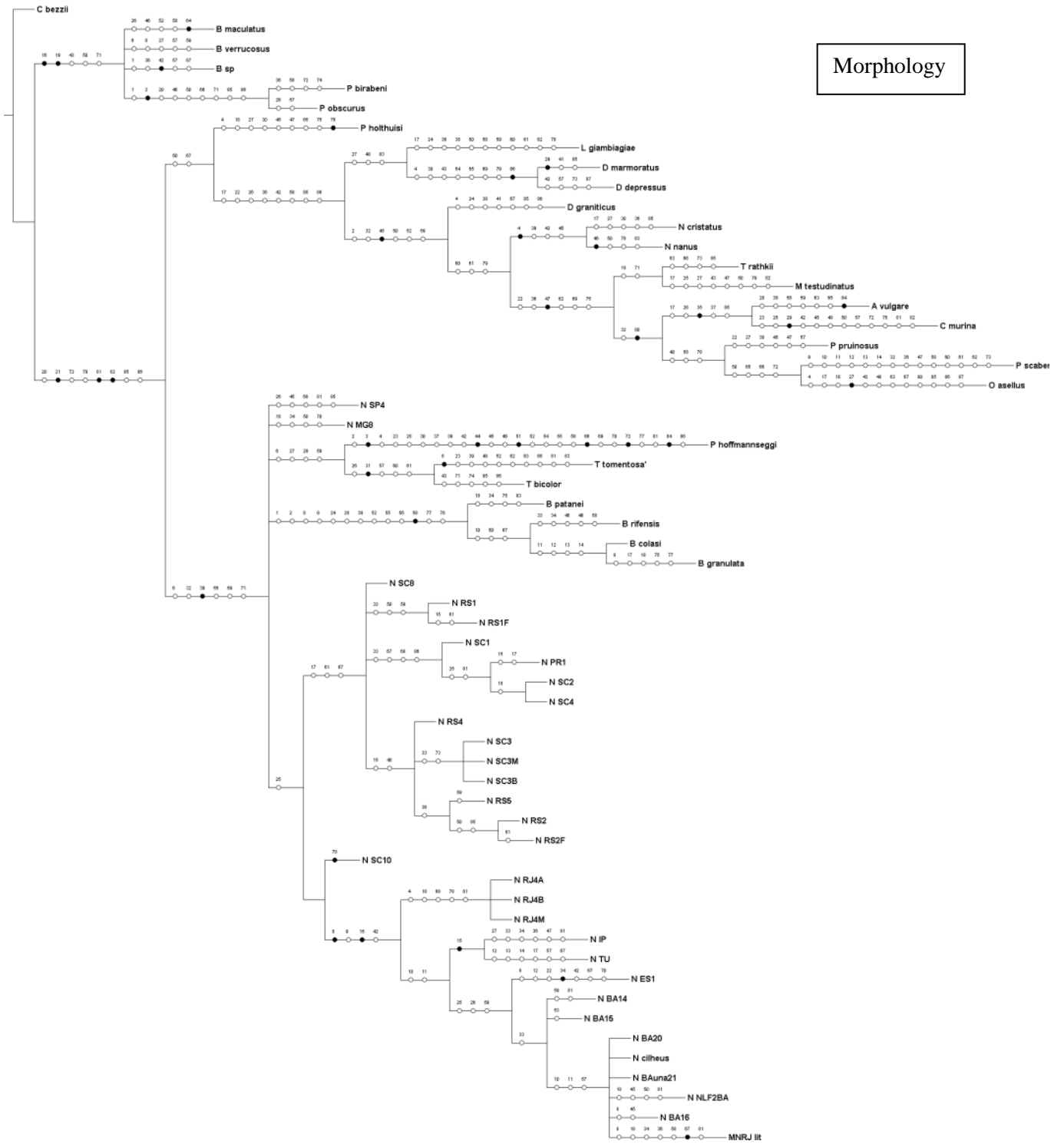




## Morphology



Morphology



Reduced analyse

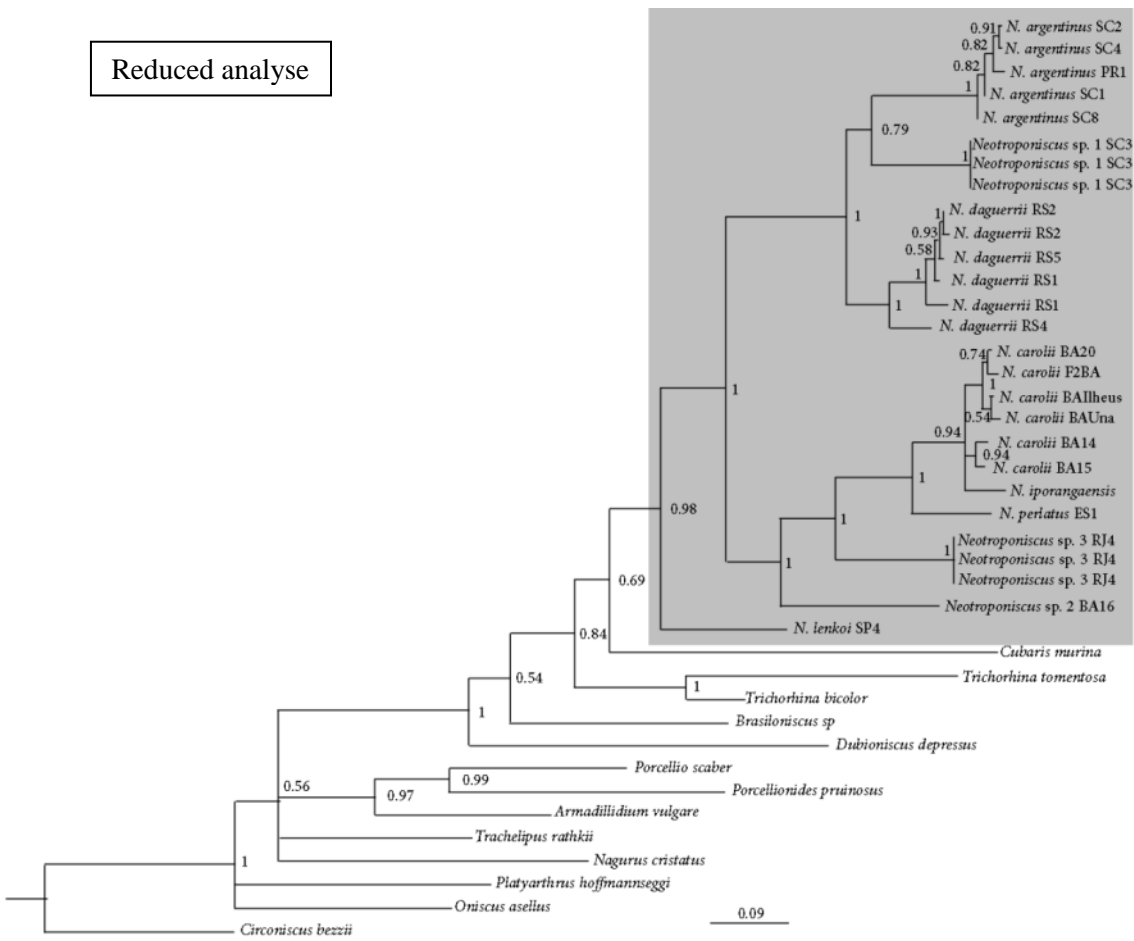


Table 3: Sequence divergence on citocromo c oxidase subunidade I (*COI*) gene between species, including outgroup.

	Avul	Cbez	Cmuri	Ddepr	NBA15	NBA16	NBA20	NBAun	NLF2BA	NRJ4A	NRJ4B	NRJ4M	NRS1	NRS1F	NRS2	NRS4	NRS5	NSC1	NSC3	NSC3B	NSC3M	NSC4	NSC8	NSP4	Oase	Phoffm	Pprui	Psca	Trath	Ttome		
Avulgare		0.019	0.019	0.019	0.019	0.018	0.032	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.025	0.019	0.019	0.020	0.019	0.019	0.018	0.019	0.018	0.019	0.020	0.020	0.017	0.016	0.017	0.018	
Cbezzii	0.265		0.021	0.020	0.020	0.020	0.030	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.019	0.020	0.025	0.020	0.019	0.020	0.019	0.019	0.019	0.020	0.020	0.021	0.019	0.019	0.019	0.021	
Cmurina	0.250	0.297		0.020	0.019	0.019	0.032	0.020	0.019	0.020	0.020	0.020	0.019	0.019	0.019	0.024	0.019	0.019	0.020	0.019	0.019	0.019	0.019	0.020	0.020	0.020	0.020	0.019	0.019	0.020	0.020	
Ddepress	0.204	0.268	0.281		0.020	0.019	0.031	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.025	0.020	0.020	0.021	0.020	0.020	0.019	0.020	0.019	0.020	0.021	0.019	0.019	0.018	0.020		
NBA15	0.256	0.288	0.248	0.261		0.016	0.020	0.012	0.012	0.018	0.018	0.018	0.017	0.018	0.018	0.024	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.019	0.019	0.021	0.019	0.018	0.019	0.019		
NBA16	0.239	0.267	0.239	0.240	0.186		0.026	0.017	0.017	0.018	0.018	0.018	0.017	0.017	0.017	0.023	0.016	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.019	0.018	0.018	0.018	0.018		
NBA20	0.297	0.262	0.282	0.287	0.092	0.169		0.017	0.008	0.027	0.027	0.028	0.026	0.026	0.028	0.026	0.029	0.028	0.028	0.028	0.028	0.028	0.029	0.029	0.029	0.029	0.031	0.030	0.031	0.029	0.031	
NBAuna	0.273	0.267	0.263	0.261	0.085	0.189	0.067		0.010	0.018	0.018	0.018	0.017	0.017	0.017	0.024	0.017	0.019	0.019	0.018	0.018	0.018	0.019	0.018	0.019	0.020	0.019	0.018	0.019	0.019	0.019	
NLF2BA	0.261	0.261	0.261	0.261	0.083	0.176	0.015	0.053		0.018	0.018	0.018	0.017	0.017	0.017	0.024	0.017	0.019	0.019	0.018	0.018	0.019	0.018	0.019	0.020	0.019	0.019	0.018	0.019	0.018	0.019	
NRJ4A	0.258	0.284	0.258	0.272	0.222	0.203	0.195	0.225	0.214		0.002	0.003	0.017	0.017	0.017	0.023	0.017	0.019	0.019	0.018	0.018	0.018	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.018	
NRJ4B	0.256	0.282	0.256	0.270	0.220	0.201	0.190	0.222	0.212	0.002		0.003	0.017	0.017	0.017	0.023	0.017	0.018	0.019	0.018	0.018	0.018	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.018	
NRJ4M	0.261	0.286	0.261	0.274	0.225	0.206	0.195	0.227	0.216	0.006	0.004		0.018	0.017	0.017	0.023	0.017	0.019	0.019	0.018	0.018	0.018	0.019	0.019	0.019	0.019	0.019	0.020	0.019	0.018	0.018	
NRS1	0.252	0.265	0.246	0.249	0.212	0.184	0.179	0.206	0.199	0.201	0.199	0.203		0.011	0.010	0.021	0.010	0.018	0.017	0.017	0.017	0.018	0.018	0.018	0.018	0.021	0.018	0.018	0.018	0.018	0.018	
NRS1F	0.254	0.271	0.250	0.236	0.210	0.182	0.179	0.206	0.203	0.197	0.195	0.199	0.064		0.004	0.020	0.004	0.018	0.017	0.016	0.016	0.018	0.018	0.018	0.019	0.020	0.018	0.019	0.018	0.018	0.018	
NRS2	0.258	0.278	0.256	0.247	0.208	0.184	0.174	0.203	0.201	0.199	0.197	0.201	0.057	0.011		0.020	0.002	0.018	0.017	0.017	0.017	0.018	0.018	0.019	0.021	0.018	0.019	0.019	0.019	0.018	0.018	
NRS4	0.283	0.290	0.259	0.283	0.239	0.212	0.205	0.239	0.229	0.229	0.226	0.232	0.152	0.148	0.145		0.020	0.024	0.022	0.022	0.022	0.023	0.024	0.024	0.025	0.026	0.025	0.025	0.026	0.026	0.026	
NRS5	0.258	0.275	0.254	0.245	0.206	0.182	0.174	0.201	0.199	0.197	0.195	0.199	0.055	0.008	0.002	0.145		0.018	0.017	0.016	0.016	0.018	0.018	0.018	0.019	0.021	0.018	0.019	0.019	0.019	0.018	
NSC1	0.261	0.261	0.250	0.259	0.220	0.222	0.226	0.244	0.242	0.222	0.220	0.225	0.197	0.197	0.195	0.215	0.193		0.019	0.018	0.018	0.007	0.003	0.019	0.020	0.020	0.018	0.019	0.019	0.020	0.020	
NSC3	0.278	0.278	0.243	0.269	0.213	0.218	0.215	0.213	0.225	0.218	0.215	0.220	0.178	0.178	0.181	0.209	0.178	0.208		0.000	0.000	0.019	0.019	0.019	0.020	0.021	0.020	0.019	0.020	0.019	0.020	0.019
NSC3B	0.267	0.275	0.246	0.265	0.227	0.220	0.215	0.222	0.235	0.216	0.214	0.218	0.174	0.176	0.178	0.209	0.176	0.208	0.000		0.000	0.018	0.018	0.019	0.019	0.020	0.019	0.018	0.019	0.019	0.019	
NSC3M	0.267	0.275	0.246	0.265	0.227	0.220	0.215	0.222	0.235	0.216	0.214	0.218	0.174	0.176	0.178	0.209	0.176	0.208	0.000	0.000		0.018	0.018	0.019	0.019	0.020	0.019	0.018	0.019	0.019	0.019	
NSC4	0.248	0.261	0.256	0.249	0.210	0.216	0.215	0.237	0.229	0.210	0.208	0.212	0.193	0.197	0.195	0.205	0.193	0.030	0.211	0.212	0.212		0.008	0.019	0.019	0.020	0.018	0.019	0.019	0.020	0.020	
NSC8	0.261	0.263	0.252	0.256	0.218	0.220	0.226	0.246	0.244	0.222	0.220	0.225	0.195	0.195	0.193	0.215	0.191	0.004	0.208	0.208	0.208	0.030		0.019	0.020	0.020	0.018	0.019	0.019	0.020	0.020	
NSP4	0.239	0.258	0.254	0.236	0.227	0.212	0.231	0.222	0.212	0.242	0.239	0.244	0.206	0.220	0.225	0.242	0.222	0.233	0.238	0.242	0.242	0.220	0.231		0.018	0.020	0.019	0.018	0.017	0.019	0.019	
Oasellus	0.254	0.299	0.288	0.277	0.254	0.231	0.262	0.248	0.248	0.258	0.256	0.261	0.242	0.250	0.248	0.320	0.246	0.288	0.259	0.261	0.261	0.280	0.288	0.246		0.020	0.018	0.018	0.019	0.018	0.018	
Phoffman	0.286	0.294	0.301	0.320	0.307	0.290	0.303	0.305	0.303	0.288	0.286	0.290	0.301	0.303	0.307	0.330	0.307	0.309	0.294	0.297	0.297	0.297	0.307	0.278	0.307		0.019	0.020	0.019	0.019	0.019	
Ppruiusosus	0.191	0.252	0.265	0.245	0.244	0.220	0.251	0.258	0.242	0.252	0.250	0.254	0.225	0.229	0.231	0.276	0.229	0.233	0.264	0.261	0.261	0.231	0.235	0.218	0.231	0.280		0.017	0.017	0.019	0.019	
Pscaber	0.153	0.265	0.235	0.227	0.235	0.214	0.267	0.235	0.231	0.246	0.244	0.248	0.237	0.237	0.244	0.290	0.242	0.246	0.245	0.244	0.244	0.244	0.248	0.227	0.227	0.282	0.180		0.017	0.018	0.018	
Trathkii	0.186	0.261	0.261	0.195	0.229	0.220	0.226	0.216	0.212	0.248	0.246	0.250	0.242	0.233	0.239	0.296	0.237	0.244	0.271	0.261	0.261	0.242	0.246	0.189	0.239	0.284	0.180	0.178		0.019	0.019	
Ttomen	0.248	0.305	0.284	0.288	0.269	0.233	0.282	0.263	0.269	0.246	0.244	0.248	0.231	0.231	0.231	0.310	0.229	0.282	0.259	0.254	0.254	0.286	0.284	0.258	0.244	0.280	0.244	0.218	0.237		0.237	



Table 4: Sequence divergence on citocromo c oxidase subunidade I (*COI*) gene between congeneric species of the *Neotroponiscus*.

COI	N_BA15	N_BA16	N_BA20	N_BAunç	N_NLF2I	N_RJ4A	N_RJ4B	N_RJ4M	N_RS1	N_RS1F	N_RS2	N_RS4	N_RS5	N_SC1	N_SC3	N_SC3B	N_SC3M	N_SC4	N_SC8	N_SP4
N_BA15		0.016	0.020	0.012	0.012	0.018	0.018	0.018	0.018	0.018	0.018	0.024	0.018	0.018	0.019	0.018	0.018	0.018	0.018	0.019
N_BA16	0.186		0.026	0.017	0.017	0.018	0.018	0.018	0.017	0.017	0.017	0.023	0.017	0.018	0.019	0.018	0.018	0.018	0.018	0.018
N_BA20	0.092	0.169		0.017	0.009	0.028	0.028	0.028	0.026	0.026	0.026	0.028	0.026	0.029	0.027	0.027	0.027	0.029	0.029	0.029
N_BAunç	0.085	0.189	0.067		0.010	0.018	0.018	0.019	0.017	0.018	0.018	0.024	0.018	0.019	0.019	0.018	0.018	0.019	0.019	0.019
N_NLF2I	0.083	0.176	0.015	0.053		0.018	0.018	0.018	0.017	0.017	0.017	0.023	0.017	0.019	0.019	0.018	0.018	0.019	0.019	0.018
N_RJ4A	0.222	0.203	0.195	0.225	0.214		0.002	0.003	0.017	0.017	0.017	0.023	0.017	0.018	0.019	0.018	0.018	0.018	0.018	0.019
N_RJ4B	0.220	0.201	0.190	0.222	0.212	0.002		0.003	0.017	0.017	0.017	0.023	0.017	0.018	0.019	0.018	0.018	0.018	0.018	0.019
N_RJ4M	0.225	0.206	0.195	0.227	0.216	0.006	0.004		0.018	0.017	0.017	0.023	0.017	0.019	0.019	0.018	0.018	0.018	0.019	0.019
N_RS1	0.212	0.184	0.179	0.206	0.199	0.201	0.199	0.203		0.011	0.010	0.021	0.010	0.018	0.018	0.017	0.017	0.018	0.018	0.018
N_RS1F	0.210	0.182	0.179	0.206	0.203	0.197	0.195	0.199	0.064		0.004	0.020	0.004	0.018	0.017	0.016	0.016	0.018	0.018	0.018
N_RS2	0.208	0.184	0.174	0.203	0.201	0.199	0.197	0.201	0.057	0.011		0.020	0.002	0.018	0.017	0.017	0.017	0.018	0.017	0.018
N_RS4	0.239	0.212	0.205	0.239	0.229	0.229	0.226	0.232	0.152	0.148	0.145		0.020	0.024	0.022	0.022	0.022	0.024	0.024	0.023
N_RS5	0.206	0.182	0.174	0.201	0.199	0.197	0.195	0.199	0.055	0.008	0.002	0.145		0.017	0.017	0.017	0.017	0.018	0.017	0.018
N_SC1	0.220	0.222	0.226	0.244	0.242	0.222	0.220	0.225	0.197	0.197	0.195	0.215	0.193		0.019	0.018	0.018	0.008	0.003	0.019
N_SC3	0.213	0.218	0.215	0.213	0.225	0.218	0.215	0.220	0.178	0.178	0.181	0.209	0.178	0.208		0.000	0.000	0.019	0.019	0.019
N_SC3B	0.227	0.220	0.215	0.222	0.235	0.216	0.214	0.218	0.174	0.176	0.178	0.209	0.176	0.208	0.000		0.000	0.018	0.018	0.019
N_SC3M	0.227	0.220	0.215	0.222	0.235	0.216	0.214	0.218	0.174	0.176	0.178	0.209	0.176	0.208	0.000	0.000		0.018	0.018	0.019
N_SC4	0.210	0.216	0.215	0.237	0.229	0.210	0.208	0.212	0.193	0.197	0.195	0.205	0.193	0.030	0.211	0.212	0.212		0.008	0.018
N_SC8	0.218	0.220	0.226	0.246	0.244	0.222	0.220	0.225	0.195	0.195	0.193	0.215	0.191	0.004	0.208	0.208	0.208	0.030		0.019
N_SP4	0.227	0.212	0.231	0.222	0.212	0.242	0.239	0.244	0.206	0.220	0.225	0.242	0.222	0.233	0.238	0.242	0.242	0.220	0.231	

Table 5: Sequence divergence on 18S ribosomal RNA (*18S*) gene between species, including outgroup.

18S	Avul	Cbez	Cmur	Ddepr	Ncris	Bra	Oase	Pbira	Pprui	Ppsca	Tbic	Trath	Phof	Ttom	SP4	BA14	BA15	BA16	BA20	Bau	ilheus	ES1	IP	F2BA	PR1	RJ11	RJ4A	RJ4B	RS1	RS1F	RS2	RS2F	RS4	RS5	SC1	SC2	SC3B	SC3M	SC4			
Avulgare		0.015	0.018	0.019	0.018	0.018	0.013	0.018	0.019	0.015	0.017	0.018	0.013	0.017	0.018	0.019	0.019	0.018	0.020	0.019	0.019	0.019	0.019	0.019	0.019	0.018	0.018	0.018	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.022	0.018	0.019		
Cbezzii	0.083		0.018	0.019	0.017	0.018	0.013	0.018	0.020	0.018	0.017	0.018	0.014	0.019	0.018	0.020	0.020	0.019	0.020	0.020	0.020	0.020	0.020	0.020	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.022	0.018	0.019	
Cmurina	0.125	0.120		0.018	0.018	0.018	0.017	0.017	0.019	0.019	0.015	0.019	0.017	0.015	0.016	0.017	0.017	0.016	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.020	0.017	0.018	
Ddepress	0.158	0.142	0.145		0.019	0.016	0.017	0.016	0.021	0.019	0.015	0.018	0.017	0.019	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.016	0.017	0.017	0.018	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.021	0.017	0.018	
Ncristatus	0.133	0.115	0.135	0.153		0.017	0.015	0.018	0.020	0.017	0.018	0.018	0.015	0.018	0.018	0.019	0.019	0.020	0.019	0.020	0.019	0.019	0.020	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.022	0.018	0.019	
Brasp	0.117	0.115	0.116	0.119	0.116		0.017	0.015	0.021	0.020	0.014	0.019	0.017	0.017	0.017	0.017	0.017	0.016	0.016	0.016	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.019	0.016	0.016	
Oasellus	0.068	0.073	0.117	0.129	0.092	0.101		0.016	0.018	0.018	0.016	0.013	0.006	0.016	0.016	0.020	0.020	0.019	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.018	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.021	0.018	0.018	
Pbirabeni	0.138	0.130	0.125	0.113	0.142	0.103	0.106		0.021	0.019	0.013	0.018	0.016	0.018	0.014	0.014	0.014	0.015	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.017	0.017	0.020	0.017	0.017	
Pporinos	0.155	0.168	0.174	0.204	0.181	0.198	0.147	0.202		0.018	0.021	0.020	0.017	0.020	0.020	0.022	0.022	0.021	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.024	0.020	0.021	
Pscaber	0.088	0.151	0.154	0.182	0.135	0.165	0.136	0.174	0.142		0.018	0.019	0.018	0.019	0.020	0.020	0.020	0.020	0.020	0.021	0.020	0.020	0.021	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.023	0.019	0.020		
Tbicolor	0.119	0.127	0.095	0.107	0.147	0.080	0.098	0.075	0.190	0.181		0.018	0.016	0.015	0.012	0.014	0.013	0.015	0.014	0.013	0.013	0.014	0.013	0.013	0.013	0.013	0.015	0.014	0.014	0.014	0.014	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.018	0.015	0.015
Trathkii	0.127	0.115	0.174	0.164	0.154	0.150	0.068	0.149	0.206	0.182	0.152		0.013	0.019	0.019	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.021	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.023	0.019	0.020	
Phoffman	0.068	0.076	0.111	0.126	0.089	0.101	0.016	0.106	0.136	0.138	0.101	0.070		0.016	0.016	0.020	0.020	0.019	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.018	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.021	0.018	0.018	
Ttomen	0.120	0.133	0.094	0.145	0.140	0.106	0.104	0.139	0.195	0.166	0.086	0.166	0.098		0.016	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.017	0.017	0.021	0.018	0.017	
NSF4	0.133	0.131	0.102	0.133	0.148	0.088	0.112	0.101	0.205	0.190	0.066	0.191	0.109	0.104		0.014	0.014	0.016	0.015	0.014	0.014	0.015	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.017	0.014	0.014	
NBA14	0.166	0.195	0.120	0.134	0.186	0.108	0.174	0.094	0.248	0.228	0.085	0.241	0.179	0.129	0.102		0.000	0.015	0.000	0.000	0.000	0.009	0.002	0.000	0.014	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.016	0.014	0.014	
NBA15	0.167	0.192	0.122	0.133	0.184	0.104	0.175	0.093	0.248	0.228	0.084	0.241	0.180	0.129	0.101	0.000		0.015	0.000	0.000	0.000	0.009	0.002	0.000	0.014	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.016	0.014	0.014	
NBA16	0.141	0.156	0.118	0.144	0.176	0.121	0.151	0.114	0.222	0.206	0.108	0.212	0.153	0.129	0.124	0.110	0.109		0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.018	0.015	0.015
NBA20	0.189	0.197	0.122	0.136	0.189	0.107	0.176	0.095	0.251	0.231	0.086	0.244	0.182	0.130	0.103	0.000	0.000	0.111		0.000	0.009	0.002	0.000	0.014	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.016	0.014	0.014	
NBAuna	0.167	0.192	0.122	0.133	0.184	0.104	0.175	0.093	0.248	0.228	0.084	0.241	0.180	0.129	0.101	0.000	0.000	0.109	0.000		0.000	0.009	0.002	0.000	0.014	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.016	0.014	0.014	
Ncilheus	0.187	0.192	0.122	0.133	0.184	0.104	0.175	0.093	0.248	0.228	0.084	0.241	0.180	0.129	0.101	0.000	0.000	0.109	0.000	0.000		0.009	0.002	0.000	0.014	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.016	0.014	0.014	
NES1	0.172	0.204	0.122	0.133	0.191	0.104	0.192	0.095	0.256	0.239	0.095	0.254	0.195	0.132	0.103	0.042	0.041	0.116	0.042	0.041	0.041	0.041	0.009	0.009	0.014	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.014	0.014		
NIP	0.164	0.190	0.119	0.130	0.182	0.104	0.172	0.090	0.245	0.225	0.082	0.239	0.177	0.126	0.099	0.002	0.002	0.106	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
NLF2BA	0.167	0.192	0.122	0.133	0.184	0.104	0.175	0.093	0.248	0.228	0.084	0.241	0.180	0.129	0.101	0.000	0.000	0.109	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
NPR1	0.148	0.149	0.130	0.146	0.159	0.108	0.136	0.125	0.218	0.188	0.099	0.192	0.136	0.126	0.089	0.087	0.086	0.092	0.088	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	
NRJ11	0.146	0.172	0.113	0.125	0.168	0.099	0.162	0.090	0.231	0.199	0.090	0.225	0.161	0.129	0.091	0.045	0.045	0.087	0.046	0.045	0.045	0.045	0.043	0.043	0.045	0.076		0.000	0.000	0.014	0.014	0.014	0.0									

Table 6: Sequence divergence on 18S ribosomal RNA (*18S*) gene between congeneric species of the *Neotroponiscus*.

18S	N_SP4	N_BA14	N_BA15	N_BA16	N_BA20	N_Bauna	N_ilheus	N_ES1	N_IP	N_F2BA	N_PR1	N_RJ11	N_RJ4A	N_RJ4B	N_RS1	N_RS1F	N_RS2	N_RS2F	N_RS4	N_RS5	N_SC1	N_SC2	N_SC3B	N_SC3M	N_SC4	N_SC8	N_SC9
N_SP4		0.014	0.014	0.016	0.015	0.014	0.014	0.015	0.014	0.014	0.014	0.014	0.014	0.014	0.015	0.015	0.015	0.015	0.015	0.015	0.014	0.014	0.017	0.014	0.014	0.014	0.014
N_BA14	0.102		0.000	0.015	0.000	0.000	0.000	0.009	0.002	0.000	0.014	0.010	0.010	0.010	0.015	0.015	0.015	0.015	0.015	0.015	0.014	0.014	0.016	0.014	0.014	0.014	0.014
N_BA15	0.101	0.000		0.015	0.000	0.000	0.000	0.009	0.002	0.000	0.014	0.010	0.010	0.010	0.015	0.015	0.015	0.015	0.015	0.015	0.014	0.014	0.016	0.014	0.014	0.014	0.014
N_BA16	0.124	0.110	0.109		0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.014	0.014	0.014	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.018	0.015	0.015	0.015	0.016
N_BA20	0.103	0.000	0.000	0.111		0.000	0.000	0.009	0.002	0.000	0.014	0.010	0.010	0.010	0.015	0.015	0.015	0.015	0.015	0.015	0.014	0.014	0.016	0.014	0.014	0.014	0.014
N_Bauna	0.101	0.000	0.000	0.109	0.000		0.000	0.009	0.002	0.000	0.014	0.010	0.010	0.010	0.015	0.015	0.015	0.015	0.015	0.015	0.014	0.014	0.016	0.014	0.014	0.014	0.014
N_ilheus	0.101	0.000	0.000	0.109	0.000	0.000		0.009	0.002	0.000	0.014	0.010	0.010	0.010	0.015	0.015	0.015	0.015	0.015	0.015	0.014	0.014	0.016	0.014	0.014	0.014	0.014
N_ES1	0.103	0.042	0.041	0.116	0.042	0.041	0.041		0.009	0.009	0.014	0.009	0.009	0.009	0.015	0.015	0.015	0.015	0.015	0.015	0.014	0.014	0.016	0.014	0.014	0.014	0.014
N_IP	0.099	0.002	0.002	0.106	0.002	0.002	0.002	0.043		0.002	0.014	0.009	0.009	0.009	0.015	0.015	0.015	0.015	0.015	0.015	0.014	0.014	0.016	0.014	0.014	0.014	0.014
N_F2BA	0.101	0.000	0.000	0.109	0.000	0.000	0.000	0.041	0.002		0.014	0.010	0.010	0.010	0.015	0.015	0.015	0.015	0.015	0.015	0.014	0.014	0.016	0.014	0.014	0.014	0.014
N_PR1	0.089	0.087	0.086	0.092	0.088	0.086	0.086	0.086	0.084	0.086		0.014	0.014	0.014	0.007	0.007	0.007	0.007	0.007	0.007	0.000	0.000	0.006	0.005	0.000	0.000	0.006
N_RJ11	0.091	0.045	0.045	0.087	0.046	0.045	0.045	0.043	0.043	0.045	0.076		0.000	0.000	0.015	0.015	0.015	0.015	0.015	0.015	0.014	0.014	0.016	0.013	0.014	0.014	0.014
N_RJ4A	0.091	0.045	0.045	0.087	0.046	0.045	0.045	0.043	0.043	0.045	0.076	0.000		0.000	0.015	0.015	0.015	0.015	0.015	0.015	0.014	0.014	0.016	0.013	0.014	0.014	0.014
N_RJ4B	0.091	0.045	0.045	0.087	0.046	0.045	0.045	0.043	0.043	0.045	0.076	0.000	0.000		0.015	0.015	0.015	0.015	0.015	0.015	0.014	0.014	0.016	0.013	0.014	0.014	0.014
N_RS1	0.106	0.103	0.102	0.105	0.105	0.102	0.102	0.102	0.100	0.102	0.018	0.095	0.095	0.095		0.000	0.000	0.000	0.000	0.003	0.007	0.007	0.010	0.008	0.007	0.007	0.009
N_RS1F	0.106	0.103	0.102	0.105	0.105	0.102	0.102	0.102	0.100	0.102	0.018	0.095	0.095	0.095	0.000		0.000	0.000	0.000	0.003	0.007	0.007	0.010	0.008	0.007	0.007	0.009
N_RS2	0.106	0.103	0.102	0.105	0.105	0.102	0.102	0.102	0.100	0.102	0.018	0.095	0.095	0.095	0.000	0.000		0.000	0.000	0.003	0.007	0.007	0.010	0.008	0.007	0.007	0.009
N_RS2F	0.106	0.103	0.102	0.105	0.105	0.102	0.102	0.102	0.100	0.102	0.018	0.095	0.095	0.095	0.000	0.000	0.000		0.000	0.003	0.007	0.007	0.010	0.008	0.007	0.007	0.009
N_RS4	0.106	0.103	0.102	0.105	0.105	0.102	0.102	0.102	0.100	0.102	0.018	0.095	0.095	0.095	0.000	0.000	0.000	0.000		0.003	0.007	0.007	0.010	0.008	0.007	0.007	0.009
N_RS5	0.108	0.103	0.105	0.107	0.105	0.105	0.105	0.105	0.102	0.105	0.021	0.097	0.097	0.097	0.003	0.003	0.003	0.003	0.003		0.007	0.007	0.010	0.009	0.007	0.007	0.009
N_SC1	0.089	0.087	0.086	0.092	0.088	0.086	0.086	0.086	0.084	0.086	0.000	0.076	0.076	0.076	0.018	0.018	0.018	0.018	0.018	0.021		0.000	0.006	0.005	0.000	0.000	0.006
N_SC2	0.089	0.087	0.086	0.092	0.088	0.086	0.086	0.086	0.084	0.086	0.000	0.076	0.076	0.076	0.018	0.018	0.018	0.018	0.018	0.021	0.000		0.006	0.005	0.000	0.000	0.006
N_SC3B	0.107	0.100	0.100	0.113	0.100	0.100	0.100	0.100	0.097	0.100	0.013	0.087	0.087	0.087	0.032	0.032	0.032	0.032	0.032	0.032	0.013	0.013		0.000	0.006	0.006	0.005
N_SC3M	0.089	0.084	0.084	0.095	0.086	0.084	0.084	0.084	0.081	0.084	0.011	0.073	0.073	0.073	0.027	0.027	0.027	0.027	0.027	0.029	0.011	0.011	0.000		0.005	0.005	0.004
N_SC4	0.089	0.087	0.086	0.092	0.088	0.086	0.086	0.086	0.084	0.086	0.000	0.076	0.076	0.076	0.018	0.018	0.018	0.018	0.018	0.021	0.000	0.000	0.013	0.011		0.000	0.006
N_SC8	0.089	0.087	0.086	0.092	0.088	0.086	0.086	0.086	0.084	0.086	0.000	0.076	0.076	0.076	0.018	0.018	0.018	0.018	0.018	0.021	0.000	0.000	0.013	0.011	0.000		0.006
N_SC9	0.097	0.092	0.091	0.102	0.094	0.091	0.091	0.091	0.089	0.091	0.016	0.081	0.081	0.081	0.032	0.032	0.032	0.032	0.032	0.035	0.016	0.016	0.010	0.008	0.016	0.016	

## Considerações Finais

A tese apresentada analisou a história evolutiva e as relações filogenéticas entre as espécies de *Neotroponiscus*, bem como com os outros componentes da família Bathytropidae. O uso de dados moleculares juntamente com aspectos morfológicos contribuiu para uma recuperação mais robusta dos relacionamentos filogenéticos para o as espécies de *Neotroponiscus*.

Para a análise filogenética, foi necessária a observação de diversas espécies provenientes de museus nacionais e internacionais, além da realização de coletas para obtenção de material fresco para o estudo genético. Durante análise dos espécimes percebeu-se a necessidade de caracteres morfológicos adequados ao diagnóstico das espécies, justificando a execução de um estudo taxonômico. Além disso, a escassez de estudos relacionados aos isopodos terrestres reforça a importância de investimentos taxonômicos. Potencialmente, a diversidade de outras famílias deve estar subestimada, assim como observado para as espécies descritas nesta tese.

No Capítulo I, o gênero *Levantoniscus* foi descrito com um material proveniente de Chipre. Este material ajudou a elucidar o *status* taxonômico de *Bathytropa wahrmani*, outro táxon conhecido da região do mediterrâneo. As espécies novas compartilhavam caracteres anteriormente atribuídos ao gênero *Bathytropa*, tais como pulmões pleopodais, que diferem das outras espécies de *Bathytropa*.

No Capítulo II, o gênero americano *Dubioniscus* foi investigado e três espécies foram revisadas, duas delas são novas espécies descritas para o Brasil. Neste trabalho foi possível examinar o material da coleção de Vandel e notar a semelhança entre as espécies descritas por ele, sendo assim *Cubanoscia romanorum* foi sinonizada a *Dubioniscus negreae*.

No Capítulo III, duas novas espécies de *Neotroponiscus* foram descritas. A primeira foi coletada em cavernas de calcário localizado no Parque Estadual Turístico do Alto Ribeira (PETAR), enquanto a segunda espécie foi coletada em cavernas de minério de ferro do Quadrilátero de Ferro em Minas Gerais. Apesar das espécies não apresentarem características troglomórficas, ambas as espécies encontram-se ameaçadas de extinção, pois sofrem com os impactos do turismo e da mineração.

No Capítulo IV, as espécies de *Neotroponiscus* foram revisadas e novos caracteres foram levantados com o objetivo de proporcionar dados morfológicos detalhados para estudos filogenéticos para o grupo. Além disso, novos registros de ocorrência foram documentados para algumas espécies.

No último capítulo, as relações filogenéticas de *Neotroponiscus* foram analisadas com o auxílio de dados moleculares e morfológicos. O gênero foi recuperado como um grupo monofilético, concordando com a literatura, assim como seu parentesco com *Bathytropa*. A relação dos demais gêneros que compõe a família não pode ser definida, devido à necessidade de dados moleculares e adicionais táxons para determinar seu devido posicionamento em Crinocheta.

Os dados taxonômicos e moleculares obtidos nesta tese servirão como base para novas análises filogenéticas, além de contribuir para o conhecimento da diversidade deste táxon. Estudos futuros com uma abordagem biogeográfica serão importantes para elucidar os padrões de divergência na distribuição de Bathytropidae. Para as espécies de *Neotroponiscus*, uma análise semelhante também poderia esclarecer os padrões morfológicos encontrados entre os indivíduos localizados ao norte e sul do Brasil.

## **Anexos**

## Normas para a submissão da Revista

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*Initialcapbolditalic* Canu and Bassler, 1930

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## Normas para a submissão da Revista

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*Holotype.* m, CAMEROON, Mount Koupé, 1600 m, rain forest, 8 February 1983, Bosmans & Bosselaers (sweep net), (MRAC).

*Paratypes.* Same data as for holotype, 4 mm 8ff W (MRAC).

*Other material.* Mount Koupé, 1300 m, rain forest, 1f, 31 January 1983 (pitfall trap); 1f, 2 February 1983 (sweep net) (MRAC Mount Koupé, 900 m, rain forest, 1 m (subadult) 2ff, 31 January 1983 (pitfall trap), Bosmans & Bosselaers (all MRAC).

*Etymology.* The name refers to the dark, reticulated marginal zone of the carapace.

*Diagnosis.* This species can be distinguished by the shape of the paracymbium (Fig. 103) and the vulvar morphology (Fig. 111) in the female.

*Description*

*Male (holotype).* Total body length 2.38mm, 1 car 1.15mm, 1 stern 0.66 mm, 1 abd 1.45 mm, w car 0.93 mm ...

*Female (paratype).* Total body length 3.03mm ...

The complete data of the holotype and paratypes, and the institutions in which they are deposited, must be recorded in the original description. All material examined should be listed in similar format: localities should be cited in order of increasing precision as in the examples; names of countries should be in capitals. Sex symbols will be used in the journal; abbreviations used to indicate sex must be clearly stated in the manuscript.

Redescriptions of taxa should be arranged as in the following example:

Family PHYLLODOCIDAE

Genus *Phyllodoce* Lamarck, 1818

*Phyllodoce citrina* Malmgren, 1865: Fig. 2.

*Phyllocore citrina* Malmgren, 1865: 95-96, pl. XIII, fig. 24.

*Phyllodoce badia* Malmgren, 1867: 22, pl. II, fig. 6.

*Anaitides citrina* Bergström 1914: 140-141, fig. 41; Eliason 1962a: 18; Hartmann-Schröder 1971: 105-107, fig. 33D-F; Uschakov 1972: 136-137, pl. V, figs 5, 6.

*Material examined.* *Phyllodoce citrina*: 3 syntypes from Spitsbergen (SMNH type collection 2419 and 2420); 1 syntype from Spitsbergen (BMNH 1865.9.23.3); about 30 specimens from Wales, Shetland, western Norway, Spitsbergen, and Greenland (SMNH, MZB); about 10 specimens from the Arctic, Bering Sea and the Sea of Okhotsk (ZIL). *Phyllodoce badia*: several syntypes (at least 4 specimens and some fragments) from Bohuslän, Sweden (SMNH type collection 2423).

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#### Article

Goloboff, P. A., Farris, J. S. & Nixon, K. C. (2008). TNT, a free program for phylogenetic analysis. *Cladistics*, 24, 774-786.

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#### Book

Parenti, L. R. & Ebach, M. (2009). *Comparative biogeography*. Berkely: University of California Press.

#### Article in book

Andrew, C. J. (2007). The grid and biodiversity informatics. In G. B. Curry & C. J. Humphries (Eds) *Biodiversity databases. Techniques, politics and applications* (pp. 83-82). Boca Raton: CRC Press.

#### Computer programs

Swofford, D. L. 1993. PAUP - *Phylogenetic Analysis Using Parsimony. Ver. 3. 1.* [Computer software and manual]. Champaign, Illinois: Illinois Natural History Survey.

#### On-line source

Eriksson, T. (1996, June). AutoDecay version 2.9.2. Available via <http://www.botan.su.se/systematik/Folk/Torsten.html>

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