

SYSTEMATICS, MORPHOLOGY AND PHYSIOLOGY

Leptohyphidae (Insecta: Ephemeroptera) from Northeastern Brazil

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Introduction

Leptohyphidae is considered to be one of the most diverse families of Ephemeroptera in South America, after Baetidae, Leptophlebiidae and Polymitarcyidae (Salles 2006). Leptohyphidae has a Pan-American distribution and is represented by approximately 138 species (Barber-James *et al* 2008), 35 of which, belonging to *Amanahyphes*, *Leptohyphes*, *Leptohyphodes*, *Macunahyphes*, *Traverhyphes*, *Tricorythodes* and *Tricorythopsis*, are reported for Brazil (Salles *et al* 2010a, b).

There is a lack of knowledge of the Ephemeroptera fauna in the Center-West and Northeastern Brazil, especially for the family Leptohyphidae (Salles *et al* 2004). The Northeast is one of the least sampled regions of Brazil, and consequently it has the most incipient taxonomic knowledge on Ephemeroptera when compared to the Southern and Southeastern Brazil (Lima *et al* 2010). In most cases, species distribution can only be accessed in often old and not easily accessible descriptive studies (*e.g.* Allen 1967, 1977). The lack of information of this nature limits the analysis of biogeographic patterns and precludes the development of regional identification keys

Abstract

New records of Leptohyphidae for Northeastern Brazil are provided. Previously, only *Tricorythopsis bahiensis* Dias, Salles & Ferreira had been recorded in this region, but we now record one species of *Amanahyphes* Salles & Molineri, one of *Leptohyphes* Eaton, three of *Traverhyphes* Molineri, three of *Tricorythodes* Ulmer, and seven of *Tricorythopsis* Traver. Two of these species are recorded for the first time in Brazil. As all of these species are reported, the Northeastern Brazil became the second most diverse geographic region in Brazil in Leptohyphidae.

and systematic studies. Therefore, our objective is to contribute to the increasing knowledge of the distribution of the Leptohyphidae fauna in Northeastern Brazil.

Material and Methods

Collections were done between July and August 2010 in four northeastern states of Brazil: Maranhão, Piauí, Ceará and Bahia. Additionally, samples collected in the state of Goiás, Center-West of Brazil, were included because the sampled area is located near the border with state of Bahia (Fig 1). Data pertaining to each sampled locality are provided in Table 1.

Nymphs were collected with an aquatic entomological net, while adults were captured with light traps. Specimens were fixed in 80% ethanol and permanent slides, whenever needed, were prepared in Euparal®. Species identification was based on Domínguez *et al* (2006) and Dias *et al* (2007a, b), but several relevant publications for each taxon were used as well (*e.g.* Molineri 2001a,b, Dias & Salles 2005, Salles & Molineri 2006). The photographs were taken using a Leica

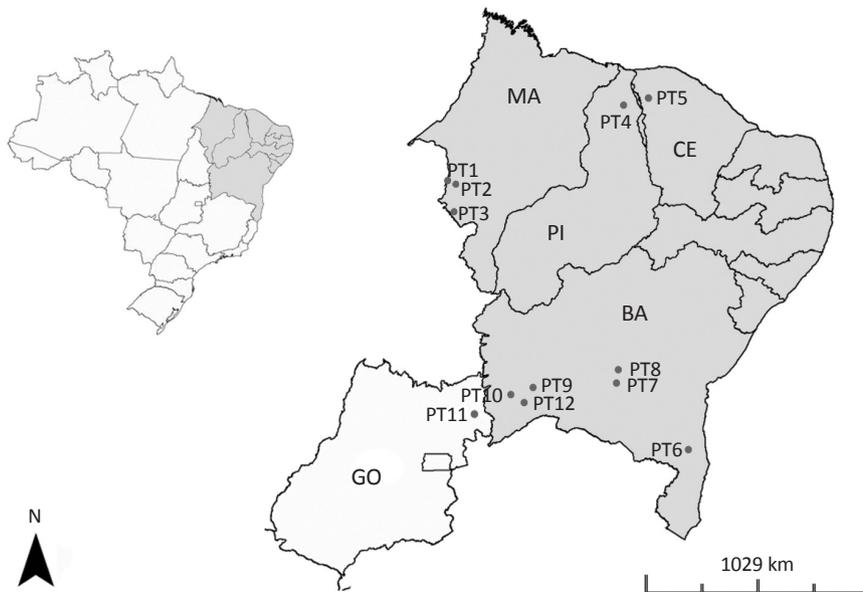


Fig 1 Map of Northeastern states and Goiás showing the sampled sites. (BA = Bahia, CE = Ceará, GO = Goiás, MA = Maranhão, PI = Piauí)

(M165C) stereomicroscope with a DFC420 digital camera.

Species that had only one specimen collected were deposited in the Coleção de Invertebrados do Instituto

Nacional de Pesquisas da Amazônia – INPA, Manaus, Amazonas, Brazil. Species represented by several specimens also had specimens deposited in the Coleção de Invertebrados do Centro Universitário Norte do Espírito

Table 1 Sampled sites in Northeastern region of Brazil and in Goiás state near the border with Bahia state, followed by locality, geographic coordinates, date and collectors.

Sample suite	State	Locality	Geographic coordinates	Date	Collectors
PT 01	Maranhão	Ribamar Riquente, MA-010, Rio Lajeado	06° 04' 15.6''S 47° 22' 56.6''W	21.vii.2010	NH, PVC, RB
PT 02	Maranhão	Porto Franco, MA-010, Rio Farinhas	06° 31' 47.3''S 47° 28' 11.4''W	22.vii.2010	NH, PVC, RB
PT 03	Maranhão	Carolina, Diable Hydroelectric, Rio Itapecuru	07° 24' 53.2''S 47° 12' 54.9''W	22.vii.2010	NH, PVC, RB
PT 04	Piauí	São João da Fronteira, Rio Jenipapo	04° 00' 15.8''S 41° 26' 53.8''W	26.vii.2010	NH, PVC, RB, RQ
PT 05	Ceará	Ubajara, Rio Jaburu, Boi Morto Waterfall	03° 52' 36.2''S 41° 10' 0.08''W	26.vii.2010	NH, PVC, RB, RQ
PT 06	Bahia	Camacan, Reserva Particular de Patrimônio Natural Serra Bonita	15° 22' 59.1''S 39° 33' 21.2''W	02.viii.2010	NH, RB, RQ
PT 07	Bahia	Rio de Contas, Pico do Itobira, Rio Comburú	13° 24' 19.1''S 41° 52' 53.9''W	04.viii.2010	NH, RB, RQ
PT 08	Bahia	Piatã, Rio de Contas	13° 07' 23.6''S 41° 50' 14.1''W	05.viii.2010	NH, RB, RQ
PT 09	Bahia	Correntina, Rio Correntina, near the restaurant	13° 19' 59.6''S 44° 36' 08.0''W	07.viii.2010	NH, RB, RQ
PT 10	Bahia	Correntina, Rio Correntina, near Posto Cachoeira	13° 31' 09.6''S 45° 21' 01.8''W	08.viii.2010	NH, RB, RQ
PT 11	Goiás	Posse, Rio do Prata, Bahia/Goiás border	14° 14' 46.4''S 46° 33' 07.0''W	09.viii.2010	NH, RB, RQ
PT 12	Bahia	Correntina, Prainha community, Rio Arrojado	13° 31' 25.1''S 44° 43' 30.7''W	05.viii.2003	NH, FFS

Santo – CEUNES, São Mateus, Espírito Santo, Brazil.

For each species recorded, data on the known stages, distribution with emphasis on Brazil, comments (if necessary), and a list of examined material is provided. Abbreviations and symbols used: “I” = imago, “N” = nymph, “PT” = collection site.

Results

A total of 159 specimens belonging to 15 species in five genera were collected.

Amanahyphes Salles & Molineri

Amanahyphes saguassu Salles & Molineri (2006) (Fig 2a)

Known stages. I ♂, N

Distribution. Brazil: states of Amazonas (Manaus and Presidente Figueiredo municipalities) (Salles & Molineri 2006), Pará (Parauapebas municipality) (Gonçalves &

Da-Silva 2010); **new record**: state of Maranhão (Carolina municipality).

Comments. This is a very common species in the states of Amazonas and Pará, usually collected on roots with sediment.

Material examined. PT3: (1N), 22.vii.2010, INPA.

Leptohyphes Eaton

Leptohyphes petersi Allen (1967) (Fig 2b)

Known stages. I ♀♂, N.

Distribution. Peru (Allen 1967); **new record**: Brazil: state of Bahia (Camacan municipality).

Material examined. PT6: (4N), 02.viii.2010, two in INPA, two in CEUNES.

Traverhyphes Molineri

Traverhyphes (Mocohyphes) edmundsi (Allen 1973) (Fig 2c)

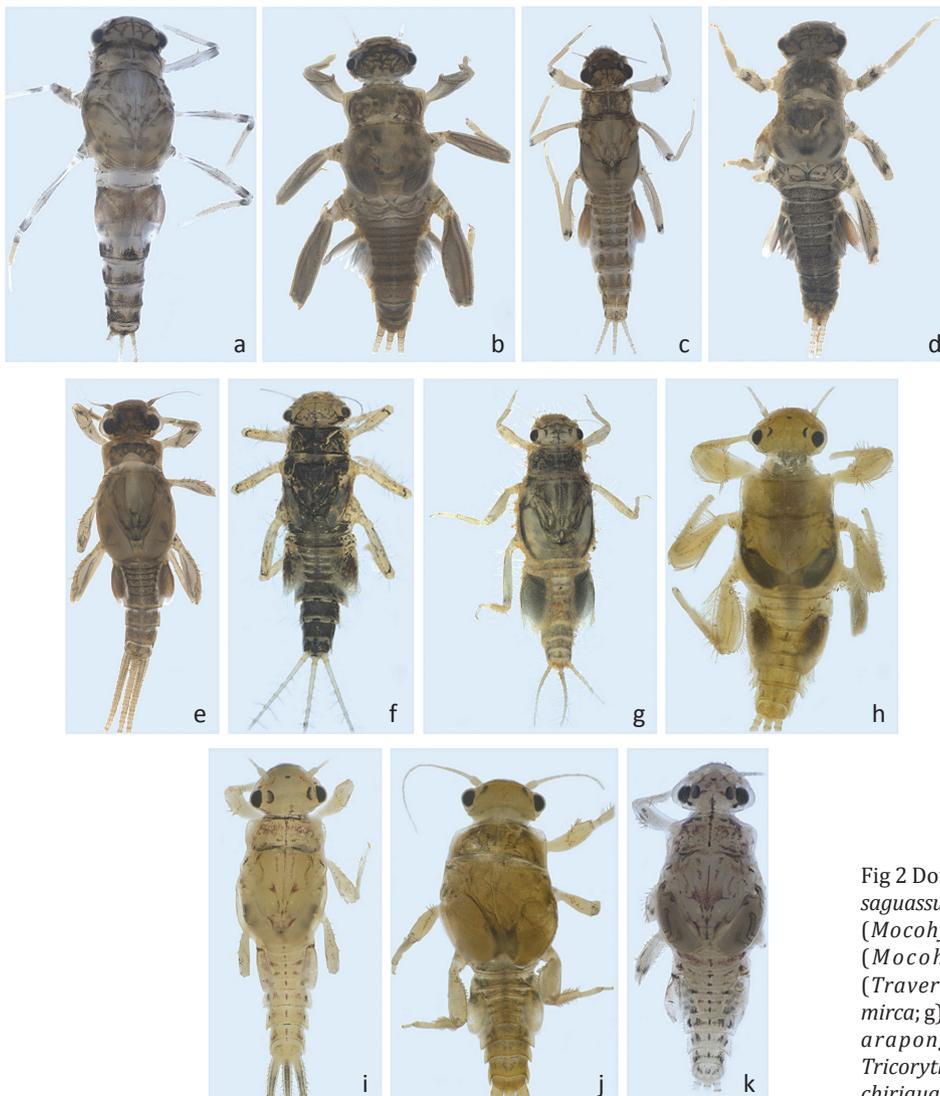


Fig 2 Dorsal habits of nymphs: a) *Amanahyphes saguassu*; b) *Leptohyphes petersi*; c) *Traverhyphes (Mocohyphes) edmundsi*; d) *Traverhyphes (Mocohyphes) indicator*; e) *Traverhyphes (Traverhyphes) indicator*; f) *Tricorythodes mirca*; g) *Tricorythodes quizeri*; h) *Tricorythopsis araponga*; i) *Tricorythopsis minimus*; j) *Tricorythopsis pseudogibbus*; k) *Tricorythopsis chiriguano*.

Known stages. I ♀♂, N.

Distribution. Argentina (Molineri 2004); Brazil: states of Paraná (Morretes, Curitiba, Sete Quedas, Prudentópolis and Guairá municipalities) (Allen 1973, Dias *et al* 2007a), São Paulo (Intervales, Campos do Jordão and Salesópolis municipalities) (Molineri 2004, Dias *et al* 2007b), Rio Grande do Sul (Cachoeira do Sul municipality) (Allen 1973, Dias *et al* 2007a), Santa Catarina (Joinville and Rio Warnow municipalities) (Allen 1973, Dias *et al* 2007a); **new records:** states of Maranhão (Ribamar Riquente and Porto Franco municipalities), Bahia (Camacam municipality), and Goiás (Posse municipality).

Material examined. PT1: (5N), 21.vii.2010; PT2: (3N), 22.vii.2010; PT6: (5N), 02.viii.2010; PT11: (1N), 09.viii.2010, seven in INPA, seven in CEUNES.

Traverhyphes (Mocohyphes) yuati Molineri (2004) (Fig 2d)

Known stages. N.

Distribution. Argentina (Molineri 2004); Brazil: states of São Paulo (Campos do Jordão, Salesópolis and Iporanga municipalities) (Molineri 2004, Dias *et al* 2007b), Rio de Janeiro (Nova Friburgo and Itatiaia municipalities) (Molineri 2004, Dias *et al* 2007a), Minas Gerais and Espírito Santo (Espera Feliz municipality) (Salles *et al* 2010a); **new records:** states of Maranhão (Ribamar Riquente and Porto Franco municipalities), Piauí (São João da Fronteira municipality) and Goiás (Posse municipality).

Comments. The collected nymphs have a series of characteristics that deviate from the original description of *T. yuati*. However, according to Carlos Molineri (personal communication), nymphs of this species can have large morphological variation. The differences observed were: 1) coxae with black mark; 2) femur with subapical black mark dorsally and on outer and inner surface; 3) maxillary palp 2-segmented, very long, more than 2.5× longer than wide, with fine and long apical seta; 4) tarsal claws with 5-7 marginal denticles and 4+3-2 submarginal denticles, with apical seta.

Material examined. PT1: (10N), 21.vii.2010; PT2: (5N), 22.vii.2010; PT4: (1N), 26.vii.2010; PT11: (1N), 09.viii.2010, nine in INPA, eight in CEUNES.

Traverhyphes (Traverhyphes) indicator (Needham & Murphy 1924) (Fig 2e)

Known stages. I ♀♂, N.

Distribution. Argentina (Needham & Murphy 1924, Molineri 2001a), Uruguay (Traver 1958), Brazil: states of São Paulo (Ribeirão Preto, Ribeirão Grande and Iporanga municipalities) (Dias *et al* 2007a, b) and Espírito Santo (Pinheiros municipality) (Salles *et al* 2010a); **new records:** states of Maranhão (Ribamar Riquente and Porto Franco municipalities), Bahia (Correntina municipality) and Goiás (Posse municipality).

Material examined. PT1: (8N), 21.vii.2010; PT2: (2N), 22.vii.2010; PT9: (4N), 07.viii.2010; PT10: (2N), 08.viii.2010; PT11: (1N), 09.viii.2010, seven in INPA, ten in CEUNES.

Traverhyphes (Traverhyphes) sp.1

Known stages. I♂.

Distribution. Brazil: **new record:** state of Ceará (Ubajara municipality).

Comments. Only one male imago was collected in a light trap. The specimen was in poor condition, preventing us from identifying the species.

Material examined. PT5: (1I), 26.vii.2010, INPA.

Tricorythodes Ulmer

Tricorythodes mirca Molineri (2002) (Fig 2f)

Known stages. I ♀♂, N.

Distribution. Bolivia (Molineri 2002); Brazil: states of Espírito Santo (São Mateus and Sooretama municipalities) (Salles *et al* 2010a); **new records:** states of Maranhão (Ribamar Riquente and Porto Franco municipalities) and Piauí (São João da Fronteira municipality).

Comments. *Tricorythodes mirca* and *T. arequita* Traver have similar nymphs. *Tricorythodes mirca* has tarsi without black mark, while the nymph of *T. arequita* has tarsi with black mark. However, some of our *T. mirca* specimens have a small black mark on the tarsi. Other variations observed in the specimens collected in this study were: 1) tarsal claws with 8–11 marginal denticles, without submarginal denticles (as previously cited by Salles *et al* 2010a); 2) maxillary palp with apical and subapical setae.

Material examined. PT1: (2N), 21.vii.2010; PT2: (21N), 22.vii.2010; PT4: (6N), 26.vii.2010, 14 in INPA, 15 in CEUNES.

Tricorythodes quizeri Molineri (2002) (Fig 2g)

Known stages. I ♀♂, N.

Distribution. Bolivia (Molineri 2002); Brazil: state of Mato Grosso (Nova Xavantina municipality) (Dias *et al* 2009); **new record:** state of Goiás (Posse municipality).

Comments. Since the locality where the specimens were collected is near to the border with Bahia, is likely that this species may also occurs in the latter state.

Material examined. PT11 (1N), 09.viii.2010, INPA.

Tricorythodes sp. 1

Known stages. N.

Distribution. **new records:** Brazil: states of Bahia (Correntina municipality) and Maranhão (Ribamar Riquente and Porto Franco municipalities).

Comments. It was not possible to identify the collected specimens. They probably represent an undescribed species.

Material examined. PT2 (2N), 22.vii.2010; PT3 (3N),

22.vii.2010; PT9 (1N), 07.viii.2010, three in INPA, three in CEUNES.

Tricorythopsis Traver

Tricorythopsis araponga Dias & Salles (2005) (Fig 2h)

Known stages. N.

Distribution. Brazil: states of Espírito Santo (Jerônimo Monteiro municipality) (Dias & Salles 2005), Minas Gerais (Araponga municipality) (Dias & Salles 2005), Rio de Janeiro (Itatiaia municipality) (Dias & Salles 2005), and São Paulo (Salesópolis municipality) (Dias & Salles 2005); **new record:** state of Bahia (Rio de Contas municipality).

Comments. The collected specimen has all diagnostic characteristics of *T. araponga*, except tarsal claw with 6-8 marginal denticles and 5-8+8-10 submarginal denticles.

Material examined. PT7 (1N), 04.viii.2010, INPA.

Tricorythopsis bahiensis Dias, Salles & Ferreira (2008)

Known stages. N.

Distribution. Brazil: states of Roraima (Arraiá municipality) (Dias *et al* 2008), Amazonas (Presidente Figueiredo municipality) (Dias *et al* 2008), and Bahia (Correntina municipality) (Dias *et al* 2008); **new record:** state of Maranhão (Ribamar Riquente municipality).

Material examined. PT1 (4N), 21.vii.2010; PT12 (7N), 05.viii.2003, five in INPA, six in CEUNES.

Tricorythopsis minimus (Allen 1973) (Fig 2i)

Known stages. I ♀♂, N.

Distribution. Argentina (Molineri 2001b), Uruguay (Traver 1958), Brazil: states of Rio Grande do Sul (Panambi municipality) (Allen 1973) and Espírito Santo (Sooretama municipality) (Salles *et al* 2010a); **new record:** state of Bahia (Correntina municipality).

Material examined. PT9 (1N), 07.viii.2010, INPA.

Tricorythopsis pseudogibbus Dias & Salles (2005) (Fig 2j)

Known stages. N.

Distribution. states of Rio de Janeiro (Itatiaia municipality) (Dias & Salles 2005, Salles *et al* 2010a), Minas Gerais (Araponga municipality) (Dias & Salles 2005, Salles *et al* 2010a), and São Paulo (unknown municipality) (Mariano & Polegatto 2011); **new record:** state of Bahia (Rio de Contas municipality).

Material examined. PT7 (1N), 04.viii.2010, INPA.

Tricorythopsis chiriguano Molineri (2001a) (Fig 2k)

Known stages. I ♀♂, N.

Distribution. Bolivia (Molineri 2001a); **new record:** Brazil: state of Maranhão (Ribamar Riquente and Porto Franco municipalities).

Comments. *Tricorythopsis chiriguano* and *T. minimus* are very similar; the abdominal color pattern and length of

operculate gills can be used to distinguish them.

Material examined. PT2 (1N), 22.vii.2010; PT3 (4N), 22.vii.2010, two in INPA, three in CEUNES.

Tricorythopsis sp. 1

Known stages. N.

Distribution. **new record:** Brazil: states of Maranhão (Ribamar Riquente municipality).

Comments. It was not possible to identify the collected specimens. They probably represent an undescribed species.

Material examined. PT1 (30N), 21.viii.2010, 15 in INPA, 15 in CEUNES.

Tricorythopsis sp. 2

Known stages. N.

Distribution. **new records:** Brazil: states of Maranhão (Ribamar Riquente and Porto Franco municipalities) and Bahia (Correntina municipality).

Comments. It was not possible to identify the collected specimens. They probably represent an undescribed species.

Material examined. PT2 (2N), 22.vii.2010; PT3 (12N), 22.vii.2010; PT9 (1N), 07.viii.2010, seven in INPA, eight in CEUNES.

Discussion

The Northeast of Brazil represents nearly 18% of the country area and it is the region that has the largest number of biomes: Amazon, Cerrado, Caatinga and Atlantic forest (IBGE 2004). Four types of climate can be found in this unique Brazilian region: equatorial humid, coastal humid, tropical and semi-arid (IBGE 2002).

Despite having a high diversity of biomes and climates, Caatinga, with a semi-arid climate and seven to 11 months of water shortage, is the predominant biome (Leal *et al* 2005). The available water resources are heavily used by the population of the region (Rebouças 1997). Caatinga is the only biome entirely restricted to Brazil's national territory. However, little attention has been given to the preservation of this region, and the contribution of this area to the country's biodiversity is high and has probably been underestimated (Silva *et al* 2004).

Only one inventory of the Ephemeroptera fauna has been done in the Northeast of Brazil, focusing on Baetidae from the state of Bahia (Lima *et al* 2010). Leptohiphidae was represented in this region only by *T. bahiensis*, which was described from Bahia (Dias, Salles & Ferreira 2008). With the new records we provided, the Leptohiphidae fauna from the Northeast of Brazil became one of the most diverse, as 20 species in five genera of Leptohiphidae are known to the Southeast, 15 species in five genera to the Northeast, 12 species in five genera to the South, six

species in five genera to the North and three species in two genera to the Center-West of Brazil.

Of the seven known Leptohephidae genera recorded in Brazil, *Macunahyphes* and *Leptohephodes* were the only ones missing from the Northeast. Two of the 15 species reported in this study represent new species records for Brazil: *L. petersi*, previously known only to Peru, and *T. chiriguano* only to Bolivia. One of the specimens collected (one imago represented by *Traverhyphes* (*Traverhyphes*) sp.1) could not be identified to the species level because of the poor conditions of specimen, but its record is important to the knowledge of the distribution of the genus in Brazil.

Our study reinforces the need to increase the sampling of aquatic insects in Brazil. We were able to considerably increase the number of known species for the Northeastern region, although the occurrence of a small number of streams and rivers sparsely distributed in our sampling area. Certainly, a larger collection effort, including more detailed samples in all of the biomes in the Northeast of Brazil would significantly increase our knowledge on the diversity of Ephemeroptera.

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