



Biota Neotropica

ISSN: 1676-0611

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Instituto Virtual da Biodiversidade  
Brasil

Raimundi, Erikksen Augusto; Falcão Salles, Frederico; de Souza-Franco, Gilza Maria  
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Biota Neotropica, vol. 13, núm. 4, octubre-diciembre, 2013, pp. 57-70  
Instituto Virtual da Biodiversidade  
Campinas, Brasil

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## Fauna of Leptophlebiidae Banks (Insecta: Ephemeroptera) on fragments of the Atlantic Forest from west region of Santa Catarina State, Brazil

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RAIMUNDI, E.A., SALLES, F.F. & SOUZA-FRANCO, G.M. **Fauna of Leptophlebiidae Banks (Insecta: Ephemeroptera) on fragments of the Atlantic Forest from west region of Santa Catarina State, Brazil.** Biota Neotrop. 13(4): <http://www.biotaneotropica.org.br/v13n4/en/abstract?article+bn01013042013>

**Abstract:** The first studies of Leptophlebiidae in the Santa Catarina State, Southern Brazil, dated from 1920. Since then, not much is known about the family (even to the Order Ephemeroptera) to the State. The main goal of this study was to survey fauna of Leptophlebiidae in the Santa Catarina State based on nymphs. The material was obtained from the collection deposited at the Laboratório de Pesquisa em Ecologia e Química of the Universidade Comunitária da Região de Chapecó, besides additional specimens collected between 2008 and 2009. Occurrences were plotted in the hydrograph map of Santa Catarina State, with one map for each genus. The Leptophlebiidae nymphs were recorded in 26 aquatic environments that included small streams and rivers. We identified 24 morphotypes distributed in 12 genera. Number of genera in the Western of Santa Catarina increased from eight to 15. *Thraulodes*, *Ulmeritoides* and *Homothraululus* presented higher frequency of occurrence in the region. *Leentvaaria* and *Hermanella* were associated to regions well conserved such as in the Araucaria forest. *Needhamella* and *Segesta* were related mainly to Irani River.

**Keywords:** Atalophlebiinae, Uruguai River, Brazilian Southern, nymphal stage, survey.

RAIMUNDI, E.A., SALLES, F.F. & SOUZA-FRANCO, G.M. **Fauna de Leptophlebiidae Banks (Insecta: Ephemeroptera) em fragmentos de Mata Atlântica no oeste de Santa Catarina, Brasil.** Biota Neotrop. 13(4): <http://www.biotaneotropica.org.br/v13n4/pt/abstract?article+bn01013042013>

**Resumo:** Os primeiros estudos de Leptophlebiidae em Santa Catarina, Sul do Brasil, datam de 1920. Desde então, pouca informação foi acrescida à Família (até mesmo à Ordem Ephemeroptera) para o estado. O objetivo deste estudo foi inventariar a fauna de Leptophlebiidae no Estado de Santa Catarina com base em ninfas. Os Leptophlebiidae foram obtidos através de coleção depositada no Laboratório de Pesquisa em Química e Ecologia da Universidade Comunitária da Região de Chapecó além de espécimes adicionais coletados entre 2008 e 2009. As ocorrências foram plotadas no mapa hidrográfico do Estado de Santa Catarina, com um mapa para cada gênero. As ninfas Leptophlebiidae foram registradas em 26 ambientes aquáticos que incluíram pequenos riachos e rios. Foram identificados 24 morfotipos distribuídos em 12 gêneros. O número de gêneros no Oeste de Santa Catarina aumentou de oito para 15. *Thraulodes*, *Ulmeritoides* e *Homothraululus* foram os gêneros com maior frequência de ocorrência na região. *Leentvaaria* e *Hermanella* estiveram associados a regiões mais bem conservadas, como na floresta Ombrófila Mista. *Needhamella* e *Segesta* estiveram relacionados principalmente ao rio Irani.

**Palavras-chave:** Atalophlebiinae, Rio Uruguai, Região Sul brasileira, estágio ninfal, levantamento.

## Introduction

Santa Catarina State was covered by 100% of Atlantic Forest, but 23.39% remains in conserved areas (SOS Mata Atlântica & Instituto... 2009). There are four forest formations in the State: Mixed Ombrophilous Forest, Dense Ombrophilous Forest, High-elevation grassland (or savannah of grass-woody) and, Deciduous Forest (SOS Mata Atlântica & Instituto... 2009). Likewise, there are other vegetal formations, such as sandbank's vegetation and, mangrove's vegetation, which can be closely found to littoral region.

The fast process of deforestation in Santa Catarina State has also compromised quality and availability of aquatic resources. Ally to poor knowledge about its aquatic biodiversity, hydrographic regions such Alto Rio Uruguai (the largest hydrographic region of western Santa Catarina), is considered one of those priorities areas for environmental conservation in Brazil (Brasil 2006).

Leptophlebiidae is one of the richest families of Ephemeroptera in the world, as well as in the Neotropical and Southern America regions, especially when it comes to the generic level (Tsui & Peters 1975; Domínguez et al. 2001, Barber-James et al. 2008). This highest richness is also accompanied by high number of endemic taxa (Barber-James et al. 2008).

Taxonomic knowledge of Leptophlebiidae in Brazil is still incipient (Salles et al. 2004). Yet, ecological and biological aspects are fragmented in papers on benthic macroinvertebrates (e.g. Bispo & Oliveira, 2007; Buckup et al. 2007) and/or taxonomic descriptions (Lima et al. 2012; Salles & Domínguez 2012). Nonetheless, in the latest years this situation has changed, and ecological researches with mayfly have been developed (e.g. Sieglösch et al. 2008, Shimano et al. 2012, 2013).

In Brazil, most of the checklists of mayflies (and Leptophlebiidae) are associated to the presence of specialists on the group, such as the states of Rio de Janeiro (14 genera; 24 species; Da-Silva et al. 2010), Espírito Santo (16 genera; 22 species; Salles et al. 2010), São Paulo (13 genera; 16 species; Mariano & Polegato, 2011), Mato Grosso (15 genera; 15 species; Shimano et al. 2011), Pernambuco (10 genera; 14 species; Lima et al. 2012), and Brazilian Amazonia Region (10 genera; 19 species; Lopes et al. 2007).

Most of the knowledge on mayflies from Santa Catarina relies on the material collected by Fritz Plaumann, a German naturalist that extensively collected insects seven decades ago (Spessatto 2001). Between the decades of 1960's and 1990's several species or even genera were described based on the material collected by him (Thew 1960; Peters 1969; Domínguez & Flowers 1989). Plaumann contributed strongly for the current knowledge of fauna and, after his studies in the State, there was not a substantial increase on descriptions of new taxa or additional records of Leptophlebiidae. With the exception of the last two new species described from Santa Catarina (Lima et al. 2013), Leptophlebiidae remains with eight genera and 16 species.

To date, the following species of Leptophlebiidae were recorded in Santa Catarina: *Askola froehlichii* Peters 1969, *Hagenulopsis diptera* Ulmer 1920, *Hermanella grandis* Domínguez & Flowers 1989, *Hermanella maculipennis* (Ulmer 1920), *Hylister plaumanni* Domínguez & Flowers 1989, *Needhamella ehrhardti* (Ulmer 1920), *Thraulodes alapictus* Mariano e Lima, 2013; *T. daidaleus* Thew 1960, *T. limbatus* Navás 1936, *T. pinhoi* Mariano & Lima, 2013; *T. traversae* Thew 1960, *T. ulmeri* Edmunds 1950, *Ulmeritoides haarupi* (Esben-Petersen 1912), *U. patagiatus* (Thew 1960), *U. uruguayensis* (Traver 1959), and *Ulmeritus balteatus* Thew, 1960 (Salles et al. 2013).

Given the diversity of the group, especially in Tropical areas, and the fact that collections in Santa Catarina were performed in few and restricted areas, it is clear that the present number of taxa is

underestimated. Based on that, the goals of the present report were to survey of Leptophlebiidae fauna in Western of Santa Catarina, Brazil beyond to contribute with knowledge about biology of group.

## Material and Methods

### 1. Region of study

Historically, the western of Santa Catarina State has developed quickly and, thus, the dense and exuberant forest has been changed in large fragments (Testa et al. 1996; Wolff & Schuh 2000). The economical base of region is based from little and middle farms (with lands about 10 and 15 ha) to large industrial poles, such as agribusiness. Currently, those poles still depend on farms.

The western of Santa Catarina (Figure 1) comprises an area with 27,500 sq Km that includes 118 municipalities (Programa et al. 2003) with an estimated population of 1,215 million. The climate in lower areas shows the lowest temperatures between 10 °C and 15 °C, and highest average above 22 °C. However, higher areas show an average temperature lower than 10 °C, and the highest average up to 22 °C (Instituto 2002, Empresa... 2004).

Despite forestal formation, it is possible to divide western in three areas: Mixed Ombrophilous Forest, a forest formation with predominance of *Araucaria angustifolia* (Bertoloni) Otto Kuntze; high-elevation grassland with sparse presence of *A. angustifolia*, and Deciduous Forest, a forest located along of Uruguai River and with marked presence of distinct deciduous Lauraceae (Klein 1978; Tabarelli et al. 2005). Forest remains covering 45% from total area of the region (SOS Mata Atlântica & Instituto... 2009); however, only 8% belong to national or state conservation unities (Marenzi et al. 2005). The remainder forest comprises basically Legal Reserves or Permanent Preservation Areas, which are legal areas with main goal, to preserve hydrographic and geological resources, conservation of native fauna and flora.

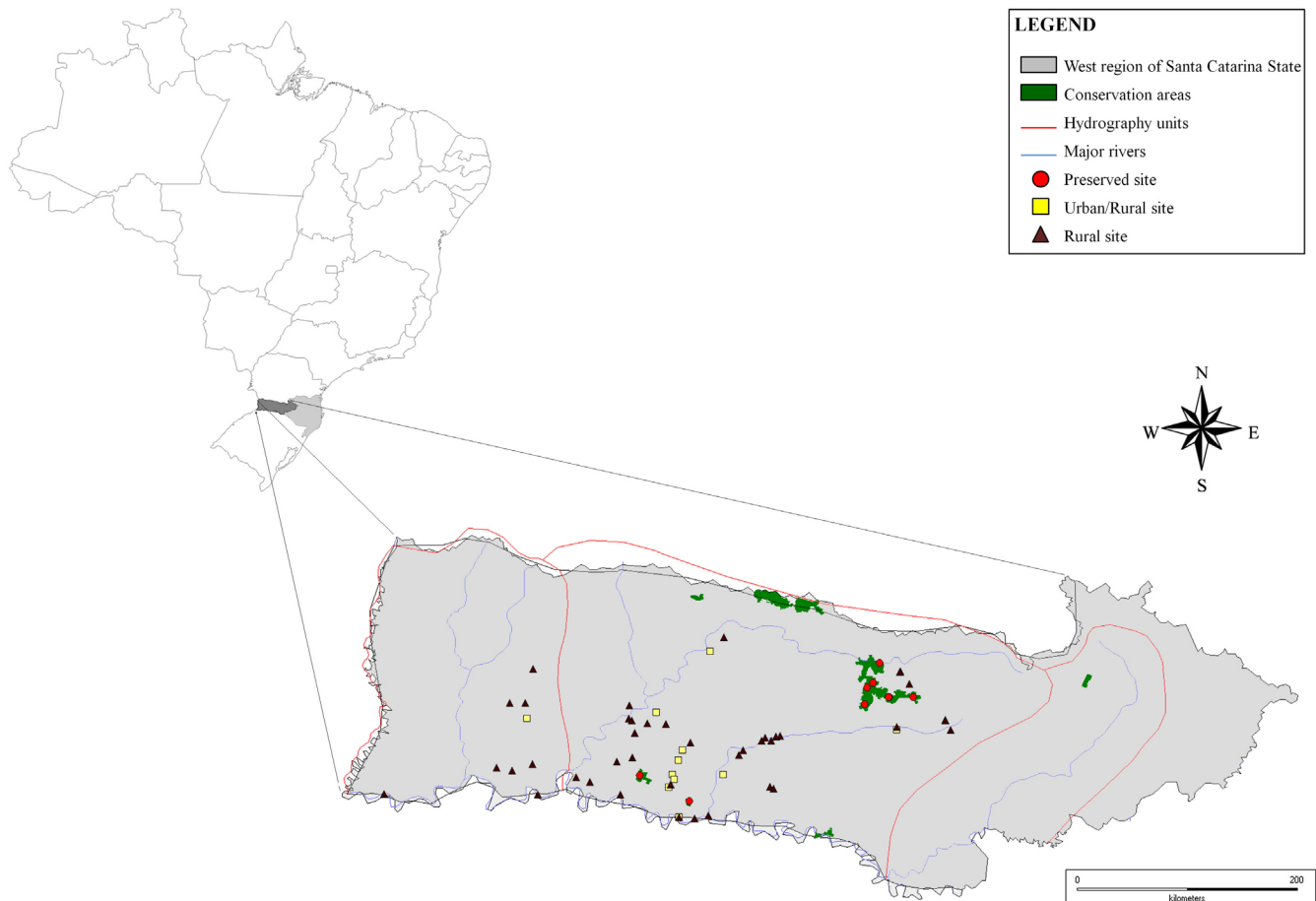
Western of Santa Catarina is formed by tree hydrographic regions: Far-western, constituted by Peperi-Guaçu and Antas hydrographic basins, with an area about 5,900 sq Km; Middle-western region, constituted by Chapecó and Irani hydrographic basins, with an area about 11,000 sq Km and; Rio do Peixe Valley, constituted by Peixe and Jacutinga hydrographic basins, with an area of 8,200 sq Km (Santa Catarina 1998). This hydrographic region is also considered one of those priorities areas for environmental conservation in Brazil (Brasil 2006).

In this work, 61 sites were sampled in 26 aquatic environments comprising rivers, streams, and reservoirs. From those sites, nine are situated in Far-western hydrographic region, and fifty-one, in Middle-western. The Rio do Peixe Valley hydrographic region was not sampled. Nine stations are ranked as preserved areas, forty-one as rural areas, and eleven between urban/rural areas (Table 1).

Were considered Preserved areas when sites were located inside or very close to Conservation Units, in this case, Araucária National Park and Chapecó National Forest. Were considered Rural areas when sites were strongly influenced by agricultural, livestock and, plantation of exotic trees. Finally, for the Urban/Rural areas were considered sites located in regions near or, within urban areas. Finally, sites pointed out as lentic environments, were located closely, or inside small hydroelectric plants and hydroelectric plants as opposed of lotic environments.

### 2. Material studied and identification

Part of the specimens studied has been already deposited in collection of Laboratory of Ecology of Universidade Comunitária da Região de Chapecó. In addition, new material was collected between



**Figure 1.** Map of Brazil, emphasizing the Western of Santa Catarina and sites sampled. Coordinates are on Appendix 1.

2008 and 2009 to complement the area of coverage. Samples between 2008 and 2009 were taken with Surber, frame aquatic net samplers, and also manually, sampling the most different kinds of substrata available on river (stones, leaf litter, and fine sediments).

Specimens were identified at lesser possible taxonomic level and further morphotyped. Taxonomic identification of nymphs was performed based on papers containing original descriptions and redescrptions, books and thesis (e.g. Domínguez & Flowers 1989, Domínguez et al. 1994, 2001, 2006, Domínguez 1999, Salles et al. 2004, Salles 2006).

### 3. Preparation of maps

Data sets of coordinates were taken with GPS (Global Positioning System), and points downloaded on GPS TrackMaker® software (Ferreira Júnior 2008). A map for each genus was made using DIVA-GIS software (Hijmans et al. 2005), based in the taxa found, coordinates of sampled areas, and map of hydrographic basin in the Western Santa Catarina State.

## Results and Discussion

A total of 1903 nymphs of Leptophlebiidae were identified belonging to 24 morphotypes of 12 genera (Table 2).

The richest genus of Leptophlebiidae found was *Thraulodes* (five morphotypes), followed by *Farrodes*, and *Miroculis* (three morphotypes). *Hermanella*, *Homothraululus*, *Simothraulopsis*, and *Ulmeritoides* were represented by two morphotypes, and *Askola*,

*Leentvaaria*, *Massartela*, *Needhamella* and *Segesta* by only one morphotype.

Below, a detailed description of each genera and morphotypes found in the Western Santa Catarina is presented, with the respective review about its distribution in the studied region.

*Askola* Peters, 1969 (Figure 2)

Of the five species of *Askola* recorded from Brazil, only *Askola froehlichii* Peters, 1969 has been reported from Santa Catarina (Salles et al. 2013). A single morphotype has been recorded in this paper.

Remarks: *Askola* was recorded in three rivers (Mato, Sede, and Caratuva), all of them located in regions of low order, few impacted, of high altitudes, close each other and limited at Araucaria Forest. Goulart & Callisto (2005) and Crisci-Bispo et al. (2007) found similar results related to environment integrity where *Askola* is found.

*Farrodes* Peters, 1971 (Figure 3)

Four species of *Farrodes* have been recorded from Brazil, none of them to the Santa Catarina State (Salles et al. 2013). Three morphotypes have been found and, therefore, the genus is recorded for the first time from Santa Catarina.

Remarks: Morphotypes of *Farrodes* were broadly distributed in the region studied, and the genus did not present a clear pattern of distribution. Thereby, we could not detect a distribution pattern for *Farrodes* sp.2 and *Farrodes* sp.3, while *Farrodes* sp.1 occurred essentially in headwaters. As observed by Da-Silva (2002), *Farrodes* occurs as in water flow as in backwater, in different kind of sediments at varied altitudes.

**Table 1.** Areas sampled in western of Santa Catarina State, followed by sites sampled, landscapes, altitudes, environments, orders of river, and comments about each site.

Areas sampled (acronym)	Site	Landscape	Altitude (m)	Kind of Environment	River order	Comments about site
Adami (ADM)	ADM1	Preserved	1155	Lotic	Low	Mixed ombrophilous forest, in Araucárias National Park.
Caçador (CAÇ)	CAÇ1	Rural	845	Lotic	Low	Agricultural and livestock with marginal vegetation almost absent.
	CAÇ2	Rural	591	Lotic	Low	Agricultural and livestock with marginal vegetation almost absent.
Caramuru (CAR)	CAR1	Urban/Rural	614	Lotic	Low	Open area with streets. Marginal vegetation almost absent.
Caratua (CTV)	CTV1	Preserved	1065	Lotic	Low	Mixed ombrophilous forest, in Araucárias National Park.
Chapécó (CHO)	CHP1	Preserved	970	Lotic	Higher	Mixed ombrophilous forest, in Araucárias National Park.
	CHP2	Rural	285	Lotic	Higher	Agricultural and livestock with little marginal vegetation.
	CHP3	Rural	228	Lotic	Higher	Agricultural and livestock with marginal vegetation almost absent. Mouth of river.
	CHP4	Rural	600	Lentic	Higher	Agricultural and livestock with marginal vegetation almost absent.
	CHP5	Urban/Rural	529	Lentic	Higher	Agricultural and livestock with marginal vegetation almost absent. Hydroelectric dam.
Chapecoizinho (CHZ)	CHZ1	Rural	1031	Lotic	Higher	Agricultural and <i>Eucalyptus</i> plantation.
	CHZ2	Preserved	833	Lotic	Higher	Mixed ombrophilous forest, in Araucárias National Park.
Iracema (IRC)	IRC1	Rural	657	Lotic	Low	Agricultural and livestock with marginal vegetation almost absent.
	IRC2	Rural	430	Lotic	Medium	Agricultural and livestock with marginal vegetation almost absent.
	IRC3	Rural	229	Lotic	Medium	Agricultural and livestock with marginal vegetation almost absent.
Irani (IRN)	IRN1	Rural	1151	Lotic	Higher	Agricultural and livestock with much marginal vegetation. Near of Araucárias National Park.
	IRN2	Urban/Rural	1046	Lotic	Higher	Agricultural and camping area with marginal vegetation almost absent.
	IRN3	Rural	594	Lotic	Medium	Agricultural and livestock with little marginal vegetation.
	IRN4	Rural	533	Lotic	Higher	Agricultural and livestock with marginal vegetation almost absent
	IRN5	Rural	470	Lotic	Medium	Agricultural and <i>Eucalyptus</i> plantation.
	IRN6	Rural	872	Lotic	Medium	Agricultural and livestock with little marginal vegetation.
	IRN7	Rural	514	Lotic	Higher	Agricultural and livestock with marginal vegetation absent.
	IRN8	Rural	505	Lotic	Higher	Agricultural and livestock with little marginal vegetation.
	IRN9	Rural	466	Lentic	Higher	Agricultural and livestock with little marginal vegetation.
	IRN10	Rural	667	Lotic	Higher	Agricultural and livestock with little marginal vegetation.
	IRN11	Urban/Rural	329	Lotic	Higher	Agricultural and livestock with little marginal vegetation.
	IRN12	Rural	291	Lentic	Higher	Agricultural and livestock with marginal vegetation almost absent. Mouth of river.
Lajeado Bonito (LBO)	LBO1	Rural	526	Lotic	Low	Livestock with marginal vegetation almost absent.
	LBO2	Rural	312	Lentic	Low	Agricultural and livestock with little marginal vegetation.
Lajeado Divisa (LDV)	LDV1	Preserved	662	Lotic	Low	Estacional decidual forest, in Chapécó National Forest.
Lajeado São José (LSJ)	LJS1	Urban/Rural	647	Lotic	Medium	Agricultural and <i>Eucalyptus</i> plantation with marginal vegetation almost absent.
	LJS2	Urban/Rural	635	Lotic	Medium	Agricultural with little marginal vegetation. Near factory of fiber pools.
	LJS3	Urban/Rural	606	Lentic	Medium	Agricultural and livestock with little marginal vegetation.
	LJS4	Urban/Rural	498	Lotic	Medium	Estacional decidual forest. River has already passed through all urban area of Chapécó city.
	LJS5	Rural	498	Lotic	Medium	Livestock and estacional decidual forest.



Table 1. Continued...

Areas sampled (acronym)	Site	Landscape	Altitude (m)	Kind of Environment	River order	Comments about site
Lambedor (LAM)	LAM1	Rural	638	Lotic	Low	Agricultural and livestock with marginal vegetation almost absent.
	LAM2	Rural	346	Lotic	Low	Livestock and estacional decidual forest.
Marconstrói (MCT)	MAR1	Preserved	950	Lotic	Low	Mixed ombrophilous forest, in Araucárias National Park.
Mato (MAT)	MTO1	Preserved	873	Lotic	Low	Mixed ombrophilous forest, in Araucárias National Park.
	MTO2	Preserved	873	Lotic	Low	Mixed ombrophilous forest, in Araucárias National Park.
Monte Alegre (MAL)	MAL1	Rural	302	Lotic	Low	Agricultural and livestock with marginal vegetation almost absent. Mouth of river.
Palmitos (PAL)	PAL1	Rural	429	Lotic	Low	Agricultural and livestock with marginal vegetation almost absent.
	PAL2	Rural	363	Lotic	Low	Agricultural and livestock with marginal vegetation almost absent. Mouth of river.
Pitoco (PIT)	PIT1	Urban/Rural	278	Lotic	Low	Estacional decidual forest with area destined to rural tourism.
	PIT2	Urban/Rural	289	Lotic	Low	Estacional decidual forest with area destined to rural tourism.
Santa Fé (STF)	STF1	Rural	293	Lotic	Low	Livestock with marginal vegetation almost absent.
Santo Antônio dos Pinhais (SAP)	SAP1	Rural	368	Lotic	Low	Agricultural and livestock with marginal vegetation almost absent.
São Domingos (SDM)	SDM1	Rural	605	Lotic	Medium	Agricultural and livestock with marginal vegetation almost absent.
	SDM2	Urban/Rural	516	Lotic	Medium	Agricultural and livestock with marginal vegetation absent. Near the city.
	SDM3	Rural	292	Lotic	Medium	Agricultural and livestock with marginal vegetation almost absent.
Sede (SED)	SED1	Rural	1046	Lotic	Low	Agricultural and <i>Eucalyptus</i> plantation. Near Araucárias National Park.
	SED2	Rural	1044	Lotic	Low	Agricultural and <i>Eucalyptus</i> plantation. Near Araucárias National Park.
Taquaruçú (TAQ)	TAQ1	Rural	617	Lotic	Low	Livestock with marginal vegetation almost absent.
	TAQ2	Rural	436	Lotic	Low	Agricultural and livestock with marginal vegetation absent.
Tarumã (TAR)	TAR1	Rural	503	Lotic	Low	Agricultural and livestock with marginal vegetation absent.
	TAR2	Rural	414	Lotic	Low	Agricultural and livestock with little marginal vegetation.
	TAR3	Rural	303	Lotic	Low	Agricultural and livestock with marginal vegetation absent.
Tigre (TIG)	TGR1	Preserved	572	Lotic	Low	Estacional decidual forest, in Chapecó National Forest.
Vargem Bonita (VAB)	VAR1	Rural	1161	Lotic	Low	<i>Eucalyptus</i> plantation and estacional decidual forest.
	VAR2	Rural	1159	Lotic	Low	<i>Eucalyptus</i> plantation and estacional decidual forest.
Xaxim (XAX)	XAX1	Urban/Rural	729	Lotic	Low	Agricultural and livestock with marginal vegetation almost absent.

*Hermanella* NEEDHAM & MURPHY, 1924 (Figure 4)

Of the four species recorded from Brazil, only *Hermanella grandis* Domínguez & Flowers, 1989 and *Hermanella maculipennis* (Ulmer 1920) have been reported from Santa Catarina (Salles et al. 2013). Two morphotypes have been recorded in this paper.

Remarks: Most of the nymphs of *Hermanella* were recorded in Conservation Units, such as Chapecó National Forest (Lajeado Divisa River) and Araucária National Park (Caratuva, and Chapecozinho), or in regions very conserved, such as Irani,

Marconstrói, and Sede rivers. Nymphs of the genus were most representative in regions of high altitude. However, *Hermanella* sp.2 was also found in the Lajeado Divisa River, situated in lower altitudes. *Hermanella* cf. *grandis* occurred in just one point at higher altitudes of the Irani River.

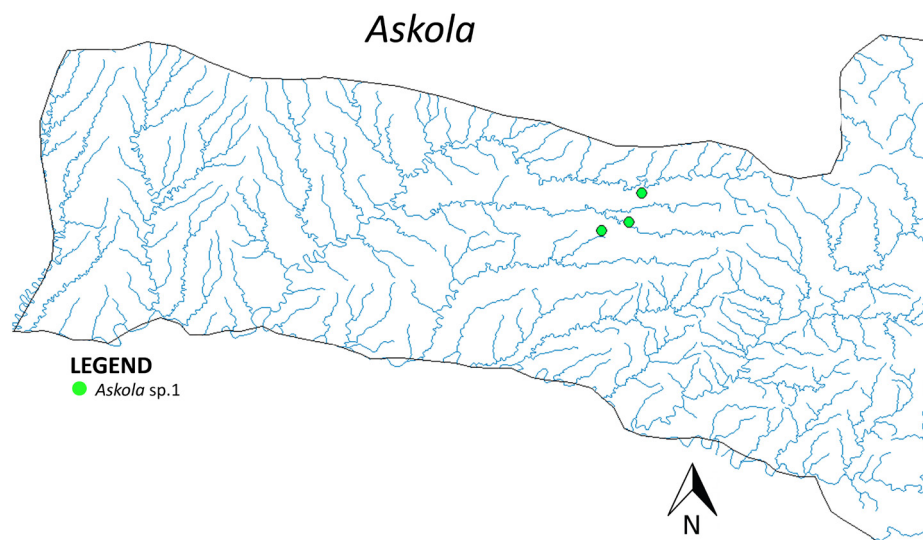
*Homothraulus* DEMOULIN, 1955 (Figure 5)

Only one species of *Homothraulus* is recorded from Brazil. *Homothraulus misionensis* (Esben-Petersen, 1912) has been previously recorded from South Brazil but specific locations were

**Table 2.** Distribution list of Leptophlebiidae in western of Santa Catarina, followed by areas sampled\*, frequency of records and abundance.

Morphotypes	Area sampled																									RECORDS	ABUNDANCE	
	Adami	Caçador	Caçador	Caratuva	Chapcô	Chapecozinho	Iracema	Irani	Lajeado Bonito	Lajeado Divisa	Lajeado São José	Lambedor	Marconstrói	Mato	Monte Alegre	Palmitos	Pitoco	Santa Fé	Santo Antônio dos Pinhais	São Domingos	Sede	Taquaruçú	Tarumã	Tigre	Vargem Bonita			Xaxim
<i>Askola</i> sp.1				x										x							x						3	7
<i>Farrodes</i> sp.1				x		x	x	x									x			x	x	x		x	x		10	30
<i>Farrodes</i> sp.2						x								x										x			3	4
<i>Farrodes</i> sp.3									x		x			x													3	4
<i>Hermanella</i> cf. <i>grandis</i>									x																		1	20
<i>Hermanella</i> sp.1				x		x		x		x			x								x						6	11
<i>Homothraulius</i> sp.1														x							x						2	2
<i>Homothraulius</i> sp.2			x	x	x	x	x	x				x	x	x	x					x	x		x		x		15	362
<i>Leentvaaria</i> cf. <i>palpalis</i>									x																x		2	4
<i>Massartella brieni</i>	x	x		x	x	x		x		x	x			x			x			x	x			x			13	158
<i>Miroculis</i> sp.1													x					x		x		x			x		5	73
<i>Miroculis</i> sp.2													x							x							2	12
<i>Miroculis</i> sp.3																					x						1	4
<i>Needhamella</i> sp.1					x	x	x	x						x													5	63
<i>Segesta</i> sp.1									x																		1	4
<i>Simothraulopsis</i> sp.1									x																	x	2	3
<i>Simothraulopsis</i> sp.2														x							x						2	6
<i>Thraulodes</i> sp.1							x	x	x		x	x								x					x		7	243
<i>Thraulodes</i> sp.2					x		x	x	x			x	x		x					x						x	9	345
<i>Thraulodes</i> sp.3				x	x		x	x	x			x	x					x		x	x	x	x			x	13	72
<i>Thraulodes</i> sp.4					x	x	x	x	x		x	x	x			x		x		x							11	220
<i>Thraulodes</i> sp.5					x							x															2	8
<i>Ulmeritoides</i> sp.1					x	x	x	x												x			x		x		7	122
<i>Ulmeritoides</i> sp.2								x	x			x		x	x	x			x	x			x		x		10	123

\*In this case, sites sampled (e.g. CAÇ1; CAÇ2) were considered as only one area (CAÇ).

**Figure 2.** Geographic distribution of *Askola* Peters, 1969 in the Western Santa Catarina.

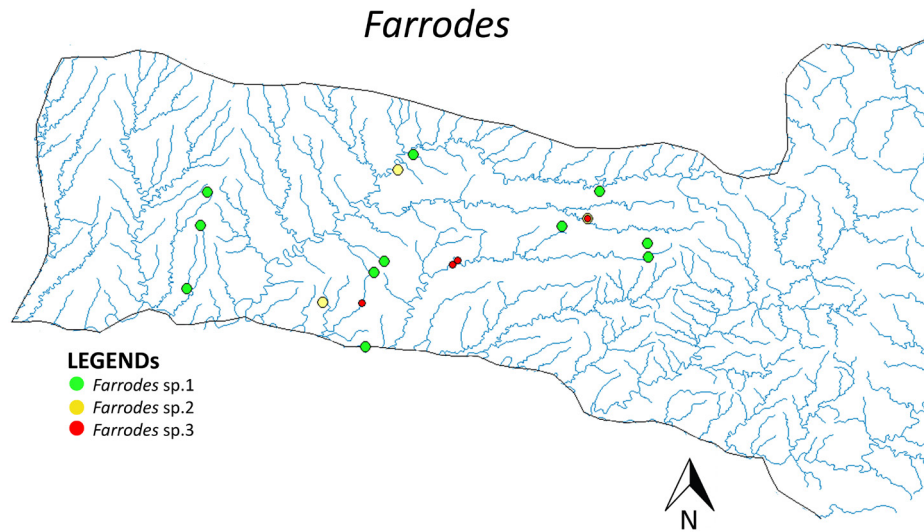


Figure 3. Geographic distribution of *Farrodes* Peters, 1971 in the Western Santa Catarina.

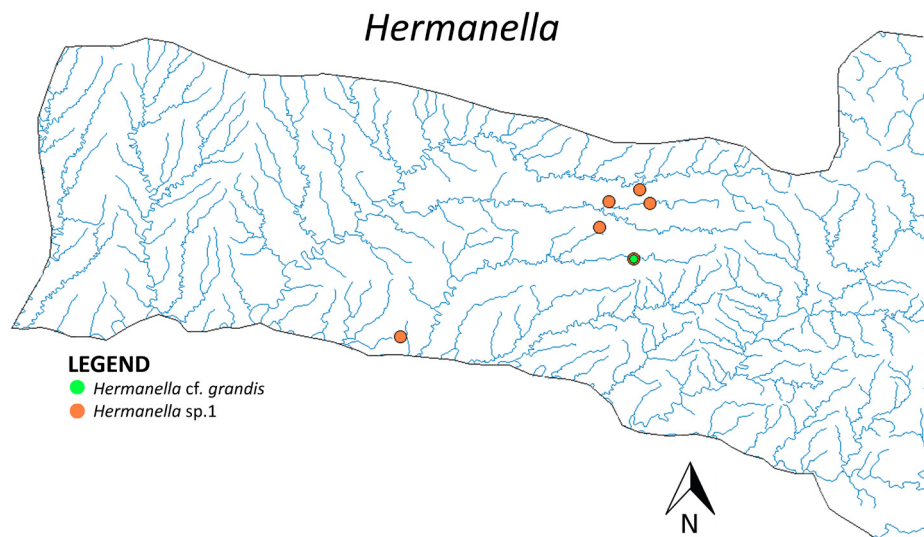


Figure 4. Geographic distribution of *Hermanella* Needham & Murphy, 1924 in the Western Santa Catarina.

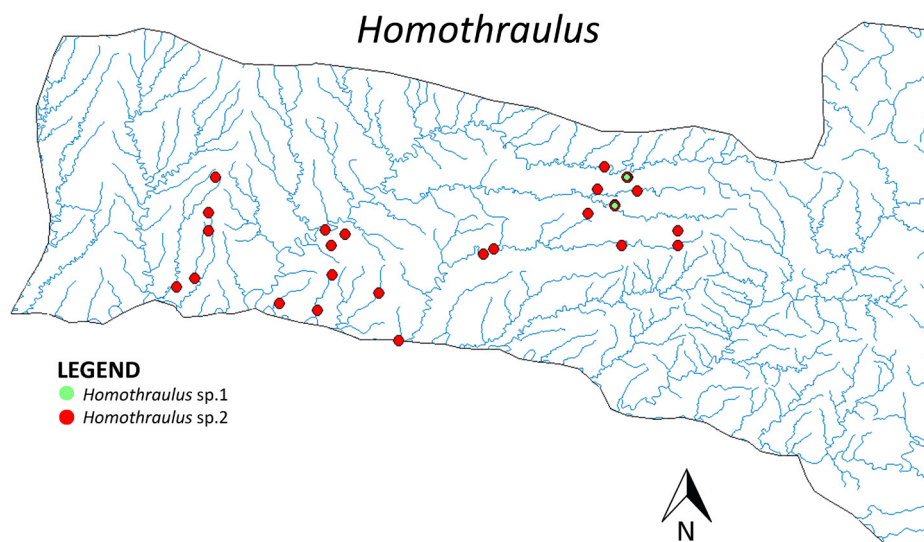


Figure 5. Geographic distribution of *Homothraulius* Demoulin, 1955 in the Western Santa Catarina.



not pointed out. (Domínguez et al. 1997). Two morphotypes have been recorded in this paper.

Remarks: *Homothraulius* was widely distributed, occupying all different kinds of sites, with a range of altitude varying from 252m to 1151m.

*Homothraulius* sp.2 was widely distributed, while *Homothraulius* sp.1 was recorded only in two first order rivers (Mato, and Sede), both with moderated flow of water, sediment with pebble and leaf litter, and restricted to area covered by dense vegetation of Araucaria Forest. According to Domínguez et al. (2006), nymphs of *Homothraulius* are found in streams and rivers, but with rapid water flow.

*Leentvaaria* DEMOULIN, 1966 (Figure 6)

One species of *Leentvaaria* has been recorded from Brazil, but not from Santa Catarina (Salles et al. 2013). In this paper one morphotype has been found and, therefore, the genus is recorded for the first time from Santa Catarina.

Remarks: *Leentvaaria* was limited to the Irani and Vargem Bonita rivers. Vargem Bonita is a river that belongs to the watershed of the Irani River. Nymphs occurred in environments characterized by strong water flow and under stones. Small hydro power plants, therefore, can compromise the establishment of *Leentvaaria* cf. *palpallis* in the Irani River, since that kind of construction convert rithral in pothamal environments.

*Massartella* LESTAGE, 1930 (Figure 7)

Two species of *Massartella* have been recorded in Brazil, none of them to the Santa Catarina State (Salles et al. 2013). In this paper one morphotypes has been found and, therefore, the genus is recorded for the first time from Santa Catarina.

Remarks: *Massartella brieri* (Lestage, 1924) was also a species widely distributed. It appeared in 13 sites, with different kinds of land used. According to Pescador & Peters (1990), the range of altitude for *Massartella* varies from 500 to 1600m. In this study, *M. brieri* was recorded in altitudes lower than 250m (Pitoco River).

*Miroculis* EDMUNDS, 1963 (Figure 8)

Ten species of *Miroculis* have been recorded in Brazil, none of them to the Santa Catarina State (Salles et al. 2013). In this paper three morphotypes have been found and, therefore, the genus is recorded for the first time from Santa Catarina.

Remarks: Morphotypes of *Miroculis* were associated to tributaries of the largest rivers sampled: Chapecó, Irani, and Uruguai. *Miroculis* sp.1, although found in few points, was widely distributed, occurring mainly in headwaters. Contrastingly, *Miroculis* sp.2 occurred in altitudes lower than 650m, with impacted environments, while *Miroculis* sp.3 was restricted to altitudes higher than 1000m, at environments with little anthropic influence and in the Araucaria Forest.

*Needhamella* Domínguez & Flowers, 1989 (Figure 9)

Of the two species of *Needhamella* recorded in Brazil, only *Needhamella ehrhardti* (Ulmer, 1920) has been reported from Santa Catarina (Salles et al. 2013). A single morphotype has been recorded in this paper.

Remarks: *Needhamella* sp.1 was recorded in two sites with distinct situations: the first one was located at higher altitudes (highest altitude is in the Chapecozinho River - 1031m) and in regions less impacted. The other one was located at lowest altitudes (Iracema River - 252m), and in areas that present significant impact. Although *Needhamella* has been widely distributed in the region, the genus is associated to open environments, rivers of lower order, and moderate and strong water flow. The same pattern was pointed out by Domínguez & Flowers (1989).

*Segesta* Sieglösch & Polegatto, 2006 (Figure 10)

One species of *Segesta* has been recorded in Brazil, but not to the Santa Catarina State (Salles et al. 2013). In this paper one morphotype has been found, therefore, the genus is recorded for the first time from Santa Catarina.

Remarks: *Segesta* sp.1 was recorded in one sample site, in the mouth of the Irani River. *Segesta riograndensis* Sieglösch et al. (2006) has been recorded in the states of Rio Grande do Sul (its type locality), and Mato Grosso do Sul (Righi-Cavallaro et al. 2008). In this study, *Segesta* sp.1 was found in rocky environment, water with strong flow, and at lower altitudes. Interestingly, the same observation was previously pointed out by Sieglösch et al. (2006) for the genus and the species.

*Simothraulopsis* DEMOULIN, 1966 (Figure 11)

Five species of *Simothraulopsis* have been previously recorded from Brazil, none of them to the Santa Catarina State (Salles et al. 2013). In this paper two morphotypes have been found and, therefore, the genus is recorded for the first time from Santa Catarina.

Remarks: *Simothraulopsis* sp.1 occurred in a low order portion of one large river, and in one stream (Irani and Xaxim rivers, respectively). *Simothraulopsis* sp.2 was restricted to higher altitudes and better conserved region. All nymphs occurred in altitudes above 700m.

*Thraulodes* Ulmer, 1920 (Figure 12)

Of the thirteen species of *Thraulodes* recorded from Brazil, only *Thraulodes alapictus* Mariano & Lima, 2013; *Thraulodes daidaleus* Thew, 1960; *Thraulodes limbatus* Navás, 1936; *Thraulodes pinhoi* Mariano & Lima, 2013; *Thraulodes traveræ* Thew, 1960; *Thraulodes ulmeri* Edmunds, 1950 have been reported from Santa Catarina (Salles et al. 2013). Five morphotypes have been recorded in this paper.

Remarks: *Thraulodes* was the genus that showed higher number of morphotypes and higher number of occurrences, especially *Thraulodes* sp.1, *Thraulodes* sp.2, *Thraulodes* sp.3, and *Thraulodes* sp.4. On the other hand, *Thraulodes* sp.5 was recorded in two points that presented distinct environmental characteristics: the first one is the Caramurú River, a small river located in urban area at lower altitudes (600m or less). The other region is Irani River, which is a large-size river and is located at higher altitudes (1000 m).

*Thraulodes* was recorded in points with both presence and absence of anthropic influence. The type locality of *Thraulodes quevedoensis* Flowers 2009 that has been described from Ecuador, for example, is a River that receives human waste and chemical residue coming from agriculture (Flowers 2009).

*Ulmeritoides* TRAVER, 1959 (Figure 13)

Of the ten species of *Ulmeritoides* recorded in Brazil, only *Ulmeritoides haarupi* (Esben-Petersen, 1912); *Ulmeritoides patagiatus* (Thew, 1960); *Ulmeritoides uruguayensis* (Traver, 1959); *Ulmeritoides balteatus* Thew, 1960 have been reported from Santa Catarina (Salles et al. 2013). Two morphotypes have been recorded in this paper.

Remarks: *Ulmeritoides* did not show a clear distribution pattern, occurring in points with varied altitudes, in different kinds of lands used, and at different orders.

## Discussion

In the present study, the number of genera recorded in Santa Catarina increased from eight to 15. Although have been recorded a high number of morphotypes (24), most part could not be identified at the specie level, once the adult stage is imperative for an accurate identification of most of the species. Besides the fact that several species, or even genera, were described based solely on adult stages,

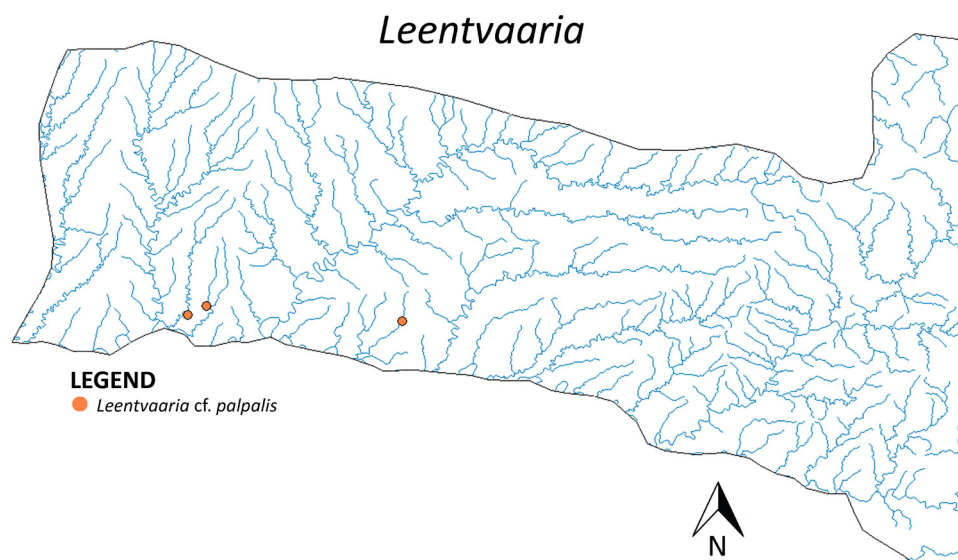


Figure 6. Geographic distribution of *Leentvaaria* Demoulin, 1966 in the Western Santa Catarina.

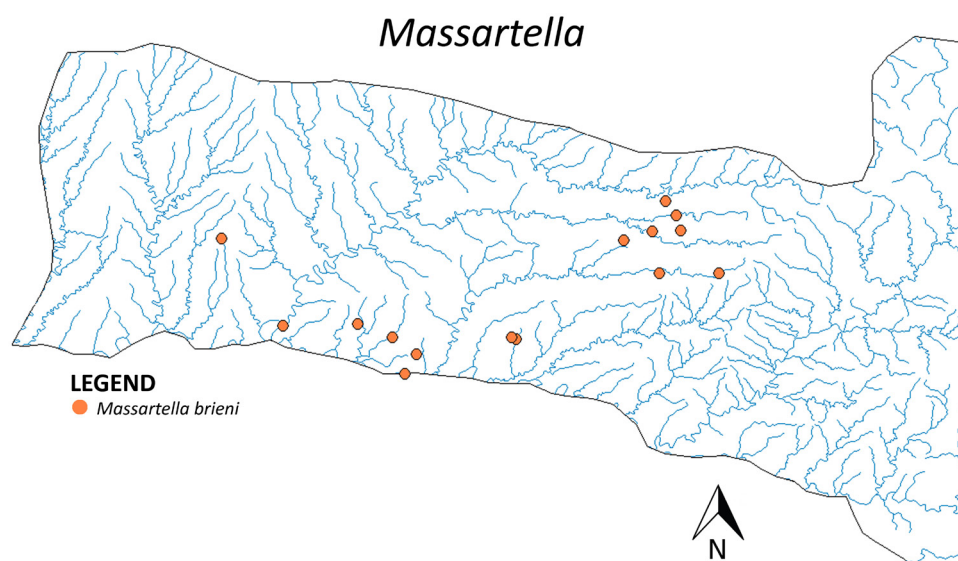


Figure 7. Geographic distribution of *Massartella* Lestage, 1930 in the Western Santa Catarina.

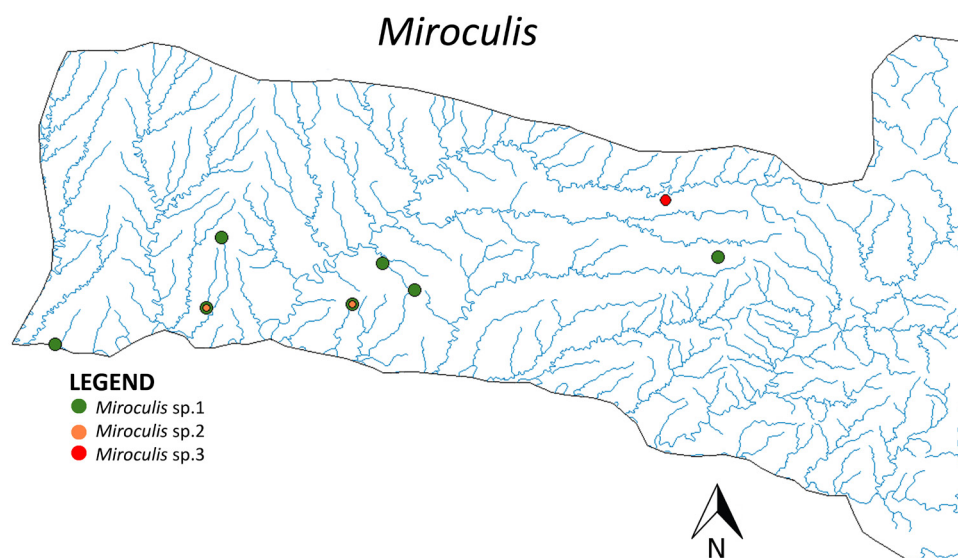


Figure 8. Geographic distribution of *Miroculis* Edmunds, 1963 in the Western Santa Catarina.

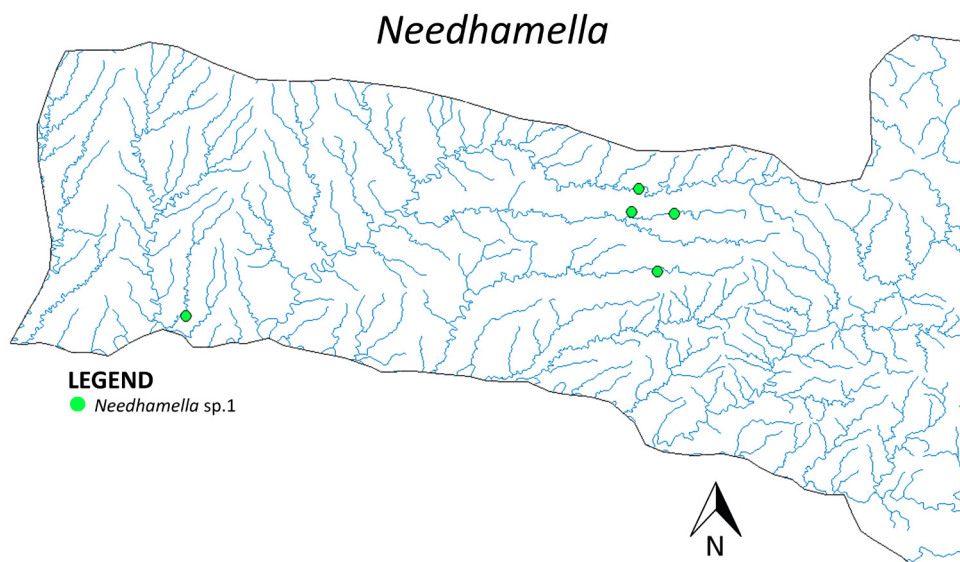


Figure 9. Geographic distribution of *Needhamella* Domínguez & Flowers, 1989 in the Western Santa Catarina.

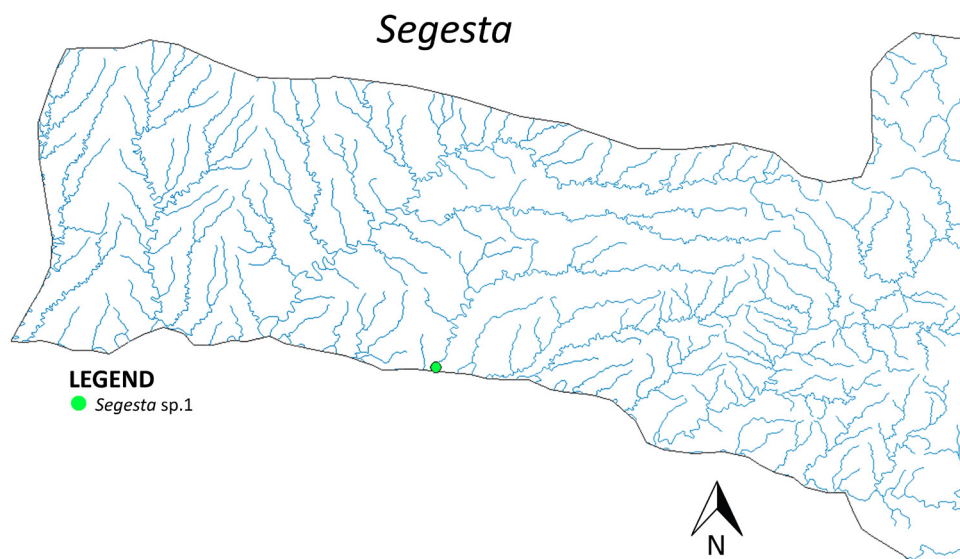


Figure 10. Geographic distribution of *Segesta* Siegloch & Polegatto, 2006 in the Western Santa Catarina.

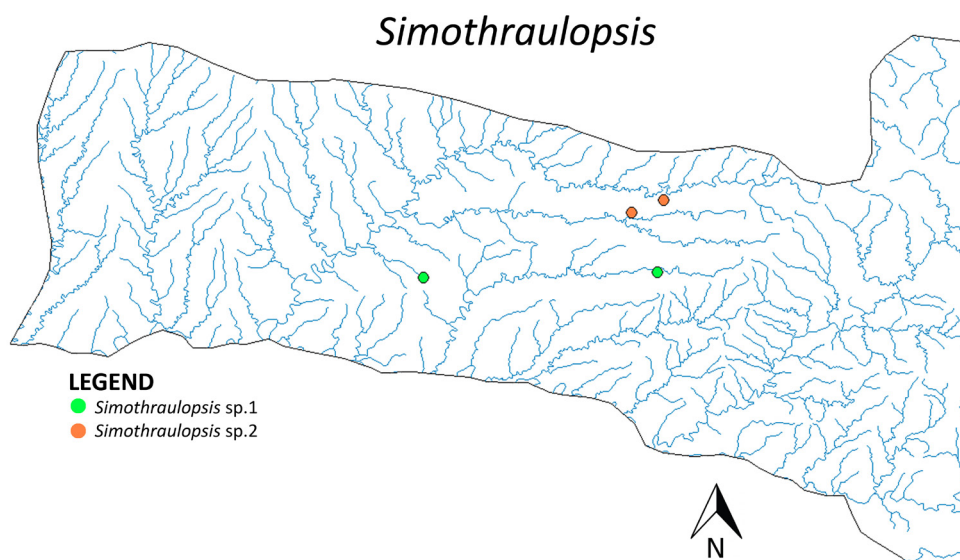
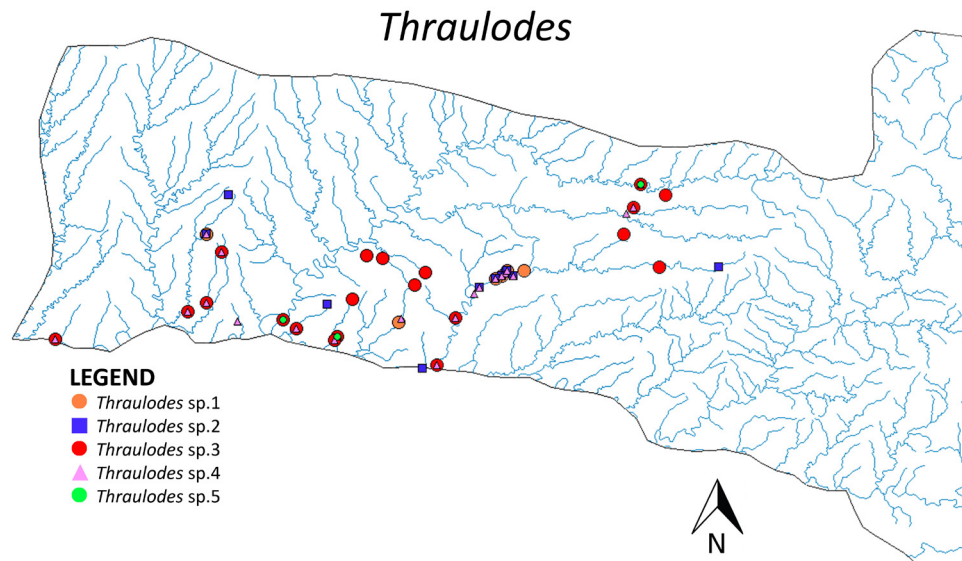
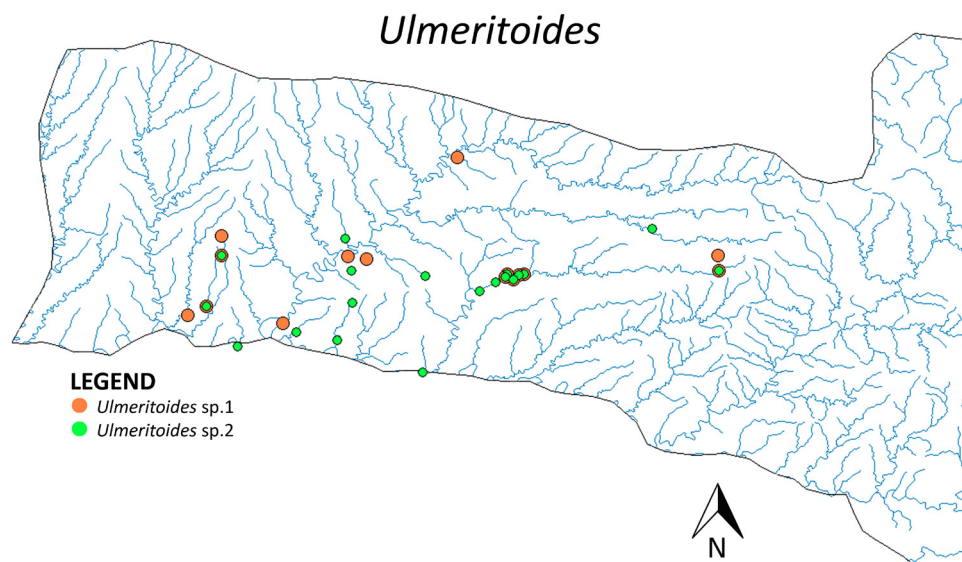


Figure 11. Geographic distribution of *Simothraulopsis* Demoulin, 1966 in the Western Santa Catarina.





**Figure 12.** Geographic distribution of *Thraulodes* Ulmer, 1920 in the Western Santa Catarina.



**Figure 13.** Geographic distribution of *Ulmeritoides* Traver, 1959 in the Western Santa Catarina.

the number of species not described, especially in tropical areas, is extremely high.

Four genera were limited at specific areas; *Leentvaaria* and *Hermanella* were associated with regions more conserved, and *Needhamella* and *Segesta* were found exclusively in the Irani River. These environments are suffering strong anthropic influence, either by the constructions of small hydro power plant, or by planting of *Pinus* and *Eucalyptus* along the banks of the Chapecó and Chapecozinho rivers. That kind of impact can interfere directly the environment.

In conclusion, this study allowed us to advance the knowledge regarding the composition of Leptophlebiidae nymphs from Western region of Santa Catarina State, and to improve some information on biology of group. To supplement this information is necessary to know the imago stage (specially associating nymph and imago) in order to accurate identification at species level to all genera of family. Thus, it will be possible to provide a better knowledge about taxonomy and then, natural history of group.

## Acknowledgements

We are thankful to João Carlos Marocco, Bruna Turra, Simone Piltz and Antônio Ganzer for their help on fieldwork and laboratory. To Dr. Denis Rosemberg and anonymous reviewers for their valuable comments on the manuscript. To Ambiental Equilíbrio for providing nymphs of Leptophlebiidae, and to Unochapecó and Associação de Preservação do Meio Ambiente e da Vida – APREMAVI, important for logistic support. We are also grateful to CAPES, and FAPESC for scholarship provided for the first author, and to CNPq for productivity scholarship provided for the second author.

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Received 08/02/2012

Revised 09/16/2013

Accepted 10/21/2013

**Appendix 1.** Localization of aquatic environments sampled in west region of Santa Catarina presenting the name of each site, and geographic coordinates.

Site	Latitude	Longitude	Site	Latitude	Longitude
Adami	26° 48' 47.3" S	51° 48' 58.8" W	Lajeado São José2	27° 02' 18.0" S	52° 38' 46.0" W
Caçador1	27° 07' 53.5" S	52° 19' 23.7" W	Lajeado São José3	27° 05' 80.0" S	52° 39' 42.0" W
Caçador2	27° 08' 14.4" S	52° 18' 35.1" W	Lajeado São José4	27° 07' 55.0" S	52° 40' 45.0" W
Caramuru	27° 05' 20.8" S	52° 39' 59.3" W	Lajeado São José5	27° 07' 21.3" S	52° 40' 24.3" W
Caratuva	26° 50' 23.9" S	51° 59' 15.6" W	Lambedor1	27° 01' 35.5" S	52° 48' 33.1" W
Chapecó1	26° 41' 31.5" S	51° 56' 06.6" W	Lambedor2	27° 08' 89.0" S	52° 50' 67.0" W
Chapecó2	26° 53' 26.1" S	52° 49' 17.2" W	Marconstrói	26° 45' 43.8" S	51° 57' 28.8" W
Chapecó3	27° 05' 51.1" S	53° 0' 25.06" W	Mato1	26° 48' 48.1" S	51° 54' 07.9" W
Chapecó4	26° 36' 03.6" S	52° 29' 03.7" W	Mato2	26° 48' 46.3" S	51° 54' 09.3" W
Chapecó5	26° 39' 07.4" S	52° 32' 02.4" W	Monte Alegre	27° 14' 33.1" S	52° 35' 19.8" W
Chapecozinho1	26° 46' 01.6" S	51° 49' 49.8" W	Palmitos1	27° 03' 04.6" S	53° 09' 44.8" W
Chapecozinho2	26° 46' 48.2" S	51° 58' 48.2" W	Palmitos2	27° 09' 33.5" S	53° 08' 37.0" W
Iracema1	26° 42' 53.0" S	53° 09' 38.9" W	Pitoco1	27° 14' 23.2" S	52° 38' 35.9" W
Iracema2	26° 50' 01.5" S	53° 14' 35.9" W	Pitoco2	27° 14' 21.2" S	52° 38' 35.9" W
Iracema3	27° 03' 48.6" S	53° 17' 21.1" W	SantaFé	27° 09' 21.1" S	53° 41' 15.8" W
Irani1	26° 55' 50.8" S	51° 41' 03.8" W	Santo Antônio dos Pinhais	26° 50' 38.7" S	52° 49' 11.6" W
Irani2	26° 55' 49.9" S	51° 52' 29.6" W	São Domingos1	26° 50' 05.4" S	53° 11' 16.2" W
Irani3	26° 57' 05.1" S	52° 17' 08.1" W	São Domingos2	26° 53' 25.3" S	53° 10' 51.8" W
Irani4	26° 57' 09.3" S	52° 18' 07.2" W	São Domingos3	27° 04' 25.9" S	53° 14' 02.7" W
Irani5	26° 55' 09.9" S	51° 52' 29.6" W	Sede1	26° 43' 22.7" S	51° 51' 44.4" W
Irani6	26° 58' 01.1" S	52° 19' 05.5" W	Sede2	26° 43' 25.8" S	51° 51' 46.2" W
Irani7	26° 57' 28.0" S	52° 20' 25.0" W	Taquaruçú1	26° 58' 29.4" S	52° 36' 11.0" W
Irani8	26° 58' 02.4" S	52° 21' 07.6" W	Taquaruçú2	26° 54' 33.8" S	52° 41' 26.4" W
Irani9	27° 00' 08.0" S	52° 25' 06.2" W	Tarumã1	26° 54' 21.1" S	52° 45' 22.9" W
Irani10	27° 01' 08.3" S	52° 26' 00.0" W	Tarumã2	26° 53' 48.1" S	52° 48' 41.8" W
Irani11	27° 05' 17.4" S	52° 29' 14.2" W	Tarumã3	26° 56' 23.0" S	52° 48' 05.8" W
Irani12	27° 14' 00.5" S	52° 32' 28.4" W	Tigre	27° 05' 27.1" S	52° 47' 00.4" W
Lajeado Bonito1	27° 02' 33.8" S	52° 51' 51.9" W	Vargem Bonita1	26° 53' 41.0" S	51° 42' 12.0" W
Lajeado Bonito2	27° 06' 49.5" S	52° 57' 33.5" W	Vargem Bonita2	26° 53' 42.0" S	51° 42' 13.0" W
Lajeado Divisa	27° 10' 53.1" S	52° 36' 30.4" W	Xaxim	26° 52' 07.1" S	52° 43' 31.8" W
Lajeado São José1	27° 00' 10.0" S	52° 37' 51.0" W			