FACULDADE DE BIOCIÊNCIAS

PROGRAMA DE PÓS-GRADUAÇÃO EM ZOOLOGIA

# BIOECOLOGIA DE ÁCAROS (ACARI) DA VIDEIRA (*Vitis vinifera* L.) OCORRENTES NO ESTADO DO RIO GRANDE DO SUL, BRASIL.

**Liana Johann**

TESE DE DOUTORADO

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**Orientador: Dr. Gervásio Silva Carvalho**

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PORTO ALEGRE - RS - BRASIL

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# ATA DE DEFESA DE TESE Nº 107

Aos vinte dias de agosto de dois mil e quatorze, às 14h, no Curso de Doutorado do Programa de Pós-Graduação em Zoologia da Pontifícia Universidade Católica do Rio Grande do Sul, realizou-se a sessão pública de defesa de tese da estudante Liana Johann. A tese intitulada **"BIOECOLOGIA DE ÁCAROS (ACARI) DA VIDEIRA (*Vitis vinifera* L.) OCORRENTES NO ESTADO DO RIO GRANDE DO SUL, BRASIL"** foi apresentada à Comissão Examinadora constituída pelos professores doutores: Gervásio Silva Carvalho da PUCRS, orientador e Presidente desta Comissão; Angelo Pallini da UFV, Marcos Botton da EMBRAPA e Nelson Ferreira Fontoura da PUCRS. A sessão foi aberta pelo membro representante da Comissão Coordenadora do PPG-Zoologia. A seguir, deu-se início às atividades relativas à defesa da tese. O Presidente da Comissão Examinadora passou a palavra à estudante concedendo-lhe cinquenta minutos para expor o seu trabalho. Após esta exposição, a estudante foi arguida pelos componentes da Comissão Examinadora. Encerrada a arguição, o Presidente suspendeu a sessão, tendo os membros da Comissão Examinadora se reunido para deliberar sobre a tese em julgamento. Cada membro da Comissão Examinadora preencheu uma "Ficha de Avaliação de Tese" avaliando os seguintes itens: (I) Em relação ao documento escrito: clareza na apresentação do problema; qualidade da revisão bibliográfica; adequação da metodologia; clareza na apresentação dos resultados; coerência dos resultados com relação aos objetivos; consideração ao referencial teórico na discussão dos resultados; coerência e clareza das conclusões; correção ortográfica e gramatical. (II) Em relação à defesa oral: demonstração de conhecimento do tema da pesquisa e capacidade de expressão oral. Reaberta a sessão, o Presidente realizou a leitura da Ata de Defesa. Os resultados do julgamento da Comissão Examinadora foram os seguintes: Dr. Angelo Pallini, APROVADO, Dr. Marcos Botton, APROVADO, Dr. Nelson Ferreira Fontoura, APROVADO, tendo a estudante sido considerada APROVADA. Uma vez encerrada a defesa pública às 17h30min, eu Luana Oliveira dos Santos, secretária de Pós-Graduação da FaBio, redigi a presente ata que será assinada por mim, pela estudante e pelos membros da Comissão Examinadora. Porto Alegre, vinte de agosto de dois mil e quatorze.

Dr. Gervásio Silva Carvalho

Dr. Angelo Pallini

Dr. Marcos Botton

Dr. Nelson Ferreira Fontoura

Liana Johann

Luana Oliveira dos Santos

À minha família, que de uma forma sempre muito especial, acreditou nos meus sonhos e encarou junto comigo todos os desafios.

Pai, Mãe e Mano, essa conquista é nossa!

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Ao Professor Dr. Gervásio Silva Carvalho, por aceitar o desafio de me orientar, por acreditar na minha capacidade, pela confiança e crédito constantes.

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A todos os Professores do Programa de Pós-Graduação em Zoologia da PUCRS pelos ensinamentos, e em especial aos Professores Dra. Guendalina Turcato Oliveira e Dr. Nelson Ferreira Fontoura por colaborar com o desenvolvimento do meu projeto, e por sempre me receberem para momentos de discussão.

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À Univates pela concessão da Bolsa-Egresso, que possibilitou a minha participação no 7$^{th}$ Symposium of the European Association of Acarologists na University of Natural Resources and Life Sciences, Viena/Áustria e nos cursos Introductory Acarology e Agricultural Acarology na Ohio State University, Columbus/EUA.

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A Vanderson Martinelli Rodrigues, meu companheiro, amigo e amante. Obrigada pelo amor, paciência, presença, pelo carinho e cuidado que tens comigo. Meus dias contigo são sempre especiais. Eu te amo!

Sinceros agradecimentos a todos, de coração.

# SUMÁRIO

# RESUMO

BIOECOLOGIA DE ÁCAROS (ACARI) DA VIDEIRA (*Vitis vinifera* L.) OCORRENTES NO ESTADO DO RIO GRANDE DO SUL, BRASIL.

As videiras são atacadas por doenças e pragas. Sob condições úmidas, doenças fúngicas e bactérias são predominantes, enquanto que em regiões áridas, insetos e ácaros são as principais pragas. Dentre estas, os ácaros fitófagos apresentam grande importância. Objetivou-se avaliar a diversidade de ácaros em parreirais das variedades Cabernet Sauvignon e Pinot Noir nos municípios de Bento Gonçalves e Candiota, Estado do Rio Grande do Sul, Brasil; identificar a nível específico todos os estigmeídeos coletados e descrever, quando o caso, espécies desconhecidas para ciência; conhecer a biologia de *Panonychus ulmi* em folhas de videiras em laboratório, assim como a biologia dos predadores *Agistemus floridanus* e *Neoseiulus californicus* alimentando-se de *P. ulmi*; avaliar a preferência alimentar dos predadores e a relação que se estabelece entre as três espécies; e, construir uma chave pictórica de identificação dos ácaros fitófagos e predadores presentes em videiras. Para avaliação da diversidade, folhas, gemas e plantas não cultivadas foram amostradas de outubro de 2006 a setembro de 2007. Em laboratório, os ácaros foram retirados das folhas, montados em lâminas com meio de Hoyer e identificados com auxílio de chaves dicotômicas. Todos os estigmeídeos coletados foram medidos e comparados com as espécies já descritas. Aqueles que possuíam medidas ou características distintas foram considerados como espécies novas. A biologia de *P. ulmi* foi iniciada com 30 ovos mantidos em folhas de Cabernet Sauvignon e 30 em Pinot Noir. As fases imaturas foram observadas três vezes ao dia, e a fase adulta uma vez ao dia. A biologia dos predadores foi iniciada com 30 ovos de *N. californicus* e 30 de *A. floridanus*, com o mesmo método de observação citado anteriormente. Os dados gerados foram utilizados para construção de tabelas de vida de fertilidade. A preferência alimentar de *A. floridanus* e *N. californicus* foi avaliada oferecendo ovos, imaturos e adultos de *P. ulmi*. Para avaliação do comportamento dos predadores na presença de *P. ulmi* e de odores de coespecíficos e heteroespecíficos foram dadas duas opções, com fontes diferentes de odor, para cada espécie de predador, além da observação das populações após a liberação de *N. californicus* em campo. Para elaboração da chave pictórica, características diagnósticas foram levantadas e utilizadas para diferenciação das famílias e espécies, com ilustrações representativas. Os resultados indicam que a riqueza de espécies e a abundância são maiores em Bento Gonçalves do que em Candiota. Sete espécies de Stigmaeidae estão presentes em videiras no Rio Grande do Sul: *Agistemus brasiliensis*, *A. floridanus*, *Agistemus mendozensis*, *Agistemus riograndensis*, *Zetzellia agistzellia*, *Zetzellia malvinae* e *Zetzellia ampelae*. *Panonychus ulmi* apresenta desenvolvimento adequado em folhas de videiras, no entanto o período de oviposição e a longevidade das fêmeas foram abaixo do esperado, e a variedade Cabernet Sauvignon parece ser mais adequada do que Pinot Noir. *Agistemus floridanus* e *N. californicus* completaram seu ciclo de desenvolvimento alimentando-se de *P. ulmi* em videiras, com parâmetros da tabela de vida diferentes. O teste de liberação de *N. californicus* revelou uma redução no número de ovos e formas móveis de *P. ulmi*, um aumento das populações de *Agistemus* sp., e estabilidade no número de *N. californicus.* Os dois predadores preferiram alimentar-se de ovos de *P. ulmi*, respondendo positivamente a presença do ácaro fitófago e reconhecendo o odor de predadores heteroespecíficos. A chave pictórica elaborada contempla Tetranychidae, Eriophyidae, Tarsonemidae, Tydeidae, Tenuipalpidae, Phytoseiidae, Stigmaeidae e Iolinidae, e será de grande utilidade para profissionais e extensionistas na rápida identificação de ácaros na cultura da videira.

# ABSTRACT

BIOECOLOGY OF MITES (ACARI) ON GRAPEVINE (*Vitis vinifera* L.) IN THE STATE OF RIO GRANDE DO SUL, BRAZIL.

Grapevines are attacked by pests and diseases. Under humid conditions, fungal and bacterial diseases are predominant, while in arid regions, the main pests consist of insects and mites. Among the latter, the phytophagous mites are very important. The present work aimed to assess the diversity of mites in vineyards of Cabernet Sauvignon and Pinot Noir varietals in the municipalities of Bento Gonçalves and Candiota, located in the state of Rio Grande do Sul, Brazil; to identify all the stigmaeids at species level and, if necessary, describe unknown species; to know *Panonychus ulmi* biology in grapevine leaves in the laboratory and the biology of *Agistemus floridanus* and *Neoseiulus californicus* feeding on *P. ulmi*; to evaluate the predators' feeding preference and the interactions among the three species; and to build an identification pictorial key for the phytophagous and predatory mites living on grapevines. To evaluate the mite diversity, leaves, buds and non-cultivated plants were sampled between October 2006 and September 2007. In the laboratory, the mites were taken from the leaves, mounted in slides using Hoyer medium and identified with the help of dichotomous keys. All stigmaeids collected were measured and compared to the species already described. Those that presented distinct measures or characteristics were considered new species. Biology of *P. ulmi* was initiated with 30 eggs kept on Cabernet Sauvignon leaves and 30 eggs kept on Pinot Noir leaves. The immature phases were observed three times per day, and the adult phase only once a day. The biology of the predators was initiated with 30 *N. californicus* eggs and 30 *A. floridanus* eggs, and the same observation method was used. The data generated was used to build fertility life tables. *Agistemus floridanus* and *N. californicus* feeding preference was assessed by offering them *P. ulmi* eggs, immature individuals and adults. In order to evaluate their behavior in the presence of *P. ulmi* and of conspecific and heterospecific odors, each predatory species was given two choices with different odor sources, and their populations were observed after *N. californicus* was liberated in the field. To make the pictorial key, the diagnostic characteristics were used to distinguish the families and the species, with representative illustrations. The results indicate that species richness and abundance are higher in Bento Gonçalves than in Candiota. Seven Stigmaeidae species live in vineyards in Rio Grande do Sul state: *Agistemus brasiliensis*, *A. floridanus*, *Agistemus mendozensis, Agistemus riograndensis, Zetzellia agistzellia, Zetzellia malvinae* and *Zetzellia ampelae*. *Panonychus ulmi* presents an adequate development on grapevine leaves, although its oviposition period and female longevity were both shorter than expected. The Cabernet Sauvignon variety seems to be more adequate than Pinot Noir. *Agistemus floridanus* and *N. californicus* completed their development cycle feeding on *P. ulmi* on grapevines, and presented different life table parameters. *Neoseiulus californicus* liberation test resulted in a decrease in the number of *P. ulmi* eggs and mobile forms and in an increase of *Agistemus* sp. populations, while the number of *N. californicus* remained stable. The two predators preferred to feed on *P. ulmi* eggs and responded positively to its presence, and recognized the odor of heterospecific predators. The pictorial key elaborated includes Tetranychidae, Eriophyidae, Tarsonemidae, Tydeidae, Tenuipalpidae, Phytoseiidae, Stigmaeidae and Iolinidae and will be very useful for professionals and researchers who wish to identify mites in the grapevine culture.
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# APRESENTAÇÃO

O Estado do Rio Grande do Sul possui o maior polo vitivinícola brasileiro, sendo a maior parte da produção destinada à elaboração de vinhos, sucos e derivados. Segundo o Cadastro Vitícola do Rio Grande do Sul (2008/2012), são registrados no Estado 41.076,46 ha de parreirais, distribuídos em 15.185 propriedades.

O cultivo da videira, com predomínio da mão-de-obra familiar, é uma atividade agrícola de grande rentabilidade. Porém, para que isso se concretize, o viticultor deve produzir uvas de qualidade e com produtividade para se tornar competitivo. Para atingir esse nível de eficiência, o produtor deve adotar tecnologias adequadas que reduzam custos e aumentem a qualidade.

A qualidade do vinho está diretamente relacionada com a qualidade das uvas. Sendo assim, o cultivo da videira requer muitos cuidados e técnicas especiais para que as uvas tenham a melhor qualidade possível. Doenças ou pragas podem causar prejuízos ao agricultor ou, até mesmo, a perda de uma safra. Além disso, dependendo da finalidade da produção, a exigência por qualidade é diferenciada, fazendo com que o controle das pragas seja essencial.

Dentre as pragas que atacam as videiras, os ácaros fitófagos apresentam grande importância. Os ácaros possuem habitats extremamente diversificados, podendo ser encontrados em colônias que podem conter de poucos a centenas de indivíduos na superfície abaxial ou adaxial das folhas. Os prejuízos causados pelos ácaros na agricultura ocorrem em função da sua forma de alimentação, pois sugam os fluídos celulares foliares. A perda da clorofila nos locais atacados pode levar ao aparecimento de manchas brancas ou amarelas e, eventualmente, a uma descoloração mais uniforme de aspecto bronzeado ou amarelado, podendo evoluir para desfolhação e, em casos mais extremos, morte da planta.

Para desenvolver métodos de manejo de ácaros é essencial que as espécies sejam conhecidas, estimadas suas populações e períodos de maior frequência. O conhecimento do ciclo de vida dos ácaros fitófagos, e principalmente dos ácaros predadores, é importante para definir estratégias de controle eficientes.

Com o objetivo de preencher as lacunas existentes no conhecimento biológico e ecológico dos ácaros associados a videiras no Rio Grande do Sul, seis artigos foram produzidos:

Artigo 1: Diversity of mites (Acari) in vineyard agroecosystems (*Vitis vinifera*) in two viticultural regions of Rio Grande do Sul state, Brazil. Artigo publicado no periódico "Acarologia".

Artigo 2: Stigmaeid mites (Acari: Stigmaeidae) from vineyards in the state of Rio Grande do Sul, Brazil. Artigo publicado no periódico "Zootaxa".

Artigo 3: Biology of *Panonychus ulmi* (Acari: Tetranychidae) on two European grape varieties cultivated in the state of Rio Grande do Sul, Brazil. A ser submetido para o periódico "Experimental and Applied Acarology".

Artigo 4: Comparative biology of *Agistemus floridanus* and *Neoseiulus californicus* feeding on *Panonychus ulmi* from grapevines cultivated in Rio Grande do Sul, Brazil. A ser submetido para o periódico "Experimental and Applied Acarology".

Artigo 5: Behavior of *Agistemus floridanus* e *Neoseiulus californicus* in response to the presence of *Panonychus ulmi* and to the odor of conspecific and heterospecific predators. A ser submetido para o periódico "International Journal of Acarology".

Artigo 6: Pictorial key for the identification of mites on grapevine in Rio Grande do Sul state, Brazil. A ser submetido para o periódico "Zootaxa".

## ARTIGO 1

Johann L., Horn T.B., Carvalho G.S., Ferla N.J. 2014. Diversity of mites (Acari) in vineyard agroecosystems (*Vitis vinifera*) in two viticultural regions of Rio Grande do Sul state, Brazil. Acarologia 54(2): 137–154. DOI: 10.1051/acarologia/20142122.

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# DIVERSITY OF MITES (ACARI) IN VINEYARD AGROECOSYSTEMS (*VITIS VINIFERA*) IN TWO VITICULTURAL REGIONS OF RIO GRANDE DO SUL STATE, BRAZIL

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ABSTRACT — The aim of this work was to study mite diversity in vineyard plots planted with Cabernet Sauvignon and Pinot Noir cultivars and on associated non-cultivated plants in two viticultural regions of Rio Grande do Sul State, Brazil. Monthly assessments of leaves and buds of vines and of non-cultivated plants were undertaken between October 2006 and September 2007. Twelve thousand mites belonging to 17 families and 46 genera and representing 61 mite species were collected. The most abundant phytophagous mites were *Calepitrimerus vitis*, *Colomerus vitis* and *Panonychus ulmi* on grapevines. Among the predatory mites, the most abundant were *Neoseiulus californicus* and *Agistemus floridanus*. The non-cultivated plants species that showed the greatest richness of mites were *Plantago tomentosa*, *Plantago lanceolata* and *Senecio* sp. The most abundant phytophagous mites on non-cultivated plants were *Tetranychus ludeni* and *Brevipalpus phoenicis* in the viticultural regions of Bento Gonçalves and Candiota, respectively, and *Pronematus anconai* was generally the most abundant predatory mite. In the region of Bento Gonçalves, species richness and abundance in the agroecosystem were far higher than in the region of Candiota.

KEYWORDS — Grapevines; grape cultivars; non-cultivated plants; *Calepitrimerus vitis*; *Panonychus ulmi*; *Neoseiulus californicus*

## INTRODUCTION

Grapevines (*Vitis vinifera* L.: Vitaceae) endure different forms of stress, with losses caused by pathogens and pests being considered even more severe, mainly when environmental conditions favor their development (Fajardo, 2003). When crops are combined with non-cultivated plants, they show a higher availability of alternative resources and microhabitats, allowing predators to reach higher levels of abundance and diversity, fostering the control of species considered pests (Root, 1973; Letourneau and Altieri, 1983).

Species belonging to the mite families Eriophyidae, Tarsonemidae, Tetranychidae and Tenuipalpidae are important crop pests (Reis and Melo, 1984; Schruft, 1985; Soria *et al*., 1993; Monteiro, 1994; Duso and De Lillo, 1996; Schultz, 2005; Ferreira *et al*., 2006; Ferla and Botton, 2008; Johann *et al*., 2009; Klock *et al*., 2011). On the other hand, species belonging to the families Phytoseiidae, Stigmaeidae


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and Iolinidae are considered the most important predators to control the latter mite pests (McMurtry *et al.*, 1970; Moraes 1991, 2002; Duso and De Lillo, 1996; Duso *et al.*, 2004).

Rio Grande do Sul State is a major wine-producing region in Brazil, where the vineyards are cultivated on about 50,646 hectares, with a grape production of approximately 829,589 tons per harvest (Mello, 2012). However, little is known about local mite diversity, and fundamental data for defining pest monitoring and controlling strategies are scarce. Therefore, this work focused on the study of mite diversity associated with Cabernet Sauvignon and Pinot Noir cultivars and non-cultivated plants in two viticultural regions of Rio Grande do Sul State.

## Materials and methods

### Experimental vineyards

The study was conducted in vineyards planted with Cabernet Sauvignon (CS) and with Pinot Noir (PN), both trained using the espalier system and located in the municipalities of Bento Gonçalves (BG) (29°13′S, 51°33′W) and Candiota (CA) (31°28′S, 53°40′W). In BG, the vineyard of CS cultivar had a total area of 5.14 hectares and that of PN 2.48 hectares. In CA, the plot planted with CS cultivar had a total area of 7.3 hectares and that of PN 1.78 hectares. All vineyards were five years old and were managed identically. During the surveys, the agrochemicals applied in the four plots were similar and normally used, and in each plot, no acaricide treatment was applied on the three rows where samplings took place.

### Samplings

Sampling was conducted once a month from October 2006 to September 2007; 20 vinestocks were randomly sampled in each cultivar, in each municipality. A branch was chosen from each vinestock, from which three leaves were taken from the apical, medial and basal thirds, totaling 60 leaves per sampling date per vineyard. In winter, between May and September 2007, 20 branches were sampled, randomly picked from each cultivar, in each municipality, from which three buds were taken, totaling 60 buds per sampling date per vineyard.

In addition to the sampling of grapevines, the five more common non-cultivated plant species growing between the three untreated rows were sampled monthly, in CS and PN plots from BG and CA. The five more common plants varied between plots and sampling events, depending on season [Rio Grande do Sul experiences an average temperature of 25 °C in summer and 10 °C in winter (Kuinchtner and Buriol, 2001)].

Grapevine leaves and branches with buds and non-cultivated plants were separated in plastic bags, and stored in a Styrofoam box with Gelox® to be transported to the laboratory, where they were observed under a stereomicroscope. Mites were gathered manually with a fine brush, from both sides of the leaves and inside the buds. The collected mites were mounted on slides in Hoyer medium (Jeppson *et al.*, 1975).

### Identifications

The identification of specimens to the species level was done using a phase contrast light microscope and identification keys (Pritchard and Baker, 1958; Atyeo, 1960; Summers and Price, 1970; Hughes, 1976; Smiley, 1978; André, 1980; Lindquist, 1986; Smiley, 1992; Baker and Tuttle, 1994; Amrine, 1996; Halliday *et al.*, 1998; Matioli *et al.*, 2002; Chant and McMurtry, 2007; Krantz and Walter, 2009; Mesa *et al.*, 2009; Ferla *et al.*, 2011). Oribatid mites were identified to the suborder level and Bdellidae to the family level. All collected material was stored at the Reference Collection of the Natural Sciences Museum of the UNIVATES University Center (Lajeado, Rio Grande do Sul, Brazil).

### Data analyses

The data analysis process included data concerning mites found on grapevines and on non-cultivated plants, which together represented the agroecosystem.

Several indices were calculated using the software DivEs version 2.0 (Rodrigues, 2005):
i) Shannon-Wiener index ($H' = -\sum p_i \, Log \, p_i$, where $p_i$

TABLE 1: Mite species collected on Cabernet Sauvignon (CS) and Pinot Noir (PN) grapevines (V) cultivars and on non-cultivated plants (P), in the Bento Gonçalves (BG) and Candiota (CA) municipalities, Rio Grande do Sul.

| | | | | CS-BG | | | PN-BG | | | CS-CA | | | PN-CA | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Suborder | Family | Genus/species | O* | Total (P / V) | C** | O* | Total (P / V) | C** | O* | Total (P / V) | C** | O* | Total (P / V) | C** |
| Astigmata | Glycyphagidae | *Lepidoglyphus destructor* | | - | | | - | | V | 1 | Aci | | - | |
| | Winterschmidtiidae | *Czenspinskia* sp. | | - | | P, V | 1/1 | Aci | | - | | V | 6 | Aci |
| Mesostigmata | Ascidae | *Asca* sp. | | - | | | - | | P | 1 | Aci | | - | |
| | | *Proctolaelaps* sp. | P | 2 | Aci | | - | | P | 1 | Aci | | - | |
| | Parasitidae | *Holoparasitus* sp. | P | 2 | Aci | | - | | | - | | | - | |
| | Phytoseiidae | *Amblyseius vitis* | P | 1 | Aci | | - | | | - | | | - | |
| | | *Arrenoseius gaucho* | P | 2 | Aci | P | 3 | Aci | | - | | P | 15 | Ace |
| | | *Euseius ho* | | - | | P, V | 5/32 | Ace | | - | | | - | |
| | | *Euseius inouei* | P | 1 | Aci | P, V | 3/45 | Aci | | - | | | - | |
| | | *Iphiseiodes metapodalis* | | - | | P | 2 | Aci | | - | | | - | |
| | | *Metaseiulus mexicanus* | | - | | | - | | | - | | P | 1 | Aci |
| | | *Neoseiulus californicus* | P, V | 2/10 | Ace | P, V | 5 / 195 | Ace | P, V | 3 / 135 | Con | P, V | 9/94 | Con |
| | | *Neoseiulus fallacis* | P | 2 | Aci | | - | | | - | | | - | |
| | | *Neoseiulus tunus* | | - | | V | 1 | Aci | | - | | | - | |
| | | *Proprioseiopsis cannaensis* | P | 1 | Aci | | - | | P | 2 | Aci | | - | |
| | | *Proprioseiopsis* sp. 1 | P | 1 | Aci | | - | | | - | | | - | |
| | | *Proprioseiopsis* sp. 2 | P | 2 | Aci | | - | | P | 1 | Aci | | - | |
| | | *Typhlodromalus aripo* | | - | | | - | | P, V | 3/1 | Ace | | - | |
| | | *Typhlodromus ( Anthoseius) ornatus* | | - | | | - | | V | 3 | Aci | P, V | 2/2 | Ace |
| Oribatida | - | - | P | 91 | Con | P, V | 13/5 | Con | P | 1 | Aci | P | 4 | Ace |
| Prostigmata | Bdellidae | Bdellidae sp. 1 | | - | | | - | | P | 1 | Aci | | - | |
| | | Bdellidae sp. 2 | | - | | V | 1 | Aci | | - | | | - | |
| | | Bdellidae sp. 3 | | - | | V | 1 | Aci | | - | | | - | |
| | Caligonellidae | Caligonellidae sp.1 | P | 1 | Aci | | - | | | - | | | - | |
| | Cheyletidae | *Cheletomimus* sp. | | - | | V | 1 | Aci | | - | | | - | |
| | Cunaxidae | *Cunaxa* sp. | P | 1 | Aci | P | 1 | Aci | | - | | | - | |
| | | *Neocunaxoides* sp. 1 | | - | | P | 1 | Aci | | - | | P | 1 | Aci |
| | | *Neocunaxoides* sp. 2 | | - | | P | 1 | Aci | | - | | | - | |
| | Eriophyidae | *Aceria* sp. | V | 1 | Aci | | - | | | - | | | - | |
| | | *Aculops* sp. | V | 1 | Aci | | - | | | - | | | - | |
| | | *Calepitrimerus vitis* | V | 1993 | Ace | V | 2705 | Ace | V | 556 | Ace | V | 884 | Con |
| | | *Colomerus vitis* | V | 151 | Ace | | - | | V | 74 | Con | V | 30 | Ace |
| | | *Criotacus* sp. | V | 1 | Aci | | - | | | - | | | - | |
| | | *Rhombacus* sp. | V | 1 | Aci | | - | | | - | | | - | |
| | | *Vasates* sp. | | - | | P | 4 | Aci | | - | | | - | |
| | Iolinidae | *Homeopronematus* sp. | | - | | | - | | | - | | P | 1 | Aci |
| | | *Pronematus anconai* | P,V | 3/11 | Ace | P, V | 17/10 | Con | P, V | 25/10 | Ace | P | 2 | Aci |
| | Pygmephoridae | *Pygmephorus aff. mesembrinae* | | - | | | - | | P | 1 | Aci | | - | |
| | Stigmaeidae | *Agistemus brasiliensis* | V | 5 | Aci | V | 1 | Aci | | - | | | - | |
| | | *Agistemus floridanus* | V | 64 | Ace | P, V | 2/99 | Ace | | - | | | - | |
| | | *Agistemus* sp. 1 | V | 1 | Aci | | - | | | - | | | - | |
| | | *Agistemus* sp. 3 | | - | | V | 4 | Aci | | - | | | - | |
| | | *Agistemus* sp. 4 | | - | | V | 1 | Aci | | - | | | - | |
| | | *Cheylostigmaeus* sp. | P | 6 | Aci | | - | | | - | | | - | |
| | | *Stigmaeus* sp. | P | 1 | Aci | | - | | | - | | | - | |
| | | *Zetzellia malvinae* | | - | | | - | | V | 5 | Ace | P, V | 2/1 | Ace |
| | Tarsonemidae | *Acaronemus* sp. | P, V | 8/1 | Ace | V | 2 | Aci | P, V | 2/17 | Ace | P, V | 1/12 | Ace |
| | | *Polyphagotarsonemus latus* | P | 87 | Aci | V | 98 | Aci | | - | | | - | |
| | | *Tarsonemus* spp. | P, V | 19 / 88 | Con | P, V | 3/40 | Con | P, V | 11/183 | Con | P, V | 26/465 | Con |
| | | *Xenotarsonemus* sp. | P, V | 56 / 1 | Ace | P | 6 | Ace | | - | | | - | |
| | Tenuipalpidae | *Brevipalpus phoenicis* | P | 2 | Aci | P | 5 | Ace | P, V | 87 / 8 | Con | P | 70 | Ace |
| | Tetranychidae | *Mononychelus planki* | | - | | P | 2 | Aci | | - | | | - | |
| | | *Oligonychus* sp. 1 | | - | | P | 17 | Aci | | - | | V | 1 | Aci |
| | | *Oligonychus* sp. 2 | | - | | P | 1 | Aci | | - | | | - | |
| | | *Panonychus ulmi* | V | 195 | Con | P, V | 3/2123 | Ace | | - | | V | 18 | Aci |
| | | *Tetranychus ludeni* | P | 57 | Ace | P | 24 | Ace | | - | | | - | |
| | Tydeidae | *Lorryia formosa* | | - | | P | 2 | Aci | | - | | | - | |
| | | *Lorryia* sp. | V | 1 | Aci | | - | | | - | | | - | |
| | | *Metatriophtydeus* sp. | | - | | V | 1 | Aci | | - | | | - | |
| | | *Neolorryia* sp. | V | 2 | Aci | | - | | | - | | | - | |
| | | *Orthotydeus* sp. | P, V | 22 / 101 | Con | P, V | 172/439 | Con | P, V | 3/40 | Con | P, V | 52/131 | Con |
| | | *Pretydeus* sp. | | - | | | - | | | - | | P, V | 1/1 | Aci |
| | | **Total specimens** | | **2998** | | | **6098** | | | **1175** | | | **1837** | |
| | | **Species richness (P / V)** | | **23 / 18** | | | **23 / 21** | | | **14 / 12** | | | **14 / 12** | |

* Occurrence: P – non-cultivated associated plant; V – grapevine.

** Constancy index: Con – Constant (species present in more than 50 % of the samples); Ace - Accessory (species present in 25 to 50 % of the samples); Aci - Accidental (species present in less than 25 % of the samples).

TABLE 2: Ecological indexes of mite communities encountered on non-cultivated plants and vine from plots planted with Cabernet Sauvignon (CS) and Pinot Noir (PN) cultivars in Bento Gonçalves and Candiota municipalities, Rio Grande do Sul, Brazil.

| Indexes | Bento Gonçalves | | Candiota | |
|---|---|---|---|---|
| | CS | PN | CS | PN |
| Number of species | 35 | 34 | 19 | 19 |
| Number of individuals | 2998 | 6098 | 1175 | 1837 |
| Diversity of Shannon (H′) | 0.6777 | 0.6268 | 0.7312 | 0.6496 |
| Evenness of J-Shannon (J) | 0.4389 | 0.4092 | 0.5718 | 0.5080 |

is the proportion of specimens of each species in relation to the total number of specimens found in assessments performed) expresses richness and uniformity, giving more weight to rare species (Shannon, 1948);
ii) Shannon's J evenness ($J = H'/H_{max'}$, where $H'$ is the Shannon-Wiener index and $H_{max'}$ is given by the following expression: $H_{max'} = Log$ s, where $s$ is the number of species sampled) expresses the equitability of abundances in a community and allows the assessment of species stability over time (Brower and Zar, 1984).

The constancy index was calculated according to Bodenheimer (1955). The species were classified as "constant" when they were present in more than 50 % of the samples, "accessory" when they were present in 25 – 50 % of the samples and "accidental" when present in less than 25 % of the samples).

The general similarity between these agroecosystems according to mite families with larger number of species was analyzed by Bray-Curtis clustering analysis, using BioDiversity Professional software (McAleece *et al*., 1997). The same analysis was performed with mites found on grapevines and with mites found on non-cultivated plants. The Bray-Curtis clustering analysis is a multifactorial analysis technique that uses a similarity matrix to build a tree, in which each branch represents a sample. Samples that share similarities are located in branches close to each other.

## RESULTS

A total of 12,108 mites were collected on vine leaves and wild plants. They belonged to 17 families, 46 genera and 61 species (Table 1). The BG areas had the highest number of species and abundance, with 35 species in CS and 34 in PN, corresponding to 2998 and 6098 mites, respectively. In CA, 19 species were observed in both plots and the number of mites collected was clearly much lower than in BG, 1175 and 1837 mites on CS and PN, respectively. Phytoseiidae was the most represented family with the highest number of species (14), followed by Stigmaeidae and Eriophyidae with eight and seven species, respectively. Six species were common to the four plots, besides Oribatida: *Calepitrimerus vitis* (Nalepa, 1905), *Orthotydeus sp.*, *Neoseiulus californicus* (McGregor, 1954), *Brevipalpus phoenicis* (Geijskes, 1939), *Pronematus anconai* Baker, 1943 and *Acaronemus* sp.

### Diversity indices

Despite differences in species richness between the two localities, diversity index (H′) values were low and quite similar. For a given cultivar, evenness indices (J) were lower in BG compared to CA (Table 2). In each municipality, diversity and evenness were slightly higher in the vineyards planted with CS but these values were close to those observed in the plots planted with PN (Table 2).

### Agroecosystems

The most abundant phytophagous mites in all the areas studied were *Calepitrimerus vitis*, *Panonychus ulmi* (Koch, 1936), *Colomerus vitis* (Pagenstecher, 1857) and *Polyphagotarsonemus latus* (Banks, 1904), with 6138, 2339, 255 and 185 specimens, respectively (Table 1). *Calepitrimerus vitis* was found on leaves of grapevines, and only one individual was found on a bud, in PN-CA. This species was considered constant only in PN-CA. *Panonychus ulmi* showed higher abundance in BG, mainly in PN, where it was considered as accessory. In this area, three individuals were collected from non-cultivated plants. In CA, *P. ulmi* only occurred in PN, where it was considered as accidental. *Polyphagotarsonemus latus*, only present in BG, was collected on grapevine leaves in PN and on non-cultivated plants in CS. This species was classified as accidental in both plots. *Colomerus vitis* was observed in the two municipalities. It was more abundant in CS-BG but was considered constant only in CS-CA. Only one individual was collected on grapevine leaves, and the remaining individuals were observed on buds.

The most abundant predatory mites were *N. californicus*, *Agistemus floridanus* Gonzales 1965 and *P. anconai*, with 448, 165 and 78 individuals, respectively. Eight predatory species were observed both on vineyards and on non-cultivated plants. Among them, *N. californicus* was the most abundant predator in PN-BG and in both plots of CA, where it was considered as constant. *Agistemus floridanus* was only observed in BG and classified as accessory. In CS-BG, it was only collected on grapevines, where it was the most abundant predator; in PN-BG it was present on grapevines and non-cultivated plants, however, it was not the most abundant predator. *Pronematus anconai,* observed in the four plots, was collected on grapevines and non-cultivated plants. It had a higher abundance in PN-BG, where it was considered as constant.

*Orthotydeus* sp. was the most abundant generalist mite, with 960 individuals, mainly collected on buds from grapevines and non-cultivated plants. It was considered as constant in all areas.

### Grapevines

In BG, the numbers of mite species and mite specimens collected on grapevines were greater than in CA. Among them, the most abundant phytophagous mites were *Cal. vitis* and *P. ulmi,* and the most abundant predatory mites were *N. californicus* and *A. floridanus* (Figure 1 A, B and Table 1). In CA, *Cal. vitis* and *Tarsonemus* sp. were the most abundant phytophagous mites in PN and CS (Figure 1 C, D and Table 1). Only 18 *P. ulmi* were observed in PN and this species was not detected in CS. Again, *N. californicus* was the most abundant predatory mite. In both localities, a greater number of mites were found on PN in comparison with CS (Figure 1).

### Non-cultivated plants

A total of 63 non-cultivated plant species were sampled from which 44 mite species were collected (Table 3). The mite species richness in the non-cultivated plants was slightly higher than that in grapevines (Table 1). In BG, mites were found on 27 out of 34 non-cultivated plant species sampled, whereas in CA, mites were found on 24 species out of 40 non-cultivated plant species. Like on grapevines, the number of mites collected on non-cultivated plants was greater in BG than in CA (Table 3). Eleven plant species were common to both municipalities: *Senecio* sp. was the only plant collected in the four plots. *Bidens pilosa* L., *Plantago tomentosa* Lam., *Richardia brasiliensis* Gomes, *Rumex* sp., *Solanum americanum* Mill., *Sonchus oleraceus* L., *Stachys arvensis* L. and *Trifolium repens* L. were collected in three plots, and *Gnaphalium spicatum* Lam. and *Plantago lanceolata* L. in two plots (Table 3). Mite diversity in these plants found in both municipalities was greater in BG than in CA: we observed on average 4.8 and 3.4 mite species per plant species in BG and CA, respectively.

The plant species that showed the greatest richness of mites also belonged to the most common plants: *P. tomentosa*, 19 mite species; *P. lanceolata*, 13 species; and *Senecio* sp., 9 species. In BG, a higher abundance of mites was observed for *P. tomentosa* (106 mites) on CS, and for *P. lanceolata* (48 mites) on PN. In CA, *Baccharis trimera* (Less.) DC. showed higher abundance of mites on CS and PN, with 49 and 67 mites, respectively (Table 3).

The most abundant phytophagous mites were *B. phoenicis* (157 specimens in 8 host plants) and *Tetranychus ludeni* Zacher, 1913 (81 specimens in 9 host plants) in CA and BG, respectively. Among predatory mites, *P. anconai* was the most abundant (47 specimens on 10 host plants, with 25 specimens collected on *Senecio* sp.). Thirteen species of phytoseiid mites were collected on non-cultivated

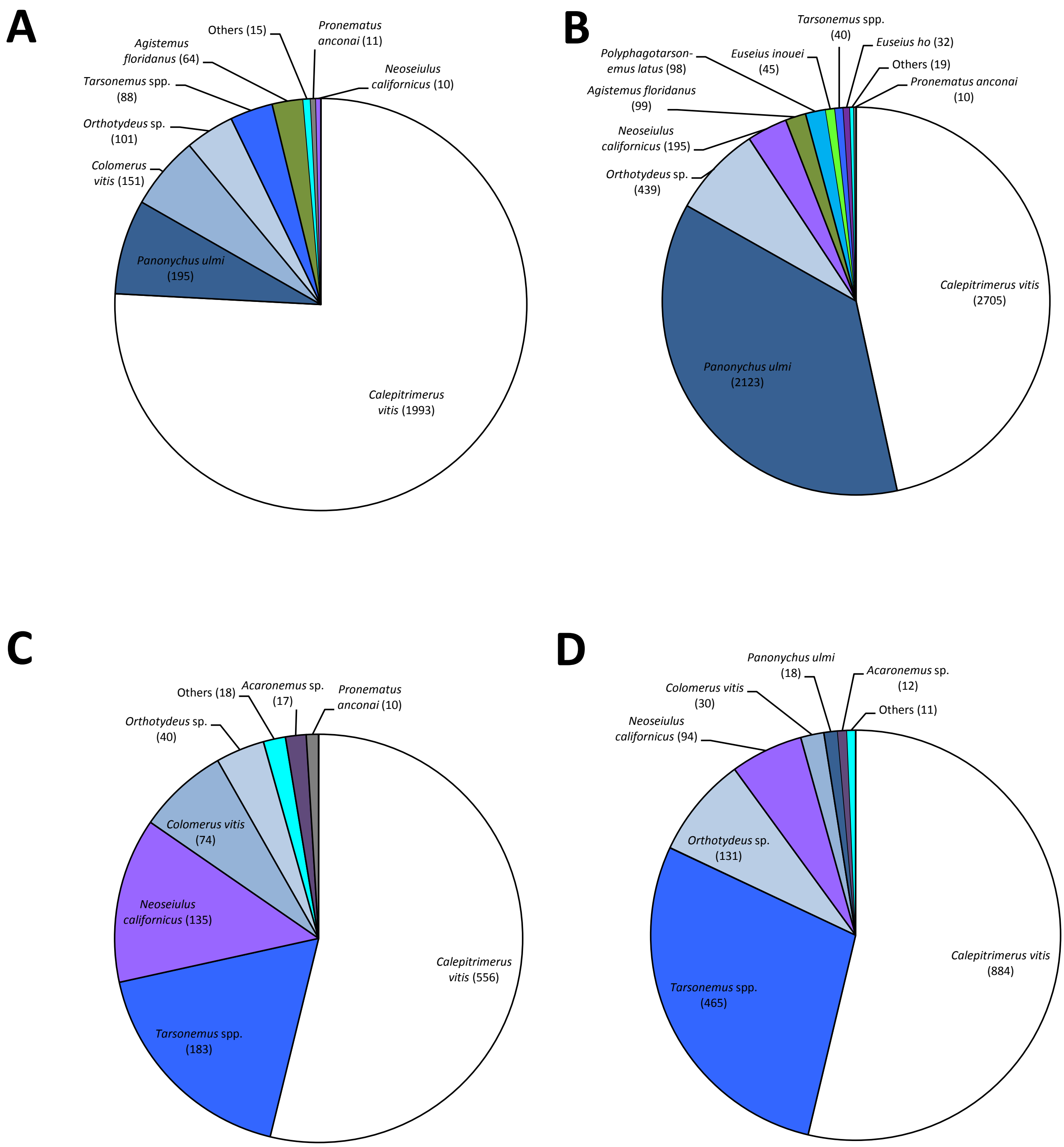



FIGURE 1: Abundance of main mite species found on grapevine in Bento Gonçalves (A - Cabernet Sauvignon; B - Pinot Noir) and Candiota (C - Cabernet Sauvignon; D - Pinot Noir) municipalities, Rio Grande do Sul, Brazil.

TABLE 3: Mite number of each species collected on non-cultivated plants in plots planted with, Cabernet Sauvignon (CS) and Pinot Noir (PN) cultivars, in the Bento Gonçalves (BG) and Candiota (CA) municipalities, Rio Grande do Sul.

| Families | Non-cultivated plants | Mites | BG | | CA | |
|---|---|---|---|---|---|---|
| | | | CS | PN | CS | PN |
| Amaranthaceae | *Amaranthus deflexus* L. | *Neoseiulus californicus* | - | - | - | 1 |
| | | *Typhlodromus* (*Anthoseius*) *ornatus* | - | - | - | 1 |
| | *Amaranthus hybridus* L. | *Pretydeus* sp. | - | - | - | 1 |
| | *Amaranthus* sp. | *Tarsonemus* spp. | - | - | - | 1 |
| | | *Orthotydeus* sp. | - | - | - | 1 |
| Apiaceae | *Conium maculatum* L. | *Neoseiulus californicus* | - | 2 | - | - |
| | | *Tetranychus ludeni* | - | 2 | - | - |
| | | *Orthotydeus* sp. | - | 4 | - | - |
| Asteraceae | *Artemisia* sp. | *Acaronemus* sp. | - | - | 1 | - |
| | | *Neoseiulus californicus* | - | - | 1 | - |
| | | *Tarsonemus* spp. | - | - | 2 | - |
| | | *Typhlodromalus aripo* | - | - | 1 | - |
| | *Baccharis* sp. | - | - | - | 0 | - |
| | *Baccharis trimera* (Less.) DC. | *Brevipalpus phoenicis* | - | - | 47 | 62 |
| | | *Neoseiulus californicus* | - | - | 1 | 0 |
| | | Oribatida | - | - | 0 | 2 |
| | | *Tarsonemus* spp. | - | - | 2 | 2 |
| | | *Orthotydeus* sp. | - | - | 0 | 1 |
| | *Bidens pilosa* L. | *Brevipalpus phoenicis* | 0 | 0 | - | 1 |
| | | Oribatida | 0 | 1 | - | 0 |
| | | *Tarsonemus* spp. | 0 | 0 | - | 3 |
| | | *Tetranychus ludeni* | 1 | 0 | - | 0 |
| | | *Orthotydeus* sp. | 1 | 0 | - | 3 |
| | | *Typhlodromus* (*Anthoseius*) *ornatus* | 0 | 0 | - | 1 |
| | | *Zetzellia malvinae* | 0 | 0 | - | 1 |
| | *Brachiaria* sp. | *Neoseiulus californicus* | - | 2 | - | - |
| | | *Oligonychus* sp. 1 | - | 17 | - | - |
| | | *Oligonychus* sp. 2 | - | 1 | - | - |
| | | *Pronematus anconai* | - | 8 | - | - |
| | *Calyptocarpus biaristatus* (DC.) H. Rob. | Oribatida | - | 1 | - | - |
| | | *Tetranychus ludeni* | - | 7 | - | - |
| | | *Vasates* sp. | - | 4 | - | - |
| | | *Xenotarsonemus* sp. | - | 1 | - | - |
| | *Conyza bonariensis* (L.) Cronquist | - | - | - | 0 | - |
| | *Conyza canadensis* (L.) Cronquist | *Acaronemus* sp. | 4 | - | - | - |
| | | Oribatida | 3 | - | - | - |
| | | *Pronematus anconai* | 2 | - | - | - |
| | | *Tarsonemus* spp. | 17 | - | - | - |
| | *Emilia* sp. | - | 0 | - | - | - |
| | *Erechtites hieraciifolius* (L.) Raf. ex DC. | - | - | - | 0 | 0 |
| | *Galinsoga parviflora* Cav. | *Acaronemus* sp. | 1 | 0 | - | - |
| | | *Agistemus floridanus* | 0 | 1 | - | - |
| | | *Euseius inouei* | 1 | 2 | - | - |
| | | *Neoseiulus californicus* | 1 | 0 | - | - |
| | | *Pronematus anconai* | 1 | 0 | - | - |
| | | *Tetranychus ludeni* | 7 | 11 | - | - |
| | | *Orthotydeus* sp. | 5 | 4 | - | - |

TABLE 3: Continued.

| Families | Non-cultivated plants | Mites | BG CS | BG PN | CA CS | CA PN |
|---|---|---|---|---|---|---|
| | *Galinsoga* sp. | - | - | - | 0 | - |
| | *Gnaphalium spicatum* Lam. | *Homeopronematus* sp. | 0 | - | - | 1 |
| | | *Tarsonemus* spp. | 0 | - | - | 2 |
| | | *Xenotarsonemus* spp. | 1 | - | - | 0 |
| | *Hypochaeris radicata* L. | *Tetranychus ludeni* | 1 | - | - | - |
| | *Hypochaeris* sp. | - | 0 | - | - | - |
| | *Senecio brasiliensis* (Spreng.) Less. | *Brevipalpus phoenicis* | - | - | 21 | 0 |
| | | *Orthotydeus* sp. | - | - | 0 | 11 |
| | *Senecio selloi* (Spreng.) DC. | *Arrenoseius gaucho* | - | - | - | 1 |
| | | *Orthotydeus* sp. | - | - | - | 1 |
| | *Senecio* sp. | *Brevipalpus phoenicis* | 0 | 1 | 0 | 7 |
| | | *Lorryia formosa* | 0 | 1 | 0 | 0 |
| | | *Metaseiulus mexicanus* | 0 | 0 | 0 | 1 |
| | | *Neoseiulus californicus* | 0 | 0 | 0 | 2 |
| | | Oribatida | 1 | 0 | 0 | 0 |
| | | *Pronematus anconai* | 0 | 0 | 24 | 1 |
| | | *Tarsonemus* spp. | 0 | 1 | 2 | 0 |
| | | *Thyphlodromalus aripo* | 0 | 0 | 2 | 0 |
| | | *Orthotydeus* sp. | 0 | 22 | 0 | 15 |
| | *Synedrella nodiflora* (L.) Gaertn. | *Brevipalpus phoenicis* | 1 | - | - | - |
| | | *Tetranychus ludeni* | 25 | - | - | - |
| | *Sonchus oleraceus* L. | *Pygmephorus* aff. *mesembrinae* | - | 0 | 1 | 0 |
| | | *Tetranychus ludeni* | - | 4 | 0 | 0 |
| | | *Orthotydeus* sp. | - | 0 | 0 | 1 |
| | *Sonchus* sp. | - | - | - | 0 | - |
| | *Taraxacum officinale* L. | *Cunaxa* sp. | 0 | 1 | - | - |
| | | *Euseius ho* | 0 | 1 | - | - |
| | | Oribatida | 0 | 2 | - | - |
| | | *Tydeus* sp. | 0 | 13 | - | - |
| | | *Xenotarsonemus* spp. | 2 | 0 | - | - |
| Boraginaceae | *Echium plantagineum* L. | - | - | - | 0 | - |
| Brassicaceae | *Raphanus raphanistrum* L. | - | - | - | 0 | - |
| | *Raphanus sativus* L. | *Orthotydeus* sp. | - | - | 1 | - |
| | *Raphanus* sp. | - | - | - | 0 | - |
| Caryophyllaceae | *Paronychia chilensis* DC. | - | - | - | - | 0 |
| | *Silene gallica* L. | - | - | - | - | 0 |
| | *Stellaria media* (L.) Cirillo | - - | - | - | - | 0 |
| Convolvulaceae | *Ipomoea* sp. | *Neoseiulus californicus* | - | - | 1 | - |
| | *Merremia umbellate* (L.) Hallier F. | - | - | - | 0 | - |
| Euphorbiaceae | *Euphorbia heterophylla* L. | *Agistemus floridanus* | - | 1 | - | - |
| | | *Euseius ho* | - | 1 | - | - |
| | | *Pronematus anconai* | - | 2 | - | - |
| Fabaceae | *Medicago hispida* Gaertn. | *Acaronemus* sp. | - | - | 1 | - |
| | | *Tarsonemus* spp. | - | - | 2 | - |
| | *Medicago lupina* L. | - | - | - | 0 | - |
| | *Trifolium pratense* L. | - | 0 | 0 | - | - |
| | *Trifolium repens* L. | *Brevipalpus phoenicis* | 0 | 1 | 1 | - |
| | | *Pronematus anconai* | 0 | 3 | 0 | - |
| | | *Tetranychus ludeni* | 2 | 0 | 0 | - |
| | | *Orthotydeus* sp. | 1 | 5 | 1 | - |

TABLE 3: Continued.

| Families | Non-cultivated plants | Mites | BG CS | BG PN | CA CS | CA PN |
|---|---|---|---|---|---|---|
| | *Trifolium* sp. | *Pronematus anconai* | 0 | 2 | - | - |
| | | *Orthotydeus* sp. | 1 | 17 | - | - |
| | | *Xenotarsonemus* spp. | 0 | 1 | - | - |
| Lamiaceae | *Stachys arvensis* L. | *Brevipalpus phoenicis* | 0 | 0 | 12 | - |
| | | Oribatida | 14 | 0 | 0 | - |
| | | *Tarsonemus* spp. | 0 | 0 | 1 | - |
| | | *Orthotydeus* sp. | 2 | 23 | 1 | - |
| | | *Xenotarsonemus* spp. | 2 | 0 | 0 | - |
| Malvaceae | *Sida santaremensis* Monteiro | - | 0 | - | - | - |
| | *Sida* sp. | *Mononychelus planki* | - | 2 | - | - |
| | | *Neoseiulus californicus* | - | 1 | - | - |
| | | *Panonychus ulmi* | - | 3 | - | - |
| | | *Pronematus anconai* | - | 2 | - | - |
| | | *Orthotydeus* sp. | - | 5 | - | - |
| | *Sida spinosa* L. | - | 0 | 0 | - | - |
| Plantaginaceae | *Plantago lanceolata* L. | *Bdellidae* sp. 1 | - | 0 | 1 | - |
| | | *Brevipalpus phoenicis* | - | 2 | 5 | - |
| | | *Czenspinskia* sp. | - | 1 | 0 | - |
| | | *Euseius ho* | - | 2 | 0 | - |
| | | *Lorryia formosa* | - | 1 | 0 | - |
| | | *Neocunaxoides* sp. 2 | - | 1 | 0 | - |
| | | Oribatida | - | 3 | 0 | - |
| | | *Proctolaelaps* sp. | - | 0 | 1 | - |
| | | *Proprioseiopsis cannaensis* | - | 0 | 2 | - |
| | | *Proprioseiopsis* sp. 2 | - | 0 | 1 | - |
| | | *Tarsonemus* spp. | - | 2 | 0 | - |
| | | *Orthotydeus* sp. | - | 34 | 0 | - |
| | | *Xenotarsonemus* spp. | - | 2 | 0 | - |
| | *Plantago tomentosa* Lam. | Aff. *Cheylostigmaeus* | 4 | 0 | - | 0 |
| | | *Amblyseius vitis* | 1 | 0 | - | 0 |
| | | *Brevipalpus phoenicis* | 0 | 1 | - | 0 |
| | | Caligonellidae | 1 | 0 | - | 0 |
| | | *Cunaxa* sp. | 1 | 0 | - | 0 |
| | | *Euseius ho* | 0 | 1 | - | 0 |
| | | *Euseius inouei* | 0 | 1 | - | 0 |
| | | *Arrenoseius gaucho* | 2 | 0 | - | 13 |
| | | *Holoparasitus* sp. | 2 | 0 | - | 0 |
| | | *Neocunaxoides* sp. 1 | 0 | 0 | - | 1 |
| | | *Neoseiulus californicus* | 0 | 0 | - | 1 |
| | | Oribatida | 51 | 3 | - | 2 |
| | | *Iphiseiodes metapodalis* | 0 | 2 | - | 0 |
| | | *Proctolaelaps* sp. | 2 | 0 | - | 0 |
| | | *Proprioseiopsis cannaensis* | 1 | 0 | - | 0 |
| | | *Proprioseiopsis* sp. 2 | 2 | 0 | - | 0 |
| | | *Stigmaeus* sp. | 1 | 0 | - | 0 |
| | | *Orthotydeus* sp. | 1 | 18 | - | 4 |
| | | *Xenotarsonemus* spp. | 37 | 0 | - | 0 |
| Polygonaceae | *Rumex* sp. | *Brevipalpus phoenicis* | 0 | 0 | 2 | - |
| | | Oribatida | 3 | 0 | 1 | - |
| | | *Orthotydeus* sp. | 2 | 27 | 0 | - |
| | | *Xenotarsonemus* spp. | 6 | 1 | 0 | - |

TABLE 3: Continued.

| Families | Non-cultivated plants | Mites | BG | | CA | |
|---|---|---|---|---|---|---|
| | | | CS | PN | CS | PN |
| Poaceae | *Bromus catharticus* Vahl. | *Neoseiulus fallacis* | 1 | - | - | - |
| | | *Proprioseiopsis* sp. 1 | 1 | - | - | - |
| | *Digitaria* sp. | *Pronematus anconai* | - | - | 1 | - |
| | *Eleusine distachya* Trin. | *Neoseiulus californicus* | - | - | - | 1 |
| | *Lolium multiflorum* Lam. | - | 0 | - | - | - |
| | *Paspalum* sp. | *Neoseiulus californicus* | 1 | - | - | - |
| | | Oribatida | 3 | - | - | - |
| | | *Tarsonemus* spp. | 1 | - | - | - |
| | *Poa annua* L. | - | - | 0 | - | - |
| Portulacaceae | *Portulaca oleracea* L. | - | - | - | 0 | - |
| Oxilidaceae | *Oxalis* sp. | - | - | - | 0 | - |
| Rubiaceae | *Richardia brasiliensis* Gomes | Aff. *Cheylostigmaeus* | 2 | 0 | 0 | - |
| | | *Asca* sp. | 0 | 0 | 1 | - |
| | | *Arrenoseius gaucho* | 0 | 2 | 0 | - |
| | | *Neocunaxoides* sp. 1 | 0 | 1 | 0 | - |
| | | Oribatida | 3 | 3 | 0 | - |
| | | *Xenotarsonemus* spp. | 8 | 0 | 0 | - |
| Solanaceae | *Nicotiana tabacum* L. | *Arrenoseius gaucho* | - | 1 | - | - |
| | | *Xenotarsonemus* spp. | - | 1 | - | - |
| | *Nicotiana* sp. | *Neoseiulus fallacis* | 1 | - | - | - |
| | | Oribatida | 1 | - | - | - |
| | | *Polyphagotarsonemus latus* | 24 | - | - | - |
| | | *Tetranychus ludeni* | 21 | - | - | - |
| | | *Orthotydeus* sp. | 1 | - | - | - |
| | *Physalis angulata* L. | - | - | - | - | 0 |
| | *Solanum americanum* Mill. | *Acaronemus* sp. | 3 | - | 0 | 0 |
| | | *Neoseiulus californicus* | 0 | - | 0 | 3 |
| | | *Tarsonemus* spp. | 0 | - | 2 | 18 |
| | | *Orthotydeus* sp. | 8 | - | 0 | 15 |
| | | *Zetzellia malvinae* | 0 | - | 0 | 1 |
| - | P1 * | Oribatida | 4 | - | - | - |
| | | *Tarsonemus* spp. | 1 | - | - | - |
| - | P2 * | *Acaronemus* sp. | - | - | - | 1 |
| | | *Arrenoseius gaucho* | - | - | - | 1 |
| | | *Neoseiulus californicus* | - | - | - | 1 |
| | | *Pronematus anconai* | - | - | - | 1 |
| Total mite number | | | 298 | 293 | 143 | 187 |

(-) plant not sampled (absent).
(0) plant sampled devoid of mite.
(*) unknown host plant.

plants. Among them, *Arrenoseius gaucho* Ferla, Silva and Moraes, 2010 and *N. californicus* were the most abundant (20 specimens collected on 5 host plants and 19 specimens found on 14 plant species, respectively) (Tables 1 and 3).

**Similarity between agroecosystems**

When considering all the mite families, Eriophyidae or Stigmaeidae found on vines and non-cultivated plants, Bray-Curtis analysis revealed that the mite composition found on two plots in a given location was more similar than the mite composition of two plots of a given cultivar in two different locations (Figure 2: A, C, D). Although the composition of phytoseiid mite species showed a high similarity between CS-CA and PN-CA (78 %), it was not the case between PN-BG and CS-BG. The mite composition found in PN-BG was closer to that observed in the plots of CA (63 %) (Figure 2B).

The comparison of the mite communities found on grapevines showed that the location effect was stronger than the varietal effect (Figure 3 A). The mite communities on vines in CS-BG and PN-BG grouped together, and it was the same with CS-CA and PN-CA.

Considering the mite communities in non-cultivated plants, the two plots (PN and CS) grouped together in CA (56 % similarity) but the similarity between CS-BG and PN-BG was low (Figure 3 B).

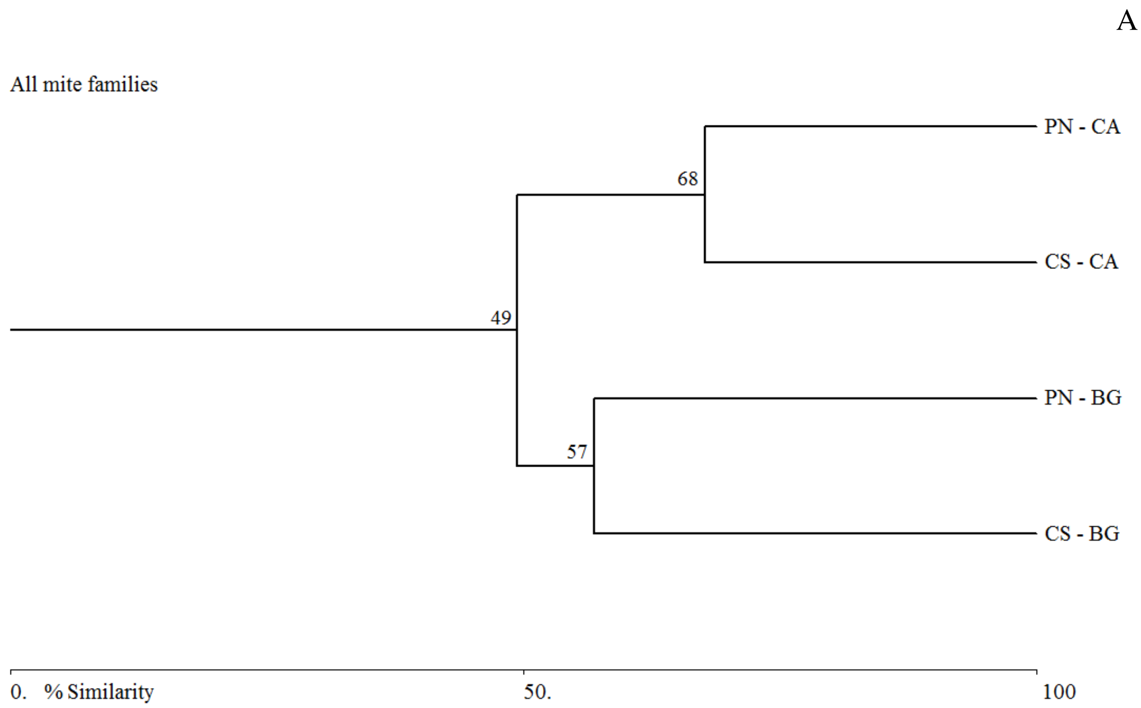
## Discussion

The present study showed that the diversity and abundance of the mite fauna found in vineyard plots as a whole (agroecosystem) and on grapevines were different in the two regions assessed. The number of mite species and abundance in plots located in the BG region were higher when compared to CA. Moreover, in BG, a greater mite species richness and abundance were also observed on non-cultivated plants. Despite our experimental setup did not allow us to conclude definitely on the possible effect of the environment on the mite communities in the two regions, we can make the following assumption. The BG region is inserted in the Atlantic Forest, which is one of the world's 25 biodiversity hotspots with more than 8,000 endemic species recorded (Tabarelli *et al.*, 2005), whereas the CA region is located in the plains, characterized by various plant formations, with a predominance of grasslands. One can assume that the mite diversity found in the plots would be linked (at least partially) to that of the neighboring area as previously shown by several authors (Altieri and Letourneau, 1982; Tixier *et al.*, 1998; Tixier *et al.*, 2000; Barbar *et al.*, 2006; Liguori *et al.*, 2011; Duso *et al.*, 2012), explaining why the number of mite species was higher in plots located in BG.

The cultivar did not seem to affect the species richness of the plot as a whole. Because the number of mite species found in plots planted with CS and PN in a given municipality was similar. Moreover, in each plot, the species richness was systematically higher on non-cultivated plants than on vines. Therefore, the potential effect of cultivar on mite species richness in the agroecosystem is limited. As a consequence, the overall richness of a plot reflects more that of non-cultivated plants found in the vineyard plot.

In contrast, the abundance of mites seemed to be influenced by the cultivar. In the two regions, the PN cultivar appeared to be more favorable to the eriophyid mite *Cal. vitis* when compared to the CS cultivar. As eriophyid mites were by far the most numerous mites (about half of all the mite specimens collected), they were mainly responsible for the differences observed in mite abundance between the two cultivars. The effect of grape cultivar on the population level of *Cal. vitis* was previously shown by several studies (e.g., Kozlowski, 1993; Tomoioga and Comsa, 2010). Castagnoli *et al.* (1997) reported that densities of *Cal. vitis* were greater on cultivars with highly hairy leaves. However, according to Michl and Hoffmann (2011), PN has leaves with low density or no hair and CS has leaves with a medium density. Thus, our observations are conflicting with those reported by Castagnoli *et al.* (1997). Nevertheless, Siqueira *et al.* (2013) observed that the population level of *Cal. vitis* could differ between cultivars according to the year in plots in Rio Grande do Sul. Thus, the cultivar effect that we have noticed could be temporary. However, considering two other numerous phytophagous mites, *P. ulmi* in BG and *Tarsonemus* sp. in CA, an obvious cultivar effect was also observed, with mites being more abundant on PN.

Since *Cal. vitis* specimens were considerably more numerous than other mite species, particularly in the BG plot planted with CS where this species was dominant, the diversity index (H') values were low and the evenness (J) values were



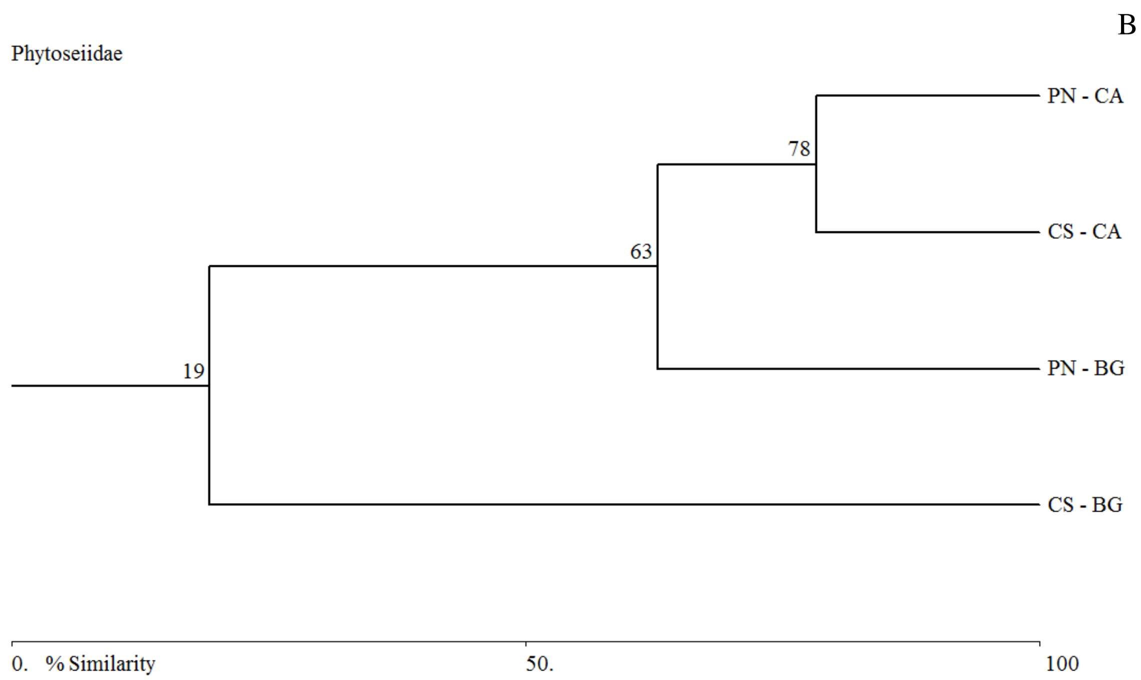




FIGURE 2: Bray-Curtis clustering analysis dendrograms of mite communities observed in four plots (agroecosystems) planted with Cabernet Sauvignon (CS) or Pinot Noir (PN) in the two vine-producing regions Bento Gonçalves (BG) and Candiota (CA), Rio Grande do Sul: A – All mite families; B – Phytoseiidae; C – Stigmaeidae; D – Eriophyidae.

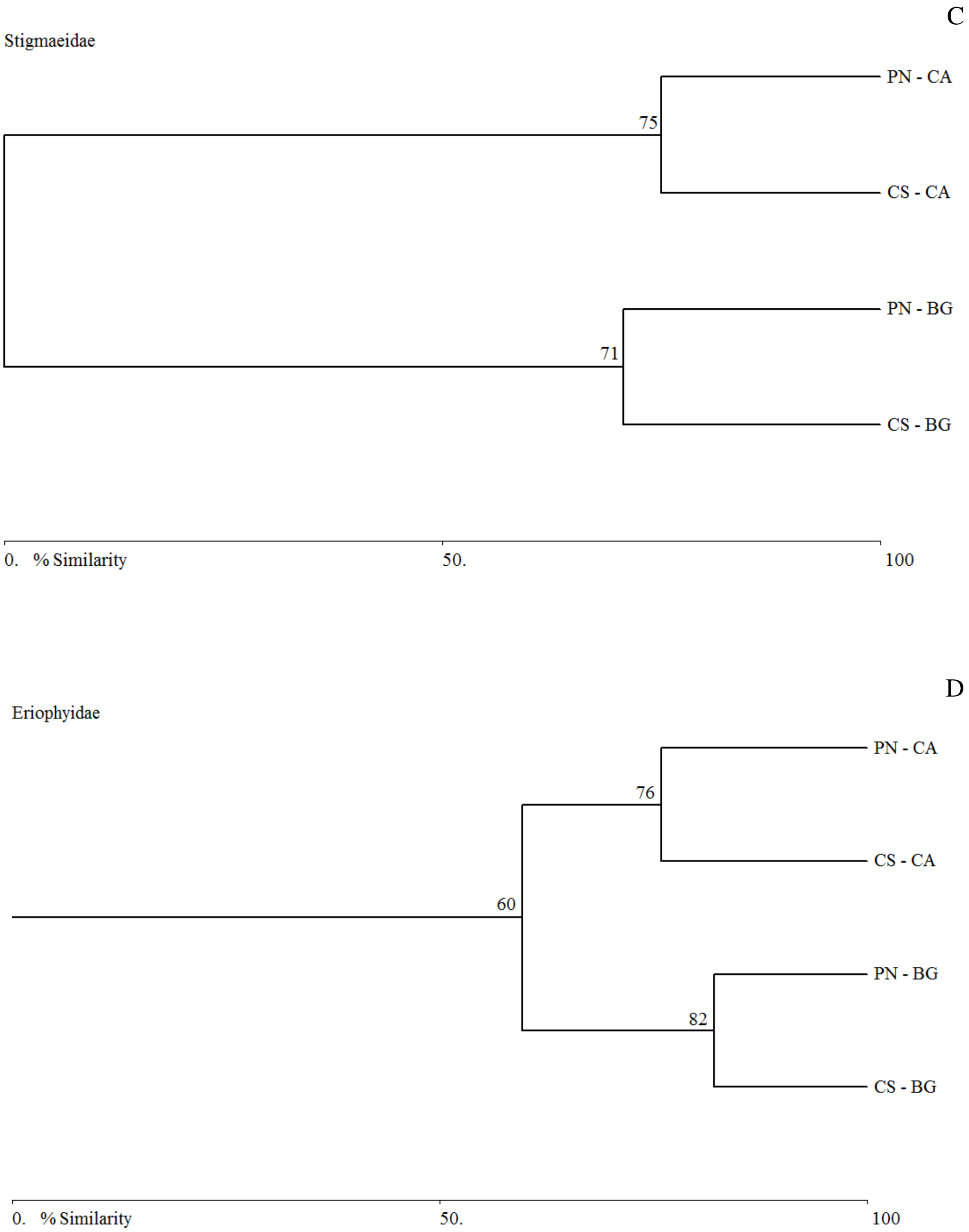



FIGURE 2: Continued.

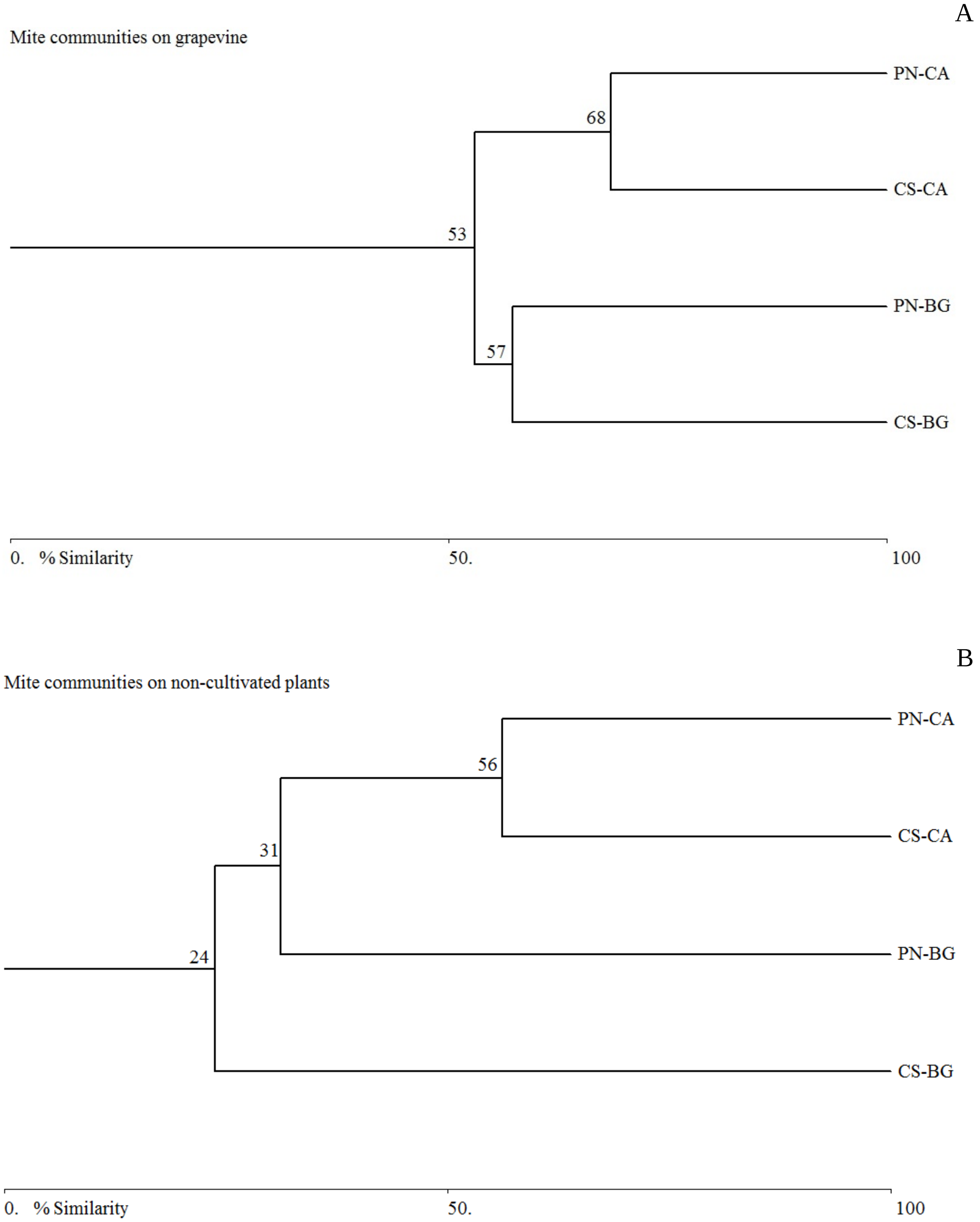



FIGURE 3: Bray-Curtis clustering analysis dendrograms of mite communities observed on grapevine (A) and on non-cultivated plants (B), in four plots planted with Cabernet Sauvignon (CS) or Pinot Noir (PN), in Bento Gonçalves (BG) and Candiota (CA) regions, Rio Grande do Sul.

lower in BG plots compared to that observed in CA plots. As previously shown by Johann *et al.* (2009) and by Klock *et al.* (2011), *Cal. vitis* and *P. ulmi* are economically important vineyard pests in Rio Grande do Sul State like in several parts of the world (e.g., Attiah 1967; Schruft 1985; Duso *et al.* 2004; Bernard *et al.* 2005; Ferla and Botton 2008). During the present study, both species were constant or accessory in their areas of occurrence.

In this work, the three most abundant species of predators, *N. californicus, A. floridanus* and *P. anconai*, were collected both on grapevines and non-cultivated plants. Despite *N. californicus* and *P. anconai* being encountered in low numbers on non-cultivated plants, this confirms that predators can inhabit wild plants found in agroecosystems. Moreover, in our study, the species richness of phytoseiid mites on non-cultivated plants was greater than that observed on grapevines, and some phytoseiids species were observed on both these plants and grapevines. On the other hand, with the exception of 3 specimens of *P. ulmi* found on non-cultivated plants while this species reached a peak on grapevines, the phytophagous mite species considered of economic importance to vineyards in Rio Grande do Sul and found on non-cultivated plants, were not observed on grapevines. Thus, non-cultivated plants present in the vineyard plots of the areas studied may serve as shelter for predators without promoting mite grapevine pests.

Among the phytoseiid mites, *N. californicus* was the most important predator in terms of number of specimens collected in both regions assessed (about 450 among 600 phytoseiid mite specimens). As noted by Johann and Ferla (2012), this species seems to be more linked to *Cal. vitis* and *P. ulmi* densities observed on PN cultivar in BG than to leaf morphology. This is in accordance with the second life-type of Phytoseiidae defined by McMurtry and Croft (1997), because *Neoseiulus* species with this lifestyle are known to feed on eriophyids in addition to controlling tetranychid mites. This is the case with *N. californicus* that feeds on *Col. vitis* (Gonzales, 1983), but Duso and de Lillo (1996) did not mention it as a predator of *Cal. vitis*. Our observation also confirms that made by Klock *et al.* (2011) who found an association between *N. californicus* and *Cal. vitis* on Chardonnay and Merlot cultivars, in Bento Gonçalves and Candiota.

Our findings appear to support the link previously shown by Johann and Ferla (2012) between *A. floridanus* and the phytophagous mites *P. ulmi* and *Cal. vitis*. They are also consistent with previous data on the biological features of this mite because Eriophyidae are considered the natural prey of Stigmaeidae (White, 1976). This was confirmed by the data of Ferla and Moraes (2003) who found that *A. floridanus* produces more eggs when fed *Calacarus heveae* Feres, 1992 than tetranychids. Moreover, *Agistemus exsertus* Gonzales, 1963 was observed controlling *Col. vitis* in Egypt and, *Zetzellia mali* Ewing, 1917, *Cal. vitis* and *Col. vitis* in Italy (Duso *et al.*, 2004). The life cycles of Stigmaeidae and Eriophyidae show similarities concerning spatial distribution, dispersion characteristics, reproductive biology and life history (Thistlewood *et al.*, 1996). Thus, *A. floridanus* could be an important biological control agent against eriophyids in Brazilian vineyards.

*Pronematus anconai,* present in all areas studied, might be directly and indirectly involved in the biological control of phytophagous mites. Indeed, *Pronematus* species have been reported as eriophyid predators (Laing and Knop, 1982; Perrin and McMurtry, 1996), and some contributions have shown the importance of *P. anconai* as an alternative prey for phytoseiid mites (Calvert and Huffaker, 1974; Flaherty and Hoy, 1971).

Further studies with a larger number of plots of each cultivar in the two viticultural regions are required to confirm our preliminary observations and to obtain more consistent results. Additional studies could also be performed to understand the influence of cultivars on the life history of phytophagous mites, the biology of *N. californicus*, *A. floridanus* and *P. anconai* when fed *P. ulmi* and *Cal. vitis,* and the dynamics of predatory mites on grapevines and associated plants.

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## ARTIGO 2

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# Stigmaeid mites (Acari: Stigmaeidae) from vineyards in the state of Rio Grande do Sul, Brazil

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## Abstract

The fauna of the family Stigmaeidae Oudemans on grapevines and weed plants associated with vineyard agroecosystem in the state of Rio Grande do Sul (Brazil) was studied. Five recognized species were reported: *Agistemus brasiliensis* Matioli *et al*., 2002, *Agistemus floridanus* Gonzales, 1965, *Agistemus mendozensis* Simons, 1967, *Zetzellia agistzellia* Hernandes and Feres, 2005, and *Zetzellia malvinae* Matioli *et al*., 2002. Two new species were described: *Agistemus riograndensis* **sp. nov**. and *Zetzellia ampelae* **sp. nov**. A pictorial key was compiled to aid in the recognition of these stigmaeids.

**Key words:** Acari, *Agistemus*, Brazil, predators, *Vitis labrusca*, *Vitis vinifera, Zetzellia*

## Introduction

Mites of the family Stigmaeidae live on plants and in soil and are considered the most diverse family among Raphignathoidea (Walter *et al.* 2009), with 30 genera and 464 species described (Spongoski 2009). They feed on immature Tetranychidae, Tenuipalpidae, Eriophyidae and their eggs, as well as other mites that infest commercial crops in many parts of the world (Muma & Selhime 1971; Swift 1987; Ferla & Moraes 2002). The stigmaeid genera, *Agistemus* and *Zetzellia* have been reported as one of the most important groups of predatory mites after Phytoseiidae (Hoyt 1969; Laing & Knop 1983; Santos & Laing 1985).

In the state of Rio Grande do Sul, stigmaeids have been observed in several agroecosystems, with low populations on strawberries (*Fragaria* sp.) and peaches (*Prunus persica* (L.) Batsch) (Ferla *et al.* 2007; Eichelberger *et al.* 2011). However, on yerba mate (*Ilex paraguariensis* St. Hil.), *Agistemus brasiliensis* Matioli *et al*., 2002 is the most abundant predator commonly associated with *Disella ilicicola* Navia and Flechtmann (Eriophyidae) (Ferla *et al.* 2005). In apple trees and grapevine, the stigmaeids are the most abundant predators after Phytoseiidae (Ferla & Moraes 1998; Klock *et al.* 2011; Johann & Ferla 2012). Johann & Ferla (2012) suggested studies to assess the ability of *Agistemus floridanus* Gonzalez, 1965 to control *Panonychus ulmi* (Koch) (Tetranychidae) and *Calepitrimerus vitis* (Nalepa) (Eriophyidae) populations on grapevines.

In this paper we provide data about stigmaeids present in grapevines and on weed plants associated to viticulture in the state of Rio Grande do Sul. Among them we describe two new species of the genera *Agistemus* Summers and *Zetzellia* Oudemans.

## Material and methods

This work was carried out in vineyards located in Bento Gonçalves (29°13' S 51°33' W), Boqueirão do Leão

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(29°18' S 52°25' W), Candiota (31°28' S 53°40' W), Dois Lajeados (28°60'S 51°51' W) and Encruzilhada do Sul (30°31 'S 52°31' W) counties, in the state of Rio Grande do Sul (Fig. 1). In all grapevine fields sampled, no miticide was applied during the study.

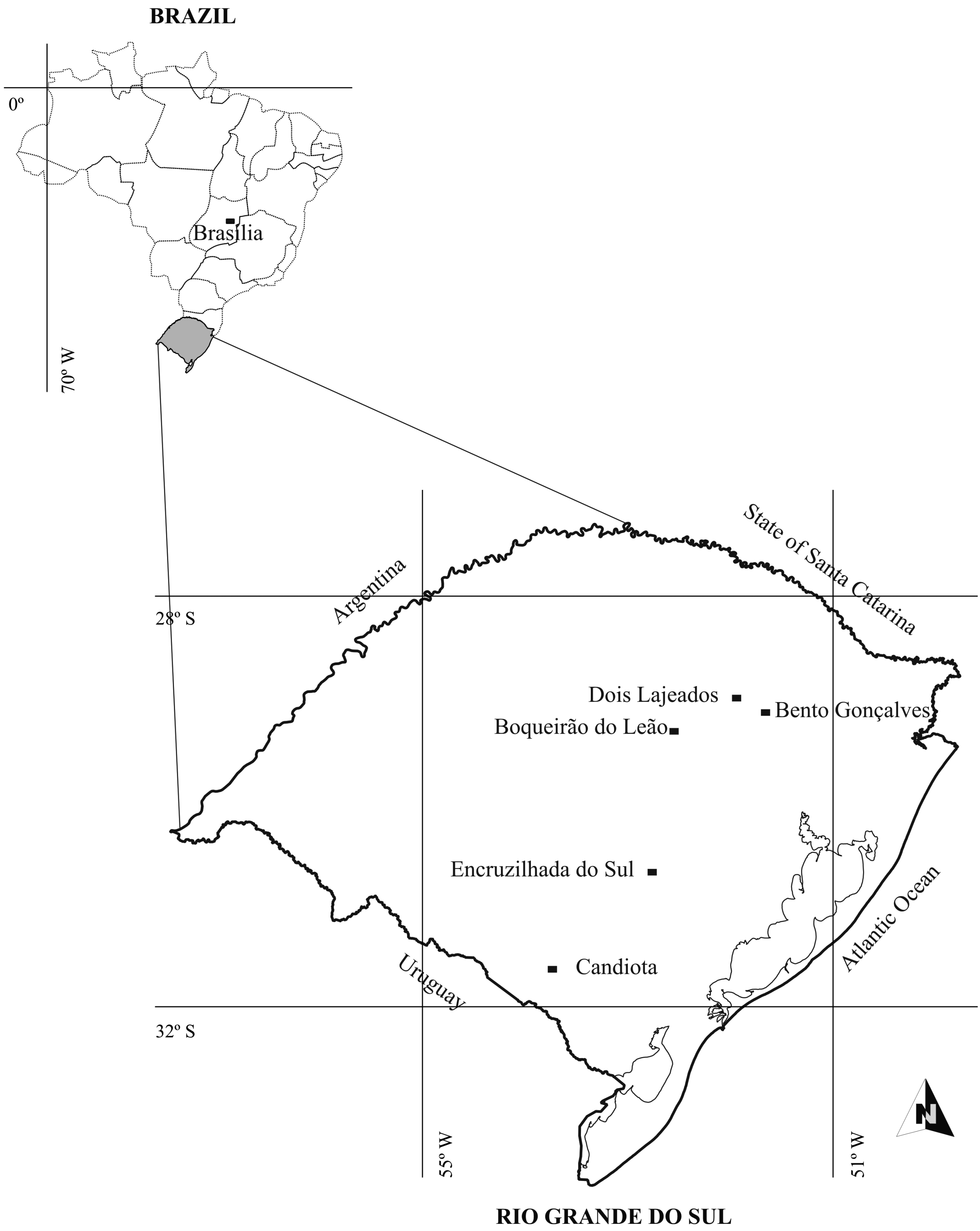


**FIGURE 1**. Geographical location of the municipalities sampled for the study of the diversity of Stigmaeidae mites in the State of Rio Grande do Sul: Bento Gonçalves, Boqueirão do Leão, Candiota, Dois Lajeados and Encruzilhada do Sul.

The research was conducted monthly, and 20 plants were randomly taken from each vineyard. A branch was chosen from each plant, and from each branch a leaf was taken from the apical, median and basal regions. To determine the presence of mites in buds, during the senescent period, a branch (± 1.5cm diameter) was removed from each of 20 plants. Also, leaves from the five most common weeds within each vineyard were sampled and examined under a stereoscopic microscope.

All vine leaves and buds and weed plants collected were stored in paper bags and kept cool during transport to the laboratory. Once in the laboratory, mites were removed from both sides of the leaves and from three buds per branch, and mounted in Hoyer's medium (Jeppson *et al*. 1975). The gnathosomal and leg setation follows Grandjean (1944, 1946). The idiosomal setation follows Grandjean (1939) as adapted to Prostigmata by Kethley (1990). Measurements are provided in micrometers. For description of new species, the measurement of holotypes corresponds to the number before the parentheses. Solenidia (on tibiae and tarsus) and supracoxal setae (on coxae) are given in parentheses. The whole material is deposited in the mite reference collection (CAS) of the Museu de Ciências Naturais (MCN), at UNIVATES Centro Universitário, Lajeado, in the state of Rio Grande do Sul.

## Results

### Family Stigmaeidae Oudemans

### Genus *Agistemus* Summers

#### *Agistemus brasiliensis* Matioli, Ueckermann and Oliveira
(Fig. 2)

*Agistemus brasiliensis* Matioli, Ueckermann and Oliveira, 2002: 106, figs. 6–10.

**Material examined.** CAS-08 (MCN). 4 females from Bento Gonçalves: 1 female from *Vitis vinifera* L., Chardonnay cultivar, 3 January 2007, coll. C.L. Klock; 2 females on same host, Merlot cultivar, 9 April 2007, coll. C.L. Klock; 1 female from *Solanum americanum* Mill., 15 January 2006, coll. T.B. Horn. 1 female from Boqueirão do Leão, *Vitis labrusca* L., Bordeaux cultivar, 8 January 2006, coll. T.B. Horn.

**Distribution.** This species was reported on *Citrus sinensis* (L.) Osbeck in the state of São Paulo, Brazil, associated with *Panonychus citri* (McGregor) (Tetranychidae) and *Brevipalpus phoenicis* (Geijskes) (Tenuipalpidae) (Matioli *et al.* 2002). It is the only species collected on yerba mate in the state of Rio Grande do Sul. The population peaks of this species and *Disella ilicicola* (Eriophyidae) are coincided (Ferla *et al.* 2005).

Measurements of this species are provided in Table 1.

#### *Agistemus floridanus* Gonzalez
(Fig. 3)

*Agistemus floridanus* Gonzalez, 1965: 42, figs. 112 and 117; Matioli, Ueckermann and Oliveira 2002: 103, figs. 1–5.

**Material examined.** CAS-7 (MCN). 18 females and 2 males from Bento Gonçalves: 3 females from *V. vinifera*, Pinot Noir cultivar, 3 January 2007, coll. T.B. Horn; 2 females with same data, 5 March 2007, coll. L. Johann; 5 females on same host, Merlot cultivar, 9 April 2007, coll. C.L. Klock; 1 female with same data, coll. T. Horn; 2 males with same data, coll. C.L. Klock; 1 female on same host, Chardonnay cultivar, 4 December 2006, coll. L.B. Oliveira; 2 females with same data, 3 January 2007, L.B. Oliveira; 1 female with same data, 30 January 2007, L.B. Oliveira; 2 females with same data, 5 March 2007, coll. L.B. Oliveira; 7 females from Boqueirão do Leão: 1 female from *V. vinifera*, Cabernet Sauvignon cultivar, 24 April 2006, coll. T.B. Horn; 1 female with same data, 22 May 2006, coll. T.B. Horn; 1 female from *V. labrusca*, Bordeaux cultivar, 11 December 2006, coll. J.F. Silva; 1 female with same data, 8 January 2007, coll. T.B. Horn; 2 females with same data, 30 January 2007, coll. J.F. Silva; 1 female from *Synedrella nodiflora* (L.) Gaertn, 30 January 2007, coll. T.B. Horn; 1 female from Dois Lajeados, *V. labrusca*, Bordeaux cultivar, 15 May 2006, coll. J.F.Silva; 5 females and 1 male from Encruzilhada do Sul, *V.vinifera*, Pinot Noir cultivar: 1 female, 13 February 2007, coll. L. Johann; 1 female, 13 February 2007, coll. M. Diehl; 2 females, 1 March 2007, coll. L. Johann; 1 female, 27 March 2007, coll. L. Johann; 1 male, 1 March 2007, coll. L. Johann.

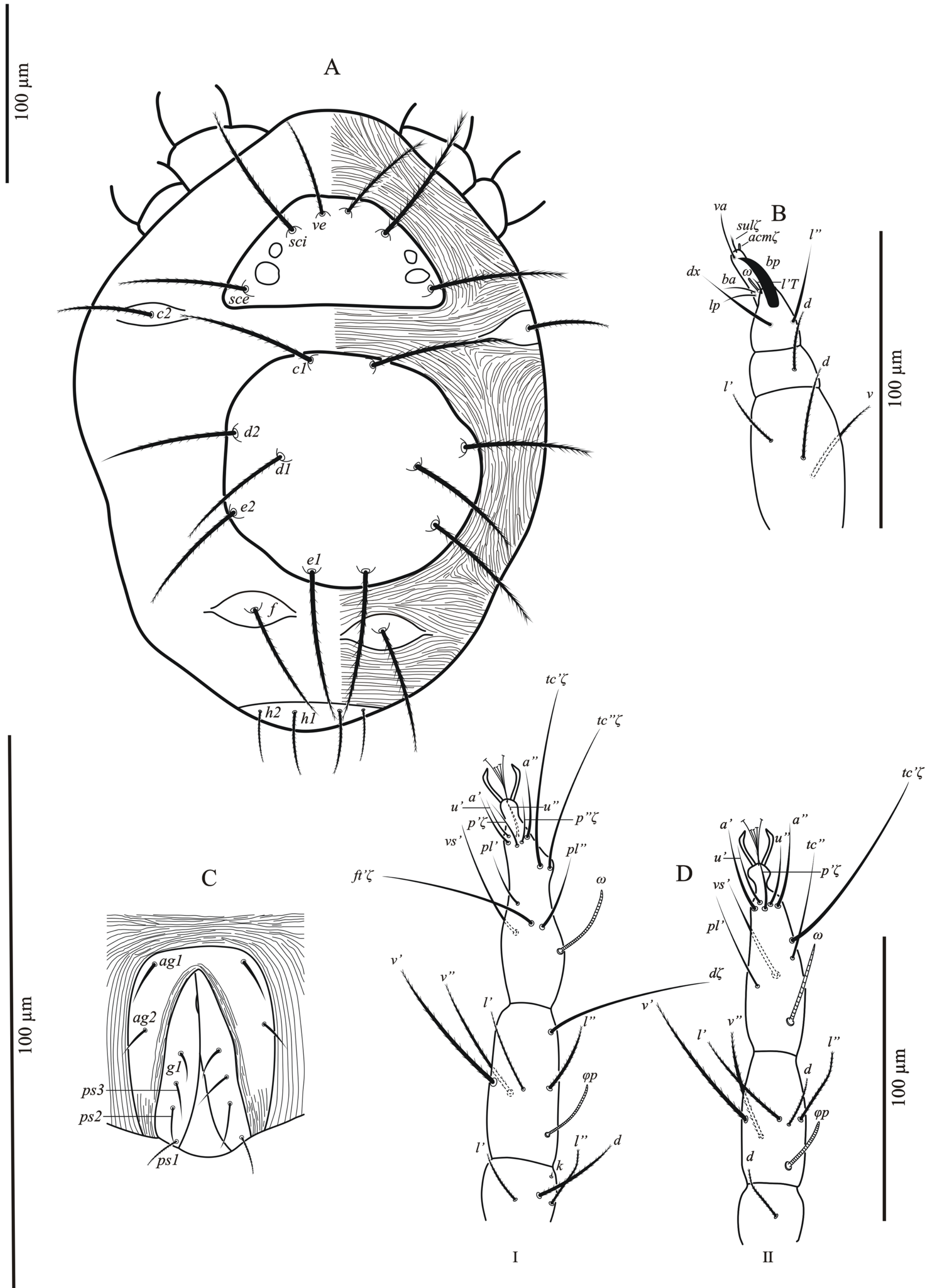


**FIGURE 2**. *Agistemus brasiliensis* Matioli, Ueckermann and Oliveira, 2002 (female). A, dorsum; B, palp; C, anogenital region ventrally; D, legs I and II in dorsal view.

**TABLE 1.** Measurements of *Agistemus brasiliensis* Matioli, Ueckermann and Oliveira, 2002.

| Character measured | Female (n=9) | | | | Male (n=3) | | | | Matioli *et al*. 2002 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Female holotype | Female (n=10) | | Male (n=5) | |
| | Mean | SD | Max | Min | Mean | SD | Max | Min | | Mean | SD | Mean | SD |
| Body length | 455 | 47.0 | 535 | 408 | 374 | 14.4 | 382 | 358 | 415 | 389 | 26.2 | 318 | 39.1 |
| Idiosoma | 328 | 41.0 | 390 | 270 | 242 | 14.4 | 250 | 225 | 300 | 278 | 36.8 | 213 | 33.4 |
| Body width | 251 | 37.6 | 308 | 200 | 183 | 7.8 | 192 | 178 | 260 | 233 | 31.7 | 170 | 22.4 |
| *ve* | 47 | 3.2 | 51 | 42 | 38 | 1.0 | 39 | 37 | 47 | 49 | 2.6 | 42 | 4.9 |
| *sci* | 76 | 4.2 | 80 | 67 | 58 | 0.6 | 59 | 58 | 77 | 77 | 1.4 | 59 | 3.9 |
| *sce* | 68 | 5.2 | 74 | 60 | 53 | 2.1 | 55 | 51 | 72 | 71 | 4.5 | 54 | 7.2 |
| $c_1$ | 67 | 5.6 | 73 | 60 | 50 | 4.0 | 54 | 46 | 63 | 60 | 2.0 | 45 | 4.0 |
| $c_2$ | 51 | 5.4 | 58 | 42 | 39 | 2.1 | 41 | 37 | 54 | 55 | 3.0 | 42 | 5.8 |
| $d_1$ | 67 | 6.3 | 75 | 57 | 38 | 1.7 | 40 | 37 | 63 | 62 | 1.8 | 36 | 4.0 |
| $d_2$ | 66 | 6.8 | 78 | 55 | 48 | 0.6 | 49 | 48 | 66 | 64 | 3.2 | 48 | 5.2 |
| $e_1$ | 69 | 9.0 | 81 | 55 | 23 | 3.1 | 26 | 20 | 69 | 71 | 3.6 | 25 | 4.1 |
| $e_2$ | 69 | 7.1 | 78 | 57 | 51 | 6.7 | 55 | 43 | 72 | 73 | 4.3 | 48 | 5.9 |
| *f* | 61 | 7.2 | 69 | 50 | 47 | 4.9 | 50 | 41 | 57 | 58 | 3.4 | 51 | 6.2 |
| $h_1$ | 40 | 4.0 | 45 | 35 | 12 | 1.2 | 13 | 11 | 38 | 39 | 2.4 | 14 | 1.6 |
| $h_2$ | 28 | 2.8 | 33 | 25 | 17 | 2.0 | 19 | 15 | 20 | 24 | 2.5 | 16 | 2.1 |
| *ve-ve* | 21 | 7.2 | 35 | 13 | 17 | 2.6 | 20 | 15 | 21 | 21 | 2.5 | 25 | 2.3 |
| $c_1$-$c_1$ | 40 | 3.8 | 45 | 34 | 35 | 2.6 | 38 | 33 | 32 | 29 | 3.4 | 27 | 6.6 |
| $d_1$-$d_1$ | 86 | 11.3 | 106 | 73 | 67 | 4.5 | 71 | 62 | 85 | 83 | 5.4 | 67 | 3.3 |
| $e_1$-$e_1$ | 37 | 4.1 | 43 | 31 | 30 | 2.1 | 32 | 28 | 26 | 25 | 2.0 | 22 | 6.6 |
| *f-f* | 67 | 9.4 | 82 | 52 | 34 | 4.7 | 39 | 30 | 60 | 58 | 9.1 | 32 | 2.6 |
| $h_1$-$h_1$ | 17 | 2.1 | 21 | 15 | 9 | 1.5 | 11 | 8 | 9 | 7 | 2.2 | 5 | 1.1 |
| *ve/ve-ve* | 2.5 | 0.8 | 3.4 | 1.2 | 2.3 | 0.4 | 2.5 | 1.9 | - | 2.3 | - | - | - |
| *c1/c1-c1* | 1.7 | 0.2 | 2.1 | 1.4 | 1.4 | 0.1 | 1.5 | 1.4 | - | 2.1 | - | - | - |
| *d1/d1-d1* | 0.8 | 0.2 | 0.9 | 0.6 | 0.6 | 0.0 | 0.6 | 0.6 | - | 0.8 | - | - | - |
| *e1/e1-e1* | 1.9 | 0.3 | 2.3 | 1.4 | 0.8 | 0.0 | 0.8 | 0.7 | - | 2.8 | - | - | - |
| *f/f-f* | 0.9 | 0.2 | 1.1 | 0.7 | 1.4 | 0.2 | 1.6 | 1.3 | - | 1.0 | - | - | - |
| *h1/h1-h1* | 2.4 | 0.4 | 3.0 | 1.9 | 1.3 | 0.3 | 1.6 | 1.0 | - | 5.6 | - | - | - |

SD = Standard Desviation

**Distribution.** This species was reported on citrus leaf in the state of Florida, USA (Gonzalez 1965), in the state of São Paulo, Brazil (Matioli *et al.* 2002; Hernandes & Feres 2006) and in the state of Mato Grosso, Brazil (Ferla & Moraes 2002). It proved to be an important predator of *Calacarus heveae* Feres (Eriophyidae) and *Tenuipalpus heveae* Baker (Tenuipalpidae) on rubber trees (*Hevea brasiliensis* Muell. Arg.) (Ferla & Moraes 2003). It is also found in the state of Rio Grande do Sul on strawberries (Ferla *et al.* 2007). In addition, this species was reported in Costa Rica and Mexico (Arruda Filho & Moraes 2003).

Measurements of this species are provided in Table 2.

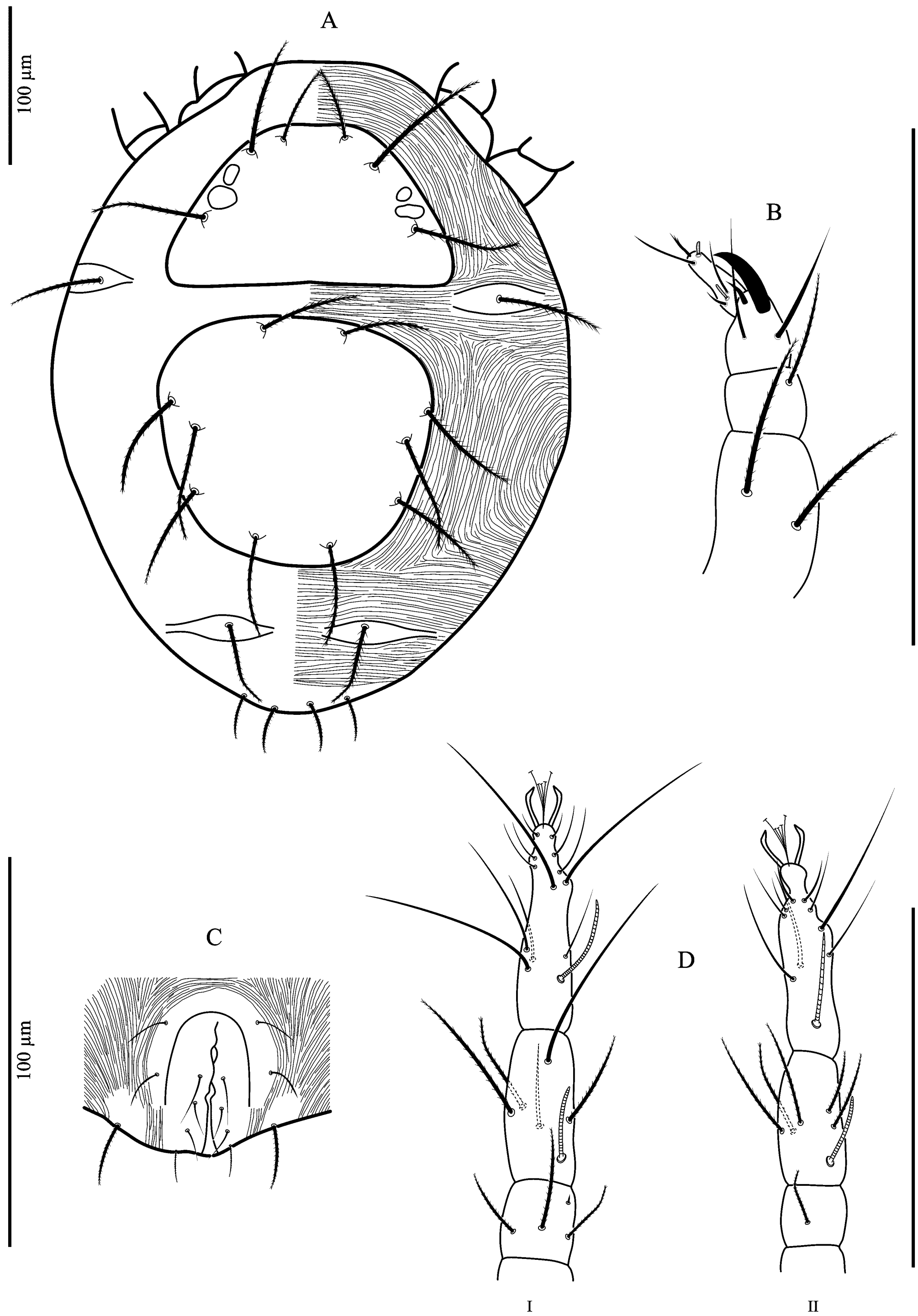


**FIGURE 3.** *Agistemus floridanus* Gonzales, 1965 (female). A: dorsum; B: palp; C: anogenital region ventrally; D: legs I and II in dorsal view.

**TABLE 2.** Measurements of *Agistemus floridanus* Gonzalez, 1965.

| Character measured | Females (n=31) | | | | Males (n=3) | | | | Gonzalez, 1965 | | Matioli *et al*. 2002 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Female (n=10) | | Female holotype | Female (n=7) | | Male (n=3) | |
| | Mean | SD | Max | Min | Mean | SD | Min | Max | Mean | SD | | Mean | SD | Mean | SD |
| Body length | 435 | 33.4 | 495 | 350 | 352 | 13.9 | 340 | 368 | 369 | 13.5 | 405 | 420 | 38.5 | 346 | 10.2 |
| Idiosoma | 321 | 32.1 | 375 | 238 | 232 | 14.6 | 215 | 242 | 290 | 7.6 | 300 | 305 | 33.6 | 237 | 24.2 |
| Body width | 263 | 29.5 | 315 | 200 | 178 | 13.8 | 162 | 188 | - | - | 250 | 246 | 24.0 | 180 | 13.7 |
| *ve* | 38 | 2.8 | 44 | 33 | 33 | 1.5 | 31 | 34 | 38 | 1.8 | 39 | 40 | 2.1 | 34 | 1.7 |
| *sci* | 66 | 4.1 | 71 | 56 | 53 | 3.1 | 50 | 56 | 58 | 2.2 | 59 | 64 | 2.7 | 50 | 0 |
| *sce* | 57 | 3.8 | 65 | 50 | 45 | 2.1 | 43 | 47 | 55 | 3.0 | 54 | 56 | 1.5 | 44 | 0 |
| $c_1$ | 52 | 3.6 | 60 | 45 | 37 | 1.5 | 36 | 39 | 52 | 1.6 | 54 | 52 | 2.3 | 37 | 1.7 |
| $c_2$ | 47 | 3.5 | 52 | 39 | 40 | 2.5 | 38 | 43 | 40 | 1.5 | 47 | 46 | 2.3 | 40 | 3.5 |
| $d_1$ | 52 | 3.8 | 60 | 41 | 29 | 2.6 | 27 | 32 | 52 | 2.7 | 50 | 51 | 2.5 | 28 | 0 |
| $d_2$ | 54 | 3.9 | 61 | 42 | 40 | 4.0 | 36 | 44 | 46 | 3.4 | 50 | 52 | 3.9 | 39 | 1.7 |
| $e_1$ | 56 | 3.4 | 63 | 49 | 18 | 0.6 | 18 | 19 | 54 | 2.2 | 54 | 55 | 1.6 | 23 | 3.5 |
| $e_2$ | 56 | 3.5 | 63 | 49 | 40 | 1.7 | 38 | 41 | 53 | 0.8 | 54 | 55 | 1.5 | 40 | 3.2 |
| *f* | 49 | 2.9 | 56 | 42 | 46 | 1.2 | 45 | 47 | 53 | 1.3 | 49 | 49 | 1.4 | 46 | 2.1 |
| $h_1$ | 33 | 2.4 | 38 | 28 | 9 | 1.5 | 7 | 10 | 34 | 0.3 | 32 | 33 | 1.5 | 12 | 2.3 |
| $h_2$ | 25 | 2.1 | 28 | 19 | 15 | 3.2 | 11 | 17 | 18 | 0.8 | 25 | 25 | 2.1 | 19 | 0 |
| *ve-ve* | 26 | 2.6 | 30 | 22 | 29 | 3.1 | 26 | 32 | - | - | 19 | 23 | 3.0 | 27 | 1.7 |
| $c_1$-$c_1$ | 36 | 3.4 | 42 | 29 | 36 | 2.0 | 34 | 38 | - | - | 32 | 33 | 2.5 | 33 | 4.5 |
| $d_1$-$d_1$ | 95 | 4.9 | 105 | 85 | 67 | 5.5 | 63 | 73 | - | - | 79 | 94 | 8.5 | 66 | 6.5 |
| $e_1$-$e_1$ | 36 | 3.1 | 43 | 30 | 28 | 1.7 | 27 | 30 | - | - | 32 | 33 | 4.7 | 27 | 2.5 |
| *f-f* | 70 | 6.5 | 84 | 60 | 34 | 1.0 | 33 | 35 | - | - | 69 | 65 | 6.7 | 31 | 5.7 |
| $h_1$-$h_1$ | 16 | 2.9 | 25 | 12 | 5 | 2.1 | 3 | 7 | - | - | 6 | 10 | 2.5 | 4 | 1.0 |
| *ve/ve-ve* | 1.5 | 0.1 | 1.8 | 1.2 | 1.1 | 0.1 | 1.3 | 1.0 | 1.4 | - | - | 1.7 | - | - | - |
| *c1/c1-c1* | 1.5 | 0.2 | 2.0 | 1.2 | 1.0 | 0.0 | 1.1 | 1.0 | 1.5 | - | - | 1.6 | - | - | - |
| *d1/d1-d1* | 0.5 | 0.0 | 0.7 | 0.4 | 0.4 | 0.1 | 0.5 | 0.4 | - | - | - | 1.1 | - | - | - |
| *e1/e1-e1* | 1.6 | 0.2 | 1.8 | 1.3 | 0.7 | 0.1 | 0.7 | 0.6 | - | - | - | 1.1 | - | - | - |
| *f/f-f* | 0.7 | 0.1 | 0.8 | 0.5 | 1.3 | 0.0 | 1.4 | 1.3 | - | - | - | 0.8 | - | - | - |
| *h1/h1-h1* | 2.1 | 0.4 | 2.9 | 1.2 | 2.0 | 0.7 | 2.5 | 1.3 | - | - | - | 3.3 | - | - | - |

SD = Standard Desviation

***Agistemus mendozensis*** **Simons**
(Fig. 4)

*Agistemus mendozensis* Simons, 1967: 56, figs. 1–10.

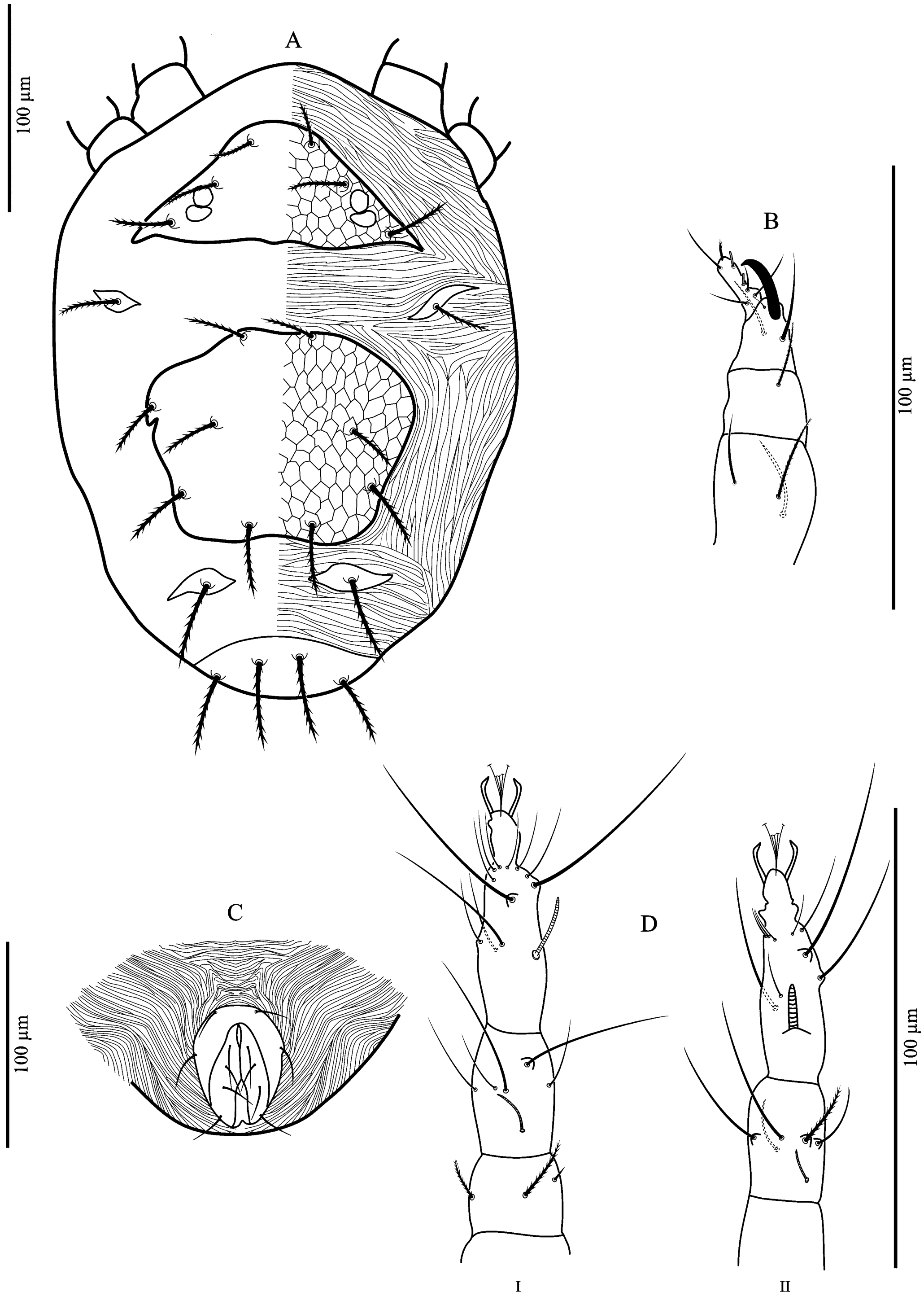


**FIGURE 4.** *Agistemus mendozensis* Simons, 1967 (female). A: dorsum; B: palp; C: anogenital region ventrally; D: legs I and II in dorsal view.

**Redescription.** FEMALE. *Gnathosoma.* Palp coxae with 1 spiniform seta; trochanter without setae; femur with 3 long and serrate setae, one of them more robust; genu with 1 serrate seta; tibia with 3 setae and 1 claw, tarsus with 4 setae, 2 solenidia and 1 trifurcated sensillum (Fig. 4B). Infracapitulum with 2 pairs of long setae and 2 pairs of adoral setae distally. *Idiosoma.* Oval outline. Dorsum: Prodorsal shield reticulated with 3 pairs of serrate setae, 1pair of eyes and 1 pair of post-ocular bodies. Hysterosomal shield reticulated with 5 pairs of short serrate setae, not reaching the bases of surrounding setae. 4 small, smooth shields each with 1 lanceolate seta (setae *c2* and *f*). Suranal shield smooth with 2 pairs of setae, *h1* and *h2*. Venter: 3 pairs of slender setae between coxae inserted on small shields, *1a* at level of coxa II, *3a* anterior to coxa III and *4a* at level of coxa IV. Anogenital regions with a horseshoe-shaped shield surrounding genital opening anteriorly (Fig. 4C) with 2 pairs of agenital setae (*ag1* and *ag2*). Genital region with 4 pairs of setae (*g1*, *ps3*, *ps2* and *ps1*). Seta *g1* almost reaching the base of *ps1*. Setae *ps3*, *ps2*, and *ps1* robust and slightly serrate. *Leg I–IV setation* (Fig. 4D): coxae 2(1)-1-2-1; trochanters 1-1-1-1; femora 4-4-2-2; genua 3-0-0-0; tibiae 5(1)-5(1)-5(1)-4; tarsi 11(1)-9(1)-7(1)-7.

MALE. Unknown.

**Material examined.** CAS-04 (MCN). 2 females from Candiota, *V. vinifera*, Merlot cultivar: 1 female, 14 February 2007, coll. C.L.Klock; 1 female, 18 May 2007, coll. C.L.Klock.

**Distribution.** This species was reported on apple trees (*Malus* sp.) in Argentina (Simons 1967). Ruiz (2007) noted that this species is one of the most abundant in apple orchards in the Rio Negro province, Argentina. This is the first time it was found in the state of Rio Grande do Sul, Brazil.

Measurements of this species are provided in Table 3.

**TABLE 3.** Measurements of *Agistemus mendozensis* Simons 1967.(females)

| Character measured | Females (n=2) | | | | Female holotype (Simons 1967) |
|---|---|---|---|---|---|
| | Mean | SD | Max | Min | |
| Body length | 426 | 23.0 | 442 | 410 | 285 |
| Idiosoma | 311 | 19.4 | 325 | 298 | 218 |
| Body width | 225 | 21.2 | 240 | 210 | 142 |
| *ve* | 16 | 0.7 | 17 | 16 | 10 |
| *sci* | 25 | 1.4 | 26 | 24 | 21 |
| *sce* | 28 | 0.7 | 28 | 27 | 21–25 |
| $c_1$ | 24 | 2.1 | 26 | 23 | 19–20 |
| $c_2$ | 27 | 0.0 | 27 | 27 | 22–23 |
| $d_1$ | 24 | 0.7 | 25 | 24 | 21 |
| $d_2$ | 26 | 0.7 | 26 | 25 | 23 |
| $e_1$ | 32 | 0.7 | 32 | 31 | 29 |
| $e_2$ | 36 | 7.8 | 42 | 31 | 29 |
| *f* | 34 | 2.8 | 36 | 32 | 29–31 |
| $h_1$ | 35 | 1.4 | 36 | 34 | 34 |
| $h_2$ | 32 | 2.1 | 34 | 31 | 34 |
| *ve-ve* | 26 | 0.7 | 27 | 26 | 32 |
| $c_1$-$c_1$ | 31 | 0.0 | 31 | 31 | 33 |
| $d_1$-$d_1$ | 60 | 2.8 | 62 | 58 | 59 |
| $e_1$-$e_1$ | 28 | 0.7 | 29 | 28 | 28 |
| *f-f* | 68 | 2.1 | 70 | 67 | 62 |
| $h_1$-$h_1$ | 18 | 1.4 | 19 | 17 | 21 |
| *ve/ve-ve* | 0.6 | 0.04 | 0.7 | 0.6 | 0.30–0.50 |
| *c1/c1-c1* | 0.8 | 0.06 | 0.8 | 0.7 | 0.58–0.68 |
| *d1/d1-d1* | 0.4 | 0.01 | 0.4 | 0.4 | 0.35–0.43 |
| *e1/e1-e1* | 1.1 | 0.06 | 1.1 | 1.1 | 0.93–1.10 |
| *f/f-f* | 0.5 | 0.06 | 0.5 | 0.5 | - |
| *h1/h1-h1* | 2.0 | 0.23 | 2.1 | 1.8 | - |

SD = Standard Desviation

***Agistemus riograndensis*** **Johann and Ferla sp. nov.**
(Fig. 5)

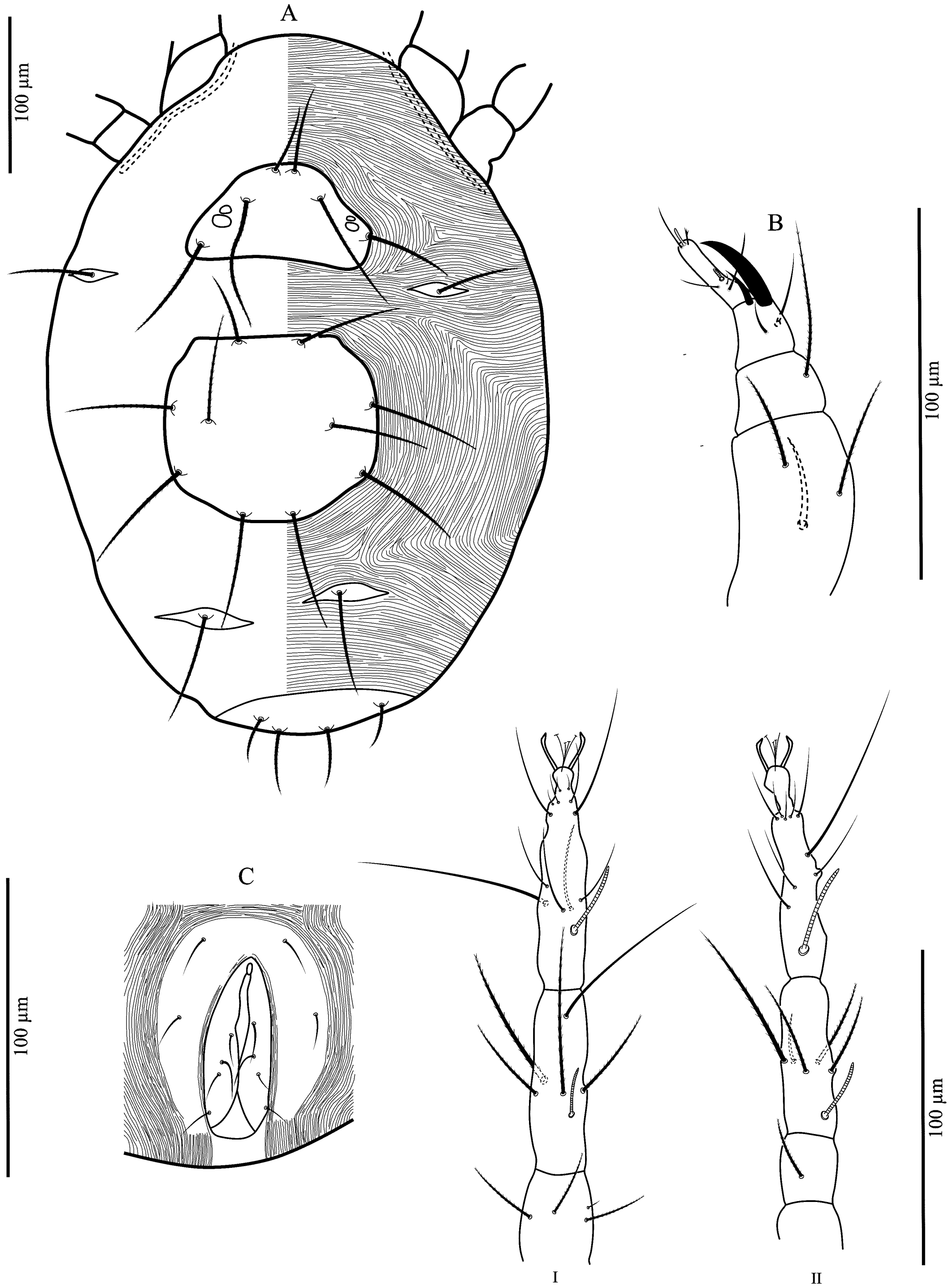


**FIGURE 5.** *Agistemus riograndensis* Johann and Ferla **sp. nov.** (female). A: dorsum; B: palp; C: anogenital region ventrally; D: legs I and II in dorsal view.

**Description.** FEMALE. *Gnathosoma*. Palp coxae with 1 spiniform setae; trochanter without setae; femur with 3 long and serrate setae, 1 of them more robust; genu with 1 long seta reaching distal claw; tibia with 2 setae, 1 claw and 1 accessory claw robust, tarsus with 4 setae, 2 solenidia and 1 trifurcated sensillum (Fig. 5B). Infracapitulum with 2 pairs of long setae and 2 pairs of adoral setae distally. *Idiosoma*. Oval outline. Dorsum: 7 smooth dorsal shields with setae inserted on small tubercles. Prodorsal shield with 3 pairs of long and serrate setae, 1 pair of eyes and 1 pair of post-ocular bodies. Hysterosomal shield with 5 pairs of long and serrate setae. Seta *c1* reaching the base of *d1*. 4 small shields each with 1 lanceolate seta (setae *c2* and *f*). Suranal shield with 2 pairs of setae, *h1* and *h2*. Podocephalic canal starting between the base of palps and leg I, extendig to base of leg II. Venter: 3 pairs of slender setae between coxae, *1a* at level of coxa II, *3a* anterior to coxa III and *4a* at level of coxa IV. Anogenital regions with horseshoe-shaped shield that surrounds genital opening (Fig. 5C) anteriorly, with 2 pairs of agenital setae (*ag1* and *ag2*). Genital region with 4 pairs of setae (*g1*, *ps3*, *ps2*, and *ps1*). Seta *g1* reaching base of *ps3*. Setae *ps3*, *ps2* and *ps1* robust and slightly serrate. *Leg I–IV setation* (Fig. 5D): coxae 2(1)-1-2-2; trochanters 1-1-1-1; femora 5-4-2-2; genua 4-1-0-0; tibiae 5(1)-5(1)-5(1)-5(1); tarsi 12(1)-9(1)-7(1)-7.

MALE. *Gnathosoma*. As in female. *Idiosoma*. Oval outline. Dorsum: 5 smooth dorsal shields and setae inserted on small tubercles. Prodorsal shield with 3 pairs of long and serrate setae, 1 pair of eyes and 1 pair of post-ocular bodies. Hysterosomal shield with 6 pairs of long and serrate setae, including seta *f*. 2 humeral shields with setae *c2*. Suranal shield with 2 pairs of setae, *h1* and *h2*. Venter: 3 pairs of slender setae between coxae, *1a* at level of coxa II, *3a* anterior to coxa III and *4a* at level of coxa IV. Terminal anogenital region with 5 pairs of setae. *Leg I–IV setation*: coxae 2(1)-1-2-2; trochanters 1-1-1-1; femora 5-4-2-2; genua 4-1-0-0; tibiae 5(1)- 5(1)- 5(1)- 5(1); tarsi 12(2)-9(2)-7(1)-7(1).

Measurements of this species are provided in Table 4.

**TABLE 4.** Measurements of *Agistemus riograndensis* Johann & Ferla **sp. nov.**

| Character measured | Female holotype | Female (n=14) | | | | Male (n=5) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | SD | Max | Min | Mean | SD | Max | Min |
| Body length | 550 | 509 | 50.9 | 575 | 412 | 362 | 58.5 | 428 | 268 |
| Body width | 305 | 364 | 48.1 | 432 | 275 | 262 | 13.4 | 310 | 206 |
| Idiosoma | 385 | 280 | 43.3 | 340 | 193 | 192 | 43.4 | 205 | 175 |
| *ve* | 54 | 54 | 3.5 | 60 | 48 | 40 | 5.4 | 46 | 34 |
| *sci* | 86 | 86 | 4.9 | 92 | 77 | 58 | 5.7 | 64 | 50 |
| *sce* | 78 | 78 | 4.7 | 89 | 70 | 51 | 5.5 | 56 | 43 |
| $c_1$ | 74 | 76 | 3.3 | 80 | 70 | 48 | 4.9 | 53 | 42 |
| $c_2$ | 57 | 52 | 6.5 | 60 | 39 | 37 | 5.3 | 43 | 30 |
| $d_1$ | 75 | 75 | 3.7 | 82 | 70 | 36 | 4.9 | 44 | 31 |
| $d_2$ | 75 | 75 | 4.9 | 84 | 66 | 47 | 6.9 | 55 | 38 |
| $e_1$ | 83 | 81 | 4.4 | 89 | 72 | 22 | 4.6 | 27 | 16 |
| $e_2$ | 85 | 81 | 5.0 | 89 | 71 | 50 | 7.0 | 57 | 41 |
| *f* | 67 | 66 | 3.8 | 73 | 60 | 49 | 1.9 | 51 | 46 |
| *h1* | 46 | 41 | 3.7 | 47 | 32 | 13 | 1.1 | 15 | 12 |
| *h2* | 31 | 29 | 2.2 | 32 | 25 | 17 | 1.2 | 18 | 15 |
| *ve-ve* | 13 | 15 | 2.3 | 18 | 10 | 20 | 3.2 | 24 | 15 |
| *c1-c1* | 41 | 40 | 3.0 | 44 | 35 | 37 | 6.4 | 42 | 26 |
| *d1-d1* | 84 | 82 | 6.0 | 90 | 70 | 69 | 3.1 | 72 | 65 |
| *e1-e1* | 35 | 35 | 4.1 | 44 | 30 | 32 | 3.2 | 36 | 28 |
| *f-f* | 80 | 74 | 12.0 | 95 | 55 | 38 | 2.1 | 41 | 36 |
| *h1-h1* | 22 | 20 | 2.3 | 24 | 15 | 10 | 1.7 | 11 | 7 |
| *ve/ve-ve* | 4.15 | 3.7 | 0.7 | 5.8 | 2.8 | 2.0 | 0.2 | 2.3 | 1.7 |
| *c1/c1-c1* | 1.8 | 1.9 | 0.2 | 2.2 | 1.6 | 1.3 | 0.3 | 1.9 | 1.0 |
| *d1/d1-d1* | 0.89 | 0.9 | 0.1 | 1.0 | 0.8 | 0.5 | 0.1 | 0.6 | 0.5 |
| *e1/e1-e1* | 2.37 | 2.3 | 0.3 | 2.8 | 1.7 | 0.7 | 0.2 | 1.0 | 0.4 |
| *f/f-f* | 0.83 | 0.9 | 0.2 | 1.2 | 0.6 | 1.3 | 0.1 | 1.4 | 1.2 |
| *h1/h1-h1* | 2.09 | 2.0 | 0.2 | 2.5 | 1.7 | 1.4 | 0.3 | 1.9 | 1.1 |

SD = Standard Deviation.

**Type material.** CAS-03 (MCN). Female holotype from Candiota, *V. vinifera*, Alfrocheiro cultivar, 5 March 2007, coll. L. Johann. 4 female paratypes from Bento Gonçalves: 1 female from *V. vinifera*, Cabernet Sauvignon cultivar, 7 November 2006, coll. L. Johann; 1 female on same host, Chardonnay cultivar, 5 March 2007, coll. L.B.

Oliveira; 1 female on same host, Merlot cultivar, 7 November 2006, coll. T.B. Horn; 1 female on same host, Pinot Noir cultivar, 3 January 2007, coll. L. Johann; 6 female and 1 male paratypes from Boqueirão do Leão: 2 females and 1 male from *V. vinifera*, Cabernet Sauvignon cultivar, 24 April 2006, coll. T.B. Horn; 1 female from *V. labrusca*, Bordeaux cultivar, 8 January 2006, coll. T.B. Horn; 1 female with same data, 16 March 2006, coll. T.B. Horn; 2 females with same data, 30 January 2007, coll. T.B. Horn; 2 female and 1 male paratypes from Dois Lajeados: 1 female from *V. labrusca*, Bordeaux cultivar, 17 April 2006, coll. T.B.Horn; 1 female and 1 male from *V. vinifera*, Cabernet Sauvignon cultivar, 15 January 2006, coll. F.Diel; 1 female and 3 male paratypes from Encruzilhada do Sul, *V. vinifera*, Pinot Noir cultivar, 13 February 2007, coll. L. Johann.

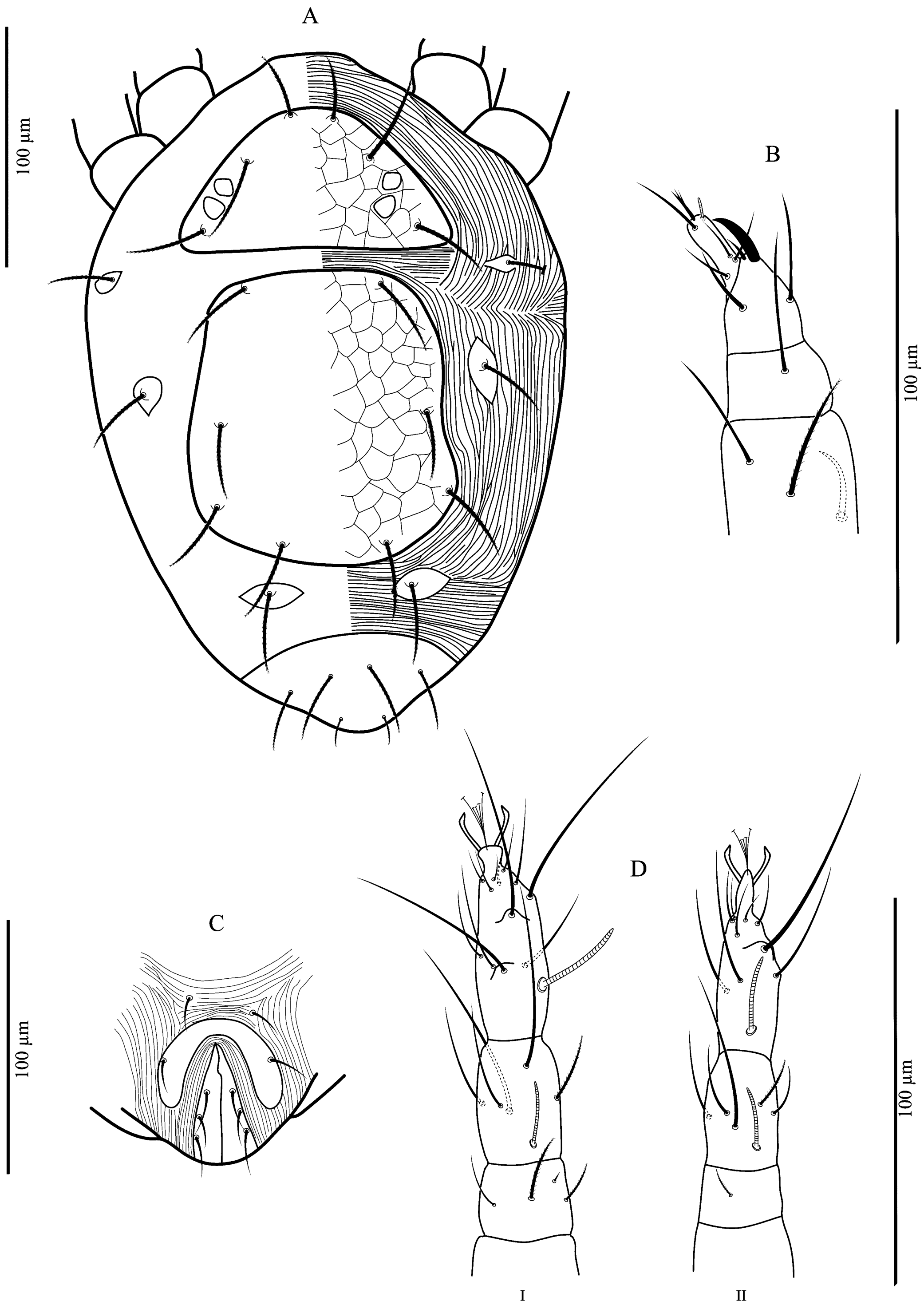


**FIGURE 6.** *Zetzellia agistzellia* Hernandes and Feres, 2005 (female). A: dorsum; B: palp; C: anogenital region ventrally; D: legs I and II in dorsal view.

**Type deposition.** Holotype and all paratypes in MCN.

**Differential diagnosis.** This species is similar to *A. brasiliensis* by *c1* setae longer than the distance between the base of *c1* and the base of *d1*. In *Agistemus riograndensis* **sp. nov.,** setae *sci, c1, d1,* and *d2* are 25% longer than those in *A. brasiliensis*; the distance between the bases of *ve* setae is shorter than in *A. brasiliensis*; and the ratio between *ve/ve-ve* is 2.8–5.8; *g1* setae exceed the bases of setae *ps3*, but do not reach the bases of *ps2*. In *A. brasiliensis, ve/ve-ve* ratio is 1.2–3.4 and *gl* setae exceed the bases of *ps2* setae. In addition, the measurements of *Agistemus riograndensis* **sp. nov.** are similar to those of *Agistemus inflatus* Meyer, 1969. *Agistemus riograndensis* **sp. nov.** bears four setae on genu I and the bases of the dorsal setae are not inflated, whereas *A. inflatus* has three setae on genu I and the bases of the dorsal setae inflated.

**Etymology**. The species name comes from the type locality – the State of Rio Grande do Sul ("riograndensis").

**Remark.** The new species was observed together with *Panonychus ulmi* (Tetranychidae) and *Calepitrimerus vitis* (Eriophyidae), and it is possibly a predator of these phytophagous.

## Genus *Zetzellia* Oudemans

### *Zetzellia agistzellia* Hernandes and Feres

(Fig. 6)

*Zetzellia agistzellia* Hernandes and Feres, 2005: 28, figs. 1–14.

**TABLE 5.** Measurements of *Zetzellia agistzellia* Hernandes and Feres, 2005.

| Character measured | Female (n=1) | Male (n=1) | Hernandes and Feres 2005 | | | | |
|---|---|---|---|---|---|---|---|
| | | | Female holotype | Female (n=7) | | Male (n=3) | |
| | | | | Mean | SD | Mean | SD |
| Body length | 370 | 350 | 367 | 371.9 | 19.9 | 282 | 26.7 |
| Idiosoma | 260 | 250 | 244 | 274.7 | 27.2 | 192 | 29.4 |
| Body width | 185 | 170 | 193 | 200.5 | 24.1 | 146 | 9.5 |
| *ve* | 23 | 21 | 26 | 25.8 | 2.4 | 22 | 0.6 |
| *sci* | 38 | 29 | 35 | 35.2 | 3.2 | 29 | 2.2 |
| *sce* | 32 | 30 | 35 | 33.0 | 3.2 | 28 | 1.3 |
| $c_1$ | 31 | 24 | 33 | 30.1 | 3.2 | 27 | 1.3 |
| $c_2$ | 27 | 25 | 33 | 30.4 | 3.3 | 26 | 1.7 |
| $d_1$ | 28 | 23 | 34 | 31.7 | 3.6 | 26 | 1.7 |
| $d_2$ | 30 | 25 | 33 | 32.7 | 2.6 | 29 | 2.2 |
| $e_1$ | 32 | 14 | 34 | 32.2 | 2.4 | 22 | 2.9 |
| $e_2$ | 30 | 23 | 33 | 32.0 | 2.8 | 26 | 2.3 |
| *f* | 32 | 28 | 35 | 34.3 | 2.8 | 29 | 1.1 |
| $h_1$ | 29 | 13 | 31 | 29.5 | 3.0 | 12 | 1.1 |
| $h_2$ | 27 | 17 | 27.8 | 27.4 | 3.4 | 16 | 0.0 |
| *ve-ve* | 16 | 16 | 17.8 | 17.4 | 1.1 | 18 | 1.3 |
| $c_1$-$c_1$ | 54 | 53 | 54.4 | 52.6 | 4.3 | 46 | 2.6 |
| $d_1$-$d_1$ | 80 | 61 | 77.7 | 81.3 | 5.8 | 59 | 2.8 |
| $e_1$-$e_1$ | 41 | 31 | 41.1 | 44.2 | 3.5 | 31 | 1.1 |
| *f-f* | 55 | 32 | 54.4 | 57.2 | 4.9 | 30 | 2.6 |
| $h_1$-$h_1$ | 16 | 12 | 14.4 | 16.0 | 1.8 | 10 | 1.3 |
| *ve/ve-ve* | 1.4 | 1.3 | 1.5 | 1.5 | 2.2 | 1.2 | 0.5 |
| *c1/c1-c1* | 0.6 | 0.5 | 0.6 | 0.6 | 0.7 | 0.6 | 0.5 |
| *d1/d1-d1* | 0.4 | 0.4 | 0.4 | 0.4 | 0.6 | 0.4 | 0.6 |
| *e1/e1-e1* | 0.8 | 0.5 | 0.8 | 0.7 | 0.7 | 0.7 | 2.6 |
| *f/f-f* | 0.6 | 0.9 | 0.7 | 0.6 | 0.6 | 1.0 | 0.4 |
| *h1/h1-h1* | 1.8 | 1.1 | 2.2 | 1.8 | 1.7 | 1.2 | 0.9 |

**Material examined.** CAS-05 (MCN). 1 female from Boqueirão do Leão, *V. vinifera*, Cabernet Sauvignon cultivar, 21 November 2006, coll. L.B. Oliveira; 1 male from Dois Lajeados, *V. labrusca*, Bordeaux cultivar, 7 November 2006, coll. T.B. Horn.

**Distribuition.** This species was reported on rubber trees, in the state of São Paulo, preying on eggs and immature stages of *Lorryia formosa* Cooreman (Tydeidae) (Hernandes & Feres 2005), *Calacarus heveae* (Eriophyidae) and *Tenuipalpus heveae* (Tenuipalpidae) (Hernandes & Feres 2006).

**Remarks.** The palptibiae of the observed specimens has one claw, one accessory slender claw and one solenidion distal on the palptarsus.

Measurements of this species are provided in Table 5.

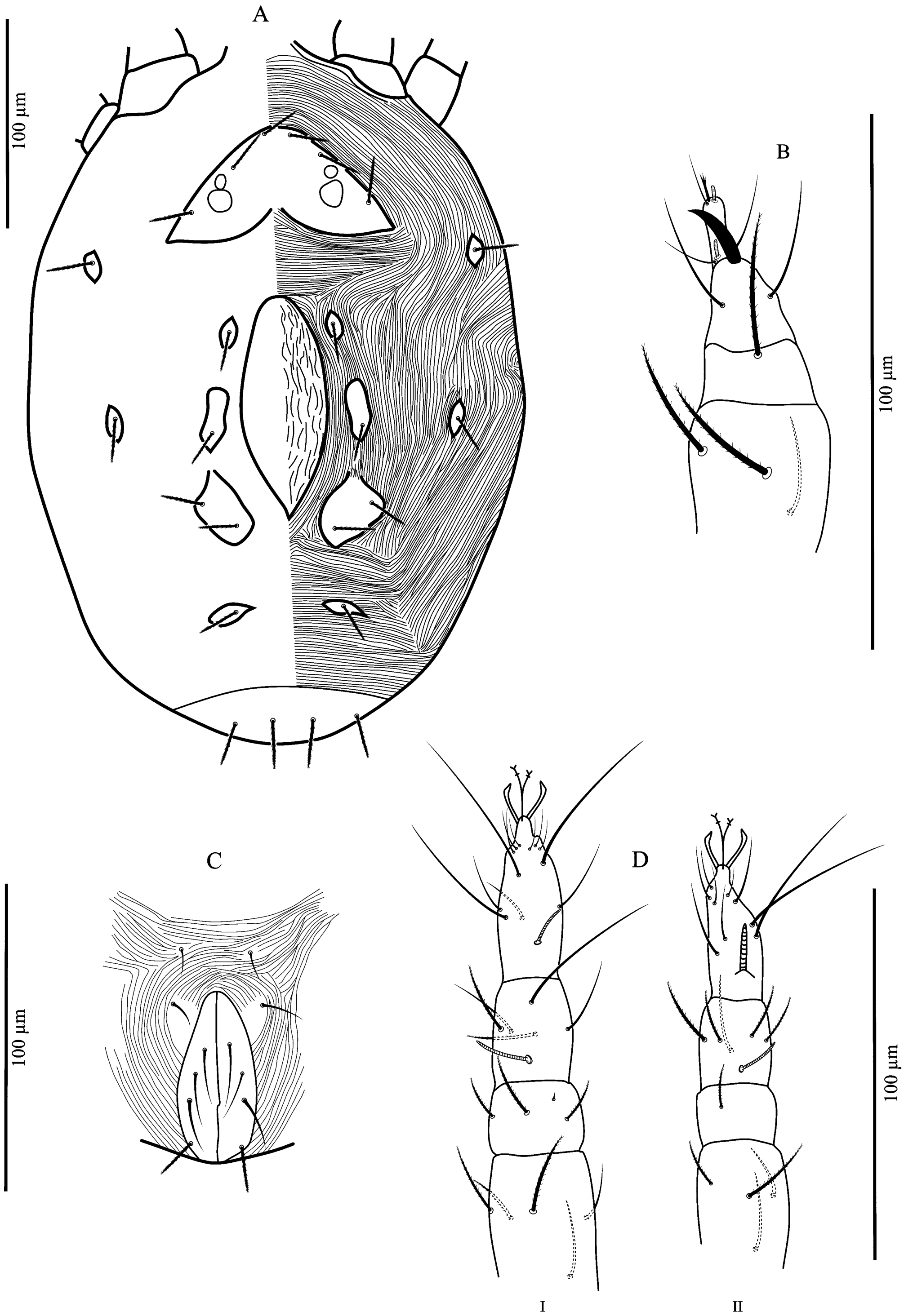


**FIGURE 7.** *Zetzellia malvinae* Matioli, Ueckermann and Oliveira 2002 (female). A: dorsum; B: palp; C: anogenital region ventrally; D: legs I and II in dorsal view.

### *Zetzellia malvinae* Matioli, Ueckermann and Oliveira
(Fig. 7)

*Zetzellia malvinae* Matioli, Ueckermann and Oliveira, 2002: 111, figs. 17–25.

**Material examined.** CAS-01 (MCN). 4 females and 1 male from Candiota: 1 female from *V. vinifera*, Merlot cultivar, 14 April 2007, coll. C.L. Klock; 1 female with same data, 14 April 2007, coll. L.B. Oliveira; 1 female with same data, 14 June 2007, coll. A. Maciel; 1 female and 1 male on same host, Alfrocheiro cultivar, 16 November 2006, coll. F. Diel.

**Distribution.** This species was described from citrus orchards in the state of São Paulo (Matioli *et al.* 2002).

Measurements of this species are provided in Table 6.

**TABLE 6.** Measurements of *Zetzellia malvinae* Matioli, Ueckermann and Oliveira, 2002.

| Character measured | Female (n= 4) | | | | Male (n=1) | Matioli *et al.* 2002 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Female holotype | Female (n=3) | | Male paratype |
| | Mean | SD | Max | Min | | | Mean | SD | |
| Body length | 415 | 47.0 | 462 | 368 | 365 | 302 | 381 | 21.9 | 340 |
| Idiosoma | 308 | 43.2 | 350 | 260 | 260 | 270 | 277 | 22.6 | 245 |
| Body width | 222 | 41.1 | 265 | 182 | 160 | 165 | 179 | 20.2 | 164 |
| *ve* | 18 | 1.0 | 19 | 17 | 16 | 19 | 18 | 1.7 | 17 |
| *sci* | 25 | 1.3 | 27 | 24 | 19 | 25 | 24 | 1.2 | 22 |
| *sce* | 24 | 1.0 | 25 | 23 | 20 | 25 | 24 | 1.7 | 22 |
| $c_1$ | 19 | 2.2 | 21 | 16 | 17 | 22 | 21 | 1.7 | 19 |
| $c_2$ | 25 | 0.5 | 26 | 25 | 22 | 25 | 25 | 0.0 | 22 |
| $d_1$ | 19 | 0.5 | 20 | 19 | 17 | 19 | 19 | 0.0 | 17 |
| $d_2$ | 22 | 0.5 | 22 | 21 | 17 | 19 | 21 | 1.7 | 20 |
| $e_1$ | 19 | 1.4 | 21 | 18 | 11 | 19 | 21 | 1.7 | 16 |
| $e_2$ | 22 | 1.3 | 23 | 20 | 17 | 19 | 21 | 1.7 | 22 |
| *f* | 22 | 1.3 | 24 | 21 | 19 | 19 | 21 | 1.7 | 22 |
| $h_1$ | 26 | 1.7 | 28 | 24 | 9 | 25 | 26 | 1.7 | 14 |
| $h_2$ | 25 | 1.3 | 27 | 24 | 21 | 25 | 25 | 3.0 | 22 |
| *ve-ve* | 16 | 1.7 | 17 | 13 | 13 | 14 | 12 | 2.7 | 17 |
| $c_1$-$c_1$ | 52 | 2.5 | 55 | 50 | 36 | 45 | 43 | 2.1 | 38 |
| $d_1$-$d_1$ | 73 | 4.2 | 78 | 70 | 50 | 67 | 68 | 1.2 | 52 |
| $e_1$-$e_1$ | 46 | 4.3 | 51 | 41 | 42 | 41 | 43 | 2.9 | 35 |
| *f-f* | 56 | 1.0 | 57 | 55 | 40 | 45 | 51 | 6.0 | 33 |
| $h_1$-$h_1$ | 20 | 1.3 | 21 | 18 | 14 | 11 | 13 | 2.5 | 11 |
| *ve/ve-ve* | 1.2 | 0.2 | 1.5 | 1.1 | 1.2 | - | 1.5 | - | 1.0 |
| *c1/c1-c1* | 0.4 | 0.0 | 0.4 | 0.3 | 0.5 | - | 0.5 | - | 0.5 |
| *d1/d1-d1* | 0.3 | 0.0 | 0.3 | 0.2 | 0.3 | - | 0.3 | - | 0.3 |
| *e1/e1-e1* | 0.4 | 0.1 | 0.5 | 0.4 | 0.3 | - | 0.5 | - | 0.5 |
| *f/f-f* | 0.4 | 0.0 | 0.4 | 0.4 | 0.5 | - | 0.4 | - | 0.7 |
| *h1/h1-h1* | 1.4 | 0.2 | 1.6 | 1.1 | 0.6 | - | 2.0 | - | 1.3 |

SD = Standard Deviation.

### *Zetzellia ampelae* Johann and Ferla sp. nov.
(Fig. 8)

**Description.** FEMALE. *Gnathosoma.* Palp coxae with 1 spiniform setae; trochanter without setae; femur with 3 long and serrate setae, one of them more robust; genu with 1 long and serrate seta; tibia with 2 setae, 1 claw and 1 accessory claw slender; tarsus with 3 setae, 1 sensillum trifurcated and 2 solenidia (Fig. 8B). Infracapitulum with 2 pairs of slender setae and 2 pairs of adoral setae distally. *Idiosoma*. Oval outline. Dorsum: Prodorsal shield with 3 pairs of serrate setae, 1 pair of eyes and 1 pair of post-ocular bodies. Hysterosomal shield smooth with 4 pairs of setae. Setae *c2, d2* and *f* inserted on small independent shields. Short podocephalic canal starting between the base of palps and leg I, extendig to the base of leg I. Venter: 3 pairs of slender setae between coxae, 1*a* at level of coxa II, 3*a* anterior to coxa III and 4*a* at level of coxa IV. Setae *ag1* inserted on small shields before genital opening and setae *ag2* inserted laterally to genital opening, situated on separate shields (Fig. 8C). Genital region with 4 pairs of setae (*g1*, *ps3*, *ps2* and *ps1*), with *ps3*, *ps2*, and *ps1* more robust and serrate. Setae *g1* reaching the base of setae *ps2*. *Leg I–IV setation* (Fig. 8D). coxae 2(1)-1-2-2; trochanters 1-1-1-1; femora 5-4-2-2; genua 4-1-0-0; tibiae 5(1)-5(1)-5(1)-5(1); tarsi 12(1)-9(1)-7(1)-7.

**Male.** Unknown.

Measurements of this species are provided in Table 7.

**TABLE 7.** Measurements of *Zetzellia ampelae* Johann & Ferla **sp. nov.** (female)

| Character measured | Female holotype | Female (n=3) | | | |
|---|---|---|---|---|---|
| | | Mean | SD | Max | Min |
| Body length | 485 | 479 | 5.2 | 485 | 475 |
| Body width | 230 | 302 | 5.2 | 308 | 298 |
| Idiosoma | 360 | 362 | 1.4 | 362 | 360 |
| *ve* | 31 | 30 | 1.0 | 31 | 29 |
| *sci* | 37 | 39 | 2.5 | 42 | 37 |
| *sce* | 35 | 34 | 1.2 | 35 | 33 |
| $c_1$ | 25 | 24 | 0.6 | 25 | 24 |
| $c_2$ | 30 | 31 | 1.2 | 32 | 30 |
| $d_1$ | 25 | 25 | 0.6 | 25 | 24 |
| $d_2$ | 24 | 25 | 0.6 | 25 | 24 |
| $e_1$ | 27 | 26 | 0.6 | 27 | 26 |
| $e_2$ | 26 | 27 | 1.2 | 28 | 26 |
| *f* | 28 | 29 | 1.2 | 30 | 28 |
| $h_1$ | 31 | 31 | 0.0 | 31 | 31 |
| $h_2$ | 28 | 29 | 1.5 | 31 | 28 |
| *ve-ve* | 30 | 31 | 3.6 | 35 | 28 |
| $c_1$-$c_1$ | 61 | 61 | 1.5 | 63 | 60 |
| $d_1$-$d_1$ | 84 | 87 | 3.1 | 90 | 84 |
| $e_1$-$e_1$ | 46 | 57 | 12.7 | 71 | 46 |
| *f-f* | 77 | 79 | 4.7 | 84 | 75 |
| $h_1$-$h_1$ | 15 | 15 | 0.0 | 15 | 15 |
| *ve/ve-ve* | 0.7 | 0.6 | 0.0 | 0.7 | 0.6 |
| *c1/c1-c1* | 0.8 | 0.8 | 0.1 | 0.8 | 0.7 |
| *d1/d1-d1* | 0.4 | 0.4 | 0.0 | 0.4 | 0.4 |
| *e1/e1-e1* | 1.1 | 1.1 | 0.1 | 1.1 | 1.1 |
| *f/f-f* | 0.5 | 0.5 | 0.1 | 0.5 | 0.5 |
| *h1/h1-h1* | 2.1 | 1.9 | 0.2 | 2.1 | 1.8 |

SD = Standard Deviation.

**Type material examined.** CAS-12 (MCN). Female holotype and 2 female paratypes from Boqueirão do Leão: holotype from *V. labrusca*, Bordeaux cultivar, 08 January 2007, coll. F. Diel; 1 female paratype with same data, 21 November 2006, coll. T.B. Horn; 1 female paratype with same data, 11 December 2006, coll. J.F. Silva.

**Type deposition.** Holotype and all paratypes in MCN.

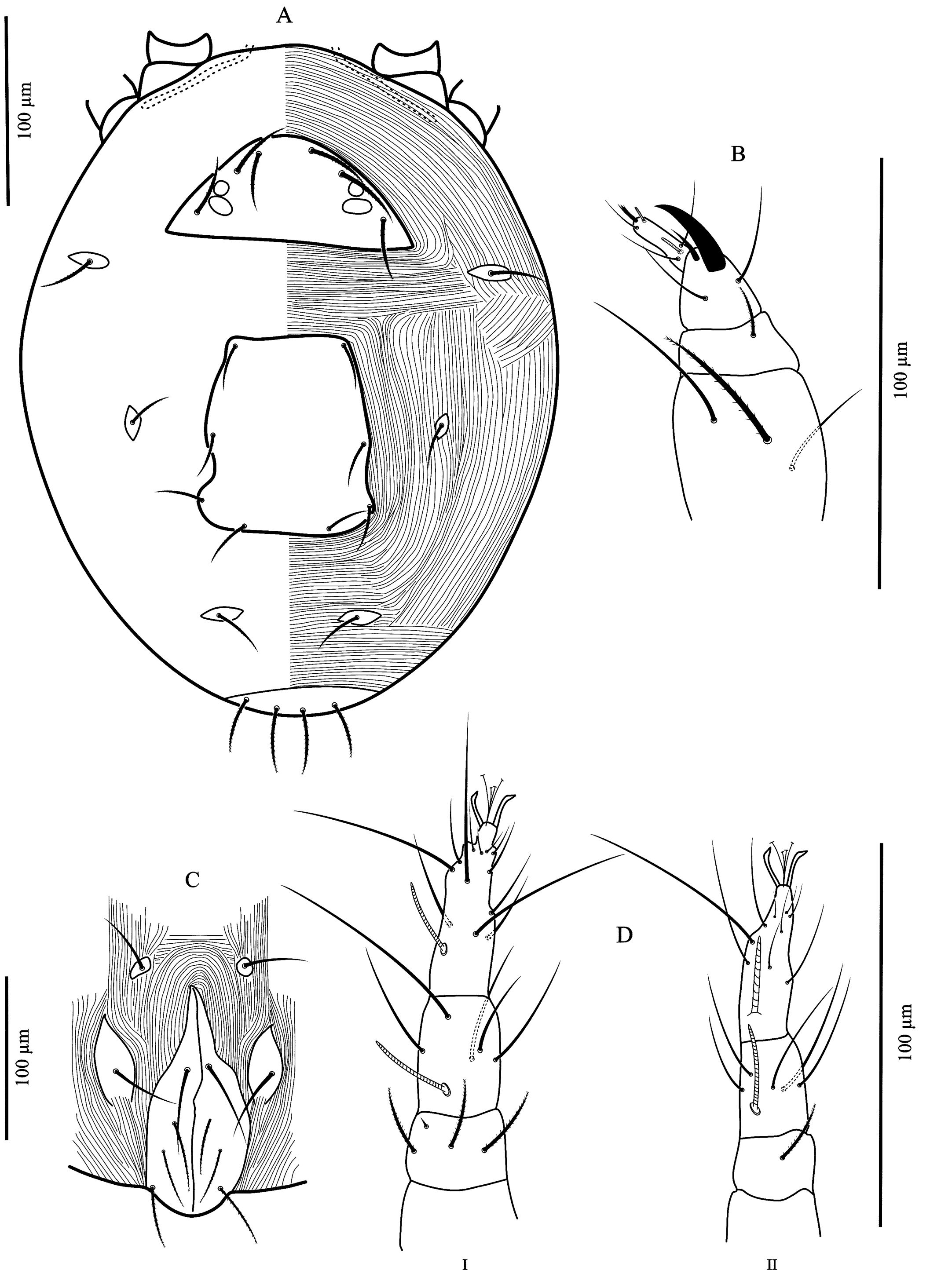


**FIGURE 8.** *Zetzellia ampelae* Johann and Ferla **sp. nov.** (female). A: dorsum; B: palp; C: anogenital region ventrally; D: legs I and II in dorsal view.

**Differential diagnosis.** The new species is similar to *Zetzellia quasagistemas* Hernandes and Feres, 2005 regarding *c1* setae inserted on the hysterosomal shield. *Zetzellia ampelae* **sp. nov.** has *ag2* setae located on the individual shields lateral to the genital opening and two setae and two claws on the palptibiae, *ve, sci* and *sce* setae are 30% longer than those in *Z. quasagistemas* (Fig. 8A). In *Z. quasagistemas, ag2* setae are located on the horseshoe-shaped shield that surrounds the genital opening and it has three setae, in addition to one claw on the palptibiae.

**Etymology**. The species name is derived from the Greek word *Ampelos* meaning "vine".

**Remark.** It is not possible to associate the new species with phytophagous mites.

## Key to stigmaeid species (females) associated to vineyard agroecosystem in the state of Rio Grande do Sul, Brazil

1. Opisthosomal setae *d1* and *d2* situated on same sclerite (Fig. 2A) ........ *Agistemus* ... 2
- Opisthosomal setae *d1* and *d2* situated on different sclerites (Fig. 6A) ........ *Zetzellia* ... 5
2. Seta *c1* shorter than distance between seta *c1* and *d1* bases (Fig. 3A) ........ 3
- Seta *c1* subequal or longer than distance between seta *c1* and *d1* bases (Fig. 2A) ........ 4
3. Prodorsal and hysterosomal shields smooth (Fig. 3A) ........ *Agistemus floridanus*
- Prodorsal and hysterosomal shields reticulated (Fig. 4A) ........ *Agistemus mendozensis*
4. Ratios of *ve/ve-ve* 2.5, *e1/e1-e1* 1.9, and *h1/h1-h1* 2.4 ........ *Agistemus brasiliensis*
- Ratios of *ve/ve-ve* 3.7, *e1/e1-e1*: 2.3, and *h1/h1-h1*: 2.0 ........ *Agistemus riograndensis* **sp. nov.**
5. Hysterosomal shield without setae (Fig. 7A); dorsal setae inserted on small lateral shields ........ *Zetzellia malvinae*
- Hysterosomal shield with 4 pairs of setae (Fig. 8A) ........ 6
6. Prodorsal and hysterosomal shield smooth (Fig. 8A) ........ *Zetzellia ampelae* **sp. nov.**
- Prodorsal and hysterosomal shield reticulated (Fig. 6A) ........ *Zetzellia agistzellia*

## Acknowledgements

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## ARTIGO 3

Johann L., Ferla N.J., Carvalho G.S. Biology of *Panonychus ulmi* (Acari: Tetranychidae) on two European grape varieties cultivated in the state of Rio Grande do Sul, Brazil.

A ser submetido para o periódico "Experimental and Applied Acarology"

**Biology of *Panonychus ulmi* (Acari: Tetranychidae) on two European grape varieties cultivated in the state of Rio Grande do Sul, Brazil.**

LIANA JOHANN[1,2], NOELI JUAREZ FERLA[2]& GERVÁSIO SILVA CARVALHO[1]

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**Abstract:** The biology of *Panonychus ulmi* feeding on apple tree leaves has been widely studied, but nothing is known about it on grapevine leaves. Recently, the species was considered of economic importance for vineyards in the Serra Gaúcha in the state of Rio Grande do Sul, Brazil. This study aims to learn about the biology of *P. ulmi* on vine leaves in the laboratory. The study was carried out at 25±3 ºC, with a 14h photoperiod and 70±5% relative humidity. The study was initiated with a total of 30 eggs on Cabernet Sauvignon (CS) cultivar and 30 eggs on Pinot Noir (PN) cultivar. The average duration of eggs was 5.99 days for CS and 5.83 days for PN, while 0.82 and 1.10 for larva, and 11.71 and 11.66 for egg-adult period, respectively. The Preoviposition period was 2.25 days for CS and 1.11 for PN; oviposition lasted 6.54 days for CS and 3.31 for PN; postoviposition lasted one day for CS and 0.56 day for PN. Female adult longevity was about 9.62 days for CS and 4.77 days for PN. The life table parameters on CS were $R_0$ = 7.88, T = 17.78 days, TD = 5.97days, $r_m$= 0.12, $\lambda$ = 1.12; on PN were $R_0$ = 5.20, T = 16.45 days, TD = 6.91 days, $r_m$= 0.10, and $\lambda$ = 1.11.

**Key words:** European red mite, phytophagous, *Vitis vinifera*, Cabernet Sauvignon, Pinot Noir.

## ARTIGO 4

Johann L., Ferla N.J., Carvalho G.S. Comparative biology of *Agistemus floridanus* and *Neoseiulus californicus* feeding on *Panonychus ulmi* from grapevines cultivated in Rio Grande do Sul, Brazil.

A ser submetido para o periódico “Experimental and Applied Acarology”

# **Comparative biology of *Agistemus floridanus* and *Neoseiulus californicus* feeding on *Panonychus ulmi* from grapevines cultivated in Rio Grande do Sul, Brazil**

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**Abstract:** It is known that Phytoseiidae are effective predators of Tetranychidae and that Stigmaeidae are strongly associated with Eriophyidae in many crops. In vineyards in the state of Rio Grande do Sul, Brazil, a relation between *Neoseiulus californicus* (Phytoseiidae) and *Panonychus ulmi* (Tetranychidae), and between *Agistemus floridanus* (Stigmaeidae) and *P. ulmi* has been observed. We seeked to understand if the two predators develop favorably when fed with *P. ulmi*. We prepared 60 arenas and, in each one, placed ten *P. ulmi* at different developmental stages to be used as food on vine leaf discs. One day after, we added a predator in each arena, using a total of 30 females of *N. californicus* and 30 females of *A. floridanus*, then waited until their oviposition, and finally removed the female predators from the arenas. We observed their eggs and their immature developmental stages three times a day, and their adult phase once a day. Sex ratio was similar for the two species (0.79 for *N. californicus*, 0.78 for *A. floridanus*), but *N. californicus* presented shorter egg-adult longevity (5.26±0.60 days for females and 5.50±0.34 for males) and adult longevity (9.38±7.22 days), while *A. floridanus* presented longer oviposition period (10.19±6.17 days) and a bigger number of eggs (28.22±18.81). The life table parameters for *N. californicus* and *A. floridanus* were: $R_0$ of 10.40±3.37 and 16.64±3.00; T of 12.49±2.36 and 18.76±0.49; TD of 3.78±0.49 and 4.67±0.32; $r_m$ of 0.19±0.02 and 0.15±0.01; $\lambda$ of 1.20±0.03 and 1.16±0.01, respectively.

**Key words:** biological control, natural enemy, agroecosystem, Tetranychidae, Phytoseiidae, Stigmaeidae

## ARTIGO 5

Johann L., Toldi M., Ferla N.J., Carvalho G.S. Behavior of *Agistemus floridanus* and *Neoseiulus californicus* in response to the presence of *Panonychus ulmi* and to the odor of conspecific and heterospecific predators.

A ser submetido para o periódico "International Journal of Acarology"

# Behavior of *Agistemus floridanus* and *Neoseiulus californicus* in response to the presence of *Panonychus ulmi* and to the odor of conspecific and heterospecific predators

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**Abstract:** Considerable populations of *Neoseiulus californicus* (Phytoseiidae) and *Agistemus floridanus* (Stigmaeidae) co-occurs with *Panonychus ulmi* (Tetranychidae) population peaks in vineyards in the state of Rio Grande do Sul, Brazil. The present study investigated: a) the two predators' feeding preference for *P. ulmi* eggs, immature individuals or adults; b) the response to the presence of phytophagous mites; c) and the response from odor of conspecific and heterospecific mites, in order to understand the results obtained with the release of *N. californicus* in the field. The study was carried out in the Acarology Laboratory at Univates and at a vineyard in the municipality of Santa Teresa, in Rio Grande do Sul, Brazil. The field release test revealed a reduction in the number of eggs and mobile forms of *P. ulmi*, an increase of *Agistemus* sp populations and stability in the number of *N. californicus* individuals in all the plants on which *N. californicus* was released, including the control plant. Both predators preferred to feed on *P. ulmi* eggs, responded positively to the presence of the phytophagous mite and recognized the odor of heterospecific predators.

**Key words:** biological control, predator avoidance, predator diet, Phytoseiidae, Stigmaeidae, vineyards

## ARTIGO 6

Johann L., Silva G.L. da, Ferla N.J., Carvalho G.S. Pictorial key for the identification of mites on grapevine in Rio Grande do Sul state, Brazil.

A ser submetido para o periódico “Zootaxa”

**Pictorial key for the identification of mites on grapevine in Rio Grande do Sul state, Brazil**

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**Abstract:** A key for the identification of mites on grapevine in Rio Grande do Sul, Brazil, is presented, with illustrations of representatives characters. The key is chiefly based on the external morphology of adults.

**Key words:** grapevine, mites, phytophagous, predator.

# CONCLUSÕES GERAIS

- A diversidade e a abundância de ácaros em agroecossistemas de videiras (*Vitis vinifera* L.) são distintas entre Bento Gonçalves e Candiota, Estado do Rio Grande do Sul, Brasil. As variedades Cabernet Sauvignon e Pinot Noir não interferem na riqueza de espécies, no entanto a abundância de ácaros é influenciada pela variedade. Pinot Noir é mais favorável para *Calepitrimerus vitis* (Nalepa), *Panonychus ulmi* (Koch) e *Tarsonemu*s spp.

- Sete espécies de Stigmaeidae estão presentes na cultura da videira: *Agistemus brasiliensis* Matioli et al., *Agistemus floridanus* Gonzales, *Agistemus mendozensis* Simons, *Agistemus riograndensis* Johann e Ferla, *Zetzellia agistzellia* Hernandes e Feres, *Zetzellia malvinae* Matioli et al. e *Zetzellia ampelae* Johann e Ferla.

- As variedades Cabernet Sauvignon e Pinot Noir são favoráveis ao desenvolvimento de *P. ulmi*. Cabernet Sauvignon apresentou maiores viabilidade e longevidade, e um crescimento populacional mais acelerado.

- *Neoseiulus californicus* (McGregor) e *A. floridanus* completam o ciclo de vida e se reproduzem quando alimentados com *P. ulmi*, apresentando potencial para o controle biológico deste ácaro fitófago.

- Os predadores *A. floridanus* e *N. californicus* alimentam-se preferencialmente de ovos de *P. ulmi*, e respondem positivamente a presença deste fitófago e reconhecem a presença de odores de predadores heteroespecíficos.

- A chave pictórica representa uma ferramenta rápida e adequada para identificação dos ácaros fitófagos e predadores ocorrentes em videira no Estado do Rio Grande do Sul, Brasil.

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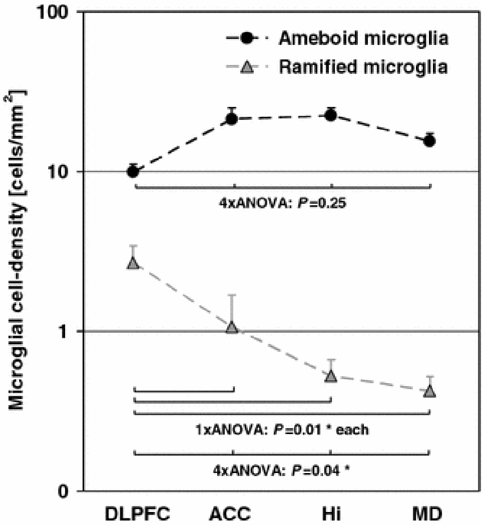
For the best quality final product, it is highly recommended that you submit all of your artwork – photographs, line drawings, etc. – in an electronic format. Your art will then be produced to the highest standards with the greatest accuracy to detail. The published work will directly reflect the quality of the artwork provided.

*Electronic Figure Submission*

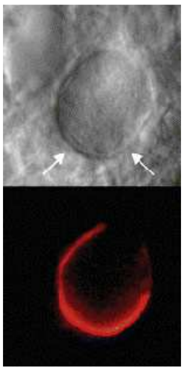
- Supply all figures electronically.
- Indicate what graphics program was used to create the artwork.
- For vector graphics, the preferred format is EPS; for halftones, please use TIFF format. MSOffice files are also acceptable.
- Vector graphics containing fonts must have the fonts embedded in the files.
- Name your figure files with "Fig" and the figure number, e.g., Fig1.eps.

*Line Art*




- Definition: Black and white graphic with no shading.
- Do not use faint lines and/or lettering and check that all lines and lettering within the figures are legible at final size.
- All lines should be at least 0.1 mm (0.3 pt) wide.
- Scanned line drawings and line drawings in bitmap format should have a minimum resolution of 1200 dpi.
- Vector graphics containing fonts must have the fonts embedded in the files.

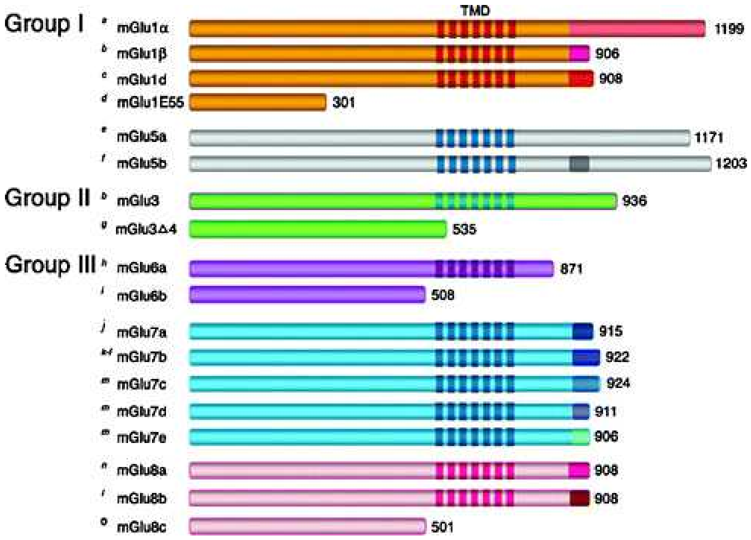
*Halftone Art*



- Definition: Photographs, drawings, or paintings with fine shading, etc.

- If any magnification is used in the photographs, indicate this by using scale bars within the figures themselves.
- Halftones should have a minimum resolution of 300 dpi.

*Combination Art*




- Definition: a combination of halftone and line art, e.g., halftones containing line drawing, extensive lettering, color diagrams, etc.
- Combination artwork should have a minimum resolution of 600 dpi.

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- Color art is free of charge for online publication.
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- If the figures will be printed in black and white, do not refer to color in the captions.
- Color illustrations should be submitted as RGB (8 bits per channel).

*Figure Lettering*

- To add lettering, it is best to use Helvetica or Arial (sans serif fonts).
- Keep lettering consistently sized throughout your final-sized artwork, usually about 2–3 mm (8–12 pt).
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- Do not include titles or captions within your illustrations.

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- All figures are to be numbered using Arabic numerals.
- Figures should always be cited in text in consecutive numerical order.
- Figure parts should be denoted by lowercase letters (a, b, c, etc.).
- If an appendix appears in your article and it contains one or more figures, continue the consecutive numbering of the main text. Do not number the appendix figures,
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- Each figure should have a concise caption describing accurately what the figure depicts. Include the captions in the text file of the manuscript, not in the figure file.
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## *Capítulo 5 – International Journal of Acarology*

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- Section headings should be concise.
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