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SHORT COMMUNICATION

Diversity of mites (Arachnida: Acari) associated with Olive trees in Southern Brazil

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Abstract - The study aimed to identify the mite communities present on olive trees (*Olea europaea* L.) of three varieties (Arbequina, Arbosana, and Koroneiki) in Barra do Ribeiro, Rio Grande do Sul, Brazil. Samples were collected seasonally in 2016 and 2017. During each sampling event, four plants of each variety were randomly selected, and two branches (approximately 20 cm in length) were collected from each plant. A total of 5,164 mites were identified, representing 15 species/morphospecies from 10 families (Acaridae, Cheyletidae, Eriophyidae, Eupalopsellidae, Phytoseiidae, Tarsonemidae, Tetranychidae, Tydeidae, Siteroptidae, and Stigmaeidae). *Tydeus linarocatus* (Schiess), a predatory/fungivorous mite, was the most abundant species, accounting for 83.2% of all mites collected and being classified as a constant and eudominant species.

Keywords: Acari. Mite diversity. Olive growing. Phytophagous mites. Predatory mites.

Diversidade de ácaros (Arachnida: Acari) associados às oliveiras no sul do Brasil

Resumo – Este estudo teve como objetivo identificar as comunidades de ácaros presentes em oliveiras (*Olea europaea* L.) de três variedades (Arbequina, Arbosana e Koroneiki) em Barra do Ribeiro, Rio Grande do Sul, Brasil. As amostras foram coletadas sazonalmente em 2016 e 2017. Em cada evento amostral, foram selecionadas aleatoriamente quatro plantas de cada variedade, coletando-se dois ramos (aproximadamente 20 cm de comprimento) de cada planta. Foram identificados 5.164 ácaros pertencentes a 15 espécies/morfoespécies de 10 famílias (Acaridae, Cheyletidae, Eriophyidae, Eupalopsellidae, Phytoseiidae, Tarsonemidae, Tetranychidae, Tydeidae, Siteroptidae e Stigmaeidae). Tydeus linarocatus (Schiess), ácaro predador/fungívoro, foi a espécie mais abundante, representando 83,2% de todos os ácaros coletados, sendo considerada uma espécie constante e eudominante.

Palavras-chave: Acari. Ácaros fitófagos. Ácaros predadores. Diversidade de ácaros. Olivicultura.

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The number of olive groves in Rio Grande do Sul has increase in recent years, mainly due to the favorable climatic conditions of the southern Brazil, where this state is located. Rio Grande do Sul has the largest area dedicated to olive cultivation in the country, with 59,865 hectares spread across 110 municipalities (Oliveira *et al*., 2022). The economic value of products from this crop has increased the interest of growers in its cultivation, encouraging the replacement of imported olives and olive oil with locally produced alternatives. Some varieties, such as Arbequina, Arbosana, and Koroneiki, have lower chilling requirements, making them better suited to the region’s climate conditions (Loussert; Brousse, 1980; Bertoncini, 2012).

In Brazil, only *Oxycenus maxwelli* (Keifer) (Acari, Eriophyidae) has been reported as an olive pest, occurring in Rio Grande do Sul and Minas Gerais (another Brazilian state where olive trees are cultivated), causing leaf silvering and curling (Reis; Oliveira; Navia, 2011; Ricalde *et al*., 2012). Another species of the same family, *Aceria oleae* (Nalepa, 1900), is listed as an absent quarantine pest in the country. This highly harmful species has been reported in neighboring Argentina, where it has caused serious damage (Brazil, 2022).

Surveys of phytophagous and predatory mites can be helpful in conducting ecological analyses in agroecosystems to prevent economic losses. The aim of this study was to evaluate the mite communities on olive plants of three varieties in Rio Grande do Sul, where such studies have not been conducted before.

The study was carried out in olive groves of the varieties Arbequina, Arbosana, and Koroneiki, in the municipality of Barra do Ribeiro, state of Rio Grande do Sul (30°30'54.95"S, 51°30'20.84"W). The orchard was established in May 2011, covering an area of 9.8 hectares, with trees planted at a spacing of 7 meters between rows and 5 meters between plants within rows. The orchard contains plants of all three cultivars, arranged in alternating rows, with each row containing a single cultivar in an interspersed pattern throughout the area.

Conventional management practices were followed throughout the study. Harvesting occurred between February and March. Pruning was performed in May, followed by the application of copper-based fungicide (Cuprogarb, 300 g/100 L) in May and June. During the months in which nutrients were applied, mechanized treatments—such as mowing and soil scarification—were conducted to facilitate the incorporation of nutrients into the soil.

Samples were collected quarterly over two years (2016 and 2017), resulting in a total of eight sampling events. A total of 192 branches were sampled, with 64 branches collected, with 64 branches sampled from each plant variety. At each sampling date, four plants of each variety were randomly selected, and two branches (approximately 20 cm in length) were taken from each plant. The branches were placed in airtight plastic bags, packed in a thermal container, and transported to the laboratory, where they were kept refrigerated until sorting was completed.

Branches and leaves were examined under a stereomicroscope, and mites were removed using a fine paintbrush (size 00), counted, and mounted in Hoyer’s medium (Moraes; Flechtmann, 2008). The slides were dried at 50 °C for 7-10 days to fix the specimens and then stored for later identification using a phase-contrast microscope and dichotomous keys available in the literature (Lindquist, 1986; Denmark; Muma, 1989; Zhang, 2003; Chant; McMurtry, 2003; Chant; McMurtry, 2007; Silva *et al*., 2014; Fan; Flechtmann; Moraes, 2016). Voucher specimens were deposited in the Didactic Collection of the Agricultural Acarology

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Laboratory of the Universidade Federal do Rio Grande do Sul, located at Porto Alegre on the Vale Campus, Faculty of Agronomy.

Following specimen identification, abundance of the mite community was determined in terms of constancy (C) and dominance (D). Constancy was calculated based on the number of samples containing the species (NA) as a function of the total number of samples (192). According to Bodenheimer (1955), the species were classified as constant (Ct) – present in more than 50 % of the collections; accessory (Ab) – present in 25 % to 50 % of collections; and accidental (Ad) – present in less than 25 % of collections. The dominance of species (D) was determined using the equation: D % = (i / t) × 100, where *i* represents the total individuals of a species, and *t* represents the total individuals collected. According to Friebe (1983), the species were categorized into dominance levels: eudominant (≥ 10 %), dominant (5–< 10 %), subdominant (2 –< 5%), occasional (1 – <2%), and rare (D <1 %). To further characterize the mite community structure in olive groves, species abundance distribution was analyzed using graphical representations in decreasing order of abundance, generated with the BioDiversity Professional Version 2 software (McAleece *et al*., 1997). This approach allowed visualization of dominant, intermediate, and rare species distributions, as described by Magurran (2011).

Mite diversity was measured through rarefaction, species richness indices (Chao 1), abundance indices (Shannon-Wiener and Simpson), and similarity indices (Bray-Curtis and Jaccard) (Magurran, 2011; Krebs, 1989; Moreno, 2001). These indices were calculated with the aid of PAST Version 3.16 (Hammer; Harper; Ryan, 2017) and the BioDiversity Professional Version 2 program (McAleece *et al*., 1997). A Venn diagram was used to identify unique and shared species among the three varieties. Mite fauna were classified into guilds according to their feeding habits (Krantz; Walter, 2009; McMurtry; Moraes; Sourassou, 2013).

Following the diversity analyses, a total of 5,164 adult mites were collected across all samples. Although immature mites were also recovered, they were excluded from the analyses due to difficulties in accurate identification. The mite specimens represented 15 species or morphospecies distributed among 10 families: Acaridae, Cheyletidae, Eriophyidae, Eupalopsellidae, Phytoseiidae, Siteroptidae, Stigmaeidae, Tarsonemidae, Tetranychidae, and Tydeidae (Table 1). The high number of collected mites—primarily from non-pest groups—suggests a relatively low impact of current cultivation practices on the mite community, highlighting the ecological suitability of the study sites for faunal assessments.

Among the identified species, *Tydeus linarocatus* (Schiess) (Tydeidae) was the most abundant, representing 83.2 % of all collected mites and classified as a constant species. This was followed by *Daidalotarsonemus* sp. (Tarsonemidae) and *Tyrophagus putrescentiae* (Schrank) (Acaridae), both categorized as accessory species. In terms of dominance, *T. linarocatus* and *Daidalotarsonemus* sp. were considered eudominant, whereas *T. putrescentiae* was classified as subdominant. Species such as *Cheletogenes ornatus* (Canestrini & Fanzago) and *O. maxwelli*, each with 12 individuals, were regarded as accidental and rare within the sampled community.

Previous mite surveys conducted on olive trees in South America have identified *O. maxwelli* as the most abundant species (Quiroz; Larraín, 2003; Leiva *et al*., 2013; Scheunemann; Bernardi; Nava, 2020). However, the results of these studies differ from those of the present study, in which *O. maxwelli* was found in relatively low numbers compared to other mite species.

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Table 1: Mite species collected from three varieties of *Olea europaea* in samples taken during 2016 and 2017 at Barra do Ribeiro, Rio Grande do Sul, Brazil (N = 192 samples).

Taxons	**NS**	**C**	**NI**	**%**	**D**
FUNGIVORES					
Tarsonemidae					
Daidalotarsonemus sp.	85	Ace	654	12,66	Eud
PHYTOPHAGOUS					
Eriophyidae					
Oxycenus maxwelli	1	Aci	12	0,23	Rr
Tarsonemidae					
Unidentified	1	Aci	2	0,04	Rr
Tetranychidae					
Tetranychus urticae	1	Aci	1	0,02	Rr
Siteroptidae					
Unidentified	2	Aci	4	0,08	Rr
PREDATORS					
Cheyletidae					
Cheletogenes ornatus	7	Aci	12	0,23	Rr
Cheletomimus berlesei	1	Aci	2	0,04	Rr
Eupalopsellidae					
Exothorhis sp.	2	Aci	4	0,08	Rr
Phytoseiidae					
Amblyseius sp.	3	Aci	3	0,06	Rr
Neoseiulus fallacis	1	Aci	1	0,02	Rr
Neoseiulus sp.	2	Aci	2	0,04	Rr
Stigmaeidae					
Eryngiopus sp.	1	Aci	2	0,04	Rr
Primagistemus sp.	2	Aci	2	0,04	Rr
PREDATORS/FUNGIVORES					
Tydeidae					
Tydeus linarocatus	173	Co	4295	83,17	Eud
SAPROPHAGOUS					
Acaridae					
Tyrophagus putrescentiae	42	Ace	168	3,25	Sub
Total = 15	**192**		**5164**	**100,0**	

NS – number of samples; NI – number of individuals; C – constancy; D – dominance; Co-constant; Ace – accessory; Aci – accidental; Eud – eudominant; Sub – subdominant; Rr – rare.

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Table 2: Diversity of mite species collected from three varieties of *Olea europaea* in samples taken during 2016 and 2017 at Barra do Ribeiro, Rio Grande do Sul, Brazil.

Diversity	**Arbequina**	**Arbosana**	**Koroneiki**
Species	9a	11a	6a
Individuals	2020a	1586a	1558a
Shannon (H')	0,4797a	0,7211a	0,5424a
Simpson (1-D)	0,2402a	0,3549a	0,2871a

* Same letters on the same line do not differ statistically according to Bootstrap (p<0.005) with 2000 replications.

In Mendoza, Argentina, Dagatti *et al*. (2010) reported *O. maxwelli* on plants of the Arauco variety, where the mite overwinters on vegetative leaves and buds, migrating in late September (when flowering begins) to flower buds and fruits, reaching peak densities by December. Ricalde *et al*. (2012) reported *O. maxwelli* on several olive varieties, including Arbequina, Arbosana, and Koroneiki, in municipalities across the state of Rio Grande do Sul, including Bagé, Candiota, Pelotas, Rio Grande, and Santana do Livramento, with densities exceeding 20 mites per leaf. In contrast, the present study recorded only 12 specimens of *O. maxwelli*, all exclusively in January.

Oxycenus maxwelli and an unidentified *Tetranychus* species were the only phytophagous species collected in this study, as well as in surveys conducted in Asia and Europe (Tzanakakis, 2003; Barranco; Fernández-Escobar; Rallo, 2008; Elmoghazy, 2014; Ersin *et al*., 2020). Additionally, the collection of a single specimen of *Tetranychus urticae* in the present study suggests a spurious occurrence, likely due to the specimen being found by chance on olive while dispersing between its actual hosts, which may include associated plant species.

Most species collected in the present study were considered rare, as confirmed by the abundance distribution curve, which follows the Geometric Series model (k = 0.3808, p = 0), indicating an inadequate environment for the mite species or a very early stage of ecological succession (Magurran, 2011). The family Phytoseiidae was the most diverse; although, only three species of this family were identified. These data support the conclusion that the olive groves under study represent a nascent mite community. The steep slope of the curve is evident, indicating lower overall diversity and greater dominance by one or two species. Fortunately, in this case, these dominant species are predators and fungivores, which do not cause damage to the plants.

The number of mite species found on plants of each variety was as follows: Arbosana – 11, Arbequina – nine, and Koroneiki – six. There was no statistical difference in diversity indices between varieties, according to the Bootstrap Test (Table 2). However, this result could be attributed to the movement of mites between varieties, as the rows of different varieties were interspersed.

In Tunisia, Chatti *et al*. (2017) reported 19 species and morpho-species belonging to four families (Eriophyidae, Phytoseiidae, Tenuipalpidae, and Tetranychidae) from a sample of 3600 branches collected across 21 olive groves.

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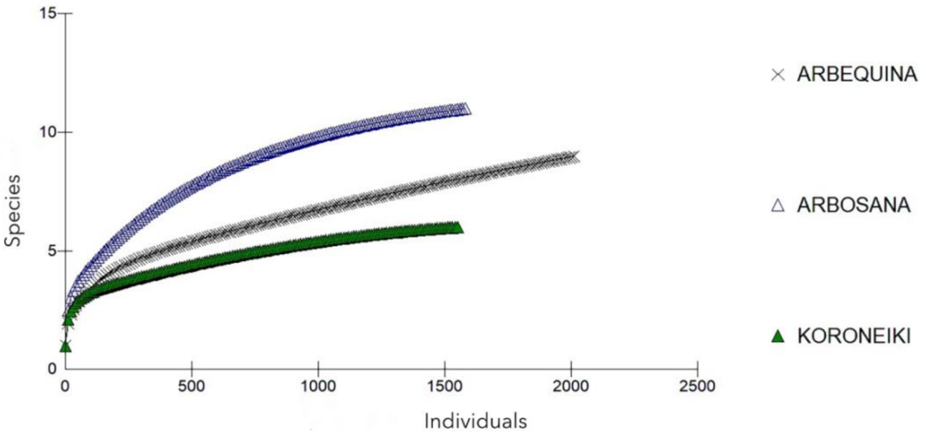

Figure 1: Rarefaction curves of mite species collected from three varieties of *Olea europaea* during 2016 and 2017 at Barra do Ribeiro, Rio Grande do Sul, Brazil.

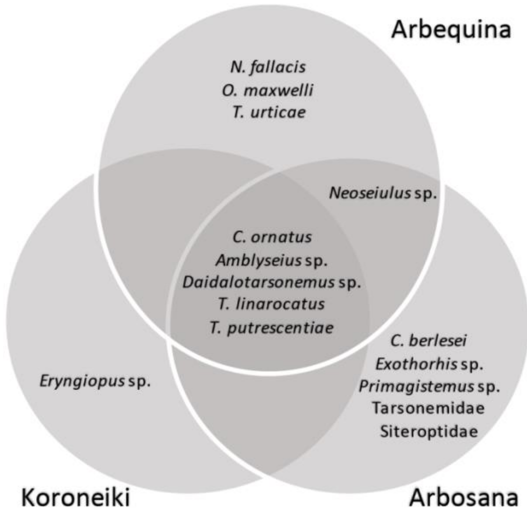

Figure 2: Venn diagram showing exclusive and shared mite species among the three varieties of *Olea europaea* in samples collected during 2016 and 2017 at Barra do Ribeiro, Rio Grande do Sul, Brazil.

The number of species identified in the present study was slightly lower (15), although this was based on a much smaller sample size (192 branches). Incomplete sampling, particularly in the 'Arbosana' and 'Koroneiki' varieties (Fig.1), suggests that slightly higher species diversity could be expected at the study sites.

According to the estimate of species richness using the Chao 1 index, which accounts for rare species, the 'Arbosana' and 'Arbequina' varieties showed an upward curve with results of 12 and 11 species, respectively, while 'Koroneiki' reached an asymptote at six species. There were no singletons (species represented by a single specimen) in the 'Koroneiki' samples, meaning that all sampled species had two or more specimens, suggesting a complete inventory for this variety according to the selected estimator. In contrast, the curve for 'Arbequina' indicated room for additional species to be identified in future samplings (Fig. 1).

The Bray-Curtis similarity index showed a 95 % similarity between the 'Arbosana' and 'Koroneiki' varieties, reflecting a high degree of similarity in the abundance of species between the two. The 'Arbequina' variety was 86 % similar to the other two. Using the Jaccard index, which considers qualitative similarity, 'Arbequina' and 'Koroneiki' had a 50 % similarity, while 'Arbosana' was 34 % similar to the other two varieties. The Jaccard index was influenced by the species richness of the communities, with 'Arbequina' having nine species, 'Koroneiki' six, and 'Arbosana' 11.

The Venn Diagram (Fig. 2) illustrates the shared and exclusive mite species among the olive varieties studied. *Tydeus linarocatus*, *Daidalotarsonemus* sp., *T. putrescentiae*, *C. ornatus*, and *Amblyseius* sp. were shared among all three varieties. Exclusive species in 'Arbequina' included *Neoseiulus fallacis* (Garman, 1948), *O. maxwelli*, and *T. urticae*. In 'Arbosana,' the exclusive species were Cheletomimus berlesei (Oudemans, 1904), Exothorhis sp., Primagistemus sp., as well as species from the families Tarsonemidae and Siteroptidae.. In 'Koroneiki,' only *Eryngiopus* sp. was exclusive. The large number of exclusive species across varieties (S = 9) corroborates the low similarity indicated by the Jaccard index. However, despite the high number of exclusive species, all were represented by very low abundances, which could suggest a casual sampling distribution pattern.

The predator/fungivore guild was represented exclusively by *T. linarocatus*, fungivores by *Daidalotarsonemus* sp., and saprophages by *T. putrescentiae*. These guilds were dominant, as they comprised the most abundant species, and consequently, these guilds dominated the community (Krantz; Walter, 2009).

Among predators, *C. ornatus* was cited by Gerson, O'Connor and Houck (1990) as naturally inhabiting fruit trees worldwide, preying on diaspidids and occasionally feeding on Tydeidae and Tarsonemidae as an alternative food source. The diaspidid species present in the olive grove under study include *Hemiberlesia lataniae* (Signoret, 1869) and *Pseudaulacaspis pentagona* (Targioni-Tozzetti, 1886) (Wolff *et al*., 2018).

Predatory mites from the families Eupalopsellidae, Phytoseiidae, and Stigmaeidae were also collected, but they were found in low numbers (a total of 28 mites), accounting for less than 1 % of the total number of adult mites collected.

Phytophagous mites were represented by species from the families Eriophyidae, Tetranychidae, Siteroptidae, and Tarsonemidae (excluding Daidalotarsonemus, which was considered non-phytophagous in this study). However, their total number was low (N = 19), accounting for less than 1 % of all the mites collected.

In this study, *C. ornatus*, *C. berlesei*, *Neoseiulus fallacis* (Garman, 1948), *T. linarocatus*, and *T. putrescentiae* are recorded for the first time on olive trees in Brazil. The most abundant species in the study, *T. linarocatus*, was present throughout all seasons. During microscopic examination of the leaves, *T. linarocatus* was observed feeding on *Saissetia coffeae* (Walker, 1852) (Coccomorpha: Coccidae). Further studies are needed to elucidate this interaction. The presence of beneficial mites may contribute to the management of olive groves, supporting natural control of harmful organisms, including mites, fungi, and scale insects.

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Conflict of Interests

The authors declare that the research was conducted in the absence of any potential conflicts of interest.

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The authors confirm that the ethical guidelines adopted by the journal were followed by this work, and all authors agree with the submission, content and transfer of the publication rights of the article to the journal. They also declare that the work has not been previously published nor is it being considered for publication in another journal.

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