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Scientific Note

Occurrence of lacewing species (Neuroptera: Chrysopidae) in an olive orchard (*Olea europea* L., Oleaceae)

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Abstract. Forest fragments associated with agricultural areas are beneficial for maintaining species that act as natural biological controls. Lacewings are an example of organisms that contribute to this control, however, there is little information on the sampling methodology for this taxon, as well as its occurrence in olive cultivation, *Olea europaea* L. (Lamiales: Oleaceae). Therefore, the aim of this study was to report the richness of lacewings (Neuroptera: Chrysopidae) collected with attractant traps in an olive orchard, associated with fragments of mixed Atlantic Forest. The traps were baited with passion fruit juice at a rate of 200 mL per bottle. The traps were installed at Sítio Carpe Diem, in the Serra da Mantiqueira, municipality of Cambuí, southern Minas Gerais (-22.625000 and -46.148333) from September 2023 to January 2024. As a result, a total of 109 lacewing specimens from one subfamily, two tribes, six genera and 14 species were collected. The occurrence of this taxon in the area may reflect the biome in which the property is located, the high temperature and the fragment of native forest. The data obtained in this study suggests that the use of passion fruit bait is advantageous for sampling lacewings, as well as highlighting the importance of agroecological practices for the permanence of natural enemies in cultivated areas.

Keywords: Agricultural crop; biodiversity; lacewings; *Leucochrysa*.

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The Oleaceae include species grown in tropical and temperate regions, with varieties resistant to the hottest and driest periods of the year, including *Olea europaea* L., the only species with edible fruits (Heywood 1978; Corrêa *et al.* 2002; Wrege *et al*. 2015; Flores *et al*. 2015). Its production has a high economic value, and Brazil is one of the main consumer countries for its products, such as olive oil and table olives (Teixeira 2024). In terms of national production, the southern states stand out, with significant expansion to the southeastern states of São Paulo and Minas Gerais (Costa & Jorge 2018; Oliveira *et al.* 2023). Production has been growing, reaching around 60,000 L/year (FAPEMIG 2024), with cultivation areas located mainly around the Serra da Mantiqueira, in the Atlantic Forest biome.

This biome is considered a world *hotspot* (Myers *et al*. 2000), with its original area of approximately 1,110,182 Km². However, current estimates indicate that only around 12.5% of forests originally belonging to the Atlantic Forest are left (IBF 2024). These remnants are mainly made up of fragments smaller than 10 ha, which corresponds to around 83% of the total areas still extant (Ribeiro *et al.* 2020).

This fragmentation can result in various environmental problems, such as the loss or reduction of ecological niches and ecosystem services, as well as the isolation, reduction and extinction of species (Stevanato *et al.* 2022; Gouvêa *et al*. 2023). Even so, these fragments associated with agricultural areas provide several benefits, as they can sustain populations of species that help in the biological control of agricultural pests (Medeiros *et al.* 2019), such as the olive mite, *Oxycenus maxwelli* (Keifer, 1939) (Acari: Eriophyidae) (Ricalde & Garcia 2013) and the black olive mealybug, *Saissetia oleae* (Olivier, 1791) (Hemiptera: Coccidae) (Oliveira *et al*. 2006).

Biological control is a practice incorporated into sustainable agricultural production, which has been growing in the 21st century in Brazil (Parra 2019). For example, lacewings (Neuroptera: Chrysopidae), which have a high foraging capacity, help regulate arthropods such as mites, mealybugs, aphids, whiteflies, lepidopteran larvae and eggs (Carvalho *et al.* 2023; Gonçalves *et al*. 2024). In addition, lacewings can be easily reared under laboratory conditions (Freitas 2002; Carvalho & Souza 2009).

These Neuroptera occur in different ecosystems, such as the Atlantic Forest and Cerrado (Souza *et al*. 2008; Costa *et al*. 2010; Ataide & Silva 2019; Machado *et al.* 2024; Lara *et al*. 2024) but are also found in agricultural areas (Souza & Carvalho 2002; Bezerra *et al.* 2009). However, there is still a lack of information on their presence in olive orchards and mixed forests, a phytophysiognomy of the Atlantic Forest.

In addition, there is little information on Chrysopidae sampling methodologies. Commonly, passive collection methods are used, such as flight interceptor traps, Malaise traps and McPhail-type attractant traps, as well as active searches using entomological nets (Ribeiro

et al. 2009; Oliveira *et al.* 2012; Ataide & Silva 2019). However, other sampling methods have been poorly explored for this group, which justifies testing additional methods for collecting these insects.

Therefore, the aim of this study was to report the lacewing (Neuroptera: Chrysopidae) richness collected using alternative attractant traps in an area where *Olea europaea* (Lamiales: Oleaceae) olive trees are grown, associated with fragments of mixed Atlantic Forest.

The study was carried out from September 2023 to January 2024 at Sítio Carpe Diem (-22.625000, -46.148333), where olive trees, *O. europaea*, are grown in association with fragments of mixed forest in the Serra da Mantiqueira. This area is located in the municipality of Cambuí, in the south of Minas Gerais, at an altitude of 1,500 m, with a high-altitude tropical climate (Reboita *et al.* 2015).

The lacewings were collected using attractant traps (Figure 1), made from 2 L PET bottles, with three triangular openings of approximately 2 centimeters (adapted from Souza et al. 2015; Figure 2). Passion fruit juice, *Passiflora edulis* Sims (Passifloraceae), in natura, was used as bait, in a quantity of 200 mL per trap. To prepare 1 L of bait, we used the juice of one passion fruit (around 50 g of pulp) and 100 g of crystal sugar and water.

A total of 30 traps were used, distributed in three rows 50 m apart. Each row contained 10 bottles separated by 30 m, fixed to the trees at a height of 1.5 m from the ground. The first row of traps was installed at the edge of the Atlantic Forest fragment and fixed to native trees (A1 to A10). The rest of the traps were set in olive trees: one in the center of the orchard (A11 to A20) and the other on the border between the main house and the road (A21 to A30).

The traps remained in the area for seven consecutive days each month, and at the end of the seventh day, the lacewings were removed from the traps using tweezers, a sieve and a tray. The specimens were then placed in duly labeled 2 mL Eppendorf tubes filled with 70% alcohol. The identification of the species was carried out by Professor Dr. Francisco José Sosa-Duque from the Rural University of Amazônia (UFRA), and the material is in the process of being registered in the biological collection of social wasps (CBVS) (registration number 12.436-2024 to 12.544-2024).

The collections were carried out in accordance with authorization from the Biodiversity Authorization and Information System (SISBIO), license: 91709-1.

A total of 109 Chrysopidae adults were collected, grouped into one subfamily (Chrysopinae), two tribes (Chrysopini and Leucochrysini), six genera (*Ceraeochrysa* Adams, 1982, *Chrysopodes* Navás, 1913, *Titanochrysa* Sosa & Freitas, 2012, *Chrysoperla* Steinmann, 1964, *Ungla* Navás, 1914 and *Leucochrysa* McLachlan, 1868) and 14 species (Table 1). *Leucochrysa* was the most abundant genus with 97 adults collected (89.9% of the total) and the richest (57.14% of the total species identified).

The high occurrence of these species in cultivated areas may be a reflection of three main conditions, however this needs to

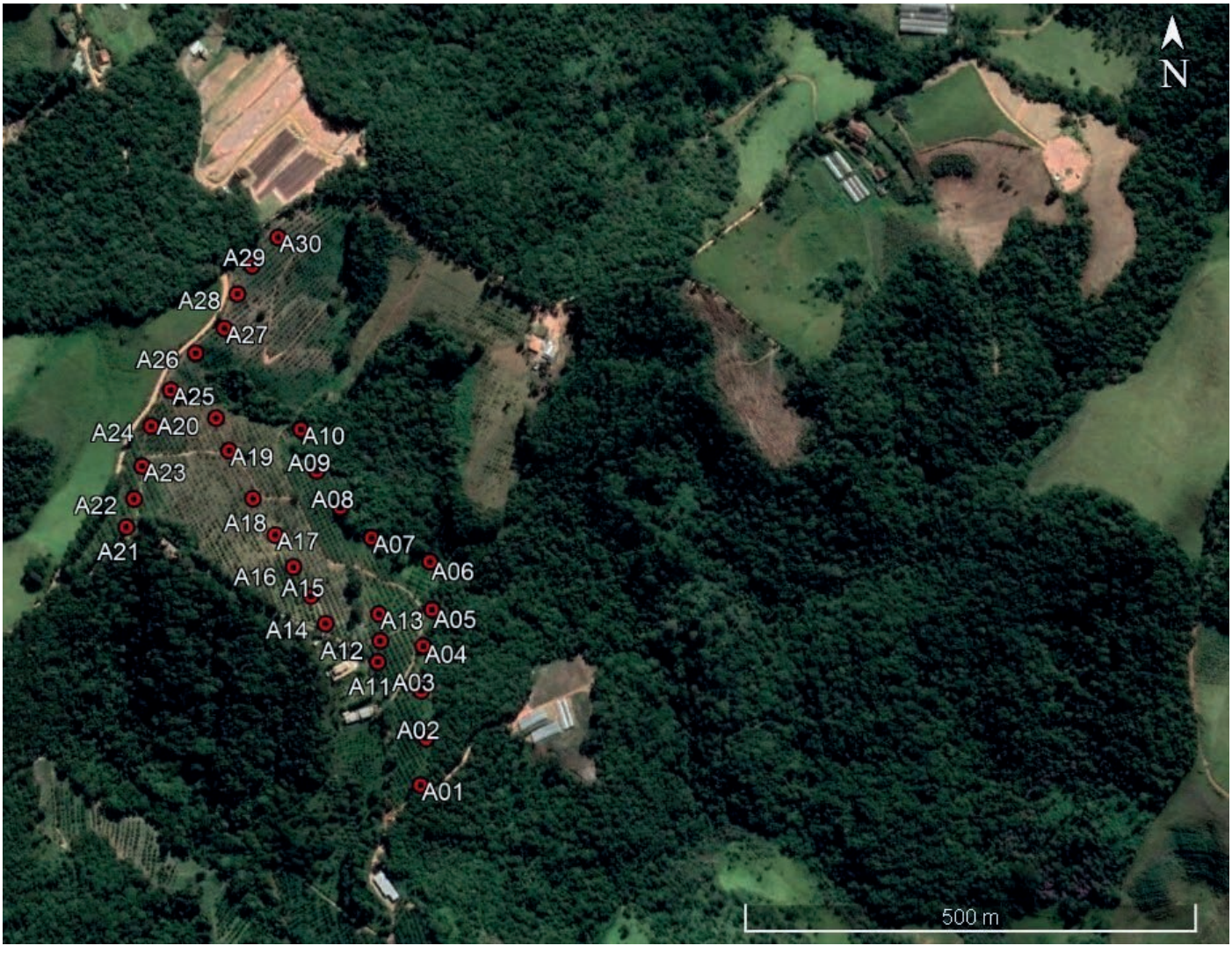

Figure 1. Attractant traps (A1 to A30) distributed in an olive (*Olea europaea*) cultivation area associated with mixed forest fragments (Atlantic Forest) for sampling lacewings in the municipality of Cambuí, southern Minas Gerais. Source: Google Earth.

Figure 2. Attractant trap with passion fruit bait used to collect the lacewings, adapted from Souza et al. (2015).

be evaluated in future studies so that we can be sure whether this is true: (i) the sampling site is located in the Atlantic Forest, a biome where some of these chrysopid species have already been reported (Souza *et al.* 2008; Costa *et al.* 2010; Ataide & Silva 2019); (ii) the high temperature in spring and summer when the collections were made, as this abiotic factor positively influences the abundance of lacewings, as demonstrated by Costa *et al* (2010); (iii) the presence of fragments of native vegetation, a condition that also positively influences biodiversity, as this mosaic of vegetation forms more heterogeneous ecosystems (Altieri & Silva 2003; Kovács-Hostyánszki *et al.* 2017), as has already been documented for chrysopids in coffee cultivation associated with a transition area between the Atlantic Forest and the Caatinga (Ribeiro *et al*. 2014), and other insect groups in coffee plantations (Milani *et al.* 2020).

The hypothesis of the influence of vegetation fragments can be validated by the fact that the traps installed at the edge of the forest collected 95% of the specimens. Natural environments have a complex structure characterized by the diversity of niches, abundance of floral resources, variety of alternative prey, shelter and a favourable microclimate for the survival of natural enemies (Olson & Andow 2008; Machado *et al*. 2024).

The presence of lacewings in olive-growing areas raises the need to investigate their potential use in biological pest control, as this crop is attacked by black mealybugs, lepidopteran caterpillars and mites (Ricalde *et.al.* 2012; Ricalde & Garcia 2013; Soares *et al*. 2013). In addition, it is already known that these pests are preyed upon by Chrysopidae (Carvalho & Souza 2009; Barbosa & Quintela 2014), although it is not yet known to what extent this predation is able to regulate the populations of these pests.

As for the methodology used in this study, the results suggest that the passion fruit bait can be used for attraction and sampling of Chrysopidae, in consortium with other collection methods, as already presented by Ribeiro *et al*. (2013). In this study, the authors used mango bait (Anacardiaceae) in an annatto crop (Bixaceae) associated with fragments of semi-deciduous seasonal forest in Vitória da Conquista, Bahia (Ribeiro *et al*. 2013). In addition, Ataide & Silva (2019) used sugarcane solution, also for collection in semideciduous seasonal forest in the Pacotuba National Forest, Cachoeiro de Itapemirim, Espírito Santo.

Table 1. Classification and abundance of Chrysopidae collected in an area of olive cultivation associated with a fragment of Atlantic Forest in southern Minas Gerais, southeastern Brazil.

Species	Abundance
Subfamily Chrysopinae Schneider, 1851	
Tribe Chrysopini Schneider, 1851	
Ceraeochrysa cincta (Schneider, 1851)	1
Ceraeochrysa silvanoi (Navás, 1916)	1
Chrysoperla externa Hagen, 1861	7
Chrysopodes divisius (Walker, 1853)	1
Titanochrysa ferreirai Sosa & De Freitas, 2012	1
Ungla sp.	1
Tribe Leucochrysini Adams, 1978	
Leucochrysa boxi Navás, 1930	21
Leucochrysa urucumis de Freitas, 2007	10
Leucochrysa sp.	1
Leucochrysa sp.1	2
Leucochrysa sp. 2	47
Leucochrysa sp. 3	4
Leucochrysa sp. 4	8
Leucochrysa sp. 5	4
Total Richness	**14**
Total abundance	**109**

Our study suggests that the presence of Atlantic Forest fragments associated with olive cultivation favors positively the richness of species and abundance of Chrysopidae, however, further studies are needed to better elucidate this possibility. In addition, we reiterate the use of attractant traps with passion fruit juice to sample this taxon.

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AUTHORS CONTRIBUTION

TBG: Formal analysis, investigation, writing – original draft; ANP: Conceptualization, formal analysis, investigation, methodology, writing – original draft; EDFF: Formal analysis, investigation, methodology, writing – original draft; FJSD: Data curation, formal analysis, supervision, validation, writing – original draft, writing – review & editing; MMS: Conceptualization, data curation, formal analysis, investigation, methodology, supervision, validation, writing – original draft, writing – review & editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interests.

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