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Survey of epigeic spiders (Arachnida: Araneae) in a litchi orchard in Mpumalanga, South Africa

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Spiders were sampled using pitfall traps over two 21-day periods in July 2020 and November 2020 at five sites within a litchi orchard in Hazyview, located in the Mpumalanga Lowveld of South Africa. In total, 407 specimens representing 16 families, 25 genera and 30 species were recorded. The Corinnidae (n = 229) represented 56.3% of all spiders collected, followed by the Salticidae (n = 56, 13.8%), Lycosidae (n = 40, 9.8%) and Gallieniellidae (n = 24, 6.0%). The families with the highest number of species were Salticidae (n = 7) and Lycosidae (n = 4). Wandering spiders made up 93.3% of the total specimens collected, while web-building spiders accounted for only 6.7%.

Conservation implications: Although this study focused on epigeic spiders rather than foliage spiders, some ground-dwelling species can help reduce pest populations through their vertical movement within the orchard. Therefore, understanding the assemblages and dominant patterns of spiders found on the floor of the litchi orchard can inform our advocacy for reducing chemical use and increasing the reliance on spiders for biological pest control. Additionally, recognising these dominant patterns is essential for maintaining suitable habitat conditions, ensuring the sustainability of biological control programmes and the conservation of predator species.

Keywords: abundance; agroecosystems; diversity; ecology; spiders.

Introduction

As a subtropical fruit, litchi (*Litchi chinensis* Sonn) originated from China and Vietnam; however, currently it is grown in more than 20 countries (Soni & Agrawal 2017). These countries include South Africa with the first introduction of litchis from Mauritius in 1875 that were imported into Durban Botanical Gardens (Begemann 2014). From the KwaZulu-Natal province, the litchis were planted in other suitable frost-free areas, including the Lowveld region in the Mpumalanga province (Begemann 2014). South Africa is one of the world's top litchi producers and produces around 8,000 tonnes of litchis annually during a good year (Department of Agriculture, Land Reform and Rural Development [DALRRD] 2020). Most of the litchis produced in South Africa are exported, mainly to Europe (DALRRD 2020).

Today Mpumalanga and Limpopo are the provinces with the highest production of litchis (Begemann 2014; DALRRD 2020). The Lowveld area of Mpumalanga accounts for about 60% of the country's litchi production yearly (DALRRD 2020).

Litchis in South Africa and elsewhere are damaged by a variety of arthropod pests (Meng et al. 2014; Schoeman et al. 2010). These pests include litchi fruit and shoot borer, *Conopomorpha sinensis* Bradley (Lepidoptera: Gracillariidae), fruit flies, *Ceratitis rosa* Karsch (Diptera: Tephritidae), stink bugs, nut borers and leaf rollers (Meng et al. 2014; Schoeman & Mohlala 2013; Schoeman et al. 2010). As a result of these pests, the application of pesticides has been implemented in many orchards. However, the efficacy of pesticide application in controlling pests is affected by different factors, such as time of application (Schoeman et al. 2010). Furthermore, pesticide application can lead to secondary pest outbreaks (Schoeman & Mohlala 2013). Additionally, Schoeman and Mohlala (2013) found no differences in the yield between litchis that had Cypermethrin application to control coconut bug, *Pseudotheraptus wayi* Brown (Hemiptera: Coreidae) and litchis that had no pesticide application. Therefore, incorporating additional methods, such as biological control is vital in managing pest populations.

As natural enemies of pests, spiders with diverse functional guilds are major predators in agricultural ecosystems (Dippenaar-Schoeman et al. 2013). Although there is still greater use of pesticides in the management of pest populations in agricultural ecosystems, according to

Dippenaar-Schoeman et al. (2013), there is also recognition of spiders in biological control. Furthermore, the South African National Survey of Arachnida (SANSA) has played a significant role in producing the baseline data on the occurrence of spiders in agroecosystems (Dippenaar-Schoeman et al. 2015). The Mpumalanga province is among the provinces with agroecosystems that have been surveyed for spiders by SANSA. In Mpumalanga, these surveys led to studies on spider diversity in various agroecosystems, including citrus (197 species) (Dippenaar-Schoeman 1998; Van den Berg et al. 1992), macadamia (80 species) (Dippenaar-Schoeman et al. 2001), and avocado (90 species) (Dippenaar-Schoeman et al. 2005).

Although spiders on litchis have been surveyed elsewhere, the species composition of spiders in this subtropical fruit remains understudied. In South Africa, no survey of spiders on litchis has been undertaken. In the Guangdong province of China, a survey of spiders in litchi orchards produced 27 genera from 15 families (Zheng et al. 2022). In Southern China, among the predators that reduced the population of *Conopomorpha sinensis* in litchi are two species of spiders, *Leucauge magnifica* Yaginuma (Araneae: Tetragnathidae) and *Oxyopes sertatus* Koch (Araneae: Oxyopidae) (Meng et al. 2014).

An inclusive grouping of spiders labels them as either ground dwellers or plant dwellers (Dippenaar-Schoeman 2023). This paper reports on a survey of epigeic spiders conducted during the cool-dry winter and wet-warm summer seasons in a litchi orchards in the Mpumalanga Lowveld.

Methods and materials

The study took place on an Agricultural Research Council (ARC) farm in Hazyview (−25.114683, 31.081717), Mpumalanga province, South Africa. The study was conducted in a litchi orchard (~ 5.8 ha) that is more than 30 years old. The height of litchi trees was approximately 6 m, while the diameter of the canopy was about 8 m and the distance between trees was about 6 m. The floor of the orchard was covered with a deep layer of leaf litter ranging from 5.8 cm to 9 cm. Management practices included watering and application of pesticides and herbicides. Watering occurred once every 2 weeks during winter, and the frequency was reduced during the wet summer season. Herbicides, glyphosate and paraquat, were applied from September 2020 to March 2020. Litchis were planted in five small blocks (~ 11 587 m^2), separated by gravel roads approximately 8 m wide. Therefore, each block of the litchi had a single sampling site. Each site (10 m × 10 m) was 10 m from the edge to avoid edge effects.

In each site, spiders were surveyed during the dry-cool winter season (July 2020) and the warm-wet summer season (November 2020). Spiders were collected using pitfall traps (6 cm diameter and 13.5 cm depth) that did not have rain covers. At each site, there were 24 pitfall traps, and each trap was quarter-filled with ethylene glycol (50%). Each site had four line transects that were about 2 m apart. In each line transect, six pitfall traps were set out about 2 m apart; this was to ensure greater coverage in each site because pitfall traps measure activity density. Pitfall traps were left open in the field for 6 days, emptied on the 7th day and new traps were set out. This was repeated three times, making the sampling period 21 days in each season. Spiders from the 21-day sampling period per site formed one sample. Therefore, the sampling effort in relation to the number of traps and days was [24 traps × 5 sites = 120 traps]; (120 traps × 21 days = 2520; 2520 × 2 seasons) 5040 traps per day. Collected specimens were preserved in 70% ethanol. Thereafter, spiders were extracted and identified to family and genus levels by the first author and later confirmed by the last author who added species names. Voucher specimens are housed in the National Collection of Arachnida at ARC in Pretoria.

Seasonal variations in species richness and abundance of spiders were compared in *R* using a *t-test* because datasets were normally distributed. Permutational multivariate analysis of variance in PRIMER 7 was used to compare spider assemblages between seasons.

Ethical considerations

Prior to 2020, no ethical clearance was required by the University of Mpumalanga for research on terrestrial invertebrates (arthropods). As such, there was no expectation on the part of researchers who were working on insects and spiders to apply for ethical clearance. Sampling was conducted in an ARC farm, and authors were permitted to conduct the survey. An ethical waiver to conduct this study was obtained from the University of Mpumalanga, Research Ethics Committee - Animal Science (non-human), dated 11 June 2025.

Results and discussion

Species abundance and richness

A total of 407 adult spiders from 16 families, 25 genera and 30 species were collected in the litchi orchard (Table 1). There was not much variation among sites in terms of abundance (69–88), species richness (10–14) and family richness (7–10). Out of the 16 families, five (Corinnidae, Ctenidae, Gallieniellidae, Lycosidae and Salticidae) were sampled in all sites (Table 2). Ten families were represented by a single species (Table 1). The most abundant species was a Corinnidae, *Copa flavoplumosa* Simon, 1885 (n = 229, 56.3%), followed by the Salticidae, *Baryphas ahenus* Simon, 1902 (n = 41, 10.1%), an undetermined Ctenidae, *Anahita* sp. (n = 32, 7.9%), a Lycosidae, *Allocosa umtalica* Purcell, 1903 (n = 28, 6.9%) and Gallieniellidae, *Austrachelas bergi* Haddad, Lyle, Bosselaers and Ramírez, 2009 (n = 24, 5.9%) (Table 2). The Salticidae was the most species-rich family, with seven species, followed by the Lycosidae with four species and the Gnaphosidae with three species. The rest of the families had one or two species (Table 1).

Abundant species

- Corinnidae: *Copa flavoplumosa* is a free-living ground dweller mainly collected from the leaf litter layer (Haddad 2013). It has been sampled from all South African provinces (Dippenaar-Schoeman et al. 2023). During the SANSA survey, *C. flavoplumosa* was also sampled from agroecosystems, such as avocado, citrus, macadamia and pistachio orchards, strawberries, cotton and maize fields (Dippenaar-Schoeman et al. 2013).
- Salticidae: *Baryphas ahenus* is a widespread species and is frequently collected by beating the foliage of shrubs and trees. This species is usually found on leaves, except for juveniles, which are sometimes present on flowers and occasionally on grasses and ground surfaces (Haddad & Vickers 2024). *Baryphas ahenus* is sampled from plant species that mostly have smooth, shiny and broad leaves. The retreats of *B. ahenus* are built between either two or three leaves sewn together with silk, in axils of leaves or among flower heads. Furthermore, *B. ahenus* was also sampled from agroecosystems, such as citrus, maize, pine plantations and strawberries (Dippenaar-Schoeman et al. 2013).
- Lycosidae: *Allocosa umtalica* is a free-running ground dweller sampled from the grassland and savanna biomes (Foord et al. 2011; Haddad et al. 2013). In South Africa, it has been recorded from Gauteng and Limpopo provinces.
- Gallieniellidae: *Austrachelas bergi* is a free-living, agile ground dweller frequently found associated with ants. These spiders have been sampled from grasses and woody habitats in the savanna biome (Foord et al. 2011).

TABLE 1: Spider diversity in litchi orchards in Hazyview, Mpumalanga Lowveld, South Africa, including the total number of specimens sampled and the percentage per family, genus, species and guild.

Family	Genera	Species	Total	%	Guild
Corinnidae	1	1	229	56.3	GD
Ctenidae	2	2	35	8.6	GD
Eresidae	1	1	4	1.0	WD
Gallieniellidae	1	1	24	6.0	GD
Gnaphosidae	2	3	5	1.2	GD
Lycosidae	2	4	40	9.8	GD
Oonopidae	1	1	2	0.5	GD
Orsolobidae	1	1	1	0.2	GD
Pisauridae	1	1	1	0.2	PD
Salticidae	6	7	56	13.8	GD or PD
Scytodidae	1	1	2	0.5	GD
Selenopidae	1	1	2	0.5	GD
Theridiidae	1	1	1	0.2	WD
Thomisidae	2	2	2	0.5	GD or PD
Trachelidae	1	2	2	0.5	GD
Zodariidae	1	1	1	0.2	GD
Total: 16	**25**	**30**	**407**	**100**	**-**

GD, ground dweller; PD, plant dweller; WD, web dweller.

TABLE 2: List of species of spiders collected from five litchi sites in two seasons.

Families	Scientific names	1.W	2.W	3.W	4.W	5.W	1.S	2.S	3.S	4.S	5.S	Total
Corinnidae	*Copa flavoplumosa*	7	21	15	0	13	36	38	24	34	41	**229**
Ctenidae	*Anahita sp.*	0	3	1	0	1	3	6	10	6	2	**32**
Ctenidae	*Ctenus pulchiventris*	0	0	0	0	0	1	0	0	2	0	**3**
Eresidae	*Dresserus colsoni*	0	0	1	0	0	0	0	3	0	0	**4**
Gallieniellidae	*Austrachelas bergi*	4	6	3	7	0	0	2	0	1	1	**24**
Gnaphosidae	*Haplodrassus solitarius*	1	0	0	0	0	0	0	0	0	0	**1**
Gnaphosidae	*Xerophaeus* sp.	0	0	0	0	0	0	0	0	1	0	**1**
Gnaphosiidae	*Xerophaeus aridus*	0	0	0	0	0	0	0	0	1	2	**3**
Lycosidae	*Allocosa* sp.	2	0	1	0	0	0	0	0	0	0	**3**
Lycosidae	*Allocosa lawrencei*	1	0	0	4	0	0	0	0	0	0	**5**
Lycosidae	*Allocosa umtalica*	3	0	1	2	0	10	1	1	5	5	**28**
Lycosidae	*Proevippa fascicularis*	0	0	0	0	0	2	1	1	0	0	**4**
Oonopidae	*Gamasomorpha australis*	0	0	0	0	0	0	1	0	1	0	**2**
Orsolobidae	*Afrilobus* sp.	0	1	0	0	0	0	0	0	0	0	**1**
Pisauridae	*Rothus aethiopicus*	0	0	0	0	0	1	0	0	0	0	**1**
Salticidae	*Baryphas ahenus*	2	1	1	3	0	11	1	5	10	7	**41**
Salticidae	*Cyrba nigrimana*	0	1	0	1	0	0	0	1	0	0	**3**
Salticidae	*Heliophanus* sp.	1	0	0	0	0	0	0	0	0	0	**1**
Salticidae	*Rumburak laxus*	0	0	0	0	0	0	2	0	3	0	**5**
Salticidae	*Stenaelurillus guttiger*	0	0	0	0	0	0	1	0	0	2	**3**
Salticidae	*Thyene* sp.	1	0	0	0	0	0	0	0	0	0	**1**
Salticidae	*Thyene inflata*	0	0	0	0	0	0	0	0	1	1	**2**
Scytodidae	*Scytodes flagellata*	0	0	0	0	1	0	0	0	0	1	**2**
Selenopidae	*Anyphops pococki*	1	0	0	0	0	1	0	0	0	0	**2**
Theridiidae	*Steatoda capensis*	0	0	0	0	0	0	0	1	0	0	**1**
Thomisidae	*Pactactes compactus*	0	0	0	1	0	0	0	0	0	0	**1**
Thomisidae	*Xysticus havilandi*	0	0	0	0	1	0	0	0	0	0	**1**
Trachelidae	*Afroceto martini*	0	0	0	0	0	0	0	0	0	1	**1**
Trachelidae	*Afroceto* sp.	0	0	0	0	0	0	1	0	0	0	**1**
Zodariidae	*Cydrela schoemanae*	0	0	0	0	0	0	0	0	0	1	**1**
Total												**407**

Note: 1.W to 5.W = winter sites; 1.S to 5.S = summer sites, along with the total (Tot.) number of specimens sampled for each species.

In addition, *A. bergi* was also collected in avocado orchards (Dippenaar-Schoeman et al. 2005, 2013). This species has been recorded in the Mpumalanga and Limpopo provinces (Haddad & Mbo 2017).

Species guilds

Eleven of the families sampled are ground dwellers (Table 1) where the litter layer provides favourable microhabitats. Only two families produce webs (Table 1). The first web-dweller is an Eresidae, *Dresserus colsoni* Tucker, 1920 that is commonly found in retreat webs, mainly under stones and sometimes in compost heaps. The second is a Theridiidae species, *Steatoda capensis* Hann, 1990, which constructs three-dimensional webs in dark places usually close to the substrate and frequently found under stones. In addition, *S. capensis* was also sampled from crops, such as maize, pear, tomatoes, pine plantations and vineyards (Dippenaar-Schoeman et al. 2013). Some spider families, such as the Salticidae and Thomisidae have species that are found in both the ground and foliage layers. The low catch of web-building spiders was expected considering that the sampling method used in this study targets surface-active species. Therefore, it is possible that if the foliage of the same orchard can be sampled, there would be greater species richness of plant-dwellers. For example, in the Northern Cape province, the chemical knockdown and pitfall trapping methods in pistachio orchards resulted in a greater diversity of arboreal and epigeic spiders, respectively (Haddad, Dippenaar-Schoeman & Pekár 2005; Haddad & Dippenaar-Schoeman 2006).

Seasonal variations

There was significantly higher abundance (t = 7.52, p < 0.001) and species richness (t = 2.52, p = 0.04) of spiders in summer than in winter, and the two seasons supported significantly different spider assemblages (*Pseudo-F* = 2.99, p = 0.009). These findings support previous South African studies that recorded greater species richness and abundance of spiders in the wet season than in the dry winter season (Foord & Dippenaar-Schoeman 2016; Haddad & Dippenaar-Schoeman 2006).

Conclusion

This study provided foundational data on assemblages of spiders in litchis in South Africa. To improve our knowledge of spider diversity in this crop, future studies with additional sampling sites and methods are recommended. This is important because the current study excluded arboreal spiders, of which spiders from the ground to the canopy layers are all vital in managing pest populations in agroecosystems. Additionally, even though the current study focused on the ground layer only, Haddad and Dippenaar-Schoeman (2006) reported that epigeic spiders may reduce pest populations because of the movement of some species between tree canopies and ground cover. Therefore, future studies should also investigate spider–prey associations within the litchi and other subtropical fruit orchards.

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Competing interests

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Authors' contributions

All authors, I.Y., T.M. and A.S.D-S., contributed to the conceptualisation of the study. Data collection was conducted by I.Y. and T.M. I.Y. secured funding and led the project. Spiders were identified by I.Y. and A.S.D-S. The original draft of the manuscript was written by A.S.D-S., and I.Y. and T.M. provided edits to the article.

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Data availability

The authors confirm that the data supporting the findings of this study are available within the article.

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