UFOs in Mooloolah River National Park – combining entomologist-led surveys with community science to document flowering plant-insect interactions

Dr Kit Prendergast

University of Southern Queensland

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Male *Xylocopa (Lestis) bombylans* collected by Dr Kit Prendergast during the Mooloolah River National Park surveys. Photo: Dr Kit Prendergast

Summary

Australia, like much of the globe, is facing a pollinator crisis, and fundamental to addressing this is the identification of species diversity, and surveying and monitoring pollinators and their interactions with flora. Sweepnetting has been found to be the most effective method for surveying pollinators and their interactions, however different sweepnetting techniques may field different results. Additionally, citizen scientists can aid in collecting data on plant-insect interactions. To this end, we created the "Identifying UFOs" project, conducted monthly surveys from Sept – March in Mooloolah River National Park, QLD. Along a transect, a pollination ecologist (Dr Kit Prendergast) trialled three sweepnetting techniques for 5 min each: targeted sweep-netting (TSN), floral sweep-netting (FSN), and line transect sweeps (LTS). Citizen scientists, led by Moolooah River Landcare coordinator Jessica Raintree, then joined her and were assigned a target plant to estimate its abundance and conduct 30 mins of observations recording all insect visitors. Dr Kit Prendergast collected a total of 38 species, comprising 155 specimens. The greatest number of species were collected via TSN, followed by LTS, and then FSN, however for native bees, all were collected by TSN. Most native bees were collected on *Leptospermum* and *Baekea.* One "UFO", a *Hylaeus,* was collected. Citizen scientists recorded a total of 294 invertebrates (insects and arachnids). The most frequently observed insect on flowers were ants (104), followed by beetles (36), flies (35), and wasps (34). Native bees were comparatively under-represented compared with the expert surveys. Plants varied greatly in their attractiveness to insects. A *Paracandovia* phasmid was found which appears to be an undescribed species. Overall this project firstly revealed for the first time the insect assemblage at Mooloolah River National Park. It also determined that targeted sweepnetting by an experienced bee scientist is the most effective means of monitoring native bees. Citizen scientists were able to undertake research that mirrored real-world science in terms of making careful, detailed observations over a relatively long duration, and advanced our understanding of insect-plant interactions.

Keywords: bees, citizen science, entomology, insects, pollinators, women in STEM, taxonomy

Introduction

Native bees are a precious component of biodiversity, and many play important roles in the structure and functioning of ecosystems (Potts et al., 2016). Their diverse ecologies (Michener, 2007), in terms of nesting substrate requirements, specialisation or generalisation on pollen resources, preferences or reliance on particular flowering plants, body size, and phenologies, means that they are bioindicators of ecosystems, and the composition of bee assemblages can provide insights into ecosystem functioning and responses to environmental change. With over 1600 species, and many more to be discovered and described (Australian Government Department of the Environment and Energy, 2021), Australian native bees represent a major component of biodiversity. Despite this, there is little known about the native bee assemblages in many parts of Australia.

Whilst the surveying, monitoring, and taxonomic descriptions of species is severely underfunded and under-researched, there are global concerns about the plight of pollinators (Potts et al., 2016). Given their roles as pollinators, it is surprising that until recently there has been little attention regarding understanding the ecologies, distributions, trends and vulnerabilities of native bees in Australia (Pyke, Prendergast, & Ren, 2023). A main cause of land-clearing in this region, especially today, is for urban expansion (Lambers, 2019). Recent research has underscored the important of bushland remnants for the conservation of native bees (K. Prendergast & Ollerton, 2021; Kit S. Prendergast, Tomlinson, Dixon, Bateman, & Menz, 2022). Surveys of bushland remnants have revealed that despite being surrounded by threatening processes and factors that negatively impact native bees such as roads, impervious surfaces, loss of trees, and replacement of native vegetation with exotic flora, bushland remnants still host a large number of native bee species (K. Prendergast, 2020, 2021; K. S. Prendergast, 2020; Kit S. Prendergast, Tomlinson, et al., 2022). Within increasing pressures on remnant vegetation, it is vital that remaining bushland remnants are surveyed to understand their species composition and potentially identify rare or new species. Indeed, the taxonomy and discovery and description of Australian native bees is poor especially when compared to vertebrates, a situation facing insects as a whole (Braby & Williams, 2016; New, 2022; Pyke et al., 2023; Sands, 2018).

In addition to the taxonomic impediment, insects are facing a lack of investment into their research and monitoring (McGrath, 2024; Miličić, Popov, Branco, & Cardoso, 2021), and are given less attention in the media compared with vertebrates, creating knowledge impediments among the public (Burns, Fitzpatrick, & Stanley, 2021). This is despite how insects are the perfect subject for community scientists to investigate (León-Cortés, Bried, & Roy), given their diversity, abundance, accessibility, and occurrence in all habitats. Added to this is poor communication strategies about insect biodiversity and taxonomy (Vereecken et al., 2024).

Methodology for monitoring pollinators is also critical (Kit S. Prendergast & Hogendoorn, 2021). Whilst research has established sweepnetting is the most effective and least biased method for monitoring pollinator assemblages (K. Prendergast, Menz, Bateman, & Dixon, 2020), there are also a number of ways to sweepnet that vary depending on the 'intentionality' of sweeps vs. random sweeping. Sweepnetting however is best conducted by an experienced entomologist, and is not practical for a community-based citizen science project.

The aim of this project was to conduct the first systematic surveys of Mooloolah River National Park's pollinator assemblage, trialling different sweep-netting techniques, and couple this with a community education and citizen science project, aiming to both educate the public about insects, how to survey them, their host associations and environmental associatoins, and connect insect enthusiast with entomologists.

Methods

Surveys were conducted in Mooloolah River National Park (MRNP), Sippy Downs, Sunshine Coast region, Queensland, Australia (Fig 1). It comprises coastal lowland habitat, which is now rare due to development. Habitat types within the park are varied, and include threatened regional ecosystems for coastal rainforest, melaleuca forests, wallum banksia woodlands, scribbly gum open forests, sedgelands and closed heaths. Soils are sandy. Threats include urbanisation, inappropriate fire regimes, and invasive species. MRNP is managed by the Queensland Parks and Wildlife Service.

Surveys were conducted near pathways to avoid any disturbance to vegetation, and to make the community component accessible to all ages (Fig. 1) Surveys were conducted along the same area for all surveys except the final one where due to flooding the path was inaccessible and the survey was moved approx. 300 m south.

Fig. 1. Map of areas surveyed a) points are iNaturalist records for where Dr Kit Prendergast, MRLC coordinator Jessica Raintree, and UFO survey participants entered observations which map on to where the surveys were conducted); b) Mooloolah River National Park showing location in the landscape and surrounding landuse.

Prior to the community arriving, Dr Kit Prendergast allocated a 50 x 4 m survey area. A path was in the centre, allowing collection and/or observation by community members without trampling of vegetation or risk of stepping on a snake. Dr Kit then employed three methods of sweepnetting for pollinators, focussing on native bees:

1) Targeted sweep-netting (TSN)” each patch of flowering plants was observed for 15 – 20 secs and insects were netted. If no insects were observed, she moved to the next patch of flowers. This continued for a duration of 5 mins, excluding the time spent transferring insects into vials. The plant species the insect was swept from was recorded.
2) Floral sweep-netting: along the transect each floral patch is swept 3 times in a non-targeted manner i.e. without sweeping only when seeing an insects. This was continued for 5 mins. The plant species insects were collected from was not recorded as netting was conducted without interruption.
3) Along a 40 m x 4 m transect, Dr Kit walked at a steady pace making 30 sweeps, without targeting any insect or plant. Each sweep comprised a full 180 degree arc.

This was conducted from approximately 12:30pm to 1pm. Dr Kit Prendergast was permitted to survey under a Queensland Entomological Society permits (P-PTUKI-100128508 and Forests P-PTC-100128505).

Once the expert sweepnetting survey was completed community scientists joined Dr Kit, who were recruited through the Mooloolah River Land Care newsletter and through social media posts (Fig. 2a). Dr Kit would then briefly show them the insects she had collected and discuss their diagnostic features (Fig 2b). Each individual or family group was then assigned a target plant species (which had more than one plant) along the 50 m transect. When there were more participants than plant species a pair was assigned a plant; when there were less participants They then were asked to estimate the flower abundance of their target plant, record environmental data (date, location, temperature, weather, cloud cover), and from approximately 1:30 pm, would spent 30 mins observing and tallying all insect visitors (including non-pollinators) to the largest patch of their target plant (Fig. 2c). Each participant had a form to fill out this information and pre-defined insect categories provided (Fig. 2d). Participants were also asked to join the 'Identifying UFOs' project on iNaturalist: https://www.inaturalist.org/projects/identifying-ufos

Due to an extreme downpour on the day of the January we did not conduct any survey (but made the most of getting together by sharing our history and interest in entomology with a diverse demographic of insect enthusiasts!) (Fig. 2e).

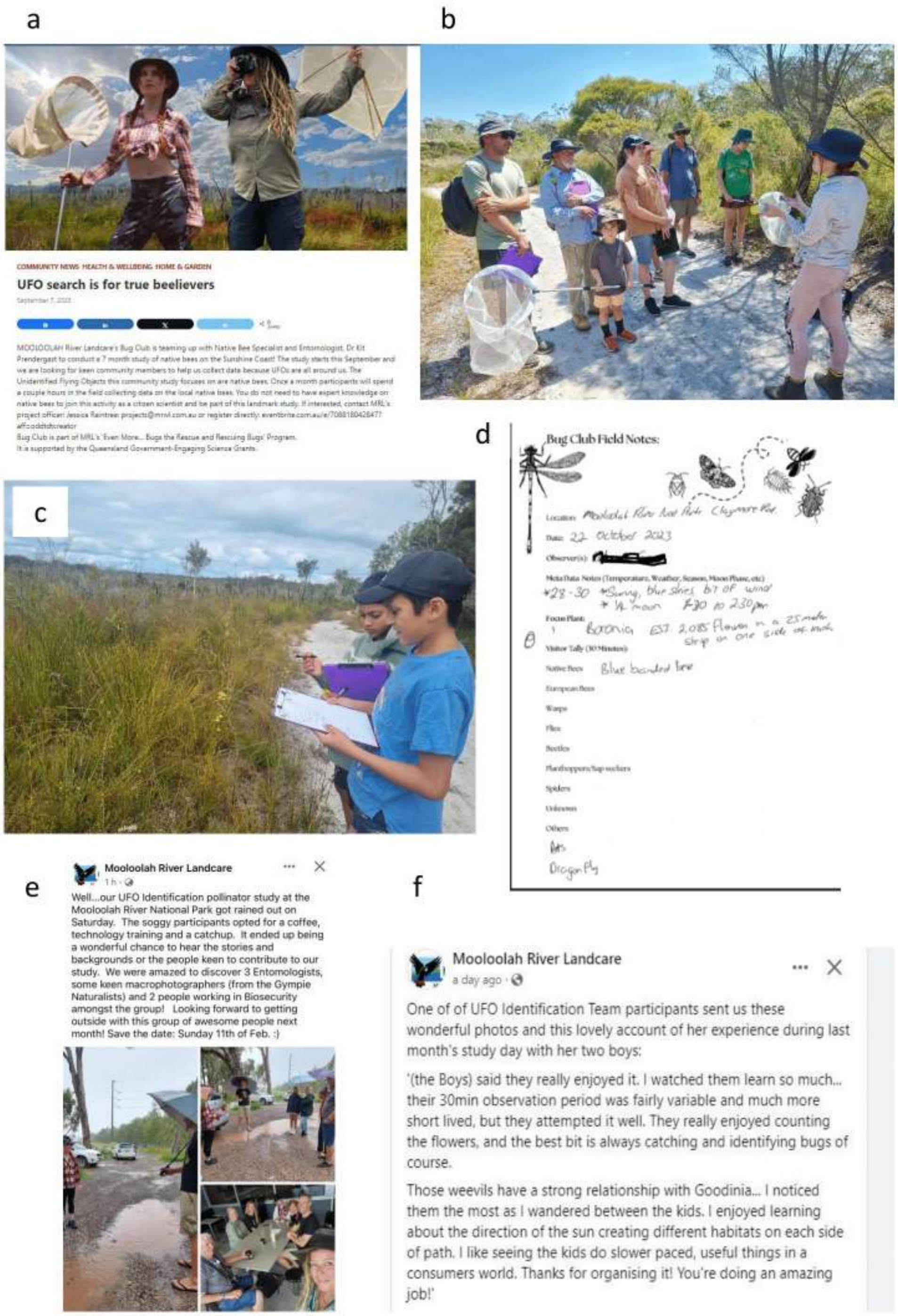

Fig. 2. a) Event UFO Identification social media; b) Dr Kit Prendergast discussing pollinators and insects with UFO Identification team participants at MRNP; c) two younger participants conducting timed observations of insects to their focal plant; d) example of the recording data sheet; e) making the most of poor weather and sharing our love of insects; f) evidence of positive feedback from UFO Identification team participants.

Results

Expert surveys

Dr Kit Prendergast collected a total of 38 species, comprising 155 specimens (Table 1). The greatest number of species were collected via targeted sweepnetting (TSN), followed by line transect sweeps (LTS), and then floral sweep-netting (FSN) (Table 1). When it came to number of individuals, the greatest number were collected by LTS, then FSN, then TSN.

Few species were collected in January due to very wet and rainy weather, nor in March either due to very overcast, cool and rainy conditions however other invertebrates as well as fungi were observed and their ecology discussed with the participants. The peak of insect activity occurred in October, as well as December (Fig. 3).

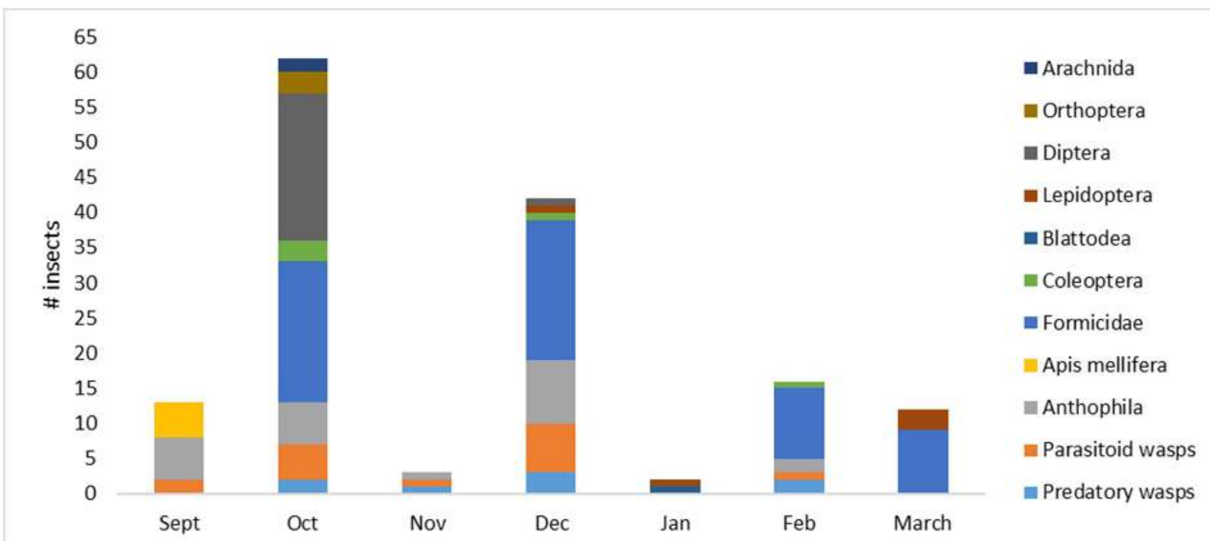

Fig. 3. Abundance of different insect taxa recorded each month during expert netting surveys

Table 1. Results of sweepnetting surveys by Dr Kit Prendergast at Mooloolah River National Park Sept – March.

								Netting technique		
Date	**Role**	**Group**	**Order**	**Superfamily**	**Family**	**Subfamily**	**Species**	**Targeted hand-netting (THN)**	**Floral sweep-netting (FSN)**	**Line transect sweeps (LTS)**
24.Sept.2023	Pollinator	Bee	Hymenoptera	Apoidea	Colletidae	Apinae	*Apis mellifera*	2	3	
24.Sept.2023	Pollinator	Bee	Hymenoptera	Apoidea	Colletidae	Hylaeinae	*Hylaeus "MRNP sp.1"*	1		
24.Sept.2023	Pollinator	Bee	Hymenoptera	Apoidea	Colletidae	Hylaeinae	*Hylaeus (Euprosopoides) cyanurus*	5		
24.Sept.2023	Parasitoid	Wasp	Hymenoptera	Evanoidea	Gasteruptiidae	Gasteruptiinae	*Gasteruption longicollie*	1		
24.Sept.2023	Parasitoid	Wasp	Hymenoptera	Ichneumonoidea	Ichneumonidae	Pimplinae	*Lissopimpla excelsa*			1
22.Oct.2023	Nutrient cycling	Ant	Hymenoptera	Vespoidea			*Formicidae*			20
22.Oct.2023	Pollinator	Bee	Hymenoptera	Apoidea	Apidae	Apinae	*Tetragonula carbonaria*	1		
22.Oct.2023	Pollinator	Bee	Hymenoptera	Apoidea	Apidae	Xylocopinae	*Xylocopa (Lestis) aerata*	1		
22.Oct.2023	Pollinator	Bee	Hymenoptera	Apoidea	Apidae	Xylocopinae	*Xylocopa (Lestis) bombylans*	1		
22.Oct.2023	Pollinator	Bee	Hymenoptera	Apoidea	Halictidae	Halictinae	*Lasioglossum (Chilalictus) instabilis?*	1		
22.Oct.2023	Pollinator	Bee	Hymenoptera	Apoidea	Halictidae	Halictinae	*Lipotriches (Austronomia) satelles M + mites on thorax*	1		
22.Oct.2023	Pollinator	Bee	Hymenoptera	Apoidea	Halictidae	Halictinae	*Lipotriches (Austronomia) muscosa*	1		

22.Oct.2023	Pollinator?	Beetle	Coleoptera	Buprestoidea	Buprestidae	Buprestinae	*Stigmodera porosa*	1		
22.Oct.2023	Defoliator	Beetle	Coleoptera	Chrysomeloidea	Chrysomelidae		*Chrysomelidae sp.*			1
22.Oct.2023	Pollinator?	Beetle	Coleoptera	Curculionoidea			*Curculionoidea sp.*			4
22.Oct.2023	Pollinator?	Fly	Diptera	Tabanoidea	Tabanidae		*Tabanidae sp.*			1
22.Oct.2023	Pollinator?	Fly	Diptera				*Diptera sp.*			20
22.Oct.2023	Defoliator	Orthoptera	Orthoptera				*Orthoptera spp.*			3
22.Oct.2023	Predator	Spider	Araneae				*Arachnid*			2
22.Oct.2023	Parasitoid	Wasp	Hymenoptera	Chalcidoidea	Chalcididae	Chalcidinae	*Brachymeria podagrica*			1
22.Oct.2023	Parasitoid	Wasp	Hymenoptera	Chrysidoidea	Chrysididae	Chrysidinae	*Stilbum cyanurum*			1
22.Oct.2023	Parasitoid	Wasp	Hymenoptera	Ichneumonoidea	Ichneumonidae	Banchinae	*Leptobatopsis sp.*	1		
22.Oct.2023	Parasitoid	Wasp	Hymenoptera	Vespoidea	Mutillidae		*Mutillidae sp.*			2
22.Oct.2023	Predator	Wasp	Hymenoptera	Vespoidea	Pompilidae	Pespinae	*Cryptocheilus bicolor*			1
22.Oct.2023	Predator	Wasp	Hymenoptera	Vespoidea	Vespidae	Eumeninae	*Paralastor sp.*		1	
24.Nov.2023	Pollinator	Bee	Hymenoptera	Apoidea	Apidae	Xylocopinae	*Xylocopa (Lestis) bombylans*	1		
24.Nov.2023	Parasitoid	Wasp	Hymenoptera	Chalcidoidea	Eupelmidae		*Eupelmidae sp.*			1

24.Nov.2023	Predator	Wasp	Hymenoptera	Vespoidea	Eumenidae		*Paralastor sp.*	1		
27.Dec.2023	Nutrient cycling	Ant	Hymenoptera	Vespoidea	Formicidae		*Formicidae*		20	
27.Dec.2023	Pollinator	Bee	Hymenoptera	Apoidea	Apidae	Apinae	*Austroplebeia australis*	5		
27.Dec.2023	Pollinator	Bee	Hymenoptera	Apoidea	Apidae	Apinae	*Amegilla (Zonamegilla) cingulata*	1		
27.Dec.2023	Pollinator	Bee	Hymenoptera	Apoidea	Colletidae	Hylaeinae	*Hylaeus (Rhodohylaeus) cf. lateralis*	2		
27.Dec.2023	Pollinator	Bee	Hymenoptera	Apoidea	Colletidae	Hylaeinae	*Hylaeus (Hylaeorhiza) nubilosus*	1		
27.Dec.2023	Pollinator?	Beetle	Coleoptera	Buprestoidea	Buprestidae	Buprestinae	*Castiarina sp.*	1		
27.Dec.2023	Pollinator?	Fly	Diptera				*Diptera sp.*		1	
27.Dec.2023	Pollinator	Moth	Lepidoptera				*Lepidoptera sp.*		1	
27.Dec.2023	Predator	Wasp	Hymenoptera	Apoidea	Crabronidae		*Cerceris sp.*	1		
27.Dec.2023	Predator	Wasp	Hymenoptera	Apoidea	Crabronidae		*Cabronidae sp.*			1
27.Dec.2023	Parasitoid	Wasp	Hymenoptera	Chalcidoidea	Chalcididae		*Brachymera sp.*	1		
27.Dec.2023	Parasitoid	Wasp	Hymenoptera	Evanoidea	Gasteruptiidae	Gasteruptiinae	*Gasteruption sp.*	1		
27.Dec.2023	Parasitoid	Wasp	Hymenoptera	Evanoidea	Gasteruptiidae		*Gasteruptiidae sp.*		1	
27.Dec.2023	Parasitoid	Wasp	Hymenoptera	Thynnoidea	Thynnoidea		*Thynnoidea sp.*	2		

27.Dec.2023	Predator	Wasp	Hymenoptera	Vespoidea	Pompilidae		*Cryptocheilus bicolor*	1		
27.Dec.2023	Parasitoid	Wasp	Hymenoptera	Vespoidea	Tiphiidae		*Tiphiidae*	2		
6.Jan.2024	Nutrient cycling	Cockroach	Blattodea	Blaberoidea	Pseudophyllodromiidae		*Ellipsidion humerale*			1
6.Jan.2024	Pollinator	Moth	Lepidoptera	Noctuidea	Erebidae	Arctiinae	*Asura bipars*			1
11.Feb.2024	Nutrient cycling	Ant	Hymenoptera	Vespoidea	Formicidae		*Formicidae*		10	
11.Feb.2024	Pollinator	Bee	Hymenoptera	Apoidea	Apidae	Apinae	*Tetragonula carbonaria*	1		
11.Feb.2024	Pollinator	Bee	Hymenoptera	Apoidea	Megachilidae	Megachilinae	*Megachile hackeri*	1		
11.Feb.2024	Pollinator?	Beetle	Coleoptera	Buprestoidea	Buprestidae	Agrilinae	*Diphucrania duodecimmaculata*	3		
11.Feb.2024	Predator	Wasp	Hymenoptera	Apoidea	Crabronidae		*Crabronidae sp*			1
11.Feb.2024	Parasitoid	Wasp	Hymenoptera	Chalcidoidea	Chalcididae		*Chalcididae sp.*			1
11.Feb.2024	Predator	Wasp	Hymenoptera	Vespoidea	Vespidae	Polistinae	*Rhopalidia fasciata*	1		
24.March.2024	Nutrient cycling	Ant	Hymenoptera	Vespoidea	Formicidae		*Formicidae*		6	3
24.March.2024	Pollinator	Moth	Lepidoptera				*Lepidoptera sp.*		2	1
							Total	**43**	**45**	**67**

Native bees and UFOs

When we consider the target group, bees, they were exclusively collected by TSN, except for three *Apis mellifera*. Focussing on bees, a total of 30 specimens were collected belonging to fifteen species (Table 2); of these 25 individuals were native bees. One was a UFO – an unidentified species, a tiny Hylaeus - *Hylaeus "MRNP sp.1"*, collected in September.

All species were in relatively low abundances, but sweepnetting was also conducted over a relatively short period (15 mins in total). Apidae were the most commonly bee encountered. Only a single megachilid was collected, in February. Bee activity was greatest in October and February, and absent in January and March surveys due to the unfavourable weather on those survey days.

Table 2. Bees collected by sweepnetting surveys by Dr Kit Prendergast at Mooloolah River National Park Sept – March.

				Netting technique		
Date	**Family**	**Subfamily**	**Species**	**Targeted hand-netting (THN)**	**Floral sweep-netting (FSN)**	**Line transect sweeps (LTS)**
24.Sept.2023	Colletidae	Apinae	*Apis mellifera*	2	3	
24.Sept.2023	Colletidae	Hylaeinae	*Hylaeus "MRNP sp.1"*	1		
24.Sept.2023	Colletidae	Hylaeinae	*Hylaeus (Euprosopoides) cyanurus*	5		
22.Oct.2023	Apidae	Apinae	*Tetragonula carbonaria*	1		
22.Oct.2023	Apidae	Xylocopinae	*Xylocopa (Lestis) aerata*	1		
22.Oct.2023	Apidae	Xylocopinae	*Xylocopa (Lestis) bombylans*	1		
22.Oct.2023	Halictidae	Halictinae	*Lasioglossum (Chilalictus) instabilis?*	1		
22.Oct.2023	Halictidae	Halictinae	*Lipotriches (Austronomia) satelles M + mites on thorax*	1		

22.Oct.2023	Halictidae	Halictinae	*Lipotriches (Austronomia) muscosa*	1		
24.Nov.2023	Apidae	Xylocopinae	*Xylocopa (Lestis) bombylans*	1		
27.Dec.2023	Apidae	Apinae	*Austroplebeia australis*	5		
27.Dec.2023	Apidae	Apinae	*Amegilla (Zonamegilla) cingulata*	1		
27.Dec.2023	Colletidae	Hylaeinae	*Hylaeus (Rhodohylaeus) cf. lateralis*	2		
27.Dec.2023	Colletidae	Hylaeinae	*Hylaeus (Hylaeorhiza) nubilosus*	1		
11.Feb.2024	Apidae	Apinae	*Tetragonula carbonaria*	1		
11.Feb.2024	Megachilidae	Megachilinae	*Megachile hackeri*	1		
			Total	**26**	**3**	**0**

Community results

Insect observations

No community members attended the December session, either due to holiday commitments, or avoiding the hot weather. However, the UFO coordinators attended and conducted the community surveys. Due to heavy rain, the community surveys were not conducted in January. Combining all community surveys, a total of 294 invertebrates (insects and arachnids) were recorded during the targeted 30 min plant observations (Appendix A). The most frequently observed insect on flowers were ants (104), followed by beetles (36), flies (35), and wasps (34). When it came to bees, 25 *Apis mellifera* were observed and 20 native bees. However, excluding observations by Dr Kit and Jess, only 5 native bees were recorded by the community scientists.

The community phenology results differed from the expert results largely due to the abundance of ants recorded (Fig. 4). Species composition also differed, which partly can be explained by the native bee focus of the target surveys, but also non-Formicidae Hymenoptera appeared to be relatively underrepresented.

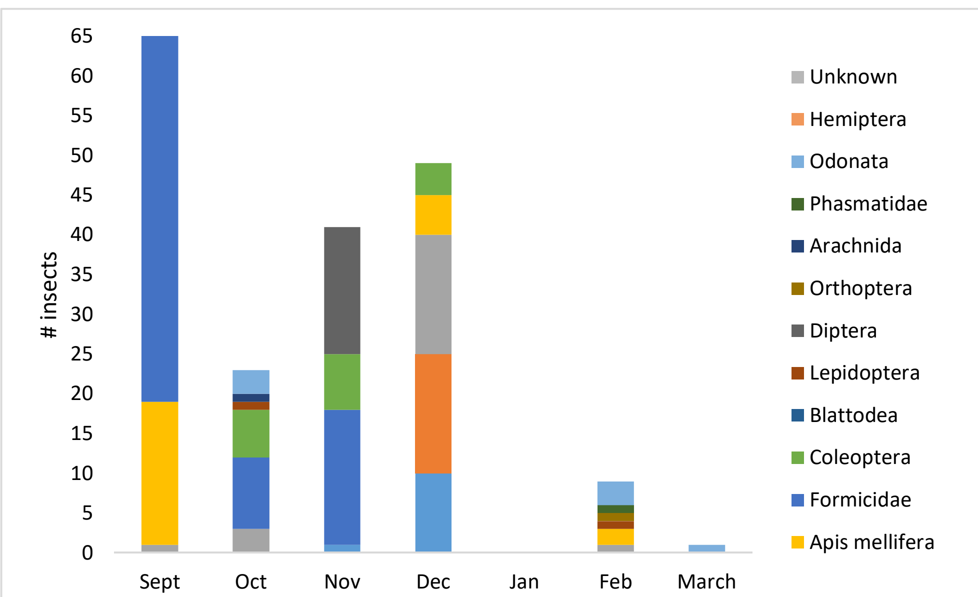

Fig. 4. Relative abundance of different taxa recorded by citizen scientists participating in the Identifying UFOs Team at Mooloolah River National Park each month.

Unfortunately only five participants (excluding Dr Kit Prendergast and MRLC coordinator Jessica Raintree) submitted observations to the iNaturalist project, and the majority of observations were by the two project coordinators. However, a phasmid found by one of the community scientists in February (Matt Kilburn) and uploaded to iNaturalist by Dr Kit Prendergast excitingly appears to be another UFO at MRNP, an undescribed species of *Paracandovia* (Fig. 5)

Fig. 5. Undescribed species of *Paracandovia* (Phasmida)

Plant-insect interactions

Pollination networks from TSN surveys

Pollination networks, constructed from TSN specimens and additional observations by Dr Kit whilst participating in the 30 min flower observation, are presented in Appendix B. Pollinators, when present, were collected from one to four plant species each survey. The most attractive plant was Leptospermaceae, which flowered Sept – Nov. In December, *Baekea frutescens* was the most attractive plant, and in February, *Epacris pulchella*. *Banksia robur*, whilst scarce (only a few flower heads in bloom) nevertheless attracted insects where present.

Plant and insect surveys by citizen scientists

24 plant species in flower were present along the transect. Flower abundance varied greatly, from one to 10,000 flowers per species. When two participants surveyed the same species, it should be noted estimates varied between participants (Appendix A). Number of plant species varied from 6 in

September, 5 in October, 8 in November, 7 in December, 6 in February, and 6 in March (Appendix A). The most highly-visited plant species was *Baekea frutescens* in December (41 invertebrates), followed by Leptospermaceae in November (36 invertebrates), and September (31 invertebrates) (Appendix A).

Discussion

Targeted sweepnetting collected the greatest number and diversity of bees. This suggests that catching bees is not a random procedure but requires seeing the individual and sweeping in a way that anticipates collecting it in the net. In contrast, smaller non-bee taxa were more likely to be collected during the line transect sweeps, likely due to how many insects will be perching on vegetation or, if predatory, seeking prey, on vegetation that may not be in flower. It should be acknowledged that the effectiveness of different sweepnetting techniques may vary by habitat: in a dense, uniform field of highly attractive bee-preferred flowers, floral sweep-netting or even line transect sweeps may catch more bees.

Despite the much shorter time period (15 mins across all plants vs. 30 mins for a number of plants), and the constraint of not netting all species observed, a greater number of native bees were collected by Dr Kit (25) compared with the community observations (5 bees). This suggests there can be discrepancies between expert observations vs. those of the community, possibly due to misidentification or missing see them due to not having a 'search image'. Similar patterns have been reported in previous studies comparing expert vs. citizen science bee observations (Kremen, Ullman, & Thorp, 2011). In addition, identification to finer taxonomic levels is not possible from observation alone (K. Prendergast et al., 2020). Future actions to improve results could be intensive training sessions prior to conducting the field work (Mason & Arathi, 2019; Ratnieks et al., 2016).

Nevertheless citizen science projects have numerous benefits, that this one demonstrated. Firstly, it allowed citizens, especially children, to meet a scientist and woman in STEM, which is important for inspiring girls into STEM subjects (González-Pérez, Mateos de Cabo, & Sáinz, 2020; Jackson & Spencer, 2017). It also allowed participants to be involved in real world science practices. Often citizen science projects involve haphazard collection, or durations of observation that are too short to get a good picture of visitation, whereas observing a single plant species for 30 mins over months is more typical of scientific studies. They also were able to not only observe insects but were mentored in the field in their diversity, identification and ecology (K. Prendergast et al., 2021). Participants also by participating experienced a National Park and the attendant benefits of being in nature have (Ramkissoon, Mavondo, & Uysal, 2018). By having numerous individuals collect data, it enabled simultaneous data collection which would not have been possible had a single person bee making 30 min observations of each plant. The Identifying UFOs underscored the 'taxonomic impediment' and revealed that many insects visitor flowers and can serve as pollinators. Overall, we believe our project contributed to changes in community knowledge, attitudes, behaviour, and scientific understanding of plant-insect interactions and ecological methodology.

Despite being ideal insect conditions, no community members participated in the December survey. It is a common phenomenon where insect activity is high on warm, sunny days, which may exceed the 'comfort' zone of most humans. Bees tend to not forage when it rains e.g. (Sanderson, Goffe, & Leifert, 2015)(Prendergast, pers. obs) and prefer warmer weather (Kit S Prendergast, Leclercq, & Vereecken, 2021). Rainfall especially led to a decrease in pollinator activity in this study.

Looking at the taxonomic composition, certain taxa that are typical of bee assemblages such as *Lasioglossum (Homalictus)* and *Leioproctus* were absent. There were also no kleptoparasitic bees (i.e. *Coleoxyis, Thyreus*). Of interest was the high representation of *Xylocopa (Lestis)*, including the rarer species *X. aerata,* indicating this area represents good habitat for them.

What was also positive to see was the relative scarcity of the introduced European honeybee *Apis mellifera. A. mellifera* is an introduced species that can harm native bees, competing with them for floral resources (Kit S. Prendergast, Dixon, & Bateman, 2022; Kit S. Prendergast & Ollerton, 2022).

One "UFO", a *Hylaeus s*pecies, was discovered. Future research to describe this species would involve seeking funding to cross-check with Museum specimens (as many species have been collected, but remain undescribed) to determine if there have been other collections of this species, having it DNA barcoded, and writing up a taxonomic description.

We also discovered another 'UFO' – an undescribed species of *Paraclava* phasmid. Despite attempts to collect a female to aid in a phasmid expert IDing it we were unable to locate one, but future collections in Nov – Feb would be valuable. We hope to send it to the QLD Museum to aid in future taxonomic work.

The community science aspect was an amazing opportunity to connect diverse insect enthusiasts of all demographics with a professional entomologist, and allow them to undertake surveys that replicate real pollinator surveys, requiring timed periods of observing a particular plant species and recording floral abundance, and identifying different insect taxa. There were clear educational benefits, as expressed from participants (Fig. 1f).

The community science component also allowed standardised records of what flowers were and were not visited, and by what taxa. It importantly revealed that not all flowering species are 'equal' in attractiveness to insects, something well-known among pollination biologist, but often obscured in the simplistic mantra of 'plant it and they will come' when it comes to popular media on gardening for pollinators. The relative attractiveness of plant species were also encouragingly similar between the targeted sweep-netting and citizen science observations. The community science results indicated many plants were not visited by bees, the stereotypical pollinators, and that a diverse array of insects, both pollinators and non-pollinators, can be present on flowers. Formicidae were the most commonly recorded insect in the community observations. Whilst ants can be pollinators (Das & Das, 2023), in the majority of cases they are nectar thieves (Junker & Blüthgen, 2008), and can even dissuade pollinators (Villamil, Boege, & Stone, 2018).

Appendices

Appendix A. UFO Identification team community science plant and insect visitor data

Appendix B. Pollinator-plant networks per month from TSN surveys

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