Potential pollinators of the Critically Endangered

Marianthus aquilonaris

Follow-up survey September 2021

Leioproctus "Marianthus" sp. – native bee species visiting *Marianthus aquilonaris.* Photography by Dr Kit Prendergast

By Dr Kit Prendergast (native bee ecologist)

On behalf of Botanica Consulting

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SUMMARY

Marianthus aquilonaris is a critically endangered flowering plant restricted to the Bremer Range region in Western Australia. While the populations are only a few hundred meters away from each other, genetic work has suggested little gene flow between populations. The mating system, pollen vector(s), and pollinator assemblage that visits this species is unknown. The first survey in 2019 occurred outside the main flowering season; consequently, the populations were again surveyed on September 7th, 2021. Despite being in peak flower, the plants received few visits, and insects, especially native bees, were scarce across locations, both in terms of visitors to the plants, as well as being uncommon across the landscape. Eighteen specimens were collected from *M. aquilonaris,* with the most frequent visitor being the introduced *Apis mellifera.* Flies, a wasp, and butterflies also were visitors, as well as a single native bee. Twelve other native bee specimens belonging to nine species were collected from other flowering plants around the populations. Ongoing monitoring is required to determine the assemblage of insect visitors, and which serve as pollen vectors. From the limited data recorded to date on flower-visiting insects of *M. aquilonaris,* this species appears to have a generalised pollination system, and an abundant, diverse insect assemblage in the surroundings may be important for pollination to occur.

INTRODUCTION

Marianthus aquilonaris N. Gibson & Wege 2009 (Pittosporaceae) is a flowering plant species that occurs only in one location in south-west Western Australia, in an area near a proposed gold mine. *M. aquilonaris* was declared as Rare Flora under the Western Australian *Wildlife Conservation Act 1950* in 2002 (under the name *Marianthus* sp. Bremer (N. Gibson & M. Lyons 1776), and is ranked as Critically Endangered (CR) under the International Union for Conservation of Nature (IUCN 2001) criteria B1ab(iii,v)+2ab(iii,v); C2a(ii) due to its extent of occurrence being less than 100 km2, its area of occupancy being less than 10 km2, a continuing decline in the area, extent and/or quality of its habitat and number of mature individuals and there being less than 250 mature individuals known at the time of ranking. Despite its listing as CR under the *Western Australian Biodiversity Conservation Act 2016*, the species is not currently listed under the *Environment Protection and Biodiversity Conservation Act 1999*. The main threats to the species are mining/exploration, track maintenance and inappropriate fire regimes (DEC, 2010). *M. aquilonaris* is known to occur only in the Bremer Range, which is listed as a Priority 1 Ecological Community (PEC) - the Plant assemblages of the Bremer Range System (DEC 2010) - located approximately 100 km west, south-west of Norseman, Western Australia

(Appendix 1, sourced from Pick, 2020). The extent of occurrence is likely to be less than 0.5 km2 (DEC, 2010). The habitat is open woodland with a sparse understorey (DEC 2010). Further survey work has identified more plants, with the most recent estimate being 5,712 *M. aquilonaris* plants distributed across five subpopulation's (Pick, 2020). All sub-populations are considered to be important to the conservation of the species, and occur on unvested, Unallocated Crown Land (DEC 2020). Field surveys within the Bremer Ranges have recorded 411 plant species (Pick, 2017).

M. aquilonaris is an erect, straggly shrub that grows to 1.6 m high (DEC 2010). It has hirsute stems, with alternate, elliptic to oblong leaves, a glabrous calyx, and a pale blue and white corolla (Wege and Gibson, 2009). It flowers between September and October (austral spring) (Wege and Gibson, 2009). The nectar quality and quantity of this species has not been assessed, however related species produce nectar, and attract flower-visiting insects such as bees (Armstrong, 1979; Carolin & Bittrich, 2018). However, for this particular species, the mating system, and assemblage of insects that visit this species for nutrition, and may act as pollen vectors, are unknown.

Pollinators are a critical part in the conservation of most angiosperms. Knowledge of the pollination system and, if insect pollinated, pollinating taxa of flowering plant species are a vital component of effective conservation (Bond, 1994; A. K. Prendergast, 2010; Wilcock & Neiland, 2002). Failure to consider pollinators and ensuring that there are abundant pollinators in the region of a target species can mean that plant populations fail to reproduce, or suffer from inbreeding depression (Wilcock & Neiland, 2002). Of all insects, bees tend to be the most effective of pollinators (Willmer et al., 2017). Australia has an estimated 2,000 species of native bees, and however a large number of these are undescribed, and the habitat and resource requirements of a large proportion of species are unknown (Batley & Hogendoorn, 2009). This situation is mirrored in Western Australia, where over 560 described species have been recorded (PaDIL 2021), however for many species their ecology is poorly known, and there are many species that have yet to be described (e.g. Prendergast, 2020), as well as many regions that have been scarcely surveyed - if at all.

The first pollinator survey of *M. aquilonaris* were conducted by Dr Kit Prendergast Oct 2 – 4th (K. Prendergast, 2019). Despite the plants having largely ceased flowering, ten insects belonging to eight species visited *M. aquilonaris:* a tiny undescribed euryglossine bee (Colletidae: Euryglossinae, *Xanthesma* undescribed sp. 60, male), two *Lasioglossum* species (*Lasioglossum (Chilalictus) castor*, female, and *Lasioglossum (Chilalictus) florale*, male and female), and three *Megachile* species (*Megachile maculosipes*, male, an undescribed species, *Megachile* 66 F "shelf clypeus", female), and one undescribed *Megachile* (*Megachile* 65 F "prongs", female), two tiny unidentified flies (*Geron* sp., Bombyliidae) and an unidentified hoverfly (Syrphidae). In addition, a rich diversity of native bees (310 bees belonging to 45 species) were collected from *Eucalyptus livida* which was flowering in the vicinity of the *M. aquilonaris*.

Due to missing the main flowering period of *M. aquilonaris* in this first survey, it was conceivable that the main pollinators were not observed, and more visits to the *M. aquilonaris* would be observed when it was flowering. In addition, numerous plants are known to undergo network rewiring between years (Alarcón, Waser, & Ollerton, 2008; Noreika, Bartomeus, Winsa, Bommarco, & Öckinger, 2019), and thus a single survey year is unlikely to capture all pollinators. A subsequent survey was therefore conducted to better understand the potential pollinators of this critically endangered plant.

METHODS and MATERIALS

The five major sub-populations of *M. aquilonaris* (sub-population A, B, C, D, E) (Appendix 1, Fig. 1) were surveyed by native bee ecologist Dr Kit Prendergast on the 7th September 2021, which corresponds to peak bloom of this species (September). Having the same native bee ecologist survey the sub-population during the present survey ensured that results could be validly compared with surveys conducted two years ago, and prevents any differences between the two survey events being attributable to inter-observer error. Similar to the previous survey (Prendergast, 2019), each population was surveyed for one hour during peak bee activity period (10:00am – 4:00pm). Briefly, the surveyor (KP) walked slowly and randomly around each population, stopping to observe all plants in flower.

All insects that visited the flowers of *M. aquilonaris* were collected with an entomological sweep-net. In addition, any native bees visiting flowering plants in the vicinity of *M. aquilonaris* were also collected. Native bees were targeted here due to how they are known to be the pollinators of related *Marianthus* (Armstrong, 1979), and how bees tend to be the main pollinators of plants in this family (Carolin & Bittrich, 2018). Sweep-netting was used as the survey method, as this method is the most effect for collecting native bees (K. Prendergast, Menz, Bateman, & Dixon, 2020), and unlike passive methods (e.g. coloured traps), enables insect-plant interactions to be determined (K. S. Prendergast & Hogendoorn, 2021) and does not suffer from habitat type biases to the extent that passive methods do (K. S. Prendergast & Hogendoorn, 2021) – namely, where passive methods collect more species in resource-poor environments (Prendergast & Hogendoorn, 2021). Each insect was transferred from the sweep-net into a specimen jar and stored in a freezer until pinned and identified by Dr Kit Prendergast. All specimens are deposited in the WA Museum Entomological collection.

RESULTS

A total of 31 specimens were collected. Eighteen of these specimens were collected from *M. aquilonaris.* The most frequent visitor was the introduced *Apis mellifera.* In addition, six flies from four families, one wasp, two butterflies from two families, and one native bee – an undescribed *Leioproctus* were collected foraging on *M. aquilonaris* (Table 1). An additional thirteen native bees belonging to ten species, including one specimen of the *Leioproctus* collected on *M. aquilonaris* were collected from four species of flowering plants located within the population boundaries of *M. aquilonaris* populations (Table 2).

The collection of *Leioproctus (Zosterocolletes) worsfoldi* is of interest, as this represents a new distribution record. The closest this species has been collected to the present locality is 18 km south of Lake King, which is approximately 158 km southwest of the Bremer Range region where the specimen was presently collected (ALA, 2021). Moreover, there are only seven recorded collections of this species, two in September 1926, four in September 2004 and one in 2009 (ALA, 2021). Therefore, this species has not been collected in over a decade.
Four native bee species could not be identified to described species (Table 2), and therefore may represent undescribed species, or new species.

Table 1. Visitors to *Marianthus aquilonaris* populations collected 7th September 2021 by Dr Kit Prendergast.

Species	**Order, Family**	***Marianthus aquilonaris* population**	**Number**	**Total number across populations**
Apis mellifera (worker)	Hymenoptera, Apidae	A	2	7
		B	1	
		C	2	
		D	2	
Leioproctus "Marianthus" sp. (male)	Hymenoptera, Collectidae	C	1	1

Anomaloninae sp.	Hymenoptera, Ichneumonidae	B	1	1
Geron sp.	Diptera, Bombyliidae	E	1	1
Nigromyia sp.	Diptera, Bombyliidae	C	1	1
Calliphoridae sp.1	Diptera, Calliphoridae	E	2	3
		C	1	
Calliphoridae sp.2	Diptera, Calliphoridae	D	1	1
Muscidae sp.	Diptera, Muscidae	D	1	1
Motasingha dirphia	Lepidotera, Hesperiidae: Trapezitinae	B	1	1
Nacaduba biocellata	Lepidoptera, Lycaenidae	A	1	1

Table 2. Native bee specimens collected in the region of *Marianthus aquilonaris* populations on 7th September 2021 by Dr Kit Prendergast.

Family	**Species**	**Sex**	**N**	**Host flower**	***Marianthus aquilonaris* population**	**Total**
Colletidae	*Leioproctus "Maquilonaris" sp.*	male	1	*Marianthus aquilonaris*	C	2
	Leioproctus "Maquilonaris" sp.	male	1	*Eremophila caerulea* subsp. *caerulea*	B	

Family	Species	Sex	N	Host flower	***Marianthus aquilonaris* population**	Total
	Leioproctus (Zosterocolletes) worsfoldi	female	1	*Melaleuca pauperiflora* subsp. *pauperiflora*	E	1
	Hylaeus (Euprosopellus) chrysaspis	male	1	*Melaleuca pauperiflora* subsp. *pauperiflora*	E	1
	Hylaeus (Euprosopis) violaceus	female	1	*Melaleuca pauperiflora* subsp. *pauperiflora*	E	1
	Hylaeus (Gnathoprosopis) amiculus	female	1	*Melaleuca pauperiflora* subsp. *pauperiflora*	E	1
	Hylaeus (Pseudhylaeus) sp."LakeJohnston"	male	2	*Melaleuca pauperiflora* subsp. *pauperiflora*	E	2
	Trichocolletes centralis	female	1	*Daviesia sp.*	B	1
Halictidae	*Lasioglossum (Chilalictus) greavesi*	male	1	*Eremophila interstans*	C	1
	Homalictus "LakeJohnston" sp.	female	1	*Eremophila caerulea* subsp. *caerulea*	B	1
Megachilidae	*Megachile sp."LakeJohnston"*	male	2	*Eremophila caerulea* subsp. *caerulea*	B	2

During the present survey, *M. aquilonaris* was one of the most abundantly flowering plant species. No *Eucalyptus* were in flower. There was not a high diversity of other plants in flower, the main ones being *Eremophila interstans,* and to a lesser extent, *Eremophila caerulea* subsp. *caerulea,* and *Melaleuca pauperiflora* subsp. *pauperiflora.*

DISCUSSION

Of the insects collected visiting *M. aquilonaris* during the present survey, only two species were also collected during the previous pollinator survey, suggesting high turnover and low fidelity of any one insect taxon to this plant. Whether this high turnover is due to fluctuations between years, or differences between months, requires ongoing surveys conducted over the same months.

The present survey, when combined with the previous surveys in 2019 (K. Prendergast, 2019), revealed a diverse array of insect taxa with *M. aquilonaris,* however infrequently and at low abundances. This may indicate a generalised pollinator system. Despite the plants being in peak flower during the present survey, even fewer native bees visited the plants than the previous survey when only a few plants were sparsely flowering. The low attractiveness of the plant remains to be determined. It does not emit any strong odours, by human perception at least, unlike some other Pittosporaceae (Carolin & Bittrich, 2018). It may trade-off a generalist pollination strategy (Benadi, Blüthgen, Hovestadt, & Poethke, 2013) with not being highly attractive to any one taxon.

The high diversity of taxa visiting this plant is at odds with genetic work that indicates limited gene flow between sub-populations (Pick, 2020). The most frequent visitor during present surveys, the introduced European honeybee *Apis mellifera,* has the potential to forage very large distances – an average of 1.5 km, but up to 10 km (Steffan-Dewenter & Kuhn, 2003). This far exceeds the distance between the sub-populations of *M. aquilonaris,* and results of genetic structuring even between sub-populations separated by approx. 500m (Pick, 2020). However, honeybees were not observed visiting the plant, nor any flora, during the previous survey (K. Prendergast, 2019). The reason for the appearance of *A. mellifera* during the present surveys is unknown, but if may be that swarms have become established from managed or feral colonies in the wider landscape.

Only a fraction of native bees was collected during the present survey compared with the previous survey. This was due to the major resource from which species were collected previously, *Eucalyptus livida*, not being in flower. Furthermore, no buds were present, and it would appear that, like many Eucalypts, this species does not flower annually (Birtchnell & Gibson, 2006). The lack of any monitoring of the native bee assemblages here means that we can only speculate about whether the native bee sub-population goes through boom and bust cycles in line with the flowering of this keystone resource (e.g. (Popic, 2013)), or whether we are seeing a drop in the native bee sub-populations (Roubik, 2001). This may be due to low rainfall in the previous year (Descamps, Quinet, & Jacquemart, 2020; Mayer & Kuhlmann, 2004) and now an unusually wet winter (BOM, 2021) which may have altered the bee-plant phenology (Forrest, 2015; Kudo & Cooper, 2019), or competition from the introduced *A. mellifera* (Prendergast, Dixon & Bateman, 2021). Further surveys when the *E. livida* flowers again are required to determine whether this is a normal part of the pollinator assemblages.

It may be that the highly variable, erratic nature of the pollinator assemblage here means that cross-pollination between sub-populations is a rare event. Additionally, varying pollinator effectiveness, and low pollinator fidelity (i.e. if visited by generalist species that do not display flower constancy, they may dilute pollen), can lead to reduced pollination (Fisogni et al., 2016; Pellmyr & Thompson 1996; Wolf et al., 1986). These factors may explain the high genetic division between the sub-populations (Pick, 2020). Hence the pollination strategy is such that there is visitation by insects despite the variable and unpredictable nature of the pollinator assemblage, which ensures some pollination, with the trade-off that the out-crossing rate is low.

Despite *M. aquilonaris* representing one of the most abundantly-flowering resources during the present study, even fewer insects, and certainly native bees, were observed foraging on the plants compared with the previous survey when only a few flowers were in bloom. It may be that the *E. livida* facilitates visitation to *M. aquilonaris* via a spill-over effect (Laverty, 1992). Indeed, some bees visiting *M. aquilonaris* were also collected from *E. livida.*

Actions to increase pollinator population abundance, such as through conservation of nesting and co-foraging flora may be important for the persistence of *M. aquilonaris.* This is critical given a decline in the number of adult plants over the past decade, the limited gene flow currently observed between populations, and the low, variable fruit set (Pick, 2020). Percentage of fruiting plants in Spring 2018 ranged from 11% (Population E) to 38% (Population B), while in Spring 2019, only one quadrat from Population D (Q1-2) had fruits (Pick, 2020).

The data to date suggest that this species has a generalised pollination system and that to ensure pollination over space and time, a functioning ecosystem with a diverse suite of pollinators and their alterative flowering resources are required if this species is to persist.

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APPENDICES

Appendix 1. Locations of *Marianthus aquilonaris* sub-populations

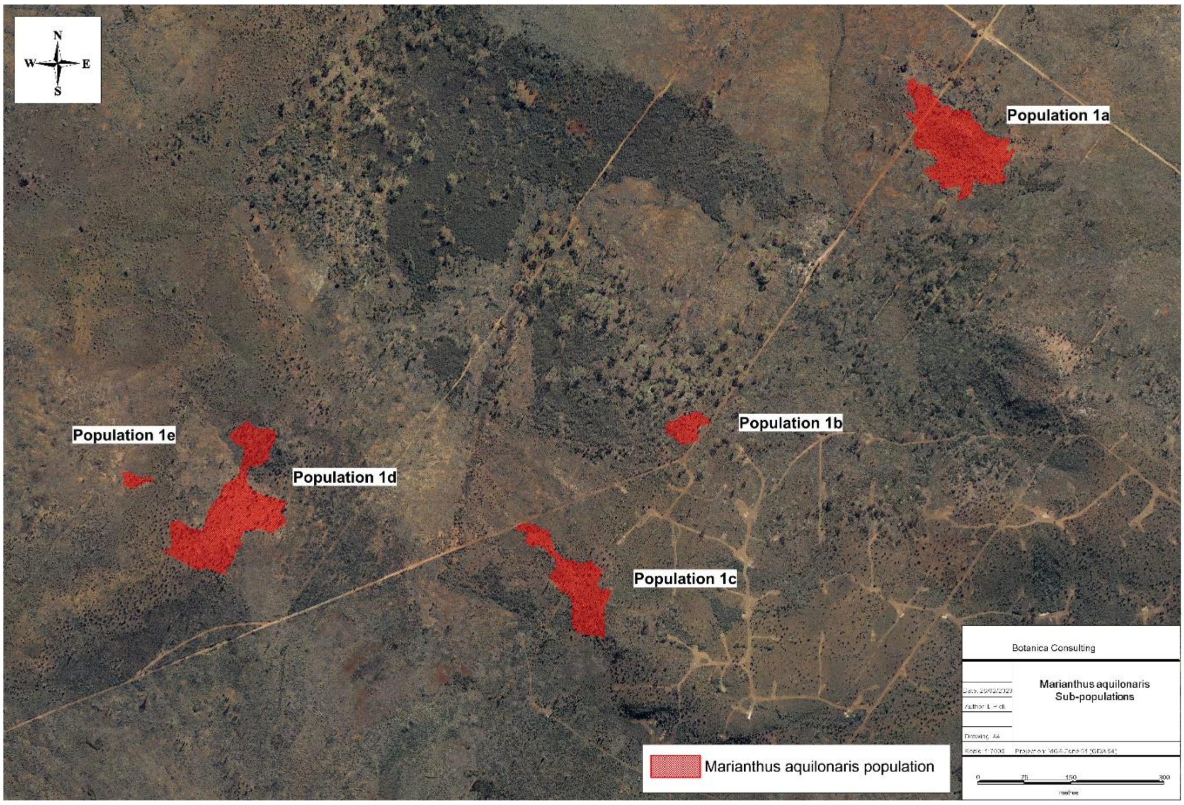

Fig. 1. Five major sub-populations of *Marianthus aquilonaris*