NECTAR-ROBBING BEHAVIOUR BY HONEY BEES ON *ALSTROEMERIA PSITTACINA*

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Summary

Nectar-robbing behaviour by honey bees, *Apis mellifera* L., was observed on parrot lilies, *Alstroemeria psittacina* Lehm., in a garden in Beecroft NSW in December 2022. Bees approaching the base of the flower alighted briefly and inserted their mouthparts between the petals and sepals, but no biting behaviour was observed. In a survey of flowers, about half were found to have sections bitten out of the base of petals, the most likely agents being small black ants. Despite the extensive nectar-robbing, pollination of the flowers was successful in nearly all cases, indicating that nectar-robbing had no detrimental effect. The structure and development of the flowers were studied and it was notable that the stamens retained their pollen caps until they hung below the opening of the corolla, making unaided self-pollination unlikely. Individual bees approached the mouth or the base of the flowers. Experiments set up in November 2023 did not clarify whether the bees were robbers, thieves or both, because of the scarcity of bees following *Varroa* mite introduction. Pollination rates were lower than in the previous season. I concluded that both bees and ants were nectar robbers. Their behaviour did not affect pollination in 2022, but pollination was reduced in late 2023 when bee numbers were low.

Key words: pollination, ants, nectar thieves, *Varroa* mite

INTRODUCTION

Nectar-robbing is a process in which bees or other pollinators obtain nectar without contacting female parts of the flower and therefore do not provide pollination services. There is a large body of recent literature on the topic. Irwin *et al*. (2010) reviewed evolutionary aspects of the relationship between plants and nectar robbers. Lichtenberg *et al*. (2020) observed that individual bumblebees showed either nectar-robbing or "legitimate" behaviour, but not usually both. Andalo *et al*. (2019) showed experimentally that nectar robbing did not affect seed production in *Antirrhinum*. Rojas-Nossa *et al*. (2021) studied the effects of nectar robbers on reproductive success of honeysuckle plants, concluding that the effects of nectar-robbers could be neutral. In contrast, Kohl and Steffan-Dewenter (2022) found that in some circumstances, related to elevation, nectar-robbers significantly reduced seed production. Some authors distinguish between nectar-robbers and nectar-thieves, the latter making use of holes made by other insects, but the term is not used consistently. For example, Peach and Gries (2016) refer to mosquitoes as potential nectar thieves although their feeding is direct, rather than facilitated by a robber as defined above. Relationships among nectar robbers, nectar thieves, "legitimate" feeders and pollination can be complex and require experimental analysis (Zhang *et al*. 2014). The presence of nectar thieves or robbers can have unexpected effects on other pollinators. Bees, especially bumblebees, generally gain entry to the bases of flowers via holes made with their mandibles, or holes made by other robbers, often unidentified, but including carpenter bees (Dedej and Delaplane, 2004).

Leonard *et al*. (2013) discussed the role of honey guides on flowers in modifying the behaviour of potential nectar robbers, and used a cultivar of *Alstroemeria* as a model flower. The possibility that flower damage by robbers might affect the visual or physiological attractiveness of flowers to legitimate pollinators was experimentally discounted by de Souza *et al*. (2019). There are many other observational and experimental studies on interactions among plants, robbers, thieves and legitimate pollinators.

Alstroemeria psittacina Lehm. is a weed pest of pastures in eastern NSW and is toxic to livestock. It can self-pollinate but still produces large amounts of nectar, attractive to bees and ants. Self-pollination is possible in *Alstroemeria* (Bridgen, 2018) and asexual reproduction occurs by budding from tubers or rhizomes. In late 2022, honey bees, *Apis mellifera* L. were seen apparently nectar-robbing flowers of *A. psittacina* in a garden in Beecroft NSW. Observations were made until most flowers had gone to seed. Bees landing at the base of flowers rapidly probed between adjacent petals and sepals (Figure 1). Field observation suggested that they depended on gaps arising naturally between the plant elements rather than chewing to create spaces. This hypothesis may not be correct: small black ants identified by the author as *Ochetellus glaber* (Mayr) were frequent visitors to the flowers (Figure 2) and may have been assisting access by the bees by deleting small sections of the margins of flower elements. If so, bees using these spaces could be regarded as robbers, thieves or both. The ant identification was based on the description by Shattuck (1992) supported by high-resolution online photographs as in PIAkey and antweb I report observations on bee behaviour and flower phenology over two flowering periods in December 2022 and December 2022.

Figure 1. Bee (*A. mellifera*) robbing nectar at the base of *A. psittacina* flower

Figure 2. Ants at base of *A. psittacina* flower

METHODS

Four patches of *A. psittacina* were selected for observation. Patch 1 was the largest, approximately 3.m x 1 m, partially in the sun most of the day. Patch 2 was along a fence, about 2.5 m x 0.5 m, and was exposed to sun all afternoon. Patch 3 was about 2.5 m x 1 m part was exposed to sun and part remained in shade. The density of flowers was lower than in the preceding two patches. Patch 4 was along the southern wall of a house and 2-3 m long and about 0.5 m deep. It had a low density of flowers.

Bees were observed for 10 min for each patch, once a day, as in Table 1. I counted bees landing in the mouth of flowers, or apparently feeding at the base of the flowers. Bees landing at the mouth of the flowers and attempting to enter the flower were noted. Observations were discontinued after 28 December, as few new flowers were being produced and few bees were attracted to the patches. The possible role of ants was examined by dissecting mature flowers to check for damage. A sample of 25 flowers was dissected on 14 January, and the number of deletions at the bases of flower elements was recorded.

The development of individual flowers was examined by tagging one flower head with well-developed buds at each site, and recording it photographically each day. Pollination rates were assessed by the number of seed capsules present after the end of flowering.

A follow-up experiment was started in the second week of November 2023, attempting to determine whether the bees were robbers or thieves. At this time only one flower head on *Alstroemeria* in Patch 1 had any opened buds. Some plants from this area, with small, uncoloured buds were excavated and potted. Ants were excluded from some plants using a water barrier. Bees were excluded from some flower heads by enclosing them in fine white plastic tree mesh, giving four treatments with four plants in each, -A-B, +A-B, -A+B, and +A+B, where A is ants and B is bees. The plants were placed in plastic trays in the same locality where they had originally grown, i.e. Patch 1. Four other plants growing undisturbed nearby served as additional +A+B controls. It was confirmed that ants could access the plants in the trays. Prior observations of bees on netted citrus trees indicated that they did not pass through the mesh, but accessed flowers via the open base of the netting. The trial was observed twice daily. Successful pollination was assessed by counting the number of seed capsules per flower head on undisturbed plants. Flower heads generally carried 8-9 flowers (Table 2).

RESULTS AND DISCUSSION

Table 1(p.18) shows observations of bee visits to flowers in 10 min observation periods in the summer of 2022-3. Patch 1 had many more visits than the other patches, probably because of its size, though other factors such as aspect could also have influenced the results. Visits to the bases of flowers always outnumbered visits to the mouth. The three smaller patches, except Patch 2 on two occasions, showed the reverse pattern, with visits to the mouth of the flower more frequent than to the base. Sometimes only one or two bees were present at a patch during an observation period. In these cases it was possible to follow the behaviour of individuals: each bee was to a large degree consistent in probing the base or alighting at the mouth of the flower, as observed also by Nagano and Yokoi (2022) who found that more experienced foragers went to the flower base. Some bees landed briefly at the mouth of the flower and were observed to

lick or nibble at the pollen caps on immature stamens, but others attempted to work their way further down the corolla tube. This was generally unsuccessful, as the basal part of the *A. psittacina* flower is narrow and blocked by the bundle of stamen filaments and the pistil. Bees could possibly reach nectar by this route in times of high nectar flow. Bees were not collecting pollen and any pollen transferred by them was incidental. Most flowers were successfully pollinated, as shown by the development of seed capsules. Though native bees (*Tetragonula*, *Amegilla*) are present in the garden, they were not seen to visit the flowers.

Dissection of a sample of flowers taken on 14 January 2023 showed that nearly half had small sections bitten out of the margins of one or two petals/sepals. These flowers ranged from young (still with pollen caps) (n=1), to mature (n=5), to flowers that were beginning to wither (n= 6) or actually withered (n=13). The flower in the "young" category had no deletions, but for the other categories, about half were bitten, with one or two areas damaged. I concluded that the ants had caused the damage by biting away small areas of the petal margin Even the "young" flower in this sample showed gaps between the petals and sepals at the base, and direct robbing by bees remains the most likely mode of nectar collection. The experiment to distinguish between ant and bee activity was not successful for three major reasons. The potted *Alstroemeria* plants did poorly, and the bee-excluding covers distorted flower growth. The main problem, however, was the almost complete absence of bees following introduction of the *Varroa* mite (*Varroa destructor* Anderson and Trueman) to the Sydney area in 2023. Bees in the preceding summer may have come largely from feral colonies in nearby bushland. Feral colonies do not usually survive *Varroa* infestation. I observed two bee visits to the bases of flowers and immediately inspected the basal ends of petals and sepals for damage. The structures were intact, supporting the nectar robbing scenario. In this system bees rob nectar without damaging flowers to gain access. In the absence of bees, pollination was inefficient. Table 2 shows that the majority of flower heads assessed had fewer than half the potential number of seed capsules, i.e. over half the flowers were not successfully pollinated.

Although self-pollination is possible in *Alstroemeria*, the structure and development of the flowers makes it unlikely. *A. aurea* is protandrous (Aizen and Raffaele 1996), with pollen produced before pistil maturity. Observations in the present study lead to the same conclusion. Newly-opened flowers contain stamens with pollen caps covering the anthers. As the stamens lengthen, the anthers (still with pollen caps) hang below the petals and the stigma does not reach the mouth of the flower. The timeline for flower life from bud opening is as follows. Day 1-3: buds begins to open. Four or five buds on a flower head open approximately at the same time. Day 4: stamens with capped and uncapped anthers present, do not extend beyond petals. Day 6: uncapped anthers hang down, extending beyond petals and pistil extends to end of petals. Day 9: stamens withering, and second group of buds opening. Day 10: petals and sepals withering. Day 14: all petals fallen from the first group of flowers and seed capsules are present. Hence the lifespan of individual flowers is about two weeks from bud opening to loss of petals and sepals, and the flowering season occupies about seven weeks from mid-November to the beginning of January, although occasional flowers were seen as late as March.

From these observations, I conclude that honeybees are the main pollinators of *Alstroemeria*, but they double as nectar robbers, probing between the bases of floral elements. They may be assisted in this by deletions in petals/sepals made by ants, though if this occurs, it is probably by accident rather than directed behaviour. Deletions are not necessary for nectar robbing by honeybees. Pollination is inefficient in the absence of bees, suggesting that self-pollination is not a general occurrence. *Alstroemeria* may have a low level of self-pollination, and other minor pollinators may contribute, including native bees, flies, moths, but these have not been observed in the present studies.

Table 1 Number of bee visits in 10 minutes to the base or mouth of flowers of *Alstroemeria psittacina*

Date	Patch	Time	Weather	Bees at base of flower	Bees at mouth of flower	Bees enter flower	Notes
17.12.2022	1	1455	cool, overcast	40	22	2	
	2		in sun	9	40	15	
	3		in shade	2	3 *		
	4			8	29	3	
18.12.22	1	1200	overcast	41	1**		
	2			8	23	15	
	3		rain	No bees			
	4		rain	No bees			
19.12.22	1	1450	sunny, windy	40	11		
	2			22	8	2	
	3			0	11	5	
	4			9	16	5	
20.12.22	1	1520		44	12	3	
	2			28	37	18	
	3			0	11	5	
	4			9	16	5	
21.12.22	1	1625	warm, breeze	40	11	4	
	2			12	21	10	
	3			0	20	6	one bee
	4			30	0		
22.12.22	1	1700	light rain	38	13		
	2			No bees			
	3			No bees			
	4			0	9		one bee
23.12.22	No obs						
24.12.22	1	1215	hot	34	18	1	
	2			21	6	2	2 bees
	3			0	0		
	4			2	25	15	1 bee
25-26.12.22	no obs						
27.12.22	1	1730	sun	33	15	7	
	2			5	5	2	
	3			No bees			Abt 12 flower heads
	4			No bees			Abt 12 flower heads
28.12.22	1	1020	sun	28	13	4	
	2,4			No bees			
	3			0	19	14	

Table 2. Numbers of fertilised flowers per flower head in undisturbed plants in January 2024, assessed by development of seedpods. *Top line shows possible number of seedpods per flower head, and the remainder of the table shows how many flower heads from each patch had that number of fertilised flowers. For example, at Patch 1, 14 flower heads had 4 fertilised flowers.*

	No. fertilised flowers per flower head	0	1	2	3	4	5	6	7	8	9	Total
Frequency of flower heads with given number of fertilised flowers	Patch 1	1	1	6	5	14	7	2	0	2	3	41
	Patch 2	0	1	8	4	6	2	5	2	0	0	28
	Patch 3		1		1	2						4
	Patch 4			1			1					2

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