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***GARDEN BEES UPDATE 1998-2001:
ANTHOPHORA PLUMIPES AND OTHER
SOLITARY BEES THAT FREQUENT A
SUBURBAN GARDEN IN KNIGHTON,
LEICESTER***

by

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GARDEN BEES UPDATE 1998-2001: ANTHOPHORA PLUMIPES AND OTHER SOLITARY BEES THAT FREQUENT A SUBURBAN GARDEN IN KNIGHTON, LEICESTER

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INTRODUCTION

Following on from a study of the Hairy-footed Flower Bee (*Anthophora plumipes*, Pallas 1772) in 1995/1996 (Frankum, 1999), the potential lure of a flower-filled garden with lots of foraging bees was difficult to ignore. Regular observations resumed in spring 1998 but just two transects were walked each day rather than every two hours as in the original study. 1998 focused attention on the foraging activities of *Anthophora plumipes* and the possibility of competition with several species of social bumblebees (*Bombus*). 2000/2001 also brought an increased awareness of other solitary bee species in the garden, including Mason bees (*Osmia*), Leaf-cutter bees (*Megachile*), Wool Carder bees (*Anthidium*), Mining bees (*Andrena*), cleptoparasites (*Melecta*) and even bee look-alikes (e.g. the various colour forms of *Eristalis intricarius* and *Merodon equestris* hoverflies mimicking *Anthophora plumipes* males, *Bombus pascuorum*, *B. pratorum* and *B. lapidarius* workers).

AIMS

Gardeners love to grow lots of flowers every year but, unfortunately, they are not always attractive to our native bees as foraging sources. This continuing garden study aimed to find out more about the various bee species that visit this garden (Figure 1) and to establish which flowers they preferred for foraging. This information may encourage gardeners to contribute towards bee conservation, by growing as many "bee-flowers" as possible for their local wild bee populations. The resulting spin-offs would include a good pollination service for any fruit and vegetable crops (e.g. raspberries, blackberries, apples, beans etc) and the bees are fascinating to observe in action.

WEATHER CONDITIONS DURING 1998 - 2001

Flowering periods and bee flight periods are very much reliant on good weather conditions in early spring. As there may be up to three weeks delay if the weather is cold, frosty and wet, energy-rich foraging sources are important in giving the early emerging bees a chance to survive.

- 1998: Mid-February was sunny and dry, with strong west winds and temperatures above 10°C even reaching a high of 18°C. The weather then cooled into March (6-11°C) with showers, cold winds and one or two overnight frosts. Throughout the month the weather was changeable but it was warmer during sunny periods (to 16°C). April continued with strong winds and rain (9-16°C with a high of 23°C), followed by snow, sleet and the wind-chill factor kept the temperatures below 10°C. May warmed up with sunny periods and occasional rain showers (14-27°C). Changeable weather continued throughout June (15-26°C). No further observations were taken after the end of the *Anthophora plumipes* flight period.

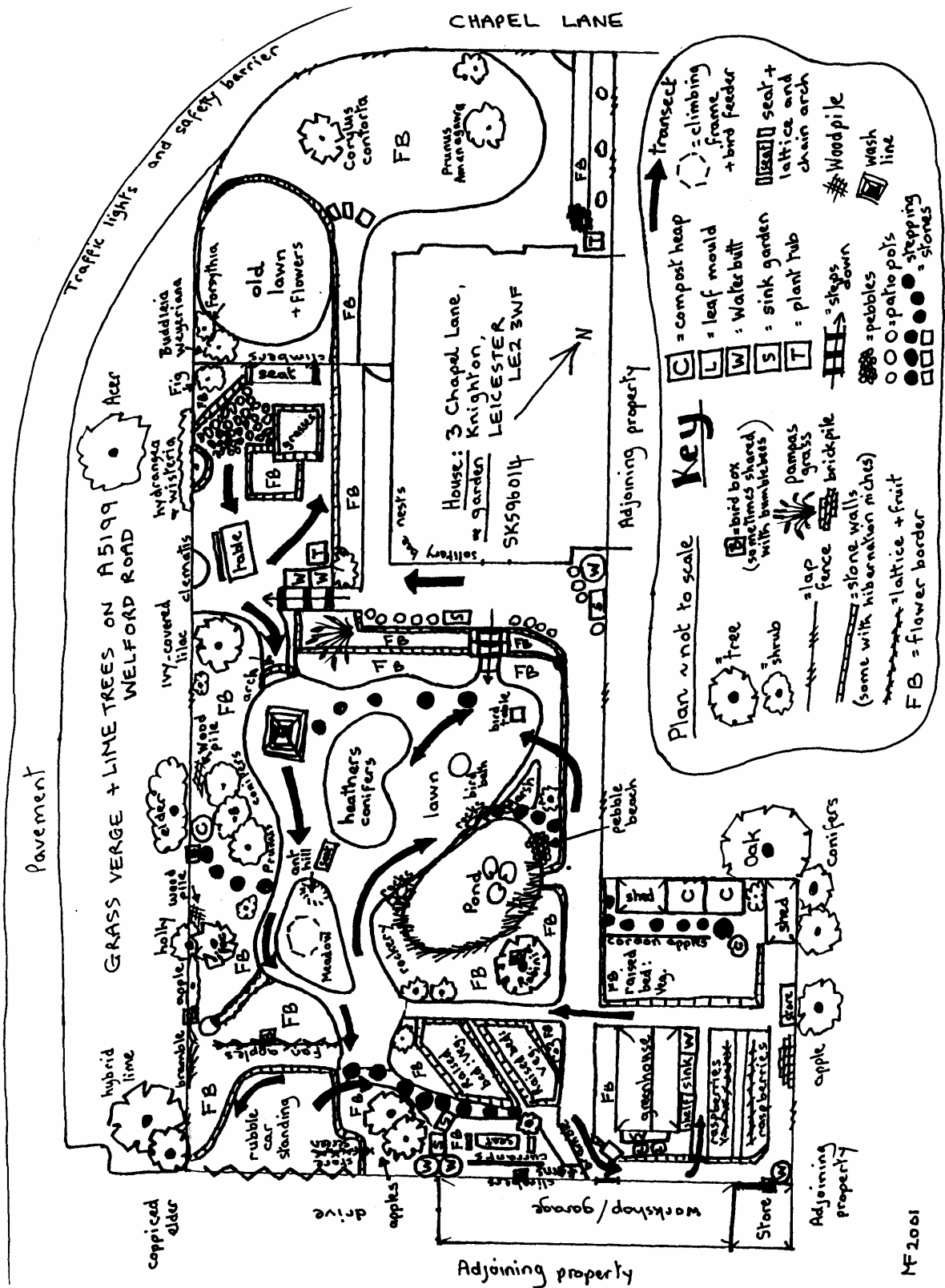
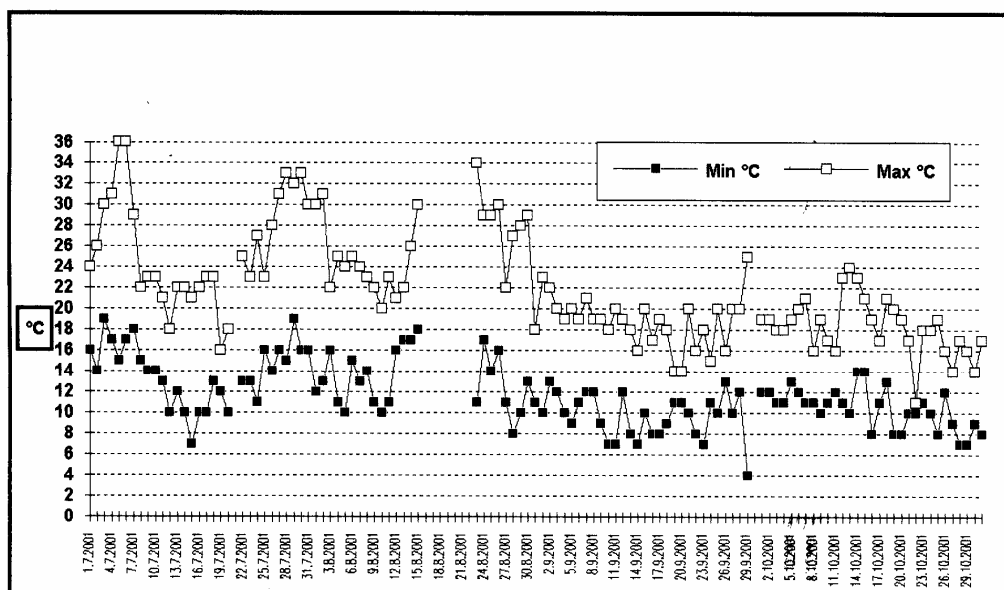
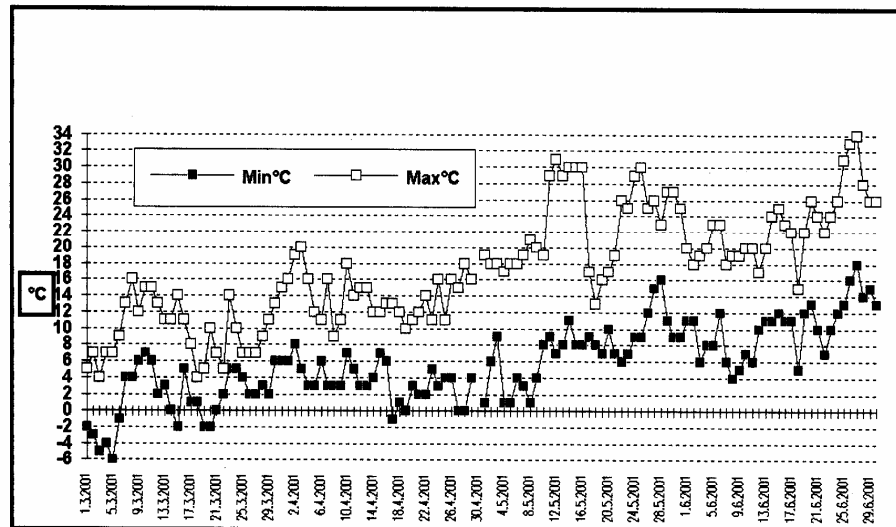


Figure 1: Garden layout and transect route

- 1999: March started sunny and dry (10-19°C), then northwest winds, cloud and rain, kept temperatures low. The changeable weather and cold winds continued into April (8-17°C) with some overnight frost, hail and rain around mid-April (3-10°C). May was mild with occasional showers, although mostly dry and warm in the sun (9-21°C). There were storms at the end of the month and into June but it was generally warmer during sunny spells (to 25°C). In 1999,

observations continued until autumn to cover the ongoing flight periods of visiting bumblebees. Mixed weather conditions continued throughout most of June and July, with strong west winds bringing occasional heavy rain or overcast and cool, changing to dry and hot (12-26°C). August started hot, humid and stormy (to 33°C) and then by mid-month, strong west winds brought cooler conditions with occasional showers (13-20°C). The remainder of the month was sunny and dry (12-22°C). The start of September was warm and wet (16-30°C) followed once again by strong southwest winds, cooling the weather for the rest of the month (14-20°C).



**Figure 2: Minimum-maximum daily temperatures (previous 24 hours) in 2001
(Top = March-June; Bottom = July-October)**

- 2000: From mid-February and into early March, cold NW winds, rain, snow and overnight frosts kept temperatures low (<10°C). Throughout the rest of March and well into April, daytime temperatures occasionally reached 19°C but strong, cold winds, rain and overnight frost were still possible and temperatures were often <10°C. The rest of April was showery, with a high of 20°C. May weather was variable, mostly cooler on wet days but with temperatures up to 26°C on milder, sunny days. June and July remained warm (max 29°C), with occasional rain showers. August was warm and sunny, with rain showers later and into September (max 23°C). Temperatures gradually became lower throughout October, still with

some rain showers.

- **2001:** A maximum/minimum thermometer was used in 2001 to record daily temperatures during the previous 24 hours (Figure 2). The upper plot covers flight periods from March to June when *Anthophora plumipes* and other early bees were active. March was showery and there was a period of snow and sleet mid-month. Rain continued into April, with a drier period mid-month and showers once more at the end. May started dry but there was a storm on the 10th and more rain during the third week and into June. There were still occasional showers throughout the month, with storms on the 16th. The lower plot of Figure 2 covers July to the end of October, for bees with longer flight periods. There were occasional showers throughout July and August and the weather was sometimes humid, with storms on the 25th August. September and October were frequently showery, with gales and fog during the second week in October.

ANTHOPHORA PLUMIPES: TIMES OF EMERGENCE AND FLIGHT PERIODS 1995 - 2001

The arrival of the first bees in the garden was established by walking the transect (Figure 1) from late February until June when no more of the bees were seen.

Table 1: Flight periods for male (M) and female (F) *Anthophora plumipes* 1995-2001

Week starting	1995		1996		1997		1998		1999		2000		2001	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
March 6														
March 13														
March 20														
March 27														
April 3														
April 10														
April 17														
April 24														
May 1														
May 8														
May 15														
May 22														
May 29														
June 5														
June 12														
June 19														

Table 1 compares weekly flight records of males and females from 1995- 2001. It highlights the annual variations in emergence times and flight period duration, reflecting good or adverse weather conditions in early spring. The males tend to emerge first and patrol the flower borders, competing for and mating with the females as they forage around the flowers. The males then take no further part in rearing their offspring and die; thus their flight period may be up to six weeks shorter than that of the females. It is the females that construct and provision the brood cells and, in previous years, female bees carrying full pollen loads had been observed flying up and away from the garden in three definite directions (presumably to where they were nesting) (Frankum, 1999). However, for the first time during Spring 2001, female *Anthophora plumipes* bees were seen entering high-level holes in the brickwork mortar on the west-facing wall of the house presumably to breed.

Table 2: Foraging preferences of *Anthophora plumipes* 1998-2001

Flower	Family	Total male visits				Total female visits			
		1998	1999	2000	2001	1998	1999	2000	2001
<i>Allium christophii</i>	Liliaceae			1					
<i>Aubretia</i>	Brassicaceae				2	2		1	1
Bugle	Lamiaceae		1			3	3	2	15
Comfrey (blue)	Boraginaceae			1	3	3		6	7
Comfrey (pink)	Boraginaceae					8	10	6	6
Comfrey (purple)	Boraginaceae					29	4	2	10
Comfrey (white)	Boraginaceae	2	2	2		11	4	4	1
Cowslip	Primulaceae								1
Daffodil (standard)	Liliaceae					3			
<i>Dipelta</i>	Caprifoliaceae						2		
Forget-me-not	Boraginaceae		1			1			5
Grape Hyacinth	Liliaceae			1					2
Heather (pink)	Ericaceae								1
Heather (purple)	Ericaceae			1					
Honesty	Brassicaceae				3	1	4		9
Jasmine	Oleaceae					3			
<i>Lithospermum</i>	Boraginaceae				1	8			3
<i>Philadelphus</i>	Philadelphaceae					2			
<i>Primula</i> hybrid (violet)	Primulaceae			2					
<i>Prunus amanagawa</i>	Rosaceae					1	2	1	18
<i>Pul longifolia</i> Ankum	Boraginaceae				2			1	1
<i>Pulm</i> Sissinghurst White	Boraginaceae							1	
<i>Pulmonaria</i> Blue Ensign	Boraginaceae				2				2
<i>Pulmonaria</i> Bowles Red	Boraginaceae	4	1	2	6	10	8	15	9
<i>Pulmonaria</i> Majeste	Boraginaceae				4				2
<i>Pulmonaria officinalis</i>	Boraginaceae	32	64	53	61	70	44	79	96
<i>Pulmonaria saccharoides</i>	Boraginaceae	1				5		6	
Red Campion	Caryophyllaceae		3			11	4	4	1
Red Deadnettle	Lamiaceae					1			
<i>Ribes</i>	Grossulariaceae							1	
Rosemary	Lamiaceae					1	3	3	5
Solomon's Seal	Liliaceae							3	7
Sprouting Broccoli	Brassicaceae				1				28
Stinking Hellebore	Ranunculaceae	6	9		5	4		6	2
<i>Verbascum</i>	Scrophulariaceae								1
<i>Verbena</i> (purple)	Verbenaceae					2			
<i>Veronica</i> (spiked)	Scrophulariaceae								1
<i>Viola</i>	Violaceae					2			
Wallflower	Brassicaceae								1
<i>Weigela</i>	Caprifoliaceae						1		
Welsh Poppy	Papaveraceae					4			1
White Deadnettle	Lamiaceae			3	1	28	33	11	27
Yellow Archangel	Lamiaceae					3	1	8	10
Yellow Flag	Iridaceae					3		1	

FLOWERS AVAILABLE FOR FORAGING BY *A. PLUMIPES* 1998 - 2001

The start of the flowering period may vary from year to year in response to prevailing weather conditions. Throughout the flight period each year, a weekly list was made of those plants in flower. This was to establish the start and duration of the flowering period of those flowers foraged by *Anthophora plumipes*. Appendix 1 shows the variation of flowering periods from

year to year (e.g. the start of the White Deadnettle flowering period varied from 27.iii to 24.iv). The number of weekly flower visits made by male and female bees to their chosen nectar sources was also noted. Table 2 compares the total number of visits made by male/female *Anthophora plumipes* to their chosen flowers during 1998-2001 reflecting their different foraging priorities.

Males dip into nectar-rich flowers to top up their energy levels for high speed territorial patrols, chasing off other male competitors and perceived competitors (they react quickly to any movement including passing *Eristalis* hoverflies, bumblebees, butterflies, wind-blown petals and even challenge humans!). They mate with as many females as will let them, to the point of occasionally queuing up in hover mode (x 3!) behind a female! The females often take evasive action from all this enthusiastic attention and hide among the flowers because their important role is one of hard work, provisioning the brood cells for the next generation, as well as obtaining enough energy for themselves in order to do this.

Table 3: Flower families favoured by *A. plumipes* 1998-2001

Flight period weeks	1998	1999	2000	2001	Flight period weeks	1998	1999	2000	2001
	0-15	1-12	0-15	0-14		0-15	1-12	0-15	0-14
	Number flowers/family (number used by <i>A. plumipes</i>)					Number flowers/family (number used by <i>A. plumipes</i>)			
Boraginaceae	12(9)	12(8)	13(9)	15(11)	Apocynaceae	1(0)	1(0)	1(0)	
Lamiaceae	9(5)	7(4)	7(3)	6(3)	Euphorbiaceae	2(0)	3(0)	5(0)	5(0)
Brassicaceae	6(2)	4(2)	5(1)	11(4)	Berberaceae	1(0)			
Rosaceae	10(1)	11(2)	7(2)	11(2)	Apiaceae	2(0)	2(0)	2(0)	1(0)
Ranunculaceae	19(1)	13(1)	27(1)	23(1)	Geraniaceae	7(0)	7(0)	8(0)	9(0)
Caryophyllaceae	4(1)	4(1)	2(1)	2(1)	Crassulaceae	1(0)	1(0)	1(0)	1(0)
Papaveraceae	2(1)	2(1)	2(0)	2(1)	Valerianaceae	2(0)	2(0)	1(0)	1(0)
Primulaceae	9(0)	8(1)	12(0)	9(1)	Bignoniaceae		1(0)	1(0)	
Caprifoliaceae	2(0)	4(2)	2(0)	2(0)	Campanulaceae	2(0)	1(0)	2(0)	1(0)
Liliaceae	8(1)	9(0)	20(3)	16(2)	Dipsacaceae	1(0)	1(0)	1(0)	1(0)
Violaceae	2(1)	1(0)	3(0)	3(0)	Polemoniaceae	1(0)	1(0)	2(0)	
Oleaceae	1(1)	1(0)	1(0)	2(0)	Malvaceae	2(0)			
Iridaceae	5(1)	8(0)	7(0)	8(0)	Solanaceae	1(0)			1(0)
Philadelphaceae	1(1)				Rutaceae	1(0)		1(0)	
Verbenaceae	1(1)		1(0)	3(0)	Convolvulaceae	1(0)			
Ericaceae	1(0)	1(0)	4(1)	5(1)	Myrtaceae	1(0)			
Grossulariaceae	1(0)	1(0)	1(1)	2(0)	Hypericaceae	1(0)		1(0)	
Scrophulariaceae	7(0)	5(0)	8(0)	6(2)	Fabaceae	3(0)	1(0)	2(0)	1(0)
Saxifragaceae	3(0)	3(0)	3(0)	5(0)	Rubiaceae			1(0)	1(0)
Asteraceae	8(0)	5(0)	5(0)	3(0)					
					Total flowers	141(26)	120(22)	159(22)	156(29)
					Total families	37(13)	29(9)	33(9)	29(11)

The most popular flower choice for both males and females was *Pulmonaria officinalis* (Boraginaceae). However, females (with a longer flight period) were able to take advantage of a wider range of flowers than the males frequently visiting White Deadnettle and Yellow Archangel (Lamiaceae), sprouting broccoli (Brassicaceae), *Prunus amanagawa* (Rosaceae) and pink/purple Comfrey (Boraginaceae). Over the four-year period, the females visited c41 different kinds of flowers and the males just c21 flowers.

The flower families represented in the garden during the 1998-2001 flight periods of *Anthophora plumipes* are shown in Table 3. The numbers of different flowers available per family are shown compared to those chosen for foraging by the bees. The totals indicated that, in each year, the bees foraged at less than 20% of the flowers available to them; flowers from 21 families were ignored completely. Even though gardeners choose to grow many

different kinds of flowers from many flower families, they may not be the ones that the bees really need.

Table 4: Comparison of total visits made by *A. plumipes* to flower families 1995-6 (Frankum, 1999) and 1998-2001

Family	Number of visits (% of total visits)					
	1995	1996	1998	1999	2000	2001
Boraginaceae	2059 (54)	610 (14)	184 (70)	135 (67)	178 (78)	221 (61)
Lamiaceae	1495 (39)	2373 (56)	36 (14)	41 (20)	27 (12)	58 (16)
Brassicaceae	144 (4)	690 (16)	3 (1)	4 (2)	1 (<1)	45 (12)
Rosaceae		252 (6)	1 (<1)	2 (<1)	1 (<1)	18 (5)
Ranunculaceae	5 (<1)	256 (6)	10 (4)	9 (4)	6 (3)	7 (2)
Caryophyllaceae			11 (4)	7 (3)	4 (2)	1 (<1)
Papaveraceae			4 (<2)			1 (<1)
Primulaceae	33 (<1)				2 (1)	1 (<1)
Caprifoliaceae				3 (1)		
Liliaceae	84 (2)	53 (1)	3 (1)		5 (2)	9 (2)
Violaceae	25 (<1)		2 (<1)			
Oleaceae			3 (1)			
Iridaceae		1 (<1)	3 (1)		1 (<1)	
Philadelphaceae			2 (<1)			
Verbenaceae			2 (<1)			
Ericaceae		3 (<1)			1 (<1)	1 (<1)
Grossulariaceae					1 (<1)	
Scrophulariaceae						2 (<1)
Total No visits	3845	4238	264	201	227	364

Table 4 shows the total visits (and expressed as a %) made by *A. plumipes* to each flower family in 1998-2001 in each year. These update years were compared to the original study in 1995/1996 even though more transects (therefore more visits) were recorded then. Thus, first choice in five out of six years was to flowers of the Boraginaceae family followed by the Lamiaceae family with fewer visits to the other families.

However, when flight periods were affected by adverse weather conditions (as in 1996) foraging bees had to use what was available with Lamiaceae being first choice (56%) followed by Brassicaceae (16%) and Boraginaceae (14%).

FORAGING COMPETITION BETWEEN *A. PLUMIPES* AND BUMBLEBEES MARCH-JUNE 1998

Solitary bees and bumblebees may have either a short or a long tongue that allows them to exploit different kinds of flowers within the same habitat. Competition occurs when bees with the same tongue length forage at the same flowers. Bees sometimes take advantage of a wider range of flowers than might be expected from just their tongue length alone, including nectar robbery and opportunistic secondary robbery. Attention was drawn to the activities of bumblebees during 1998 because some were seen foraging at the same flowers as *A. plumipes* (especially the females). During March-June 1998, the foraging choices of each bumblebee species was compared with that of *A. plumipes*, to highlight this competition.

- *Anthophora plumipes* vs *Bombus pratorum* – *A. plumipes* is a solitary bee with a long tongue adapted to forage at flowers with long tubular corollas and other deep nectar sources (Proctor, Yeo & Lack, 1996). In comparison, *Bombus pratorum* has a moderate tongue length, mostly forages open flowers with easily accessible nectar, especially Perennial Cornflower,

geraniums, *Campanula*, and is a good pollinator of blackberries and raspberries. However, *B. pratorum* is able to compete with long-tongued bees because it can push its relatively narrow head right inside long, tubular corollas, thus accessing deep-seated nectar (Prys-Jones & Corbet, 1987). Table 5 illustrates the flight period overlap whilst Figure 3 shows the flowers foraged by both species (mostly Comfrees, Yellow Archangel and White Deadnettle). *B. pratorum* was also frequently seen taking advantage of robber holes made by *B. terrestris/lucorum* although other workers ignored the holes.

Table 5: Flight periods of *Anthophora plumipes*, bumblebees and cuckoo bumbles in 1998 (hatched) and 1999 (X)

Week		<i>Anthophora plumipes</i> (m)	<i>Anthophora plumipes</i> (f)	<i>Bombus pratorum</i>	<i>Bombus pascuorum</i>	<i>Bombus hortorum</i>	<i>Bombus terrestris/lucorum</i>	<i>Bombus lapidarius</i>	<i>Psithyrus vestalis</i>	<i>Psithyrus sylvestris</i>	<i>Psithyrus campestris</i> (?)
Number	Starting										
0	Mar 6										
1	Mar 13	X	X	X			X				
2	Mar 20	X	X	X			X	X			
3	Mar 27	X	X	X	X		X				
4	Apr 3	X	X	X	X		X				
5	Apr 10	X	X	X	X	X					
6	Apr 17	X	X	X	X		X				
7	Apr 24	X	X	X	X			X			
8	May 1	X	X	X	X		X				
9	May 8	X	X	X	X	X	X				
10	May 15	X	X	X	X	X	X	X			
11	May 22		X	X	X	X	X	X			
12	May 29		X	X	X	X	X				X
13	Jun 5			X	X	X	X	X		X	
14	Jun 12			X	X	X	X	X	X		
15	Jun 19			X	X	X	X	X	X		
16	Jun 26			X	X	X	X		X		
17	Jul 3			X	X	X	X	X			X
18	Jul 10			X	X	X	X	X	X	X	
19	Jul 17			X	X	X	X	X	X	X	
20	Jul 24			X	X	X	X	X	X		
21	Jul 31			X		X	X	X	X		
22	Aug 7			X	X	X	X	X	X		
23	Aug 14			X	X	X	X	X	X		X
24	Aug 21			X	X		X	X	X		X
25	Aug 28			X	X	X	X	X			
26	Sep 4				X	X	X				
27	Sep 11			X	X	X	X	X			
28	Sep 18			X	X	X	X				
29	Sep 25				X						

- *Anthophora plumipes* vs *Bombus pascuorum* – *B. pascuorum* is a long-tongued bumble and Table 5 shows flight period overlap. Figure 4 shows flowers foraged by both species, especially White Deadnettle and comfrees. However, these were just a few of the much wider range of flowers that *B. pascuorum* visited which included Geraniums, Perennial Cornflower, Sage and Purple Toadflax.

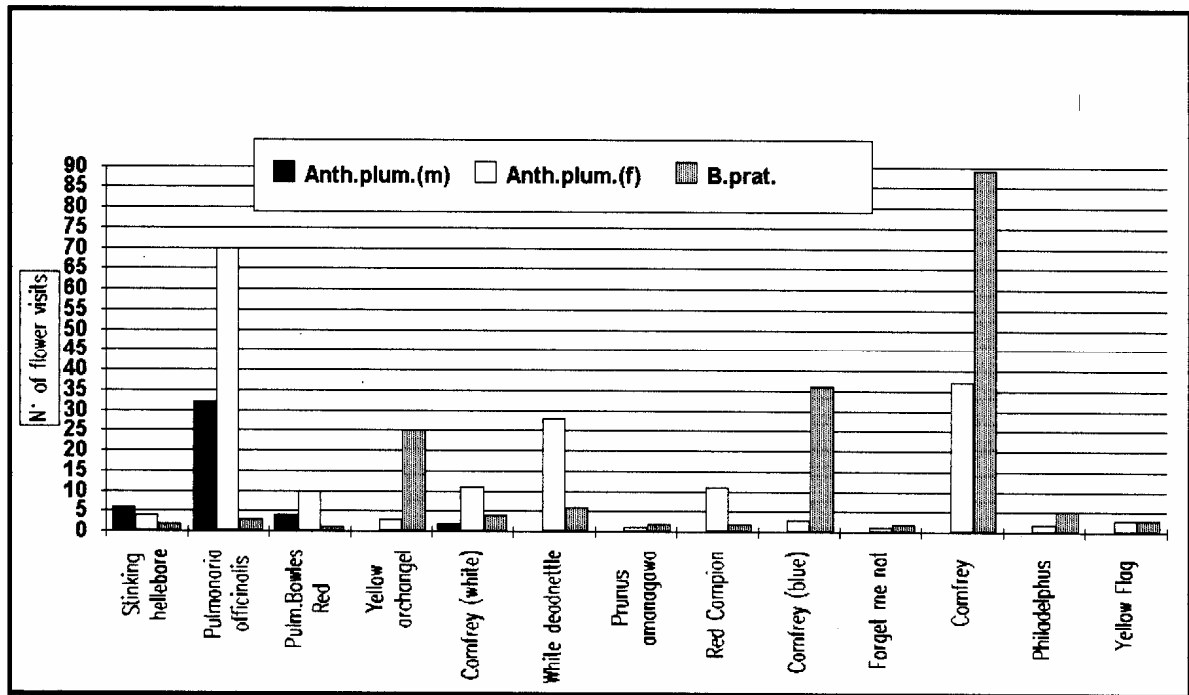


Figure 3: Flowers visited by *A. plumipes* and *B. pratorum* March-June 1998

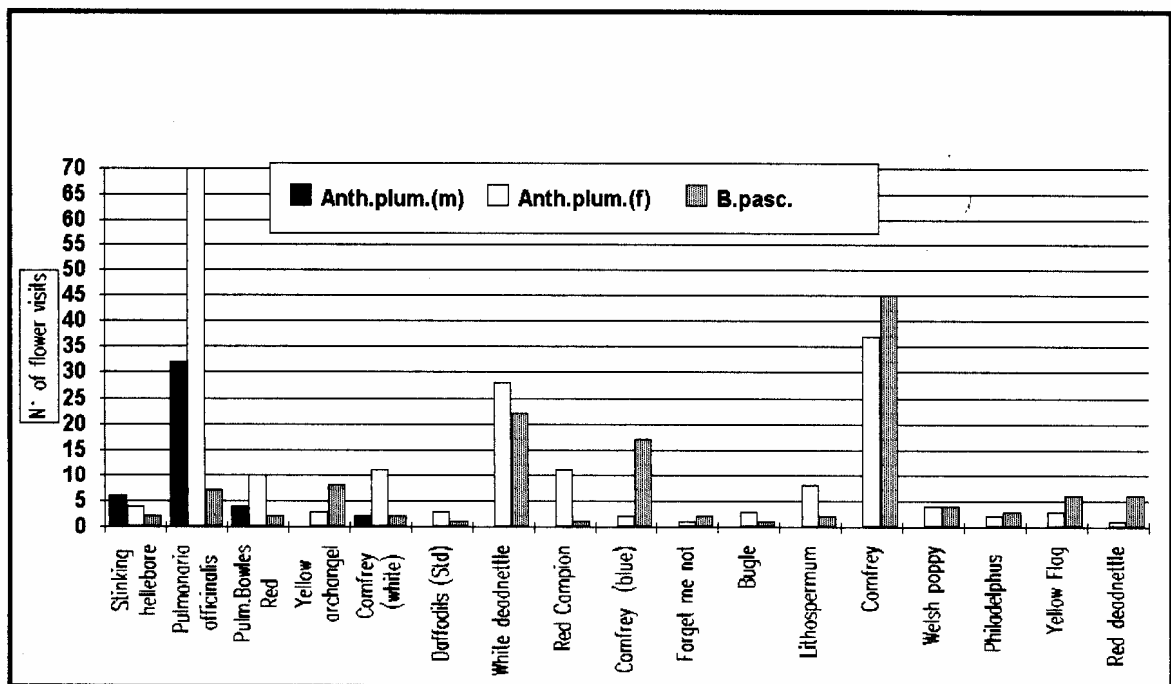


Figure 4: Flowers visited by *A. plumipes* and *B. pascuorum* March-June 1998

- Anthophora plumipes* vs *Bombus terrestris/lucorum* – *B. terrestris* and *B. lucorum* are listed together because, although the queens are easy to identify in early spring, the workers (two dull yellow bands/ buff tail; two bright yellow bands/white tail respectively) are often difficult to distinguish in the field. They both have short tongues and because they are not very agile, mostly forage at short, upward facing flowers or at those that have a large landing platform. These include Perennial Cornflower, *Campanula*, Bramble and Eucalyptus (Myrtaceae). They also collect pollen by "buzzing" flowers such as Welsh and Oriental poppies (Papaveraceae) and *Aruncus* (Rosaceae). They are unable to take nectar directly from long tubular flowers,

but frequently bite holes in the base of spurs/corollas of *Aquilegia*, Honeysuckle, Red Campion and comfrets thus robbing the nectar and by-passing the pollination process (Prys-Jones & Corbet, 1987). In this way, they compete with *A. plumipes* for the same nectar sources, especially comfrets and Red Campion (Figure 5). Other opportunistic bees may then exploit the nectar short cut, although *A. plumipes* bees never seem to do this. However, even with all this robbery taking place, there were still enough bumblebees around that obtained their nectar "legitimately" and effective flower pollination still occurs.

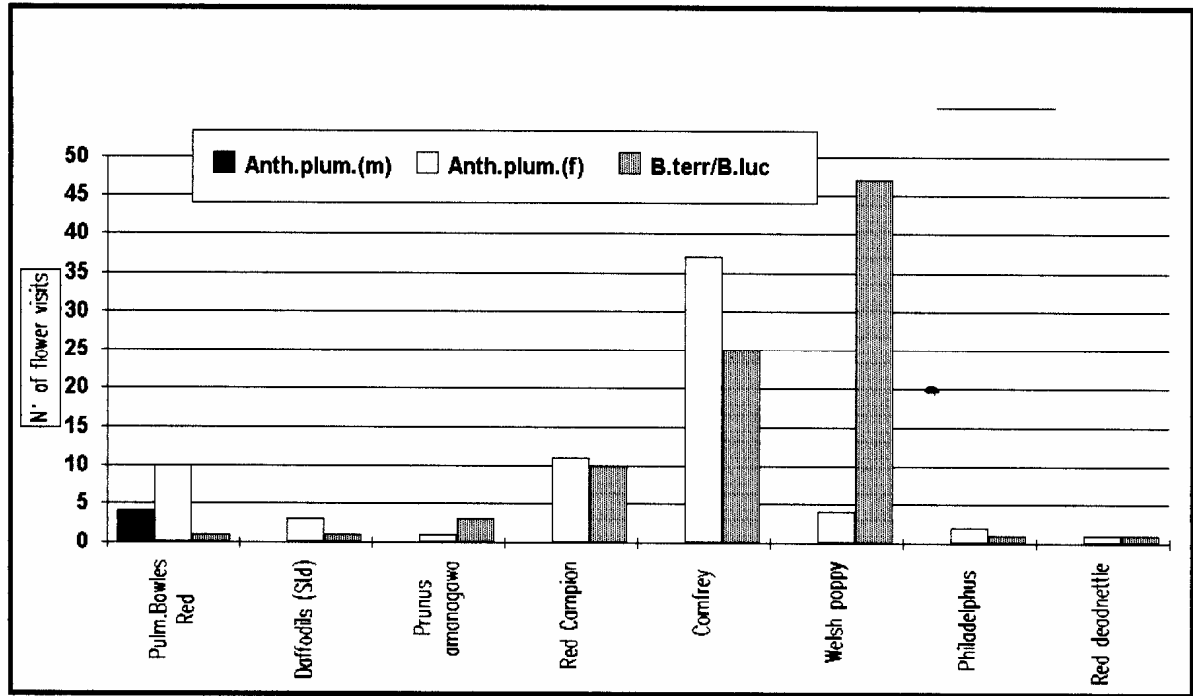


Figure 5: Flowers visited by *A. plumipes* and *B. terrestris/lucorum* March-June 1998

- *Anthophora plumipes* vs *Bombus hortorum* - Although *B. hortorum* has a longer tongue than other common British bumblebee species, the queens emerge late to start nest building (Prys-Jones & Corbet, 1987). Figure 6 shows that there was only limited competition with *A. plumipes* with White Deadnettle, Red Campion and Comfrey being visited the most. Other flowers visited by *B. hortorum* during April-June were very few, mainly to *Phlomis*, Monkshood, *Aquilegia*, Honeysuckle and Iris.
- *Anthophora plumipes* vs *Bombus lapidarius* - *B. lapidarius* prefers to clamber over massed flowers which, although are often nectar poor, offer an opportunity to probe many florets between flights (Prys-Jones & Corbet, 1987). In the present study, competition with *Anthophora plumipes* was virtually non-existent with just one or two visits to Comfrey, Perennial Cornflower and yellow/blue Iris.

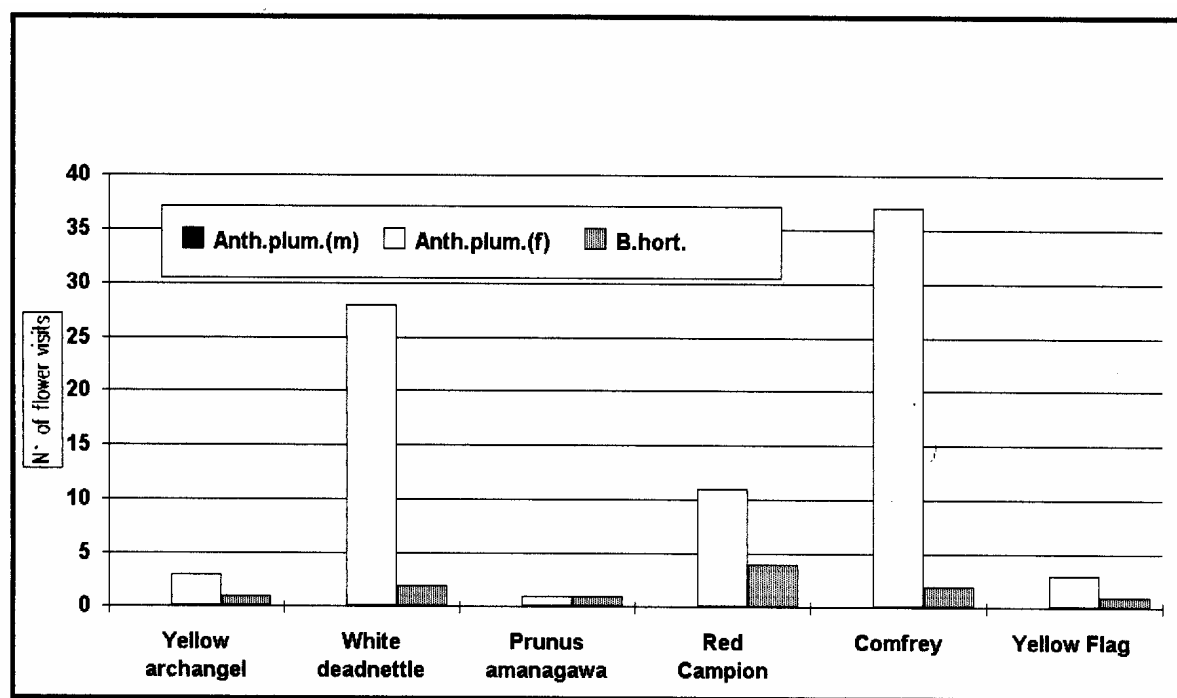


Figure 6: Flowers visited by *A. plumipes* and *B. hortorum* April-June 1998

THE ACTIVITIES OF OTHER SOLITARY BEES DURING THE STUDY PERIOD

(Table 6)

(a) Red Mason bees (*Osmia rufa*)/ Blue Mason bees (*Osmia coerulescens*)

For several years, brown hairy bees (Red Mason bee, *Osmia rufa*) have nested in holes in the brickwork on the west-facing wall of the house. In February 1999, lengths of bamboo cane were jammed behind the down-pipe outside the kitchen door to provide the bees with additional homes. The females soon took advantage of these when they emerged in April and were busy stocking brood cells and capping them with mud. The bees successfully used the canes again in 2000. In early spring 2001, custom-made bee boxes (Oxford Bee Company) were put up around the garden and the female bees were soon using these as well. These bee-boxes made the comings and goings of the *Osmia* bees easier to observe. There were two sizes of tubes in the bee-boxes: (i) 8mm dia. (room enough for producing the next generation of females) and (ii) 7mm dia. (room enough only for producing males or for possible use by the smaller Blue Mason bee, *Osmia coerulescens*). The flight period of this latter species follows on after *Osmia rufa* and females were seen for the first time on 5.vi.2001 and again on 17.vi.2001 when they were observed capping brood cells with chewed leaf mastic.

(b) Solitary bee (*Colletes daviesanus*)

During October 2001, when it was time to sort out the nest-boxes for over-wintering, some of the spaces between the 7mm tubes had cells made from some sort of transparent secretion, each with a white larva inside. The bee most likely to have done this was the solitary bee, *Colletes daviesanus*. These are often seen on Yarrow (Zahradnik, 1999) and small bees (confirmed as females of this species) have been found in the garden during July on *Achillea*.

(c) Leaf-cutter bees (*Megachile centuncularis*)

During June 1999, Leaf-cutter bees were seen taking pieces of leaf into holes in an old, rotting, table-top (made from a slice of elm). In July 2000, one was seen collecting pollen from Yellow Knapweed and on 28.vii.2001 a female struggled to heave a leaf section into one of the 8mm dia. bee-box tubes. Another female was using one of the bamboo canes and it took her a count of 29 to whizz down the

garden out of sight, chop out another leaf section and carry it back. She pressed this final piece into position and scissored off the surplus (just like an upholsterer!).

Table 6: Sightings of solitary bees 2000-2001

Week commencing	<i>Osmia rufa</i>		<i>Osmia coerulescens</i>		<i>Megachile centuncularis</i>		<i>Melecta albifrons</i>		<i>Anthidium manicatum</i>		<i>Andrena</i> species	
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
Apr 3	X											
Apr 10	X											
Apr 17	X	X										
Apr 24	X	X										X
May 1	X	X										
May 8	X	X						X				X
May 15	X	X										
May 22		X										
May 29		X					X					
Jun 5				X							X	
Jun 12				X								
Jun 19				X								
Jun 26				X								
Jul 3					X				X	X		
Jul 10						X				X		
Jul 17					X							
Jul 24						X				X		
Jul 31						X				X		
Aug 7						X				X		
Aug 14										X		
Aug 21										X		

(d) *Wool Carder bees (Anthidium manicatum)*

An article in the BWARS Newsletter (Neil A. Robinson, Spring 2000) suggested that an *Anthidium manicatum* female collects leaf-hairs from *Stachys lanata* to construct her brood cells. The male was also reported to be very territorial by chasing off other bees from a clump of flowers enabling them to be used by his own female(s). An unidentified species, photographed in July 1999, proved to be *Anthidium manicatum* and there were plenty of clumps of *Stachys lanata* growing in the garden. A male *Anthidium manicatum* was briefly spotted in July 2000 and, in July/August 2001, a very territorial male patrolled a circuit around the flower borders, where *Stachys lanata*, Purple Toadflax and *Verbascum thapsus* were growing, vigorously chasing off big *Bombus pascuorum* workers. Females collecting leaf hairs for nesting have not yet been seen.

(e) *Mining bees (Andrena cineraria (det), Andrena haemorrhoa (?) and Andrena fulva(?))*

The distinctive black and silver-grey *Andrena cineraria* was photographed in June 1998 on *Philadelphus coronarius aureus* but it has not been seen since and no nests have been found. A solitary bee with pollen-laden "yellow trousers" (possibly *Andrena haemorrhoa?* - undet.) was seen flying into a hole at the base of a stone wall 8.vi.2000. It was caught, photographed and released. Since April 1998, tawny-haired female bees (determined as *Andrena fulva*) have been seen in the garden. On a warm and sunny 2.iv.2002 several of these (c6 females, c4 males) had emerged and were flying low over the lawn and flower borders where there were patches of bare soil. Since then, the females have seemed to spend their time basking in the sun with one having visited gooseberry flowers (the less distinctive males are much harder to spot).

(f) *Parasitic bees*

On 30.v.2000, a black bee was seen looking rather like a female *Anthophora plumipes* but without

orange pollen baskets and with white spots on the sides of the abdomen. This was identified as a male *Melecta albifrons*, the cleptoparasite of *Anthophora plumipes*. On 13.v.2001, a similar bee (all black and no white spots) was observed and identified as a female *Melecta albifrons*. Another bee parasite seen in the garden in May 1999, was a Ruby-tailed wasp (*Chrysis angustula*) which was flying around the entrances to the *Osmia rufa* nests in the bamboo canes. In 2001, some of the *Osmia* brood cells in the bee-nest tubes were parasitised by the fly *Cacoxenus indagator*. Also on 22.v.2001, a female *Sapyga quinquepunctata* (det) was seen flying around the nest box tubes. This species is a cleptoparasite of *Osmia* spp (Gauld & Bolton, 1996).

CONCLUSIONS

This ongoing garden study has revealed that, even in this "bee-friendly" garden, the bees use less than 25% of the available flowers during the spring and summer. This has emphasised the real need for gardeners to grow as many as possible of the favoured flowers to help to encourage and conserve their local wild bee populations. These bees may not necessarily be classed as endangered at the present time but if they do not have access to a continuous supply of foraging sources during the spring and summer, their populations (and important pollination services) may soon decline. The study also showed that, no matter how much information is gathered and recorded about the activities and needs of garden bees, more questions always remain to be answered. For instance, an important question must be "what level of the used foraging sources do the bees use just for pollen collection?" The study also showed that gardens probably provide sanctuary for many species of bees; it is just that most people remain unaware of them until they start looking. The remaining problem is having the skills/keys to identify them and having an encouraging expert on hand to determine that the bee is just what you think it is!

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APPENDIX 1: FORAGING PREFERENCES OF ANTHOPHORA PLUMIPES 1998-2001

1998

Flowering period	Number of male (female) flower visits															
	March				April				May				June			
Week commencing	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19
<i>Pulmonaria officinalis</i>		5(9)	2(3)	12(6)	5(13)	3(7)	5(17)	0(2)	0(3)	0(10)						
Stinking Hellebore	1(0)	0(2)	1(0)	4(2)												Bees seen but not foraging
<i>Pulmonaria saccharoides</i>				0(1)	0(2)		1(1)			0(1)						
<i>Pulmonaria</i> Bowles Red		0(1)	0(2)	0(2)	3(1)	0(1)	1(2)			0(1)						
Comfrey (white)			1(0)	0(3)	0(3)		1(2)			0(1)			0(2)			
Daffodil (standard)					0(1)		0(2)									
Rosemary										0(1)						
<i>Viola</i>												0(1)	0(10)			
<i>Aubretia</i>				0(1)									0(1)			
Yellow Archangel						0(1)	0(2)									
Forget-me-not						0(1)										
White Deadnettle						0(1)	0(6)	0(1)	0(2)	0(8)	0(3)	0(1)	0(6)			
Honesty							0(1)									
<i>Lithospermum</i>										0(1)	0(2)	0(3)	0(2)			
<i>Prunus amanagawa</i>					0(1)											
Red Campion										0(5)	0(1)	0(2)	0(3)			
Comfrey (blue)							0(2)			0(1)						
Bugle										0(2)	0(1)					
<i>Philadelphus</i>													0(2)			
<i>Verbena</i> (purple)												0(1)	0(1)			
Welsh Poppy													0(1)	0(3)		
Comfrey (pink)											0(7)	0(1)				
Comfrey (purple)											0(1)	0(6)	0(19)	0(3)		
Yellow Flag													0(2)	0(1)		
Red Deadnettle														0(1)		
Jasmine														0(3)		

1999

Flowering period	Number of male (female) flower visits															
	March				April				May				June			
	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19
<i>Pulmonaria officinalis</i>		13(1)	1(1)	2(0)	14(4)	1(8)	6(6)	22(17)	2(6)	0(1)						
Stinking Hellebore		9(0)														
Comfrey (white)		1(0)		1(1)			0(2)			0(1)						
<i>Pulmonaria saccharoides</i>			0(1)													
Hybrid Primula (magenta)					0(1)											
Rosemary							0(1)	0(2)								
<i>Lithospermum</i>						0(1)		0(1)	0(2)	1(4)	1(1)					
<i>Pulmonaria</i> Bowles Red				0(1)			0(2)	1(2)	0(3)							
<i>Prunus amanaga</i>						0(1)	0(1)									
Yellow Archangel							0(1)									
Foreget-me-not									0(1)							
Honesty							0(4)									
<i>Aubretia</i>					0(1)											
White Deadnettle						0(2)		0(10)	0(10)	0(8)	0(2)		0(1)			
Red Champion								0(3)		3(0)	0(1)					
Bugle									0(1)	1(1)	0(1)					
Welsh Poppy								0(4)			0(2)					
Apple							0(1)									
Comfrey (pink)										0(6)	0(3)	0(1)				
Comfrey (purple)											0(2)	0(1)	0(1)			
<i>Weigela</i>											0(1)					
<i>Dipelta</i>											0(2)					

2000

Flowering period	Number of male (female) flower visits															
	March				April				May				June			
	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19
Comfrey (white)					1(1)	1(1)	0(1)	0(1)	0(1)							
<i>Pulmonaria</i> Bowles Red			1(5)	1(1)	0(2)	0(1)	0(3)		0(2)							Bees seen but not foraging
<i>Pulmonaria</i> Sissinghurst white						0(1)										
Stinking Hellebore		0(2)	0(1)			0(1)										
Rosemary					0(1)	0(1)		0(1)								
<i>Pulmonaria officinalis</i>	5(3)	0(3)	3(25)	3(5)	11(3)	4(2)	1(6)	1(8)	1(13)	1(4)						
Heather (pink)			1(0)													
<i>Pulmonaria saccharoides</i>							0(3)	0(1)	0(3)							
<i>Pulmonaria longifolia</i>					0(1)											
<i>Ribes</i>								0(1)								
Grape Hyacinth							1(0)									
Yellow Archangel					0(1)		0(5)	0(4)								
<i>Aubretia</i>													0(1)			
White Deadnettle							3(3)	0(5)	0(2)	0(1)						
<i>Allium christophii</i>						1(0)										
Comfrey (blue)									0(1)	1(2)	0(1)	0(1)		0(1)		
<i>Prunus amanagawa</i>									0(1)							
Red Campion													0(3)	0(1)		
Bugle										0(2)						
Solomon's Seal										0(2)	0(1)					
Comfrey (pink)										0(1)		0(1)	0(3)	0(1)		
Comfrey (purple)													0(1)			

2001

Flowering period	Number of male (female) flower visits															
	March				April				May				June			
	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19
<i>Pulmonaria officinalis</i>				7(7)	6(7)	9(7)	13(3)	15(33)	5(22)	6(7)	0(8)	1(2)	0(1)			
<i>Pulmonaria rubra</i>					3(0)	3(0)	0(1)	2(3)	0(3)	0(2)						
Stinking Hellebore	2(0)	2(0)	0(0)	0(2)												
Heather (pink)							0(1)									
<i>Pulmonaria Majeste</i>							2(0)		0(1)	1(1)		1(0)				
<i>Aubretia</i>									1(1)	1(0)						
Comfrey (white)									0(1)			0(2)				
Rosemary								0(1)	0(1)	0(3)						
<i>Pulmonaria longifolia</i> Ankum						0(1)		1(0)	1(0)							
Forget-me-not								0(1)	0(1)	0(2)		0(1)				
Grape Hyacinth								0(1)	0(1)	0(1)						
Honesty								0(3)	1(1)	2(5)						
Cowslip										0(1)						
<i>Pulmonaria Blue Ensign</i>								1(1)	1(1)							
Yellow Archangel									0(3)	0(6)	0(1)					
White Deadnettle								0(3)	0(4)	1(4)	0(7)	0(6)	0(3)			
<i>Prunus amanaga</i>									0(16)	0(5)						
Sprouting Broccoli									0(8)	0(4)	0(12)	1(2)				
<i>Lithospermum</i>											1(2)					0(1)
Welsh Poppy															0(1)	
Red Campion																0(1)
Comfrey (blue)									0(1)		3(3)	0(3)				
Bugle											0(3)	0(2)				
Wallflower									0(1)							
Solomon's Seal											0(5)	0(3)				
Comfrey (purple)												0(2)	0(1)	0(6)		
Comfrey (pink)												0(4)	0(2)	0(1)		
<i>Verbascum</i> (pink)												0(1)				
<i>Veronica</i> (spiked)													0(1)			

