

LEICESTERSHIRE ENTOMOLOGICAL SOCIETY

***FORAGING BEHAVIOUR OF BUMBLEBEES
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SUBURBAN GARDEN IN KNIGHTON,
LEICESTER 1998-2001***

by

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Occasional Publications Series

Number 21

January 2003

ISSN 0957 - 1019

FORAGING BEHAVIOUR OF BUMBLEBEES AND CUCKOO BUMBLEBEES IN A SUBURBAN GARDEN IN KNIGHTON, LEICESTER 1998-2001

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INTRODUCTION

As part of the on-going study of the occurrence and behaviour of bees in a Leicester suburban garden, this report examines the foraging activities of both bumblebees and cuckoo bumblebees during the period 1999-2001. The garden is maintained to encourage a diverse insect fauna and the layout, range of available plants and the methods used for monitoring have been previously described (Frankum 1999, 2002). The prevailing weather conditions during the present study period, also described before (Frankum, 2002) have a marked effect on flowering periods and the appearance and foraging habits of bees.

FLIGHT PERIODS IN THE GARDEN 1998-2001

Table 1 details the flight periods of bumblebees and cuckoo bumblebees in 2000-2001 compared with those previously reported for 1998-1999 (Frankum, 2002). Variability in the start of flight periods was probably linked to prevailing weather conditions and affected the time of emergence of over-wintering queens. In 1998, bumblebees were only considered as possible foraging competitors to the solitary bee *Anthophora plumipes* and, accordingly, no records of either bumblebees or cuckoo bumblebees are available after the end of the *A. plumipes* flight period (last recorded week commencing 19.vi.98). The information is included in the present report to indicate the emergence time of the bees but is not considered in terms of longevity of flight period.

(i) Bombus pratorum

This species is frequently the first to appear in spring (Benton, 2000) and *B. pratorum* queens were seen searching for nest sites in the garden during early March 2000 but not until a month later in 2001. Prys-Jones & Corbet (1987) suggested that colonies mature in mid-summer when most of the young queens go into hibernation; however, Benton (2000) comments that there is evidence for double, or even triple, broods in some years. In 2000 and 2001, the flight period of *B. pratorum* extended into early autumn, when queens were seen foraging during sunny periods in October, prior to hibernation.

(ii) Bombus pascuorum

Prys-Jones & Cobert (1987) noted that colonies of this species may vary in size and can be relatively large and long-lived with no second brood. In the garden, this species always appeared at the end of March or beginning of April and was observed throughout the summer months and usually well into autumn. In 2000 and 2001, *B. pascuorum* was still on the wing and busy foraging until the last week of October when recording finished.

(iii) *Bombus hortorum*

Compared with the previous two bumblebee species, the flight period of *B. hortorum* was much shorter, from April to late July although in 1999 the bee was observed into September. Prys-Jones & Corbet (1987) have suggested that colonies of this species may be quite small in size, with a short life-cycle, although inconclusive evidence indicates the possibility of a second brood in a good year. During early June 2001, a large dark-coloured (three indistinct dark brownish-yellow bands/dirty beige tail), dark winged bumblebee, with a long face and tongue, was seen foraging the long tubular corollas of purple *Aquilegia*. No conclusive identification was made but the bee might have been the intermediate form of *B. ruderatus* (Nb) or perhaps a dark form of *B. hortorum*. The bee was compared to museum specimens, photographed and released but it was only seen on one further occasion in mid-July.

(iv) *Bombus terrestris/lucorum*

Although the early queens are easily recognised, it is often difficult to differentiate between workers of *B. terrestris* and *B. lucorum* in the field; so these two species are considered as a complex. In 1999-2001 they were noted more or less continuously from the beginning of March to mid-September (in 1999) and the end of October (2000, 2001).

(v) *Bombus lapidarius*

B. lapidarius queens were usually seen searching for nest sites in the garden during April and into May. Benton (2000) postulates that they have a higher temperature threshold for activity than other common species; they also spend a lot of time sunning themselves or are grounded in cooler weather conditions. The shorter flight period of this bumblebee species extended, at best, to early September.

(vi) *Psithyrus vestalis* and *Psithyrus sylvestris*

As may be expected, the appearance of cuckoo bumblebees is highly dependent upon the availability of viable colonies of host species. Thus, in each year, these parasites appeared several weeks after their bumblebee hosts. *P. vestalis* is a parasite in the nests of *B. terrestris* whilst *P. sylvestris* parasitises the nests of *B. pratorum*. *P. vestalis* seemed to have a longer flight period than *P. sylvestris* although it is possible that the latter had a lower population in the garden. The flight periods were never as long as those of their hosts and neither species was seen beyond the end of August in any year.

FORAGING ACTIVITY OF BUMBLEBEES

In order to have a successful breeding season, bumblebees require substantial (and varied) nectar and pollen sources. The types of flowers that they will use will, to a certain extent, be determined by their tongue length and how deep they can probe. However, short-tongued bees (*B. terrestris*), that are unable to reach nectar "legitimately" in long tubular flowers, sometimes bite a hole at the base of the corolla in order to rob the nectar and thus by-pass the pollination process. It has been pointed out before (Frankum, 1999, 2002), that the garden offers an abundance of

nectar and pollen sources and the present report examines which of these were most favoured by the bumblebees that visited during 1999-2001.

Each year, throughout the bumblebee flight period March-October, all flowers available for foraging were listed each week to determine their flowering period and accessibility to the foraging bees. Some flowering periods were of short duration and others flowered for several weeks. There were 197 different kinds of flowers in 1999, 224 in 2000 and 270 in 2001 and those chosen by each bumblebee species (and the number of visits) were noted. There were annual variations in foraging choices perhaps influenced (a) by flight period duration, (b) flower availability related to weather conditions or (c) even the gardener's choice! Appendix 1 details the number of visits made to each available flower for each bumblebee species with the summary presented in Table 2 showing that, despite a wide variety of nectar sources being available to the bumblebees in the garden, the majority were not used.

Table 2: Numbers of flowers favoured by bumblebees 1999-2001

Bumblebee species	Number of flowers visited (% of total available)		
	1999 (197 flowers)	2000 (224 flowers)	2001 (270 flowers)
<i>Bombus pratorum</i>	40 (20)	42 (19)	52 (19)
<i>Bombus pascuorum</i>	62 (31)	60 (27)	84 (31)
<i>Bombus terrestris/lucorum</i>	44 (22)	29 (13)	47 (17)
<i>Bombus hortorum</i>	27 (14)	21 (9)	24 (9)
<i>Bombus lapidarius</i>	27 (14)	10 (4)	35 (13)

(i) Flowers preferably foraged by *Bombus pratorum*

This small black (with yellow bands and orange tail) bumblebee has a tongue of only moderate length but Prys-Jones & Corbet (1987) have reported that it uses flowers with a wide range of corolla depths. It will visit very short open flowers but equally may use some of the long tubular flowers, including those that hang downwards e.g. Comfrey, by thrusting its relatively narrow head deep into the corolla. Behaviour of this kind is supported by evidence gathered in the Knighton garden. *B. pratorum* also carried out opportunistic secondary robbery of nectar through existing holes cut by short-tongued bumblebees. Table 3 shows the Top Ten flowers most frequently used by *B. pratorum* as a sum of all visits over three years.

Table 3: Overall Top Ten preferred flowers foraged by *Bombus pratorum* 1999-2001 (total of 1271 visits)

Flower	Number of visits 1999-2001	% of all flower visits
Cornflower	158	12
Comfrey (blue)	152	12
Comfrey (purple)	142	11
Comfrey (pink)	111	9
Geranium phaeum	91	7
Geranium (blue)	90	7
White Deadnettle	75	6
Geranium (pink)	64	5
Bramble	52	4
Yellow Archangel	36	3
Overall totals	971	76

These ten flowers accounted for over three-quarters of visits made by *Bombus pratorum* over the three-year study period and it was noticeable that they were predominantly purple, pink and blue in colouration. The range of corolla types used was in accord with previous reports, with tubular Comfreys (Boraginaceae) being the most favoured flowers (accounting for 32% of all visits) and open Geraniums in

second place (19%). The foraging of Yellow Archangel and White Deadnettle (Lamiaceae, 9%) emphasised the ability of the bee to force its way into protected nectar tubes. *B. pratorum* occasionally (but not always) carried out opportunistic secondary robbery of Comfrees previously robbed by *B. terrestris/lucorum*.

However, it should be noted that not all the flowers were in the Top Ten list in each year with some appearing only once and the positions of others varying e.g. Raspberry and Bramble (Rosaceae, 6%) (Table 4). Of particular interest was the obvious preference for Perennial Cornflower (Asteraceae, 12%) that appeared in the top three on each occasion.

Table 4: Top Ten flowers foraged each year by *Bombus pratorum*

Position	1999	2000	2001
1	Comfrey, purple	Cornflower	Comfrey, blue
2	Cornflower	Comfrey, blue	Comfrey, purple
3	Comfrey, pink	Comfrey, pink	Cornflower
4	Comfrey, blue	<i>Geranium phaeum</i>	Geranium, blue,
5	<i>Geranium phaeum</i>	Geranium, blue	Geranium, pink
6	White Deadnettle	White Deadnettle	White Deadnettle
7	Bramble	Comfrey, purple	<i>Geranium phaeum</i>
8	Geranium, blue	Yellow Archangel	Comfrey, pink
9	Geranium, pink	Geranium, pink	Yellow Archangel
10	Geranium, Mrs K Clark	Bramble	Raspberry

(ii) Flowers preferably foraged by *Bombus pascuorum*

This bumblebee is distinctive as being the only common species to have a uniformly ginger-coloured thorax (Prys-Jones & Corbet, 1987). *B. pascuorum* queens emerge from hibernation to forage a wider range of flowers than early workers (Benton, 2000). It is a long-tongued species and is especially attracted to flowers with long tubular corollas with White Deadnettle being a favourite. The overall Top Ten preferred foraging sources in the garden reflected this (with the exception of Geranium) as indicated in Table 5. The Top Ten also accounted for more than 60% of the total visits by *B. pascuorum* to preferred flowers in the garden

Table 5: Overall Top Ten preferred flowers foraged by *Bombus pascuorum* 1999-2001 (total of 2024 visits)

Flower	Number of visits 1999-2001	% of all flower visits
White Deadnettle	239	12
Purple Toadflax	158	8
Comfrey, purple	145	7
Comfrey, blue	139	7
Lavender	111	5
Purple Loosestrife	108	5
Comfrey, pink	96	5
Marjoram	86	4
Cornflower	84	4
Geranium, pink	83	4
Overall totals	1249	62

There was little change in the Top Ten foraging choices from year to year emphasised by the use of nine of the Top Ten preferred plants in every year of the study (Table 6). Even the tenth (pink Comfrey) appeared in two of the years being replaced in 2001 by Tutsan. Prys-Jones & Corbet (1987) state that the males tend to visit clustered or compound flowers more often than workers. Appendix 1 shows that, during the long flight period of this species, a wide range of other flowers were visited often briefly and possibly by males, including Bramble, Raspberry, Knapweeds and Michaelmas Daisies.

Table 6: Top ten flowers foraged each year by *Bombus pascuorum*

Position	1999	2000	2001
1	White Deadnettle	White Deadnettle	Purple Toadflax
2	Comfrey, purple	Comfrey, blue	White Deadnettle
3	Comfrey, pink	Purple Toadflax	Comfrey, purple
4	Comfrey, blue	Marjoram	Lavender
5	Purple Loosestrife	Comfrey, purple	Cornflower
6	Lavender	Purple Loosestrife	Geranium, pink =
7	Marjoram	Geranium, pink	Purple Loosestrife =
8	Purple Toadflax	Comfrey, pink	Tutsan
9	Cornflower	Lavender	Comfrey, blue
10	Geranium, pink	Cornflower	Marjoram

(iii) Flowers preferably foraged by *Bombus terrestris/lucorum*

Workers of *Bombus terrestris* and *Bombus lucorum* (two yellow bands and a buff or white tail) are very difficult to separate in the field and this examination of their foraging habits has treated the two species as a complex. Both species have short tongues and are reported as preferring to forage from short open flowers. However, they are regular nectar robbers by biting holes at the base of long tubular flowers such as Comfrey, Red Champion and *Aquilegia*. Other opportunistic bumblebees then use the holes for secondary robbery. Table 7 lists the most favoured flowers in 1999-2001 based on the total number of visits in this period to each flower. However, this data is misleading in that the wide range of flowers used by *B. terrestris/lucorum* is more accurately reflected in the lists of flowers favoured in each individual study year (Table 8).

Table 7: Overall Top Ten preferred flowers foraged by *Bombus terrestris/lucorum* 1999-2001 (total of 738 visits)

Flower	Number of visits 1999-2001	% of all flower visits
Marjoram	157	21
Welsh Poppy	90	12
Lavender	43	6
Red Champion	40	5
<i>Aruncus</i>	34	5
Red Poppy	31	4
Purple Toadflax	30	4
Purple Loosestrife	26	4
Teasel	23	3
White Deadnettle	19	3
Overall totals	493	67

Table 8: Top Ten flowers foraged each year by *Bombus terrestris/lucorum*

Position	1999	2000	2001
1	Marjoram	Welsh Poppy	Marjoram
2	Welsh Poppy	Red Champion	Welsh Poppy
3	Purple Toadflax	Red Poppy	Lavender
4	Purple Loosestrife	Marjoram	<i>Aruncus</i>
5	Lavender	Purple <i>Aquilegia</i>	Globe Thistle
6	Teasel	Meadowsweet	Red Poppy
7	<i>Aruncus</i>	White Deadnettle	Purple <i>Aquilegia</i> =
8	Yellow <i>Sedum</i>	Bramble	Red Champion =
9	Red Champion	Geranium, pink	White Deadnettle =
10	<i>Campanula</i>	<i>Aruncus</i> & <i>Campanula</i>	Cornflower

It is obvious that, in the main, these bumblebees preferred to forage at either short corolla flowers (e.g. Marjoram, Lavender, Purple Toadflax), at open flowers buzzing to free up the pollen (e.g. Poppies), where there is a platform with many florets that can be easily probed (e.g. Cornflower) or where pollen is easily collected by

scrambling over the anthers (e.g. *Aruncus*, Meadowsweet) (in agreement with Prys-Jones & Corbet, 1987). One advantage of having a wide foraging choice is that the flight period can be extended well into the autumn (Table 1).

(iv) Flowers preferably foraged by *Bombus hortorum*

Bombus hortorum is readily identified in the field as a white-tailed bumblebee with three yellow bands. It has a long face and a long tongue which allows it to probe the deepest of nectar sources usually visiting single flowers. The low numbers of this bumblebee seen foraging in the garden during 1999-2001 (total of 292 visits) does not allow accurate assessment of preferred nectar sources. However, in Table 9 it is obvious that a range of tubular flowers were foraged each year. Some of these flowers only had short flowering periods e.g. Monkshood, *Phlomis*, *Digitalis lutea* and purple *Aquilegia*, and timing may have meant limited access for the bees. Some tubular flowers with longer flowering periods, such as Red Campion, meant that it was highly favoured in 1999 and 2001) but only four visits were noted in 2000. Variations such as these probably reflected weather conditions (Frankum, 2002) and the resulting patchy flowering periods (Appendix 2). In 2001, the possible *B.ruderatus*/*B. hortorum* (dark form) also visited Red Campion, *Aquilegia* and White Deadnettle.

Table 9: Top flowers foraged each year by *Bombus hortorum*

1999	2000	2001
Marjoram	White Deadnettle	Red Campion
Red Campion	<i>Phlomis</i>	Yellow Flag
Monkshood	Monkshood	White Deadnettle
White Deadnettle	Cornflower	Comfrey (blue)
<i>Phlomis</i>	Red Campion	<i>Stachys lanata</i>
Sage	<i>Aquilegia</i> (purple)	<i>Phlomis</i>
Red Deadnettle	<i>Digitalis lutea</i>	<i>Aquilegia</i> (purple)

(v) Flowers preferably foraged by *Bombus lapidarius*

Bombus lapidarius bumblebees are coloured black with a red tail with the males having a yellow band on the thorax. Although the queens are large and manage to visit tubular flowers, such as Red Campion, workers of this species may be very small with comparatively short tongues. Prys-Jones & Corbet (1987) report that the bees prefer to forage at massed flowers which, although nectar poor, enable sufficient to be gathered from many flowers in one "landing" thus saving energy between flights. As with *B. hortorum*, the numbers of *Bombus lapidarius* observed in the garden were low (total of 213 visits) and, although a range of flowers were foraged briefly, only two flowers (*Campanula* and Marjoram) attracted them in any numbers and even these varied from year to year.

FLOWERS PREFERRED BY *BOMBUS* SPECIES

It is obvious from the preceding that (a) some flowers are used more for foraging by bumblebees than others and (b) there is a degree of preference between bumblebee species. The garden during 1999, 2000 and 2001 had totals of 197, 224 and 270 flowers respectively, aimed at giving a wide range of types of flower that the bees could forage and also offer sufficient nectar sources that could be used throughout the bumblebee seasons. Table 2 has already indicated the numbers of flowers used each year by each *Bombus* species but it useful to measure the overall effectiveness of the planting regime in the garden by assessing (a) how many species use the

flowers and (b) determining the most successful plants as related to the number of visits made by all *Bombus* species. It is recognised that there are severe limits to the accuracy of such assessments e.g. the low frequency of some bumblebee species in the garden, the low number of observations carried out daily (two), the effect of weather on bee (and flower) appearance, whether the flowers were available just singly or in a mass, how long flowers are available for foraging etc. However, it is hoped that it will be possible to give guidance on what types of flower should be included in an urban garden in order to encourage its use by these social bees. Table 10 considers the number of flowers that were visited by one to five *Bombus* species whilst Table 11 lists those flowers which had 100 or more *Bombus* visits over the 1999-2001 period.

As may be expected, the number of flowers receiving one or two visits accounted for the majority of the flowers foraged with only 26 flowers being used by four or five of the *Bombus* species (Table 10).

Table 10: Number of flowers visited by 1 or more *Bombus* species 1999-2001

No <i>Bombus</i> visiting	No flowers visited
5	11
4	13
3	26
2	42
1	86

Table 11: Flowers receiving more than 100 visits by *Bombus* species during 1999-2001

Flower	Number of <i>Bombus</i> visits	No <i>Bombus</i> sp visiting
White Deadnettle	366	5
Marjoram	322	5
Purple Comfrey	313	5
Viue Comfrey	300	4
Cornflower	278	5
Pink Comfrey	214	5
Purple Toadflax	195	5
Pink Geranium	175	5
Lavender	167	3
Purple Loosestrife	145	4
Red Campion	139	5
Blue Geranium	116	4
Bramble	101	5
Welsh Poppy	100	4

The flowers that received more than 100 visits during the three-year period were predominantly foraged by four out five of the *Bombus* species but this does not give an entirely true picture of foraging preferences as some flowers were visited more frequently than others by some bumblebees leading to a bias in the overall counts. For example, White Deadnettle received the most visits with all five species being recorded as using the flower. However, closer examination of the data (Appendix 1, Table 12) shows that the flower was most often visited by *B. pratorum* and *B. pascuorum* with only two visits in three years by *B. lapidarius*. Indeed, the two dominant species accounted for 87% of all visits to White Deadnettle.

A similar pattern was observed with foraging visits to Purple, Blue and Pink Comfrees, Cornflower, Pink Geranium and Bramble (Table 12). In contrast, Marjoram predominantly attracted *B. pascuorum* and *B. terrestris/lucorum* as did Purple Toadflax and Lavender. However, it was obvious that some flowers attracted specific bumblebees e.g. Welsh Poppy was almost exclusively foraged by *Bombus terrestris/lucorum* demonstrating the preference by this bee for open flowers.

One important consideration in assessing the foraging choices of bumblebees is the relationship between the flight period and what flowers are available as food sources. Comfrees, for instance, are extremely important as nectar and pollen sources in early spring as colonies of bees are being established. As summer

progresses, a wider range of flowers becomes available which will be foraged by workers as colonies increase in numbers whilst late summer and early autumn will see the later flowering plants e.g. Marjoram, White Deadnettle and Cornflower, being used by queens as they prepare for over-wintering.

Table 12: Foraging preferences (total number of visits) by *Bombus* species of flowers receiving 100 or more visits

Flower	<i>Bombus pratorum</i>	<i>Bombus pascuorum</i>	<i>Bombus terrestris/lucorum</i>	<i>Bombus hortorum</i>	<i>Bombus lapidarius</i>
White Deadnettle	75	239	19	28	2
Purple Comfrey	142	145	13	8	5
Blue Comfrey	152	139	2	7	0
Marjoram	7	86	157	41	31
Cornflower	158	84	10	9	17
Pink Comfrey	111	96	4	2	1
Purple Toadflax	4	158	30	1	2
Pink Geranium	64	83	11	3	14
Lavender	13	111	43	0	0
Purple Loosestrife	1	108	26	0	10
Red Campion	16	10	40	61	12
Blue Geranium	90	17	2	0	7
Bramble	52	34	11	2	2
Welsh Poppy	1	8	90	0	1

BUMBLEBEE POPULATIONS 1999-2001

Whilst the present study was not designed to assess population levels of each *Bombus* species in the garden, it is possible to draw some tentative conclusions based upon the numbers observed foraging. Table 13 summarises the numbers of each species foraging 1999-2001 with a total of 4538 observations.

Table 13: Numbers of *Bombus* species visits each year

Year	<i>Bombus pratorum</i>	<i>Bombus pascuorum</i>	<i>Bombus terrestris/lucorum</i>	<i>Bombus hortorum</i>	<i>Bombus lapidarius</i>
1999	388	660	337	143	61
2000	379	546	139	56	28
2001	504	818	262	93	124
Totals	1271	2024	738	292	213

Based on these figures it would seem that the commonest bumblebee in the garden was *B. pascuorum* accounting for almost half (45%) of all bumblebees recorded in this survey closely followed by *B. pratorum* (28%). The *B. terrestris/lucorum* complex was the third most common (16%) followed by *B. hortorum* (6%) and *B. lapidarius* (5%). Caution must be exercised in assuming that the garden held large populations of the commoner species as the observations were probably influenced by (a) the likelihood that many bees may have been recorded more than once in each transect walk as they flitted around the garden and (b) the timings of transect walks may have been biased towards some species e.g. *B. pratorum* is reported to be on the wing in early morning whereas others may prefer to wait until the temperature climbs.

FORAGING ACTIVITIES OF CUCKOO BUMBLEBEES 1998-2001

(*Bombus* sub-genus *Psithyrus vestalis*, *P. sylvestris* and possibly *Psithyrus campestris* (?))

[Note: Since this survey work commenced, evidence has been put forward to suggest that the *Psithyrus* species fall within the *Bombus* genus such that, for example, *Psithyrus vestalis* should now be referred to as *Bombus* (sub-genus *Psithyrus*) *vestalis* (Williams, 1998 cited in

Benton, 2000). However, for the purposes of the present report the original nomenclature has been followed.]

Table 14: Foraging choices of cuckoo bumblebees 1999-2001

Flower foraged	Number of visits per flower								
	<i>Psithyrus vestalis</i>			<i>Psithyrus sylvestris</i>			<i>Psithyrus campestris</i> (?)		
	1999	2000	2001	1999	2000	2001	1999	2000	2001
<i>Allium christophii</i>		1	1						
<i>Bergenia Silberlicht</i>			1f						
Bramble		4	3						
<i>Campanula</i>	3	2							
Cornflower	4	3			2	5m			
<i>Correopsis</i>							2		
<i>Cotoneaster</i>				1					
<i>Delphinium</i>		1							
Geranium (blue)	1								
Geranium (pink)		2	3						
Globe Thistle							3		
Heather (pink)			1f						
Knapweed			10						
<i>Knautia</i>			5						
Lavender	2		22						
Lemon Verbena		2	1						
Lesser Celandine						1f			
Marigold			1						
Marjoram	58	2	95	1			1	No records	
<i>Pulmonaria officinalis</i>			1						
Purple Loosestrife	13		5						
Purple Toadflax		3	4						
Salvia (blue)			1						
Scabious (yellow)		5	10						
<i>Sedum</i> (yellow)	1						1		
Spear Thistle	4	2							
Sunflower			5						
Teasel	21	5	13						
<i>Teucrium</i>			3						
Tree Mallow			1						
Tree Onion		1							
Valerian		10	2						
<i>Verbascum nigrum</i>			1						
White Deadnettle		1							
<i>Wisteria</i>	1								
Yellow Archangel			1						

Cuckoo bumblebees have no worker caste, cannot produce wax and have no means of collecting pollen. This is because the females locate and take over the established nests of bumblebees, sometimes (but not always) killing the bumble queen and relying on her workers to rear the “cuckoo” young (Benton, 2000). Cuckoo bumblebee females have a very thick cuticle that is thought to help protect against the stings of defending workers until she takes on the accepted scent of the host. However, this does not always work where there is a strong host population and the nest may be littered with bodies of dead *Psithyrus* invaders (O’Toole, 2002). Each *Psithyrus* species is normally parasitic on a particular host species e.g. *P. vestalis* is parasitic in the nests of *B. terrestris*, *P. sylvestris* takes over *B. pratorum* and *P.*

campestris takes over *B. pascuorum*. However, these parasitic bees still require to fuel their activities by foraging for nectar.

In the garden, *Psithyrus vestalis* cuckoo bumblebees were first noticed in 1998, when bumblebee identification was on a steep learning curve and there was yet another new species to identify! The *P. vestalis* females were always slightly later emerging than their hosts in order to give the *B. terrestris* queens time to establish new nests and produce workers (Table 1). In 1999-2001, the males spent a lot of time sluggishly clambering over Marjoram, Teasel, Purple Loosestrife and Lavender etc.

Sporadic sightings in all survey years of another species visiting Perennial Cornflower proved to be *Psithyrus sylvestris* (Table 1) while *Psithyrus campestris* was possibly seen briefly in 1999. A female *Psithyrus bohemicus* (verified by Paul Lee) was found in the same year and, although searched for, has not been seen since (it closely resembles *P. vestalis* in the field). The host for *P. bohemicus* is usually *B. lucorum*. Table 14 indicates the foraging choices of the *Psithyrus* species during 1999-2001.

The scarcity of data for all but *Psithyrus vestalis* makes it difficult to assess flower preferences. However, the data for *P. vestalis* does allow some conclusions to be drawn. A total of 32 flowers were visited by this bee with a particular preference for Marjoram in 1999 and 2001, although the flower was hardly visited in 2000. The latter observation may have been due to the general lack of observations of *P. vestalis* during 2000 (44) compared with 108 (1999) and 190 (2001) in the other years. Other than Marjoram (155 visits), only Teasel (39 visits) attracted the bee in any numbers over the three years. In 2001, more bees were visiting Knapweed, Yellow Scabious and Lavender than in previous years. Table 15 shows the number of flowers used by this parasitic bee 1999-2001.

Table 15: Flowers foraged by *Psithyrus vestalis*

Year	1999	2000	2001
Number of flowers available	197	224	270
Number of flowers foraged	10	15	23
% foraged	5	7	9

CONCLUSIONS

The presence of a wide variety of nectar and pollen sources in a suburban Knighton (Leicester) garden proved attractive in encouraging foraging by both bumblebees and cuckoo bumblebees. However, it was evident that, despite being spoilt for choice, the bees used relatively few of the available flowers. *Bombus pascuorum* used an average of 28% of available flowers over the 1999-2001 study period whilst *Bombus terrestris/lucorum* only used an average of 18%. *Bombus hortorum* was even more selective using about 11% of flowers. The number of plants used by the cuckoo bumblebee *Psithyrus vestalis* was even more conservative utilising only 32 (10%) of the flowers available in 1999-2001.

Over the period 1999-2001, the number of flowers available for foraging by the bumblebees increased from 197 to 270. However, there was little evidence of a greater range being used by the bees. For instance, the Top

Ten flowers foraged by *Bombus pratorum* and *Bombus pascuorum* in each year was remarkably stable with eight of each year's Top Ten appearing in every year. In contrast, *Bombus terrestris/lucorum* had a wider range of flowers appearing in their Top Ten with only four being present each year. *Bombus hortorum* only had one regular flower that it used for foraging (White Deadnettle) with eleven flowers appearing at one time or another in the Top Five each year. In the case of the cuckoo bumblebee, *Psithyrus vestalis*, foraging was even more restricted with only Marjoram and Teasel being visited each year.

The evidence points to the need for gardeners to be aware of the foraging needs of bumblebees and their cuckoo parasites if there is to be active conservation and encouragement of these familiar insects in suburban environments. The most widely used plant in the Knighton garden was White Deadnettle, a plant familiar of hedgerow bottoms but considered by gardeners as nothing more than a weed. Perhaps it is worth noting that this species was visited by all *Bombus* species and *Psithyrus vestalis* although not overly favoured by the latter and *B. lapidarius*. Amongst the "garden" varieties, the early flowering Comfreys (grown for composting) were particularly used for foraging as were the later Marjoram and Cornflower. It is important to provide nectar and pollen sources throughout the bumblebee flight periods so that (a) newly emergent queens can establish viable colonies in spring, (b) workers can provision the developing colony during summer and (c) nectar is available for the queens as they prepare for over-wintering.

The data presented in this report indicates that suburban gardens have an important role in promoting bumblebees (and their parasitic cuckoo cousins) but awareness of the foraging requirements of each species is necessary to ensure success. Filling a garden with inappropriate flowers as potential nectar and pollen sources for bumblebees without such awareness is non-productive. Of course, these unused flowers will probably serve as adequate nutrient sources for other insects!

ACKNOWLEDGEMENTS

My thanks go to Paul Lee for verifying *Psithyrus bohemicus*, Robin Williams for guidance with *Psithyrus vestalis* and Mike Edwards (BWARS) for information about *Bombus ruderatus* (?) / dark *Bombus hortorum*. Finally many thanks to Ray Morris of the LES for editing this paper.

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ADDENDUM – BUMBLEBEE NESTS IN THE GARDEN 1995-2001

During the study period, bumblebee queens occasionally took advantage of the early spring foraging on offer and chose to establish their nests in the garden and surrounding area. Some nested well above the ground (c 2m) and others preferred to use existing underground holes. In 1995, after the blue-tit chicks had fledged, a *Bombus lapidarius* queen moved into the trellis nest box and established her colony in the flea-ridden nesting material left behind by the birds. In the same year, *Bombus hortorum* nested in one of the old woodmouse holes at the base of the pampas grass clump while in the following year a cavity in a dry-stone wall, with access via a horizontal drainage pipe, was used. *Bombus terrestris* also like to nest underground and in 1997/98 they were in the roots of an old elm stump on the grass verge just outside the garden fence. Although *Bombus pascuorum* has never nested in the garden, a neighbour (some 50m away) disturbed a mossy cluster of cells at the base of a rough grass tussock when mowing the grass! In 1997, *Bombus pratorum* nested in the moss-lined wren's nest box on the north-facing wall of the garage; in 1998 they used the woodpile and a blue-tit box, also on the garage wall; in 2000, an east-facing nestbox on the garden fence (near the trellis nest box) was used. On this latter occasion they were noticed quite by chance - when the new drones (males) had left the nest they were not allowed back inside. They milled around the entrance hole, looking for the new queens coming out and no doubt the successful ones flew off with their potential mates into the wide blue yonder!

Flower	<i>Bombus pratorum</i>			<i>Bombus pascuorum</i>			<i>Bombus terrestris/lucorum</i>			<i>Bombus hortorum</i>			<i>Bombus lapidarius</i>		
	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001
Comfrey (blue)	42	44	66	51	59	29			2			7			
Comfrey (pink)	48	42	21	55	23	18		2	2		1	1			1
Comfrey (purple)	54	22	66	58	28	59	10		3	2	2	4	3		2
Comfrey (white)	3	1	1	2	1	1									
Cornflower	52	47	59	25	21	38	3	1	6	2	6	1	4	5	8
<i>Correopsis</i>							8								
<i>Corydalis</i> (yellow)												1			
<i>Cosmos</i> (chocolate)					4										
Cotoneaster	1														
Currant, Red			1												
Daboecia		1	4		18	2			1						
Daffodil (mini)					1										
Daffodil (standard)								1							
<i>Dahlia</i> (Bishop of Llandaff)					2										
Dandelion												1			
Deadnettle, Red	1									6					
Deadnettle, White	28	24	23	90	69	80	4	7	8	11	9	7, 1R			2
Delasperma						1									
Depelta										1					
Eryngium									1						
<i>Erysium</i> (orange)					1										
<i>Erysium</i> (purple)				1											
Euphorbia													1		
Evening Primrose						4			1						
Forget-me-not	1	6	4	1			1		1						
Foxglove						2				3		2			
Foxglove (<i>Digitalis lutea</i>)					2										
Foxglove (<i>Digitalis lutea</i>)										1	4	1			
<i>Fritillaria</i>						1q									1
Fuchsia				5	2	4									
<i>Geranium</i> (blue)	13	32	45	3	8	6			2				1	5	1
<i>Geranium</i> (pink)	12	17	35	23	24	36	2	5	4	2	1		2	4	8
<i>Geranium</i> Kashmir		1													
<i>Geranium</i> Mrs K-Clark	11	9	8	2											
<i>Geranium</i> phaeum	29	36	26	3	3	1							1		
<i>Geranium phaeum</i> (white)	6														
<i>Geranium sanguineum</i>			1			1									
Globe Thistle	1			12	10	7	2		10						

Flower	<i>Bombus pratorum</i>			<i>Bombus pascuorum</i>			<i>Bombus terrestric/lucorum</i>			<i>Bombus hortorum</i>			<i>Bombus lapidarius</i>		
	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001
Gooseberry			1												
Heather	8	1	2	20	1		9	3	4				1		
<i>Hebe</i> (white)								2							
Helenium						5									1
Hellebore (oriental)			1q						1						
Hellebore, Stinking	1	2	2q				1								
Hemp Agrimony						1									
Herb Robert						1									
Hollyhock				3	1				1				1		
Honesty	1		1	1		1									
Honeysuckle		1									1				
Hyacinth (white)								1							
Hydrangea petiolaris									1						
<i>Hypericum</i>						4									1
Iris (yellow)													1		
Iris (yellow/blue)										2					
Knapweed				4	3	24	1						1		6
Knapweed (yellow)				1	1	2				1					1
<i>Knautia</i>			1		6	14									
Lady's Mantle						1									
Lavender		2	11	39	22	50	25	2	16						
Leek															1
<i>Linaria</i>				1		2	1								1
Lithospermum				2											
<i>Lobelia</i> (red)							1								
Loosestrife (purple)			1	47	25	36	26						4		6
Lovage							3								
Macleaya							1	1							
Marguerite Daisy									1						1
Marigold									1						
Marjoram	3		4	29	32	25	63	8	86	40	1		2	2	27
Meadow Clary (blue)					1										
Meadowsweet		1					5	6							
Michaelmas Daisy				6	13	5	2		2				2	2	
Mimulus				2							1				
Mint, Water				4	6	4	1						1		
Monkshood				2	1	2				14	6	4			
Morning Glory (red)						1									
Mullein (<i>V. nigrum</i>)				1		8		1	2						

Flower	<i>Bombus pratorum</i>			<i>Bombus pascuorum</i>			<i>Bombus terrestris/lucorum</i>			<i>Bombus hortorum</i>			<i>Bombus lapidarius</i>		
	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001
Snapdragon				4											
Snapdragon (magenta)						1				1					
Snapdragon (pink)							1								
Snapdragon (yellow)						2									
Solomon's Seal	5		3									1			
<i>Spiraea</i>							1		1						1
<i>Spiraea</i> (pink)						2									
<i>Stachys lanata</i>			1		21	8	4	3	2			7			
Sunflower						8			5						3
Teasel				4	4	13	21		2	1			1		1
<i>Teucrium</i>					3	4									
Thistle, Spear				3			5						3		
Thyme			1												
Thyme (white)							1								
Toadflax (purple)		3	1	27	40	91	28	1	1		1			2	
Toadflax (yellow)						2									
Tomata						1									
Tree Mallow	1		1	6	4	1							1		1
Tree Onion			4							3					1
Tutsan	1			2	17	32	2					1			
Valerian	3	1	1		1	1	2		2	2					
<i>Verbascum thapsus</i>									1						
<i>Verbena</i> (purple)					1										
Violet			1q					2							
Water Avens						1									
Weigela			4	2		1				2		1			
Willowherb, Great				3	2	3	1						1		
Willowherb, Lesser					1										
Wisteria							2	2							
Yellow Flag				2	3	3				3	1	8			

