VALTION MAATALOUSKOETOIMINNAN JULKAISUJA N:o 197
PUBLICATIONS OF THE FINNISH STATE AGRICULTURAL RESEARCH BOARD No. 197

BUMBLEBEE SPECIES ON RED CLOVER IN CENTRAL FINLAND

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SELOSTUS:

PUNA-APILAN KIMALAISLAJISTOSTA KESKI-SUOMESSA

HELSINKI 1962

Received 20th Mars 1961

This publication to be obtained abroad from the Library of the Agricultural Research Centre, Tikkurila, Finland.

Helsinki 1962. Valtioneuvoston kirjapaino

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Introduction

Up to present 26 bumblebee species belonging to the *Bombus* family have been observed in Finland (ELFVING 1960). This worker considers 14 of these species more or less common in this country; viz. *B. hortorum* L., *B. distinguendus* Mor., *B. ruderarius* Müll., *B. equestris* F., *B. silvarum* L., *B. agrorum* F., *B. solstitialis* Pz., *B. soroeënsis* F., *B. sporadicus* Nyl., *B. lucorum* L., *B. lapidarius* L., *B. pratorum* L., *B. jonellus* Kirby, and *B. hypnorum* L. The remaining 12 species are either very uncommon here or else occur only in Lapland.

Bumblebee species in relation to different plants in this country have been extensively investigated by HULKKONEN (1928). He observed bumblebees on ca. 190 different species of plants.

Bumblebee species visiting red clover have been most investigated in Finland by VALLE (e. g. 1935, 1949, 1955, 1959, 1960). Over several decades his investigations have revealed that almost all the species named above visit red clover. Only *B. silvarum*, *B. solstitialis* and *B. sporadicus* are missing from his list. In addition reference may be made to the Finnish reports on red clover and bumblebees by POHJAKALLIO *et al.* (1937), KORCKMAN (1938) and POHJAKALLIO (1938).

VALLE's investigations on bumblebees have been chiefly carried out in southern Finland, mainly around Helsinki. On the basis of these protracted investigations we have a fairly clear picture of the frequency and variation in bumblebee fauna during the last 25 years. Recently VALLE has begun bumblebee investigations even in other parts of the country (VALLE *et al.* 1960). These last investigations although of only one year's duration also provide us with information about the bumblebee species in Central Finland [1]). VALLE and coworkers' report is so far the only observation from Central Finland.

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[1]) The investigations by VALLE *et al.* on bumblebees in Central Finland were made in conjunction with the present author's red clover seed trials. Their observations on tetraploid red clover were from the same stands as the results to be presented below, but the diploid red clover stands in their investigations were other than the present author's.

This report covers the results of observations of bumblebees on red clover in Central Finland during the years 1957—60, and the purpose of these investigations has been to determine the part played by various bumblebee species in the bumblebee fauna on red clover in this area.

Bumblebees are in Finland the most important pollinators of red clover (cf. VALLE l. c.). However not all bumblebees are equally suitable as pollinators of red clover. It is well known that certain bumblebee species damage red clover flowers. Thus one of the first tasks in red clover seed production investigations is to determine at least approximately the role of the various species in the bumblebee fauna visiting red clover.

I. Area investigated

The area in which the investigations were carried out consists mainly of the province of Central Finland. The southern border of the province is latitude 62°, the northern 63°, the western border longitude 25° and the eastern approximately longitude 26°. The whole area is typically afforested. The main trees are pine and spruce, but expecially in the southern and central parts of the area birch is quite common. Another characteristic of the area is the frequency of lakes of various sizes which divide the forest area.

The only considerable area of denser population is around Jyväskylä town, with only small factory and built-up areas elsewhere. Cultivated land is relatively scarce, being mostly in the southern part of the area, but even there forming less than 20 % of the total area. Fields are mainly small, being mostly openings in the middle of the forest or bordered by lakes and forest.

Bushes (e. g. *Salix spp.*) are common both in afforested areas and around fields.

Most of the fields have open ditches, and about 60 % of the fields is under grass. Up to present plant protection products have been used only on a very small scale.

Each winter the whole area is covered by a solid, longlasting layer of snow. Because of this the land is not usually firmly frozen to any great depth each winter.

II. Material and methods

The material consists of observations made of bumblebees on red clover seed cultivation trials in different parts of Central Finland during the years 1957—60. Observations were made on both diploid and tetraploid red clover stands. The former were usually local strains, the later varieties »Ulva» or »JoTPA 1». The diploid red clover trials were 200—500 m^2 in size, the tetraploid 10—710 m^2.

The diploid red clover material includes 42 and the tetraploid 4 seed trials. The diploid stands were distributed through 11 communes in the province; the tetraploid stands were situated on the same farm during Summer 1960. The investigated trials were in no case more than 300 meters from the forest edge, and often were under 100 m.

Observations on bumblebees were made during the second half of red clover flowering period, mainly during the first third of August. Observations were made

only during the middle of the day, between 11 a. m. and 4 p. m. No observations were made on cloudy or windy days. All the present observations were carried out by the author.

Only one bumblebee count was made on each diploid red clover trial. It was made by walking round and counting the bumblebees present in 2 m. (1957—59) or 4 m. (1960) broad strips. The length of the observations strips was 50—100 m., so that observation areas were 100—200 m^2 in the first 3 years, and 200—400 m^2 in 1960.

3 counts at 2 hours intervals were made on each tetraploid red clover trial. In trials 43 and 44 (vide Table 1) the observation area was the whole trial plot (50 m^2 and 10 m^2 respectively), and in trials 45 and 46 an area of 50 m^2 was counted.

The species of bumblebees on the plants was determined visually, and at the same time their habits were observed. In certain cases samples were taken for confirmation of species, and all the more important species were filmed in color.

Visual determination of bumblebee species from a distance is quite reliable in the Finnish species *B. agrorum*, *B. distinguendus*, *B. equestris*, *B. hypnorum* and *B. pratorum*. These species are more or less distinctly differentiated from each other, and according to ELFVING (1960) species which might be mistaken for them are very rare here. On the other hand *B. lucorum*, *B. sporadicus* and *B. soroeënsis* can not distinguished from each other in this manner. In the field it is even difficult to distinguish between *B. lapidarius* and *B. ruderarius*. Similarly *B. hortorum* and *B. jonellus* are difficult to distinguish from each other in the field. In these investigations each of these three groups is treated collectively. Thus in the tables the following terminology is used: *B. lucorum* (+ *B. soroeënsis* + *B. sporadicus*), *B. lapidarius* (+ *B. ruderarius*), *B. hortorum* (+ *B. jonellus*). In the text species in parenthesis are omitted for the sake of brevity. According to ELFVING (l. c. and 1961) the species given in parenthesis in these groups are conciderably less common in Finland than the first mentioned species in each group.

In the field observations sex has been ignored, all queens, workers and males being included in the same total.

In certain cases the results have been treated statistically, and these results are accompanied by P-values.

III. Results

The primary results from the counts of bumblebees are presented in Table 1, and the yearly means in Tables 2 & 3.

A. Diploid red clover

B. lucorum

This species was observed on 37 trials, and was thus missing from only 5 trials. During the first 3 years of these investigations this species was especially common and numerous (Table 2). During the last year of the investigations it varied considerably in different trials. With the exception of 1960 it usually made up half, sometimes 80—90 % of all the bumblebees observed.

Table 1. The relative occurence of bumblebee species in Central Finland 1957—60; results from individual observation sites (trials).

Taulukko 1. Kimalaislajien suhteellinen esiintyminen Keski-Suomessa 1957—60; yksittäisten kenttien tulokset.

	Locality and year — *Koepaikka ja vuosi*		*Bombus* spp. total number observed — *havaintojen kokonaismäärä*	*B. lucorum* (+ *B. soroënsis* + *B. sporadicus*)	*B. agrorum*	*B. hortorum* (+ *B. jonellus*)	*B. distinguendus*	*B. lapidarius* (+ *B. ruderarius*)	Others [1] — *Muut* [1]
				relative occurence (%) — *suhteellinen esiintyminen (%)*					
	A. Diploid red clover [2] — *A. Diploidi puna-apila* [2]								
1	Leivonmäki, Jussila	1960	171	1	52	47	0	0	0
2	Toivakka, Vihijärvi	1957	39	33	49	8	8	2	0
3	» »	1959	59	31	55	14	0	0	0
4	» »	1960	146	0	70	30	0	0	0
	Average — *Keskim.*		(244)	21	58	17	3	1	0
5	Toivakka, Läsä	1959	92	89	2	9	0	0	0
6	» »	1960	137	2	53	37	8	0	0
	Average — *Keskim.*		(229)	45	28	23	4	0	0
7	Muurame, Hautala	1959	107	23	67	9	0	1	0
8	Jyväskylä, Keljo	1958	278	68	31	0	0	1	0
9	» »	1959	71	48	42	4	0	6	0
	Average — *Keskim.*		(349)	58	37	2	0	3	0
10	Jyväskylä, Survo	1957	33	55	18	6	12	9	0
11	» »	1958	383	92	2	1	0	5	0
12	» »	1959	100	32	39	4	2	22	1
13	» »	1960	60	2	53	33	8	2	2
	Average — *Keskim.*		(576)	45	28	11	5	10	1
14	Jyväskylä, Visala	1960	101	16	0	29	17	35	3
15	Laukaa, Kauramaa	1958	27	30	70	0	0	0	0
16	Laukaa, Pekkala	1957	30	80	3	0	17	0	0
17	» »	1958	79	67	32	1	0	0	0
	Average — *Keskim.*		(109)	74	17	1	8	0	0
18	Laukaa, Ainola	1957	38	42	32	26	0	0	0
19	» »	1958	79	26	57	13	1	3	0
	Average — *Keskim.*		(117)	34	44	19	1	2	0
20	Laukaa, Kangasaho	1957	32	44	34	19	3	0	0
21	» »	1958	74	5	91	4	0	0	0
	Average — *Keskim.*		(106)	24	62	12	2	0	0
22	Laukaa, Tempaala	1958	35	43	40	6	0	11	0
23	» »	1959	115	42	31	24	0	3	0
24	» »	1960	53	0	23	72	4	1	0
	Average — *Keskim.*		(203)	28	32	34	1	5	0
25	Laukaa, Tuokala	1959	63	19	65	14	0	2	0
26	» »	1960	102	4	26	50	13	6	1
	Average — *Keskim.*		(165)	12	45	32	6	4	1

Table 1. (continued)
Taulukko 1. (Jatk.)

	Locality and year — *Koepaikka ja vuosi*		*Bombus* spp. total number observed — *havaintojen kokonaismäärä*	*B. lucorum* (+ *B. soroënsis* + *B. sporadicus*)	*B. agrorum*	*B. hortorum* (+ *B. jonellus*)	*B. distinguendus*	*B. lapidarius* (+ *B. ruderarius*)	Others [1]) — *Muut* [1])
				relative occurence (%) — *suhteellinen esiintyminen (%)*					
27	Laukaa, Ylä-Saarikko	1960	102	19	12	44	21	2	2
28	Laukaa, Koskela	1960	83	23	48	27	2	0	0
29	Laukaa, Kuusanmäki	1960	108	0	70	19	10	1	0
30	Laukaa, Varjola 1	1960	143	0	32	55	13	0	0
31	Laukaa, Varjola 2	1960	254	2	43	39	16	0	0
32	Laukaa, Ollila	1960	75	1	11	76	7	5	0
33	Konnevesi, Hytölä	1959	49	16	78	6	0	0	0
34	» »	1960	168	31	41	24	3	0	1
	Average — *Keskim.*		(217)	23	59	15	2	0	1
35	Sumiainen, Mäkelä	1959	31	61	36	3	0	0	0
36	» »	1960	370	74	14	10	1	0	1
	Average — *Keskim.*		(401)	67	25	6	1	0	1
37	Suolahti, Kirppula	1958	76	40	58	1	1	0	0
38	Äänekoski, Ahola	1957	23	43	4	23	30	0	0
39	Äänekoski, Hoikkala	1960	115	0	62	32	6	0	0
40	Saarijärvi, Kolkanniemi	1960	172	2	20	33	45	0	0
41	Saarijärvi, Kalmari	1960	192	2	7	49	42	0	0
42	Karstula, Mäkelä	1960	136	1	41	53	5	0	0
	B. Tetraploid red clover [3]) — *B. Tetraploidi puna-apila* [3])								
43	Laukaa, Varjola 3	1960	154	0	5	94	1	0	0
44	Laukaa, Varjola 4	1960	35	0	11	89	0	0	0
45	Laukaa, Varjola 5	1960	67	0	3	96	1	0	0
46	Laukaa, Varjola 6	1960	133	0	8	87	5	0	0

[1]) *B. equestris, B. pratorum, B. hypnorum.*
[2]) Observation areas 100—200 m² (1957—59) and 200—400 m² (1960); one counting. — *Havaintoruudut 100—200 m² (1957—59) ja 200—400 m² (1960); yksi laskenta.*
[3]) Observation areas 10—50 m²; three countings. — *Havaintoruudut 10—50 m²; kolme laskentaa.*

Table 2. The relative occurence of bumblebee species on diploid red clover in Central Finland; yearly means.

Taulukko 2. Kimalaislajien suhteellinen esiintyminen diploidilla puna-apilalla Keski-Suomessa; vuosikeskiarvot.

Species — *Laji*	1957	1958	1959	1960	1957—60
	relative occurence (%) — *suhteellinen esiintyminen (%)*				
B. lucorum (+ *B. soroeënsis* + *B. sporadicus*)	49	46	39	10	36
B. agrorum	23	48	45	35	37
B. hortorum (+ *B. jonellus*)	14	3	10	40	17
B. distinguendus	12	1	1	11	6
B. lapidarius (+ *B. ruderarius*)	2	2	4	3	3
Others — Muut	0	0	1	1	1

Field observations revealed that this species robbed almost regularly, the occasional individuals which pollinated being probably *B. soroeënsis*. This later species has a longer tongue than *B. lucorum* (HULKKONEN 1928, p. 18, KORCKMAN 1938).

VALLE *et al.* (1960) found *B. lucorum* to be relatively infrequent in Central Finland during Summer 1960. The present results indicate that *B. lucorum* occurs here largely as in southern Finland (e. g. VALLE 1949).

B. agrorum

This species was observed on 41 trials, and is thus an especially common species. The yearly means (Table 2) indicate that it was abundant each year. Over the whole period of the investigations *B. agrorum* was as common and numerous as *B. lucorum*. The yearly variation was however less than with *B. lucorum*. There was however considerable variation between individual trials, but it was rare on only a few trials, in many trials making up over half and on occasion up to $^3/_4$ the total of bumblebees observed.

B. agrorum has always been a pollinator.

ELFVING (1960) states that this species is very common throughout Finland. VALLE *et al.* (1960) found it to be most important pollinator of diploid red clover in one part of Central Finland. In southern Finland VALLE (e. g. 1949, 1959) found relatively few of this species on red clover in his long-time observations. However, POHJANKALLIO's (1938) observations would appear to indicate that this species can be more numerous in certain areas.

B. hortorum

This species was observed on 39 trials, while only 3 examined trials did not reveal it. Thus *B. hortorum* can be considered a common species in Central Finland. The yearly means (Table 2) show however that this

species was not as numerous during the years 1957—59 as the above 2 species of bumblebees. Only in 1960 was *B. hortorum* especially numerous, when it was with *B. agrorum* the most abundant species. For the whole period of investigations *B. hortorum* was the third most numerous species, after *B. agrorum* and *B. lucorum*.

On individual trials *B. hortorum* was abundant only in 1960; during 1957—59 it can best be described as common but not numerous.

All examples of *B. hortorum* which were observed pollinated, which would appear to indicate that this material does not include many *B. jonellus*, which is also a robber (VALLE *et al.* 1960). *B. hortorum* has the longest tongue of all our common bumblebee species, while *B. jonellus* has a very short tongue (HULKKONEN 1928, p. 18).

ELFVING (1960) states that *B. hortorum* is present throughout the country, while *B. jonellus* increases in frequency towards the northern part of the country. VALLE *et al.* (l. c.) found *B. hortorum* to be one of the most important pollinators of red clover in one part of Central Finland during Summer 1960. Its occurence in southern Finland has been very variable numerically in different years at different observation sites (e. g. VALLE 1935, 1949, 1960, POHJAKALLIO 1938).

B. distinguendus

This species was only observed on 25 of the 42 trials. This indicates that *B. distinguendus* has been much less common than the species above. Its occurence has also varied much from year to year. It was only observed on any scale during 1957 and 1960, and had practically dissappeared during the intervening years. The yearly means (Table 2) reveal that *B. distinguendus* was never numerous. On individual trials only a few individuals of this species were observed. It was only fairly abundant on a couple of trials. It is interesting to note that this species was observed on all trials in the northern part of the province (Table 1, trials 38—42).

In the field all individuals of *B. distinguendus* were observed to pollinate. This species has a long tongue. HULKKONEN (1928) states that *B. distinguendus* is in this respect comparable with *B. agrorum*. KORCKMAN's (1938) measurements reveal that the tongue at least in workers was longer in *B. distinguendus* than in *B. agrorum*.

ELFVING (1960) states that *B. distinguendus* occurs throughout the country. VALLE *et al.* (1960) found this species to be an important pollinator of red clover in one part of Central Finland. In southern Finland this species has been a frequently observed pollinator of red clover, but even there has been a very considerable variation in numbers observed (e. g. VALLE 1949, 1959).

B. lapidarius

This species was present on only 18 trials. It has thus been a relatively uncommon species in Central Finland. On average this species has formed only 2—4 % of all observed bumblebees (Table 2). *B. lapidarius* has mainly been observed in two separate areas and elsewhere only sporadically. It was present in largest numbers on the trials in the immediate neighbourhood of Jyväskylä town, where it was observed regularly on all 7 trials (Table 1, trials 8—14); occasionally it was almost numerous in this area. The other area where *B. lapidarius* was present, although less numerous, was in Laukaa commune, in an area cultivated over hundreds of years (Table 1, trials 22—26). This species was not observed at all in the northern part of the province.

B. ruderarius, which as stated above was not counted separately, was only encountered once with certainty[1]), in the neighbourhood of Jyväskylä, on trial 14 (vide Table 1).

B. lapidarius functioned mainly as pollinator, but especially small workers were robbers.

According to ELFVING (1960) *B. lapidarius* is common in central East Bothnia up to Kainuu. VALLE *et al.* (1960) did not observe at all this species in Central Finland during Summer 1960. In southern Finland this species has in some places been very numerous, and one of the most important diploid red clover pollinators (VALLE 1935, 1949, 1959). POHJAKALLIO's (1938) observations however show that this species can be infrequent in many places.

Other bumblebee species

In the tables are included *B. equestris*, *B. pratorum* and *B. hypnorum*. All these were observed very seldom on red clover. *B. pratorum* and *B. hypnorum* have been often observed on other species of plants, but seldom on red clover. It appears that both species avoid red clover. In contrast *B. equestris* is only observed on red clover. This species occured only in Summer 1960 on a few trials in the southern and middle parts of the investigated area and at most only a couple of examples per trial. Thus this species has been an uncommon species.

ELFVING (1960) states that *B. equestris* occurs in southern and central Finland. VALLE (1949, 1960) found that this species has in some years been very important pollinator of red clover in southern Finland. In contrast *B. pratorum* and *B. hypnorum* have been uncommon even there on red clover.

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[1]) Species determined by M. MARKKULA Ph. D. from a sample.

B. Tetraploid red clover

Bumblebees have only been counted on tetraploid red clover during Summer 1960. All 4 trials are situated on the same farm, with maximum distance between trials of ca. 700 meters. The means of the results are presented in Table 3 (see also Table 1, trials 43—46). For comparison all results from diploid trials in the neighbourhood of tetraploid ones are inculuded in this table, i. e. Table 1, trials 27—31. These diploid stands were situated 20—2 000 m. from the tetraploid stands. All the bumblebee observations in Table 3 were made on the same day.

Observations on tetraploid stands of red clover are of great interest, as this form of red clover has a distinctly longer corolla tube than the diploid form.

B. lucorum

This species was not observed at all on tetraploid red clover. It was also relatively infrequent on the comparative diploid trials. It seems probable that the scarceness of this species in general during Summer 1960 affected the results. BINGEFORS *et al.* (1960) have observed that this species seems to prefer tetraploid red clover.

VALLE *et al.* (1960) observed this species relatively seldom on tetraploid red clover in Central Finland, and only during the beginning and middle of the flowering period.

Table 3. The relative occurence of bumblebee species on tetraploid red clover and certain diploid red clover stands, Summer 1960.

Taulukko 3. Kimalaislajien suhteellinen esiintyminen tetraploideissa ja eräissä diploideissa puna-apilakasvustoissa kesällä 1960.

Stand of red clover — *Puna-apilalaji*	Number of trials — *Kenttien lukumäärä*	*B. lucorum* (+ *B. soroënsis* + *B. sporadicus*)	*B. agrorum*	*B. hortorum* (+ *B. jonellus*)	*B. distinguendus*	Others — *Muut*
		relative occurence (%) — *suhteellinen esiintyminen (%)*				
tetraploid (I) — *tetraploidi (I)*	4	0	7	91	2	0
diploid (II) — *diploidi (II)*	5	9	41	37	12	1
difference (I—II) — *erotus (I—II)*	(9)	—9	—34	54	—10	—1
P			<0.001	<0.001	0.02	

B. agrorum

This species was relatively infrequent on tetraploid red clover trials. On the comparative diploid stands it was relatively numerous. The difference in favour of the diploid trials was also statistically highly significant. This species has thus during Summer 1960 specially sought out diploid red clover. This phenomen was also observed by VALLE *et al.* (1960)[1]).

B. agrorum was always a pollinator when it visited tetraploid red clover. HULKKONEN (1928, pp. 35—36) observed that this species visits many plants with even longer corolla tube than (diploid) red clover normally to collect honey.

B. hortorum

This long-tongued species was undoubtedly the most numerous on all tetraploid stands. In mean, as much as 90 % of all bumblebees were this species. In contrast it was much less numerous on the comparative diploid stands, where it made up only a little over third of all bumblebees. Thus there is a great difference in favour of the tetraploid stands, which is statistically highly significant. This species has sought out tetraploid red clover during Summer 1960. VALLE *et al.* (1960) also observed this in Central Finland[1]).

All members of this species on tetraploid red clover were pollinators.

B. distinguendus

This species was observed very infrequently on tetraploid trials, while it was much oftener on the comparative diploid stands. This difference in favour of diploid red clover is also statistically significant. Thus *B. distinguendus* has to some extent avoided tetraploid red clover during Summer 1960. In this respect it has resembled *B. agrorum*. HULKKONEN (1928, pp. 18—21) observed that on the basis of tongue length these two species are very similar.

All individuals of this species observed on tetraploid red clover were pollinators.

Other bumblebee species

No other species of bumblebee was observed on tetraploid red clover during counts.

[1]) See footnote p. 5.

C. Discussion

Diploid red clover. The results clearly indicate that *B. lucorum* and *B. agrorum* were the commonest and most numerous species. *B. hortorum* was as common as the previous two species, but less abundant except during 1960, when this species was also very numerous. Other species were much less common and abundant.

There was in general a great deal of variation in the numbers of each species observed on individual trials. This also applied to the two species with the largest means, i. e. *B. lucorum* and *B. agrorum*. Observations were made in many often widely separated places and over several years, which can have contributed to this variation in results. However, the composition of the bumblebee fauna on sites not far from each other was often very different. For example, trials 23 and 25 (Table 1) which were only 400 m. from each other had the following compositions:

	Trial 23	*Trial 25*
	% of all bumblebees observed	
B. lucorum	42	19
B. agrorum	31	65
B. hortorum	24	14
B. lapidarius	3	2

This phenomen was also stressed by VALLE (1935, pp. 490—491). HULKKONEN (1928, pp. 11—12) found in observations of bumblebees on other forage plants that they first seek out forage plants in the immediate neighbourhood of their nest (see also VÄRE 1960).

Table 4. Diploid red clover trials on the basis of predominant pollinating species of bumblebee.

Taulukko 4. Diploidin puna-apilan havaintokentät ryhmiteltyinä dominoivan pölyttävän kimalaislajin perusteella.

Species predominant[1]) in trial — *Dominoiva laji* [1])	1957	1958	1959	1960	1957—60
	number of trials — *kenttien lukumäärä*				
B. agrorum	3	7	8	9	27
B. hortorum (+ *B. jonellus*)	0	0	1	7	8
B. distinguendus	2	0	0	0	2
B. lapidarius (+ *B. ruderarius*)	0	1	0	0	1
No predominant species — *Ei dominoivaa lajia*	1	0	0	3	4
Total — *Yhteensä*	6	8	9	19	42

[1]) A species is considered predominant when it is as or more numerous as all other pollinating species together. — *Dominoivaksi on katsottu laji, jota on tavattu kentällä yhtä paljon tai enemmän kuin kaikkia muita pölyttäviä lajeja yhteensä.*

The robber *B. lucorum* was present throughout the investigation area as in southern Finland (cf. VALLE 1935, 1949, 1959). On the other hand in the case of the pollinator *B. agrorum* there was a distinct difference to southern Finland, where this species was in general observed much less frequently on red clover (VALLE l. c.). From the yearly means (Table 2) it is obvious that this was the most important pollinator of diploid red clover in Central Finland. However this is even more obvious from the Table 4, in which the trials are classed on the basis of predominant pollinator species present there. This reveals that *B. agrorum* was as, or more, numerous than all other pollinating species together on altogether 27 trials, or almost $^2/_3$ of observations. Especially during years 1958 and 1959 this species was by far the most important in ensuring red clover pollination.

It is interest to note from Table 4 that in almost every case one pollinator species was predominant on each trials. It is apparent that the biotope round each trial seldom was suitable for more than one species. That *B. agrorum* was so often predominant indicates that conditions are espesially suitable for this species in Central Finland. POHJAKALLIO *et al.* (1937, pp. 33—34) found that this species prefers the forest edge or parkland. PITTIONI and SCHMIDT (1942) classed *B. agrorum* as a typical forest type, present in forest openings and on the forest edge. Central Finland's afforested nature and small fields are almost wholely of this type. In southern Finland the cultivated area is greater, and field areas quite extensive, and there *B. agrorum* presumably cannot compete as well with other species.

B. lapidarius which has been common and numerous on diploid red clover in southern Finland (VALLE l. c.), was infrequent in Central Finland. This species was present regularly only in 2 areas, which have long been cultivated and populated. The area where most were observed was in the neighbourhood of Jyväskylä town and densely populated, the other a long cultivated field area with relatively large field areas.This indicates that *B. lapidarius* is associated in Central Finland with the human population to some degree, in contrast to *B. agrorum* (see above). PITTIONI & SCHMIDT (l. c.) and POSTNER (1952) found that *B. lapidarius* occurs in many biotopes in Central Europe. However Central Finland is much less densely populated that these author's European areas. Especial mention must be made of the largely natural state of the extensive forest areas in Finland and of the plentiful nature of undergrowth and deadwood.

In some Swedish investigations (BINGEFORS *et al.* 1960) there has been some indication that the frequency of the species *B. lapidarius* and *B. agrorum* are to some degree in inverse proportion, if one is numerous the other is scarce. The present investigations also indicate a similar tendency. Typically, in the only trial where *B. agrorum* was not present *B. lapidarius* was most numerous (Table 1, trial 14).

Tetraploid red clover. The composition of the bumblebee fauna on tetraploid red clover during Summer 1960 was distinctly different from that on diploid stands. On tetraploid red clover the undoubtedly most numerous species was *B. hortorum*. In contrast *B. agrorum* and *B. distinguendus* were distinctly less numerous than on diploid stands, and *B. lucorum* was not observed at all on tetraploid red clover. It would appear that *B. hortorum* because of its long tongue can function very well on tetraploid red clover flowers, and that this seeks out tetraploid red clover. The somewhat shorter-tongued species *B. agrorum* and *B. distinguendus* have on the other hand avoided this form of red clover. The fact that *B. lucorum* was not observed at all on tetraploid red clover can be attributed to the infrequency of this species during Summer 1960 (vide Table 2, p. 10).

These results from tetraploid red clover are based on relatively few observations. Therefore further investigations are necessary to confirm these results. For this purpose special trials were sown during Summer 1960.

Summary

The results are presented from observations of bumblebees on red clover seed trials in various parts of the province of Central Finland. The material was obtained from diploid red clover during 1957—60 and from tetraploid red clover during 1960.

The results from diploid red clover were as follows:

Bombus lucorum L., *B. agrorum* F. and *B. hortorum* L. were the three commonest species, the first two being on average the most numerous. *B. hortorum* was on average much less numerous than the first two, but with large yearly variations. The fourth commonest species was *B. distinguendus* Mor., and showed even larger variations in frequency than *B. hortorum*. *B. lapidarius* L. was present regularly but usually numerically few on certain trials. Very few examples of other species (*B. equestris* F., *B. pratorum* L. and *B. hypnorum* L.) were observed.

The composition of the bumblebee fauna varied greatly between observation sites, even when they were quite near each other.

Practically all observed *B. lucorum* individuals were robbers, while *B. agrorum*, *B. hortorum* and *B. distinguendus* were always pollinators. *B. lapidarius* was observed both as a robber and a pollinator, but mainly the latter.

The most important diploid red clover pollinator was *B. agrorum*. This results is in strong contrast to the results reported from the southern Finland, where this species has been of little importance as a pollinator of red clover.

Attention is drawn to the different biotopes required by *B. agrorum* and *B. lapidarius*. The former species would appear to thrive best in largely afforested areas without intense agriculture, while the latter species is associated with intense agriculture or dense population to some degree.

The preliminary results from tetraploid red clover were as follows: *B. hortorum* was the predominant species. *B. agrorum* and *B. distinguendus* were observed infrequently, and *B. lucorum* not at all. All the species observed were pollinators.

Comparative results from diploid red clover in the same neigbourhood indicated that *B. hortorum* shows a clear preference for tetraploid red clover, and *B. agrorum* showed a similar aversion. *B. distinguendus* also appeared to show to some degree of aversion for tetraploid red clover.

These preliminary results from tetraploid red clover indicated that these observations should be continued.

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Selostus:

Puna-apilan kimalaislajistosta Keski-Suomessa

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Kirjoituksessa on esitetty tuloksia puna-apilan siemenviljelyksillä eri puolilla Keski-Suomea suoritetuista kimalaishavainnoista. Aineisto on koottu diploidin puna-apilan osalta 1957—60 ja tetraploidin puna-apilan osalta 1960.

Diploidilla puna-apilalla suoritetuista havainnoista saatiin seuraavia tuloksia: *Bombus lucorum* L., *B. agrorum* F. ja *B. hortorum* L. olivat kolme yleisintä lajia. Kaksi ensin mainittua olivat myös keskimäärin runsaslukuisimmat lajit. *B. hortorum* oli keskimäärin näitä kahta huomattavasti vähälukuisempi; sen esiintymisessä oli kuitenkin suuria vuosivaihteluja. Neljäs koko alueella tavattu laji oli *B. distinguendus* Mor.; tälle lajille olivat ominaisia vieläkin suuremmat vaihtelut kuin *B. hortorum*ille. Lajia *B. lapidarius* L. esiintyi säännöllisesti, mutta yleensä vähälukuisesti eräissä havaintopaikoissa. Muita lajeja (*B. equestris* F., *B. pratorum* L. ja *B. hypnorum* L.) tavattiin erittäin vähän.

Kimalaislajiston koostumuksessa oli erittäin suuria vaihteluja yksittäisillä havaintopaikoilla; myös melko lähekkäin sijainneissa paikoissa oli tässä suhteessa eroja.

Jokseenkin kaikki *B. lucorum*-yksilöt ryöstivät, kun sitä vastoin *B. agrorum*, *B. hortorum* ja *B. distinguendus* säännöllisesti pölyttivät. *B. lapidarius*ta tavattiin sekä pölyttävänä että ryöstävänä, pääasiassa kuitenkin ensin mainitulla tavalla työskentelevänä.

Diploidin puna-apilan tärkein pölyttäjä oli *B. agrorum*. Tämä tulos poikkeaa suuresti Etelä-Suomesta esitetyistä tuloksista; siellä tämä laji on ollut yleensä varsin vähämerkityksellinen puna-apilan pölyttäjä.

Lajien *B. agrorum* ja *B. lapidarius* kohdalla on kiinnitetty huomiota niiden erilaisiin biotooppivaatimuksiin. Vaikuttaa siltä, että edellinen on ainakin jossain määrin kulttuuria väistävä laji, kun sitä vastoin jälkimmäistä voidaan pitää kulttuurin seuralaisena.

Tetraploidilla puna-apilalla suoritetuista havainnoista saatiin seuraavia (alustavia) tuloksia:

B. hortorum oli ylivoimaisesti runsaslukuisin laji. *B. agrorum*ia ja *B. distinguendus*ta tavattiin vain vähän ja *B. lucorum*ia ei ensinkään. Kaikki tavatut lajit pölyttivät.

Diploidilta puna-apilalta saadut vertailutulokset osoittivat, että *B. hortorum* oli hyvin selvästi hakeutunut tetraploideille kasvustoille ja että *B. agrorum* oli lähes yhtä selvästi niitä hylkinyt. Myös *B. distinguenduksen* kohdalla havaittiin merkkejä tetraploidin puna-apilan vieroksumisesta.

Kaikki tetraploidilla puna-apilalla saadut tulokset vaativat vielä aineiston vähäisyyden ja koejakson lyhyyden vuoksi jatkotutkimuksia.