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Guy Söderman

Diversity of pollinator communities in Eastern Fennoscandia and Eastern Baltics

Results from pilot monitoring with Yellow traps in 1997 - 1998

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Introduction

Insects that visit flowers belong to different orders and families of which the economically most important, and the most important ones for maintaining biodiversity of ecosystems, are the bees, wasps and hoverflies. These groups may locally constitute up to more than 90% of all flower visiting species, in particular in the boreal latitudes.

The distribution and ecology of bees and wasps are quite well-known in Eastern Fennoscandia [Finland, northwestern part of Russia including the autonomous Republic of Karelia and northern part of the Leningrad oblast] (Elfving 1960, 1968; Pekkarinen et al.1981, Pekkarinen 1982a, 1988, Pekkarinen & Hulde'n 1991, 1995) but in Eastern Baltics [Estonia, Latvia, Lithuania, southern part of Leningrad oblast, Pskov oblast, Novgorod oblast and Kaliningrad oblast] only the bees of Lithuania have been thoroughly surveyed (Monsevicius 1995). The ecology of hoverflies is also quite well-known, but data on distribution of species within the area is incomplete.

In the area of the European Union there are 264 different crop species of which 84% are dependent on bee pollination. The commercial value of the pollination has been estimated to 5 billion EURO/year (Williams 1996). In Finland the corresponding value has been calculated to 300 million FIM (Yläoutinen 1994, unpublished manuscript). Whereas the pollination of commercial crops can be regulated mainly with domestic bees, the pollination of natural flowers can not, because domestic bees are short-tongued and can not pollinate flowers with deep corollas (O'Toole 1993).

This report marks the final step in the development of a monitoring system for pollinators.

As wild pollinators represent a key-group of organisms in many ecosystems (La Salle & Gauld 1993), especially flower-rich herb meadows, they were chosen as objects for biodiversity monitoring.

The objective of the monitoring is to follow-up long-term changes, both quantitative and qualitative, in the pollinator communities of grasslands (and forests) in northern Europe, because grasslands (and forests) have undergone considerable changes over the last 50 years (see *e.g.* Alanen 1997) and may still change for the worse regarding natural resources needed by pollinators. As flower plants and pollinators are key-stone mutualists, viz. partner species whose fates are linked (La Salle & Gauld 1993), follow-up of their changes is very important from a nature conservation point of view.

The development of the monitoring system started with a feasibility analysis of possible logistics and costs. It was deduced that passive trap-sampling was much more cost-effective than netting in the field (and analyses of flowering vascular plants). Pollinators also react, due to their (predominantly) annual generations faster than plants to adverse changes of natural and anthropogenic type. A pilot study to test the yellow-trap method was made in Finland in 1996 (Söderman *et al.*1997). This was followed by a pilot monitoring programme, covering the two years 1997–98 in the above mentioned geographic area. The aims of the pilot monitoring were:

- to test the logistics of the monitoring design and make necessary corrections, if required;
- to collect data from the monitoring network, in order to analyse variations from year to year and to produce a base-line for future operative monitoring;
- to use the collected data for developing different relevant parameters to be followed-up in possible future, operative long-term monitoring.

In addition, a number of additional questions were set, for which answers were to be sought through additional studies in connection with the pilot monitoring:

1) is the yellow-trapping technique efficient enough, or should other techniques be implemented parallel to this?
2) what is the species composition in different regions as reflected by the yellow-trap samples?
3) do populations of the same species react in the same way to the traps in different latitudes?
4) do trap samples reflect the populations of different species in nature?

The main target group of this report comprises nature conservation, agriculture and forestry authorities in the countries concerned, as well as, researchers interested in the faunistics of the pollinator species groups.

2

Methods and Material

The majority of the material was collected with yellow-traps (Fig.1; Söderman *et al.* 1997). The traps were installed in clusters of three in several places within the study area (Fig.2; Annex 1). A total of 124 places were investigated (86 in 1997, 116 in 1998).

The sampling network in Finland is rather dense and geographically fairly balanced. About 40% of the sites has some degree of protection (many included in the national NATURA-2000 network). The sampling network in Russia is less balanced and many sites had to be established in culturally influenced places to prevent loss of traps. In the Baltic countries the network of sites is rather sparse and in Latvia not geographically well-balanced (only western part covered). In Estonia and Latvia about 40% of the sites are located in nature protection areas, in Lithuania as much as 67%, but in Russia only about 20% of all sites are protected.

The yellow-traps were hung 1-2 metres above the ground (which was regarded optimal for bumblebees) and 3-5 metres apart along a forest margin. South-facing habitats were recommended. DDVP-strips were used to kill the insects that entered the traps. The samples were collected once (or twice) a week during the period of expected pollinator flight. The collected samples were then intermittently stored in cold before sending them for identification.

Fig. 1 A yellow-trap used for collecting of pollinators (photo Reima Leinonen, 1996).

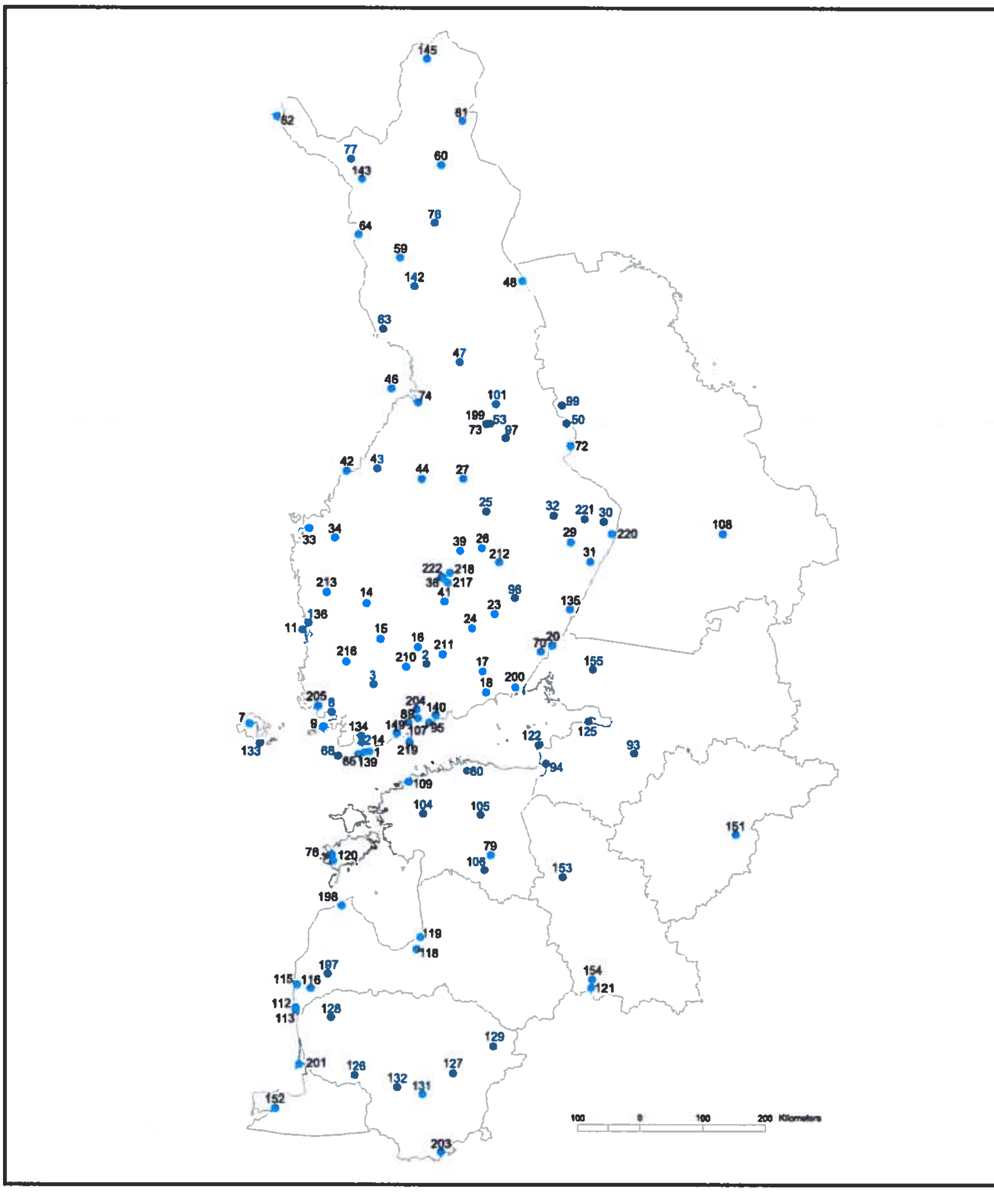


Fig.2. Sites in the pilot monitoring in 1997–98. The site characteristics are given in Annex 1.

The author has determined all the individuals to species. In a few problematic cases identification help has been given by Mr Antti Pekkarinen, University of Helsinki or Mr Virgilijus Monsevicius, Cepkeliai Nature Reserve. The major taxonomic works used in the identification were: Löken 1973, 1984, Pekkarinen & Teräs 1977 (Apinae), Pekkarinen 1973 (Vespidae), Bluthgen 1961, Richards 1980 (Eumenidae), Scheuchl 1995, 1996, Schmid-Egger & Scheuchl 1997 (Apidae), Dathe 1980, Lomholdt 1977, Warnke 1992, Noskiewicz 1936 (Apidae:selected families), Stackelberg 1971, Torp 1994 (Diptera, Syrphidae), Morgan 1984 (Chrysididae), Lomholdt 1984 (Sphecidae), Wolf 1972 (Pompilidae).

In order to examine species that might prefer to visit white and blue flowers, traps painted white and heaven-blue were installed parallel to the yellow traps at two sites in Finland in 1997. In addition, material from some 20 light-traps (bulbs emitting UV) with white plastic design and material from a few bait-traps were collected for comparsion. At one of the sites a Malaise-tent (model BioQuip 2875D) was used for evaluating the capture effect of the yellow-traps with flying insects in general.

Groups, Ecology and Behaviour of Pollinators

3

All pollen collecting species can be divided into two groups, polylectic and oligolectic. Polylectic species collect pollen from many types of flowers, oligolectic species only from flowers of certain plant families or groups. A special case of the latter are monolectic species that only collect pollen of one species. When using yellow-traps the probability is higher for capturing polylectic species as well as oligolectic species confined to plants with yellow flower.

There are 44 eusocial bees, viz. bumble bees (including cuckoo bees) and the honey bee, in Northern Europe. Some species of the genera *Halictus* and *Lasioglossum* that are eusocial in central Europe (Westrich 1990) may also be eusocial at higher latitudes, but strict evidence of this is still missing. The species richness of Apidae is highest in the hemiboreal, southern and middle boreal regions. There are equally many species (32) in Lithuania as in the forested areas of Finland. The species number only drops about 50% in the northernmost parts of the investigated area, viz. the northern boreal and orohemiarctic regions, which indicates that bumble bees are well adapted to cool climates. All bumble bee species, except the monolectic *Bombus consobrinus*, collecting pollen practically only from *Aconitum*, are polylectic due to the seasonal length of their colonies that exceeds that of any pollen plant.

There are more than 300 species of solitary bees in the area and the species number increases towards south (e.g. 183 species have been found in Finland, 290 species in Lithuania). The proportion of oligolectic bee species is about 30% in the hemiboreal, southern and middle boreal regions, corresponding to that of central Europe, but drops to below 20% in the northernmost parts (Pekkarinen 1998). Quite a number of oligolectic bee species have specialised on yellow flowers like *Salix*, *Lysimachia*, *Tanacetum*, *Ranunculus* etc. At least 150 species according to literature visit yellow flowers (Elfving 1968, Monsevicius 1995, Mueller *et al.* 1997).

Social wasps (Vespidae) and solitary wasps (Eumenidae) do not collect pollen and nectar for their larvae and only visit flowers for their own nutrition. Therefore, their role as pollinators has been considered small. A total of 14 social wasp species have been recorded in Northern Europe in addition to some 40 solitary wasp species.

Hoverflies visit flowers only for their nutrition. The majority of the flower visiting species belong to the subfamily Syrphinae, the larvae of which are aphidophagous. There are two other groups, mostly belonging to Eristalinae, which have different bionomy. One of these groups include species with larvae living in manure or dirty waters, the other group comprises species which larvae live in decaying wood. In the first group the adults visit flowers, but according to literature (Torp 1994) prefer white-coloured ones. Adult hoverflies of the second group rarely visit flowers and usually forage on aphid dew on leaf surfaces. A total of some 350 hoverfly species is known from the study area and there is a decline in species richness going northwards. At least 190 species are known to visit yellow flowers (Torp 1994).

As may be deduced from the facts mentioned above, the pollinators, including their sexes and castes, behave differently in visiting flowers, both with respect to regions, biotopes, various days and times of the day, all depending on the development of the nutritional source (Teräs 1985, Prys-Jones & Corbet 1991). Therefore estimations of their abundance and size of colonies by mere field studies is difficult and laborous. The technique of using yellow-traps can be regarded as implanted, artifical flowers and they probably react in a similar manner to them irrespective of the biotope and its flower composition. If this is the case, then within-species comparisons can be made on abundancy of pollinators, and perhaps, between-species variability on resource competition. One should however be aware of possible errors in such a hypothesis. For instance, in places where nutritional sources are limited in time and space these yellow-traps might attract more individuals than in areas with plentiful flower resources.

Threatened Species

4

Influence of man upon the distribution and populations of bees and other pollinators have in Finland been dealt with by Pekkarinen *et al.* 1987, Teräs & Pekkarinen 1992, Söderman *et al.* 1997, Pekkarinen & Teräs 1998. In central Europe many pollinators, in particularly bees, are regarded as a highly threatened group, e.g. in Baden-Wurttemberg 190 bee species have been classified as threatened (Westrich 1990), in England 96 species (Falk 1991) and in Poland 51 species (Banaszak 1995).

The number of threatened species in northern Europe is much less (table 1A-E), but this might also be due to incomplete knowledge, use of different assessment methods, rather than better preserved natural conditions. Bumblebees have been protected in Estonia, but the protection clausule is inefficient as no direct measures have been taken to reduce the most severe threats to them, like adverse change in land management.

Table 1A-1E. Number of threatened pollinator species in different parts of northern Europe (sources: Finland: Komiteamietintö 1991, Lithuania: Balevicius 1992, Sweden: Ehnström *et al*, 1993, Denmark: Torp 1994, Estonia: Lilleleht ed. 1998).

Country	Extinct	Endangered	Vulnerable	In need of surveillance
A. Bumble bees and cuckoo bees				
Finland	-	-	1	3
Sweden	-	-	-	-
Estonia	-	-	-	9
Lithuania	-	-	1	2
B. Solitary bees				
Finland	-	-	-	12
Sweden	18	-	7	13
Estonia	1	1	-	9
Lithuania	1	1	5	11
C. Social wasps				
Finland	-	1	-	-
Sweden	1	-	1	-
Estonia	-	-	-	3
Lithuania	-	-	-	-
D. Solitary wasps				
Finland	-	-	-	8
Sweden	-	-	3	7
Estonia	2	-	-	4
Lithuania	-	-	-	-
E. Hoverflies				
Finland	-	-	4	9
Sweden	6	2	5	8
Denmark	6	3	2	36

5 Results from Comparative Tests

Trap effectiveness

The yellow-trap cluster collected very little insects compared to the Malaise-trap, although quite selectively. Individuals of the insect orders Coleoptera and Hymenoptera appear to be more frequently attracted to yellow-traps (table 2). Of the pollinator groups social bees and wasps are proportionally more common in yellow-traps. Hoverflies, on the other hand, were much more common in the Malaise-trap, probably because many hoverfly species fly low and may not be particularly interested in yellow flowers (like species of the genera *Platycheirus* and *Melanostoma* visiting wind pollinating flowers and a number of saproxylic species being predominantly honey-dew lickers).

Table 2. Proportion (%) of insect individuals in a cluster of yellow traps and in a Malaise-trap in Sipoo, Finland, 1997.

Insect order/group	Yellow trap cluster	Malaise-trap
ORTHOPTERA	0.00	0.01
HETEROPTERA	1.40	0.20
HOMOPTERA	3.10	2.90
THYSANOPTERA	10.8	0.10
NEUROPTERA	1.40	0.10
LEPIDOPTERA	2.10	2.80
TRICHOPTERA	0.00	0.03
COLEOPTERA	9.70	1.70
DIPTERA	49.7	84.9
* Syrphidae	(1.74)	(6.33)
HYMENOPTERA	21.9	7.10
* Social bees	(6.35)	(0.01)
* Solitary bees	(0.35)	(0.12)
* Social wasps	(9.72)	(0.13)
* Solitary wasps	(0.00)	(0.01)
TOTAL	100 (=288 specimens)	100 (=9414 specimens)

The effect of trap sampling on the natural populations of social bees (*Bombus* and *Psithyrus*) was estimated at the same test site (Sipoo) in 1997. Queens and workers were collected during May–June with a net after which they were cooled down in a cold bag before applying a green paint-spot (quick-drying enamel paint) on the dorsum of the individuals. After that they were released to fly away and captured specimens were analysed if being marked or not. This capture-recapture test indicated that the capture effectivity of the yellow traps is very low. The maximum recapture was 4..<6% for some of the species, but for most species it was well this value (table 3). The test showed that yellow-trapping itself does not harm the populations living in the vicinity of the monitoring sites.

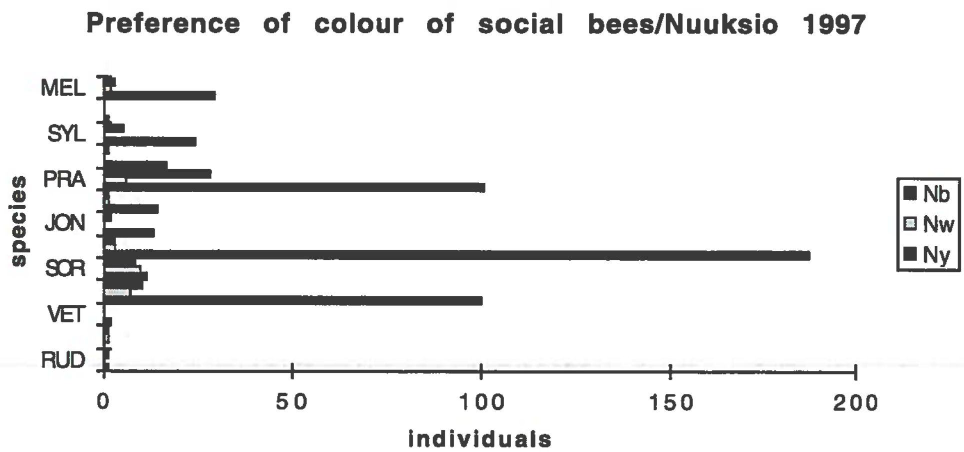
Table 3. Results of capture-recapture experiment in Sipoo, southern Finland in 1997. QM = total number of netted and marked queens, WM = total number of netted and marked workers, QCY = total number of queens captured by yellow-traps, WCY = total number of workers captured by yellow-traps, QMR = number of marked queens recaptured by yellow-traps, WMR = number of marked workers recaptured by yellow-traps, QP = percentage of recaptured marked queens, WP = percentage of recaptured marked workers.

Species	QM	WM	QCY	WCY	QMR	WMR	QP	WP
B.lucorum	30	50	0	0	0	0	<3%	<2%
B.pascuorum	50	50	2	0	2	0	4%	<2%
B.hypnorum	25	50	0	0	0	0	<4%	<2%
B.soroeensis	15	25	0	0	0	0	<6%	<4%
B.lapidarius	25	25	8	0	1	0	4%	<4%
B.ruderarius	25	15	2	0	0	0	<4%	<4%
B.veteranus	30	50	3	1	0	1	<3%	2%
B.hortorum	25	15	3	0	0	0	<4%	<6%
P.bohemicus	15	-	0	-	0	-	<6%	-
Total	240	280	18	1	3	1	1.25%	0.36%

Colour preference

The test using differently coloured traps revealed that the yellow colour is several times more effective in collecting individuals than white or blue (Fig.3). All the species collected in the other coloured traps were also sampled with yellow ones (although not necessarily at the test sites). The material did imply that solitary wasps (Eumenidae) might have a small preference for blue-coloured traps, but their numbers were too low to be statistically significant. The material collected from light-traps (see annexes 2–5) indicates that there are some pollinator species which are more common in these traps than in yellow-traps. Most of the recorded social bees and social wasps in light-trap samples probably entered them in early morning or late evening when the bulbs were lighted. They were thus attracted by the UV-light emission. On the other hand, hoverflies are known only to fly in the daytime, so they are apparently attracted by the white plastic colour of the trap design itself. The following hoverfly genera were found more common in light-traps (attracted to white colour): *Sericomyia, Rhingia, Helophilus* and *Eristalis.*

Although the colour tests failed to show any distinct preference of any species to white and blue coloured traps, the colour preference of different species (and different castes of social bees) do play an important role in the captures (see chapter 6).


Preference of colour of social bees/Nuuksio 1997
MEL
SYL
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species
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individuals
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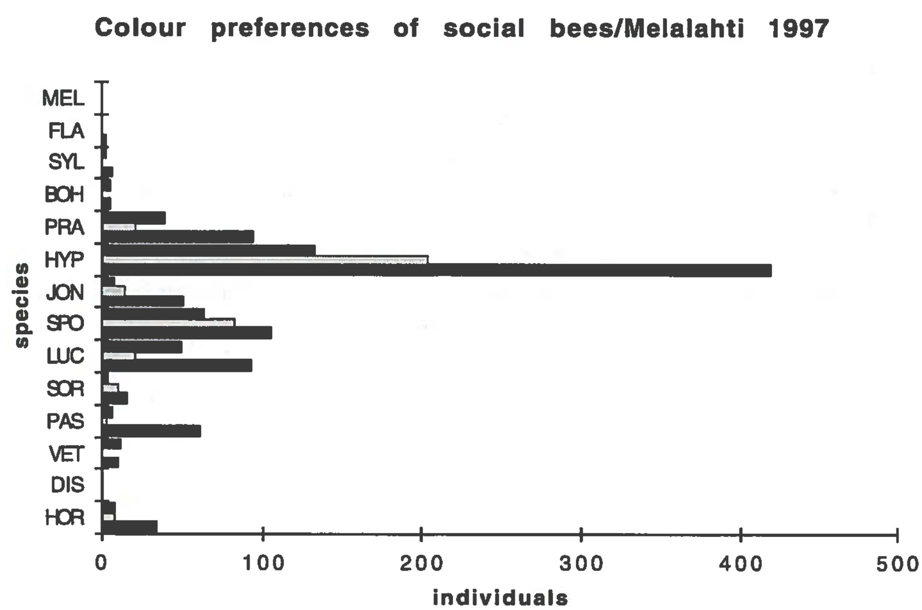
Colour preferences of social bees/Melalahti 1997
MEL
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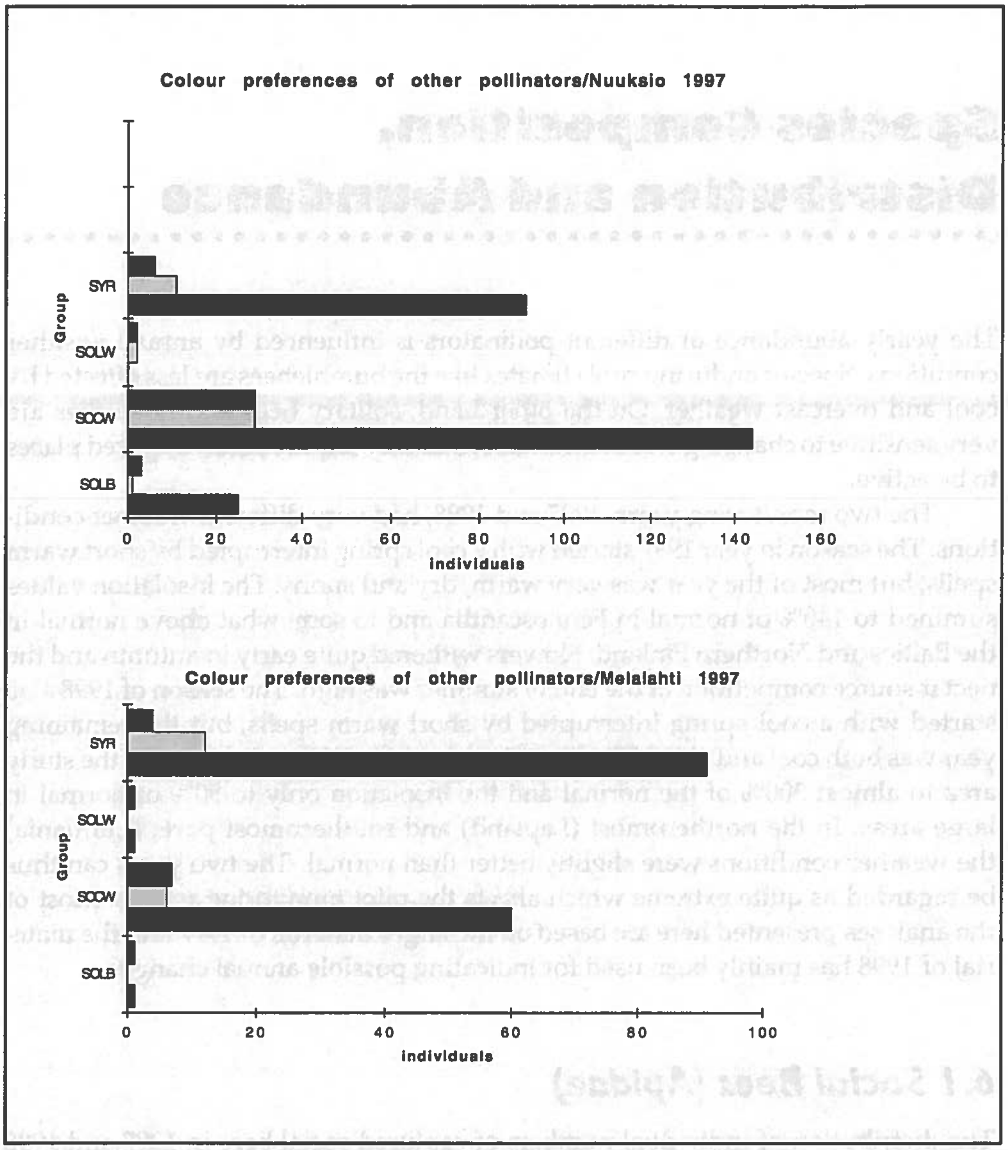

Fig. 3. Eusocial bees and other pollinators captured by differently coloured traps at two sites in Finland in 1997. Abbreviations: mel =Apis mellifera, *fla* = Psithyrus flavidus, *syl* = Psithyrus sylvestris, *boh* = Psithyrus bohemicus, *pra* = Bombus pratorum, *hyp* = Bombus hypnorum, *jon* = Bombus jonellus, *spo* = Bombus sporadicus, *luc* = Bombus lucorum, *sor* = Bombus soroeensis, *pas* = Bombus pascuorum, *vet* = Bombus veteranus, *dis* = Bombus distinguendus, *hor* = Bombus hortorum, *lap* = Bombus lapidarius, *rud* = Bombus ruderarius, *syr = Syrphidae, solw = solitary wasps, socw = social wasps, solb = solitary bees; Mb= blue, Mw= white, My=yellow.*

6 Species Composition, Distribution and Abundance

The yearly abundance of different pollinators is influenced by annual weather conditions. Species enduring cool climates like the bumblebees are less affected by cool and overcast weather. On the other hand, solitary bees and hoverflies are very sensitive to changing weather conditions as they require sunny exposed places to be active.

The two monitoring years, 1997 and 1998, had very different weather conditions. The season in year 1997 started with a cool spring interrupted by short warm spells, but most of the year was very warm, dry and sunny. The insolation values summed to 140% of normal in Fennoscandia and to somewhat above normal in the Baltics and Northern Finland. Flowers withered quite early in autumn and the nectar source competition at the end of summer was high. The season of 1998 also started with a cool spring interrupted by short warm spells, but the remaining year was both cool and rainy. The precipitation summed in some parts of the study area to almost 300% of the normal and the insolation only to 50% of normal in large areas. In the northernmost (Lapland) and southernmost parts (Lithuania) the weather conditions were slightly better than normal. The two years can thus be regarded as quite extreme which affects the pilot monitoring results. Most of the analyses presented here are based on the larger material of 1997 and the material of 1998 has mainly been used for indicating possible annual changes.

6.1 Social Bees (Apidae)

The distribution of individual numbers of captured social bees in 1997 and 1998 are depicted in Fig.4. The recorded species are listed in Annex 2. Twenty-seven species of the genus *Bombus* were recorded in 1997–98. The species not recorded have very restricted ranges, although a few may locally be very common: *Bombus hyperboreus* (orohemiarctic), *B.consobrinus*, *B.patagiatus* (eastern), *B.pomorum*, *B.cullumanus*, *B.confusus*, *B.ruderatus* (southern), *B.wurflenii* (alpine) and *B.maculidorsis* (steppes). Seven species of the genus *Psithyrus* were recorded and only two (*P.vestalis* and *P.quadricolor*) were not met with.

The poor summer weather of 1998 affected the colonies of social bees quite much. The average individual captures dropped everywhere except in northermost Lapland and Lithuania. The change in species composition of the sites is shown in Fig.5. The difference is on the whole not too pronounced as many species can be active also in overcast and cool weather. Apparently some species, like *B.cryptarum*, *B.magnus* and *B.pascuorum*, even benefitted in relation to others, possibly due to their adaptability to stenothermic cool conditions. The most drastic decline in the 1998 captures concerns continental species like *B.hypnorum*, *B.sporadicus* and *B.ruderarius*. It also appears, that despite the general decline of absolute species number in 1998, the relation of species number between the sites still remains the same between the two years.

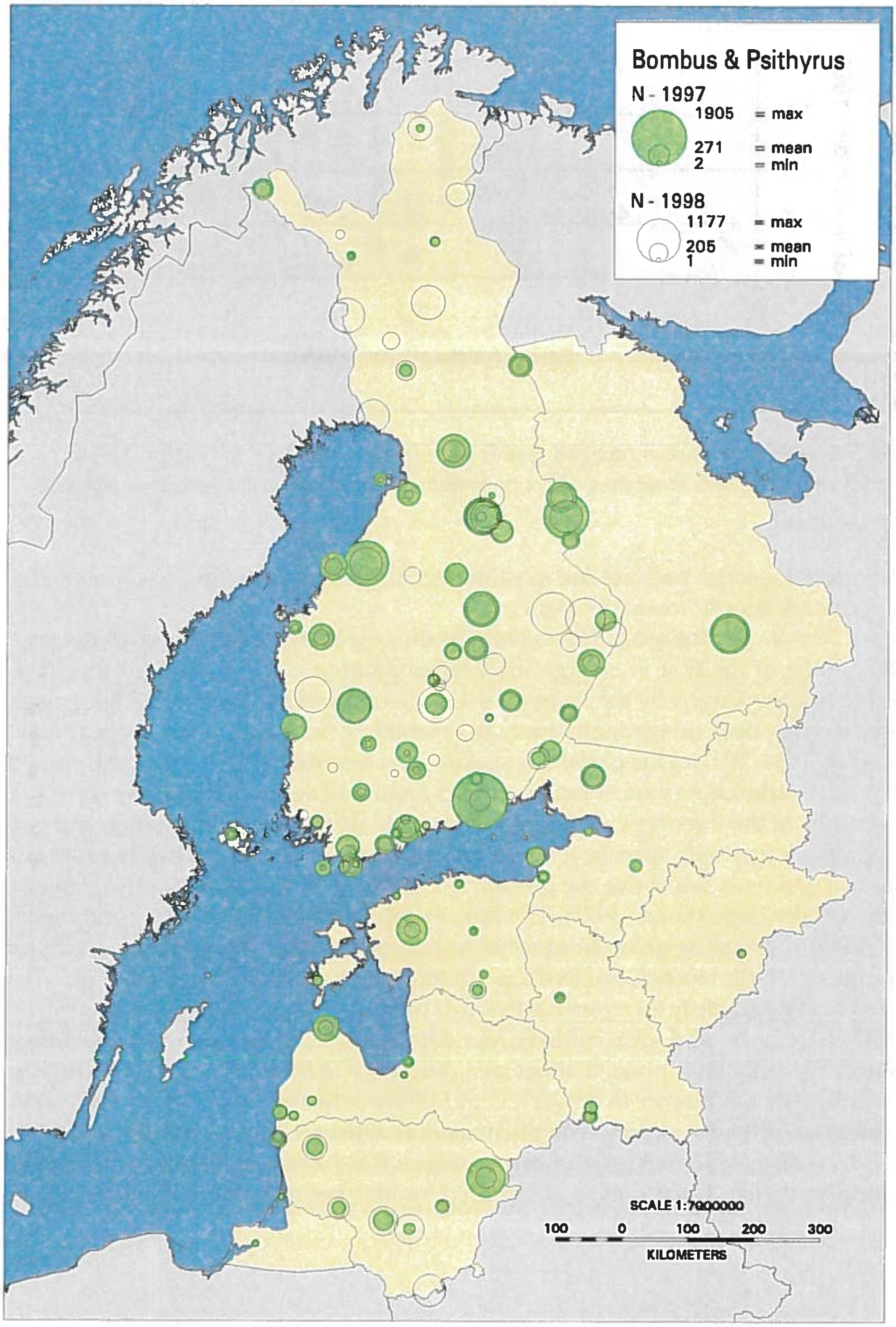

Fig. 4. Distribution of Bombus *and* Psithyrus *individuals in the samples of 1997 and 1998. The green circles stand for records in 1997 and the unfilled circles for records in 1998.*

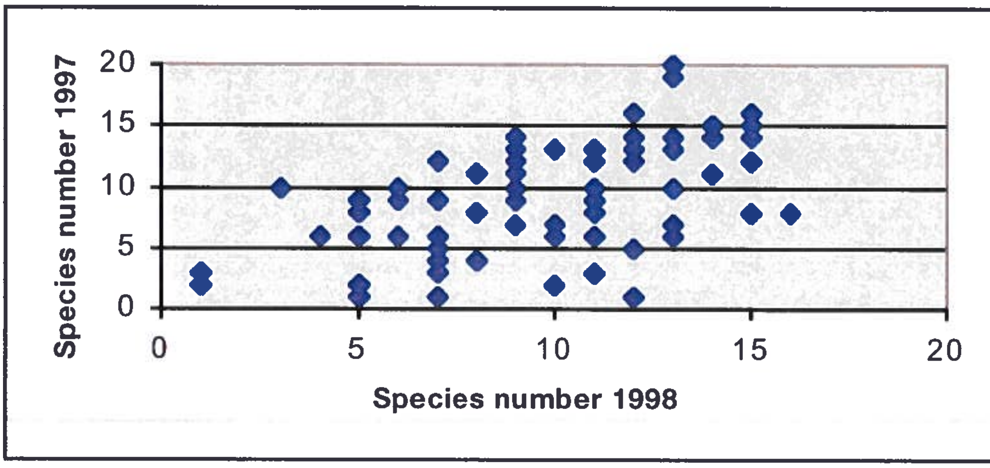

Fig. 5. Comparison between captured species number of bumble bees and cuckoo bees in 1997 and 1998. Only those sites, where traps were operated both years have been included.

Because the social bees are the most important pollinators in the study area, the species are shortly treated hereafter:

B.lucorum (Linnaeus,1761) is perhaps the best known bumble bee in the area being one of the first to emerge from hibernation in early spring and therefore often acknowledged by the layman as a "sign of the start of spring". The species has recently been divided into three, all of which occur in northern Europe (Pamilo *et al.* 1984, 1997). This particular species was recorded all over the area, except for the northermost part of Finland (Inari Lapland), and it is definitely the most common of the three species. It appears to avoid dense human habitation and is a typical country-side species. It builds its nest underground, but have been found to use various holes above the ground in man-made environments. The colonies are usually large (Löken 1973). The ratio of captured queens, workers and males (QWM) is changing going from south to nForth. In the southern regions queens dominate in the catches, but in the north workers predominate – also the proportion of males slightly increases northwards (table 4). Despite that no preference for difference castes and sexes could be found in the colour tests, these regional differences can only be explained either as a difference in brood size (which is highly unlikely) or a difference in flower colour fidelity between the workers of the same species in different regions. The phenomenon with more workers captured in the north is also evident in other species, such as *B.hypnorum*, *B.sporadicus*, *B.jonellus* and *B.pratorum*. The numbers of captured bumble bee queens are shown in Fig 6.

Table 4. Proportion of captured queens, workers and males of *B.lucorum* in different regions of the investigated area in 1997.

Region	Female-queens (%)	Female-workers(%)	Males (%)
Lapland	2	65	33
Northern Ostrobotnia	26	64	10
Kainuu	11	69	20
Middle Ostrobotnia	49	31	20
Southern Ostrobotnia	82	9	9
Central Finland	46	39	15
Northern Savonia	68	15	17
Northern Karelia	42	20	38
Russian Karelia	37	44	19
Tavastia	69	16	15
Southern Savonia	42	58	0
Southwest-Finland	90	7	3
Southern Finland	88	10	2
Southeast-Finland	67	18	15
Leningrad Oblast	31	34	35
Estonia	97	3	0
Latvia	92	4	4
Pskow Oblast	98	2	0
Lithuania	99	1	0

B.cryptarum (Fabricius,1775) has quite recently been separated from the former (Rasmont 1984) and is much rarer. It appears to prefer barren biotopes and landscapes. Pamilo et al. (1997) state that it would be more common than *lucorum* in the north and in the "boreal" environments of the southwestern archipelago of Finland. In central Europe *cryptarum* is more common in higher altitudes (von Hagen 1993). The monitoring samples indicate that the species is rare in Eastern Baltics and the southwestern part of Finland and most abundant in the areas covered with coniferous wood in central and northern Finland, where it locally may be more common than *lucorum*. The QWM-ratio in 1998 in Finland was 80:13:7.

B.magnus Voigt,1901 has also been separated from *lucorum* and is the rarest one of the three. It has been found in many of the same sites as the former species, but it does not appear to go as much to the north as *cryptarum*. The northermost sites of recording were Kokkola, Viiksimo and Kostamuksa. In the Baltic countries *magnus* is very scarce and was recorded only in Lithuania. The most abundant sites of this species were Lauhanvuori (>100 individuals), Seitseminen, Kontiolahti and Kivatsu, most of which are supra-aquatic areas with relatively old forests. The QWM-ratio in 1998 in Finland was 98:1:1.

B.terrestris (Linnaeus,1758). Only two specimens belonging to this species has been recorded from Finland (Pekkarinen & Kaarnama 1994). The species is quite common in Sweden north to 60oN and it appears to be not uncommon in Eastern Baltics. Older information (Löken 1973) setting its northern distribution limit in southern Lithuania is definitely disputed by the monitoring results. The species was recorded north to the southern coast of the Gulf of Finland in single specimens in 1997 and it is fairly abundant in Lithuania and along the coast of Latvia. The statement that this species prefer built or ruderal areas (Löken 1973, Pekkarinen 1979) is not supported by the present findings.

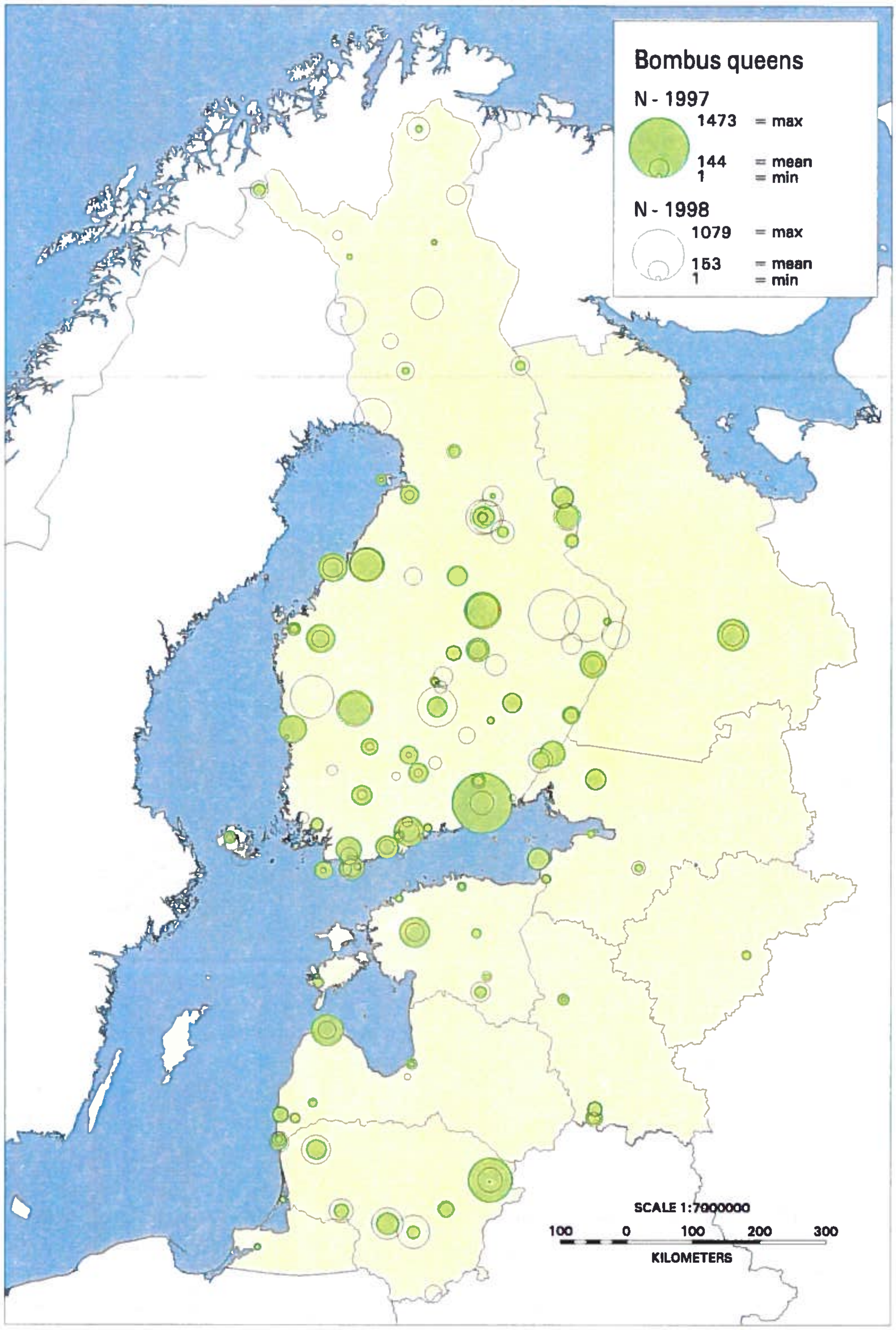

Fig. 6. Distribution of Bombus *queens in the samples of 1997 and 1998. The green circles stand for records in 1997 and the unfilled circles for records in 1998.*

B.sporadicus Nylander,1848 is an element of the Siberian fauna and confined to the vast taiga. It is considerably more abundant in northern than southern Fennoscandia. The southernmost records in 1997 were from Lammi, Luopioinen, Tampere and Hirvivuolle and the northernmost records are from the line Kolari–Sodankylä. It has not been met with in the Baltic countries. The colonies are large and workers have been captured in much higher proportions than by other species (QWM-ratio of 1997 was 10:84:6).

B.soroeensis (Fabricius,1776) was recorded north to its limit, the northermost records were from Tornio and Rovaniemi (see Pekkarinen *et al.*1981). The abundance varies much within its range in 1997–98. The species was abnormally abundant in three sites: Pyhtää (Hirvivuolle) in south-eastern Finland, Märjamaa (Jalase) in western Estonia and Utena (Rugsteliskes) in northwestern Lithuania. These three sites differ much from each other and so far there is no explanation to why these high-density areas exist. Otherwise the abundance is quite low. It prefers dry and open landscapes and has a preference for flowers of *Campanula rotundifolia* (Pekkarinen 1984) and *Calluna* (Pekkarinen & Teräs 1986). The species nests underground. The colonies are generally quite small. It is said to be rare in Germany (von Hagen 1993). Within its area the bee is polymorphic and the nominate form prevails almost everywhere. The other red-backed colour morph, usually named *ssp.proteus* Gers tacker,1869, has an stronghold in western Estonia that is fairly isolated from the central European one (where this morph prevails). The rare *ssp.proteus* has previously only been recorded occasionally and scattered in Lithu ania, Latvia and Estonia. Intraspecific forms between the nominate form and this one are also found in western Estonia. The species also has a strong tendency for melanism (Pekkarinen & Teräs 1986, Pekkarinen *et al.* 1994, Pekkarinen & Teräs 1995). Melanic individuals were recorded over a much larger area than hitherto known (table 5). The proportion of melanism is highest along the eastern coast of the Baltic Sea, but melanic individuals were also captured far inland. Some of these inland sites locate close to large lakes or large bog landscapes, which would support the theory of melanism developing in areas with unfavourable microclimate in early spring (Pekkarinen 1979). But there are several records of melanism in inland populations as well, the explanation to which is not yet known. The QWM-ratio in 1997 in Finland was 68:31:1.

Table 5. Percentage of melanic and red-backed morphs of *B.soroeensis* in the monitoring network in years 1997–1998. Values in brackets are only indicative because of too low total number of individuals. The influence of microclimate on the locality is given when assumed to be of importance.

Site number	Site name	N 1997-98	% melanic	% proteus	Influence
116	Virga	23	69.6	-	coastal
115	Grobina Vitini	20	50.0	-	coastal
113	Pape Koni	23	43.5	-	coastal
198	Slitere	100	35.0	-	coastal
139	Täktom	35	34.3	-	coastal
104	Jalase	132	31.8	68.2	
129	Rugsteliskes	306	31.0	-	
131	Dubrava	27	25.9	-	
127	Ukmerge	23	21.8	-	
39	Konnevesi	35	17.1	-	large lake
217	Jääskelä	12	16.7	-	large lake
107	Nuuksio	22	13.6	-	
214	Bromarv	47	10.6	-	coastal
132	Lekeciai	22	9.1	-	
70	Joutseno	45	8.9	-	
134	Tenhola	46	8.7	-	coastal
155	Vuoksa	117	6.8	-	
41	Korpilahti	348	3.2	-	large lake
26	Suonenjoki	71	2.8	-	large lake
221	Eno	60	1.7	-	
14	Seitseminen	85	1.2	-	
213	Lauhanvuori	99	1.0	-	
18	Hirvivuolle	609	0.3	-	large bog
120	Viidumäe	16	0.0	43.8	coastal
118	Riga	1	(100)	-	coastal
201	Klaipeda	4	(75)	-	coastal
105	Endla	3	(67)	-	large bog
104	Puka	3	(67)	(33)	
197	Rudbarzi	9	(56)	-	
65	Tulliniemi	2	(50)	-	coastal
94	Keikino	2	(50)	-	coastal
119	Carnikava	6	(33)	-	coastal
128	Plateliai	7	(29)	-	
149	Inkoo	10	(20)	-	
121	Sebez Osyno	6	(17)	(66)	large lake
122	Kurgolovo	9	(11)	-	coastal
109	Kloogaranna	1	-	(100)	coastal

B.pratorum (Linnaeus,1761) is common and prefers forest margins and brushwood. It can build nests in a variety of microhabitats (*e.g.* tree holes, holes underground, in thurfs of vegetation) and the colonies are rapidly developing and small (von Hagen 1993). In years of warm early summers a partial second generation may develop (Prys-Jones & Corbet 1991). The species is less common in the southern parts of the investigated area and it may locally be prevailing in the subarctic birch zone. The QWM-ratio in 1997 in Finland was 51:44:5.

B.pascuorum (Scopoli,1793) has an areal colour variation. It is the most commonest bumble bee species in the Baltic countries where the *ssp.pallidofacies*Vogt, 1911 occurs. This form grades through a narrow intergrading zone with *ssp.sparreanus* Löken, 1973 prevailing in the boreal region. The intergrading zone runs from the SW-archipelago of Finland in ESE direction and quite closely follows the limit between the southern boreal and the hemiboreal zones. The *ssp.sparreanus* was recorded north to the line Kolari–Sodankylä. In the Caledonian mountain chain, in nortwestermost Finland *ssp.smithianus* White,1851was captured (see Löken 1973, Pekkarinen 1979). The species is common almost everywhere, preferring pastures and legumen fields (Pekkarinen & Teräs 1977), and its highest abundancy was found in the same sites previously mentioned under *soro eensis*. It is said to avoid large uniform forest areas and also to be a very thorough pollinator having high economic relevance (Löken 1973). The nests are built either on the ground or underground (von Hagen 1993) and the colonies are relatively large but slowly developing (Prys-Jones & Corbet 1991). The QWM-ratio in 1997 in Finland was 74:21:5.

B.hypnorum (Linnaeus,1758) is originally an eastern boreal forest species that has adapted fairly well to man-made habitats and as a consequence been able to spread west- and southwards. It prefers to build nests in holes above the ground, very often in bird cages and other cavities and holes made by man. It, perhaps, reached the Åland islands as late as in the 1970's (Pekkarinen *et al.* 1981). In the Baltic countries it seems to be widely spread but not very abundant. The abundancy is highest in the middle boreal region. The QWM-ratio in 1997 in Finland was 24:62:14.

B.cingulatus Wahlberg,1855, is a rare species of the northern boreal region, preferring alder forests and brushwood. It may locally be common (Pekkarinen & Teräs 1977) but is also missing in several places. The record from Kouvola in Finland (1997), representing a proximal moist wood of the Salpausselkä end formation, is one of the southermost known (some old sites in Karelia lie more to the south). The northernmost records of the monitoring are from Sarmijärvi. Very little is known about the bionomy of the species – it is clearly less anthropochorous than *B.hypnorum* and avoids extensive cultural areas.

B.lapidarius (Linnaeus,1758) has adapted well to anthropogenic environments and is often observed (and recor ded in this scheme) in city parks and around human habitations. It becomes scarce in the middle boreal region and was recorded north to the line Vasa–Ilomantsi. The abundance is high along barren coastal strips (it was the only bumblebee species recorded on islands in the archipelagoes) and in gravelly terrain (especially along the Salpausselkä ridges in southern Finland. Males are less frequent in the trap samples because they fly higher than the standard sampling height (Bringer 1973). The bumblebee is said to prefer shallow aggregated flowers of the family Asteraceae (Prys-Jones & Corbet 1991). The colonies are large and the nests are established underground, often in coarse stony ground (Löken 1973). The QWM-ratio in 1997 in Finland was 82:17:1.

B.ruderarius (Mueller,1776) prefers ruderate communities close to human habitation. It has previously been relatively common in Finland (Forsius 1935), but regarded as scarce by Pekkarinen & Teräs (1977). It was not found in southwestern Finland and appears to be absent many places inland in Finland. It is however still quite common in some eastern parts of the area, like Pskov region, the Leningrad region, south-eastern Finland and in most of Estonia. The northermost record was from Tohmajärvi in northern Karelia. It builds its nest on the ground which is often destroyed by agricultural activity such as grass-burning and ploughing (von Hagen 1993). The colonies are rather small (Löken 1973). In Russia the colourmorph *rossicus* was relatively abundant in the Pskov region. The QWM-ratio in 1997 in Finland was 87:4:9.

B.veteranus (Fabricius,1793) is the most common of all the species building nests on the ground. The bum blebee has a continental distribution and is found only in the southernmost parts of Scandinavia (Löken 1973). In the study area its abundance is high east of the line Osyno–Puka–Kingisepp–Joutseno–Maaninka–Kiuruvesi–Liminka. It was not recorded on any islands. In Fennoscandia *veteranus* is expanding northwards because it was recorded north to Tornio and Rovaniemi lying much more northern than its formerly known northern limit. Melanism is a quite recent phenomenon in this species and melanic individuals have so far been found (also in the monitoring samples) only from the southwestern coast of Finland in Hanko peninsula (Pekkarinen & Teräs 1986). The QWM-ratio in 1997 in Finland was 80:14:6.

B.schrencki (Morawitz,1881) is a southeastern species that was regarded to be extinct in Poland until re-discovered in the beginning of the 1990's (Banaszak 1995). It was very soon after that also recorded from Lithuania and then from Latvia. The oldest records from Estonia date back to the middle of 1980's. The expansion towards north evidently continues because the yellow-trap samples indicate that *schrencki* has already reached the southern coast of the Gulf of Finland and north of 62oN in Russian Karelia (largest captures were from Kivatsu in 1997–98). The species is said to prefer moist forests and forest margins (Monsevicius 1995). Its expansion must have benefitted from accelerated afforestation of open fields in the Baltic countries.The QWM-ratio in Lithuania is 88:8:4 and in Russian Karelia 31:54:15 (1997).

B.sylvarum (Linnaeus,1761) is a continental species too, which is expanding westwards (recorded new to Finland in the 1930's). The abundancy is highest in areas around the inner parts of the Gulf of Finland where it was recorded fairly common in 1997 (but absent in 1998). Another strong core area appears to be situated in SW-Latvia. In 1998 it was recorded close to its westernmost and northernmost occurrence in Finland (from Mietoinen and Tohmajärvi), but it appears to have declined from the middle parts of the Finnish south coast. The species nests on the ground and the colonies are rather small. The QWM-ratio in Russia is 47:33:20 (1997).

B.distinguendus Morawitz,1869, is a local species with low abundancy. It appears to have become somewhat rarer in the last decades. The highest number was recorded in Liminka, Finland in 1997, but it disappeared from there in 1998. In the same year it was however recorded quite far north in Tornio and Liikasenvaara. It was not recorded from Estonia at all, and very unfrequently from Latvia (2 sites), Lithuania (3 sites) and Russia (2 sites) in the pilot monitoring period. It nests on the ground and prefers traditional agricultural landscapes with pastures and florishing meadows. The QWM-ratio in Finland was 83:13:4 for 1997.

B.muscorum (Linnaeus,1758) is a very local species preferring wet coastal (upheaval) meadows. It was only found in two coastal sites (Dragsfjärd Örö and Hailuoto) in 1997 in Finland. Melanism is known in this species as well (*ssp.liepetterseni* Löken 1973). It builds its nest on the ground and the colonies are small (von Hagen 1993).

B.humilis Illiger,1806, is the species that have declined most in the area over the last decades. It has earlier been distributed over large areas, but has been recorded only in southwestern Finland since 1975. The monitoring showed it to be present in a few sites in Lithuania (Rugskelistes, Dubrava) and Latvia (Pape, Grobina Vitini). Half of the specimens belong to the capucine-brown coloured morph, the other half to the dark form *tristis*. The species nest on the ground in grass-tussocks and underneath moss-polsters and the colonies are small (Löken 1973, Pekkarinen & Teräs 1987).

B.hortorum (Linnaeus,1761) has a long proboscis and is a very important species in maintaining biodiversity because it prefers deep-corolla flowers. It is widely distributed throughout the area, but the colonies are usually small everywhere. The highest abundancy was recorded in Luopioinen, Ylistaro, Korpilahti, Maaninka, Haapajärvi and Melalahti. It has adapted well to human environments and is frequently found in ornamental gardens and plantations. The species is melanic in Scandinavia. The QWM-ratio in Finland was 79:16:5 in 1997.

B.subterraneus (Linnaeus,1758). is a local species building nests undergound. It prefers fields of red clover (Pekkarinen *et al.* 1981). It was recorded very locally in Eastern Baltics (3 sites in Lithuania, 1 site in Pskov, 1 site in Novgorod) and in the southeast of Finland (2 sites) in 1997. In 1998 it was not recorded at all. Melanic individuals have been met with around the metropolitan area of Helsinki where the species is dimorphic (Pekkarinen & Teräs 1993, Pekkarinen *et al.*1994).

B.jonellus (Kirby,1802), largely represented by *ssp.subborealis* Richards, 1933, prefers barren landscapes and is particularly common in the north. It becomes rarer towards south where it is found in larger forest refuges and in the archipelago. It avoids cultural landscapes and is important in pollinating forest berries. It is very rare in the Eastern Baltic (where it is represented by its nominal form) and confined to boglands and heathlands. In 1998 it was not found in traps from Lithuania or the Pskov region. It builds its nest in subterranean hollows and has rather small colonies. It might have a partial second generation in warm summers (Prys-Jones & Corbet 1991). The species has heavily declined in central Europe where it is regarded as a glacial relict (von Hagen 1993, Kosior 1995). The QWM-ratio in 1997 in Finland was 36:60:4.

B.semenoviellus Skorikov,1909 is a rare and local species. It has a continental distribution and is most frequent in the southeastern parts of the range where it was recorded from Rugskelistes (1997–98), Ukmerge (1997–98) and Sakiai (1998) in Lithuania, Osyno (1997), Knjazevo (1998),Valdai (1997–98) and Keikino (1998) in Russia, and Elva (1997) in Estonia. It has only once, one male in 1964, been reporded from Finland (Elfving 1965), but the monitoring in 1998 proved colonies to be present in Parikkala (3.6.1998), Joutseno (24.5.1998),Ylistaro (6.7.1998) and Paltamo Melalahti (4.7.1998). Three of these sites lie close to the eastern border of Finland, one however quite far away from it. The species might have been overlooked before, but there are so far no other specimens in Finnish collections beside the one previously mentioned.

B.lapponicus (Fabricius,1793) is a circumpolar species and particularly common in the subarctic birch-zone. It was not found south of the Arctic Circle in the monitoring, but elder data imply occurrences south of this as well (Pekkarinen et al. 1981). It was most common in Kilpisjärvi, Sarmijärvi and Sodankylä.

B.monticola (Smith,1849) is a boreoalpine species and very similar to the former species, but appears to be more common in mountains in the north (cf. Svensson 1979, Pekkarinen 1982b). It was recorded only as one worker in Kevo.

B.alpinus (Linnaeus,1758) is an arctoalpine species confined in Finland to mountain areas in the north. One specimen was recorded in Kevo in 1998.

B.polaris (Kirby,1802) is also a circumpolar species and confined in Finland to mountain areas in the north. One worker was recorded in Kilpisjärvi in 1998.

B.balteatus Dahlbom,1832, is a circumpolar species prefering in Finland slope meadows in mountain areas. It was recorded only in three sites: Pallastunturi (1997), Kevo (1997) and Kilpisjärvi (1997–98). Melanic individuals are common in Scandinavia and western Lapland (Löken 1973). No melanic individual were recorded in the monitoring.

The cuckoo bee species are inquilines and only forage on flower nectar for nutrition of their own. The abundancy of cuckoo bees is said to indicate the stability and abundancy of the host colonies (Ortiz-Sanchez 1995). Therefore the ratio between the host and the inquiline is of interest in the monitoring.

Psithyrus bohemicus (Seidl,1837) is the most common cuckoo bee of the area investigated and is an inquiline of *B.lucorum* (and probably other species of the *lucorum*-complex). The female-male ratio (FM) in Finland was 69:31for 1997. The ratio between *bohemicus* and *lucorum* is locally between 1:10 and 1:3 (Fig.7), but there are places where it is higher (Konnevesi; >1:1) and places where the inquiline is almost missing or missing (Slitere Nature Reserve and Inkoo, both lying close to the coast). This might be due to migrated specimens of the host species (cf. Mikkola 1978, 1984). The inquiline does not extend as far north as is host and was recorded north to the Kolari–Sodankylä line. It was most abundant in Tornio Kalkkimaa where > 100 specimens were captured in 1998.

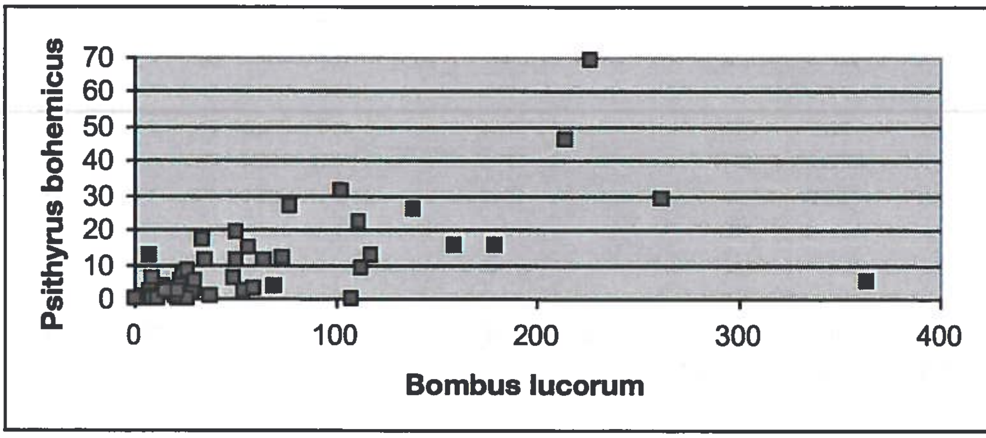

Fig.7. Ratio between Psithyrus bohemicus *and* Bombus lucorum *queens in the samples of 1997.*

P. sylvestris Lepeltier,1832, is an inquiline of *B.pratorum*. The FM-ratio in Finland was 71:29 for 1997. The ratio between *sylvestris* and *pratorum* is usually higher than that of *bohemicus/lucorum*, often being 1:8...1:2 (Fig.8). There are however colonies of the host with little inquilines (Pyhtää Hirvivuolle). The species is distributed quite far to northwest (Tornio–Kolari) but appears to be absent in the southeastern parts of the area (Pskov, Novgorod)

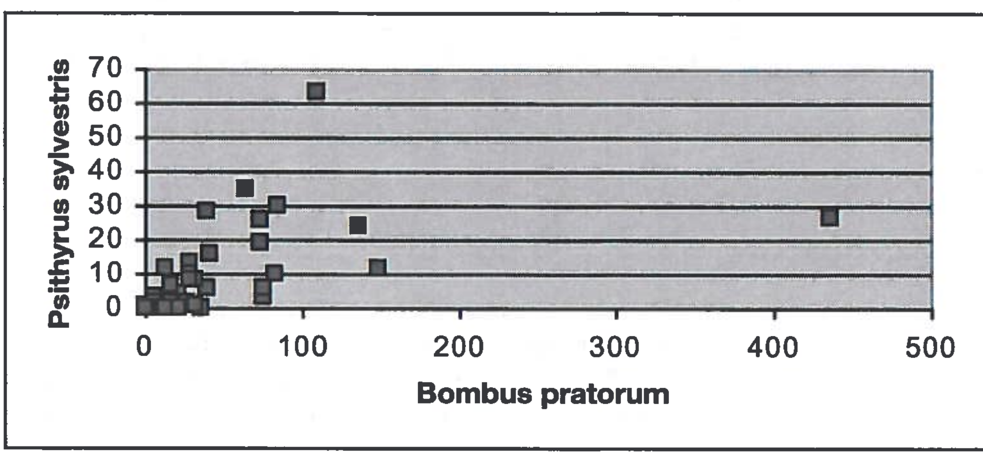

Fig.8. Ratio between Psithyrus sylvestris *and* Bombus pratorum *queens in the samples of 1997.*

P. campestris (Panzer,1801) is a presumed inquiline of *B.pascuorum* (and possibly other species of the subgenus *Thoracobombus*) that was recorded mostly in Eastern Baltics, and even here scarcely (Kurgolovo, Jalase, Puka, Virga, Lekeciai, Dubrava and Rugskelistes). The only records from Finland were from Etelä-Kuivasto in SW-Finland (1997) and Petkeljärvi in Northern Karelia (1998). Its distribution is far from that of the presumed host species and other hosts have been suggested such as *B.humilis*. As this species is even less common than *P.campestris* this seems very unlikely. It might be requiring fast developing colonies of *B.pascuorum*, which could explain why it is more common in the area where *ssp.pallidofacies* occurs and why very few of the large, but slowly developing colonies of *ssp.sparreanus* in the boreal region were not parasitized at all. The species has evidently declined in the last 20 years, which is confirmed by records in museum collections.

P.flavidus (Eversmann,1852) is an inquiline of *B.jonellus* only occuring in northern Fennoscandia. *P.flavidus* was recorded fairly common south to the line Kannus–Kajaani north of which its host is abundant. Two records from southern Finland in 1997 (Espoo Nuuksio and Pyhtää Hirvivuolle) may indicate *B.soroeensis* as a secondary host.

P.norvegicus Sparre Schneider,1918 is an inquiline of *B.hypnorum* and is very scarce in relation to its host species. It was only recorded in Eiciai in Lithuania (1997). Apparently the inquiline have become rarer, but there are quite recent and abundant findings along the Oulujoki river in the north (samples in the Zoological Museum of the Oulu University).

P.rupestris (Fabricius,1793) is an inquiline of *B.lapidarius* that also has become rarer in the last two decades. It was only recorded in a few sites: Ruissalo Turku in Finland (1997), Marjaniemi Vuoksa in Russia (1998), Vilsandi Saarenmaa in Estonia (1998), Utena Rugsteliskes (1997), Plunge Plateliai (1998), Eiciai Lekeciai (1998) in Lithuania.

P.barbutellus (Kirby,1802) is an inquiline of *B.hortorum* that has become very scarce in the region and has already been red listed in Finland and Estonia. Only two southern records came out of the pilot monitoring (Kaunas Dubrava in Lithuania,1997 and Nisha Knjazevo in Pskov oblast, 1998).

Apis mellifera Linnaeus,1758, the honey bee, has been introduced to the area a long time ago. Two races are reared, the nominal race which is hardier in the northern climates but more aggressive and with slowly growing colonies, and the *var.ligustica*, which is less agressive and developing faster. The latter is less hardened to northern climates and therefore mainly reared in the south of the area. The honey bee can not compete with the bumblebees in pollinating nature flowers (often because of too short proboscis), but it is an important component in pollinating oil seed flowers (Free 1993). The species was recorded north to the line Oulu–Kajaani (64oN) in the trap samples, but was rather scarce in most places. It was most frequently found in early spring and late autumn samples and only workers were recorded (males have been captured only in light-traps in Sebez Osyno). The workers have obviously also a clear colour fidelity, other than yellow, in the south.

6.2 Solitary Bees (Apoidea, other families)

The number of trapped species were low in the whole area (Fig.9) and the maximum number of species of any site was 20 in 1997 and 25 in 1998 (ca 7% of all known species). The species richness in 1997–98 was highest close to the coast of the Baltic Sea and very few individuals were trapped north of the Arctic Circle in Finland. Totally 110 solitary bee species were recorded which is only ca 1/3 of the known fauna. Of these 83 species were recorded in 1997 and 82 species in 1998.

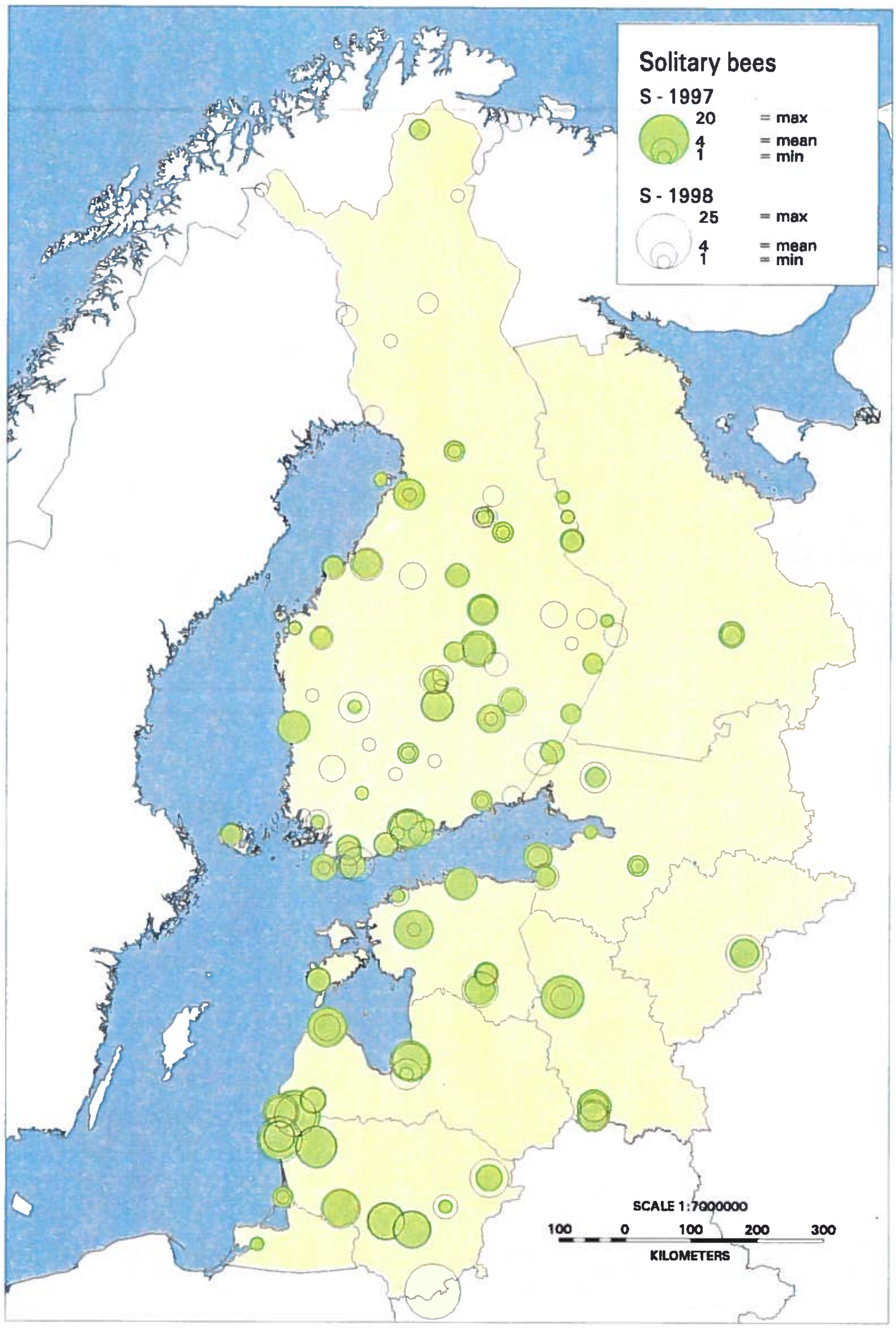

Fig. 9. Distribution of sampled solitary bee species in 1997 and 1998.The green circles stand for records in 1997 and the unfilled circles for records in 1998.

Common for both years were only 54 species, which indicates the local occurrence of many species and that the number of species will still increase with continuous monitoring. With the exception of Lithuania, all other countries showed a decline in average individuals/site in 1998 as a result of the poor summer weather of that year.

In 1997–98 twenty-seven oligolectic species out of about 70 known (cf. Monsevicius 1995, Pekkarinen 1998) were recorded. Most of these (18) visit yellow flowers and only 3 species visit red. The oligolectic bee species were (colour preference in bracket as Y=yellow, W=white, B=blue and R=red): *Colletes daviesanus (Y), C.similis (W), C.succinctus (R), C.cunicularius (Y), Panurgus calcaratus (Y), Andrena denticulata (Y), A.hattorfiana (R), A.lapponica (R), A.gelriae (Y), A.wilkella (Y), A.clarkella (Y), A.vaga (Y), A.praecox (Y), A.ruficrus (Y), A.curvungula (B), Heriades truncorum (Y), Dasypoda altercator (Y), Megachile ericetorum (Y), M.nigriventris (Y), M.lapponica (R), Anthophora furcata (Y), Melitta haemorrhoidalis (B), Macropis fulvipes (Y), Chelostoma campanularum (B), C.rapunculi (B), C.florisomne (Y), Hylaeus nigritus (W).*

Of the species prefering red flowers only single male specimens were recorded.

In 1997–98 nineteen inquiline species were recorded (host in parenthesis, if known) from the yellow-traps:

Stelis minima (Chelostoma campanularum), Nomada striata (Andrena gelriae), N.goodeniana (Andrena cineraria), N.bifida (Andrena haemorrhoa), N.alboguttata (Andrena barbilabris), N.panzeri (Andrena fucata), N.fulvicornis (Andrena carbonaria, A.tibialis, A.bimaculata), N.lathburiana (Andrena vaga), N.leucophthalma (Andrena clarkella), N.fabriciana (Andrena bicolor), N.flavoguttata (Andrena subgenus Taeniandrena sp.), N.obscura (Andrena ruficrus), Epeolus cruciger (Colletes daviesanus), Sphecodes ephippius (Lasioglossum leucozonium), S.crassus (Lasioglossum subgenus Evylaeus), S.pellucidus (Lasioglossum subgenus Evylaeus and *Andrena barbilabris), S.gibbus (Halictus spp.), S.monilicornis (Lasioglossum incl.subgenus Evylaeus)* and *S.geofrellus (Lasioglossum leucopum).*

The host species of *N.fulvicornis* was not captured by trapping. In general, the host and its inquiline were recorded at the same site, but there were also records of inquilines in trapping sites where the host was not recorded.

In 1997–98 sixty-seven polylectic species were recorded. In some common species one of the sexes were predominating in the captures. Such were *Andrena praecox, A.clarkella* (males) and species of the family Halictidae (females). Of the last mentioned family, males are more seldom met with as mating usually takes places within the nest, and the fact that only females hibernate (and are frequently captured in spring and late autumn) may explain these sex-ratios of the captures.

Some rare species are here commented upon:

Anthophora plumipes (Pallas, 1772). Four males were captured in Latvia, Pape Koni 21–28.4.1998. The species flies very early and is therefore seldom otherwise recorded. It nests in steep clay or sand slopes and prefers *Primula veris* when visiting flowers.

Osmia aurulenta (Panzer,1799). One female was captured in Latvia, Pape Koni 13.5.98. The species nests in empty shells of *Cepaea*. Earlier known only from Kaliningrad in the region (Monsevicius 1995).

Osmia pilicornis F.Smith,1846. One male was captured in Finland, Korpilahti 11.5.1998. The species prefers herb-rich forests and forages mainly on *Pulmonaria*.

Andrena hattorfiana (Fabricius,1775). One male was captured in Lithuania, Plateliai 30.6.1997. The species is an oligolect on *Knautia arvensis*.

Andrena bicolor Fabricius, 1775 and *Nomada fabriciana* (Linnaeus,1767). The host, prefering *Viola*-flowers, was captured in Plateliai (Lithuania), Grobina, Kuldiga, Talsi (Latvia), Jalase (Estonia) and Valdai (Russia) between 30.4–2.6.1997. Its inquiline was recorded only in Lithuania (Plateliai 5.5.1997, Lekeciai 5.7.1997) without records of the host.

Andrena ventralis Imhoff,1832. One female was captured in Latvia, Carnikava 7.5.1997

Andrena curvungula Thomson,1870. One male was captured in Lithuania, Dubrava 11.5.1997. This oligolectic species confined to *Campanula*-flowers has been defined as vulnerable in Lithuania (Balevicius 1992).

Halictus sexcinctus (Fabricius,1775). Two females were captured in Latvia, Pape Koni 10.6.1998

Lasioglossum costulatum (Kriechbaumer,1873). One female was captured in Lithuania, Dubrava 19.7.1997

Hylaeus nigritus (Fabricius,1798) was captured in Estonia, Jalase 29.6.1997 and Kloogaranna 19.7.1998. The species is very local and collects pollen only from Umbelliferae.

Hylaeus difformis (Eversmann,1852) was captured in Lithuania, Eiciai 16.8.1998 and Rugsteliskes 28.6.1998, and in Pskov region, Knjazevo 13.7.1997 & 16.6.1998. The species is rare and local in the southern part of the investigated region.

Hylaeus sinuatus (Schenck,1853) was captured in Latvia, Carnikava 12-28.7.1997 and 12–20.7.1998, and Kuldiga 5.7.1997. The species is rare and local south of the Fennoscandian area.

6.3 Social Wasps (Vespidae)

Social wasps are common throughout the area (Fig.10), although only one species (*Dolichovespula norvegica*) was met with in the northernmost and most elevated places. High number of individuals were recorded in some places (Pori, Nuuksio, Riga and Kuldiga), where usually one species clearly dominated the catches. In Lithuania and Kaliningrad the number of wasps was quite low during the monitoring period. The high number of social wasps in the samples cannot simply be explained as visits to flowers for nutrition. They must have been attracted by the amount of killed flies that acted as attractants to the wasps. Three species of interest are specially treated hereunder:

Vespa crabro Linnaeus,1758. The Hornet occurs in the investigated area in two forms, the nominate form occu ring in the eastern and northern part and the colour morph *germana* in the western parts of the Baltics. The species nests in decaying wood and is therefore dependent on old forest stands. It was rather common in the 1930's but declined with a reduction in the distribution in the 1960...1990s. The decline has been related to lower summer temperatures (Pekkarinen 1989). The monitoring results indicate that the species is local but not uncommon in parts of Lithuania, Latvia and Russia. The northernmost find is from Russian Karelia (1997), which would indicate that it is re-expanding nortwards as a result of the warmer summers in the 1990's. One queen was also recorded Rantasalmi (62o02'–28o10') in Finland in a bait trap in 1997 (leg.P.Sundell) and another one in a bait trap at Ruotsinpyhtää (60o30'–26o30') in 1998 (leg.Harry Lonka). Records of queens and males have also been made in southwestern and southeastern Finland (Kullberg, Kaitila, pers.comm.). Small colonies evidently still exist in the Saimaa Lake region and in the Virolahti area in southeastern Finland.

Vespula germanica (Fabricius,1776). Pekkarinen & Hulde'n (1995) inform that it is resident in the Åland islands (latest record in 1970's), which was also confirmed by the monitoring. The monitoring results clearly shows that the species is widespread mainly along the Baltic coast east to the Kurgolovo peninsula in the Leningrad region. This means that the Finnish population is not isolated from the main distribution. The species is however local, but the colonies are quite large.

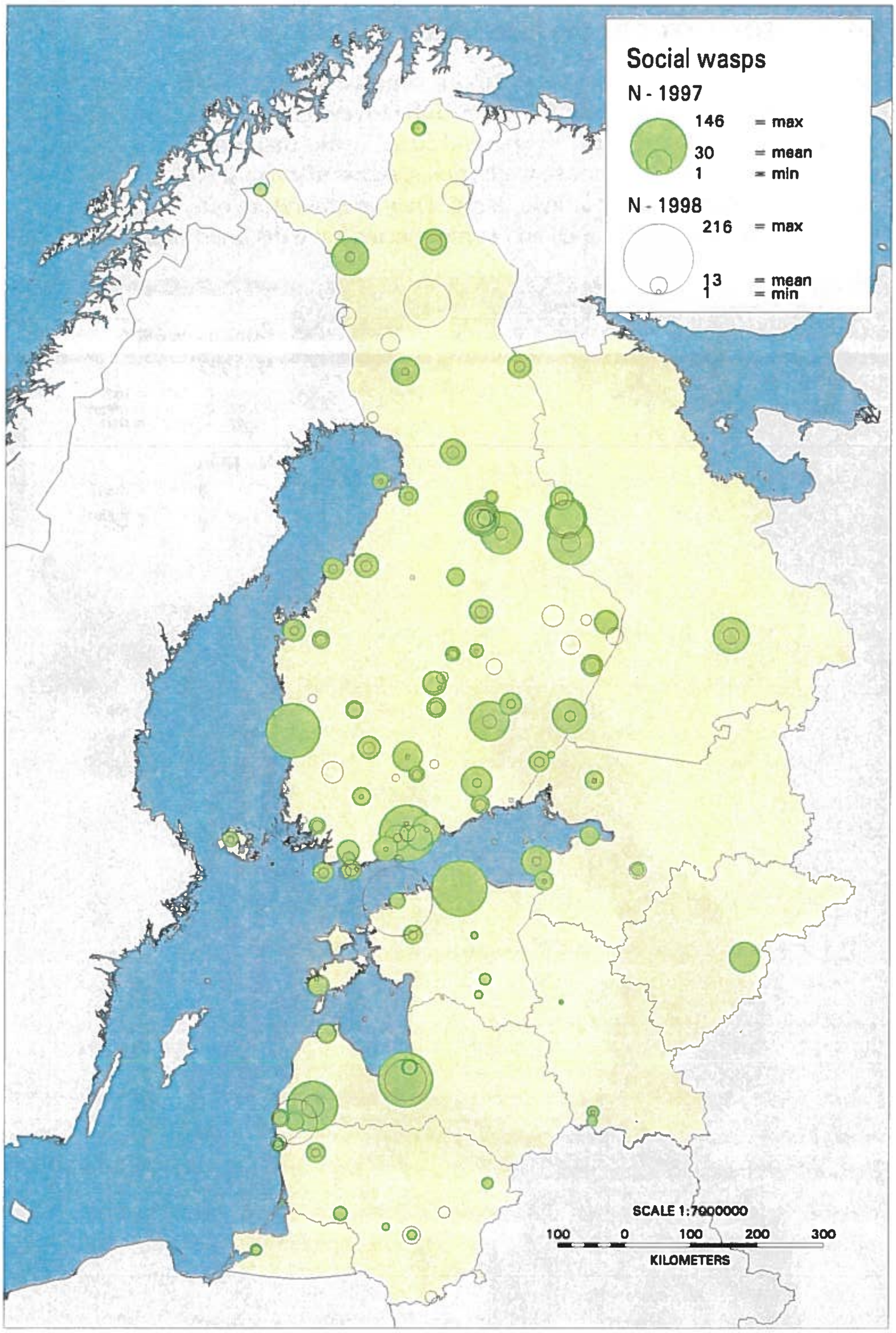

Fig. 10. Distribution of sampled social wasp individuals in 1997 and 1998. The green circles stand for records in 1997 and the unfilled circles for records in 1998.

Polistes dominulus (Christ,1791) was the only paper wasp recorded. One male of this species was taken in Riga in Latvia (2.8.1998). The species has been known to have a much more southern distribution but another recent recording in Lithuania would support the possibility of fast spread to the north of this synanthropic species (Pekkarinen & Gustafsson, in print). The record from Riga is the northernmost in wild in Europe.

6.4 Solitary Wasps (Eumenidae)

Solitary wasps were scarce and local in the captures (Fig.11). They were most frequently found in the southwestern part of the investigated area. Most of the species belong to the genera *Ancistrocerus* and *Symmorphus* that nest in holes in woody material (deciduous trees, house walls, poles, stems of currant and *Rubus*-bushes) close to traditional country-side housing. They are therefore often regarded indicators of traditional landscapes and some species have declined much in the last

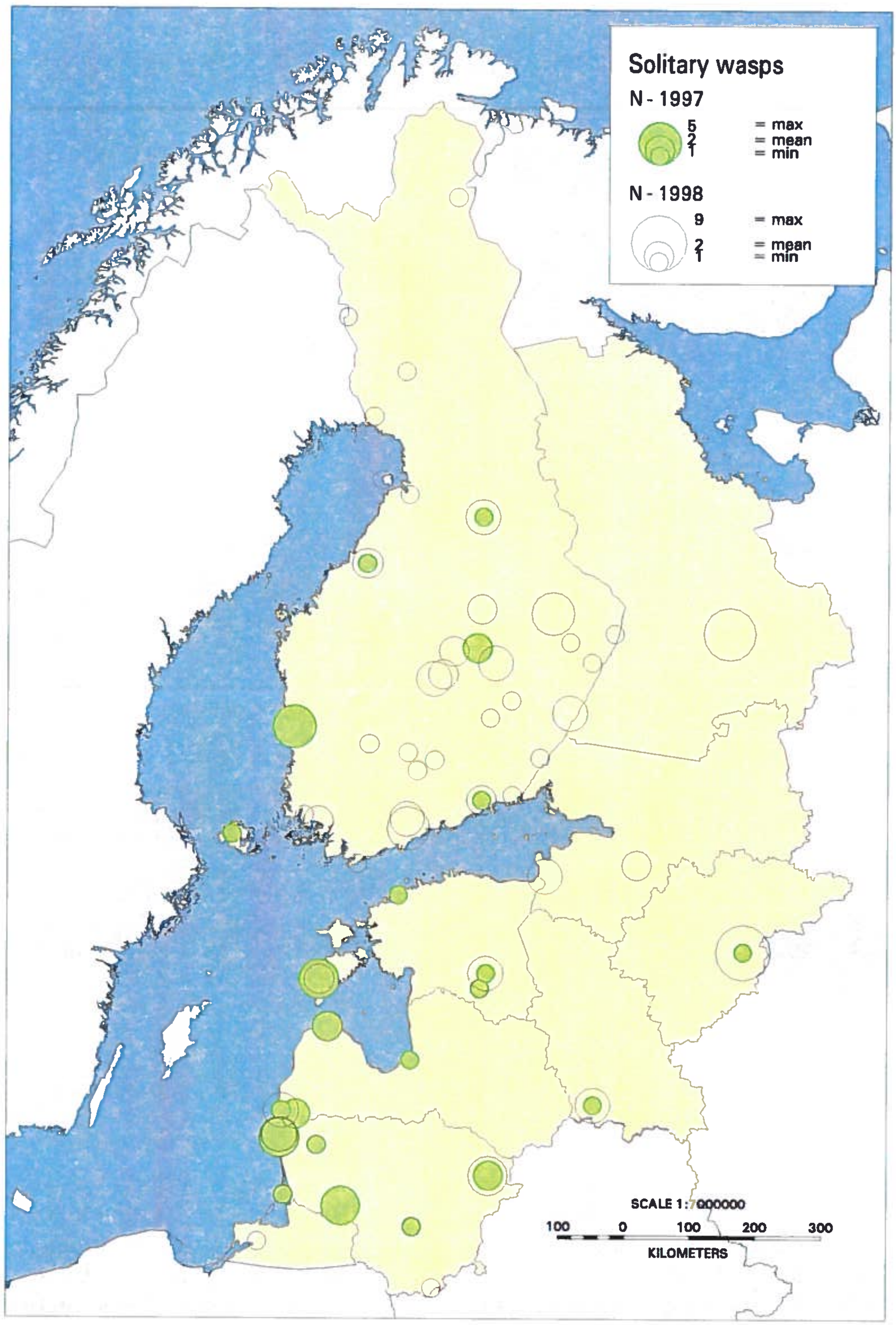

Fig. 11. Distribution of solitary wasp individuals in the samples of 1997 and 1998. The green circles stand for records in 1997 and the unfilled circles for records in 1998.

20–25 years (Pekkarinen & Hulde'n 1991). Three species nesting in the soil (*Euodynerus quadrifasciatus, Gym nocerus laevipes, Odynerus spinipes*) were recorded. All these three species have little nest site flexi bility. Records of two species are worth mentioning:

Ancistrocerus antilope (Panzer, 1798) nests in holes of old trees and wood buildings. It has become rare since the 1970's and is considered "near threatened" (Pekkarinen & Hulde'n 1981, Komiteamietintö 1991).

The species was recorded from five sites in Eastern Fennoscandia: Finström Husö (13.8.1997), Paltamo Melalahti (9.7.1997), Espoo Nuuksio (10.7.1998), Kuopio Pieni Neulamäki (7.8.1998) and Petroskoi Kiwach (25.7.1998). Previous to this, there were no recordings of the species in northern Finland in this century.

Symmorphus murarius (Linnaeus, 1758) nests in holes in sun-exposed walls or in reed stems. It has declined over much of Europe this century (Witt 1998). It is considered near threatened in Finland and Estonia.

The species was trapped only in Valdai in Russia in 3 specimens (10.–17.7.1998).

6.5 Hoverflies (Syrphidae)

The total species number per site must be regarded as low (Fig. 12) as the maximum number of one site in 1997 was only 25 and in 1998 only 31 (about 7% of the fauna of the whole area). On the other hand, a total of 153 species (1997–98) were captured in yellow-traps, which is almost 50% of all known species from the area. Hoverflies are thus attracted by the colour, but the efficiency of the traps in sampling them is low. Many individuals have been seen hovering in front of, and sitting on, the yellow collar of the traps without entering the traps themselves. The most commonly trapped species are those that have a migratory tendency and that can locally develop considerably large second ("native") generations (see subchapter 6.5.3).

Some species groups of different habitat preference are treated in short hereafter.

Species of old natural forests (saproxylic species)

Despite the general conception that adult hoverflies of saproxylic species do not visit flowers, a number of these were nevertheless captured. In 1997–98 the following species were recorded: *Sphecomyia vespiformis, Temnostoma apiforme, T.vespiforme, T.bombylans, Xylota tarda, X.segnis, X.coeruleiventris, X.sylvarum, Chalcosyrphus nemorum, C.valgus, Brachypalpoides lentus, Myathropa florea* which is not a true saproxylic species, but requires water-filled tree hollows for breeding, *Brachyopa dorsata, B.testacea, B.conica* and *Ferdinandea cuprea.*

Of the mentioned species, seven have according to literature been observed to visit yellow flowers occasionally. Of the above mentioned species a few like *Temnostoma, Sphecomyia and Brachypalpoides* are regarded as good indicators of natural forests in need of conservation in Europe as they require decaying or dead wood (Speight 1989). Most of the recorded specimens were from nature conservation sites, but some were also found in economically managed forests. Data on five obligatory saproxylics are given hereunder:

S.vespiforme Gorski, 1852 was caught in yellow-traps in Melalahti in Kainuu (4.9.1997), in Kuopio in northern Savonia (25.8.1998), in Nuuksio in Espoo, southern Finland (22.8.1998), in Jyväskylä in central Finland (14.9.1998) and in Kiwach in Russian Karelia (14.9.1998). The species was also recorded in the field in Pyhtää Vanhakylä in July, 1997 (leg.G.Söderman). These findings are quite conspicuous as the latest known record of the species in Finland is from 1963. *S.vespiformis* mimics in appearance (and in its behaviour in keeping the wings folded along its body) social wasps and is hence difficult to distinguish by sight only, so it may be that it has escaped notice before. The exact habitat requirement of the species is unknown, but most findings have been made in wet and old mixed forests with tall aspens or alders. The species has recently been re-discovered in Sweden as well (Bartsch et al. 1998).

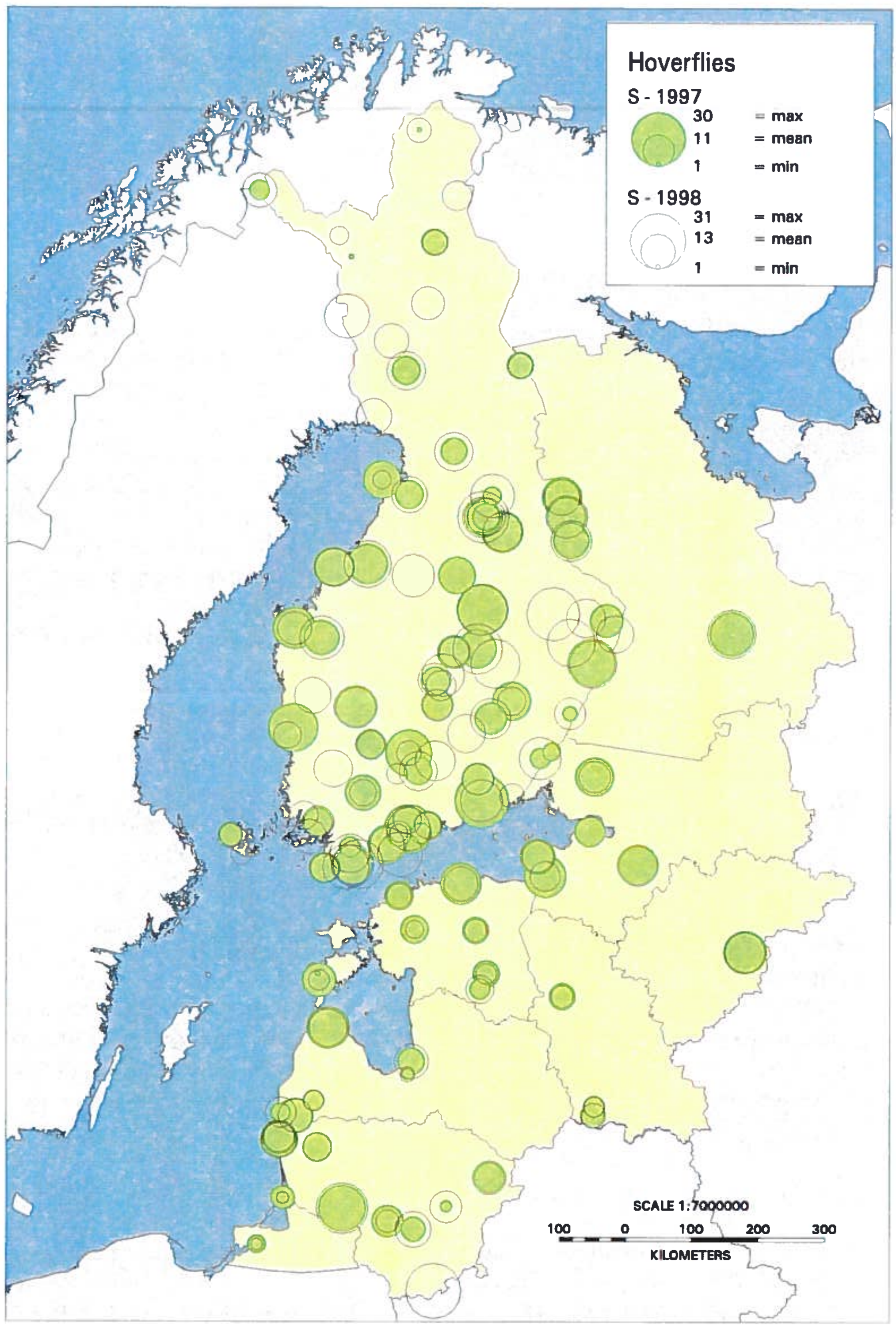

Fig. 12. Distribution of sampled hoverfly species in 1997 and 1998. The green circles stand for records in 1997 and the unfilled circles for records in 1998.

T.apiforme (Fabricius, 1794) was caught at five sites: Pori Ahlainen (1.7.1997), Pallas Mustavaara (18.7.1997), Sarmijärvi Inari (29.7.1998), Valdai in Novgorod (29.6.1997) and Elva in Estonia (29.6.1998). The species is said to require old decaying small-leaved deciduous forests as a habitat. The Mustavaara and Sarmijärvi findings are in subarctic birch forest areas, the other ones close to humid alder-birch mixed stands.

T.vespiforme (Linnaeus,1758) was captured in Utena Rugsteliskes in Lithuania (22.6.1997), Jyväskylä Jääskelä in Finland (24.8.1998) and Kiwach Petroskoi in Russia (13.7.1998). It requires decaying broad-leaved deciduous wood for its surrounding.

T.bombylans (Fabricius,1805) was captured in Liepaja Grobina in Latvia (10.6.1998) and Tosno in the Leningrad oblast (14.6.1998). It requires decaying small-leaved deciduous wood for its habitat.

B.lentus (Meigen,1822) was captured in Lekeciai (15.6.1997) and Cepkeliai (14.6.1998) in Lithuania. It requires decaying broad-leaved deciduous wood for its surrounding.

Species of traditional landscapes (pasture species)

Very few species can be regarded as good indicators of traditional landscapes (grazed grasslands, pastures etc.). To these belong species which larva are coprophagous like *Rhingia campestris*, *R.rostrata* and *R.austriaca*. Of these the records of *R.rostrata* are worth mentioning (Kaliningrad 25.7.1997 in light-trap and Liepaja Virga 17.7.1998 in yellow-trap) as the species has become extinct in large parts of western Europe (Torp 1994). Species like *Eristalinus sepulchralis*, *Eristalis intricarium*, *E.antophorinum*, *E.interruptum*, *E.abusivum*, and *E.horticolum* are also quite good indicators as their larva live in manure water. The captured number of these were quite small that might indicate a change in their environment since the time of more extensive cattle breeding. Still two other species might be mentioned, *Xanthogramma festivum* and *X.pedissequum* that require the company of ant societies on dry pastures. Both were very rare in the monitoring samples.

Species with known migratory tendencies

Migrating hoverflies may be set in three categories:

(1) obligatory migrants, where fertilized female migrate in early summer to establish new colonies upon their arrival. Their native generations tend to migrate further, but the species can not survive the winter in the region. To these belong *Episyrphus balteatus* and *Eupeodes corollae*. The phenology of the firstmentioned is depicted in Fig.13. The first fertilized females arrive in small numbers in June and the native generation comprising both males and females developes in July. Individuals of this generation migrates further north and some apparently sthrive back to south (Mikkola 1986). Both mentioned species are protandrous. The migration pattern reminds of that of some butterflies and moths (e.g. *Pieris rapae*, *Vanessa cardui*, *Autographa gamma*).

(2) facultative migrants, where both males and females arrive in autumn, often at the turn of August–September. These species, e.g. *Scaeva pyrastri*, *S.selenitica*, *Meliscaeva auricollis*, *Eristalis tenax*, *E.pertinax*, *E.pratorum*, can not survive the winter in the region either (an exception might be *E.tenax* that might produce a "native" population in southern Lithuania (925 specimens of which 483 females between 25.8..11.10.1998 in Cepkeliai). These

species might be numerous in years of suitable migration weather patterns, like in year 1998, but be almost lacking in other years, like in 1997 with very stable high pressure periods over Eastern Fennoscandia.

(3) occasional migrants, that can hibernate in the area but with a reduction of the population, and which during suitable migration weather patterns receive strengthening of their populations through migrating individuals mixing with the "native" populations. Such species are *Melanostoma mellinum, Syrphus torvus, S.vitripennis, S.ribesii, Lapposyrphus lapponicus, Meliscaeva cinctella* and *Sphaerophoria scripta.*

Notable is that most of the captured hoverfly individuals in both 1997 and 1998 belong to species of some of these categories. The intensity and frequency of migrations from south therefore highly affect the captures from year to year whereby the quantitative calculations of diversity is subsequently affected by the migrations and do not give a reliable picture of the local biodiversity.

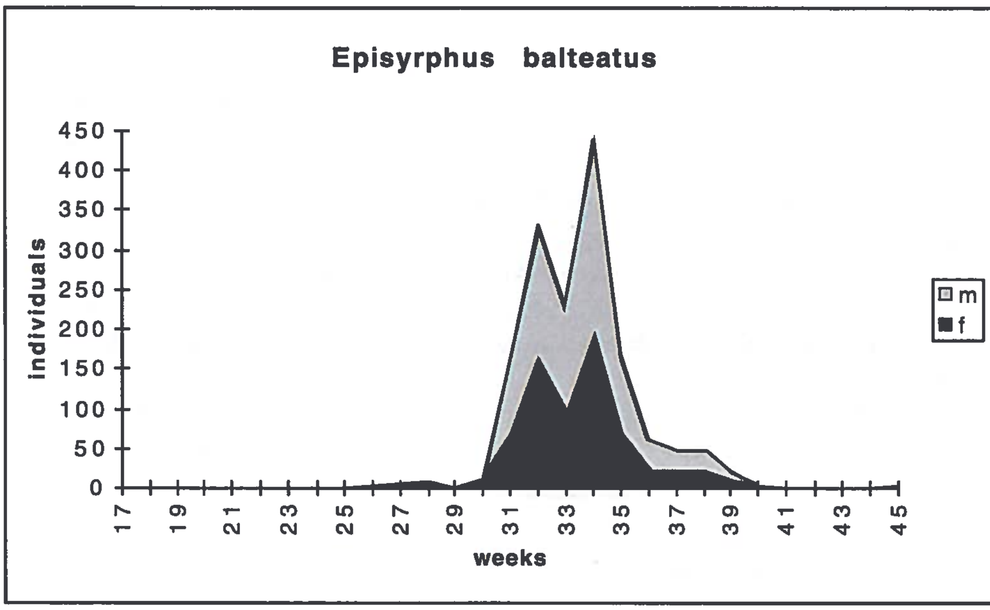

Fig. 13. Sex distribution (m=males, f=females) of Episyrphus balteatus *weekly records in Finland in 1997.*

Species living in forest canopies

Species of a few genera mainly spend their time both as larvae and adults in tree canopies. As a result of this they are rarely captured by netting. The yellow-traps however captured several species of these genera: *Parasyrphus* (7 species), *Dasysyrphus* (6 species) and *Epistrophe* (3 species). Most of the species of the genera *Parasyrphus* and *Dasysyrphus* were recorded over large areas, and almost all common *Parasyrphus*-species developed partial second generations both in 1997 and 1998. Notable are the records of *Parasyrphus punctinalis* from two sites (Sipoo and Kouvola) in Finland. This species has not officially been recorded before, but the species has probably been mixed with the slightly larger, *P.macularis* in the earlier collections.

Wetland species

Very few typical wetland species were recorded: *Sericomyia silentis, S.lappona, Neoascia meticulo sa, N.podagrica, N.tenur, Helophilus pendulus, H.affinis, H.hybridus, H.trivittatus, Parhelophilus frutetorum* and *P.consimilis.* One reason for this is that the sampling sites often located far away from wetland habitats, another that most of the species have a preference for white-coloured flowers.

6.6 Other Groups

A small number of other families of Hymenoptera and Diptera were also surveyed in the yellow-trap materials. To these belong the ruby tails (Chrysididae) that are inquilines of other Hymenoptera (mostly solitary bees and Eumenidae), digger wasps (Sphecidae), that prey on other insects, with some species that nest in old wood, spider wasps (Pompilidae), that prey on spiders, and soldier-flies (Stratiomyidae), of which some species live on pastures, some only in clear, running waters.

Ruby tails (Chrysididae)

Seven species were recorded in 1997–98: *Cleptes semiauratus* (Estonia, Lithuania), *Chrysis sybarita* (Latvia), *C.ignita* (Finland, Estonia, Latvia, Russia), *Hedychridium zelleri* (Latvia), *H.cupreum* (Russia), *Osmalus violaceus* (Finland), *O.auratus* (Finland, Russia), *Trichrysia cyanea* (Russia). Of these *C.ignita* was most common.

Digger wasps (Sphecidae)

Quite many species were recorded in the yellow-traps: *Trypoxylon figulus, T.medius, T.attenuatus, Crabro cribrarius, C.peltarius, Ectemnius continuus, E.lapidarius, E.fossorius, E.cephalotes, Lindenius albilabris, Mimumesa dahlbomi, Crossocerus nigritus, C.pusillus, C.barbipes, C.cinxius, C.heydeni, C.megacephalus, C.annulatus, C.assimilis, C.cetratus, C.ovalis, Pemphredon inornatus, P.lugubris, P.montanus, P.balticus, Spilomena vagans, Psenulus pallidus, P.concolor, P.fuscicornis, Passaloecus insignis, P.eremitus, P.clypearis, Diodontus medius, Rhopalum coarctatum, R.clavipes, Oxybelus uniglumis, Diodonthus tristis, Astata boops, A.pinguis, Ammophila sabulosa, A.pubescens, Podalonia hirsuta, Mellinus arvensis, Cerceris arenaria, C.quadrifasciata, C.quinquefasciata, Nysson interruptus, Philanthus ruspatrix.* Most of the species are very common and widely distributed (Lomholdt 1984). The most common species was *M.arvensis* (>100 individuals), nesting in aggregates in sandy localities and preying on flies. Males were more numerous and they are known to be honeydew lickers. Also *C.cribrarius* (>20 individuals) nests in aggregates in sandy localities and prey on flies. Also in this species males were more common in the samples. For other species usually single or a few specimens were captured.

Spider wasps (Pompilidae)

As can be expected, very few individuals were captured by the yellow-traps. They belonged to the following species: *Anoplius infuscatus, A.nigerrimus, A.viaticus, Priocnemis exaltata, Dipogon va riegatum, D.hircanum, Auplopus carbonarius, Evagetes dubius, Episyron rufipes, Homonotus sanguinolentus* and *Calicurgus hyalinatus.* All of these are common within the area (Wolf 1967).

Soldierflies (Stratiomyidae)

Only six species were captured: *Microchrysa polita* (Finland, Latvia, Russia), *Sargus iridatus* (Finland), *Chloromyia formosa* (Estonia, Latvia, Lithuania), *Beris morrisii, B.chalybeata* (Finland) and *Odontomyia argentata* (Huittinen, Finland). The two first-mentioned species are common and widespread on meadows, the third is confined to dry grasslands (and not found in Finland), the fourth and fifth are rather common in northern Fennoscandia and the lastmentioned is very scarce (previously known from only one site in Finland) along flower-banked small rivulets (Rozkosny 1973).

Relation between Captures and Natural Fauna

7

7.1 Within-species Relations

The above mentioned species distribution and abundance patterns indicate that the yellow-trap samples correspond well with previous information on distribution and abundancy of the species, i.e. species common in the north are also more abundant in the north and species common in the south are more abundant in the south. This means that different populations of the same species react in a similar manner to the yellow-trap clusters.

Representability of sites

It is difficult to estimate the effective capture area of a yellow-trap cluster because of insufficient information on foraging ranges in literature. Prys-Jones & Corbet (1991) state that the range of foraging for bumble bee queens may be even up to several kilometres, while Teräs (1979) informs "at least 600 m's" and Pekkarinen & Teräs (1977) give "usually not very much beyond 1000 metres from the nest". If 1000 metres is taken as feasible radius, then the samples would represent an area of a little more than 3 km^2 which means that the results must be interpreted as local rather than regional. If the value and the average capture effectivity of 0.8% (average of queens & workers, see table 3) is taken as a basis, the highest capture of bumble bees at Pyhtää (1903 specimens in 1997) would give a density of ca 80 000 individuals/km2. This value is not particularly high as Duhayon (1992,1993) gives densities in France for one species between 1 000–10 000 individuals/hectare. As the captures in the investigation area normally ranged between 100–400 individuals per site, this equals to only 42–167 individuals/ha.

Zapetal (1961) informs that an average density of 700 bumblebees is needed to pollinate one hectare of red clover. As *B.pascuorum*, being the best pollinator, produces some 80–100 workers per colony, 7–9 colonies of this species would be enough for economic pollination. Using a capture effectivity of 1.25% for the queens (see table 3), there would need to be 26–33 queens/year/capture to fulfil this criterion. This treshold is exceeded in many places in Eastern Baltics, as well as in southern and middle Fennoscandia.

7.2 Between-species Relations

There is no direct way to analyse the true between-species variation of the samples with that in nature. Indirectly, comparisons between the sample statistics and statistics of species in collections can be made if the latter have been analysed. Tables 6 and 7 make comparisons between species proportions in collections of social bee (*Bombus* and *Psithyrus*) and queens of social wasp species with those of Finnish yellow-trap samples. As can be seen, common species are relatively more common in the monitoring samples than in collections and rare species are less common in the monitoring samples than in collections. Which of these reflect natural conditions better? A known fact is that collections are biased, because rare species are stored in relatively larger numbers than common ones. So in this case, the percentage of rare species are probably too high in the collection material. Wheter their natural proportions (see Figs. 4 and 6) correspond to the monitoring samples can not be deduced. Another fact, making this kind of comparsion difficult, is that (Eastern Fennoscandian) collections have piled up during a century's time and do not therefore relate to the present time only.

Although the variation in percentages between the two monitoring years for some species exceeds the variation between the percentages in the museum collections and the monitoring material, a comparison between the mean percentages in the monitoring material with those of the collections may still indicate larger trends. In such a comparison differences in bumble bees is to be seen, e.g. concerning *Bombus pratorum* (increased), *B.sporadicus* (increased) and *B.hypnorum* (increased), and in many rarer *Bombus-* and *Psithyrus*-species (decreased). This would

Table 6. Comparison between bumble bee and cuckoo bee species percentages in Finnish collections (from Pekkarinen *et al.* 1981) and the Finnish yellow-trap material.

Species	Percentage in collections	Percentage in capture 1997	Percentage in capture 1998
B.lucorum	17.16	21.63	13.83
B.jonellus	11.14	6.61	7.93
B.pascuorum	10.35	11.61	22.25
B.pratorum	6.72	18.92	15.99
B.lapponicus	6.54	0.29	1.47
B.hypnorum	6.02	16.48	9.38
B.lapidarius	6.02	1.59	2.00
P.bohemicus	3.97	2.93	3.62
B.hortorum	3.89	2.56	1.91
B.soroeensis	2.56	6.70	7.67
B.veteranus	2.48	1.52	1.28
B.cingulatus	2.21	0.04	0.19
B.ruderarius	2.12	0.18	0.05
P.flavidus	2.07	0.07	0.44
B.balteatus	1.95	0.02	0.15
B.distinguendus	1.95	0.13	0.07
P.sylvestris	1.90	2.71	2.50
B.sporadicus	1.77	5.83	4.12
P.rupestris	1.34	0.01	0.01
B.humilis	1.15	0.00	0.00
B.subterraneus	1.15	0.02	0.00
P.campestris	0.74	0.01	0.01
B.sylvarum	0.71	0.05	0.07
P.norvegicus	0.38	0.00	0.00
B.muscorum	0.35	0.01	0.00
P.barbutellus	0.23	0.00	0.00
B.cryptarum	(incl.in *lucorum*)	0.04	4.00
B.magnus	(incl.in *lucorum*)	0.02	1.02
B.monticola	<0.001	0.01	0.00
B.alpinus	0.002	0.00	0.01
B.semenoviellus	<0.001	0.00	0.02
B.polaris	0.003	0.00	0.01
Total	100 (=38,170 individuals)	100 (=18,051 individuals)	100 (=16,788 individuals)

indicate that stenotopic grassland species (see Teräs 1985) have declined, whereas eurytopic species preferring woodlands have remained rather strong despite the many anthropogenically induced changes of many habitats.

For social wasps the bias of collections might be smaller as the species are not easily distinguished in the field. The comparison would indicate that the two most common species, *Vespula vulgaris* and *Dolichovespula norwegica* would either be better attracted to yellow-traps than other species, or that their abundancy have grown with respect to the other species. The former explanation is the most plausible, because comparisons between different species in captures with different methodology clearly indicate that these species have a preference for yellow-traps. Material from bait-traps in Finland and Russia indicate that species like *Dolichovespula media* and *Vespa crabro* are more common in bait-traps than the mentioned two common species. *Dolichovespula saxonica* is also in relation to *D.norwegica* much more common in light-traps (ratio 40:60, which is close to that of collections).

Table 7. Comparison between social wasp queen percentages in Finnish collections (from Pekkarinen & Hulde'n 1995) and the Finnish yellow-trap material.

Species	Percentage in collections	Percentage in capture 1997	Percentage in capture 1998
D.norvegica	22.56	66.28	50.30
V.vulgaris	19.48	6.04	14.15
D.saxonica	17.95	13.84	6.33
V.rufa	16.22	9.75	19.88
D.media	6.12	3.51	4.52
D.sylvestris	5.81	0.39	0.00
V.austriaca	4.03	0.00	0.00
V.germanica	2.43	0.00	0.00
V.crabro	2.08	0.00	0.00
D.adulterina	1.76	0.00	0.60
D.norvegicoides	0.68	0.19	4.22
D.omissa	0.85	0.00	0.00
P. nimpha	0.00	0.00	0.00
Total	100 (=7372 queens)	100 (= 513 queens)	100 (= 332 queens)

8 Diversity and Associated Features of the Fauna

8.1 Quantitative Aspects of Pollinator Diversity

Species number

The simplest expression on diversity, viz. species richness, behaves differently within the groups. For social bees and wasps, the species richness does not increase much to the south and it drops very gently in the northernmost parts. For solitary species the increase from north to south is more pronounced.

Studying the species richness for social bees (*Bombus* & *Psithyrus*) one can note that there is very little difference between the number of species recorded of the sites. In most places there appear to be 9–11 bumblebee species and 1–3 cuckoo-bee species (Fig.14). The low number of bumblebee species are related to sites very close to the open sea. In such sites strong winds keep the traps in swaying motion prohibiting the landing of pollinators on the traps.

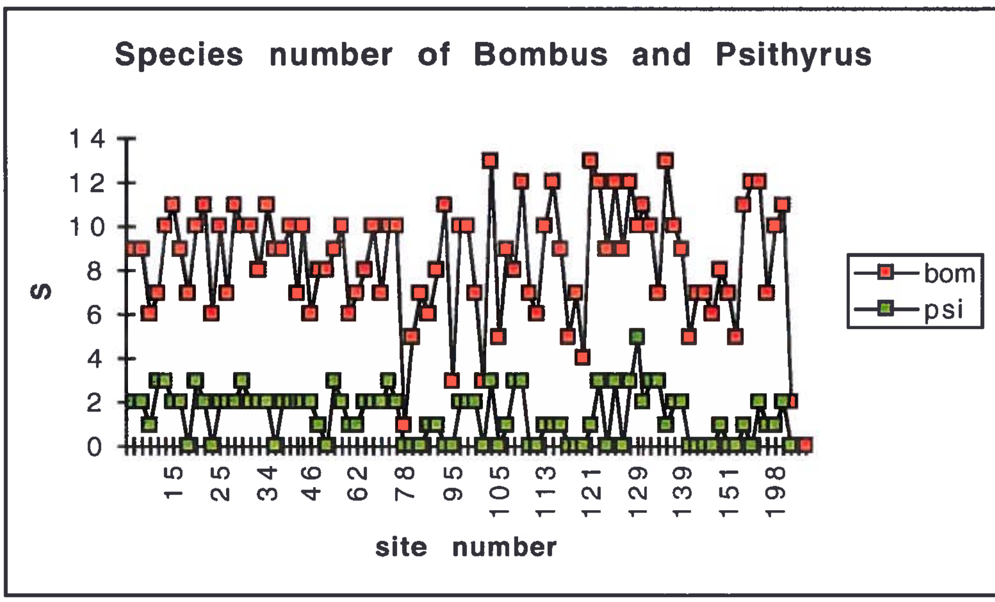

Fig.14. Species richness (S) of bumble bees (bom) and cuckoo bees (psi) in the monitoring sites in 1997

Alpha-diversity

Alpha-diversity (ln) values (cf. Taylor et al. 1976) for the sites ranged between 2–32, the values being low because of rather few species and high individual numbers. Of the driving variables for alpha-diversity, the species number (S) is very dependent upon the number of hoverfly species. On the other hand, the individual number (N) is very much controlled by hoverfly migrants in the south and bumble bee workers in the north. Thus alpha-diversity does not tell so much about pollinator diversity as different factors affect the calculated values in different parts of the study area.

Resource partitioning

There are many studies on the number of bumble bee species that can coexist and compete for food resources at the same site. A number of 4 dominating species (one short-tongued, one medium-tongued, one long-tongued and one robber species) have been set forward (Inouye 1977) on the basis of pollination functionality, but several other figures have been presented as well, like 7 by Pyke (1982), 6–11 by Ranta & Vepsäläinen (1981), 7 by Pekkarinen (1984), Teräs (1985) and 7 by Hanski (1982) based on the core-satellite species hypothesis. In most of the last mentioned articles the lower limit of 3% abundance has been used as a criterion. The material from 1997 was used to analyse how many species coexist if the 3% abundancy criterion is used on the trap captures (Fig.15).

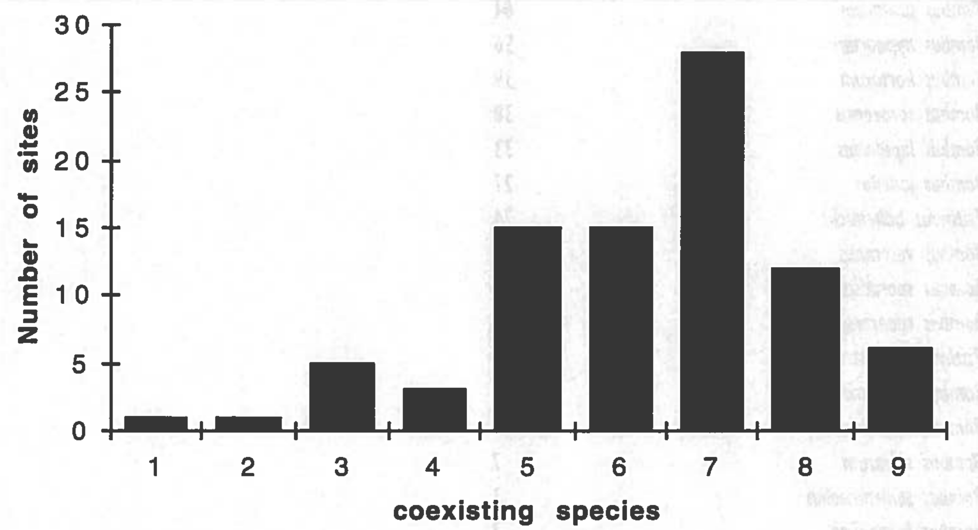

Fig.15 Distribution of number of coexisting bumble bee species (>3% of capture) in 1997.

The results show that a coexistence between 5–8 species is common, with a peak for 7. The maximum number is 9, which is less than 11 presented by Ranta & Vepsäläinen. There are some places with low coexistence values, many of these caused by the fact that the number of recorded species was very low, e.g. in subarctic areas of Lapland, in the south-western archipelago of Finland, in the north-western archipelago of Estonia and the spit and dune areas in Lithuania and Latvia. Also urban areas and areas close to large bog complexes showed small coexistence values affected by low number of recorded species.

Despite this, one would expect the curve to be more evenly distributed. The values given by Ranta & Vepsäläinen can be regarded as extremes in an even distribution, viz. the lower value 5 represents arbitrary biotopes with only common eurytopic species and the higher value 11 luxurious grassland biotopes with enough large population also of stenotopic species. The monitoring samples would thus indicate loss of competition of stenotopic species in the best foraging biotopes and a shift to decline of more common species even in arbitrary biotopes, as may be based on the negative skewness of the curve. The loss of resource partitioning is strong in some areas of investigation, i.e. in southwestern and western part of inland Finland as well as in Estonia and in parts of Russia. This is a result of changed land management in these areas creating agricultural areas with monocultures and overgrown fields that cannot support a natural variety of bumble bees any more.

The flexibility of the species to adapt to different habitats can be analysed on the basis of the 3% criterion (table 8). A flexible species can compete for resources in many of the monitoring sites, whereas less flexible species can only compete when the environmental factors are optimal for them. As can be seen there are only 4 species that appear to be able to compete for resources in half of all sites, 8 species that can compete in < 10% of the sites and an additional 8 species that cannot succesfully compete anywhere.

Table 8. Number of sites of *Bombus* and *Psithyrus* species in 1997 based on the > 3% criterion. Maximum number of sites is 86.

SPECIES	Sites of successful competition in 1997
Bombus lucorum	77
Bombus pascuorum	76
Bombus pratorum	64
Bombus hypnorum	56
Bombus hortorum	39
Bombus soroeensis	38
Bombus lapidarius	33
Bombus jonellus	27
Psithyrus bohemicus	24
Bombus veteranus	22
Bombus sporadicus	18
Bombus ruderarius	14
Psithyrus sylvestris	12
Bombus terrestris	12
Bombus schrencki	10
Bombus sylvarum	7
Bombus semenoviellus	3
Bombus lapponicus	3
Bombus cryptarum	2
Bombus balteatus	2
Bombus subterraneus	1
Bombus distinguendus	1
Bombus monticola	1
Bombus magnus	0
Bombus cingulatus	0
Bombus muscorum	0
Psithyrus flavidus	0
Psithyrus rupestris	0
Psithyrus norvegicus	0
Psithyrus campestris	0
Psithyrus barbutellus	0

In studying the domination of bumble bee species, a cumulative approach has been used according to which those species which fall within 50% cumulative abundancy starting from the most commonest one (each species represented by at least 10 individuals in the captures) are regarded as dominating. This gives the possibility for detecting the strongest competitors as well. Of all sites in 1997 only two had 4 species within the 50% cumulative range, 19 sites had 3 species, 50 sites had 2 species and 15 sites had only one species. A majority of the sites with two dominating species had the combination of *B.lucorum-B.pascuorum*. When competition proceeds to only one remaining species, *B.lucorum* is usually the one left. Notable is that as many as 42 different combinations of species were found to fit the 50% cumulative abundancy criterion.

8.2 Qualitative Aspects of Pollinator Diversity

Qualitative aspects of pollinator diversity are difficult to approach. The bionomy of different species must be well known as well as their distribution. In developing habitat-oriented quality indices, the used criteria must be discriminative and can be based on both presence/absence of character species and indicator species.

Since the yellow-traps were placed in ecotones between forest stands and grasslands (fields or meadows) their capture can reflect the fauna of both of these habitats. An attempt to produce criteria and scoring for valuable forest and grassland habitats is presented in tables 8 and 9. Putting the scores together the sum may also reflect the quality of the forest edge itself.

The criteria were tested for all of the sites in the pilot monitoring. The results are shown in Fig 16. It appears that the criteria for forests work well for the sites. For grasslands there is still need to improve the criteria, because there were more sites scoring 1 than 0 (often because of extensive presence of at least one solitary wasp species). Many sites that scored high for one of the habitats also scorded high or relatively high for the other. This implies that high quality habitats are preserved in larger complexes of landscapes, e.g. traditional agricultural landscapes, nature reserves etc.

The high-scoring sites for forests were (nature reserves and national parks have been emphasized in bold):

Petroskoi Kiwach (10), Kontiolahti Romppala (8), Kannus Kitinkangas (8), **Varena Cepkeliai** (7), **Kuhmo Viiksimo** (7), **Plunge Plateliai** (6), Sakiai Lekeciai (6), Maaninka Halola (6), Pori Ahlainen (6), **Espoo Nuuksio** (6), Liepaja Virga (5), **Taurage Eiciai** (5), **Paltamo Melalahti** (5), Paltamo Mieslahti (5), Eno Kirjovaara (5), Tohmajärvi Kemie (5), Hanko Täktom (5), **Kuru Seitseminen** (5),

Table 9. Criteria matrix for evaluating forest habitat quality.

Criteria (presence of)	Scores	Indication
> 28 queens/year* of *Bombus lucorum, B.cryptarum, B.hypnorum, B.jonellus, B.schrencki*	1 per species	High potential for pollination of shrubs and forest berries
Bombus magnus, B.cingulatus	1 per species	Forest (dry/wet) that at least partly have preserved natural conditions
Andrena lapponica, A.fulvida, A.fuscipes, Colletes succinctus	1 per species	Good potential for pollinating woody species typical for dry forests
Species belonging to genera *Temnostoma, Sphecomyia, Spilomyia, Sphegina, Criorhina, Ferdinandea, Brachypalpoides*	1 per species	Decomposed stages of hardwood species present - features of virgin forests preserved
Species belonging to genera *Blera, Brachyopa, Myolepta, Xylota, Chalcosyrphus*	1 per genera	Standing dead trees, partly decomposed wood and stumps preserved - features of sustainable forestry present
Vespa crabro, Dolichovespula media, D.sylvestris	1 per species	Age and stem structure of forest is diverse
Species of Sphecidae nesting in decayed wood**	1 per genera	Diverse age and structure of woody material present

* the limit is based on the calculations in subchapter 7.1, indicating a total population of about 700 individuals/hectare

** *Pemphredon lugubris, P.montanus, P.lugens, P.flavistigma, Ectemnius cavifrons, E.lapidarius, E.dives, Lestica clypeata, Crossocerus podagricus, C.annulipes, C.heydeni, C.leucostomus, C.vagabundus, C.dimidiatus* and the high-scoring sites for grasslands were (nature reserves and national parks have been emphasized in bold):

Kannus Kitinkangas (9), Maaninka Halola (9), Liepaja Virga (7), Kaunas Dubrava (7), **Varena Cepkeliai** (7), Sakiai Lekeciai (6), Kontiolahti Romppala (6), Pori Ahl-ainen (6), **Kuru Seitseminen** (6), **Lumanda Viidumäe** (5), **Liepaja Pape** (5), **Liepa-ja Pape Koni** (5), **Plunge Plateliai** (5), **Taurage Eiciai** (5), **Utena Rugskelistes** (5), **Petroskoi Kiwach** (5), Suonenjoki Käpylä (5), **Kuopio Pieni Neulamäki** (5), **Es-poo Nuuksio** (5).

Table 10. Criteria matrix for evaluating quality of grassland habitats.

Criteria (presence of)	Scores	Indication
>28 queens/year* of *Bombus pascuorum, B.soroeensis, B.distinguendus*	1 per species	High coexistence and potential for pollinating both economic crops and flowers of meadows
Psithyrus barbutellus, P.campestris, P.globosus	1 per species	Viable populations of host species important for pollination of flower meadows
Narrow oligolectic bee species (excl.oligolectics on *Salix*)	1 per species	Diverse and viable populations of certain vascular plant groups typical for rich meadows
Species belonging to genera *Ancistrocerus, Symmorphus, Euodynerus*	1 per genera	Features of traditional agricultural landscapes have been preserved
Species belonging to genera *Eristalis (non-migratory), Eristalinus, Rhingia*	1 per genera	Traditional cattle-breeding is preserved (grazed land)
Inquiline species of wild bees	1 per species	Viable nesting of host species in microclimatically and edaphically suitable places
Xanthogramma pedissequum, X.festivum, Doros profuges	1 per species	Complex ecological relationships on grazed/harvested fields

* see above

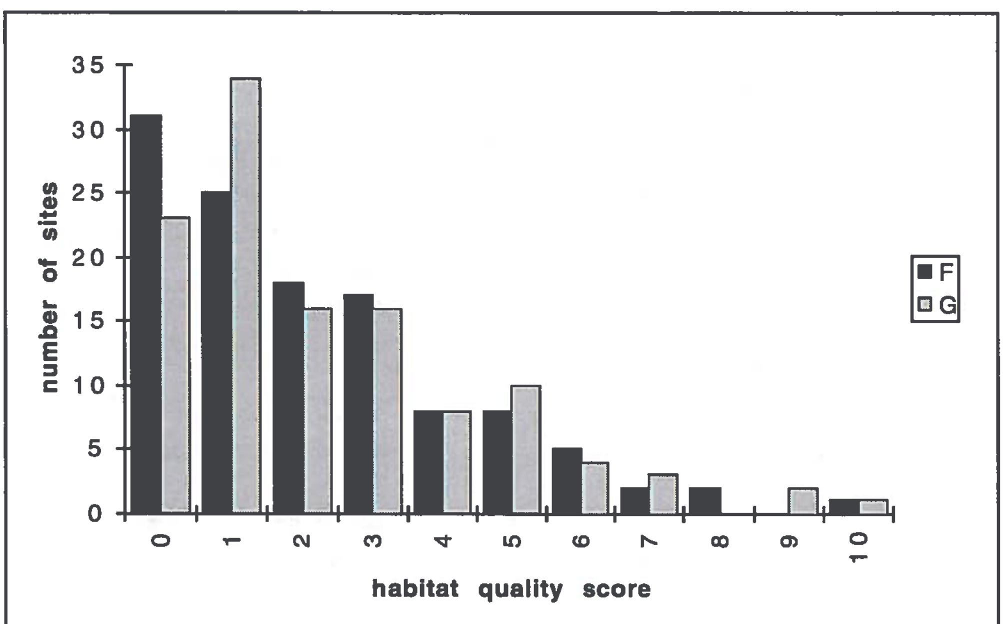

Fig. 16 Habitat quality scores of sites for forests and grasslands based on species indications in the 1997–98 pollinator trap material. F = forest score, G = grassland score.

8.3 Effects of Land Use

Protected and non-protected areas

Differences in species richness between protected and non-protected areas were small. In Finland the average trapped number of species of sites within protected areas was 26 (range 8–55) and in economically used areas 30 (range 9–56).

Managed and abandoned grasslands

A comparison between managed and abandoned grassland habitats were conducted by choosing two close lying sites (interspaced 1 km) representing these habitats in Paltamo, Kainuu. In Viilo (site 199, Fig.17) the grassland has been grazed by cattles between June–August during the last five years (including the two monitoring years), whereas in Ellukka (site 73, Fig.18) the grazing was abandoned 10 years ago and is now been recovered to a high-herb meadow (Leinonen 1998, unpublished manuscript).

The comparison shows that the difference in species number of different pollinator groups is not very pronounced, but that individual numbers in the captures differ greatly in advance for abandoned grassland (table 11). This is because abandoned grassland provides better foraging ground than cattle-grazed pastures. However, there are always a few specimens of the main foraging population seeking for new resources outside the core habitat and some of these deriving from the abandoned grassland may be captured by yellow-traps in the managed grassland, whereby the difference in species numbers are reduced. The comparison indicates that managed grasslands are poor habitats for pollinators, but in the long turn, a periodical rotation between managed and abandoned areas are probably necessary in order to keep the biodiversity at a sustainable level.

Table 11. Comparison between pollinator captures in managed (cattle grazed) and abandoned grassland in Paltamo Melalahti 1997–98.

Group	Abandoned grassland	Managed grassland
Social bees, species	16	15
Social bees, individuals	1622	657
Solitary bees, species	2	2
Solitary bees, individuals	6	10
Social wasps, species	6	5
Social wasps, individuals	94	62
Solitary wasps, species	2	0
Solitary wasps, individuals	4	0
Hoverflies, species	31	27
Hoverflies, individuals	231	63
Other groups, species	2	0
Other groups, individuals	2	0

Fig. 17. The cattle-grazed grassland in Viilo (photo Reima Leinonen, 29.8.1997)

Fig. 18. The abandoned grassland in Ellukka showing the invaded high-grown herbs (photo Reima Leinonen, 29.8.1997).

9

Discussion and Conclusions

9.1 Yellow-trapping as a Monitoring Technique

The following general results from the pilot monitoring can be drawn:

1) The method can be regarded as operative and not subjected to human artefacts, which is a presumption for long-term monitoring.

2) The method works best for the polylectic social bees (queens) and (indirectly) for social wasps, for which within-species comparions from year to year apparently can be made. For solitary bees, only species foraging in spring and late autumn may be followed-up on an annual basis as they are abundantly attracted to yellow colour, whereas comparisons of summer species, often visiting other coloured flowers, require longer periods to be used (e.g. 3 year rolling averages). If hoverflies, in particular aphidophagous species, are to be addressed properly, Malaise-traps will perform better than yellow-traps. For other groups, the method does not seem to be enough efficient in providing information on local faunas, except perhaps for digger wasps.

3) Between-species relationships can be analysed for the social groups, but the high proportion of oligolectics and inquilines in solitary bees affects this relationship so much, that realistic comparisons do not come out valid for these.

Despite the above mentioned restrictions of the technique, yellow-trapping of pollinators is a promising method for monitoring state and abundance of species in this key-group as well as for assessing quantitative and qualitative diversity of herb-rich grasslands and restoration of agricultural landscapes. The following parameters are of interest in long-term monitoring:

- total species number of social bees
- number of resource partitioning bumble bee species
- total number of queens of bumble bees
- total species number of solitary bees
- species number of oligolectic bees
- ratio inquilines/host species of social and solitary bees
- habitat quality indices for grasslands and forests

The last mentioned parameter requires the analysis of hoverflies, social and solitary wasps, and digger wasps in the monitoring samples in future as well.

9.2 Changes in the Fauna and Species Abundancy

There appear to be quite many changes in the social bee fauna in the area if compared to older data. At least two continental bumble bees are expanding northwards, *B.veteranus* and *B.schrencki*. On the other hand, several species appear to have declined much, such as *B.humilis*, *B.muscorum* and *B.ruderarius*. All of these species build nests on the ground and are local in their occurrence today. Although other bumble bees seem to have maintained their range of distribution, an alarming fact is that the populations (number of colonies) of many common bumble bees have declined in the central and southwestern parts of Finland where land management changes have been most intensive. The same holds true, at least for large parts of northern Eastern Baltics as well. One result of this is reflected in the scarcity of their inquilines, e.g. *P.quadricolor* (not recorded), *P.barbutellus* (two sites only), *P.rupestris* (very few sites), *P.norvegicus* (one site only) and *P.campestris* (two sites in Finland and a few south of the Gulf of Finland).

The material on solitary bees is yet too small for any general conclusions about their status. However, certain oligolectic bee species have become quite rare and classified in need of surveillance (Komiteamietintö 1991) and in a few cases their distribution have been reduced (Pekkarinen & Teräs 1998). Inquilines of many solitary bee species have become very rare, as they like the cuckoo bees require a large enough metapopulation of host nests to survive. Comparisons with elder records imply that some formerly widespread and common species appear to have become rarer in Eastern Fennoscandia although there still are plentiful food sources left. Solitary bees usually need little space for nesting, but some nest in large aggregates that need suitable sandy and open areas. Some of these nest-aggregating species have become rarer, at least in Finland, because of extensive extraction of mineral soil resources. It may be argued that the trapping technique is not fully capable of monitoring solitary bee populations, but on the other hand, many species were captured by the traps, and there are evidence of quite large captures with yellow-traps in other regions of Europe (Ortiz-Sanchez 1995). According to Monsevicius (pers.comm.) large captures of solitary bees might require the placing of yellow-traps closer to the ground in open terrain.

There is at least three social wasp species that have become more common in the monitoring area: *Vespa crabro*, *Vespula germanica* and *Dolichovespula media*. The two firstmentioned are still rare in Fennoscandia, but the colonies in the southern parts have grown stronger. The last mentioned wasp species (*D.media*) appears to have become more common in the forest landscapes in Finland and is expanding along the eastern border northwards. On the other hand, the paper-wasp *Polistes nimpha* is perhaps extinct from the area today (may still occur in Russian Karelia) and *Dolichovespula sylvestris* is becoming rarer based on the data from the trap samples.

As the previous knowledge on the distribution and abundancy of hoverflies is very incomplete, and as the monitoring results show that hoverflies are not particularly well attracted to yellow-traps in high numbers (except for some migratory species), very little can be concluded about the change of their distribution and abundancy. Specimens of the genus *Eristalis* were scarce all over and even if the species prefer white flowers, their numbers were still very low. This can be interpreted to be a result of changed agriculture policy (with reduction in cattle-breeding and loss of pastures) and improved environmental performanence (reduce of spread of sludge and manure on the fields). Although the most threatened hoverfly species have saproxylic larvae that require decaying wood, surprisingly many records of these species were made in the pilot monitoring. In particular, the new finds of *Sphecomyia vespiformis* and *Temnostoma apiforme* show that at least these species may not be in as high danger for extinction as earlier assessed.

10

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Literature

Alanen, A. 1997. Maaseudun mansikkapaikat – muistojako vain? Luonnon Tutkija 100(5): 197–208.

Balevicius, K.(ed.) 1992. Lietuvos raudonoji knyga. Red Data Book of Lithuania. Environmental Protection Department of the Republic of Lithuania. Vilnius,1992.

Banaszak, J. 1995. Natural resources of wild bees in Poland and an attempt at estimation of their changes. in Banaszak (ed.). Changes in Fauna of Wild Bees in Europe. Pedagogical University.Bydgoszcz 1995.

Bartsch, H., Hellqvist, S. & Sörensson, M. 1998. Nya fynd av getinglik blomfluga *Sphecomyia vespiformis* (Diptera, Syrphidae), tidigare ansedd som utdöd. Natur i Norr 17:53–60.

Bringer, B. 1973. Territorial flight of bumble-bee males in the coniferous forests on the northernmost part of the island of Öland. Zoon, Supplement 1.

Dathe, H.H. 1980. Die Arten der Gattung *Hylaeus* in Europa. Mitteilungen Zoologisches Museums Berlin 56:207–294.

Duhayon, G. 1992. Effectifs et densite' des populations de grands Apoides (Hymenoptera, Apoidea: *Bombus, Xylocopa, Habropoda*) de sud de la France: mise au point d'une me'thode d'estimation. Me'moire, Universite' de Mons-Hainaut, 121 pp.

Duhayon, G. 1993. Dynamique des populations de *Pyrobombus pratorum* (L.)(Hymenoptera, Apidae) au Plateau des Tailles. M'emoire de 3'eme cycle. Universite' Catholique de Louvain. 46 pp.

Falk, S. 1991. A review of the scarce and threatened bees, wasps and ants of Great Britain. Research and Survey for Nature Conservation 35:1–344.

Ehnström, B., Gärdenfors, U. & Lindelöw, Å. 1993. Rödlistade evertebrater i Sverige 1993. Databanken för hotade arter. Uppsala

Elfving, R.1960. Die Hummeln und Schmarotzerhummeln Finnlands. Fauna Fennica 10:1–43.

Elfving, R. 1965. *Bombus semenoviellus* Skor. (Hym.,Apoidea) in Finnland gefunden. Notulae Entomologicae 45:101–104.

Elfving, R.1968. Die Bienen Finnlands. Fauna Fennica 21:1–69.

Forsius, R. 1935. Enumeratio Insectorum Fenniae II.Hymenoptera.1 Symphyta et Aculeata.

Free, B. 1993. Insect pollination of crops. Academic Press, London, 684 pp.

Hanski, I. 1982. Communities of bumblebees: testing the core-satellite species hypothesis. Annales Zoologici Fennici 19:65–73.

Inouye, D.W. 1977. Species structure of bumblebee communities in North America and Europe. in Mattson, J.W. (edit.) The role of arthropods in forest ecosystems: 35–40. Springer. New York.

Komiteamietintö 1991:30. Uhanalaisten eläinten ja kasvien seurantatoimikunnan mietintö. Helsinki.

Kosior, A. 1995. Changes in the fauna of bumble-bees (*Bombus* Latr.) and cuckoo-bees (*Psithyrus* Lep.) of selected regions in southern Poland. in Banaszak (ed.). Changes in Fauna of Wild Bees in Europe. Pedagogical University.Bydgoszcz 1995.

Kullberg, J. 1995.

La Salle & Gauld. 1993. Hymenoptera and Biodiversity. The Natural History Museum. CAB International. Wallingford, 348 pp.

Lilleleht, V. (ed.) 1998. Eesti Punane Raamat. Eesti Teaduste Akadeemia. Tartu.

Lomholdt, O. 1977. De danske blodbier, *Sphecodes* (Hymenoptera, Apidae). Entomologiske Meddelerser 45:99–108.

Lomholdt, O. 1984. The Sphecidae (Hymenoptera) of Fennoscandia and Denmark. Fauna Entomologica Scandinavica vol.4 (2nd edition), 442 pp.

Löken, A. 1973. Studies on Scandinavian Bumble Bees (Hymenoptera, Apidae). Norsk Entomologisk Tidsskrift 20:1.

Mikkola, K. 1978. Spring migrations of wasps and bumble bees on the southern coast of Finland (Hymenoptera, Vespidae and Apidae). Annales Entomologici Fennici 44: 10–26.

Mikkola, K. 1984. Migration of wasp and bumble bee queens across the Gulf of Finland (Hymenoptera: Vespidae and Apidae). Notulae Entomologicae 64:125–128.

Mikkola, K. 1986. Direction of Insect Migrations in Relation to the Wind. In Danthanarayana, W. (ed.) Insect Flight. Dispersal and Migration: 152–171. Springer Verlag, Berlin–Heidelberg–New York–London–Paris–Tokyo, 289 pp.

Monsevicius, V. 1995. A check-list of wild bee species (Hymenoptera, Apoidea) of Lithuania with data to their distribution and bionomics. Institute of Ecology. Lithuanian Entomological Society. Vilnius,1995.

Morgan, D. 1984. Cuckoo-Wasps (Hymenoptera, Chrysididae). Handbooks for the identification of British insects Vol.6:part 5.

Mueller, A., Krebs, A. & Amiet, F. 1997. Bienen. Mitteleuropeische Gattungen, Lebensweise, Beobachtung. Natur Buch Verlag. Munchen, 384 pp.

Noskiewicz, J. 1936. Die paläarktischen *Colletes*-Arten. Prace naukowe wydasnictzoo towarzystwa naukowege we Lwowie 3: 1–532.

Ortiz-Sanchez, F.J. 1995. Diversity of bees (Hymenoptera, Apoidea) in several Spanish ecosystems. in Banaszak (ed.). Changes in Fauna of Wild Bees in Europe. Pedagogical University.Bydgoszcz 1995.

O'Toole, C. 1993. Diversity of Native Bees and Agroecosystems. In La Salle & Gauld. 1993. Hymenoptera and Biodiversity: 169–196

Pamilo, P.,Varvio-Aho, S. & Pekkarinen, A. 1984. Genetic variation in bumblebees (*Bombus, Psithyrus*) and putative sibling species of *Bombus lucorum*. Hereditas 101:245–251.

Pamilo, P., Tengö, J., Rasmont, P., Pirhonen, K., Pekkarinen, A. & Kaarnama, H. 1997. Pheromonal and enzyme genetic characteristics of the *Bombus lucorum* species complex in northern Europe. Entomologica Fennica 7:187–194.

Pekkarinen, A. 1973. Suomen yhteiskunta-ampiaisista (Vespidae). Luonnon Tutkija 77:12–19

Pekkarinen, A. & Teräs, I.1977. Suomen kimalaisista ja loiskimalaisista. Luonnon Tutkija 81:1,1–24.

Pekkarinen, A. 1979. Morphometric, colour and enzyme variation in bumblebees (Hymenoptera, Apidae, *Bombus*) in Fennoscandia and Denmark. Acta Zoologica Fennica 158:1–60.

Pekkarinen, A., Teräs, I., Viramo, J. & Paatela, J. 1981. Distribution of bumblebees (Hymenoptera, Apidae: *Bombus* and *Psithyrus*) in eastern Fennoscandia. Notulae Entomologicae 61:71–89.

Pekkarinen, A.1982a. *Eumenes* species in eastern Fennoscandia (Hymenoptera, Eumenidae). Notulae Entomologicae 62:43–50

Pekkarinen, A. 1982b. Morphology and specific status of *Bombus lapponicus* (Fabricius) and *B.monticola* Smith (Hymenoptera: Apidae). Entomologica Scandinavica 13: 41–46.

Pekkarinen, A. 1984. Resource partitioning and coexistence in bumblebees (Hymenoptera, Bombinae). Annales Entomologici Fennici 50: 97–107.

Pekkarinen, A. & Teräs, I. 1986. Melanism in *Bombus veteranus* and *B.soroeensis* (Hymenoptera:Apidae) in southern Finland. Notulae Entomologicae 66:49–53.

Pekkarinen, A., Teräs, I. & Wuorenrinne, H. 1987. Suomen myrkkypistiäislajien taantuminen ja uhanalaisuus. Luonnon Tutkija 91:124–129.

Pekkarinen, A. 1988. Species of the genera *Odynerus, Gymnomerus, Stenodynerus, Euodynerus* and *Pterocheilus* (Hymenoptera, Eumenidae) in eastern Fennoscandia. Notulae Entomologicae 68:135–140.

Pekkarinen, A. 1989. The hornet (*Vespa crabro* L.) in Finland and its changing northern limit in northwestern Europe. Entomologisk Tidskrift 110:161–164.

Pekkarinen, A. & Hulden, L. 1991. Distribution and phenology of the *Ancistrocerus* and *Symmorphus* species in eastern Fennoscandia (Hymenoptera, Vespidae).Entomologica Fennica 2.

Pekkarinen, A. & Kaarnama, E. 1994. *Bombus terrestris* auct. new to Finland (Hymenoptera, Apidae). Sahlbergia 1:11–13.

Pekkarinen, A. & Hulden, L. 1995. Distribution and phenology of of the Vespinae and Polistinae species in eastern Fennoscandia (Hymenoptera: Vespidae). Sahlbergia 2: 99–111.

Pekkarinen, A. 1998. Oligolectic bee species in Northern Europe (Hymenoptera,Apoidea). Entomologica Fennica 8:205–214.

Pekkarinen, A. & Teräs, I. 1987. Observations on *Bombus humilis* (Hymenoptera; Apoidea) in Finland. Notulae Entomologicae 67:208–209.

Pekkarinen, A. & Teräs, I. 1993. Zoogeography of *Bombus* and *Psithyrus* in northwestern Europe (Hymenoptera, Apidae). Annales Zoologici Fennici 30:187–208.

Pekkarinen, A. & Teräs, I. 1998. Mesipistiäiset – kasviemme tärkeimmät pölyttäjähyönteiset. Luonnon Tutkija 102 (3): 88–102.
Pekkarinen, A. & Gustafsson, B. (submitted to Entomologica Fennica). The *Polistes* species in northwestern Europe (Hymenoptera: Vespidae).
Prys-Jones, O.E. & Corbet, S.A. 1991. Bumblebees. Naturalists' handbook vol.6. Richmond Publishing Co.Ltd.
Pyke, G.H. 1982. Local geographic distribution of bumblebees near Crested Butte, Colorado: competition and community structure. Ecology 63:555–573.
Ranta, E. & Vepsäläinen, K. 1981. Why are there so many species? Spatio-temporal heterogeneity and northern bumblebee communities. Oikos 36:28–34.
Rasmont, P. 1984. Les bourdons du genre *Bombus* Latreille sensu stricto en Europe occidentale et centrale. Spixiana 7:136–160.
Richards, O.W. 1980. Scolioidea, Vespoidea and Sphecoidea (Hymenoptera, Aculeata). Handbooks for the identification of British insects Vol.6:part 3b.
Rozkosny, R. 1973. The Stratiomyoidea (Diptera) of Fennoscandia and Denmark. Fauna Entomologica Scandinavica, vol.1, 140 pp.
Scheuchl, E. 1995. Illustrierte Bestimmungstabellen der Wildbienen Deutschlands und Österreichs. Bd.I. Anthophoridae. Eigenverlag, Velden.
Scheuchl, E. 1996. Illustrierte Bestimmungstabellen der Wildbienen Deutschlands und Österreichs. Bd.II. Megachilidae-Melittidae. Eigenverlag, Velden.
Schmid-Egger, C. & Scheuchl, E. 1997. Illustrierte Bestimmungstabellen der Wildbienen Deutschlands und Österreichs. Bd.III. Andrenidae. Eigenverlag, Velden.
Speight, M.C.D. 1989. Saproxylic invertebrates and their conservation. Council of Europe. Nature and Environment Series 42:1–82. Strasbourg.
Stackelberg, A.A. 1971. Family Syrphidae, in Bei-Bienko, G.A (ed.)1989. Keys to the Insects of the European Part of the USSR. Vol.5:2.
Svensson, B.G. 1979. *Pyrobombus lapponicus* auct., in Europe recognized as two species: *P.lapponicus* (Fabricius, 1793) and *P.monticola* (Smith, 1849) (Hymenoptera, Apoidea, Bombinae). Entomologica Scandinavica 10:275–296.
Söderman, G., Leinonen, R. & Lundsten, K-E. 1997. Monitoring bumblebees and other pollinator insects. Mimeograph Series of the Finnish Environment Institute 58.
Taylor, L.R, Kempton, R.A. & Woiwod, I.P. 1976. Diversity statistics and the log-series model. Journal of Animal Ecology 45:255–271.
Teräs, I. 1979. Om humleindividernas blombesök. Entomologisk Tidsskrift 100:165–167.
Teräs, I. 1985. Food plants and flower visits of bumblebees (*Bombus*:Hymenoptera, Apidae) in southern Finland. Acta Zoologica Fennica 179.
Teräs, I. & Pekkarinen, A. 1992. Myrkkypistiäiset muuttuvassa Suomessa. Biological Research Report of the University of Jyväskylä 25: 131–140.
Torp, E. 1994. Danmarks Svirrefluer (Diptera:Syrphidae). Danmarks Dyreliv 6. Apollo Books. Stenstrup.
Warnke, K. 1992. Die westpaläarktischen Arten der Bienengattung *Sphecodes*. Berichte Naturfreunde Gesell schaft von Augsburg 52:9–64.
Westrich, P. 1990. Die Wildbienen Baden-Wurttembergs I–II.2nd edition. Verlag Eugen Ulmer, Stuttgart. 972 pp.
Williams, I.H. 1996. Aspects of bee diversity and crop pollination in the European Union. In Matheson, A., Buchmann, S.L., O'Toole, C., Westrich, P. & Williams, I.H. (ed.). The conservation of bees. Academic Press, London, 63–80.
Witt, R. 1998. Wespen beobachten, bestimmen. Natur Buch Verlag, Augsburg, 360 pp.
Wolf, H. 1967. Wegwespen (Hym.Pompiloidea) Finnlands. Acta Entomologica Fennica 23:1–45.
Wolf, H. 1972. Hymenoptera Pompilidae. Insecta Helvetica 5.
Zapetal, F. 1961. Über die Domestikation von Hummeln. Archiv fur Geflugelzucht und Kleintierkunde, 10 (4).

Annex 1. Pollinator Monitoring Sites 1997–98

Reg	Siteno	Status	Commune	Sitename	Coordinates	Biotope/ecotone	Selection criteria	Period 1997	Period 1998
EE02	109	EA	Keila	Kloogaranna	5922:2416	Deciduous forest/garden	Economic marginal forest	1.4...2.11	19.4...11.10
EE05	105	NA	Tooma	Endla	5849:2614	Bog margin/dry meadow	Nature Reserve	21.4...26.10	12.7…11.10
EE07	80	NA	Lahemaa	Palmse	5928:2557	Deciduous forest/dry meadow	National Park	23.4...5.10	12.4...10.10
EE11	104	EA	Märjamaa	Jalase	5854:2437	Wooded meadow	Traditional landscape area	14.4...2.11	12.4…1.11
EE12	120	NA	Lumanda	Viidumäe	5817:2206	Wooded meadow	Nature Reserve	28.4...2.11	19.4...10.10
EE12	78	NA	Vilsandi	Suur-Vilsandi	5822:2204	Grassy shore meadow	National Park	22.6...24.8	26.4...11.10
EE13	79	EA	Elva	Elva suburb	5813:2624	Garden	Economic forest area	14.4...4.11	1.6...11.10
EE14	106	EA	Puka	Röömu	5801:2612	Garden	Traditional landscape area	14.4...2.11	5.4...11.10
FI01	219	NA	Kirkkonummi	Mäkiluoto	6640:3500	Rocky brushwood	Migration research area		6.5...9.10
FI01	65	NA	Hanko	Tulliniemi	6640:3270	Deciduous forest/rocky pine forest	Nature Reserve		25.4...21.10
FI01	139	NA	Hanko	Täktom	6642:3281	Humid pine forest/reedy shore meadow	Nature Reserve	13.4...26.9	25.4...21.10
FI01	1	NA	Hanko	Tvärminne	6642:3289	Rocky forest/dry meadow	Nature Reserve		1.5...30.10
FI01	149	EA	Inkoo	Tähtelä	6668:3335	Garden/cropland margin	Economic agriculture area	20.4...26.9	20.4...13.10
FI01	134	EA	Tammisaari	Etelä-Kuivasto	6670:3270	Rocky pine forest/reedy shore	Margin of Nature Reserve	6.5...26.9	
FI01	214	EA	Tammisaari	Bromarv	6659:3278	Mixed forest/dry meadow	Forestry research area		9.5…31.10
FI01	89	EA	Espoo	Mäkkylä	6682:3380	City garden	Urban area/detached houses	27.4...11.10	26.4...11.10
FI01	95	EA	Helsinki	Tapaninkylä	6683:3391	City garden	Urban area/semidetached houses	27.4...20.9	
FI01	140	EA	Sipoo	Nikkilä	6690:3400	Garden/cropland margin	Economic agriculture area	20.4...20.9	1.5...22.8
FI01	107	NA	Espoo	Nuuksio Kattila	6693:3361	Mixed forest/dry meadow	National Park	27.4...10.10	23.4...17.10
FI01	204	EA	Nurmijärvi	Lepsämä	6702:3370	Cropland margin	Environment-friendly agriculture		25.5...4.10
FI02	133	EA	Lemland	Västeränga	6675:3116	Oak forest/garden	Economic agriculture area		26.4...7.11
FI02	68	NA	Dragsfjärd	Örö	6642:3238	Mixed forest/shore meadow	National Park	9.5...10.8	17.5…30.9
FI02	7	NA	Finström	Husö	6707:3104	Garden/cropland margin	Economic agriculture area	14.4...27.10	…19.10
FI02	9	NA	Nauvo	Seili	6691:3221	Pine forest/dry rocky meadow	National Park		22.4…28.10
FI02	8	NA	Turku	Ruissalo	6713:3236	Wooded meadow	Nature Reserve	18.4...7.11	14.4…30.10
FI02	205	EA	Mietoinen	Saari	6724:3215	Cropland margin	Agricultural research area		14.4…6.11
FI02	216	NA	Huittinen	Vanhankoskenlehto	6791:3267	Deciduous forest	Nature Reserve		28.4...4.10
FI02	136	EA	Pori	Ahlainen	6858:3215	Dry meadow	Traditional landscape area	28.4...17.10	
FI02	11	NA	Pori	Reposaari	6847:3205	Dry meadow	Nature Reserve		22.4…28.10
FI03	3	EA	Jokioinen	Kirkonkylä	6750:3308	Garden/cropland margin	Agricultural research area	26.5...6.10	18.5...28.9
FI03	2	NA	Lammi	Pappilanniemi	6773:3394	Esker pine forest/cropland margin	Nature Reserve	14.5...19.9	1.5...28.10
FI03	210	NA	Hämeenlinna	Aulanko	6772:3360	Deciduous forest	Forestry research area		1.5…1.10
FI03	211	NA	Asikkala	Vesivehmaa	6779:3430	Pine forest	Economic forestry area		27.4...12.10
FI03	16	EA	Luopioinen	Kuohijoki	6801:3382	Cropland margin	Economic forestry area	26.5...25.9	17.5…30.8
FI03	15	NA	Tampere	Peltolammi	6820:3326	Clearing in small-leaved mixed forest	Nature Reserve	12.5...13.10	8.5…9.10
FI03	14	NA	Kuru	Seitseminen	6879:3309	Pine forest/slope meadow	National Park	15.5...23.10	24.4…9.10
FI04	18	NA	Pyhtää	Hirvivuolle	6719:3485	Mixed forest/garden	Margin of National Park	23.4...30.9	9.5...27.9
FI04	17	EA	Kouvola	Kangas	6751:3483	Fallowland	Suburban fabric area	5.5...19.9	1.5…5.10

Reg	Siteno	Status	Commune	Sitename	Coordinates	Biotope/ecotone	Selection criteria	Period 1997	Period 1998
FI04	70	EA	Joutseno	Kähärilä	6773:3580	Garden/cropland margin	Economic agriculture area	18.5...1.10*	10.5..18.10
FI04	20	EA	Imatra	Pelkola	6781:3598	Dry meadow	Economic forestry area	13.5...12.6*	
FI04	200	EA	Virolahti	Kirkonkylä	6700:3540	Mixed forest/garden	Economic forestry area		17.6…24.9
FI04	135	NA	Parikkala	Siikalahti	6835:3633	Garden	Nature Reserve	2.5...13.9	8.5...3.9
FI05	23	EA	Mikkeli	Karila	6840:3512	Garden	Economic agriculture area	26.5...5.10	1.5...27.9
FI05	96	EA	Juva	Huttula	6864:3547	Garden	Economic agriculture area	1.6...5.10	1.5...27.9
FI05	24	EA	Pertunmaa	Pankaharju	6822:3472	Garden	Economic agriculture area		1.6...27.9
FI06	26	EA	Suonenjoki	Käpylä	6948:3503	Pine forest/cropland margin	Economic agriculture area	21.4...27.10	27.4...26.10
FI06	25	EA	Maaninka	Halola	7004:3516	Mixed forest/improved grassland	Economic agriculture area	29.4...6.10	6.5…6.10
FI06	27	EA	Kiuruvesi	Hingunniemi	7061:3483	Pine forest/lake-shore pasture	Traditional landscape area	11.5...10.10	
FI06	212	MA	Kuopio	Pieni Neulamäki	6922:3528	Small-leaved deciduous forest	Nature Reserve		27.4..2.11
FI07	31	EA	Tohmajärvi	Kemie	6907:3674	Garden/cropland margin	Agricultural research area	16.4...17.10	8.5…12.10
FI07	30	NA	Ilomantsi	Mekrijärvi	6969:3702	Dry rocky meadow	Forestry research area	13.6...18.9	
FI07	220	NA	Ilomantsi	Petkeljärvi	6948:3714	Pine forest	Nature Reserve		18.5…23.9
FI07	29	EA	Joensuu	Kukkola	6942:3645	Cropland margin	Economic agriculture area		7.5..14.10
FI07	32	EA	Kontiolahti	Romppala	6989:3639	Cropland margin	Economic agriculture area		9.5…3.10
FI07	221	NA	Eno	Kirjovaara	6977:3673	Old spruce forest	Nature Reserve		11.5…24.9
FI08	34	EA	Ylistaro	Haapajyrä	6989:3271	Garden	Economic agriculture area	5.5...29.9	27.4…26.10
FI08	33	EA	Vaasa	Vanha Vaasa	7007:3232	Garden	Suburban fabric area	5.5...6.10	27.4…2.11
FI08	213	NA	Isojoki	Lauhanvuori	6903:3248	Pine forest	National Park		1.5...2.11
FI09	41	NA	Korpilahti	Korospohja	6868:3433	Clearing in birch-alder forest	Nature Reserve	1.6...19.9	26.4...27.10
FI09	38	EA	Jyväskylä	Viitaniemi	6905:3434	Humid meadow/garden	Suburban fabric area	12.5...5.10	
FI09	222	EA	Jyväskylä	Palokka	6909:3433	Cropland margin	Economic agriculture area		1.6...21.9
FI09	217	NA	Jyväskylä mlk	Jääskelä	6899:3441	Deciduous forest	Nature Reserve		25.5..16.9
FI09	39	EA	Konnevesi	Siikakoski	6945:3466	Humid meadow	Economic forestry area	26.5...23.9	19.5…22.9
FI09	218	EA	Laukaa	Vuontee	6913:3447	Cropland margin	Agricultural research area		13.5..18.9
FI10	43	EA	Kannus	Kitinkangas	7092:3350	Garden	Economic forestry area	18.4...23.10	28.4…25.9
FI10	42	EA	Kokkola	Märaskär	7094:3300	Garden	Archipelago	18.4...19.9	28.4…30.10
FI10	44	EA	Haapajärvi	Hautakangas	7069:3418	Coniferous forest	Economic forestry area		4.5...18.9
FI11	74	NA	Liminka	Rehula	7191:3425	Fallowland	Economic agriculture area	1.5...21.10	14.4...20.10
FI11	46	EA	Hailuoto	Marjaniemi	7218:3385	Pine forest/dry meadow	Nature Reserve	9.5...19.9	8.5…18.9
FI11	47	EA	Pudasjärvi	Kurenalus	7250:3499	Garden	Economic forestry area	26.5...13.10	18.5...21.9
FI11	48	NA	Kuusamo	Liikasenvaara	7366:3613	Improved grassland	National Park	1.6...9.9	8.6…14.9
FI12	72	NA	Kuhmo	Rajakangas	7094:3662	Pine-spruce forest/garden	Economic forestry area	24.4...19.9	24.4...26.9
FI12	97	EA	Sotkamo	Naapurivaara	7121:3560	Pasture	Traditional landscape area	24.4...18.9	17.4...25.9
FI12	50	EA	Kuhmo	Viiksimo	7133:3664	Fallowland	Economic forestry area	25.4...19.9	24.4...26.9
FI12	53	EA	Paltamo	Mieslahti	7144:3548	Alder stand/garden	Economic agriculture area	22.4...18.9	17.4...25.9
FI12	73	NA	Paltamo	Melalahti	7145:3532	Aspen stand margin/humid meadow	Traditional landscape area	3.5...19.9	17.4...26.9
FI12	199	NA	Paltamo	Viilo	7146:3532	Pasture	Traditional landscape area	16.5...18.9	17.4...26.9
FI12	101	NA	Puolanka	Paljakka	7174:3551	Spruce forest/garden	Nature Reserve	25.4...19.9	24.4...25.9
FI13	63	EA	Tornio	Kalkkimaa	7314:3384	Humid fresh meadow	Economic agriculture area		28.5...18.

Reg	Siteno	Status	Commune	Sitename	Coordinates	Biotope/ecotone	Selection criteria	Period 1997	Period 1998
FI13	142	EA	Rovaniemi	Apukka	7379:3440	Cropland margin	Agricultural research area	1.6...26.9	8.5…9.10
FI13	59	EA	Rovaniemen mlk	Meltaus	7425:3423	Pine forest	Economic forestry area		20.5…21.10
FI13	76	EA	Sodankylä	Tähtelä	7475:3483	Pine forest	Economic forestry area		19.5…30.9
FI13	60	NA	Sodankylä	Tankavaara	7565:3504	Pine forest	National Park	4.6...13.8	2.6…15.10
FI13	64	EA	Kolari	Teuravuoma	7469:3607	Pine forest	Economic forestry area		18.5...12.10
FI13	143	NA	Muonio	Pallas Mustavaara	7560:3377	Subarctic birch forest	National Park	12.6...19.9	10.6…31.8
FI13	77	EA	Enontekiö	Hetta	7593:3363	Pine forest	Economic forestry area		4.6...8.10
FI13	62	NA	Enontekiö	Kilpisjärvi	7674:3253	Subarctic birch forest	Nature Reserve	18.6...1.10	4.6...8.10
FI13	61	EA	Inari	Sarmijärvi	7634:3504	Bog margin	Economic forestry area		27.5…7.10
FI13	145	NA	Utsjoki	Kevo	7741:3500	Subarctic birch forest	Nature Reserve	11.6...10.9	27.5…4.9
LT01	129	NA	Utena	Rugsteliskes Aukstatijos	5528:2601	Cropland margin	National Park	13.4...2.11	5.4...27.9
LT02	126	NA	Taurage	Eiciai Viesviles	5511:2228	Brushwood meadow	Nature Reserve	29.4...21.10	20.4...25.10
LT03	128	NA	Plunge	Plateliai Zemaitijos	5601:2156	Cropland margin	National Park	21.4...27.10	20.4…2.11
LT04	127	EA	Ukmerge	Kertusa	5508:2456	Cropland margin	Economic agriculture area	30.4...1.6*	26.4…30.9
LT06	131	EA	Kaunas	Dubrava	5451:2407	Cropland margin	Economic agriculture area	24.4...20.9	12.4...27.9
LT06	203	NA	Varena	Cepkeliai	5400:2430	Dry meadow	Nature Reserve		6.4…11.10
LT08	132	EA	Sakiai	Lekeciai	5459:2331	Cropland margin	Economic agriculture area	20.4...20.9	12.4…27.9
LT10	201	NA	Klaipeda	Smiltyne	5521:2106	Dune forest	Nature Reserve	1.5.2.11	30.3..1.11
LV12	197	EA	Kuldiga	Rudbarzi	5639:2153	Garden	Economic forestry area	21.4...22.10	13.4…24.10
LV13	113	NA	Liepaja	Pape Koni	5608:2102	Dune meadow	Nature Reserve	21.4...22.10	13.4…24.10
LV13	112	NA	Liepaja	Pape	5610:2102	Dry meadow	Nature Reserve	21.4...22.10	13.4…24.10
LV13	116	EA	Liepaja	Virga	5627:2126	Cropland margin	Economic agriculture area	21.4...22.10	13.4…24.10
LV13	115	EA	Liepaja	Grobina Vitini	5630:2105	Humid mixed forest margin	Economic agriculture area	21.4...22.10	14.4…24.10
LV20	118	EA	Riga	Purvciems	5657:2412	City garden	Urban area	21.4...24.10	20.4...22.10
LV20	119	EA	Riga	Carnikava	5707:2419	Garden	Economic agriculture area	21.4...25.10	10.4…31.10
LV22	198	NA	Talsi	Slitere	5738:2217	Sandy slope meadow	Nature Reserve	21.4...21.10	21.4…20.10
RU05	99	NA	Kostamus	Ehrimanvaara	6431:3014	Spruce forest/garden	National Park	20.5...16.9	13.5…1.10
RU10	108	NA	Petroskoi	Kiwach	6216:3430	Dry meadow/grassland	Nature Reserve	28.4...27.10	4.5…2.11
RU14	155	EA	Vuoksa	Marjaniemi	6042:2956	Mixed forest/garden	Economic forestry area	12.4...4.10	20.4…4.10
RU15	93	EA	Tosno	Kastenkaja	5925:3043	Clearing in mixed forest	Traditional landscape area	6.5...5.10	20.4...30.9
RU15	125	EA	Lomonosov	Bolchaja Izora	5958:2935	Fallowland/garden	Economic agriculture area	15.4...6.9	
RU16	94	EA	Kingisepp	Keikino	5927:2813	Brushwood/cropland	Economic agriculture area	22.4...5.10	18.4...26.9
RU16	122	EA	Kingisepp	Kurgolovo peninsula	5944:2805	Clearing in pine forest	Economic forestry area	22.4...21.9	19.4..12.9
RU17	121	EA	Sebez	Osyno	5609:2841	Alder stand/garden	Economic agriculture area	14.4...12.10	1.4…28.9
RU17	154	EA	Knjazevo	Nisha	5616:2844	Brushwood lake shore	Economic agriculture area	20.4...11.10	9.4…2.10
RU17	153	EA	Pskov	Murkovka	5748:2817	Garden	Economic agriculture area	10.5...27.9	11.4…3.10
RU20	152	EA	Kaliningrad	Kaliningrad suburb	5443:2029	Garden	Economic agriculture area	5.4...25.10	20.4…28.9
RU21	151	EA	Valdai	Valdai village	5800:3304	Garden/pasture slope	Forestry research area	1.5...28.9	17.4…30.9
		NA	Protected area		Finnish coordinates in YKJ				
		EA	Non-protected area		Baltic and Russian coordinates in lat-long				

Annex 2. Social Bees 1997-98

	FI-97		FI-98		EE-97		EE-98		LV-97		LV-98		LT-97		LT-98		RU-97		RU-98		AL	AB	AM
	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ			
APIDAE																							
Bombus soroeensis (F,1776)	1206	38	1288	49	128	5	28	3	29	7	151	6	257	5	159	8	76	7	80	6		*	
B.terrestris (L,1758)					2	2	1	1	35	5	28	5	36	7	33	5	15	4	4	2			
B.sporadicus Nylander,1848	1052	31	691	32													136	3	82	2			
B.lucorum (L,1761)	3907	48	2318	64	36	5	15	5	501	8	37	6	349	6	266	7	730	12	127	9	**	**	
B.cryptarum (F,1776)	31	2	673	48	6	2	1	1			4	2	4	3	88	7	2	2	57	6	*		
B.magnus Vogt,1911	3	3	172	10											16	2	6	1	9	2			
B.pratorum (L,1761)	3431	46	2677	61	33	3	33	4	30	5	12	4	119	6	208	8	268	8	292	7	*		
B.jonellus (Kirby,1802)	1196	40	1337	44	5	3	2	2	11	3	24	4	8	3	21	7	147	6	23	6			
B.semenoviellus Skorikov 1910			4	4	1	1					4	1	4	2	10	6	4	3	4	3			
B.lapponicus (F,1793)	54	4	246	8																			
B.monticola (Smith,1849)	1	1																					
B.hypnorum (L,1758)	2959	46	1562	63	5	2	7	5	14	5	4	3	31	6	34	7	285	9	199	9	**		
B.cingulatus Wahlberg 1849	8	6	33	10																			
B.lapidarius (L,1758)	289	24	341	31	35	5	10	5	21	5	21	6	12	4	28	5	69	7	48	6			
B.balteatus Dahlbom,1832	3	3	25	2																			
B.alpinus (L,1758)			1	1																			
B.polaris Curtis,1835			1	1																			
B.hortorum (L,1761)	463	40	322	52	30	4	18	4	20	8	19	5	32	5	60	7	49	11	22	5	*		
B.pascuorum (Scopoli,1763)	2107	46	3711	65	256	6	168	6	134	8	154	8	482	7	1193	8	481	12	255	9	**		*
B.muscorum (L,1758)	2	2													1	1							
B.humilis Illiger,1806											8	3	1	1	2	2							
B.schrencki Morawitz,1869					7	2	1	1	6	2	1	1	105	6	522	7	52	6	26	3			
B.sylvarum (L,1761)	9	3	12	3	19	3	22	2	28	4	63	6	1	1	13	5	15	6	18	5			
B.veteranus (F,1793)	273	27	215	25	13	3	32	2	14	3	2	2			7	4	92	9	29	8	*		*
B.ruderarius (Mueller,1776)	32	9	9	5	18	4	73	4	2	2	10	5			10	5	41	8	57	9			*
B.subterraneus (L,1758)	3	2											5	2			2	2			*		
B.distinguendus Morawitz,1869	24	7	12	8					1	1	1	1	1	1	2	2	1	1	1	1	*		
Psithyrus rupestris (F,1793)	1	1	1	1			1	1					2	2	1	1			2	1			
P.campestris (Panzer,1802)	1	1	1	1	3	2	1	1	1	1			11	3	12	3	1	1					
P.bohemicus (Seidl,1837)	530	36	586	49	1	1	2	1	10	2	10	4	89	5	115	7	141	7	106	5	*		
P.sylvestris (Lepeletier,1848)	493	33	390	38	2	1	5	1	1	1	1	1	33	4	22	4	50	4	21	6	*		
P.barbutellus (Kirby,1802)													1	1					1	1			
P.flavidus Eversmann,1853	15	9	101	15													7	2					
P.norvegicus S-Schneider, 1911													3	1									
A.mellifera L,1758	193	15	41	10	28	6	14	2	161	6	52	6	45	5	145	5	143	9	22	5	***		*
Total	18286		16770		628		434		1019		606		1631		2968		2813		1485				
Maximum		51		74		8		8		8		8		7		8		12		11			
Per site	359		227		79		54		127		76		233		371		234		135				

*** > 100 specimens
** 10-100 specimens
* < 10 specimens
AL = ad lucem
AB = ad bait
AM = in Malaise trap
N = specimens
FQ = sites recorded

Annex 3. Solitary bees 1997-98

	FI-97		FI-98		EE-97		EE-98		LV-97		LV-98		LT-97		LT-98		RU-97		RU-98		AL	AB	AM
	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ			
ANTHOPHORIDAE																							
Anthophora furcata (Panzer,1798)	1	1	1	1			1	1	1	1	4	1			1	1	1	1					
A.plumipes (Pallas,1772)											4	1											
Nomada bifida Thomson,1870			1	1	1	1																	*
N.striata Fabricius,1793	1	1																					
N.panzeri Lepeletier,1841	6	5	20	9					7	1			5	1	5	4							
N.leucophthalma (Kirby,1802)			7	2									1	1	2	1	1	1					
N.goodeniana (Kirby,1802)															1	1							
N.fulvicornis Fabricius,1793									1	1													
N.lathburiana (Kirby,1802)																	5	1					
N.flavoguttata (Kirby,1802)			1	1																			*
N.montana (Mocsary,1894)																							*
N.fabriciana (Linnaeus,1767)													2	1									
Epeolus cruciger (Panzer,1799)			1	1																			
MEGACHILIDAE																							
Anthidium punctatum Latreille,1809			1	1																			
Megachile ericetorum (Lepeletier,1841)									1	1													
M.ligniseca (Kirby,1802)									5	3	1	1			1	1			1	1			
M.lapponica Thomson,1872	1	1	1	1													1	1					*
M.versicolor F.Smith,1844			5	3					2	1					1	1	1	1					
M.willughbiella (Kirby,1802)	3	3							1	1					2	1							
M.circumcincta (Kirby,1802)									4	3			1	1									
M.nigriventris Schenck,1867	1	1	1	1																			
M.centuncularis (Linnaeus,1758)													1	1									
M.alpicola Alfken,1924											1	1											
M.pyrenaea Perez,1890					1	1			1	1	1	1											
M.analis Nylander,1852	1	1																					
M.rotundata (Fabricius,1787)			1	1																			
Hoplitis leucomelaena (Kirby,1802)	1	1							1	1													
Osmia rufa (Linnaeus,1758)					2	1			9	4	9	2	7	2	6	4			2	1			
O.bicolor (Schrank,1781)					3	3	14	2															
O.aurulenta (Panzer,1799)											1	1											
O.nigriventris (Zetterstedt,1838)	1	1																					
O.inermis (Zetterstedt,1838)	1	1	1	1																			
O.uncinata Gerstaecker, 1869	7	6	4	4									1	1	5	2	1	1	1	1			
O.parietina Curtis,1828													1	1	1	1	1	1					
O.pilicornis F.Smith,1846			1	1																			
Heriades truncorum (Linnaeus,1758)			1	1	1	1			3	2	8	2											
Chelostoma rapunculi (Lepeletier,1841)											1	1											
C.campanularum (Kirby,1802)																			4	1			
C.florisomne (Linnaeus,1758)							1	1															
Stelis minima Schenck,1859									1	1													
ANDRENIDAE																							

	FI-97		FI-98		EE-97		EE-98		LV-97		LV-98		LT-97		LT-98		RU-97		RU-98		AL	AB	AM
	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ			
Panurgus calcaratus (Scopoli,1763)	1	1																					
Andrena coitana (Kirby,1802)																			1	1			
A.tarsata Nylander,1848																	1	1					
A.similis Smith,1849											1	1											
A.hattorfiana (Fabricius,1775)													1	1									
A.saundersella Perkins,1914			2	2							1	1											
A.subopaca Nylander,1848									2	2	1	1			1	1							
A.haemorrhoa (Fabricius,1781)	22	10	14	7	4	4			4	3	16	6	14	4	7	4	2	1	4	3			
A.gelriae van der Vecht,1927	2	1													1	1							
A.wilkella (Kirby,1802)											1	1	3	2	2	2	1	1					
A.intermedia Thomson,1870	1	1															1	1					
A.cineraria (Linnaeus,1758)	3	3															3	1					
A.vaga Panzer,1799	4	3	15	1							3	2	3	2	1	1	33	1	1	1			
A.fulvida Schenck,1853	2	1	3	3			2	1			2	2	2	2	2	1	1	1					
A.ruficrus Nylander,1848	5	5	10	8			1	1	1	1					6	3			2	1			
A.labiata Fabricius,1781									1	1													
A.denticulata (Kirby,1802)			3	3	1	1			1	1	1	1			2	2	2	2					
A.clarkella (Kirby,1802)	1	1	6	3			8	2	8	1	3	2	6	3	22	5	4	2	17	4			
A.fucata F.Smith,1847	5	5	2	2	5	3			8	2	1	1	1	1	8	3	2	1					*
A.bicolor Fabricius,1775					1	1			6	2			2	1					2	1			
A.lapponica Zetterstedt,1838	22	7	11	8	1	1			2	1	1	1	2	1	15	4	1	1					
A.praecox (Scopoli,1763)	11	8	16	7	13	3	1	1	5	4	4	3	7	3	1	1	7	4	1	1	*		
A.helvola (Linnaeus,1758)							1	1							6	2			1	1			
A.varians (Rossi,1792)															3	1							
A.ventralis Imhoff,1832									1	1													
A.nitida (Fourcroy,1785)					1	1					2	2	2	2	6	4			1	1			
A.bluethgeni Stöckhert,1930									1	1													
A.curvungula Thomson,1870													1	1									
MELITTIDAE																							
Dasypoda altercator (Harris,1780)									1	1									1	1			
Melitta haemorrhoidalis (Fabricius,1775)										1	1												
Macropis fulvipes (Fabricius)															1	1							
HALICTIDAE																							
Halictus rubicundus (Christ,1791)			1	1																	*		
H.maculatus Smith,1848											2	1											
H.sexcinctus (Fabricius,1775)											2	1											
Lasioglossum calceatum (Scopoli,1763)	12	6	7	3	13	4	2	1	9	6	4	3	24	4	25	6	9	4	3	2	*		
L.rufitarse (Zetterstedt,1838)							1	1	2	1					1	1							*
L.albipes (Fabricius,1781)	2	1	6	4	1	1					1	1			7	3			1	1			
L.punctatissimum (Schenck,1853)							1	1	1	1													*
L.villosulum (Kirby,1802)									1	1													
L.fratellum (Perez,1903)	143	25	213	33	7	3	2	1			5	4	5	3	7	4	9	7	2	2			

	FI-97		FI-98		EE-97		EE-98		LV-97		LV-98		LT-97		LT-98		RU-97		RU-98		AL	AB	AM
	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ			
L.fulvicorne (Kirby,1802)	6	3	1	1	1	1			5	2					2	1	1	1					
L.leucopus (Kirby,1802)	1	1	1	1					6	2	3	1											
L.aeratum (Kirby,1802)									1	1	1	1											
L.tumulorum (Linnaeus,1758)	2	2	15	5					3	1	3	3					1	1	1	1			*
L.confusum (F.Smith,1853)															2	2							
L.leucozonium (Schrank,1781)			1	1							1	1	1	1	1	1							
L.zonulum (Smith,1849)	1	1							3	3	3	3	1	1	5	2							
L.quadrinotatulum (Schenck,1859)									1	1													
L.sexnotatulum (Nylander,1852)			1	1					1	1							2	2					
L.costulatum (Kriechbaumer,1873)													1	1									
Sphecodes crassus Thomson,1870															1	1	2	1					*
S.pellucidus F.Smith,1845			3	3																			
S.ephippius (Linnaeus,1767)									3	3	1	1	2	2	3	3	2	1					
S.monilicornis (Kirby,1802)					1	1																	
S.gibbus (Linnaeus,1785)			1	1																			
S.geofrellus (Kirby,1802)			3	3																			
COLLETIDAE																							
Hylaeus communis Nylander,1852	11	6	12	9	1	1			7	3	3	3	3	2	14	3			2	2			*
H.annulatus (Linnaeus,1758)	2	2	2	2					1	1									2	2			
H.annularis (Kirby,1802)																	1	1					
H.nigritus (Fabricius,1798)					1	1	1	1															
H.brevicornis Nylander,1852					1	1																	
H.gracilicornis (Morawitz,1867)									1	1													
H.gibbus Saunders,1850			1	1																			
H.confusus Nylander,1852	4	4	5	4	1	1							1	1			1	1	1	1			
H.difformis (Eversmann,1852)															1	1	1	1	1	1			
H.sinuatus (Schenck,1853)									7	2	2	1											
H.cardioscapus Cockerell,1924					1	1									1	1			1	1			
Colletes cunicularius (Linnaeus,1761)	3	1	42	4			1	1	8	1	8	1					74	4	2	1			
C.similis Schenck,1853											1	1											
C.succinctus (Linnaeus,1758)	1	1											2	1	2	1	1	1					
C.daviesanus F.Smith, 1846	1	1			1	1			2	1							1	1					
Total	292		444		63		37		141		107		103		181		174		55				
Maximum		51		74		8		8		8		8		7		8		12		11			
Mean ind./site	6		6		8		5		18		13		15		23		15		5				

*** > 100 specimens
** 10-100 specimens
* < 10 specimens
AL = ad lucem
AB = ad bait
AM = in Malaise trap
N = specimens
FQ = sites recorded

Annex 4. Social and Solitary Wasps 1997-98

	FI-97		FI-98		EE-97		EE-98		LV-97		LV-98		LT-97		LT-98		RU-97		RU-98		AL	AB	AM
	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ			
VESPIDAE																							
Vespa crabro Linnaeus, 1758									120	4	10	2	6	1	5	3	36	5	1	1	**	*	
Dolichovespula media (Retzius,1783)	34	18	28	14	1	1			14	4	5	2	2	2	5	2	7	3			**	**	
D.norwegica (Fabricius,1781)	700	48	254	50	9	6			5	3	2	2	1	1			28	5	11	3	***		**
D.norvegicoides (Sladen,1918)	1	1	16	7																			
D.saxonica (Fabricius,1793)	145	28	28	16	6	2	3	2	25	5	7	4	2	2	6	3	17	7	6	3	**	*	*
D.sylvestris (Scopoli,1763)	11	5											1	1			4	3	1	1	*		*
D.adulterina (Buysson,1905)			2	1																	*		
Vespula austriaca (Panzer,1799)	1	1															1	1			*		**
V.rufa (Linnaeus,1758)	94	36	83	42	9	7	1	1	19	7	16	6	16	4	7	4	11	6	5	2	**	*	*
V.vulgaris (Linnaeus,1758)	815	41	248	42	172	5	229	5	38	7	59	7	11	4	7	3	131	11	6	2	***	***	**
V.germanica (Fabricius,1793)	1	1			3	3	16	1	105	5	152	7	1	1	5	4	11	2	3	1	*		*
Polistes dominulus (Christ,1791)											1	1											
EUMENIDAE																							
Odynerus spinipes (Linnaeus,1758)													1	1									
Gymnocerus laevipes (Schuckard,1837)					1	1																	
Euodynerus quadrifasciatus (Fabricius,1793)	1	1	4	3			2	2	2	1													
Ancistrocerus nigricornis (Curtis,1826)			1	1							3	3	3	2	3	3			1	1			
A.oviventris (Wesmael,1836)			4	3							1	1							1	1			
A.parietinus (Linnaeus,1761)	1	1	4	4			1	1			2	1							1	1			
A.parietum (Linnaeus,1758)			1	1					5	2	1	1											
A.claripennis Thomson,1874					2	2			1	1													
A.trifasciatus (Mueller,1776)	1	1	18	15			2	2	3	3	2	2	5	3	2	2			7	4	*		*
A.antilope (Panzer,1798)	2	2	2	2															1	1			
Symmorphus allobrogus (Saussure,1855)	9	5	20	11	1	1					2	2					2	2	9	4	*		
S.angustatus (Zetterstedt,1838)	1	1	1	1					1	1									2	2			
S.crassicornis (Panzer,1798)											1	1									*		
S.murarius (Linnaeus,1758)																			3	1			
S.bifasciatus (Linnaeus,1761)	1	1	1	1	3	3	1	1	1	1									1	1			
Total	1818		715		207		255		339		264		49		40		248		59				
Maximum		51		74		8		8		8		8		7		8		12		11			
Mean ind./site	36		10		26		32		42		33		7		5		21		5				

Annex 5. Hoverflies 1997–98

	FI-97		FI-98		EE-97		EE-98		LV-97		LV-98		LT-97		LT-98		RU-97		RU-98		AL	AB	AM
	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ			
SYRPHIDAE																							
Syrphus ribesii (Linnaeus,1758)	696	38	5783	67	77	5	34	4	8	6	53	8			77	7	125	11	100	11	**		**
S.sexmaculatus Zetterstedt,1838	1	1	2	2																			
S.torvus Osten Sacken,1875	109	24	788	64	34	3	17	5	3	1	11	5	2	1			7	4	100	10	*		*
S.vitripennis Meigen,1822	419	46	582	60	52	4	14	5	11	6	16	6	28	7	3	2	105	11	22	7	**		*
Epistrophe eligans (Harris,1780)									1	1													
E.grossulariae (Meigen,1822)			12	6									1	1			4	2	6	1			
E.melanostomoides (Strobl,1888)									1	1													
E.nitidicollis (Meigen,1822)	2	1																					
E.ochrostoma (Zetterstedt,1849)			1	1																			
Eupeodes corollae (Fabricius,1794)	67	14	277	22	2	2			3	3	1	1			6	2	2	2	12	2	***	**	***
E.latifasciatus (Macquart,1829)	9	9	7	7			1	1	3	2	3	3	1	1	1	1	1	1	1	1	*		*
E.lundbecki (Soot-Ryen,1946)	14	5	216	37	3	2	3	3			1	1			2		1	1	3	1		*	**
E.luniger (Meigen,1822)	1	1																					
E.nielseni (Dusek&Laska,1976)	4	4	2	2																			*
E.nitens (Zetterstedt,1843)	8	5	15	12							1	1											*
Lapposyrphus lapponicus (Zetterstedt,1838)	40	17	200	46	3	2	2	1	3	2			2	1			8	5	4	3	**		*
Scaeva pyrastri (Linnaeus,1758)	4	3	19	9	2	1					3	3			2	2			1	1	**		*
S.selenitica (Meigen,1822)			4	3	2	1			1	1	1	1	1	1	1	1	1	1			*		
Dasysyrphus albostriatus (Fallen,1817)	4	4	2	2													2	2			**		*
D.postclaviger Stys&Moucha,1962	8	8	28	13	2	1							5	2			2	2	1	1	*		*
D.pinastri (DeGeer,1776)	61	21	25	15	6	3									1	1	2	2	2	1	*		**
D.nigricornis (Verrall,1873)	4	3	4	3											4	1	1	1			*		*
D.venustus (Meigen,1822)	148	28	84	21	6	3							8	4	12	6	9	8	3	3	**		*
D.hilaris (Zetterstedt,1843)	8	6	5	3																			*
D.tricinctus (Fallen,1817)	33	21	25	19									1	1	1	1	4	3	2	2	**		*
Ischyrosyrphus glaucius (Linnaeus,1758)	11	4	56	15	1	1									1	1			45	1			
I.laternarius (Mueller,1776)	6	5	26	11																			
Leucozona lucorum (Linnaeus,1758)	2	2	14	7															1	1			
Melangyna compositarum (Verrall,1873)	57	19	292	34					1	1	1	1					11	5	62	5	**		
M.lasiophthalma (Zetterstedt,1843)	178	24	20	9	2	2	1	1	1	1			12	2	10	2	8	6			*		*
M.quadrimaculata (Verrall,1873)	1	1																					
M.umbellatarum (Fabricius,1794)	12	6	12	8													3	3	3	2			*
M.ericarum (Collin,1946)	1	1	1	1																			
Meligramma guttata (Fallen,1817)																	1	1					
M.triangulifera (Zetterstedt,1843)			34	15							1	1							1	1			*
Parasyrphus annulatus (Zetterstedt,1838)	4	4	2	2													2	1					
P.lineolus (Zetterstedt,1838)	61	18	54	22	2	2	1	1	1	1	2	1	2	1	2	1	11	3	28	2			*
P.macularis (Zetterstedt,1843)	31	12	73	14											4	3	2	1			*		*
P.punctulatus (Verrall,1873)	3	3	1	1																			
P.malinellus (Collin,1952)	6	4	1	1											1	1							
P.nigritarsis (Zetterstedt,1843)	50	12	4	2									1	1			1	1					*
P.tarsatus (Zetterstedt,1838)			2	2																			
P.vittiger (Zetterstedt,1843)	13	4	80	25											2	2			1	1			
Xanthogramma festivum (Linnaeus,1758)	1	1																					
X.pedissequum (Harris,1776)									1	1													
Didea alneti (Fallen,1817)	20	13	25	17	1	1	1	1							2	2			2	1		*	

	FI-97		FI-98		EE-97		EE-98		LV-97		LV-98		LT-97		LT-98		RU-97		RU-98		AL	AB	AM
	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ			
D.fasciata Macquart,1834	6	3	10	10	1	1					1	1			5	3	3	2	3	2			
D.intermedia Loew,1854	30	12	19	14	3	1			1	1			6	3			1	1	2	2			*
S.lappona (Linnaeus,1758)			3	3																			
S.nigra Portschinsky,1872																					*		
S.silentis (Harris,1776)	4	4	11	10									1	1			2	2			**		
Megasyrphus erraticus (Linnaeus,1758)					1	1																	
Meliscaeva auricollis (Meigen,1822)																	1	1					
M.cinctella (Zetterstedt,1843)	145	32	93	33	8	3	5	1	4	2	2	2	46	6	31	7	12	5	52	5	**		**
Episyrphus balteatus (DeGeer,1776)	1311	41	4782	62	86	7	141	7	80	7	269	8	53	6	343	8	277	12	54	9	***		**
Sphaerophoria menthastri (Linnaeus,1758)	16	8	13	9	2	1	1	1					2	1	14	2	5	4					
S.rueppelli (Wiedemann,1830)	2	2	13	4	4	2			1	1													**
S.philanthus (Meigen,1822)			2	1																			
S.scripta (Linnaeus,1758)	49	18	75	24	14	2	3	1	8	5	2	2	2	2	4	3	9	5	2	2	**	*	***
S.taeniata (Meigen,1822)	2	2	5	4			2	1	3	1					1	1			1	1			**
Melanostoma dubium (Zetterstedt,1838)	2	2	2	2																			*
M.mellinum (Linnaeus,1758)	2	2	44	24					1	1	3	3			10	3	4	3	3	3	**		***
M.scalare (Fabricius,1794)	1	1	2	2													1	1			*		**
Xanthandrus comtus (Harris,1780)			8	7			1	1			5	2	1	1	4	4	1	1	2	1			
Platycheirus cyaneus (Mueller,1764)	31	13	41	17	11	5							1	1			2	1	1	1	*		**
P.angustatus (Zetterstedt,1843)																							*
P.clypeatus (Meigen,1822)	1	1	1	1																			**
P.discimanus Loew,1871	1	1																					
P.fulviventris (Macquart,1829)																							*
P.manicatus (Meigen,1822)	2	2																					**
P.occultus Goeldlin,Maibach&Speight,1990																							*
P.peltatus (Meigen,1822)	5	5	39	14	1	1	2	2							2	2	1	1	3	3			**
P.podagratus (Zetterstedt,1838)																							*
P.scambus (Staeger,1843)																							*
P.scutatus (Meigen,1822)	2	2	7	2									1	1									*
Pyrophaena granditarsa (Förster,1771)																							*
Baccha elongata (Fabricius,1775)			1	1											1	1							
B.obscuripennis Meigen,1822	2	1																					*
Chrysotoxum arcuatum (Linnaeus,1758)	3	1	6	5	1	1			1	1	2	2			3	2	1	1					*
C.bicinctum (Linnaeus,1758)	3	2	3	3	1	1	2	1			1	1			1	1			1	1	*		*
C.cautum (Harris,1776)			1	1																			
C.fasciatum (Mueller,1764)	4	2	11	10											4	2							
C.festivum (Linnaeus,1758)															3	2							
C.vernale Loew,1841	1	1			1	1			1	1													
C.verralli Collin,1940															14	2							
Paragus majoranae Rondani,1857																							*
Microdon mutabilis (Linnaeus,1758)							1	1															
Pipiza austriaca Meigen,1822	1	1																					*
P.noctiluca (Linnaeus,1758)																			1	1			
P.bimaculata Meigen,1822	1	1	13	8	1	1											1	1					*
P.lugubris (Fabricius,1775)	5	1	1	1																			
P.luteitarsis Zetterstedt,1843			1	1																			

	FI-97		FI-98		EE-97		EE-98		LV-97		LV-98		LT-97		LT-98		RU-97		RU-98		AL	AB	AM
	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ			
P.notata Meigen,1822	7	5	11	8									1	1					2	2			
P.quadrimaculata (Panzer,1804)	1	1	7	6									1	1									
Pipizella viduata (Linnaeus,1758)			4	3											3	1			1	1			*
Neocnemodon pubescens (Del.&P-W.,1955)	2	1	3	3									2	1			1	1					
N.vitripennis (Meigen,1822)	11	6	9	6	2	1											3	2					
Cheilosia albipila Meigen,1838													1	1									
C.albitarsis (Meigen,1822)																							
C.antiqua (Meigen,1822)			1	1													1	1					
C.carbonaria Egger,1860			2	1																			*
C.chloris (Meigen,1822)			1	1											1	1							
C.gigantea (Zetterstedt,1838)																							*
C.grossa (Fallen,1817)																							*
C.honesta Rondani,1868	1	1																					
C.illustrata (Harris,1780)																					*		
C.latifrons (Zetterstedt,1843)			2	1					5	2													**
C.longula (Zetterstedt,1838)																							*
C.impressa Loew,1840																					*		
C.mutabilis (Fallen,1817)	1	1	2	2					1	1			2	1									*
C.nigripes (Meigen,1822)			1	1											1	1							*
C.nasutula Becker,1894																							*
C.pagana (Meigen,1822)	18	8	43	13	1	1			1	1			1	1	1	1	4	4	4	4	*		*
C.proxima (Zetterstedt,1843)			1	1																			*
C.praecox (Zetterstedt,1843)	5	2									1	1											*
C.chrysocoma (Meigen,1822)																							*
C.vernalis (Fallen,1817)													2	2	1	1	2	1					
Ferdinandea cuprea (Scopoli,1763)					1	1					2	1	1	1	2	1	1	1					
Rhingia austriaca (Meigen,1830)	1	1	2	2													1	1					
R.campestris Meigen,1822	6	4					1	1													**		**
R.rostrata (Linnaeus,1758)											1	1									*		
Pelecocera tricincta Meigen,1822																							*
Brachyopa testacea (Fallen,1817)			15	8																			
B.dorsata Zetterstedt,1838	4	3	8	4																			*
B.conica (Panzer,1798)													18	1	7	1							
Neoascia meticulosa (Scopoli,1763)															1	1	2	1					
N.tenur Harris,1780)			1	1																			
N.podagrica (Fabricius,1775)	1	1	2	2													1	1					
Orthonevra intermedia Lundbeck,1916									5	1									1	1			
O.geniculata (Meigen,1830)			1	1																			
Chrysogaster lucidum (Scopoli,1763)																							*
Lejogaster metallina (Fabricius,1777)																							*
Volucella bombylans (Linnaeus,1758)			2	2			1	1									1	1			*		
V.pellucens (Linnaeus,1758)	15	7	31	16							1	1					3	3	3	1	**	**	*
V.inanis (Linnaeus,1758)			2	2																	**	**	*
Eumerus sogdianus Stackelberg,1952									1	1					1	1							
E.strigatus (Fallen,1817)									1	1													*
Eristalis abusivum Collin,1931			1	1																			*

	FI-97		FI-98		EE-97		EE-98		LV-97		LV-98		LT-97		LT-98		RU-97		RU-98		AL	AB	AM
	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ	N	FQ			
E.anthophorinum (Fallen,1817)	2	1																			*		
E.arbustorum (Linnaeus,1758)	4	3	9	6			2	1							1	1	3	2	2	2	*		
E.cryptarum (Fabricius,1794)															2	2	1	1					
E.piceum (Fallen,1817)			1	1											1	1							
E.rupium (Fabricius,1805)	1	1	1	1																			
E.horticolum (DeGeer,1776)	2	2	1	1															1	1			
E.intricarium (Linnaeus,1758)			2	2					1	1													
E.interruptum (Poda,1761)	6	5	4	4															2	2			
E.pertinax (Scopoli,1763)	1	1	19	7			1	1			21		1	1			1	1	1	1			
E.pratorum (Meigen,1822)			1	1																	*		
E.tenax (Linnaeus,1758)			58	10	2	2	8	3	10	3	91	7	8	4	957	5	6	2	4	2	**		*
E.vitripennis Strobl,1893																					*		
Eristalinus sepulchralis (Linnaeus,1758)	3	1	1	1									1	1			1	1					
Helophilus affinis Wahlberg,1844			16	10											1	1	2	1			*		
H.hybridus Loew,1846			1	1																			
H.trivittatus (Fabricius,1805)	2	2	45	9							2	1			47	2					*		
H.pendulus (Linnaeus,1758)	2	2	200	35	1	1	7	4	5	4	13	4	8	4	11	4	1	1	29	8	**		*
Parhelophilus frutetorum (Fabricius,1775)									2	2													
P.consimilis (Malm,1863)															2	1							
Myathropa florea (Linnaeus,1758)									6	5	3	3			4	2	1	1					*
Sphecomyia vespiformis Gorski,1852	1	1	3	3															1	1			
Temnostoma apiforme (Fabricius,1794)	3	2	1	1			1	1									1	1			*		
T.vespiforme (Linnaeus,1758)			1	1									1	1					1	1			
T.bombylans (Fabricius,1805)											1	1							1	1			*
Blera fallax (Linnaeus,1758)																							*
Syritta pipiens (Linnaeus,1758)	12	7	6	4	1	1			5	3	1	1			2	1	13	5	2	1			*
Xylota coeruleiventris Zetterstedt,1838			4	4					1	1									1	1			
X.florum (Fabricius,1805)			1	1																			*
X.segnis (Linnaeus,1758)	1	1							2	1	1	1											*
X.ignavum (Panzer,1798)											1	1											
X.sylvarum (Linnaeus,1758)									1	1											*		
X.tarda Meigen,1822	1	1							1	1													*
Chalcosyrphus valgus (Gmelin,1790)			1	1																			*
C.nemorum (Fabricius,1805)			1	1											2	1	4	1	1	1			
Brachypalpoides lentus (Meigen,1822)													1	1	1	1							
Total	3843		14514		338		253		186		518		226		1621		688		582				
Maximum		51		74		8		8		8		8		7		8		12		11			
Per site	75		196		42		32		23		65		32		203		57		53				

Documentation page

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Author(s)	Guy Söderman	
Title of publication	Diversity of Pollinator Communities in Eastern Fennoscandia and Eastern Baltics Results from Pilot Monitoring with Yellow-traps in 1997–1998	
Parts of publication/ other project publications		
Abstract	The objective of the pilot monitoring was to investigate the effectivity of yellow-traps in capturing pollinators and to assess possibilities for regional and temporal comparsions based on the results. The monitoring network comprised 124 sites of which 36 in adjacent regions of Eastern Fennoiscandia. During the period 35 species of social bees, 110 species of solitary bees, 12 species of social wasps, 15 species of solitary wasps and 153 species of hoverflies were captured. The total monitoring material counted to 75,000 individuals during years 1997–98. The investigations showed that the yellow-traps were better in capturing pollinators than other coloured traps and superior in capturing wild bees. The results imply that social species are easier to monitor and that their results can be compared on an annual basis. For other pollinator groups at least a 3-year period is needed for comparisons. The pilot monitoring produced much new faunistic information. The results from the two first monitoring years indicate that the populations of important pollinators have declined in parts of the investigated area, particularly in southwestern and central Finland and Estonia.	
Keywords	Monitoring, pollinators, yellow-traps, species composition, biological diversity	
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Theme of publication	Nature and Natural Resources	
Project name and number, if any		
Financier/ commissioner	Finnish Environment Institute	
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Kuvailulehti

Julkaisija	Suomen ympäristökeskus	Julkaisuaika Joulukuu 1999
Tekijä(t)	Guy Söderman	
Julkaisun nimi	Diversity of Pollinator Communities in Eastern Fennoscandia and Eastern Baltics Results from Pilot Monitoring with Yellow-traps in 1997–1998 (Pölyttäjien monimuotoisuus Itä-Fennoskandiassa ja sen lähialueilla. Keltarysillä tehdyn pilottiseurannan tulokset 1997–1998)	
Julkaisun osat/ muut saman projektin tuottamat julkaisut		
Tiivistelmä	Pölyttäjäseurannan pilottijakson aikana tavoitteena oli selvittää keltarysäpyydysmenetelmän toimivuutta ja tulosten alueellista ja ajallista vertailukelpoisuutta. Seurantaverkko koostui 124 paikasta, joista 36 lähialueilla. Jakson aikana pyydystettiin 35 lajia yhdyskuntamehiläisiä, 110 lajia erakkomehiläisiä, 12 lajia yhdyskunta-ampiaisia, 15 lajia erakkoampiaisia ja 153 lajia kukkakärpäsiä. Seuranta-aineistoa kertyi vuosien 1997–98 aikana 75.000 yksilöä. Tutkimukset osoittivat keltarysien olevan muun värisiä rysiä tehokkaampia sekä niiden paremmuutta mesipistiäisten pyydystämisessä. Lisäksi tulokset osoittivat, että yhteiskuntalajeja on helpommin seurattavissa ja että niiden tulokset ovat vuodesta toiseen verrattavissa. Muiden ryhmien osalta vertailu edellyttää vähintäin 3-vuotisjaksoja. Pilottiseurannan yhteydessä saatiin runsaasti uutta faunistista tietoa. Kahden ensimmäisen vuoden tulokset viittaavat siihen, että pölyttäjien kannat ovat pienentyneet osassa seuranta-aluetta, erityisesti Lounais- ja Keski-Suomessa sekä Virossa.	
Asiasanat	Seuranta, pölyttäjät, keltarysä, lajisto, monimuotoisuus	
Julkaisusarjan nimi ja numero	Suomen ympäristö 355	
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Publikationens delar/ andra publikationer inom samma projekt		
Sammandrag	Målet för pilotövervakningen var att undersöka gulfällornas effektivitet att fånga pollinatorer samt att göra regionala och tidsmässiga jämförelser. Övervakningsnätet bestod av 124 platser av vilka 36 i närområdena. Under perioden fångades 35 arter sociala bin, 110 arter solitära bin, 12 arter sociala getingar, 15 arter solitära getingar och 153 arter blomflugor. Totalt uppgick materialet till 75.000 individ under perioden 1997–98. Undersökningarna visade att gulfällorna var överlägsna andra färgfällor vid insamling av vildbin. Resultaten antyder också, att sociala arter är lättare att övervaka och att resultaten kan jämföras på årsbasis. För andra pollinator-grupper förutsätter jämförelser minst en tre-årsperiod. Pilotövervakningen insamlade rikligt med ny faunistisk information. Resultaten från de två första åren antyder, att populationerna för viktiga pollinatorer har minskat i vissa delar av övervakningsområdet, speciellt i sydvästra och mellersta Finland samt i Estland.	
Nyckelord	Övervakning, pollinatorer, gulfälla, artsammansättning, mångfald	
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The Finnish Environment

NATURE AND
NATURAL RESOURCES

Diversity of pollinator communities in Eastern Fennoscandia and Eastern Baltics
Results from pilot monitoring with Yellow traps in 1997 - 1998

Changes in the country-side during the last decades have resulted in loss of habitats important for both nesting and foraging of pollinators. The need to follow up the effect of these changes on the diversity of pollinator communities has thus become urgent.
This report describes the method of monitoring pollinator communities using yellow-traps. The effectiveness and the constraints of the method are studied by analysing two-year data sets from an extensive network of trap sites covering Finland, the Baltic countries and northwestern Russia.
The emphasis is on bumble bees, being the most easily captured pollinators with this technique. The report concludes that social bees can be monitored fairly well using this method, and parameters to be reported to express community diversity are suggested. For other pollinator groups, the solitary bees, social and solitary wasps and hoverflies, the method can only give indications of the composition of the local fauna, since many species are not regularly captured by yellow-traps. It is estimated that a monitoring period between 3 and 5 years is required for a diversity analysis of the communities of these groups.

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