

ALARM Field Site Network: Bumblebee Project

Genetic diversity and parasite load of bumblebees across a land use intensity and climatic gradient

Catrin Westphal, Robin Moritz, and Ingolf Steffan-Dewenter



Bombus pascuorum worker foraging on red clover

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The FSN bumblebee project: overview

Schedule	What to do?	Location
May	<ul style="list-style-type: none">preliminary observations of <i>B. pascuorum</i>	backyard, university, parks, etc.
mid June	<ul style="list-style-type: none">start collecting <i>B. pascuorum</i> in field sites	mediterranean field sites
July	<ul style="list-style-type: none">start collecting <i>B. pascuorum</i> in field sites	all other field sites
until end of August	<ul style="list-style-type: none">collect a minimum of 100 workers and 50 males during 3 boutsif necessary, carry out additional collecting bouts	all field sites
September	<ul style="list-style-type: none">send specimens to Catrin	University of Bayreuth Department of Animal Ecology I Population Ecology Universitätsstr. 30 95447 Bayreuth, Germany

Introduction

There is recent evidence that not only the availability of floral resources but also the genetic diversity affects the overall population fitness of bumblebees in agricultural landscapes. In addition, the population dynamics of bumblebees are also influenced by the prevalence of natural enemies. Hence, these factors might be of major importance for determining the vulnerability of bumblebee populations to environmental risks, such as climate change or biological invasions.

In this project we plan to analyse the effects of climate and land use intensity (as indicator of resource availability) on the genetic diversity, parasite load, colony densities, and colony sizes of *Bombus pascuorum* (Common carder bee), which is a common bumblebees species throughout Europe.

Questions

- Does the genetic diversity of *B. pascuorum* populations vary across land use intensity and climatic gradients?
- Are the densities of *B. pascuorum* colonies affected by land use intensity and/or climatic factors?
- Is the parasite load of *B. pascuorum* related to land use intensity, climate, and genetic diversity?
- Which are the most important factors that increase the vulnerability of bumblebee populations to climate and land use change?

Collecting *B. pascuorum*

In this project *B. pascuorum* individuals will be collected for genetic analyses and the determination of parasite load. The bumblebees should ideally be collected when the colonies are about to reach their maximum size and start producing males and young queens. This will be approximately in mid June in the mediterranean sites and at the beginning of July in the other ALARM field sites. To determine this point in time, it will be helpful, when you start observing *B. pascuorum* in May in your backyard, in parks, or in any other location with lots of flowers. The numbers of *B. pascuorum* workers will increase steadily and once there are lots of workers and the very first males flying around, you should start immediately collecting *B. pascuorum* individuals in the ALARM field sites.

In total, a minimum of 100 workers and 50 males of *B. pascuorum* will be collected in both the undisturbed and disturbed field sites. *B. pascuorum* is abundant in open and flower rich habitats, such as calcareous grasslands, field margins, extensively managed grasslands, and flowering crops (e.g. *Trifolium* spp.). Hence, the sampling should be conducted in these flower rich habitats, which should be located in the central area of the field sites. In this central area, which should not be larger than 1 km², you should walk slowly across (or along) the flower rich habitats and collect all *B. pascuorum* workers and males with a sweep net. Approximately, 20 - 40 workers and 10 - 20 males should be collected during one collecting bout. The time that you will spend collecting the specimens will be depending on the densities of *B. pascuorum* in the field site. The duration of each collecting bout should therefore be recorded as a measure of bumblebee abundance in the site. In addition, the numbers of

observed *B. pascuorum* individuals and the average flower cover in the sampled habitats should be recorded (see check list). A minimum of 3 collecting bouts should be conducted in weekly intervals during suitable weather conditions, i.e. on dry, warm, and sunny days. If necessary, additional collecting bouts should be carried out in field sites with low densities of *B. pascuorum*, so that the minimum amount of 100 workers and 50 males for the genetic analyses will be reached. *B. pascuorum* is a wide-spread and abundant bumblebee species throughout Europe, and thus should occur in relatively high densities in all ALARM FSN.

Country: Germany
Site name: Barterode disturbed
Date: 02.07.2007
Collecting bout: 1

Fig. 1. Example for a label which must be placed in the vials with the specimens. Please, do not forget to note the site characteristics, i.e. disturbed or undisturbed on the labels.

The collected bumblebees will be transferred individually from the sweep nets to the provided vials (1 bumblebee per vial). Each vial must contain a pencil written label or laser print-out (see provided template) that indicates the FSN region, the name of the field site, the type of the field site (i.e. disturbed vs. undisturbed), the date, and the number of the collecting bout (Fig. 1). Please, do NOT use ink, as ink will be washed out! The vials will then be stored in a cooling bag during the field work. The cool temperature and the darkness will calm down the bees. After returning from the field, the vials should be put immediately in a freezer. The bumblebees will be killed via freezing at -20°C for at least a week. The dead bumblebees will be stored in 70 % ethanol for shipment. Please, fill the vials with enough alcohol so that the specimens are entirely covered and cannot dry out. The specimens then will be sent to Catrin (Address: Catrin Westphal, University of Bayreuth, Department of Animal Ecology I, Population Ecology, Universitätsstr. 30, 95447 Bayreuth, Germany).

Identification of *B. pascuorum*

B. pascuorum is a fairly small, brown to orange bumblebee species, which however can be highly variable in its colour pattern (cover picture, Fig. 2, Fig. 3).

Information on *B. pascuorum* and its colour variation is available in the Online Guide to British Bumblebees by Paul Williams (http://www.nhm.ac.uk/research-curation/projects/bombus/_key_colour_british/ck_widespread.html#pascuorum).

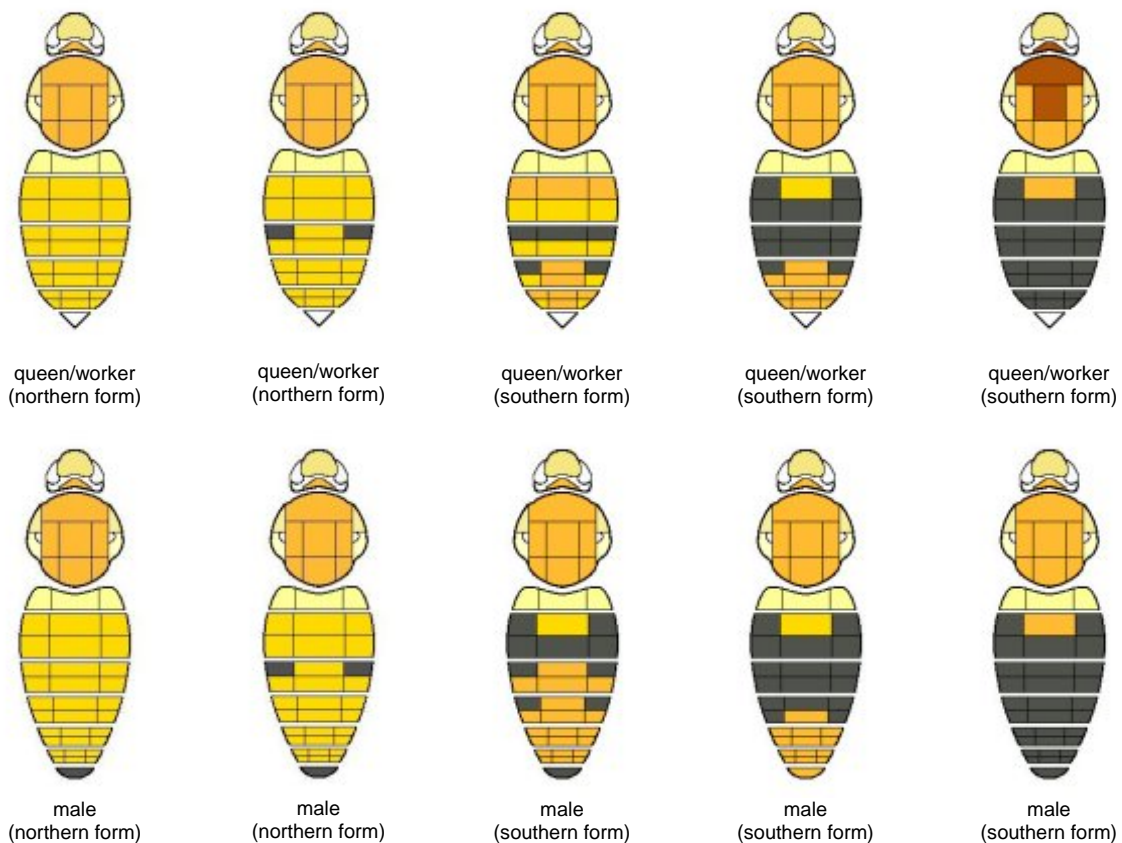


Fig. 2 The colour pattern of *B. pascuorum* is particularly variable. Here the examples represent British individuals. Black hairs are fewest on individuals from northern Scotland, and more abundant on those from southern Scotland, England and Wales. (Paul Williams, http://www.nhm.ac.uk/research-curation/projects/bombus/_key_colour_british/ck_widespread.html#pascuorum).

B. pascuorum might be confounded with two similar species: *B. humilis* and *B. muscorum*, which are however rare across Europe. For this reason, the majority of the brown to orange bumblebees that will be found in the ALARM field sites will be *B. pascuorum*.

Details on the differentiation between the bumblebee species and colour plates of *B. humilis* and *B. muscorum* can be found in the Guide to British Bumblebees (Paul Williams, http://www.nhm.ac.uk/research-curation/projects/bombus/_key_colour_british/ck_widespread.html#pascuorum):

“Unlike *B. humilis* and *B. muscorum*, *B. pascuorum* have (1) shaggy hair, (2) usually have at least a few black hairs on the sides of abdominal segment 3 after the waist (sometimes black hairs are completely absent), and (3) in fresh specimens the hair on abdominal segment 1 is lighter than the pale hair on segment 3; and males can be distinguished by their genitalia.”

Differences between workers and males



Fig. 3 Male of *B. pascuorum* with tuft of pale yellow hair in the face (red arrow). (Paul Westrich , http://www.wildbienen.info/grossansichten/bomb_pascuorum_m01.htm).

In general, bumblebee workers (and queens) have a pointed tip of the abdomen (Fig. 2), with a small opening for the sting, and 12 antennal segments. Workers can be observed busily collecting pollen and nectar for the colony, whereas males often appear to move more slowly when feeding on nectar. Only workers carry pollen in the corbiculae of their legs. Due to the fairly large genitalia, the genital opening at the tip of the abdomen of male bumblebees is broad and looks truncated (Fig. 2). Moreover, bumblebee males have 13 antennal segments, thus their antennae are longer than the female ones. Males of *B. pascuorum* frequently have a

tuft of pale yellow hairs in their face (Fig. 3). On the first glimpse *B. pascuorum* males look more colourful (orange) than workers, which are often bleached or worn-out.

Table 1 Differences between *B. pascuorum* workers and males.

<i>B. pascuorum</i> worker	<i>B. pascuorum</i> male
pointed tip of abdomen	truncated tip of abdomen
shorter antennae (12 segments)	longer antennae (13 segments)
face not densely haired	tuft with yellow hair in face
often pollen loads in corbiculae	legs without corbiculae
often bleached or worn-out	often more colourful (orange)
fast foraging	slower foraging

Soon after the emergence of the males, young *B. pascuorum* queens will occur. The young queens are larger than the workers and have bright colours. **Please, do not collect any queens for this project!**

Work load

	Working days
Collecting of bumblebees	3-6
Handling, labelling and shipping	2
Total work load	5-8

Cooperation within ALARM

This project will be associated with the PACRAT protocol (LEEDS/READING) and the butterfly and bumblebee inventories (UFZ). It will be conducted in cooperation with Michal Woyciechowski (UJAG) and Mark Brown (University of Dublin).

Photographs

To get an impression of the habitats in which the bumblebees were collected, it would be nice, if you could provide some digital photographs that document the flower rich habitats in which the bumblebees were collected.

Materials provided

1 male and 1 worker *B. pascuorum* (pinned)

1 sweep net

200 vials

1 cooling bag

2 cold packs

Please send the collected bumblebees and all materials back to

Catrin Westphal
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Department of Animal Ecology I
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95447 Bayreuth
Germany

Thank you very much for your cooperation!

ALARM Field Site Network: Bumblebee project

Example: Field protocol for the collection of *B. pascuorum*

ALARM FSN experiment coordinated by C. Westphal, R. Moritz, and I. Steffan-Dewenter

FSN region: *Germany*

Field site name: *Barterode*

disturbed

undisturbed

Field worker: *Catrin Westphal*

Collecting bout no.: *1*

Date: *02.07.2007*

Start time: *15:10*

End time: *16:40*

Duration of collecting bout: *90 min*

No. of observed *B. pascuorum* individuals:

|||| |||| |||| |||| |||| |||| |||| ||||
|||

No. of workers collected: *24*

No. of males collected: *12*

Habitat type:

Cover of flowers (%)

field margin

< 1%

extensive meadow

3 %

Trifolium pratense field

60 %

Notes:

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ALARM Field Site Network: Bumblebee project

Field protocol for the collection of *B. pascuorum*

ALARM FSN experiment coordinated by C. Westphal, R. Moritz, and I. Steffan-Dewenter

FSN region:

Field site name:

disturbed

undisturbed

Field worker:

Collecting bout no.: 1

Date:

Start time:

End time:

Duration of collecting bout:

No. of observed *B. pascuorum* individuals:

No. of workers collected:

No. of males collected:

Habitat type:

Cover of flowers (%)

Notes:

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ALARM Field Site Network: Bumblebee project

Field protocol for the collection of *B. pascuorum*

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FSN region:

Field site name:

disturbed

undisturbed

Field worker:

Collecting bout no.: 2

Date:

Start time:

End time:

Duration of collecting bout:

No. of observed *B. pascuorum* individuals:

No. of workers collected:

No. of males collected:

Habitat type:

Cover of flowers (%)

Notes:

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ALARM Field Site Network: Bumblebee project

Field protocol for the collection of *B. pascuorum*

ALARM FSN experiment coordinated by C. Westphal, R. Moritz, and I. Steffan-Dewenter

FSN region:

Field site name:

disturbed

undisturbed

Field worker:

Collecting bout no.: 3

Date:

Start time:

End time:

Duration of collecting bout:

No. of observed *B. pascuorum* individuals:

No. of workers collected:

No. of males collected:

Habitat type:

Cover of flowers (%)

Notes:

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ALARM Field Site Network: Bumblebee project

Field protocol for the collection of *B. pascuorum*

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FSN region:

Field site name:

disturbed

undisturbed

Field worker:

Collecting bout no.:

Date:

Start time:

End time:

Duration of collecting bout:

No. of observed *B. pascuorum* individuals:

No. of workers collected:

No. of males collected:

Habitat type:

Cover of flowers (%)

Notes:

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