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The bumblebees of North China (Apidae, *Bombus* Latreille)

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Abstract

Bumblebees are important pollinators for wild flowers and agricultural crops. North China is a region of varied geomorphology and vegetation, with plateaus, plains, mountains and deserts, and is part of the greatest hotspot of bumblebee diversity worldwide. We report on a field survey of the bumblebees of North China made between 2005–2012. A sample of 21,636 bumblebee specimens are assigned to 76 species. One older specimen held in London added one more species to this list. Together, these 77 species represent 10 subgenera of the genus *Bombus*. Seven species are recorded from North China for the first time: *B. (St.) distinguendus*, *B. (Th.) anachoreta*, *B. (Th.) pseudobaicalensis*, *B. (Th.) exil*, *B. (Ps.) campestris*, *B. (Pr.) infirmus* and *B. (Ag.) validus*. We provide identification keys for both males and females, photographs of the common colour patterns, and distribution maps for all species. We describe variation in local species richness and abundance, and list the food plants used by bumblebees in North China. The most abundant 10 bumblebee species are: *B. (Ml.) pyrosoma*, *B. (Bo.) lantschouensis*, *B. (Bo.) patagiatus*, *B. (St.) melanurus*, *B. (Sb.) sibiricus*, *B. (Bo.) ignitus*, *B. (Th.) hedinii*, *B. (Pr.) picipes*, *B. (Mg.) trifasciatus* and *B. (Mg.) longipes*. Bumblebees are distributed widely within North China, from low elevations near the edge of the North-China plain to high elevations at the edge of the east Qinghai-Tibetan plateau (65–4011 m). The highest species richness is found in meadows of the high elevation east Qinghai-Tibetan plateau and in forests of the Qilianshan mountains in southwestern Gansu. The 337 food plant species recorded here belong to 49 families, showing that bumblebees play an important role in interconnecting agricultural and natural ecosystems in North China.

Key words: fauna, biogeography, distribution, richness, abundance, pollinator, food plants, key to species

Introduction

Insect pollination is important in agricultural production and in natural ecosystems (Williams, 1994; Morse & Calderone, 2000; Velthuis & van Doorn, 2006; Losey & Vaughan, 2008; Chacoff *et al.*, 2010; An & Chen, 2011; Bommarco *et al.*, 2012). Bumblebees are worth tens of billions of dollars for the commercial pollination of many fruit and vegetable crops (Velthuis & van Doorn, 2006). Klein *et al.* (2007) reviewed the literature and concluded that 85% of the 107 crops used directly for human food in the world are dependent on insect pollination. Gallai *et al.* (2009) used the figures from this review to calculate that the total economic value of animal pollination worldwide amounted to €153 billion, which represented 9.5% of the total value of the agricultural production used directly for human food in 2005.

Currently approximately 250 bumblebee species are recognized worldwide, occurring throughout most of Eurasia and the Americas, especially in the high mountains of the Northern Hemisphere (Williams, 1998). There is mounting evidence that many bumblebee species have declined in recent decades, particularly in developed regions such as western Europe, North America and South America (Williams, 1982; Grixti *et al.*, 2009; Cameron *et al.*, 2011; Morales *et al.*, 2013). Principal causes are all believed to be linked to human activities and include habitat destruction, pesticides, introduced species including pathogens and parasites, and food competition (Goulson *et al.*, 2008; Williams & Osborne 2009; Gill *et al.*, 2012; Laycock *et al.*, 2012; Whitehorn *et al.*, 2012; Arbetman *et al.*, 2013; Graystock *et al.*, 2013; Morales *et al.*, 2013).

China is the country richest in bumblebee species world-wide, with approximately 50% (125 species based on the records of IAB and IZB) of all of the world's known bumblebee species (Williams, 1998). Although China has a similar land area to the USA or to Europe, it has more than twice as many bumblebee species as the USA and more than 50% more than Europe (Williams, 1998; Williams *et al.*, 2014).

So far the bumblebee fauna of North China has been insufficiently studied, so there has been a serious taxonomic impediment to recognising which species occur where. A major part of this problem is that species in Asia often show extreme variability in colour patterns within species (Williams *et al.*, 2009), while some species mimic one another closely in colour pattern (Williams, 2007).

North China is a region of very varied geomorphology and vegetation with different plateaus, plains, mountains and deserts (Zhao, 1995), and overlaps with part of the greatest hotspot of bumblebee diversity in the world (Williams, 1998; Williams *et al.*, 2010; An *et al.*, 2011). There is a broad diversity of habitats within the region, including not only the high elevation east Qinghai-Tibetan plateau meadows and the associated Qilianshan mountain meadows in the west, the wet Qin-Ba mountains forests in the south, the semi-arid Loess plateau scrub in the centre, and the low elevation agriculture of the Hebei plain in the southeast. There are also the forests of the Taihang mountains, the Yanshan mountains, and the Great Khingan mountains, from the southeast to the northeast, and the Otindag semi-desert, the Mu Su semi-desert, the Tengger desert, the Badain Jaran desert, and the arid Beishan mountains from the north to the northwest (Liu *et al.*, 2002; Guo *et al.*, 2005; An *et al.*, 2010; An *et al.*, 2011; Wu *et al.*, 2011) (Fig. 1, 2). This variety makes North China a good place for studying species' distribution patterns in relation to habitat variation.

Previous reports on the bumblebees of North China have been based on only small collections (Bischoff, 1936; Panfilov, 1957; Tkalců, 1961) and often from very restricted parts of the region (Yao & Wang, 2005; Jiang, 2007). Other bumblebee faunal reviews that cover some parts of the fauna of this region include those dealing with Xizang (Wang, 1982), Xinjiang (Wang & Yao, 1985), Kashmir (Williams, 1991), Zhejiang (Wang & Yao, 2004), Chongqing (Yao & Luo, 1997), and Sichuan (Williams *et al.*, 2009). None of these papers describe distribution patterns within North China.

Since 2005, the BBCI (Bumblebees of China Initiative) has carried out a systematic survey of bumblebees across China (Williams *et al.*, 2010). Within North China, accounts of smaller surveys of Shanxi (An *et al.*, 2008), the Hebei Region (An *et al.*, 2010), and Gansu (An *et al.*, 2011) have already been published. Here, we report on the larger combined survey of all of North China made between 2005–2012, to describe the current distribution and taxonomic status of all of the region's bumblebee species. From this, the largest sample available so far, we summarize available information on the geographic and elevational distributions of the species.

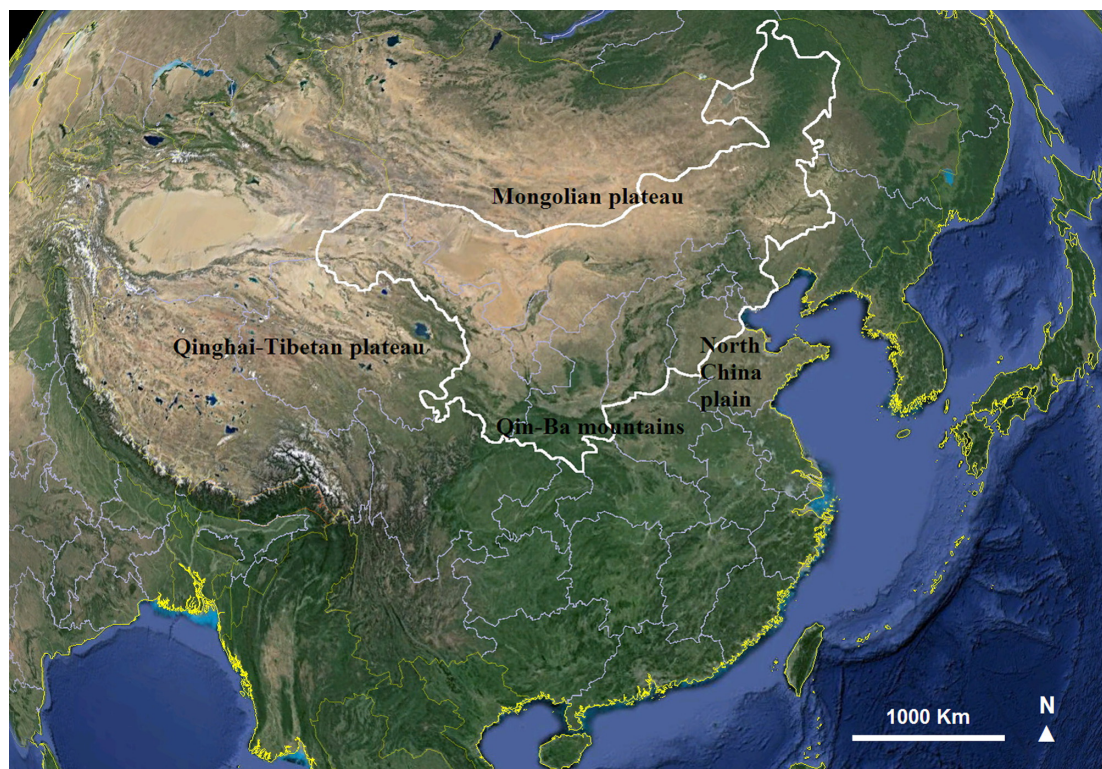


FIGURE 1. Map of China showing the region of North China treated in this study (outlined in white). The main geomorphological features around this region are marked as the Mongolian plateau, the Qinghai-Tibetan plateau, the Qin-Ba mountains and the North China plain. Background image from GoogleEarth using data from: SIO, NOAA, US Navy, NGA, GEBCO, IBCAO, Landsat.



FIGURE 2. Map of North China showing the principal geomorphological structures (numbered in white) within North China, 1: the Qilian mountains; 2: the east Qinghai-Tibetan plateau; 3: the Qin-Ba mountains; 4: the Loess plateau; 5 the Hebei plain; 6: the Taihang mountains; 7: the Yanshan mountains; 8 the Great Khingan mountains; 9: the Otindag semi-desert; 10: the Mu Su semi-desert; 11: the Tengger desert; 12: the Badain Jaran desert; 13: the dry Beishan mountains. Background image as in Fig. 1.

Material and methods

Material examined. For this paper we consider the administrative region of North China that includes Beijing, Tianjin, Hebei, Shanxi, and Neimenggu, but extend it to include Shaanxi, Gansu, and Ningxia. The land area of North China in the sense of this study is 2.3×10^6 km² (Fig. 2). Sample sites were chosen preferentially from nature reserves, forest parks, and scenic spots with relatively undisturbed vegetation. These represent the broad spectrum of environmental variation, from the Neimenggu (Inner Mongolian) plateau, the edge of the east Qinghai-Tibetan plateau, the Loess plateau, the Taihang mountains, the Yanshan mountains, the Great Khingan mountains, the Qin-Ba mountains, the Qilianshan mountains, the Otindag semi-desert, the Mu Su semi-desert, the Tengger desert, the Badain Jaran desert and the arid Beishan mountains within North China. Most field visits were made while travelling from south to north between June and September each year. At each site, bumblebees were collected at random for 1–2 hours within 0.25 km² by 3–4 non-specialists (most without identification training), on sunny days or on cloudy but bright days. Major sites were visited at least three times during the eight years. Bumblebees were collected into empty plastic water bottles with breathing holes in the sides and containing paper towels to absorb excess moisture. Site data (latitude, longitude, and elevation) were taken from a hand-held GPS (GARMIN eTrex Vista HCx, China). At the same time, digital pictures were taken of the food plants visited by bees, both of the whole plants and of the flowers and the leaves. All bumblebee specimens were pinned, labelled, and given individual identifier numbers in the laboratory before being identified. Specimens were identified by comparison with original type specimens and other reference material. Specimens from 15 depositories have been examined for this study (Table 1). Some difficult species (*B. lucorum*, *B. longipennis*, and *B. cryptarum*; *B. patagiatus*, *B. lantschouensis*, and *B. minshanensis*; *B. czerskii*, *B. sushkini* s.l., and *B. consobrinus*; *B. laesus*, *B. filchnerae*, *B. deuteronymus*, *B. pseudobaicalensis*, and *B. humilis*; *B. branickii*, and *B. rupestris*; *B. validus* and *B. nobilis*) were identified in part from COI barcode sequences. Specimens were then databased using individual identifier numbers as a reference and deposited in the collection of the Institute of Apiculture, Chinese Academy of Agricultural Sciences, Beijing, China (IAB). Food plants were identified as far as possible from photographs by Dr. Lei Meng of China Agricultural University and Dr. Gangmin Zhang of Beijing Forest University, and all plant names were checked against the International Plant Names Index (<http://www.ipni.org>, accessed July 5, 2013).

TABLE 1. Collections from which material has been examined.

Abbreviation	Address
BMNH	Natural History Museum, London, UK
OLL	The Oberösterreichisches Landesmuseum, Linz, Austria
IAB	Institute of Apiculture, Chinese Academy of Agricultural Sciences, Beijing, PRC
INHS	Illinois Natural History Survey, Urbana, Illinois, USA
ISEAK	Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, Kraków, Poland
IZB	Institute of Zoology, Chinese Academy of Sciences, Beijing, PRC
LSL	Linnean Society, London, UK
MNHU	Museum für Naturkunde an der Humboldt-Universität, Berlin, Germany
PHW	Paul Williams, London, UK
UMO	University Museum, Oxford, UK
USNM	US National Museum of Natural History, Washington DC, USA
ZISP	Zoological Institute, Russian Academy of Sciences, St Petersburg, Russia
ZMA	Zoological Museum Amsterdam, Amsterdam, The Netherlands
ZMC	Zoological Museum, University of Copenhagen, Copenhagen, Denmark
ZMMU	Zoological Museum of the Moscow State University, Moscow, Russia

Analysis. The distribution and species richness maps were drawn using ESRI ArcView version 3.3. Species were classified by abundance as rare/common/abundant species in quartiles (<25% / 25–75% / >75% of species after the species had been ranked by their numbers of records). Similarly, species were classified by elevation as

low/medium/high elevation species by quartiles after they had been ranked by their recorded elevation. The Provinces of China are grouped into regions following the list of administrative divisions, as North (Beijing, Tianjin, Hebei, Shanxi, Neimenggu), Northeast (Liaoning, Jilin, Heilongjiang), East (Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Shandong), Southcentral (Henan, Hubei, Hunan, Guangdong, Guangxi, Hainan), Southwest (Chongqing, Sichuan, Guizhou, Yunnan, Xizang), Northwest (Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang), Hongkong, Macau and Taiwan (PRC, 2007). The food plants are listed in alphabetical order both for families and for genera and species.

Results

In this review, 21,636 bumblebee specimens, collected from 570 sites (Fig. 3) in North China between 2005 and 2012, were assigned to 76 species. One older specimen held in London added one more species to this list. Together, these 77 species belong to 10 of the 15 subgenera of the genus *Bombus* (Table 2).

TABLE 2. List of the bumblebee species and their distributions by province in North China, *Md.*: *Mendacibombus*; *St.*: *Subterraneobombus*; *Mg.*: *Megabombus*; *Th.*: *Thoracobombus*; *Ps.*: *Psithyrus*; *Pr.*: *Pyrobombus*; *Bo.*: *Bombus s. str.*; *Ag.*: *Alpigenobombus*; *ML.*: *Melanobombus*; *Sb.*: *Sibiricobombus*. BJ, Beijing; TJ, Tianjin; HB, Hebei; SX, Shanxi; NMG, Neimenggu; SAX, Shaanxi; GS, Gansu; NX, Ningxia; O, Oriental; P, Palaearctic; W, Widespread (Oriental+Palaearctic); NS, Number of specimens; ME, Median elevation (m); WD, World distribution.

Species	Distribution in North China								NS	ME	WD
	BJ	TJ	HB	SX	NMG	SAX	GS	NX			
<i>B.(Md.) convexus</i>							•		106	3050	O
<i>B.(Md.) waltoni</i>							•		39	3386	O
<i>B.(St.) personatus</i>							•		15	3386	O
<i>B.(St.) difficillimus</i>							•		1	3656	O, Pb
<i>B.(St.) melanurus</i>	•		•	•	•	•	•	•	1656	1644	W
<i>B.(St.) amurensis</i>			•		•				57	1446	P, Ob
<i>B.(St.) subterraneus</i>					•				1	618	P
<i>B.(St.) distinguendus*</i>					•				4	1174	P
<i>B.(Mg.) ussurensis</i>			•		•				54	675	W
<i>B.(Mg.) longipes</i>	•		•	•		•	•	•	535	1476	O, Pb
<i>B.(Mg.) trifasciatus</i>						•	•		564	1218	O
<i>B.(Mg.) bicoloratus</i>						•	•		48	733	O
<i>B.(Mg.) supremus</i>							•		7	3279	O
<i>B.(Mg.) religiosus</i>						•	•	•	6	2407.5	O
<i>B.(Mg.) czerskii</i>			•	•	•		•		30	1174	W
<i>B.(Mg.) sushkini s. l.</i>							•	•	73	2739	O
<i>B.(Mg.) consobrinus</i>	•		•	•	•		•	•	254	1992	W
<i>B.(Mg.) koreanus</i>	•		•	•		•	•		99	1146	W
<i>B.(Th.) laesus</i>	•		•	•	•		•	•	224	1290	W
<i>B.(Th.) filchnerae</i>			•	•	•		•	•	224	2032	W
<i>B.(Th.) muscorum</i>					•				3	602	P
<i>B.(Th.) anachoreta*</i>					•				12	215	W
<i>B.(Th.) opulentus</i>	•	•	•	•		•	•	•	360	976	W
<i>B.(Th.) deuteronymus</i>			•	•	•		•		88	877	W
<i>B.(Th.) humilis</i>	•		•	•	•	•	•	•	152	1572	W

.....continued on the next page

TABLE 1. (Cotnined)

Species	Distribution in North China								NS	ME	WD
	BJ	TJ	HB	SX	NMG	SAX	GS	NX			
<i>B.(Th.) pascuorum</i>					•				28	649	P
<i>B.(Th.) schrencki</i>			•	•	•			•	64	1665	W
<i>B.(Th.) hedinii</i>	•	•	•	•	•	•	•	•	1105	1621	W
<i>B.(Th.) pseudobaicalensis*</i>					•				71	649	P
<i>B.(Th.) remotus</i>				•		•	•	•	511	1705	O
<i>B.(Th.) impetuosus s. l.</i>							•	•	186	2531.5	O
<i>B.(Th.) exil*</i>					•				7	649	P
<i>B.(Th.) tricornis</i>	•								1	1590	P, Ob
<i>B.(Th.) atripes</i>						•			11	628	O
<i>B. (Ps.) tibetanus</i>							•		1	3350	O
<i>B. (Ps.) cornutus</i>				•		•	•	•	13	1932	O
<i>B. (Ps.) turneri</i>									2	2584.5	O
<i>B. (Ps.) expolitus</i>							•		3	3524	O
<i>B. (Ps.) chinensis</i>									21	2436	O
<i>B. (Ps.) rupestris</i>							•	•	5	2601	W
<i>B. (Ps.) bellardii</i>						•			9	1064	O
<i>B. (Ps.) campestris*</i>								•	9	2594	P
<i>B. (Ps.) bohemicus</i>			•	•	•		•		11	1665	W
<i>B. (Ps.) coreanus</i>	•		•			•	•		7	1379	O, Pb
<i>B. (Ps.) barbutellus</i>	•			•					2	2291	P
<i>B. (Ps.) skorikovi</i>							•	•	54	2580	O
<i>B. (Ps.) norvegicus</i>			•				•		7	1992	W
<i>B. (Ps.) sylvestris</i>				•					5	1490	P, Ob
<i>B.(Pr.) hypnorum</i>				•		•	•	•	103	1705	W
<i>B.(Pr.) lemniscatus</i>						•	•		18	2865	O
<i>B.(Pr.) lepidus</i>							•	•	444	2588	O
<i>B.(Pr.) infirmus*</i>						•			1	2556	O
<i>B.(Pr.) picipes</i>	•	•	•	•		•	•	•	688	1585	W
<i>B.(Pr.) infrequens</i>							•		20	1992	O
<i>B.(Pr.) flavescens</i>				•		•	•		10	1024.5	O
<i>B.(Pr.) modestus</i>			•	•	•	•		•	30	2076	W
<i>B.(Pr.) wangae</i>						•	•		113	2767	O
<i>B.(Bo.) sporadicus</i>					•				8	649	P
<i>B.(Bo.) ignitus</i>	•	•	•	•		•	•		1192	1193	O
<i>B.(Bo.) longipennis</i>						•	•	•	387	2177	O
<i>B.(Bo.) lucorum</i>					•				2	534	P, Ob
<i>B.(Bo.) lantschouensis</i>	•		•	•	•	•	•	•	2486	1796	P, Ob
<i>B.(Bo.) minshanensis</i>							•		69	3279	O
<i>B.(Bo.) patagiatus</i>	•		•	•	•	•	•	•	1986	1652	P, Ob
<i>B.(Bo.) cryptarum</i>				•	•				13	1779	W
<i>B.(Ag.) kashmirensis</i>							•		155	3188	O, Pb

.....continued on the next page

TABLE 1. (Cotnined)

Species	Distribution in North China								NS	ME	WD
	BJ	TJ	HB	SX	NMG	SAX	GS	NX			
<i>B.(Ag.) validus</i> *							•		104	3188	O
<i>B.(Ag.) grahami</i>						•	•		14	1754	O
<i>B.(Ag.) breviceps</i>						•	•		31	801	O
<i>B.(Ml.) festivus</i>						•	•		96	1992	O
<i>B.(Ml.) rufofasciatus</i>							•		383	3011	O, Pb
<i>B.(Ml.) pyrosoma</i>	•	•	•	•	•	•	•	•	4489	1590	O, Pb
<i>B.(Ml.) ladakhensis</i>							•		26	3386	O, Pb
<i>B.(Ml.) keriensis</i>							•		139	2576	W
<i>B.(Ml.) sichelii</i>			•	•	•		•	•	468	1642	W
<i>B.(Sb.) sibiricus</i>			•		•	•	•	•	1390	1751	W
<i>B.(Sb.) asiaticus</i>							•		27	2834	W
Total	17	5	25	28	28	30	56	29	21637		

*: New record for North China

O, P border =O; P, O border=P. As regional components analysis in this study.

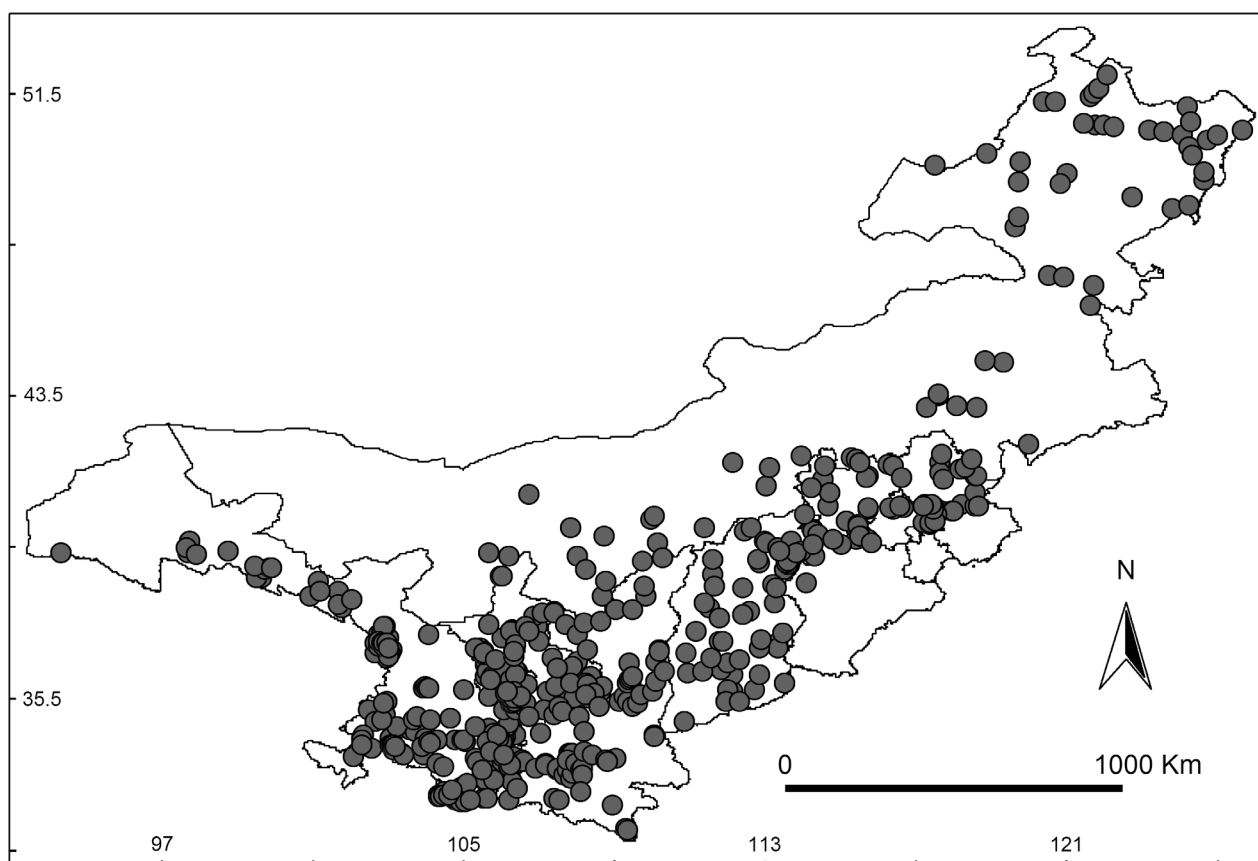


FIGURE 3. Map of North China showing the sites with records of bumblebees collected between 2005 and 2012 as grey spots with the province boundaries shown in grey.

Key to the species of the genus *Bombus* known from North China for females:

- 1 Hind tibia with the outer surface broad, almost flat, most of the outer surface in the distal half without moderate to long hairs, but fringed with stout hairs that form a pollen basket (corbicula), the inner distal margin with a comb of stout spines (rastellum); S6 without ventro-lateral keels 2
- Hind tibia with the outer surface strongly and uniformly convex and uniformly densely covered with moderate to long stout hairs throughout, the fringing hairs often poorly differentiated and not forming a pollen basket (corbicula), the inner distal margin without a comb of stout spines (rastellum); S6 with ventro-lateral keels 45 *Psithyrus*
- 2 (1) Mandible with the anterior keel reaching and continuous with the distal margin; the labrum with a longitudinal median furrow and a ventral transverse lamella; hindleg tibia outer surface smooth, shiny and with at most with one or two stout long hairs near the centre in the proximal half 3
- Mandible with the anterior keel not reaching and separated from the distal margin; the labrum lacks a distinct longitudinal median furrow and ventral transverse lamella; hindleg tibia outer surface rough, matte and with many widely spaced stout long hairs near the centre in the proximal half 10 *Mendacibombus*
- 3 (2) Mandible distally broadly rounded, with two anterior teeth and often a posterior tooth; hindleg basitarsus with the longest erect hairs near the anterior margin of the outer surface as long as or usually shorter than the narrowest breadth of the basitarsus 4
- Mandible distally not broadly rounded, but with six evenly-spaced large triangular teeth (which may become worn down); hindleg basitarsus with the longest erect hairs near the anterior margin of the outer surface as long or longer than the narrowest breadth of the basitarsus (but which may become broken off) 73 *Alpigenobombus*
- 4 (3) Midleg basitarsus with the distal posterior corner extended to form a sharp angle of 45° or less, often produced as a narrow tooth or spine (it may be less pronounced in some of the smallest individuals), *or if* borderline *then* the cheek (oculo-malar area) in the centre with many small widely-spaced punctures (e.g. *B. (Sb.) sibiricus*) 5
- Midleg basitarsus with the distal posterior corner broadly or narrowly rounded, but forming an angle of more than 45° and without a narrow tooth or spine, *or if* borderline *then* the area between the lateral ocellus and the inner margin of the eye with the unpunctured shining part occupying three quarters of the distance between the lateral ocellus and the eye (e.g. *B. (Pr.) hypnorum*) 8
- 5 (4) Hindleg basitarsus with the proximal posteriorly-directed process with the dense plume of moderately long branched hairs on its proximal surface not continuing onto its outer surface, which is shining and often bare, or at most the outer surface with widely scattered rather reclining short hairs with broad shining areas between them; cheek (oculo-malar area) in the centre smooth and shining at most with a few very shallow punctures; median ocellus with its anterior margin lying on the narrowest line between compound eyes 6
- Hindleg basitarsus with the proximal posteriorly-directed process with the dense plume of moderately long branched hairs on its proximal surface continuing onto its outer surface as a dense erect brush of moderately long branched hairs that obscures the outer surface of the basitarsus between them; cheek (oculo-malar area) in the centre with many small widely-spaced punctures; median ocellus with its anterior margin lying anterior to the narrowest line between the compound eyes 81 *Sibiricobombus*
- 6 (5) Clypeus central area bulbous and often with at least a very few scattered large or medium punctures, *or if* the clypeus is mostly smooth and shining *then* the clypeus has a dorsal median longitudinal groove marked with punctures and the cheek (oculo-malar area) is more than half as long as the eye; the corbicular fringes are always longer than the greatest breadth of the hindleg tibia; S6 *either* without a raised median longitudinal ridge in the posterior one third *or if* a strong ridge is present *then either* the clypeus has medium and large punctures *or* antennal segment A4 is shorter than broad 7
- Clypeus central area flattened and often smooth and shining with only widely spaced micro-punctures, the larger punctures only at the edges, *or if* the clypeus is more extensively and densely covered with many small and medium punctures *then* the corbicular fringes are shorter than the greatest breadth of the hindleg tibia; clypeus without a dorsal median longitudinal groove marked with punctures; cheek less than half as long as the eye; S6 with a raised and often shiny median longitudinal keel in the posterior one third 11 *Subterraneobombus*
- 7 (6) S2 usually slightly bulging between the anterior and posterior margins in a weakly rounded transverse ridge; hindleg tibia with the corbicular surface moderately convex and often swollen anteriorly and lacking any posterior concavity in the distal half; clypeus dorsally uniformly convex and always without a deep dorsal median longitudinal groove with many punctures 27 *Thoracobombus*
- S2 flat between the anterior and posterior margins, with the weakly bulging transverse ridge absent; hindleg tibia with the corbicular surface nearly flat and only very weakly convex anteriorly and distinctly very slightly concave posteriorly in the distal half; clypeus in its dorsal third usually with a deep median longitudinal groove marked with many punctures 16 *Megabombus*
- 8 (4) Mandible near its distal posterior corner with a notch (incisura) that is nearly as deep as wide separating a strong posterior tooth (which may become worn down); clypeus in its central area always strongly swollen and bulging, contrasting with deep lateral depressions adjacent and parallel to the labral margin, large punctures dense throughout with few smaller punctures; hindleg basitarsus posterior margin broadly and evenly strongly curved 65 *Bombus s. str.*
- Mandible near its distal posterior corner with a notch (incisura) that is usually less than half as deep as wide, or often completely lacking and not separating a weak posterior tooth; clypeus in its central area usually weakly swollen or nearly flat, with only shallow lateral depressions adjacent and parallel to the ventral labral margin, large punctures at most widely scattered among many more of the smaller punctures; hindleg basitarsus posterior margin often curved *either* evenly but weakly, *or* much more strongly in its proximal half and nearly straight in its distal half 9
- 9 (8) Central area of the clypeus with widely scattered large and small punctures, appearing irregular and dull; area between the lat-

eral ocellus and the inner margin of the eye with the band of punctures along the inner margin of the eye dorsally usually for most of its length with very few small punctures, mostly consisting of a few scattered large punctures separated by shining areas broader than the puncture widths, the large unpunctured and shining area adjacent to the ocellus usually large, occupying as much as three quarters of the distance between the lateral ocellus and the inner margin of the eye; hindleg basitarsus in the distal half with short slightly feathered hairs widely spaced so that the shining surface is clearly visible in between

- 57 *Pyrobombus*
- Central area of the clypeus with scattered mostly small punctures, appearing smooth and shiny, *or if* with large punctures *then* the labrum with the median longitudinal furrow only 0.2× the labral breadth; area between the lateral ocellus and the inner margin of the eye with the band of punctures along the inner margin of the eye dorsally usually with many small and large punctures intermixed and separated by less than the widths of the large punctures, *or if* there are few small punctures *then* the part of the puncture band with only large punctures is absent or occupies only a short part of its length and the unpunctured and the shining area adjacent to the ocellus occupies less than half of the distance between the lateral ocellus and the inner margin of the eye; hindleg basitarsus in the distal half with dense overlapping short slightly feathered hairs largely obscuring the shining surface 76 *Melanobombus*
- 10 (2) *Mendacibombus*: hair of the thoracic dorsum with black and white hairs intermixed without a distinct anterior white band, T4–5 orange with white tips (Gansu) *B. waltoni*
- Hair of the thoracic dorsum with black and white hairs but with a distinct anterior white band, T4–5 mainly white without orange (Gansu) *B. convexus*
- 11 (6) *Subterraneobombus*: clypeus smooth and shining with only micropunctures in its central half, hair of T4–5 either white or yellow or black, or pale with continuous anterior black bands 12
- Clypeus rough with small and large punctures scattered throughout, hair of T4–5 yellow with black posteriorly-directed anterior triangles in the middle *B. amurensis*
- 12 (11) Clypeus with the micropunctures sparse, most separated by more than 2× their own breadths; hair of T1–2 *either* extensively black, *or if* T1–2 entirely yellow or white, *then either* T3–4 entirely black, *or* T3–4 mostly yellow 13
- Clypeus with many micropunctures, many separated by only 2× their own breadths; hair of T1–2 entirely yellow or cream-yellow, T3–4 usually black with broad posterior fringes of long white hairs, *or if* with only a few pale hairs, *then* the black band between the wing bases is nearly as broad as the yellow thoracic bands combined *and* black hairs intermixed throughout the posterior half of the anterior yellow thoracic band (Gansu) *B. personatus*
- 13 (12) Hair of T1–2 entirely yellow or white, T3–5 usually entirely black 14
- Hair of T1–2 *either* extensively black, *or if* T1–2 entirely yellow *then* T3–4 also mostly yellow 15
- 14 (13) Clypeus with a few sparse small punctures in its central half; hair of the thoracic dorsum *either* entirely yellow, *or if* a black band is present between the wing bases, *then* it is less than 0.8× the breadth of the anterior yellow thoracic band; pale hair of the thorax lemon yellow or straw yellow, but usually only cream yellow if faded by the sun; hair (short) on T2 straight and erect over the anterior one quarter (or less), curved and more decumbent over the posterior three quarters; T5 with longest hairs projecting beyond the posterior edge by less than the greatest breadth of the hindleg basitarsus *B. melanurus*
- Clypeus almost devoid of even micropunctures in its central half; hair of the thoracic dorsum with a black band between the wing bases, which is 0.75–1.0× the breadth of the anterior yellow or white thoracic band; pale hair of the thorax cream yellow or white; hair (long) of T2 straight and erect over the anterior two thirds, curved and more decumbent along the posterior edge; T5 with longest hairs projecting beyond the posterior edge by more than the greatest breadth of the hindleg basitarsus (Gansu) *B. difficillimus*
- 15 (13) Hair of T1–3 mostly yellow or brown, T4–5 with yellow or brown or black hair, but never white hair (Neimenggu) *B. distinguendus*
- Hair of T1–3 with extensive and conspicuous areas of black, usually with narrow posterior fringes of short white or yellow hairs, T3–5 with conspicuous white hair (Neimenggu) *B. subterraneus*
- 16 (7) *Megabombus*: cheek (oculo-malar area) length <1.5× the breadth of the mandible at its base between and including the mandibular articulations; hair of T3 black with a yellow patch near the midline, tail orange *B. bicoloratus*
- Cheek (oculo-malar area) length >1.5× the breadth of the mandible at its base between and including the mandibular articulations; hair of T3 and tail black or brown or yellow or white or orange 17
- 17 (16) Hair of the thoracic dorsum yellow or orange or brown, without an obvious band of black hairs between the wing bases ... 18
- Hair of the thoracic dorsum yellow or orange or brown, with an obvious band of black hairs between the wing bases ... 21
- 18 (17) Antennal segment A4 shorter than broad 19
- Antennal segment A4 as long as or longer than broad 20
- 19 (18) Hair of T3–6 black at most with a few slightly paler hairs in posterior fringes and especially at the sides, thoracic dorsum orange-brown, corbicular fringes black but sometimes with pale tips *B. longipes*
- Hair of T3–6 black with broad posterior white fringes, thoracic dorsum yellow, corbicular fringes pale *B. ussurensis*
- 20 (18) Hair of the thoracic dorsum yellow or yellow-brown, lower side of the thorax nearly white, T4–5 extensively white, corbicular fringes extensively pale tipped, hair long *B. consobrinus*
- Hair of the thoracic dorsum orange-brown, lower side of the thorax black, T4–5 extensively orange or yellow, corbicular fringes black, hair short *B. koreanus*
- 21 (17) Hair of the thoracic dorsum white with a broad black band between the wing bases, at least T3 bright red (Gansu) *B. supremus*
- Hair of the thoracic dorsum entirely black or with some yellow or brown hairs anteriorly and posteriorly, T3 black or brown or yellow or white 22
- 22 (21) Antennal segment 4 shorter than broad, hair of T5 orange *B. trifasciatus*

-	Antennal segment 4 as long as or longer than broad, hair of T5 black or brown or yellow or white	23
23(22)	Hair of the thoracic dorsum usually bright yellow with a clearly defined black band between the wing bases, the yellow without black hairs extensively intermixed	25
-	Hair of the thoracic dorsum predominantly black with only dull yellow or brown hairs intermixed anteriorly and posteriorly in very weakly defined bands	24
24(23)	Hair of the side of the thorax and T1 black or orange	<i>B. koreanus</i>
-	Hair of the side of the thorax and T1 pale yellow-white	<i>B. consobrinus</i>
25(23)	Hair of T1 bright lemon yellow, T2 entirely black, T5 more than the median half stretching from the midline is black	<i>B. religiosus</i>
-	Hair of T1 dull sand yellow, T2 yellow at least anteriorly, T5 predominantly white at most with the median third black	26
26(25)	Short hair of the face pale, thoracic dorsum with the black band between the wing bases without yellow hairs intermixed, lower side of the thorax and the leg bases entirely white, T2–3 sometimes predominantly pale, hair length medium	<i>B. sushkini</i>
-	Short hair of the face black, thoracic dorsum with the black band between the wing bases often with yellow hairs intermixed, lower side of the thorax and the leg bases predominantly black or at least with many black hairs intermixed, T2–3 predominantly black, hair very short	<i>B. czerskii</i>
27(7)	<i>Thoracobombus</i> : hair of the thoracic dorsum orange-brown, any black hairs on the thoracic dorsum either concentrated anteriorly or in a minority and not obviously forming a distinct black band or spot between the wing bases	28
-	Hair of the thoracic dorsum grey or yellow or brown, with a distinct black band or spot or obviously greater concentration between the wing bases	35
28(27)	Corbicular fringes predominantly black or sometimes a few hairs with pale tips, hair of the face predominantly black or sometimes the short hair is yellow	29
-	Corbicular fringes predominantly yellow or sometimes a few hairs black, hair of the face predominantly yellow	32
29(28)	Hair of T3–6 entirely black	<i>B. opulentus</i>
-	Hair of T3–6 extensively orange or yellow	30
30(29)	Hair of the side of the thorax black, thoracic dorsum and T1–5 entirely bright orange-red, wings uniformly dark brown (Shaanxi)	<i>B. atripes</i>
-	Hair of the side of the thorax may be black but usually brown or yellow or white, thoracic dorsum and T1–5 extensively yellow, or if orange then the side of the thorax with orange hairs at least intermixed and T5 often with some black hairs, wings yellow near the body and grey distally	31
31(30)	Hair of the face mostly black or grey, T1–4 when viewed from the side nearly uniformly orange, T4 in the median area with the hairs rising from flat punctures separated by 1–2× their own breadths	<i>B. hedini</i> (part)
-	Shorter hair of the face and T1 yellow, T2–4 when viewed from the side orange anteriorly and yellow posteriorly, T4 in the median area with the hairs rising from raised pustulate punctures separated by 0.5–1× their own breadths	<i>B. tricornis</i>
32(28)	Hair of T2–3 with some black laterally	33
-	Hair of T2–3 without black laterally	34
33(32)	Hair of T5 often with very little black but T2–4 with small patches of black laterally or rarely medially on some segments, thoracic dorsum grey or brown with many black hairs concentrated anteriorly (Neimenggu)	<i>B. pascuorum</i> (part)
-	Hair of T2 usually with very little black but T3–5 with broad black anterior bands, thoracic dorsum orange with few scattered black hairs	<i>B. schrencki</i>
34(32)	T3–5 with the median posterior hairless areas large and smooth and very shiny, corbicular surface in the proximal third strongly convex and forming a strong longitudinal ridge	<i>B. laesus</i> (part)
-	T3–5 with the median posterior hairless areas small and striate and dull, corbicular surface in the proximal third weakly convex without a strong longitudinal ridge (Neimenggu)	<i>B. muscorum</i>
35(27)	Hair of the tail bright orange	36
-	Hair of the tail yellow or grey or black	37
36(35)	Hair of T2 yellow with black intermixed laterally, T3 predominantly black, thoracic dorsum with either a more (queens) or a less (workers) well defined band of black between the wing bases	<i>B. remotus</i>
-	Hair of T2 grey or yellow anteriorly with orange posteriorly, sometimes with black extensively between them, T3 predominantly orange, thoracic dorsum with a well defined band of black between the wing bases, the black extending posteriorly in a median point	<i>B. impetuus</i>
37(35)	Hair of the thoracic dorsum yellow or white with a very well defined band or spot of black between the wing bases with few or no black hairs intermixed in the anterior pale band, T4–5 yellow or white with few or no black hairs	38
-	Hair of the thoracic dorsum brown or yellow or white with black intermixed between the wing bases and with many black hairs intermixed in the anterior pale band, T4–5 brown or yellow or white with many black hairs	41
38(37)	Hair of T2–3 extensively black (Neimenggu)	<i>B. exil</i>
-	Hair of T2–3 yellow	39
39(38)	Hair of the face and the femora of the legs almost entirely bright lemon yellow (Neimenggu)	<i>B. anachoreta</i>
-	Hair of the face and the femora of the legs with many black hairs	40
40(39)	Hair of the corbicular fringes and S2–5 black	<i>B. filchnerae</i>
-	Hair of the corbicular fringes and S2–5 with yellow intermixed	<i>B. laesus</i> (part)
41(37)	Hair of the thoracic dorsum with some brown at least posteriorly	42
-	Hair of the thoracic dorsum grey and black	43
42(41)	Hair of the thoracic dorsum brown sometimes with black intermixed, side of the thorax black with some brown intermixed, hair short	<i>B. hedini</i> (part)

- Hair of the thoracic dorsum brown posteriorly and grey anteriorly with black widely intermixed, side of the thorax grey without black intermixed, hair long (Neimenggu) **B. pascuorum** (part)
- 43(41) Hair of T3–4 with few black hairs, pale hair of the thoracic dorsum posteriorly distinctly more grey than the yellow of T3–4 **B. humilis**
- Hair of T3–4 with narrow bands of black hairs anteriorly, pale hair of the thoracic dorsum posteriorly a similar grey-yellow to the pale hairs of T3–4 44
- 44(43) Hair of T2 laterally with patches of black, midleg tibia posterior fringe usually with many long pale hairs ... **B. deuteronymus**
- Hair of T2 laterally with few or no black hairs, midleg tibia posterior fringe mostly black with a few pale tips (Neimenggu) ... **B. pseudobaicalensis**
- 45(1) **Psithyrus**: T6 very strongly curved under the metasoma so that the apex points anteriorly, S6 strongly projecting distally (at the tip) beyond T6 as a shiny curved spine, the lateral keels small as just short curved bumps 46
- T6 at most weakly curved under the metasoma so that the apex points ventrally, S6 scarcely projecting distally (at the tip) beyond T6, the lateral keels long and strongly projecting 48
- 46(45) Hair of the thoracic dorsum with broad yellow bands anteriorly and posteriorly, T1 predominantly yellow **B. skorikovi**
- Hair of the thoracic dorsum with a broad yellow band anteriorly but posteriorly black or with only a few pale hairs, T1 predominantly black 47
- 47(46) T6 medially with a weak shiny longitudinal ridge for most of its length, T1 usually without pale hairs **B. norvegicus**
- T6 dorsally flat without a median longitudinal ridge, T1 with some pale hairs **B. sylvestris**
- 48(45) Tail white or yellow 49
- Tail red or orange or pinkish 53
- 49(48) Hair of the thorax predominantly yellow, sometimes with a few black hairs scattered between the wing bases or a small black spot, hair very short (Shaanxi) **B. bellardii**
- Hair of the thoracic dorsum yellow with a black band between the wing bases, hair length medium 50
- 50(49) Hair of T1–2 yellow, labrum with a large median sharp acute triangular projection before the ventral margin (Gansu) **B. expolitus**
- Hair of T1–2 predominantly black, labrum with a broad median rounded obtuse triangular projection before the ventral margin 51
- 51(50) T6 strongly shining with only very shallow micropunctures, hair of the thoracic dorsum with only an anterior yellow band, the posterior black, the tail white **B. bohemicus**
- T6 with many medium-sized punctures, hair of the thoracic dorsum with anterior and posterior yellow bands, the tail yellow 52
- 52(51) T6 matte with close punctures and a median longitudinal ridge, S6 with the lateral keels curving round to meet each other in a semi-circle with scarcely a trace of extensions towards the posterior apex **B. barbutellus**
- T6 shining with broadly scattered punctures and no median longitudinal ridge, S6 with the lateral keels S-shaped, curving round to meet each other but then curving back towards the posterior apex **B. campestris**
- 53(48) Hair of the body mostly black without yellow or white bands **B. coreanus**
- Hair of the body with some yellow or white bands 54
- 54(53) Hair of T1–3 extensively black with small yellow posterior fringes laterally on T2–3 **B. rupestris**
- Hair of T1 entirely yellow or white, T2 with yellow or white at least anteriorly, T3 entirely black or with a narrow orange posterior fringe across its breadth 55
- 55(54) Hair of T2 entirely yellow, S6 with the lateral keels only very weakly angled midway along their length, narrow, and scarcely visible projecting beyond T6 from the dorsal aspect (Gansu) **B. tibetanus**
- Hair of T2 extensively black at least laterally, S6 with the lateral keels strongly angled midway along their length, broad, and clearly visible projecting beyond T6 from the dorsal aspect 56
- 56(55) Labrum with a median sharp and acute triangular projection before the ventral margin **B. cornutus**
- Labrum with a median broadly rounded projection before the ventral margin **B. chinensis**
- 57(9) **Pyrobombus**: hair of the thoracic dorsum posteriorly entirely black 58
- Hair of the thoracic dorsum posteriorly entirely pale or with pale hair intermixed 59
- 58(57) Hair of the thoracic dorsum entirely black, legs predominantly orange **B. flavescens**
- Hair of the thoracic dorsum anteriorly with a broad yellow band, legs predominantly black **B. infirmus**
- 59(57) Hair of the thoracic dorsum entirely orange-brown, without black hair even between the wing bases **B. hypnorum**
- Hair of the thoracic dorsum yellow or white, with *either* black hair intermixed at least in part *or* often with a black band between the wing bases 60
- 60(59) Pale hair of the thoracic dorsum white, the black hair always forming a distinct band between the wing bases 61
- Pale hair of the thoracic dorsum yellow, the black hair *either* forming a band between the wings *or* intermixed more broadly 62
- 61(60) Hair of the head predominantly grey, corbicular fringes orange **B. lepidus**
- Hair of the head predominantly black, corbicular fringes black although often with pale tips **B. lemniscatus**
- 62(60) Hair of the upper quarter of the side of the thorax and T2 pale with many black hairs intermixed (Gansu) **B. infrequens**
- Hair of the side of the thorax and T2 pale without black hairs intermixed 63
- 63(62) Hair of T5 *either* black but with a posterior white fringe *or* entirely white, thoracic dorsum *either* predominantly pale yellow with a few scattered black hairs between the wings *or* with a weakly defined black band **B. modestus**
- Hair of T5 orange although sometimes very pale, thoracic dorsum always with many black hairs either scattered evenly throughout or concentrated between the wings as a weakly defined black band 64

- 64(63) Corbicular fringes orange or yellow but rarely in some queens black, hair of the thoracic dorsum usually with yellow and black hairs evenly intermixed, only in some queens with a distinct black band between the wing bases, the anterior and posterior yellow bands equal in breadth measured along the midline, T3 yellow or orange with black hairs intermixed anteriorly, only in some queens predominantly black *B. picipes*
- Corbicular fringes with many hairs part black (at least the short ones), hair of the thoracic dorsum with a black band between the wing bases, the anterior yellow band much broader than the posterior band measured along the midline, T3 black with a narrow posterior pale fringe *B. wangae*
- 65 (8) *Bombus* s. str.: hair of T4–5 red or orange 66
- Hair of T4–5 nearly white 67
- 66 (65) Hair of the face black, thoracic dorsum anteriorly and T2 black or black with a few golden yellow hairs laterally, T4–5 deep red, hindleg tibia with the corbicular fringes black *B. ignitus*
- Hair of the face black with bright orange hairs below antenna, thoracic dorsum anteriorly with grey hairs intermixed, T2 dull yellow, T4–5 pale orange, hindleg tibia with the corbicular fringes with at least the tips orange *B. patagiatus* (part)
- 67(65) Cheek (oculo-malar area) distinctly shorter than broad; hair of the face and the lower side of the thorax black or yellow or white; wings clear or lightly clouded with brown 68
- Cheek (oculo-malar area) nearly as long as broad; hair of the face and the lower side of the thorax black; wings lightly clouded with brown (Neimenggu) *B. sporadicus*
- 68 (67) Hair of the thoracic dorsum with the pale anterior band bright lemon yellow, the posterior band (scutellum) usually with few or no pale hairs, side of the thorax with the lower half black or with many black hairs intermixed 69
- Hair of the thoracic dorsum with the pale anterior band very pale yellow or cream or white, the posterior pale band (scutellum) broad and of the same colour, side of the thorax with the lower half pale or with many black hairs intermixed 71
- 69 (68) Upperside (vertex) of the head, side of the thorax, thoracic dorsum posteriorly (scutellum) and T1 laterally with unusually abundant long thickly feathery hair intermixed, queens usually with much feathery hair of the face light grey *B. longipennis*
- Upperside (vertex) of the head, side of the thorax, thoracic dorsum posteriorly (scutellum) and T1 laterally without unusually abundant long thickly feathery hair intermixed, queens with the short feathery hair of the face black 70
- 70 (69) Labral lamella narrow (in queens, often lamella breadth < 0.4× labral breadth), T2 with punctures in the medial posterior area dense with strong intervening surface sculpturing *B. cryptarum*
- Labral lamella broad (in queens, often lamella breadth > 0.4× labral breadth), T2 with punctures in the medial posterior area sparse with weak intervening surface sculpturing (Neimenggu) *B. lucorum*
- 71 (68) Hair of the thoracic dorsum with the pale anterior and posterior bands very pale yellow or cream, lower side of the thorax with some pale and black hairs intermixed *B. lantschouensis*
- Hair of the thoracic dorsum with the pale anterior and posterior bands white, lower side of the thorax usually with white hair but sometimes with many black hairs intermixed 72
- 72 (71) Hair of the thoracic dorsum with the black band between the wing bases clearly defined, with very few white hairs intermixed within it laterally, and with few black hairs intermixed at the front of the anterior pale band or in the pale posterior (scutellar) band, side of the thorax in its lower half white or with many black hairs intermixed (Neimenggu) *B. patagiatus* (part)
- Hair of the thoracic dorsum with the black band between the wing bases weakly defined, white hairs intermixed throughout but especially densely laterally, and with many black hairs intermixed at the front of the anterior pale band or in the pale posterior (scutellar) band, side of the thorax in its lower half white (Gansu) *B. minshanensis*
- 73 (3) *Alpigenobombus*: hair of the thoracic dorsum with a black band between the wing bases between broad anterior and posterior pale bands 75
- Hair of the thoracic dorsum predominantly black or with olive-grey hair, any pale bands narrow and heavily intermixed with black 74
- 74(73) Hair of the thoracic dorsum dark olive-grey with paler hairs along the midline *B. grahami*
- Hair of the thoracic dorsum predominantly black, anteriorly often with a few grey hairs intermixed (Gansu) *B. validus*
- 75 (73) Hair of the thoracic dorsum pale bands white, hair long, wings clear (Gansu) *B. kashmirensis*
- Hair of the thoracic dorsum pale bands golden yellow, hair short, wings dark brown *B. breviceps*
- 76 (9) *Melanobombus*: hair of the thoracic dorsum white or brown, between the wings without a black band *B. festivus*
- Hair of the thoracic dorsum white or yellow, between the wings *either* with a broad black band *or* the thoracic dorsum almost entirely black 77
- 77 (76) Hair of the thoracic dorsum predominantly black, T3–5 red *B. pyrosoma*
- Hair of the thoracic dorsum with broad white or yellow bands, *either* T3 mostly black *or* T5 white 78
- 78 (77) Hair of the thoracic dorsum with the pale bands white 79
- Hair of the thoracic dorsum with the pale bands yellow (Gansu) *B. keriensis*
- 79 (78) Hair of the face black, T3 with some red, T5 white 80
- Hair of the face usually white, T3 black with white at the sides, T5 pale orange or pale pink but not white *B. sichelii*
- 80 (79) Hair of the lower half of the side of the thorax black, T2 *either* entirely black *or* anteriorly with some bright yellow, body size medium and hair of medium length (Gansu) *B. rufofasciatus*
- Hair of the lower half of the side of the thorax usually white, T2 anteriorly white or cream or rarely yellow, body size small and hair long (Gansu) *B. ladakhensis*
- 81 (5) *Sibiricobombus*: hair of the thoracic dorsum yellow without black but often with an orange band between the wing bases, T3 yellow *B. sibiricus*
- Hair of the thoracic dorsum yellow and always with a black band between the wing bases, T3 black (Gansu) *B. asiaticus*

Key to the species of the genus *Bombus* known from North China for males

- 1 Gonostylus with the inner proximal process without medium-length branched hairs; volsella and gonostylus usually strongly sclerotised and mid or dark brown in colour; volsella often but not always with a process or hooks on its inner margin; penis-valve head *either* straight, *or* curved inwards, *or* curved outwards 2
- Gonostylus with the inner proximal process associated with many medium-length branched hairs; volsella and gonostylus usually weakly sclerotised and pale yellowish in colour; volsella always without a process or hooks on its inner margin; penis-valve head always nearly straight 42 *Psithyrus*
- 2 (1) Antenna medium to long, reaching back at least to the anterior margin of the tegula at the wing base; penis spatha narrowly and sharply pointed at its proximal end; penis-valve head *either* straight, *or* curved inwards, *or* curved outwards; eye *either* enlarged *or* not enlarged relative to any females 3
- Antenna short, not quite reaching back to the anterior margin of the tegula at the wing base; penis spatha rounded at its proximal end; penis-valve head always straight; eye always strongly enlarged relative to any females 10 *Mendacibombus*
- 3 (2) Penis valve narrow dorso-ventrally, at least in its distal third, which is slightly ventrally curved; antenna *either* of medium length *or* longer, reaching to or beyond the tegula at the wing base 4
- Penis valve greatly broadened dorso-ventrally so as to form half of a broad tube, the distal end flared outwards as half of a broad 'funnel'; antenna of medium length, not reaching back as far as the posterior margin of the tegula at the wing base 63 *Bombus s. str.*
- 4 (3) Penis-valve head from the dorsal aspect turned inwards distally as a distinct broad hook, *either* dorso-ventrally flattened in the form of a 'sickle' *or* as an incurved 'spoon' 6
- Penis-valve head from the dorsal aspect distally *either* nearly straight *or* turned slightly outwards, at most with only a tiny inwardly curved narrow point 5
- 5 (4) Volsella in ventral aspect in its distal half broad, the inner hooks placed *either* close to the midpoint of its length between its broadest point and the distal end, *or if* close to the distal end *then* reduced to a broad blunt process; gonostylus with the inner proximal process often weakly sclerotised in the ventral part of the shelf, and *if* it has a long spine *then* this is usually nearly straight sharp and inwardly pointed; hind tibia with the outer surface inside the posterior margin convex 26 *Thoracobombus*
- Volsella in ventral aspect in its distal half narrow, the inner hooks pointed and always placed close to the distal end; gonostylus with the inner proximal process uniformly strongly sclerotised and strongly re-curved away from the body midline and back towards the distal part of the gonostylus, with *either* at least one long strongly curved tubular spine with a blunt tip *or* flatter and with many teeth; hind tibia with the outer surface inside the posterior margin concave, *or if* convex *then* the volsella has the more anterior of the inner hooks with many radiating teeth 16 *Megabombus*
- 6 (4) Gonostylus usually a simple triangle, always without an inner proximal process; gonostylus with the inner distal margin at least slightly thickened in cross section with a submarginal longitudinal groove 55 *Pyrobombus*
- Gonostylus very variable in shape, but usually with a distinct inner proximal process; gonostylus with the inner distal margin simple flattened and blade-like in cross section without a submarginal longitudinal groove 7
- 7 (6) Penis-valve shaft with a ventral angle about half way along its length and distinct *either* as a pronounced sharp angle *or* produced as a larger transverse process 8
- Penis-valve shaft with a ventral angle about half way along its length *either* reduced and very broadly rounded (not sharply marked) *or* absent 9
- 8 (7) Penis-valve head turned inwards distally as an incurved 'bowl' or 'spoon' shape; penis-valve shaft with the ventral angle about half way along its length produced ventrally and laterally as a broad transverse paddle-like process; mandible distally pointed and with one anterior tooth 11 *Subterraneobombus*
- Penis-valve head turned inwards distally as a dorso-ventrally flattened 'sickle' shape; penis-valve shaft with the ventral angle about half way along its length produced ventrally as a pronounced angle; mandible distally pointed and with two anterior teeth 71 *Alpigenobombus*
- 9 (7) Mid basitarsus on its outer surface with many medium and long hairs; gonostylus with the distal lobe at least just shorter than broad; antenna *either* medium *or* long, reaching to or beyond the tegula at the wing base 74 *Melanobombus*
- Mid basitarsus on its outer surface with sparse short hairs and very few or no moderate and long hairs; gonostylus with the distal lobe always longer than broad; antenna very long, reaching distinctly beyond the wing base 79 *Sibiricobombus*
- 10 (2) *Mendacibombus*: hair of the thoracic dorsum with black and white hairs intermixed without a distinct anterior white band, T4–6 black or orange with white tips (Gansu) *B. waltoni*
- Hair of the thoracic dorsum with black and white hairs and with a distinct anterior white band, T4–6 mainly white and without orange (Gansu) *B. convexus*
- 11 (8) *Subterraneobombus*: gonocoxa with a sharp dorsal ridge reaching all the way to the distal edge, on its inner side distally with a dorsally flat or concave triangular inwardly directed process 14
- Gonocoxa with the sharp dorsal ridge subsiding into the convex dorsal surface before the distal edge, so that the distal portion is rounded and finger like, *or if* the sharp dorsal ridge subsides only just before the distal edge *then* the gonostylus lacks a distinct and narrowed inner proximal process 12
- 12 (11) Hair of T3–7 yellow with small triangles of black anteriorly and medially; gonostylus approximately or nearly as long as broad with the apex truncate with two weakly marked angles, the inner proximal process at its narrowest point almost as broad as the length of the gonostylus; penis-valve head proximal outer corner with a long proximally-directed process; penis-valve ventro-lateral process often with teeth but without long spine *B. amurensis*
- Hair of T3–7 black; gonostylus much shorter than broad and triangular with the apex with one angle, the inner proximal pro-

- cess at its narrowest point half as broad as the length of the gonostylus; penis-valve head proximal outer corner without a long proximally-directed process; penis-valve ventro-lateral process with a dorsal and a ventral long spine 13
- 13(12) Hair of the face yellow, *or if* black *then* there is no band of black hairs between the wing bases; gonostylus with the inner proximal process breadth at its narrowest $0.25\times$ the length of the gonostylus; hair short and even ***B. melanurus***
- Hair of the face usually black, *but if* with many pale hairs *then* there are few or no pale hairs just above the wing base in the black band between the wing bases; gonostylus with the inner proximal process at its narrowest as broad as nearly $0.5\times$ the length of the gonostylus; hair long and uneven (Gansu) ***B. difficillimus***
- 14(11) *Either* hair of T2 black anteriorly *or* hair of T4 entirely yellow or white; penis-valve head on its outer proximal corner with a toothed ridge, with two distinct anteriorly-directed flattened teeth or processes 15
- Hair of T1–2 yellow, T3–6 anteriorly black and posteriorly yellow or white; penis-valve head on its outer proximal corner with a simple anteriorly-directed long conical or cylindrical spine (Gansu) ***B. personatus***
- 15(14) Penis valve with the ventro-lateral process with a strong dorsal tooth; the majority of the hairs just dorsal to the antennal base and anterior to the ocelli black; T2 with black hairs usually intermixed for at least $0.5\times$ the length from the anterior to posterior edges so as to appear as at least a conspicuous brown band, but occasionally reduced to inconspicuous patches of a few black hairs intermixed laterally near the anterior edge (Neimenggu) ***B. subterraneus***
- Penis valve with the ventro-lateral process with a weak dorsal tooth; the majority of at least the shorter hairs just dorsal to the antennal base usually yellow; T2 without any black hair (Neimenggu) ***B. distinguendus***
- 16 (5) ***Megabombus***: cheek (oculo-malar area) length $<1.5\times$ the breadth of the mandible at its base between and including the mandibular articulations; volsella with the posterior (distal) inner process about as long as broad; hair of T3 black with a yellow patch near the midline, tail orange, body size very large ***B. bicoloratus***
- Cheek (oculo-malar area) length $>1.5\times$ the breadth of the mandible at its base between and including the mandibular articulations; volsella with the posterior (distal) inner process much longer than broad; hair of T3 and tail black or brown or yellow or white or orange, body size medium 17
- 17 (16) Hair of the thoracic dorsum yellow or orange or brown, without an obvious band of black hairs between the wing bases ... 18
- Hair of the thoracic dorsum yellow or orange or brown, with an obvious band or spot of black hairs between the wing bases ... 21
- 18 (17) Antennal segment 4 as long as or shorter than broad; gonostylus with a single inner proximal process forming a long narrow curved spine; volsella with the posterior (distal) inner process divided into two with the anterior branch broad like a hammer head 19
- Antennal segment 4 longer than broad; gonostylus with the inner process forming a broad flat plate; volsella with the posterior (distal) inner process divided into two with the anterior branch reduced to a small tooth 20
- 19 (18) Hair of the thoracic dorsum orange-brown, T5–7 black with a few paler hairs in posterior fringes and especially at the sides ... ***B. longipes***
- Hair of the thoracic dorsum yellow, T5–7 black with broad posterior white fringes ***B. ussurensis***
- 20 (18) Hair of the thoracic dorsum dull yellow or yellow-brown, upper half of the side of the thorax nearly white and paler than the thoracic dorsum, face usually with many long hairs pale as well as some black, hair long ***B. consobrinus***
- Hair of the thoracic dorsum yellow-brown or orange-brown, upper half of the side of the thorax dull yellow-brown or orange-brown and similar in colour to the thoracic dorsum, face usually with the long hairs mostly black, hair short ... ***B. koreanus***
- 21(17) Hair of the thoracic dorsum white with a black band between the wing bases, at least T3 bright red (Gansu) ... ***B. supremus***
- Hair of the thoracic dorsum entirely black or with some yellow or brown hairs anteriorly and posteriorly, T3 black or brown or yellow or white 22
- 22 (21) Antennal segment 4 as long as or shorter than broad; gonocoxa distally broad, beyond it the gonostylus forming a short broad rectangular strap; hair of T5 orange ***B. trifasciatus***
- Antennal segment 4 longer than broad; gonocoxa distally narrowed to a rounded point, beyond it the gonostylus triangular; hair of T5 black or brown or yellow or white 23
- 23 (22) Hair of the thoracic dorsum usually bright yellow with a clearly defined black band or small spot between the wing bases, the yellow without black hairs extensively intermixed 24
- Hair of the thoracic dorsum extensively black with only dull yellow or brown hairs more intermixed anteriorly and posteriorly in very weakly defined bands ***B. consobrinus***
- 24 (23) Volsella with the distal inner process divided into two hooks with the anterior branch forming a broad cone separated from the posterior branch and about half as long as the posterior branch, gonostylus with the inner basal process reduced to a long conical posteriorly directed spine; hair of T5 black over at least the median half with pale lateral tufts ***B. religiosus***
- Volsella with the distal inner process divided into two hooks with the anterior branch forming a short tooth on the side of the posterior branch and much less than half as long as the posterior branch, gonostylus with the inner basal process flattened and broad; hair of T5 pale at most only narrowly interrupted medially with black 25
- 25 (24) Hair of the face with many black hairs intermixed, thoracic dorsum yellow with a clearly defined black band between the wing bases ***B. sushkini***
- Hair of the face with few black hairs intermixed, thoracic dorsum predominantly yellow with a poorly defined small black spot between the wing bases ***B. czerskii***
- 26(5) ***Thoracobombus***: hair of the thoracic dorsum orange-brown, any black hairs on the thoracic dorsum in a minority and not obvious and not forming a distinct black band or spot between the wing bases 27
- Hair of the thoracic dorsum grey yellow or brown, with a distinct black band or spot or obviously greater intermixture between the wing bases 35
- 27 (26) Hair of T4–5 entirely black ***B. opulentus***

-	Hair of T4–5 with some orange or yellow or grey	28
28 (27)	Gonostylus with the proximal inner process reduced to two long curved spines, the distal posterior part of the gonostylus longer than broad	29
-	Gonostylus with the proximal inner process forming a flattened plate sometimes with a one long spine, the distal posterior part of the gonostylus shorter than broad	30
29 (28)	Hair of the thoracic dorsum and T1–5 entirely bright orange-red, wings dark brown (Shaanxi)	B. atripes
-	Hair of the thoracic dorsum yellow-brown, T1–5 with varying proportions of yellow and black, wings nearly clear	B. tricornis
30 (28)	Volsella projecting beyond the gonostylus posteriorly as a broad rectangle that is just longer than broad with two distal corners that are scarcely pointed, the double-hooked inner projection clearly separate more anteriorly	B. laesus
-	Volsella projecting beyond the gonostylus posteriorly as a single long curved narrow triangle or spine, the double-hooked inner projection clearly separate more anteriorly	31
31 (30)	Hair of the thoracic dorsum lemon yellow intermixed with many black hairs, sometimes slightly fewer black hairs anteriorly and posteriorly, T2 predominantly lemon yellow sometimes with a few black hairs intermixed posteriorly, T5–6 often with orange	B. remotus
-	Hair of the thoracic dorsum orange-brown <i>either</i> with few black hairs <i>or</i> with the black hairs much more numerous in the anterior three quarters	32
32 (31)	Gonostylus enlarged with the proximal inner projection with a strong elbow so that the main part of its length is directed posteriorly as a long straight narrow spine of almost uniform diameter; hair of the thoracic dorsum often with many black hairs intermixed, especially in the anterior three quarters (Neimenggu)	B. pascuorum
-	Gonostylus unenlarged with the proximal inner projection <i>either</i> directed in towards the midline, <i>or if</i> directed more posteriorly <i>then</i> it is triangular and gradually narrowing towards the tip; hair of the thoracic dorsum usually with few black hairs	33
33 (32)	Volsella posteriorly in lateral view broadly rounded at the apex; hair of the thoracic dorsum anteriorly and posteriorly narrowly yellow, T1–6 yellow without black hair (Neimenggu)	B. muscorum
-	Volsella posteriorly in lateral view narrowly pointed at the apex; hair of the thoracic dorsum brown without yellow but sometimes with some black, T1–6 brown or yellow often with black anteriorly	34
34 (33)	Hair of T2–6 anteriorly black and posteriorly grey, hair long	B. schrencki
-	Hair of T2–6 predominantly orange or with black hair anteriorly on T4–6, hair short	B. hedini
35 (26)	Antenna with segments A11–12 expanded to give a clubbed end, strongly concave on the posterior side (Neimenggu)	B. exil
-	Antenna with segments A11–12 similar in diameter to A9–10 and nearly cylindrical	36
36 (35)	Hair of T3–6 orange	B. impetuosus
-	Hair of T3–6 with some yellow or grey or black	37
37 (36)	Hair of the thoracic dorsum anterior and posterior bands yellow	38
-	Hair of the thoracic dorsum anterior and posterior bands grey-white	40
38 (37)	Volsella projecting beyond the gonostylus posteriorly as a broad rectangle that is just longer than broad with two distal corners that are scarcely pointed, the double-hooked inner projection clearly separate more anteriorly	B. laesus
-	Volsella projecting beyond the gonostylus posteriorly as a single rounded or pointed triangle, the double-hooked inner projection reduced to a long blunt stump but clearly separate more anteriorly	39
39 (38)	Volsella projecting beyond the gonostylus posteriorly as a rounded triangle; hair of legs and T7 predominantly black	B. filchnerae
-	Volsella projecting beyond the gonostylus posteriorly as a pointed triangle; hair of legs and T7 predominantly yellow (Neimenggu)	B. anachoreta
40 (37)	Hair of T3–4 with few black hairs, pale hair of the thoracic dorsum posteriorly distinctly more grey than the yellow of T3–4; volsella with the long inner process ending in a deeply divided Y shaped double hook	B. humilis
-	Hair of T3–4 with narrow bands of black hairs anteriorly, pale hair of the thoracic dorsum posteriorly a similar grey to the pale hairs of T3–4; volsella with the long inner process ending in a broad blunt stump or a long narrow spoon shape	41
41 (40)	Volsella with the long inner process ending in a long narrow spoon shape; midleg tibia posterior fringe predominantly grey	B. deuteronymus
-	Volsella with the long inner process ending in a broad blunt stump; midleg tibia posterior fringe predominantly black (Neimenggu)	B. pseudobaicalensis
42 (1)	Psithyrus : volsella in its posterior distal half beyond the inner corner greatly narrowed, almost parallel sided, and finger shaped, gonostylus with only a few long hairs	43
-	Volsella distally <i>either</i> broader in the form of a broad nearly triangular plate, <i>or if</i> the distal part is narrowed <i>then</i> the inner corner is very strongly produced, gonostylus usually with many long hairs around the inner proximal	45
43 (42)	Hair of the thoracic dorsum with the pale anterior and posterior bands of nearly equal breadth measured along the body midline	B. skorikovi
-	Hair of the thoracic dorsum black with a narrow band of yellow anteriorly and a few pale hairs scattered posteriorly	44
44 (43)	Antennal scape with weak surface sculpturing and shiny	B. sylvestris
-	Antennal scape with strong surface sculpturing and matte	B. norvegicus
45 (42)	Penis valve half way along its length with the ventral lateral angle reduced to a small notch and not visible from the dorsal aspect	46
-	Penis valve half way along its length with the ventral lateral angle strongly and broadly produced ventrally and outwardly so that it is visible from the dorsal aspect	47
46 (45)	Hair of the thoracic dorsum and T1 entirely black, T4–7 orange	B. coreanus

-	Hair of the thoracic dorsum with yellow anterior and posterior bands with black between the wing bases, T1 yellow or black, T4–7 white or black	<i>B. bohemicus</i>
47 (45)	Hair of T5 orange or red	52
-	Hair of T5 black or yellow or white	48
48 (47)	Pale hair of T5 black or black with white tips	49
-	Pale hair of T5 entirely white or yellow	50
49 (48)	Hair of the thoracic dorsum posteriorly black, S2–4 black; gonostylus and volsella weakly sclerotised (pale), penis valve with the ventral lateral angle distally narrowed so that it is almost a spine (Gansu)	<i>B. tibetanus</i>
-	Hair of the thoracic dorsum posteriorly with yellow or pale tips, S2–4 with pale tips; gonostylus and volsella strongly sclerotised (dark), penis valve with the ventral lateral angle distally broadened so that it is almost a right angle distally (Gansu)	<i>B. expolitus</i>
50 (48)	Hair of the thoracic dorsum usually predominantly yellow with only a small black spot between the wing bases, T4–5 predominantly yellow, hair very short, wings dark brown (Shaanxi)	<i>B. bellardii</i>
-	Hair of the thoracic dorsum with yellow bands anteriorly and posteriorly and a black band between the wing bases, T4–5 predominantly yellow or white, hair long, wings nearly clear	51
51 (50)	Volsella distally rounded, gonostylus about as long as broad; hair of the side of the thorax predominantly black, T4–5 white	<i>B. barbutellus</i>
-	Volsella distally pointed, gonostylus much shorter than broad; hair of the side of the thorax yellow, T4–5 yellow	<i>B. campestris</i>
52 (47)	Volsella in its distal posterior half very pale yellow, with the inner corner strongly produced in towards the the mid-line to almost twice the volsella breadth halfway along the distal half	54
-	Volsella in its distal posterior half brownish, with the inner corner scarcely produced in towards the the mid-line	53
53 (52)	Gonocoxa from the inner aspect distally broadened and tuncate, with a double pointed end, gonostylus broader near the inner side and narrowing towards the outer side	<i>B. cornutus</i>
-	Gonocoxa from the inner aspect distally narrowed to a single pointed end, gonostylus narrower near the inner side and broadening towards the outer side	<i>B. turneri</i>
54 (52)	Volsella in its distal posterior half beyond the inner corner forming a broad, almost equilateral triangle, with the inner margin only weakly incurved or almost straight when viewed perpendicularly to the dorsal surface; pale hair of the thoracic dorsum yellow or white	<i>B. chinensis</i>
-	Volsella in its distal posterior half beyond the inner corner distinctly longer than broad, with the inner margin strongly incurved when viewed perpendicularly to the dorsal surface; pale hair of the thoracic dorsum yellow	<i>B. rupestris</i>
55 (6)	<i>Pyrobombus</i> : exoskeleton of the midleg and hindleg tibiae and tarsi orange-brown, fringed with orange-yellow hairs, the hindleg tibia outer surface often almost covered in midlength orange hairs	<i>B. flavescens</i>
-	Exoskeleton of the midleg and hindleg tibiae and tarsi nearly black, fringed with black or yellow hairs, the hindleg tibia outer surface with the central area hairless and shiny	56
56 (55)	Hair of the thoracic dorsum with a very obvious band of black between the wing bases, the edges sometimes indistinct because of intermixing of black and pale hairs	57
-	Hair of the thoracic dorsum with no obvious band of black between the wing bases, although there may be some black hairs intermixed	59
57 (56)	Hair of the thoracic dorsum anteriorly and T1 predominantly white	<i>B. lemniscatus</i>
-	Hair of the thoracic dorsum anteriorly and T1 predominantly yellow	58
58 (57)	Hair of T4–6 orange	<i>B. lepidus</i>
-	Hair of T4–6 black sometimes with white tips	<i>B. infirmus</i>
59 (56)	Hair of the thoracic dorsum orange-brown, T3 black	<i>B. hypnorum</i>
-	Hair of the thoracic dorsum predominantly yellow, T3 with at least a broad pale posterior fringe	60
60 (59)	Penis-valve shaft in lateral view much (1.4x) broader beyond the ventral angle about half way along its length; hair of the thoracic dorsum anteriorly yellow with many scattered black hairs intermixed	61
-	Penis-valve shaft in lateral view scarcely (1.1x) broader beyond the ventral angle about half way along its length; hair of the thoracic dorsum anteriorly yellow without any black hairs	62
61 (60)	Hair of T3–5 short and entirely bright yellow	<i>B. picipes</i>
-	Hair of T3–5 long with about equal amounts of black and yellow intermixed (Gansu)	<i>B. infrequens</i>
62 (60)	Hair of the thoracic dorsum without black hairs between the wing bases, T5–6 without pale orange hairs	<i>B. modestus</i>
-	Hair of the thoracic dorsum with a band between the wing bases with black hairs intermixed, T5–6 often with some pale orange hairs	<i>B. wangae</i>
63 (3)	<i>Bombus</i> s. str.: hair of the thoracic dorsum pale bands and T1–2 golden yellow, T5–6 orange-red; penis-valve head in dorsal view straight, with the tip not turned outwards from the body midline	<i>B. ignitus</i>
-	Hair of the thoracic dorsum pale bands and T1–2 lemon yellow, white, or brownish-yellow, T5–6 white, yellow, pink, or brown, sometimes with some black; penis-valve head in dorsal view with the tip turned outwards from the body midline	64
64 (63)	Hair of the face always black, thoracic dorsum pale bands and T1–2 brownish yellow; wings light brown; penis-valve head in dorsal view where it is turned outwards on its inner distal margin uniformly convex (Neimenggu)	<i>B. sporadicus</i>
-	Hair of the face often pale, thoracic dorsum pale bands and T1–2 lemon yellow or white; wings nearly clear or slightly grey; penis-valve head in dorsal view where it is turned outwards on its inner distal margin concave	65
65 (64)	Gena posterior to the eye and on the scutellum with obvious dense long thickly branched feathery hairs; hair of the thoracic dorsum posteriorly usually black, rarely the branched hairs grey and the long hairs of the posterior fringe yellow	

- *B. longipennis*
- Gena posterior to the eye and on the scutellum with only weakly branched hairs, a little more branched on the scutellum; hair of the thoracic dorsum posteriorly black or yellow or white 66
 - 66 (65) Hair of the face black or *if yellow then* with many black hairs intermixed, the thoracic dorsum posteriorly with the yellow band narrow *and* black hairs on the body generally rarely with pale tips, T3 almost entirely black and usually without a complete posterior pale fringe, T4 predominantly white, T5 bright white *B. cryptarum*
 - Hair of the face and the thoracic dorsum posteriorly broadly yellow or white *or if this pale band is weak then* the black hairs on the body generally often have pale tips, T3 black but often posteriorly with a strong pale fringe, T4 predominantly black or yellow or brown or pink, T5 white or yellow or brown or pink 67
 - 67 (66) Hair of T5 orange-pink *B. patagiatus* (part)
 - Hair of T5 white, yellow, or rarely brown mixed with black 68
 - 68 (67) Hair of the thoracic dorsum anterior pale band without scattered black hairs in the anterior half 69
 - Hair of the thoracic dorsum anterior pale band with a few scattered black hairs in the anterior half 70
 - 69 (68) Hair of the thoracic dorsum posterior band broadly yellow, similar in breadth to the anterior yellow band, T5 yellow, cream, or rarely brown mixed with black, black hairs on the body generally without pale tips *B. lantschouensis*
 - Hair of the thoracic dorsum posterior band narrowly yellow, less than half of the breadth of the anterior yellow band, T5 bright white, black hairs on the body often with pale tips (Neimenggu) *B. lucorum*
 - 70 (68) Hair of the thoracic dorsum pale bands and T1 white or cream-white (Neimenggu) *B. patagiatus* (part)
 - Hair of the thoracic dorsum pale bands and T1 yellow (Gansu) *B. minshanensis*
 - 71 (8) *Alpigenobombus*: hair of the thoracic dorsum with a black band between the wing bases between broad anterior and posterior pale bands 73
 - Hair of the thoracic dorsum predominantly black or with olive-grey hair, any pale bands narrow and heavily intermixed with black 72
 - 72 (71) Hair of the thoracic dorsum dark olive-grey with paler hairs along the midline *B. grahami*
 - Hair of the thoracic dorsum predominantly black, anteriorly often with a few grey hairs intermixed (Gansu) *B. validus*
 - 73 (71) Hair of the thoracic dorsum pale bands white, hair long, wings clear (Gansu) *B. kashmirensis*
 - Hair of the thoracic dorsum pale bands golden yellow, hair short, wings dark brown *B. breviceps*
 - 74 (9) *Melanobombus*: hair of the thoracic dorsum uniformly orange brown *B. festivus*
 - Hair of the thoracic dorsum yellow or white, usually with a band of black between the wing bases 75
 - 75 (74) Eyes distinctly enlarged relative to those of any female bumblebees; hair of T1 white, T2 yellow, T5–6 predominantly white (Gansu) *B. rufofasciatus*
 - Eyes similar in relative size to those of any female bumblebees; hair of T1–2 both yellow or both white, T5–6 predominantly orange or orange with white tips 76
 - 76 (75) Penis-valve recurved head broadly fused to the adjacent penis-valve shaft so that it is spear-shaped; hair of T5–6 orange with white tips (Gansu) *B. ladakhensis*
 - Penis-valve recurved head not fused to the adjacent penis-valve shaft so that it is sickle-shaped; hair of T5–6 orange without white tips 77
 - 77 (76) Gonostylus $<0.5\times$ as long as broad, the volsella projecting beyond the gonostylus by $>2\times$ the length of the gonostylus; hair of T3 orange *B. pyrosoma*
 - Gonostylus nearly $1\times$ as long as broad, the volsella projecting beyond the gonostylus by $<1\times$ the length of the gonostylus; hair of T3 black 78
 - 78 (77) Volsella with the distal inner process having a marked inner basal corner so that the process forms a broad short stump; hair of T2 along the posterior margin black, T4 anteriorly black especially broadly laterally *B. sichelii*
 - Volsella with the distal inner process having an obscure broadly rounded inner basal corner so that the process forms a narrow curved hook; hair of T2 entirely yellow, T4 entirely orange (Gansu) *B. keriensis*
 - 79 (9) *Sibiricobombus*: hair of the thoracic dorsum yellow without black but often with a broad orange band between the wing bases, T3 yellow *B. sibiricus*
 - Hair of the thoracic dorsum yellow and always with a black band between the wing bases, T3 black (Gansu) *B. asiaticus*

Subgenus *MENDACIBOMBUS* Skorikov

1. *Bombus* (*Mendacibombus*) *convexus* Wang

(Figs 4, 5)

Bombus lugubris Morawitz, 1880:339 (not of Kriechbaumer, 1870:159 = *B. barbutellus* (Kirby)).

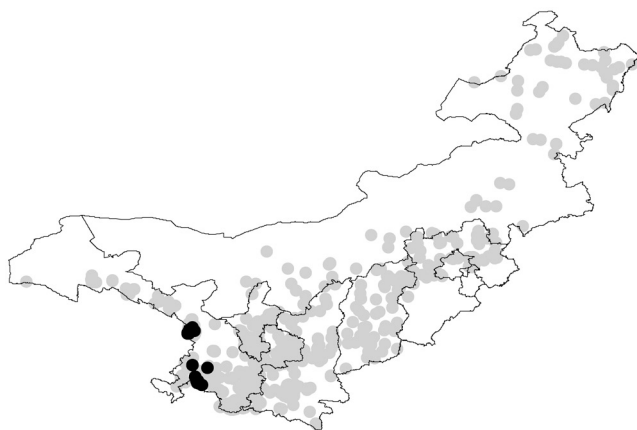
Bombus (*Mendacibombus*) *convexus* Wang, 1979:190.

Material examined. 2 queens, 73 workers, 31 males (IAB).

Distribution in North China. Only on the edge of the east Qinghai-Tibetan plateau. Common at medium to high elevations of the Zhagana nature reserve, the Liancheng nature reserve, and the Lianhuashan nature reserve in Gansu. 18 localities (Fig. 4) between 2196–3524 m (IAB).

Distribution in China. Sichuan, Xizang, Gansu (IAB).

Forage plants. ASTERACEAE: *Carduus acanthoides*, *Ligularia* sp., *Saussurea purpurascens*, *Saussurea* sp., *Senecio jacobaea*; LAMIACEAE: *Nepeta prattii*, *Salvia przewalskii*, *Thymus mongolicus*; RANUNCULACEAE: *Aconitum flavum*, *A. gymnandrum*, *A. leucostomum*, *Aconitum* sp., *Clematis tangutica*; SCROPHULARIACEAE: *Pedicularis spicata*, *P. torta*, *Pedicularis* sp.



FIGURES 4–5. 4. Map showing the distribution of *B. convexus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 5. *B. convexus* worker visiting *Carduus acanthoides* (Asteraceae) in Gansu.

2. *Bombus* (*Mendacibombus*) *waltoni* Cockerell

(Figs 6, 7)

Bombus mendax ssp. *chinensis* Skorikov, 1910a:330 (not of Morawitz, 1890:352 = *B. chinensis* (Morawitz)).

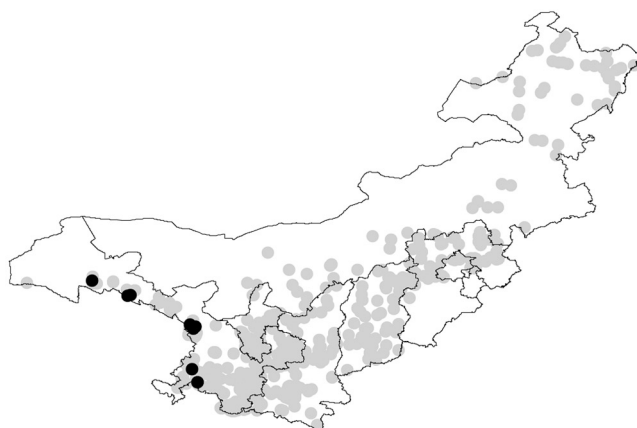
Bombus waltoni Cockerell, 1910:239.

Bombus rufitarsus Friese, 1913:85.

Bombus asellus Friese, 1924:438.

Material examined. 336 workers, 3 males (IAB).

Distribution in North China. Only on the edge of the east and northeast Qinghai-Tibetan plateau. Common at high elevations of the Qilianshan nature reserve and the Zhagana nature reserve in Gansu. 8 localities (Fig. 6) between 2604–3524 m (IAB).



FIGURES 6–7. 6. Map showing the distribution of *B. waltoni* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 7. *B. waltoni* male from Gansu (PW).

Distribution in China. Sichuan, Xizang, Gansu, Qinghai (IAB).

Forage plants. ALLIACEAE: *Allium cyaneum*; ASTERACEAE: *Carduus acanthoides*, *Olgaea tangutica*, *Saussurea* sp.; GERANIACEAE: *Geranium pratense*; LAMIACEAE: *Salvia przewalskii*; RANUNCULACEAE: *Aconitum gymnandrum*; SCROPHULARIACEAE: *Pedicularis kansuensis*, *Pedicularis* sp.

Subgenus *SUBTERRANEOBOMBUS* Vogt

3. *Bombus (Subterraneobombus) personatus* Smith

(Figs 8, 9)

Bombus personatus Smith, 1879:132.

Bombus Roborowskyi Morawitz, 1887:197.

Taxonomy. Revised by Williams *et al.* (2011).

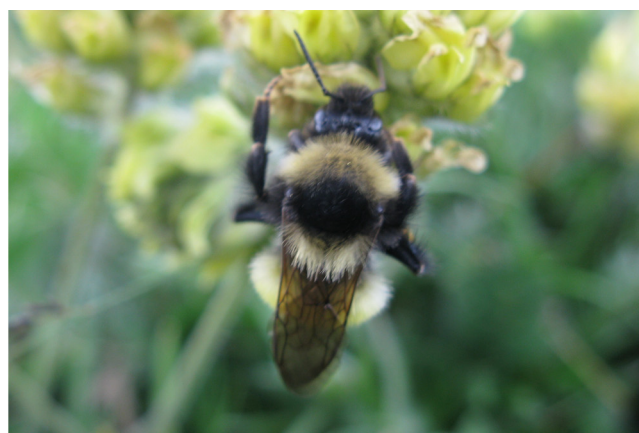
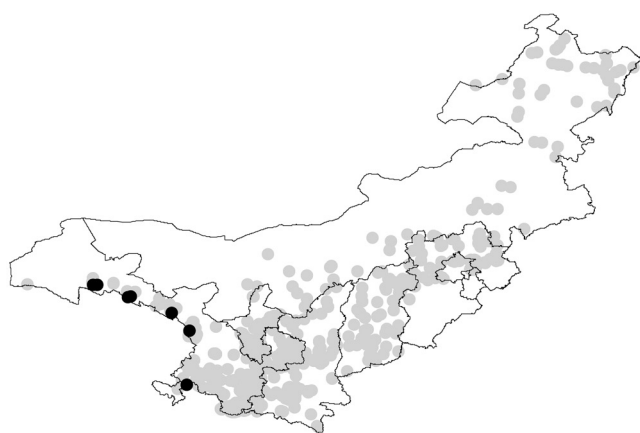
Material examined. 13 workers, 2 males (IAB).

Distribution in North China. Only on the edge of the east and northeast Qinghai-Tibetan plateau. Common at high elevations of the Qilianshan nature reserve, and rare at high elevations of the Gahai nature reserve in Gansu. 7 localities (Fig. 8) between 2659–3656 m (IAB).

Similar species in North China. This species can be similar in its black- and yellow-banded colour pattern to *B. difficillimus* (see the key; Figs 9, 13).

Distribution in China. Xizang, Gansu, Qinghai (IAB).

Forage plants. ASTERACEAE: *Saussurea* sp., *Tephrosieris pseudosonchus*; CAMPANULACEAE: *Adenophora polyantha*; FABACEAE: *Hedysarum tanguticum*, *Oxytropis ochrocephala*; GERANIACEAE: *Geranium pylzowianum*; LAMIACEAE: *Caryopteris mongholica*; ROSACEAE: *Rubus* sp.; SCROPHULARIACEAE: *Pedicularis chinensis*, *P. kansuensis*.



FIGURES 8–9. 8. Map showing the distribution of *B. personatus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 9. *B. personatus* worker visiting *Oxytropis ochrocephala* (Fabaceae) in Gansu.

4. *Bombus (Subterraneobombus) melanurus* Lepeletier

(Figs 10, 11)

Bombus melanurus Lepeletier de Saint-Fargeau, [1835]:469.

Bombus Tschitscherini Radoszkowski, 1862:591, by indication of Radoszkowski (1860:485).

Bombus (Subterraneobombus) lantschouensis Tkalců, 1961:360, by indication of Vogt, 1909:53 (not of Vogt, 1908:101 = *B. lantschouensis* Vogt).

Taxonomy. Revised by Williams *et al.* (2011).

Material examined. 11 queens, 1462 workers, 183 males (IAB).

Distribution in North China. Widely distributed in the transition dry zone between the Neimenggu plateau, the loess plateau, and the Qinghai-Tibetan plateau. Most abundant at medium elevations of the Liupanshan nature reserve of the loess plateau in southern Ningxia. Common at high elevations of the Qilianshan nature reserve and the Liancheng nature reserve of the edge of the northeast Qinghai-Tibetan plateau in western Gansu, at medium elevations of the Ziwojing nature reserve of the loess plateau in eastern Gansu and western Shaanxi, and at medium elevations of the edge of the southern Neimenggu plateau through Neimenggu, Hebei, Shanxi, Shaanxi, Ningxia and Gansu. Rare at medium elevations of the Beihuashan nature reserve of the Taihangshan mountains in Beijing, at medium elevations of the northern Lvliangshan mountains and the northern Taihangshan mountains in Shanxi, at medium elevations of the Helanshan mountains in northern Ningxia, and at high elevations of the Dangjinshan pass of Aierjinshan mountains in northwestern Gansu. 133 localities (Fig. 10) between 632–2959 m (IAB).



FIGURES 10–11. 10. Map showing the distribution of *B. melanurus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 11. *B. melanurus* worker visiting *Astragalus adsurgens* (Fabaceae) in Gansu.

Variation in North China. This species shows strong variation in the colour pattern of the hair across its global distribution (Williams *et al.*, 2011). In North China it varies in colour pattern with the presence or absence of a black band in the hair between the wing bases.

Similar species in North China. This species is very similar in its black- and yellow-banded colour pattern to *B. difficillimus* (see the key; Figs 11, 13).

Distribution in China. Beijing, Hebei, Shanxi, Neimenggu, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang (IAB).

Forage plants. ASTERACEAE: *Cosmos bipinnatus*, *Olgaea tangutica*, *Saussurea* sp., *Sinacalia tangutica*; BRASSICACEAE: *Brassica rapa*; CAMPANULACEAE: *Adenophora polyantha*; FABACEAE: *Astragalus bhotanensis*, *A. adsurgens*, *Hedysarum mongolicum*, *H. tanguticum*, *Melilotus albus*, *M. officinalis*, *Onobrychis viciifolia*, *Oxytropis ochrocephala*; LAMIACEAE: *Dracocephalum heterophyllum*, *Leonurus sibiricus*, *Scutellaria baicalensis*, *Thymus mongolicus*; MALVACEAE: *Alcea rosea*, *Gossypium hirsutum*, *Malva cathayensis*; PAPAVERACEAE: *Corydalis* sp.; SOLANACEAE: *Solanum melongena*; ROSACEAE: *Rubus* sp.

5. *Bombus* (*Subterraneobombus*) *difficillimus* Skorikov (Figs 12, 13)

Bombus difficillimus Skorikov, 1912:609.

Taxonomy. Revised by Williams *et al.* (2011).

Material examined. 1 worker (IAB).

Distribution in North China. Only on the edge of the northeast Qinghai-Tibetan plateau. Very rare at high elevations of the Qilianshan nature reserve in Gansu. 1 locality (Fig. 12) at 3656 m (IAB).

Similar species in North China. This species is very similar in its black- and yellow-banded colour pattern to some *B. melanurus* (see the key; Figs 84, 85).

Distribution in China. Gansu, Qinghai, Xinjiang (IAB).

Forage plants. FABACEAE: *Hedysarum tanguticum*.



FIGURES 12–13. 12. Map showing the distribution of *B. difficillimus* in North China with record as black spot, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 13. *B. difficillimus* worker from Gansu.

6. *Bombus* (*Subterraneobombus*) *amurensis* Radoszkowski

(Figs 14, 15)

Bombus Amurensis Radoszkowski, 1862:590.

Bombus fragrans ssp. *mongol* Skorikov, 1912:607.

Bombus (*Subterraneobombus*) *chaharensis* Yasumatsu, 1940:94.

Taxonomy. Revised by Williams *et al.* (2011).

Material examined. 5 queens, 47 workers, 5 males (IAB).

Distribution in North China. Common at medium elevations of the transition zone between the Yanshan mountains in Hebei and the Neimenggu plateau, and rare at low elevations of the Hulunbeir grassland in northeastern Neimenggu. 9 localities (Fig. 14) between 712–1498 m (IAB).



FIGURES 14–15. 14. Map showing the distribution of *B. amurensis* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 15. *B. amurensis* worker from Hebei.

Similar species in North China. This species is similar in its yellow colour pattern to some yellow *B. distinguendus*, *B. laesus*, *B. filchnerae* and *B. anachoreta* (see the key; Figs 15, 19, 41, 43, 47).

Distribution in China. Hebei, Neimenggu (IAB).

Forage plants. ASTERACEAE: *Cosmos bipinnatus*, *Helianthus annuus*; FABACEAE: *Astragalus dahuricus*, *Vicia amoena*, *V. cracca*; LAMIACEAE: *Leonurus sibiricus*.

7. *Bombus (Subterraneobombus) subterraneus* (Linnaeus)

(Figs 16, 17)

APIS fubterranea [subterranea] Linnaeus, 1758: 579.

Megabombus (Subterraneobombus) subterraneus dlabolai Tkalcû, 1974a:47.

Taxonomy. Revised by Williams *et al.* (2011).

Material examined. 1 male (IAB).

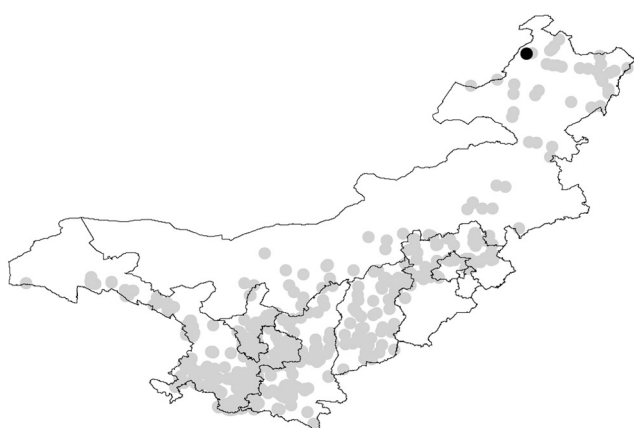
Distribution in North China. Very rare at low elevations of the Moerdaoga forest park in northeastern Neimenggu, the transition zone between the Hulunbeir grassland and the Great Khingan mountains forests. 1 locality (Fig. 16) at 618 m (IAB).

Variation in North China. This species shows strong variation in the colour pattern of the hair across its global distribution (Williams *et al.*, 2011), but shows little variation in North China (Fig. 17).

Similar species in North China. This species is similar in its grey colour pattern to *B. exil* (see the key; Figs 17, 67).

Distribution in China. Neimenggu, Xinjiang (IAB).

Forage plants. No records.



FIGURES 16–17. 16. Map showing the distribution of *B. subterraneus* in North China with record as black spot, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 17. *B. subterraneus* male from Neimenggu.

8. *Bombus (Subterraneobombus) distinguendus* Morawitz

(Figs 18, 19)

Bombus elegans Seidl, 1837:67. *Nomen oblitum* (Williams *et al.*, 2011).

Bombus distinguendus Morawitz, 1869:32. *Nomen protectum* (Williams *et al.*, 2011).

Taxonomy. Revised by Williams *et al.* (2011).

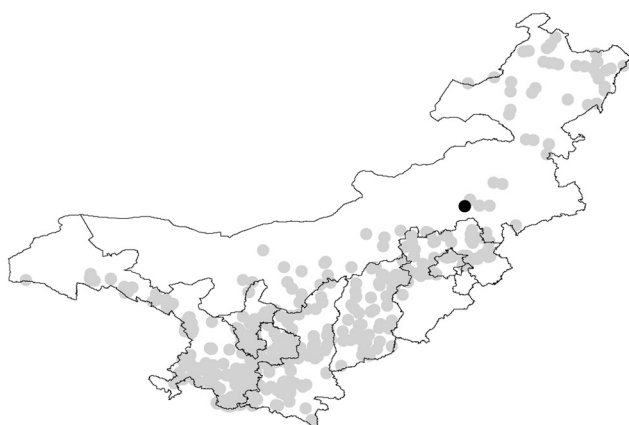
Material examined. 2 workers, 2 males (IAB).

Distribution in North China. Rare at medium elevations of the transition zone between the edge of the east Otindag semi-desert and the southernmost of Great Khingan mountains, in Majiayingzi, Keshiketeng, Neimenggu. 2 localities (Fig. 18) between 1174–1422 m (IAB).

Similar species in North China. This species is similar in its yellow colour pattern to some yellow *B. amurensis*, *B. laesus*, *B. filchnerae* and *B. anachoreta* (see the key; Figs 15, 19, 41, 43, 47).

Distribution in China. Neimenggu (IAB).

Forage plants. ASTERACEAE: *Helianthus annuus*.



FIGURES 18–19. 18. Map showing the distribution of *B. distinguendus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 19. *B. distinguendus* worker from Neimenggu.

Subgenus *MEGABOMBUS* Dalla Torre

9. *Bombus (Megabombus) trifasciatus* Smith (Figs 20, 21)

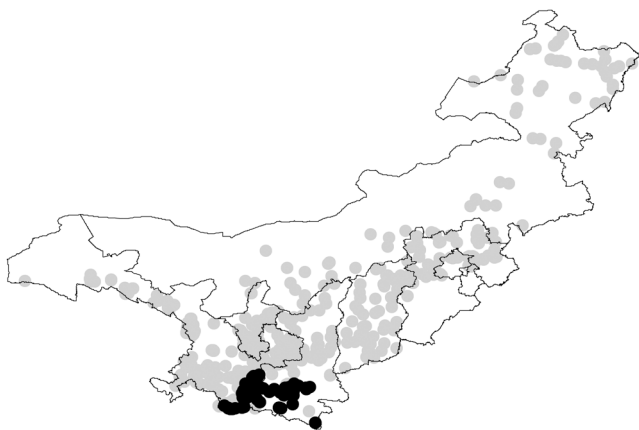
Bombus trifasciatus Smith, 1852a:43.

Bombus ningpoënsis Friese, 1909:676.

Bombus (Diversobombus) ningpoensis ssp. *minshanicus* Bischoff, 1936:19.

Taxonomy. For a discussion of the taxonomy of this species complex see Williams *et al.* (2009) and Hines & Williams (2012).

Material examined. 563 workers, 1 male (IAB).



FIGURES 20–21. 20. Map showing the distribution of *B. trifasciatus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 21. *B. trifasciatus* queen visiting *Dahlia pinnata* (Asteraceae) in Gansu.

Distribution in North China. Only in the Qin-Ba mountains in southern Shaanxi and southern Gansu. Abundant at low to medium elevations of the Baishuijiang nature reserve and the Xiaolongshan nature reserve in Gansu, the Heihe nature reserve, the Fuping nature reserve, the Qingmuchuan nature reserve, the Sangyuan nature reserve, the Changqing nature reserve, the Tianhuashan nature reserve, and the Micangshan nature reserve in Shaanxi. Rare at medium elevations of the Maijishan forest park in Gansu, at low to medium elevations of the

Shouyangshan nature reserve, the Zhongnanshan nature reserve, and the Niubeiliang nature reserve in Shaanxi. 57 localities (Fig. 20) between 540–2026 m (IAB).

Variation in North China. This species shows strong variation in the colour pattern of the hair across its global distribution (Hines & Williams, 2012). In North China the principal variation is in the relative extent of the yellow and black hair on the dorsum of the thorax (Fig. 21).

Similar species in North China. This species is similar in its red-tailed colour pattern to *B. bicoloratus* (see the key; Figs 21, 27).

Distribution in China. Anhui, Fujian, Henan, Hubei, Guangdong, Chongqing, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu (IAB).

Forage plants. ASTERACEAE: *Arctium lappa*, *Cosmos bipinnatus*, *Cirsium monocephalum*, *Dahlia pinnata*, *Erigeron annuus*, *Helianthus annuus*, *Rudbeckia laciniata*; BALSAMINACEAE: *Impatiens balsamina*; BUDDLEJACEAE: *Buddleja officinalis*; CARYOPHYLLACEAE: *Silene fortunei*; CLUSIACEAE: *Hypericum ascyron*, *H. perforatum*, *Hypericum* sp.; CONVULVULACEAE: *Ipomoea nil*; CUCURBITACEAE: *Cucumis sativus*, *Cucurbita moschata*, *Thladiantha dubia*; FABACEAE: *Campylotropis macrocarpa*; LAMIACEAE: *Agastache rugosa*, *Caryopteris divaricata*, *Clinopodium chinense*, *Leonurus japonicus*, *Stachys japonica*, *Vitex negundo*; LYTHRACEAE: *Lagerstroemia indica*; MALVACEAE: *Alcea rosea*, *Hibiscus syriacus*, *Malva cathayensis*; NYCTAGINACEAE: *Mirabilis jalapa*; ONAGRACEAE: *Oenothera biennis*; PAPAVERACEAE: *Corydalis edulis*; ROSACEAE: *Rubus* sp., *Spiraea japonica*; SAXIFRAGACEAE: *Astilbe chinensis*; SOLANACEAE: *Capsicum annuum*, *Nicandra physalodes*, *Solanum septemlobum*; TILIACEAE: *Grewia biloba*.

10. *Bombus (Megabombus) longipes* Friese (Figs 22, 23)

Bombus longipes Friese, 1905:511.

Bombus (Diversobombus) hummeli Bischoff, 1936:18.

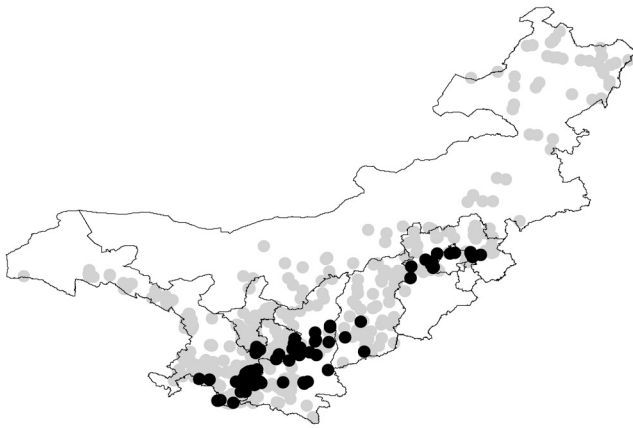
Material examined. 5 queens, 415 workers, 115 males (IAB).

Distribution in North China. Widely distributed in the Yanshan mountains, the loess plateau and the Qinling mountains. Abundant at medium elevations of the Lingshan nature reserve in Beijing, at low to medium elevations of the Wulingshan nature reserve in Hebei, at medium elevations of the Ziwuling nature reserve, the Kundongshan nature reserve and the Maijishan forest park in Gansu. Common at medium elevations of the Zhongnanshan nature reserve and the Niubeiliang nature reserve in Shaanxi, and the Baishuijinag nature reserve in Gansu. Rare at medium elevations of the Liupanshan nature reserve in Ningxia, the Lishan nature reserve in Shanxi, the Lazikou forest park in Gansu, and the Huashan forest park in Shaanxi. 81 localities (Fig. 22) between 551–2278 m (IAB).

Similar species in North China. This species is similar in its brown and black colour pattern to *B. opulentus* (see the key; Figs 23, 49).

Distribution in China. Beijing, Hebei, Shanxi, Shaanxi, Gansu, Qinghai, Ningxia (IAB).

Forage plants. ASTERACEAE: *Arctium lappa*, *Cirsium leo*, *C. monocephalum*, *C. shansiense*, *Calendula officinalis*, *Dahlia pinnata*, *Helianthus annuus*, *H. tuberosus*, *Ixeridium sonchifolium*, *Saussurea* sp., *Senecio laetus*, *Sonchus brachyotus*, *Tagetes patula*, *Zinnia peruviana*; BIGNONIACEAE: *Incarvillea sinensis*; BUDDLEJACEAE: *Buddleja officinalis*; CLUSIACEAE: *Hypericum ascyron*; CONVULVULACEAE: *Ipomoea purpurea*; DIPSACACEAE: *Dipsacus japonicus*, *Scabiosa comosa*; FABACEAE: *Astragalus dahuricus*, *Campylotropis macrocarpa*, *Lespedeza juncea*, *Melilotus albus*, *Vicia amoena*, *V. cracca*; LAMIACEAE: *Elsholtzia stauntonii*, *Leonurus japonicus*, *L. macranthus*, *L. sibiricus*, *Phlomis umbrosa*, *Phlomis* sp., *Salvia deserta*, *S. przewalskii*, *Salvia* sp.; MALVACEAE: *Alcea rosea*, *Hibiscus syriacus*; PAPAVERACEAE: *Corydalis* sp.; RANUNCULACEAE: *Aconitum gymnanthum*, *A. kusnezoffii*, *Anemone tomentosa*, *Clematis glauca*; ROSACEAE: *Potentilla multicaulis*; SCROPHULARIACEAE: *Phtheirospermum japonicum*, *Pedicularis torta*; SOLANACEAE: *Solanum septemlobum*; THYMELAEACEAE: *Wikstroemia chamaedaphne*; VALERIANACEAE: *Patrinia scabra*.



FIGURES 22–23. 22. Map showing the distribution of *B. longipes* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 23. *B. longipes* worker visiting *Hypericum ascyron* (Clusiaceae) in Hebei.

11. *Bombus (Megabombus) ussurensis* Radoszkowski
(Figs 24, 25)

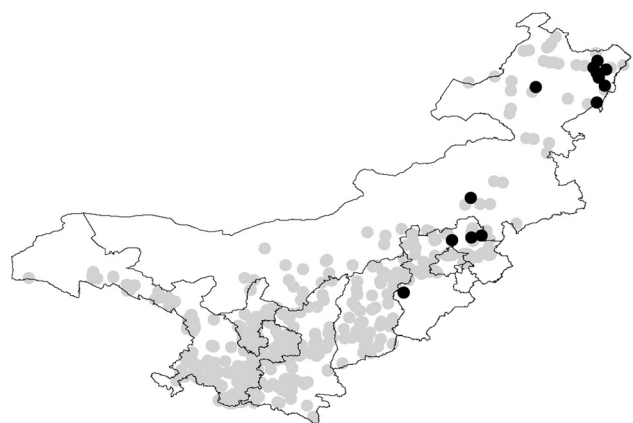
Bombus Ussurensis Radoszkowski, 1877:196.

Material examined. 40 workers, 14 males (IAB).

Distribution in North China. Common at low elevations of the Bashang plateau in northern Hebei, and low elevations of the Nenjiang river valley within northeastern Neimenggu. Rare at low elevations of the transition zone from the south Taihangshan mountains to western Hebei plain, medium elevations of the Huangangliang forest park of the south Great Khingan mountains in Neimenggu, and low elevations of the east Hulunbeir grassland in Yakeshi, Neimenggu. 15 localities (Fig. 24) between 215–1779 m (IAB).

Distribution in China. Hebei, Neimenggu, Jilin, Heilongjiang (IAB).

Forage plants. ASTERACEAE: *Cosmos bipinnatus*, *Helianthus annuus*; LAMIACEAE: *Leonurus sibiricus*.



FIGURES 24–25. 24. Map showing the distribution of *B. ussurensis* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 25. *B. ussurensis* worker from Neimenggu.

12. *Bombus (Megabombus) bicoloratus* Smith

(Figs 26, 27)

Bombus bicoloratus Smith, 1879:132.

Bombus kulingensis Cockerell, 1917:266.

Bombus (Senexibombus) tajushanensis Pittioni, 1949:244.

Material examined. 41 workers, 7 males (IAB).

Distribution in North China. Only in the Qin-Ba mountains in southern Shaanxi and southern Gansu. Common at low to medium elevations of the Changqing nature reserve, and the Fuping nature reserve in Shaanxi. Rare at medium elevations of the Baishuijiang nature reserve, the Maijishan forest park in Gansu, and the Tianhuashan nature reserve in Shaanxi. 13 localities (Fig. 26) between 607–1754 m (IAB).

Similar species in North China. This species is similar in its red-tailed colour pattern to *B. trifasciatus* (see the key; Figs 21, 27).

Distribution in China. Fujian, Guangdong, Chongqing, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu (IAB).

Forage plants. ASTERACEAE: *Helianthus annuus*; BUDDLEJACEAE: *Buddleja officinalis*, *Buddleja* sp.; CLUSIACEAE: *Hypericum* sp.; FABACEAE: *Campylotropis macrocarpa*; LAMIACEAE: *Leonurus japonicus*; LYTHRACEAE: *Lagerstroemia indica*; ONAGRACEAE: *Oenothera biennis*; SAXIFRAGACEAE: *Astilbe chinensis*.



FIGURES 26–27. 26. Map showing the distribution of *B. bicoloratus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 27. *B. bicoloratus* worker visiting *Lagerstroemia indica* (Lythraceae) in Shaanxi.

13. *Bombus (Megabombus) supremus* Morawitz

(Figs 28, 29)

Bombus supremus Morawitz, 1887:196.

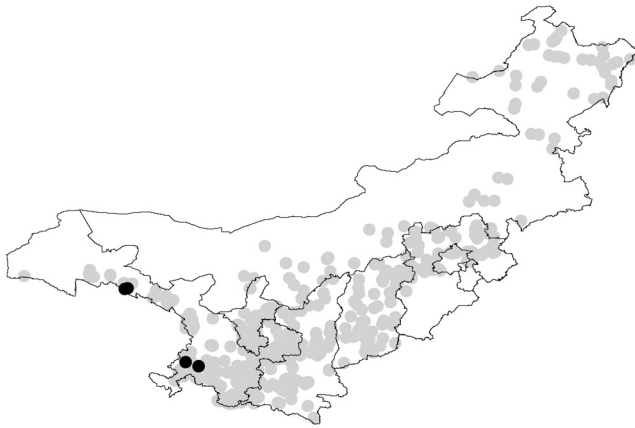
Bombus linguarius Morawitz, 1890:351.

Material examined. 7 workers (IAB).

Distribution in North China. Only on the edge of east and northeast Qinghai-Tibetan plateau. Rare at high elevations of the Lianhuashan nature reserve and the Qilianshan nature reserve in Gansu. 4 localities (Fig. 28) between 2874–3386 m (IAB).

Distribution in China. Xizang, Gansu, Qinghai (IAB).

Forage plants. ALLIACEAE: *Allium cyaneum*; GERANIACEAE: *Geranium pratense*; RANUNCULACEAE: *Aconitum gymnandrum*, *Delphinium grandiflorum*; SCROPHULARIACEAE: *Pedicularis kansuensis*.



FIGURES 28–29. 28. Map showing the distribution of *B. supremus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 29. *B. supremus* worker visiting *Delphinium grandiflorum* (Ranunculaceae) in Sichuan (PW).

14. *Bombus (Megabombus) religiosus* (Frison)
(Figs 30, 31)

Bremus (Hortobombus) religiosus Frison, 1935:344.

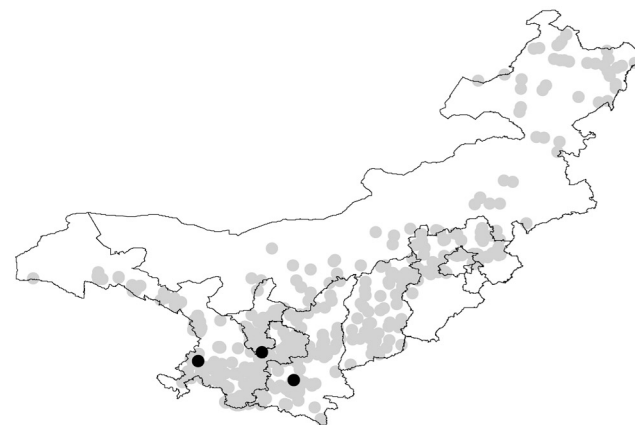
Material examined. 6 workers (IAB).

Distribution in North China. Rare at medium elevations of the east Qinghai-Tibetan plateau, Hezuo, Gansu; the Liupanshan nature reserver of the the loess plateau in Ningxia, and the Taibai natural seserve of the Qinling mountains in Shaanxi. 3 localities (Fig. 30) between 1303–2524 m (IAB).

Similar species in North China. This species is similar in its yellow-banded colour pattern to *B. czerskii* and *B. sushkini* (see the key; Figs 31, 33, 35).

Distribution in China. Sichuan, Yunnan, Xizang, Shaanxi, Gansu, Ningxia (IAB).

Forage plants. LAMIACEAE: *Caryopteris incana*.



FIGURES 30–31. 30. Map showing the distribution of *B. religiosus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 31. *B. religiosus* worker from Gansu.

15. *Bombus (Megabombus) czerskii* Skorikov
(Figs 32, 33)

Bombus czerskii Skorikov, 1910b:413.

Material examined. 4 queens, 17 workers, 9 males (IAB).

Distribution in North China. Common at medium elevations of the transition zone between the edge of the east Otindag semi-desert and the southernmost of the Great Khingan mountains, in Majiayingzi, Keshiketeng, Neimenggu. Rare at medium elevations of the Ziwuling nature reserve of the loess plateau in Gansu, at medium elevations of the Lvliangshan mountains in Shanxi, at medium elevations of the Bashang plateau in Hebei, at low elevations of the Honghuaerji forest park, on the edge of the east Hulunbeir grassland to the Great Khingan mountains in Neimenggu, and at low elevations in the grasslands in Keerqinyouyiqianqi and in Ningcheng, Neimenggu. 12 localities (Fig. 32) between 471–1557 m (IAB).

Similar species in North China. This species is similar in its yellow-banded colour pattern to *B. religiosus* and *B. sushkini* (see the key; Figs 31, 33, 35).

Distribution in China. Hebei, Shanxi, Neimenggu, Gansu (IAB).

Forage plants. ASTERACEAE: *Cosmos bipinnatus*, *Helianthus annuus*; FABACEAE: *Onobrychis viciifolia*; LAMIACEAE: *Leonurus sibiricus*.



FIGURES 32–33. 32. Map showing the distribution of *B. czerskii* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 33. *B. czerskii* worker from Neimenggu.

16. *Bombus (Megabombus) sushkini* (Skorikov) s. l.
(Figs 34, 35)

Hortobombus sushkini Skorikov, 1931:235.

Taxonomy. For a discussion of the taxonomy of this species see Williams *et al.* (2009).

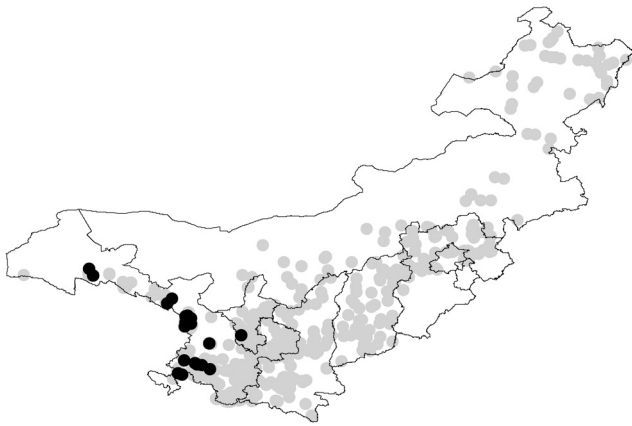
Material examined. 19 queens, 47 workers, 7 males (IAB).

Distribution in North China. Primarily on the edge of the northeast Qinghai-Tibetan plateau. Common at medium to high elevations of the Qilianshan nature reserve and the Lianhuashan nature reserve in Gansu. Rare at medium elevations of the Liancheng nature reserve, at high elevations of the Gahai nature reserve in Gansu, and at medium elevations of the Yueliangshan mountain in Xiji, Ningxia. 22 localities (Fig. 34) between 2148–3490 m (IAB).

Similar species in North China. This species is similar in its yellow-banded colour pattern to *B. religiosus* and *B. czerskii* (see the key; Figs 31, 33, 35).

Distribution in China. Sichuan, Xizang, Gansu, Qinghai, Ningxia (IAB).

Forage plants. ASTERACEAE: *Arctium lappa*, *Saussurea* sp.; FABACEAE: *Oxytropis ochrocephala*; LAMIACEAE: *Caryopteris incana*, *Dracocephalum heterophyllum*; RANUNCULACEAE: *Aconitum flavum*, *A. gymnantrum*, *Clematis tangutica*; SCROPHULARIACEAE: *Pedicularis kansuensis*.



FIGURES 34–35. 34. Map showing the distribution of *B. sushkini* s. l. in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 35. *B. sushkini* s. l. male visiting *Pedicularis kansuensis* (Scrophulariaceae) in Gansu.

17. *Bombus (Megabombus) consobrinus* Dahlbom
(Figs 36, 37)

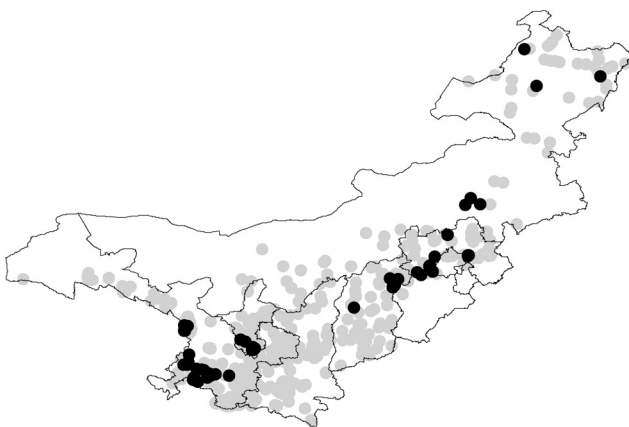
Bombus consobrinus Dahlbom, 1832:49.

Material examined. 7 queens, 142 workers, 105 males (IAB).

Distribution in North China. Primarily in the Taihangshan mountains, the Yanshan mountains, and the edge of the east Qinghai-Tibetan plateau. Common at medium elevation of the Baicaopan nature reserve and the Lingshan nature reserve in Beijing, at medium elevation of the Wulingshan nature reserve in Hebei, and at medium to high elevations of the Wutaishan forest park in Shanxi. Rare at medium to high elevations of the Qilianshan nature reserve, the Liancheng nature reserve, the Lianhuashan nature reserve, the Zhagana nature reserve of the east Qinghai-Tibetan plateau in Gansu, the Liupanshan nature reserve of the loess plateau in southern Ningxia, at medium elevations of the Huanggangliang forest park, and at low elevations of the Hulunbeir grasslands in Neimenggu. 53 localities (Fig. 36) between 315–3279 m (IAB).

Similar species in North China. This species is similar in its brown colour pattern with a white tail to *B. hypnorum* and workers of *B. festivus* (see the key; Figs 37, 101, 143).

Distribution in China. Beijing, Hebei, Shanxi, Neimenggu, Jilin, Heilongjiang, Gansu, Qinghai, Ningxia, Xinjiang (IAB).



FIGURES 36–37. 36. Map showing the distribution of *B. consobrinus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 37. *B. consobrinus* worker visiting *Aconitum barbatum* (Ranunculaceae) in Hebei.

Forage plants. *Carduus acanthoides*, *Cirsium leo*, *C. setosum*, *Cosmos bipinnatus*, *Helianthus annuus*, *Ixeridium sonchifolium*, *Saussurea* sp.; CRASSULACEAE: *Orostachys fimbriata*; LAMIACEAE: *Dracocephalum heterophyllum*, *Elsholtzia ciliata*, *E. fruticosa*, *E. stauntonii*, *Leonurus sibiricus*, *Phlomis umbrosa*, *Salvia* sp.; MALVACEAE: *Malva cathayensis*; RANUNCULACEAE: *Aconitum barbatum*, *A. kusnezoffii*, *Clematis tangutica*, *Trollius chinensis*; ROSACEAE: *Potentilla chinensis*. This species is known in northern Europe to be monolectic (Loken, 1973) but in North China it collects both nectar and pollen from multiple plant species.

18. *Bombus (Megabombus) koreanus* (Skorikov)
(Figs 38, 39)

Hortobombus koreanus Skorikov, 1933b:59.

Material examined. 4 queens, 85 workers, 10 males (IAB).

Distribution in North China. Primarily in the Yanshan mountains and the Qinling mountains. Common at medium elevations of the Puwa nature reserve and the Lingshan nature reserve in Beijing, the Wulingshan nature reserve in Hebei, the Fuping nature reserve in Shaanxi, and the Xiaolongshan nature reserve in Gansu. Rare at medium elevations of the southern Taihangshan mountains in Shanxi, at the medium elevations on the edge of the Mu Us semi-desert in northern Shaanxi and the loess plateau in central Shaanxi. 32 localities (Fig. 38) between 522–2076 m (IAB).

Similar species in North China. This species is similar in its orange-tailed colour pattern to *B. ignitus* (see the key; Figs 39, 121).



FIGURES 38–39. 38. Map showing the distribution of *B. koreanus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 39. *B. koreanus* worker from Beijing.

Distribution in China. Beijing, Hebei, Shanxi, Henan, Shaanxi, Gansu (IAB).

Forage plants. ASTERACEAE: *Cosmos bipinnatus*; CUCURBITACEAE: *Cucumis sativus*; FABACEAE: *Vicia cracca*; BALSAMINACEAE: *Impatiens balsamina*; LAMIACEAE: *Elsholtzia ciliata*, *Leonurus sibiricus*; MALVACEAE: *Malva cathayensis*; ROSACEAE: *Duchesnea indica*.

Subgenus *THORACOBOMBUS* Dalla Torre

19. *Bombus (Thoracobombus) laesus* Morawitz
(Figs 40, 41)

Bombus laesus Morawitz, 1875:3.

Bombus (Laesobombus) tianschanicus Panfilov, 1956:1327.

Bombus (Laesobombus) maculidorsis Panfilov, 1956:1328, by indication of Skorikov, 1922:23.

Taxonomy. For a discussion of the taxonomy of this species see Williams *et al.* (2009) and Williams (2011).

Material examined. 29 queens, 171 workers, 24 males (IAB).

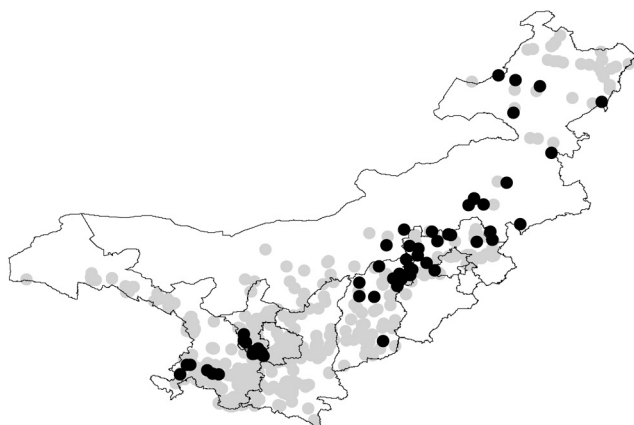
Variation in North China. This species or species-complex shows strong variation in the colour pattern of the hair across its global distribution. In North China the principal variation is in the colour of the hair on the dorsum of the thorax, which may be orange-brown or yellow with a black band between the wing bases (see the key).

Similar species in North China. This species is very similar in its orange-brown colour pattern to *B. muscorum*, *B. tricornis* and *B. atripes* (see the key; Figs 41, 45, 69, 71) and very similar in its colour pattern of yellow with a black band between the wing bases to *B. amurensis*, *B. distinguendus*, *B. filchnerae* and *B. anachoreta* (see the key; Figs 15, 19, 41, 43, 47).

Distribution in North China. Widely distributed on the edge of the east Qinghai-Tibetan plateau, the Liupanshan mountains, the edge of the southern Neimenggu plateau close to Shanxi and Hebei, and the grasslands of northeastern Neimenggu. Common at medium elevations of the Liupanshan mountains in southern Ningxia and eastern Gansu, at medium elevations of the Bashang plateau in northern Hebei, at medium elevations of the transition zone between the edge of east Otindag semi-desert and the southernmost of the Great Khingan mountains, in Majiayingzi, Keshiketeng, Neimenggu, and at low elevations of the Hulunbeir grasslands in northeastern Neimenggu. Rare at medium elevations of the Baihuashan nature reserve in Beijing, at medium to high elevations of edge of the east Qinghai-Tibetan plateau in Gansu, and at medium elevations of the Taihangshan mountains and the Lvliangshan mountains in Shanxi. 62 localities (Fig. 40) between 215–3472 m (IAB).

Distribution in China. Beijing, Hebei, Shanxi, Neimenggu, Heilongjiang, Gansu, Qinghai, Ningxia, Xinjiang (IAB).

Forage plants. ASTERACEAE: *Cosmos bipinnatus*, *Helianthus annuus*, *Saussurea stella*; FABACEAE: *Hedysarum gmelinii*, *Medicago sativa*, *Onobrychis viciifolia*; GENTIANACEAE: *Gentiana* sp.; LAMIACEAE: *Caryopteris tangutica*, *Dracocephalum heterophyllum*, *Elsholtzia densa*, *E. fruticosa*; RANUNCULACEAE: *Aconitum gymnandrum*, *Delphinium grandiflorum*.



FIGURES 40–41. 40. Map showing the distribution of *B. laesus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 41. *B. laesus* worker from Neimenggu.

20. *Bombus (Thoracobombus) filchnerae* Vogt (Figs 42, 43)

Bombus Filchnerae Vogt, 1908:100.

Agrabombus adventor Skorikov, 1914:119.

Bombus (Agrobombus) lii Tkalců, 1961:355.

Material examined. 21 queens, 179 workers, 24 males (IAB).

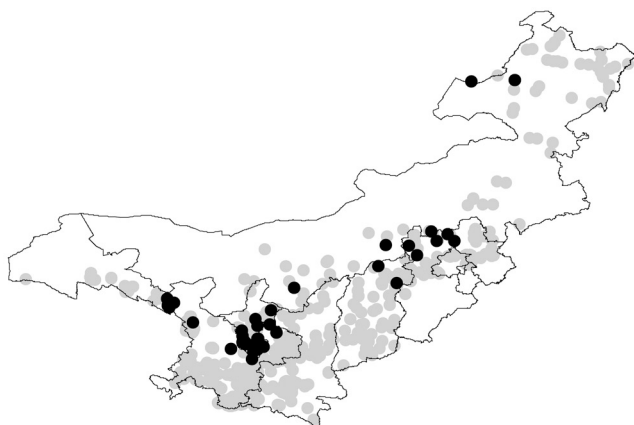
Distribution in North China. Primarily on the edge of the northeast Qinghai-Tibetan plateau, the Liupanshan

mountains, the Bashang plateau and the Hulunbeir grasslands. Common at medium elevations of the Qilianshan nature reserve in Gansu, at medium elevations of the Liupanshan nature reserve in southern Ningxia, at medium elevations of the loess plateau in eastern Gansu, and at low elevations of the Hulunbeir grasslands in northeastern Neimenggu. Rare at medium elevations of the Bashang plateau in northern Hebei, at medium elevations of the Taihangshan mountains in northern Shanxi, and at medium elevations of the sandy grasslands of the edge of the southern Neimenggu plateau. 44 localities (Fig. 42) between 602–2659 m (IAB).

Similar species in North China. This species is similar in its yellow colour pattern to some yellow *B. amurensis*, *B. distinguendus*, *B. laesus* and *B. anachoreta* (see the key; Figs 15, 19, 41, 43, 47).

Distribution in China. Hebei, Shanxi, Neimenggu, Gansu, Qinghai, Ningxia, Xinjiang (IAB).

Forage plants. ASTERACEAE: *Cirsium leo*, *Helianthus annuus*, *Ligularia sagitta*, *Olgaea tangutica*; FABACEAE: *Medicago sativa*, LAMIACEAE: *Leonurus sibiricus*, *Salvia japonica*.



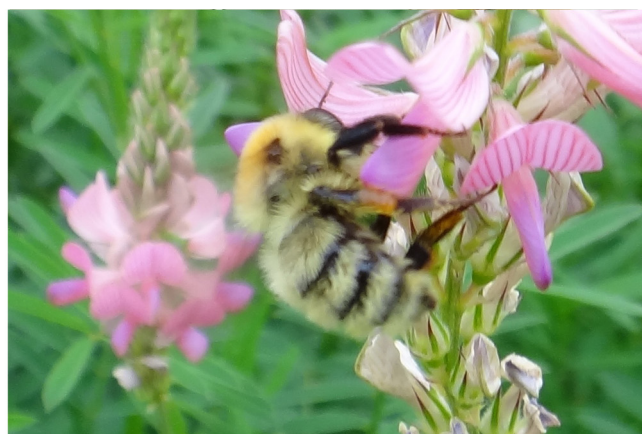
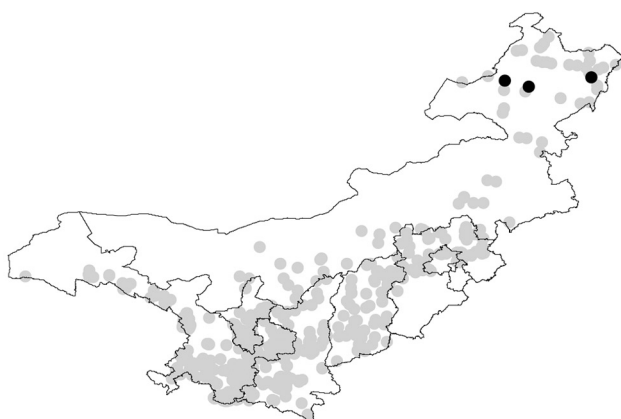
FIGURES 42–43. 42. Map showing the distribution of *B. filchnerae* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 43. *B. filchnerae* worker from Ningxia.

21. *Bombus (Thoracobombus) muscorum* (Linnaeus)

(Figs 44, 45)

Apis Mucorum [*muscorum*] Linnaeus, 1758:579.

Material examined. 1 worker, 2 males (IAB).



FIGURES 44–45. 44. Map showing the distribution of *B. muscorum* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 45. *B. muscorum* worker visiting *Onobrychis pulchella* (Fabaceae) in Xinjiang.

Distribution in North China. Rare at low elevations of the Hulunbeir grasslands and the Nenjiang river valley in northeastern Neimenggu. 3 localities (Fig. 44) between 315–678 m (IAB).

Similar species in North China. This species is very similar in its orange-brown colour pattern to some *B. laesus*, *B. tricornis* and *B. atripes* (see the key; Figs 41, 45, 69, 71)

Distribution in China. Neimenggu, Heilongjiang, Xinjiang (IAB).

Forage plants. ASTERACEAE: *Helianthus annuus*; ONAGRACEAE: *Chamerion angustifolium*.

22. *Bombus (Thoracobombus) anachoreta* (Skorikov)
(Figs 46, 47)

Agrobombus anachoreta Skorikov, 1914:121.

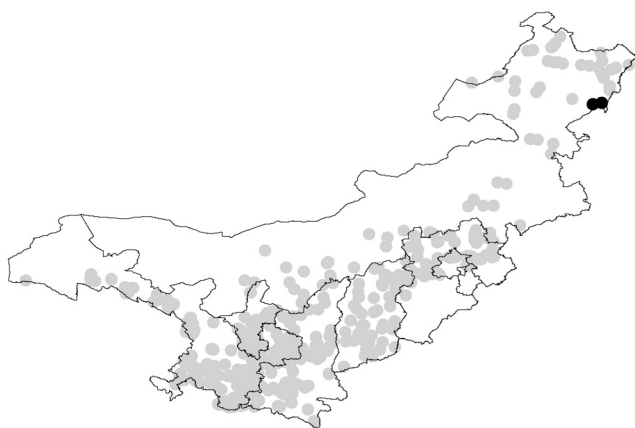
Material examined. 7 workers, 5 males (IAB).

Distribution in North China. Common at low elevations on the edge of the farmland of the Nenjiang river valley in northeastern Neimenggu. 2 localities (Fig. 46) between 215–240 m (IAB).

Similar species in North China. This species is similar in its yellow colour pattern to some yellow *B. amurensis*, *B. distinguendus*, *B. laesus* and *B. filchnerae*, (see the key; Figs 15, 19, 41, 43, 47).

Distribution in China. Neimenggu, Heilongjiang (IAB).

Forage plants. ASTERACEAE: *Cosmos bipinnatus*.



FIGURES 46–47. 46. Map showing the distribution of *B. anachoreta* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 47. *B. anachoreta* worker from Neimenggu.

23. *Bombus (Thoracobombus) opulentus* Smith
(Figs 48, 49)

Bombus opulentus Smith, 1861:153.

Material examined. 8 queens, 328 workers, 24 males (IAB).

Distribution in North China. Primarily on the Bashang plateau, the Yanshan mountains, the Taihangshan mountains, the loess plateau and the Qinling mountains. Abundant at low elevations of the Simatai Greatwall scenic spots of the Yanshan mountains in Beijing. Common at low elevations of the Bashang plateau and at medium elevations of the Wulingshan nature reserve in Hebei, at medium elevations of the Ziwuling nature reserve and the Maijishan forest park in Gansu, at low elevations of the Fuping nature reserve in Shaanxi. Rare at low to medium elevations of the Panshan forest park, the Shangfangshan forest park, the Lingshan nature reserve, the Puwa nature reserve in Beijing, at low elevations of the Jiudingshan forest park in Tianjin, at low to medium elevations of the Taihangshan mountains in Shanxi, at medium elevations of the loess plateau in northern Shaanxi, at medium elevations of the Xiaolongshan nature reserve and the Baishangjiang nature reserve, at high elevations

of the Gahai nature reserve in Gansu, and at medium elevations of the Liupanshan nature reserve in southern Ningxia. 78 localities (Fig. 48) between 65–3432 m (IAB).

Similar species in North China. This species is similar in its brown and black colour pattern to *B. longipes* (see the key; Figs 23, 49).

Distribution in China. Beijing, Tianjin, Hebei, Shanxi, Shaanxi, Gansu, Ningxia (IAB).



FIGURES 48–49. 48. Map showing the distribution of *B. opulentus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 49. *B. opulentus* queen visiting *Salvia farinacea* (Lamiaceae) in Beijing.

Forage plants. ASTERACEAE: *Arctium lappa*, *Cirsium shansiense*, *Cosmos bipinnatus*, *Helianthus annuus*, *H. tuberosus*, *Senecio laetus*; *Solidago canadensis*; CUCURBITACEAE: *Thladiantha dubia*; CONVULVACEAE: *Merremia sibirica*, *Ipomoea purpurea*; FABACEAE: *Astragalus adsurgens*, *A. dahuricus*, *Campylotropis macrocarpa*, *Lablab purpureus*, *Lespedeza bicolor*, *L. juncea*, *Melilotus albus*, *Onobrychis viciifolia*, *Vicia amoena*, *V. cracca*; LAMIACEAE: *Elsholtzia ciliata*, *E. stauntonii*, *Leonurus japonicus*, *L. macranthus*, *L. sibiricus*, *Phlomis umbrosa*, *Salvia deserta*, *S. farinacea*, *Stachys chinensis*, *Vitex negundo*; MALVACEAE: *Hibiscus syriacus*; ROSACEAE: *Duchesnea indica*; SOLANACEAE: *Solanum nigrum*, *S. septemlobum*.

24. *Bombus (Thoracobombus) deuteronymus* Schulz (Figs 50, 51)

Bombus senilis Smith, 1879:131 (not of Fabricius, 1775:382, = *B. pascuorum* (Scopoli)).

Bombus deuteronymus Schulz, 1906:267, replacement name for *senilis* Smith, 1879:131.

Agrobombus superequester Skorikov, 1926:116, by indication of Skorikov, 1914:405.

Material examined. 1 queen, 75 workers, 12 males (IAB).

Distribution in North China. Primarily on the Bashang plateau, the northeastern Neimenggu, and the edge of the east Qinghai-Tibetan plateau. Common at low to medium elevations of the Bashang plateau in northern Hebei, at low elevations of the Nenjiang river valley in northeastern Neimenggu, and at medium to high elevations of edge of the east Qinghai-Tibetan plateau in Gansu. Rare at medium elevations of the Taihangshan mountains in Hebei and Shanxi, at medium elevations of the Huanggangliang forest park of the southernmost of the Great Khingan mountains, at low elevations of the Hulunbeir grasslands in northeastern Neimenggu, and at medium elevations of the Maijishan forest park in Gansu. 24 localities (Fig. 50) between 215–2872 m (IAB).

Similar species in North China. This species is very similar in its grey colour pattern to *B. humilis* and *B. pseudobaicalensis* (see the key; Figs 51, 53, 61).

Distribution in China. Hebei, Shanxi, Neimenggu, Heilongjiang, Gansu, Qinghai (IAB).

Forage plants. ASTERACEAE: *Cirsium leo*, *Helianthus annuus*, *Saussurea* sp., *Sinacalia tangutica*; CAMPANULACEAE: *Adenophora potaninii*; FABACEAE: *Astragalus bhotanensis*, *Lespedeza bicolor*, *L. floribunda*, *Melilotus officinalis*; LAMIACEAE: *Caryopteris tangutica*, *Dracocephalum heterophyllum*; RANUNCULACEAE: *Aconitum gymnantrum*; SCROPHULARIACEAE: *Pedicularis semitorta*.

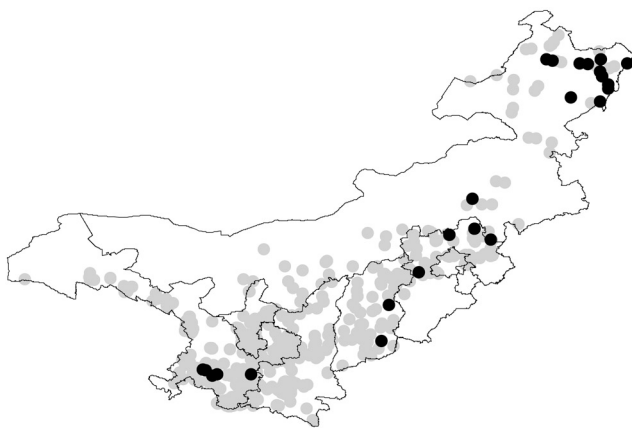


FIGURE 50. Map showing the distribution of *B. deuteronymus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey.

FIGURE 51. *B. deuteronymus* worker visiting *Cirsium leo* (Asteraceae) in Gansu (PW).

25. *Bombus (Thoracobombus) humilis* Illiger

(Figs 52, 53)

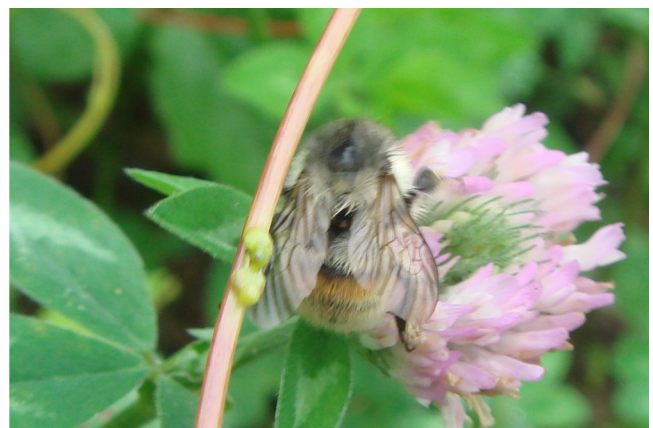
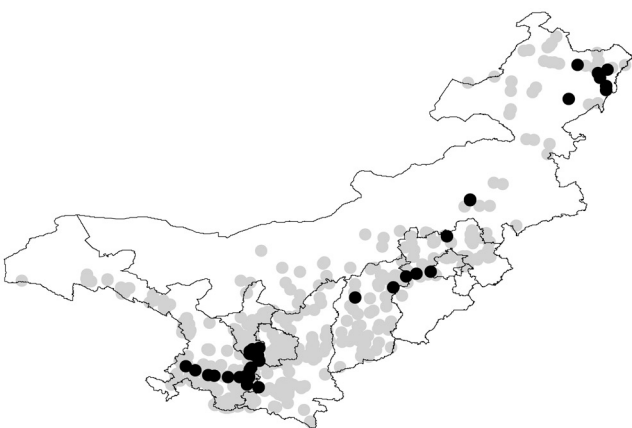
Apis fulvescens [*fulvescens*] Schrank, 1802:367. *Nomen oblitum* (Williams *et al.*, 2009).

Bombus humilis Illiger, 1806:171. *Nomen protectum* (Williams *et al.*, 2009).

Bombus (Agrobombus) helferanus var. *subbaicalensis* Vogt, 1911:42, 54.

Material examined. 3 queens, 137 workers, 12 males (IAB).

Distribution in North China. Primarily in northeastern Neimenggu, on the loess plateau and the west Qinling mountains. Common at low elevations of the Nenjiang river valley in northeastern Neimenggu, at medium elevations of the Kongdongshan nature reserve and the Maijishan forest park in Gansu, at medium elevations of the Liupanshan nature reserve in southern Ningxia, and the west Qinling mountains in Shaanxi. Rare at medium elevations of the Baihuashan nature reserve and the Lingshan nature reserve in Beijing, at medium elevations of the Xiaowutaishan nature reserve in Hebei, at medium elevations of the Taihangshan mountains and Lvlaingshan mountains in Shanxi, and at medium to high elevations on the edge of the east Qinghai-Tibetan plateau in Gansu. 51 localities (Fig. 52) between 315–3130 m (IAB).



FIGURES 52–53. **52.** Map showing the distribution of *B. humilis* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. **53.** *B. humilis* worker visiting *Trifolium pratense* (Fabaceae) in Shaanxi.

Variation in North China. This species shows strong variation in the colour pattern of the hair across its global distribution but shows little variation in North China (Fig. 53).

Similar species in North China. This species is very similar in its grey colour pattern to *B. deuteronymus* and *B. pseudobaicalensis* (see the key; Figs 51, 53, 61).

Distribution in China. Beijing, Hebei, Shanxi, Neimenggu, Heilongjiang, Sichuan, Xizang, Shaanxi, Gansu, Ningxia, Xinjiang (IAB).

Forage plants. ASTERACEAE: *Cirsium leo*, *C. monocephalum*, *C. setosum*, *Cosmos bipinnatus*, *Helianthus annuus*; CAMPANULACEAE: *Adenophora divaricata*; CONVULVACEAE: *Calystegia hederacea*; FABACEAE: *Astragalus bhotanensis*, *Trifolium pratense*, *Trifolium repens*; LAMIACEAE: *Caryopteris tangutica*, *Dracocephalum heterophyllum*, *Elsholtzia densa*, *Mentha canadensis*; MALVACEAE: *Hibiscus trionum*, RANUNCULACEAE: *Clematis tangutica*; TILIACEAE: *Grewia biloba*.

26. *Bombus (Thoracobombus) pascuorum* (Scopoli)

(Figs 54, 55)

APIS Pascuorum [*pascuorum*] Scopoli, 1763:306.

Apis fenilis [*senilis*] Fabricius, 1775:382.

Apis agrorum Fabricius, 1787:301 (not of Schrank, 1781:397 = *B. mesomelas* Gerstaecker).

Material examined. 8 workers, 20 males (IAB).

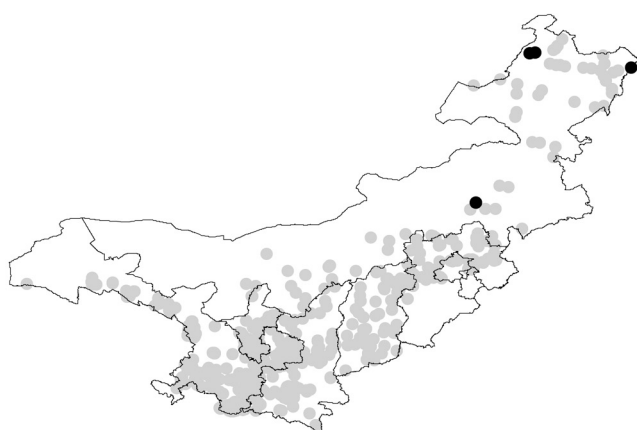
Distribution in North China. Only in northeastern Neimenggu. Common at low elevations of the Moerdaoga forest park, in the transition zone between the Hulunbeir grasslands and the Great Khingan mountains forests in northeastern Neimenggu. Rare at low elevations of the Nenjiang river valley in Elunchun, northeastern Neimenggu, and at medium elevations of the Huanggangliang forest park of the southernmost of the Great Khingan mountains in Neimenggu. 4 localities (Fig. 54) between 395–1665 m (IAB).

Variation in North China. This species shows strong variation in the colour pattern of the hair across its global distribution. In North China it shows only a small part of this variation (see the key).

Similar species in North China. This species is similar in its brown colour pattern to *B. schrencki*, *B. hedini*, *B. tricornis* and *B. atripes* (see the key; Figs 55, 57, 59, 69, 71).

Distribution in China. Neimenggu, Heilongjiang, Xinjiang (IAB).

Forage plants. ASTERACEAE: *Achillea millefolium*, *Hieracium umbellatum*, *Saussurea* sp., *Serratula coronata*; CRASSULACEAE: *Orostachys fimbriata*, *O. malacophylla*; ONAGRACEAE: *Chamerion angustifolium*; RANUNCULACEAE: *Aconitum kusnezoffii*; SCROPHULARIACEAE: *Pseudolysimachion linariifolium*.



FIGURES 54–55. 54. Map showing the distribution of *B. pascuorum* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 55. *B. pascuorum* worker visiting *Serratula coronata* (Asteraceae) in Neimenggu.

27. *Bombus (Thoracobombus) schrencki* Morawitz

(Figs 56, 57)

Bombus Schrencki Morawitz, 1881:250.

Material examined. 1 queen, 39 workers, 24 males (IAB).

Distribution in North China. Primarily on the Bashang plateau, the Taihangshan mountains, and the Great Khingan mountains. Common at medium to high elevations of the Wutaishan forest park in Shanxi, at medium elevations of the Huanggangliang forest park of the southernmost Great Khingan mountains in Keshiketeng, Neimenggu, and at low elevations of the northernmost Great Khingan mountains in Genhe, Neimenggu. Rare at medium elevations of the Bashang plateau in northern Hebei, at medium elevations of the Pangquangou nature reserve of the Lvliangshan mountains in northern Shanxi, at medium elevations of the loess plateau in southern Ningxia, and at low elevations of the Moerdaoga forest park, the transition zone between the Hulunbeir grasslands and the Great Khingan mountains forests in northeastern Neimenggu. 19 localities (Fig. 56) between 593–3056 m (IAB).



FIGURES 56–57. 56. Map showing the distribution of *B. schrencki* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 57. *B. schrencki* male visiting *Serratula coronata* (Asteraceae) in Neimenggu (PW).

Similar species in North China. This species is similar in its brown colour pattern to *B. pascuorum*, *B. hedini*, *B. tricornis* and *B. atripes* (see the key; Figs 55, 57, 59, 69, 71).

Distribution in China. Hebei, Shanxi, Neimenggu, Jinling, Heilongjiang, Ningxia, Xinjiang (IAB).

Forage plants. ASTERACEAE: *Chrysanthemum chanetii*, *Cirsium leo*, *Helianthus annuus*, *Ixeris polycephala*, *Leontopodium omeiense*, *Saussurea purpurascens*, *Serratula coronata*; CAMPANULACEAE: *Adenophora wawreana*; CRASSULACEAE: *Orostachys fimbriata*; DIPSACACEAE: *Scabiosa comosa*; FABACEAE: *Vicia unijuga*; LAMIACEAE: *Elsholtzia densa*, *E. stauntonii*; ROSACEAE: *Potentilla fruticosa*.

28. *Bombus (Thoracobombus) hedini* Bischoff

(Figs 58, 59)

Bombus silvarum ssp. *unicolor* Friese, 1905:514 (not of Kriechbaumer, 1870:159 = *B. barbutellus* (Kirby)).

Bombus (Agrobombus) hedini Bischoff, 1936:15 (not of Bischoff, 1936:25 = *B. bohemicus* Seidl).

Nomenclature. The name *hedini* Bischoff (1936:15) was selected as the valid name for this species by Williams (1998) by the Principle of the First Reviser (ICZN, 1999).

Material examined. 6 queens, 1045 workers, 54 males (IAB).

Distribution in North China. Widely distributed within the zone from the edge of southern Neimenggu plateau, the Yanshan mountains, the Taihangshan mountains, the loess plateau, to the edge of the east Qinghai-Tibetan plateau. Abundant at medium elevations of the loess plateau in eastern Gansu and southern Ningxia. Common at medium elevations of the Bashang plateau in northern Hebei, at low to medium elevations of the Yanshan mountains in northnorthern Beijing, at medium elevations of the Lvliangshan mountains in Shanxi, and at

medium elevations of the loess plateau in northwestern Shaanxi. Rare at medium elevations of the Jiudingshan forest park in Tianjin, at medium elevations of the Taihangshan mountains in Shanxi, at medium elevations of the Huanggangliang forest park of the southernmost of the Great Khingan mountains in Neimenggu, at the medium elevations of the edge of the southern Mu Us semi-desert in northern Shaanxi and northern Ningxia, and at medium elevations of the Baishuijiang nature reserve of southernmost Gansu, and at high elevations of the edge of the east Qinghai-Tibetan plateau in western Gansu. 137 localities (Fig. 58) between 232–3432 m (IAB).

Variation in North China. This species shows some variation in North China (see the key).

Similar species in North China. This species is similar in its brown colour pattern to *B. pascuorum*, *B. schrencki*, *B. tricornis* and *B. atripes* (see the key; Figs 55, 57, 59, 69, 71).

Distribution in China. Beijing, Tianjin, Hebei, Shanxi, Neimenggu, Shaanxi, Gansu, Qinghai, Ningxia (IAB).

Forage plants. ASTERACEAE: *Cirsium shansiense*, *Cosmos bipinnatus*, *Helianthus annuus*, *Solidago canadensis*, *Saussurea* sp.; FABACEAE: *Astragalus bhotanensis*, *A. dahuricus*, *A. penduliflorus*, *Lespedeza bicolor*, *L. juncea*, *Medicago sativa*, *Melilotus albus*, *M. officinalis*, *Onobrychis viciifolia*, *Vicia amoena*, *V. unijuga*; GENTIANACEAE: *Halenia elliptica*; LAMIACEAE: *Dracocephalum heterophyllum*, *Elsholtzia ciliata*, *Leonurus japonicus*, *L. sibiricus*, *Phlomis* sp., *Salvia deserta*, *S. farinacea*, *Salvia* sp., *Stachys chinensis*, *S. japonica*? *Vitex negundo*; PAPAVERACEAE: *Corydalis* sp.; RANUNCULACEAE: *Trollius chinensis*; ROSACEAE: *Potentilla chinensis*, *Rubus crataegifolius*; SCROPHULARIACEAE: *Euphrasia pectinata*; THYMELAEACEAE: *Wikstroemia chamaedaphne*; VALERIANACEAE: *Patrinia scabra*.



FIGURES 58–59. 58. Map showing the distribution of *B. hedini* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 59. *B. hedini* worker visiting *Phlomis* sp. (Lamiaceae) in Gansu.

29. *Bombus (Thoracobombus) pseudobaicalensis* Vogt (Figs 60, 61)

Bombus (Agrobombus) Pseudobaicalensis Vogt, 1911:43, 53.

Agrobombus gilvus Skorikov, 1926:117.

Material examined. 27 workers, 44 males (IAB).

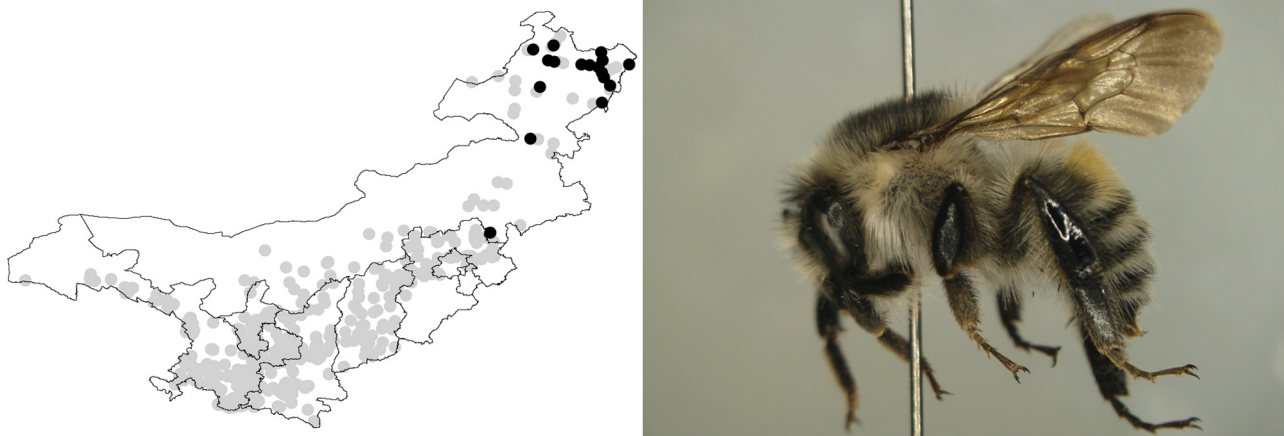
Distribution in North China. Only in the northeast of Neimenggu. Common at low elevations of the northernmost Great Khingan mountains in Genhe, and the Nenjiang river valley in Elunchun, northeastern Neimenggu. Rare at low elevations of the south Great Khingan mountains in Eerguna, Yakeshi and Aershan in northeastern Neimenggu, and at low elevations of the Bashang plateau in Kalaqinqi, Neimenggu. 17 localities (Fig. 60) between 215–855 m (IAB).

Similar species in North China. This species is very similar in its grey colour pattern to *B. deuteronymus* and *B. humilis* (see the key; Figs 51, 53, 61).

Distribution in China. Neimenggu, Jilin, Heilongjiang (IAB).

Forage plants. ASTERACEAE: *Cirsium setosum*, *Cosmos bipinnatus*, *Helianthus annuus*, *H. tuberosus*, *Serratula coronata*; FABACEAE: *Vicia cracca*; LAMIACEAE: *Elsholtzia densa*; ONAGRACEAE: *Chamerion*

angustifolium; POLYGONACEAE: *Fagopyrum esculentum*; RANUNCULACEAE: *Aconitum kusnezoffii*; ROSACEAE: *Sorbaria sorbifolia*, *Spiraea salicifolia*; TROPAEOLACEAE: *Tropaeolum majus*.



FIGURES 60–61. 60. Map showing the distribution of *B. pseudobaicalensis* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 61. *B. pseudobaicalensis* worker from Neimenggu.

30. *Bombus (Thoracobombus) remotus* (Tkalčů) (Figs 62, 63)

Megabombus (Agrobombus) remotus Tkalčů, 1968:45.

Material examined. 6 queens, 444 workers, 61 males (IAB).

Distribution in North China. Primarily on the southern loess plateau, the Qin-Ba mountains in southern Gansu and southern Shaanxi. Abundant at medium elevations of the Maijishan forest park, the Xiaolongshan nature reserve and the Baishuijiang nature reserve in southern Gansu. Common at medium elevations of the Liupanshan nature reserve in southern Ningxia and the Qinling mountains in southern Shaanxi. Rare at medium elevations of the Taihangshan mountains in Shanxi, the Dabashan mountains in Shaanxi, and the Zhagana nature reserve of the edge of the east Qinghai-Tibetan plateau in Gansu. 49 localities (Fig. 62) between 885–2766 m (IAB).

Similar species in North China. This species is similar in its yellow-grey colour pattern to some, *B. picipes*, *B. infrequens* and *B. wangae* (see the key; Figs 63, 109, 111, 117).



FIGURES 62–63. 62. Map showing the distribution of *B. remotus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 63. *B. remotus* worker visiting *Cirsium leo* (Asteraceae) in Gansu.

Distribution in China. Shanxi, Chongqing, Sichuan, Yunnan, Shaanxi, Gansu, Ningxia (IAB).

Forage plants. ASTERACEAE: *Arctium lappa*, *Cirsium leo*, *C. monocephalum*, *Erigeron annuus*, *Tagetes patula*; BUDDLEJACEAE: *Buddleja officinalis*; CLUSIACEAE: *Hypericum perforatum*; FABACEAE: *Campylotropis macrocarpa*, *Lespedeza bicolor*, *Melilotus albus*, *Trifolium pratense*, *T. repens*, *Vicia cracca*; LAMIACEAE: *Nepeta cataria*, *Phlomis umbrosa*, *Verbena officinalis*; RANUNCULACEAE: *Anemone tomentosa*.

31. *Bombus (Thoracobombus) impetuosus* Smith s. l.

(Figs 64, 65)

BOMBUS IMPETUOSUS Smith, 1871:249.

Bombus Potanini Morawitz, 1890:350.

Bombus silvarum var. *subrufescens* Friese, 1913:87.

Bombus (Agrobombus) yuennanensis Bischoff, 1936:14.

Bombus (Agrobombus) combai Tkalců, 1961:357.

Taxonomy. For a discussion of the taxonomy of this species see Williams *et al.* (2009). Assessment of COI barcodes supports this interpretation.

Material examined. 3 queens, 169 workers, 14 males (IAB).

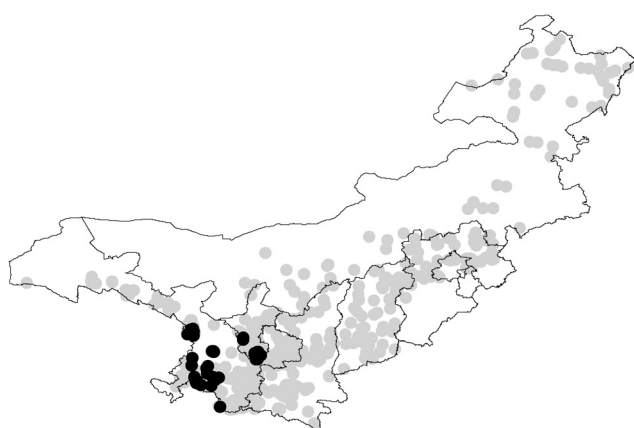
Distribution in North China. Only on the edge of the east Qinghai-Tibetan plateau and the southwest loess plateau. Common at high elevations of the Zhagana nature reserve, at medium elevations of the Lianhuashan nature reserve, the Xinglongshan nature reserve, the Liancheng nature reserve in southwestern Gansu, and at medium elevations of the Liupanshan nature reserve in southern Ningxia and eastern Gansu. Rare at medium elevations of the Baishuijiang nature reserve in southernmost Gansu. 45 localities (Fig. 64) between 1716–3524 m (IAB).

Variation in North China. This species shows strong variation in the colour of the pale hair bands in China but shows little variation in North China (Fig. 65).

Similar species in North China. This species is similar in its grey-banded colour pattern to *B. lepidus* (see the key; Fig. 65, 105).

Distribution in China. Chongqing, Sichuan, Yunnan, Xizang, Gansu, Qinghai, Ningxia (IAB).

Forage plants. ASTERACEAE: *Arctium lappa*, *Cirsium leo*, *Saussurea pulchella*, *S. stella*, *Saussurea* sp., *Senecio jacobaea*, *Sinacalia tangutica*; BORAGINACEAE: *Myosotis* sp.; CAMPANULACEAE: *Adenophora potaninii*; FABACEAE: *Astragalus bhotanensis*, *Melilotus officinalis*, *Oxytropis kansuensis*, *O. ochrocephala*; GENTIANACEAE: *Halenia elliptica*; LAMIACEAE: *Caryopteris incana*, *Dracocephalum heterophyllum*, *D. isabellae*, *Nepeta prattii*, *Salvia przewalskii*, *Salvia* sp., *Thymus mongolicus*; PAPAVERACEAE: *Corydalis* sp.; RANUNCULACEAE: *Aconitum carmichaelii*, *A. gymnantrum*, *A. leucostomum*, *Clematis tangutica*; SCROPHULARIACEAE: *Euphrasia pectinata*, *Pedicularis kansuensis*, *P. spicata*, *Pedicularis* sp.



FIGURES 64–65. 64. Map showing the distribution of *B. impetuosus* s. l. in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 65. *B. impetuosus* s. l. worker visiting *Saussurea stella* (Asteraceae) in Gansu (PW).

32. *Bombus (Thoracobombus) exil* (Skorikov)

(Figs 66, 67)

Mucidobombus exil n. nov. Skorikov, [1923]:150 (not a replacement name).

Megabombus exil (Skorikov); Milliron, 1961:56, justified emendation.

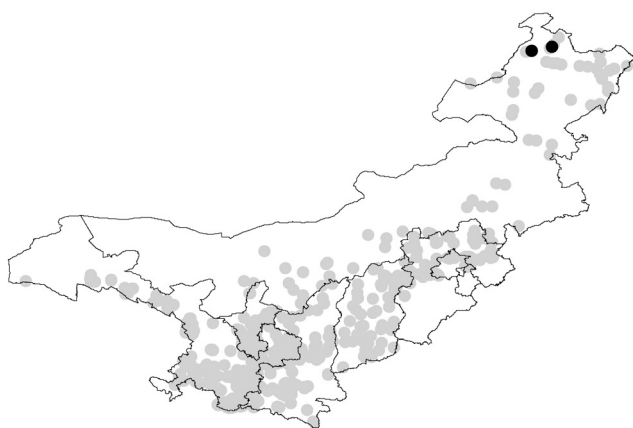
Material examined. 1 worker, 6 males (IAB).

Distribution in North China. Rare at low elevations of the Moerdaoga natural reserve of the Great Khingan mountains in Eerguna and Genhe, northeastern Neimenggu. 2 localities (Fig. 66) between 649–732 m (IAB).

Similar species in North China. This species is similar in its grey colour pattern to *B. subterraneus* (see the key; Figs 17, 67).

Distribution in China. Neimenggu (IAB).

Forage plants. ASTERACEAE: *Hieracium umbellatum*, *Serratula coronata*; DIPSACACEAE: *Scabiosa comosa*.



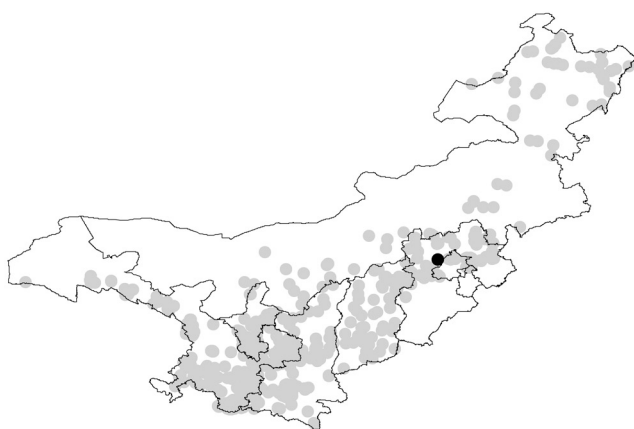
FIGURES 66–67. 66. Map showing the distribution of *B. exil* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 67. *B. exil* worker from Neimenggu.

33. *Bombus (Thoracobombus) tricornis* Radoszkowski

(Figs 68, 69)

Bombus tricornis Radoszkowski, 1888:319.

Material examined. 1 queen (IAB).



FIGURES 68–69. 68. Map showing the distribution of *B. tricornis* in North China with record as black spot, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 69. *B. tricornis* queen from Beijing.

Distribution in North China. Rare at medium elevations of the Songshan nature reserve of the Yanshan mountains in northern Beijing. 1 locality (Fig. 68) at 1590 m (IAB).

Similar species in North China. This species is similar in its brown colour pattern to *B. pascuorum*, *schrencki*, *B. hedini* and *B. atripes* (see the key; Figs 55, 57, 59, 69, 71).

Distribution in China. Beijing, Jilin, Heilongjiang (IAB).

Forage plants. LAMIACEAE: *Vitex negundo*.

34. *Bombus (Thoracobombus) atripes* Smith (Figs 70, 71)

Bombus atripes Smith, 1852a:44.

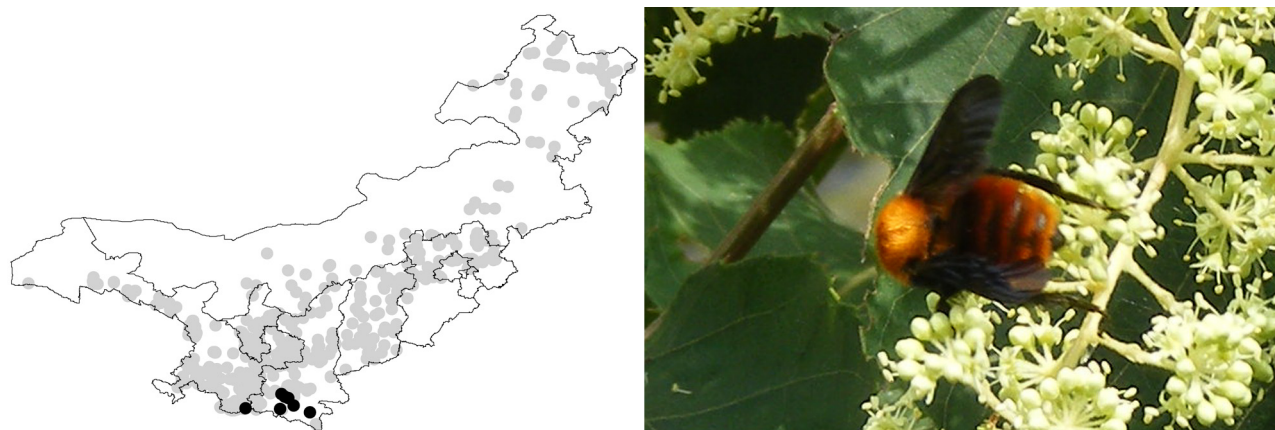
Material examined. 11 workers (IAB).

Distribution in North China. Only in the Qin-Ba mountains in southern Shaanxi. Rare at low to medium elevations of the Changqing nature reserve of the Qinling mountains, and at low elevations of the Micangshan mountains in southern Shaanxi. 7 localities (Fig. 70) between 272–1137 m (IAB).

Similar species in North China. This species is similar in its brown colour pattern to *B. pascuorum*, *schrencki*, *B. hedini* and *B. tricornis* (see the key; Figs 55, 57, 59, 69, 71).

Distribution in China. Chongqing, Shaanxi (IAB).

Forage plants. ARALIACEAE: *Aralia chinensis*; LYTHRACEAE: *Lagerstroemia indica*; SAXIFRAGACEAE: *Astilbe chinensis*.



FIGURES 70–71. 70. Map showing the distribution of *B. atripes* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 71. *B. atripes* worker visiting *Aralia chinensis* (Araliaceae) in Shaanxi.

Subgenus *PSITHYRUS* Lepeletier

35. *Bombus (Psithyrus) tibetanus* (Morawitz) (Figs 72, 73)

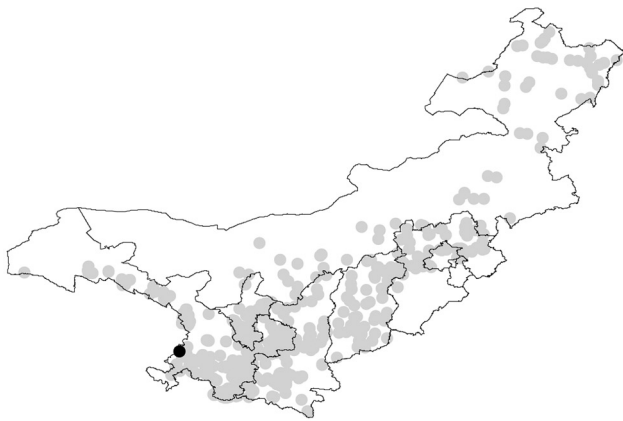
Apathus tibetanus Morawitz, 1887:202.

Material examined. 1 female (PHW).

Distribution in North China. Very rare at high elevations of the edge of the east Qinghai-Tibetan plateau in Xiahe, Gansu. 1 locality (Fig. 72) between 3000–3700 m (PHW).

Distribution in China. Gansu, Qinghai (IAB, PHW).

Forage plants. No records.



FIGURES 72–73. 72. Map showing the distribution of *B. tibetanus* in North China with record as black spot, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 73. *B. tibetanus* female from Gansu.

36. *Bombus (Psithyrus) cornutus* (Frison)
(Figs 74, 75)

Psithyrus (Psithyrus) cornutus Frison, 1933:338.

Psithyrus (Psithyrus) pyramideus Maa, 1948:19.

Psithyrus (Psithyrus) acutisquameus Maa, 1948:21.

Psithyrus (Ceratopsithyrus) klapperichi Pittioni, 1949:273 (not of Pittioni, 1949:266 = *B. picipes* Richards).

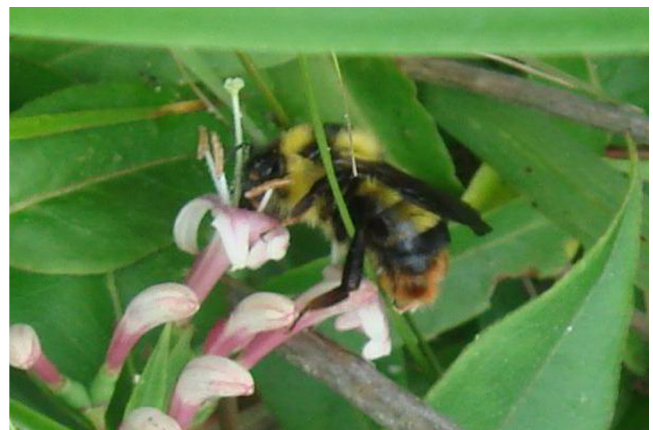
Psithyrus (Eopsithyrus) cornutus ssp. *canus* Tkalců, 1989:42 (not of Schmiedeknecht, 1883:359 = *B. pomorum* (Panzer)).

Material examined. 3 females, 10 males (IAB).

Distribution in North China. Primarily in the Qinling mountains. Rare at medium elevations of the Lishan nature reserve in southern Shanxi, the Maijishan forest park and the Baishuijiang nature reserve in southern Gansu, the Taibai nature reserve, the Niubeiliang nature reserve, and the Huashan park in southern Shaanxi, and the Liupanshan nature reserve in southern Ningxia. 9 localities (Fig. 74) between 1379–2601 m (IAB).

Distribution in China. Shanxi, Anhui, Fujian, Chongqing, Yunnan, Shaanxi, Gansu, Ningxia (IAB).

Forage plants. ASTERACEAE: *Cirsium monocephalum*; BUDDLEJACEAE: *Buddleja officinalis*.



FIGURES 74–75. 74. Map showing the distribution of *B. cornutus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 75. *B. cornutus* female visiting *Lonicera acuminata* (Caprifoliaceae) in Fujian.

37. *Bombus (Psithyrus) turneri* (Richards)

(Figs 76, 77)

Psithyrus turneri Richards, 1929:141.

Psithyrus (Eopsithyrus) decoomani Maa, 1948:26.

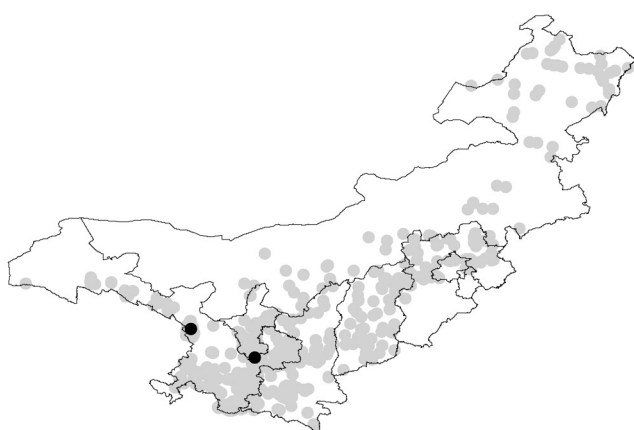
Psithyrus (Eopsithyrus) martensi Tkalců, 1974b:314.

Material examined. 2 males (IAB).

Distribution in North China. Rare at medium elevations of the Qilianshan nature reserve of the edge of the east Qinghai-Tibetan plateau in Gansu and the Liupanshan nature reserve of the loess plateau in southern Ningxia. 2 localities (Fig. 76) between 2291–2878 m (IAB).

Distribution in China. Anhui, Gansu, Qinghai, Ningxia (IAB).

Forage plants. LAMIACEAE: *Dracocephalum heterophyllum*.



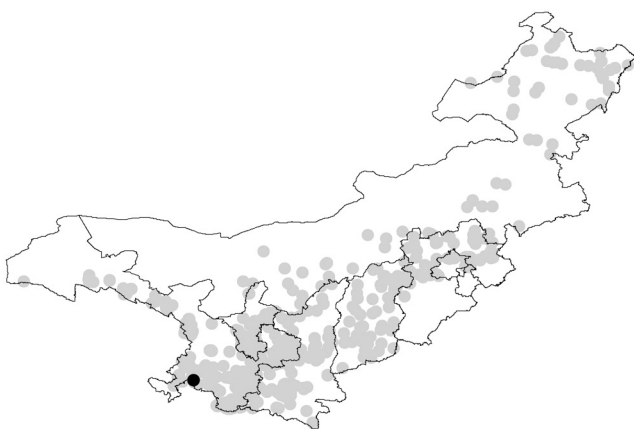
FIGURES 76–77. 76. Map showing the distribution of *B. turneri* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 77. *B. turneri* male from Ningxia.

38. *Bombus (Psithyrus) expolitus* (Tkalců)

(Figs 78, 79)

Psithyrus (Eopsithyrus) expolitus Tkalců, 1989:44.

Material examined. 3 females (IAB).



FIGURES 78–79. 78. Map showing the distribution of *B. expolitus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 79. *B. expolitus* female from Gansu.

Distribution in North China. Rare at high elevations of the Zhagana nature reserve of the east Qinghai-Tibetan plateau. 1 locality (Fig. 78) at 3524 m (IAB).

Distribution in China. Xizang, Gansu, Qinghai (IAB).

Forage plants. ASTERACEAE: *Carduus acanthoides*.

39. *Bombus (Psithyrus) chinensis* (Morawitz)

(Figs 80, 81)

Apathus rupestris var. *chinensis* Morawitz, 1890[April 30]:352 (not of Dalla Torre, 1890[June 25]:139 = *B. rufofasciatus* Smith).

Psithyrus morawitzi Friese, 1905:516 (not of Radoszkowski, 1876:101 = *B. morawitzi* Radoszkowski).

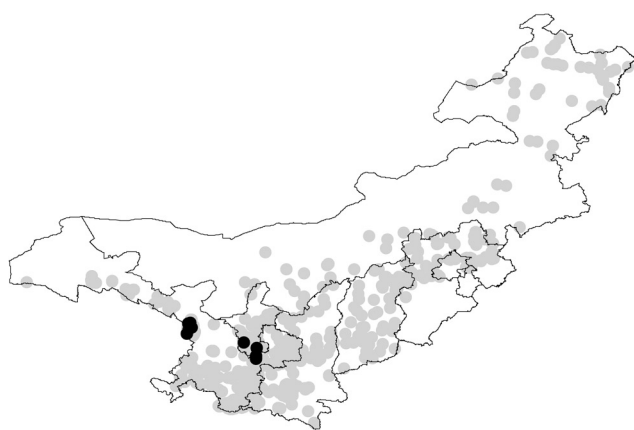
Psithyrus (Psithyrus) chinensis ssp. *hönei* Bischoff, 1936:26 (not of Bischoff, 1936:10 = *B. friseanus* Skorikov).

Material examined. 3 females, 18 males (IAB).

Distribution in North China. Common at medium elevations of the Liupanshan nature reserve in southern Ningxia. Rare at medium elevations of the Liancheng nature reserve and the Qilianshan nature reserve in western Gansu. 9 localities (Fig. 80) between 2020–2952 m (IAB).

Distribution in China. Yunan, Xizang, Gansu, Ningxia (IAB).

Forage plants. APIACEAE: *Angelica* sp.; ASTERACEAE: *Ligularia* sp.; LAMIACEAE: *Dracocephalum heterophyllum*.



FIGURES 80–81. 80. Map showing the distribution of *B. chinensis* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 81. *B. chinensis* female from Gansu.

40. *Bombus (Psithyrus) rupestris* (Fabricius)

(Figs 82, 83)

APIS rupefiris [*rupestris*] Fabricius, 1793:320.

Psithyrus rupestris f. *buyssoni* Vogt, 1911:64.

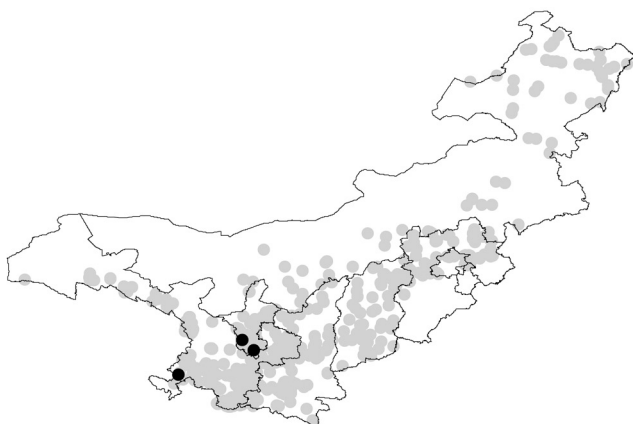
Psithyrus rupestris ssp. *orientalis* Reinig, 1930:276 (not of Smith, 1854:402 = *B. haemorrhoidalis* Smith).

Material examined. 2 females, 3 males (IAB).

Distribution in North China. Rare at high elevations of the Gahai nature reserve of the east Qinghai-Tibetan plateau in Gansu, and at medium elevations of the Liupanshan nature reserve in southern Ningxia. 3 localities (Fig. 82) between 2094–3454 m (IAB).

Distribution in China. Sichuan, Gansu, Ningxia (IAB).

Forage plants. No records.



FIGURES 82–83. 82. Map showing the distribution of *B. rupestris* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 83. *B. rupestris* female from Gansu.

41. *Bombus (Psithyrus) bellardii* (Gribodo)
(Figs 84, 85)

Psithyrus Bellardii Gribodo, 1892:108.

Psithyrus (Metapsithyrus) pieli Maa, 1948:29.

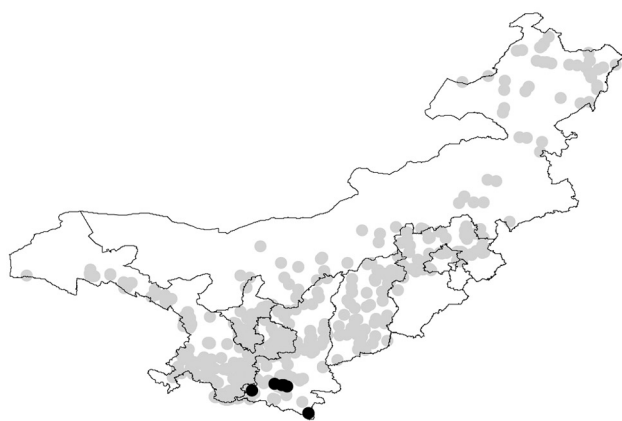
Psithyrus (Metapsithyrus) tajushanensis Pittioni, 1949:277 (not of Pittioni, 1949:244 = *B. bicoloratus* Smith).

Material examined. 7 females, 2 males (IAB).

Distribution in North China. Rare at medium elevations of the Fuping nature reserve, the Changqing nature reserve, the Tianhuashan nature reserve of the Qinling mountains, and the Hualongshan nature reserve of the Dabashan mountains in southern Shaanxi. 6 localities (Fig. 84) between 885–1486 m (IAB).

Distribution in China. Hubei, Chongqing, Yunnan, Shaanxi (IAB).

Forage plants. ASTERACEAE: *Cirsium setosum*, *Helianthus annuus*;



FIGURES 84–85. 84. Map showing the distribution of *B. bellardii* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 85. *B. bellardii* female from Shaanxi.

42. *Bombus (Psithyrus) campestris* (Panzer)
(Figs 86, 87)

APIS campestris [*campestris*] Panzer, 1801:74.

Psithyrus (Metapsithyrus) susterai Tkalců, 1959:251 (not of May, 1944:267 = *B. barbutellus* (Kirby)).

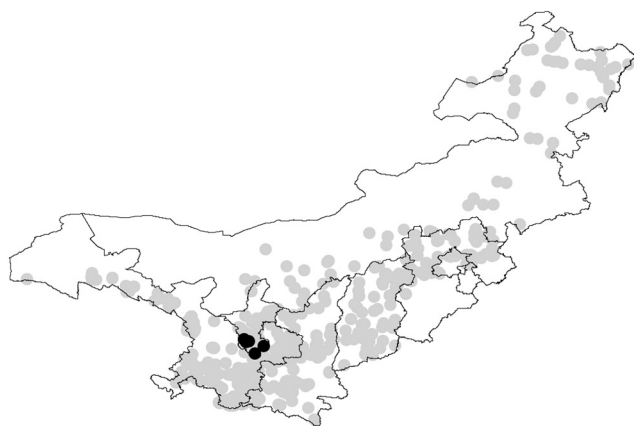
*Psithyrus (Metapsithyrus) susterai*anusk Tkalci, 1977:224, replacement name for *B. susterai* (Tkalci).

Material examined. 9 males (IAB).

Distribution in North China. Rare at medium elevations of the Liupanshan nature reserve in southern Ningxia. 5 localities (Fig. 86) between 1459–2601 m (IAB).

Distribution in China. Jilin, Ningxia (IAB).

Forage plants. ASTERACEAE: *Cirsium setosum*.



FIGURES 86–87. 86. Map showing the distribution of *B. campestris* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 87. *B. campestris* male from Ningxia.

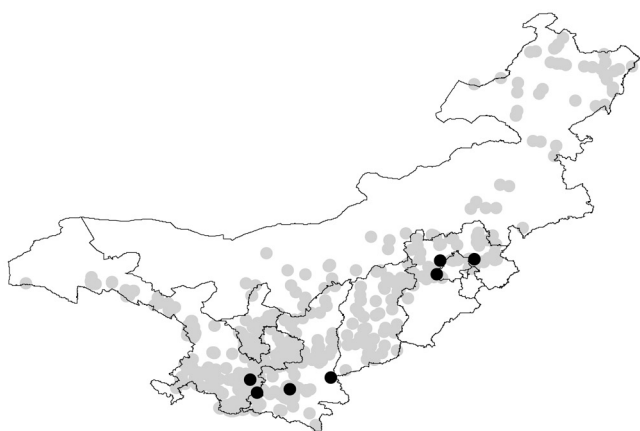
43. *Bombus (Psithyrus) coreanus* (Yasumatsu)

(Figs 88, 89)

Psithyrus (Ashtonipsithyrus) coreanus Yasumatsu, 1934:399.

Material examined. 2 females, 5 males (IAB).

Distribution in North China. Rare at medium elevations of the Baihuashan nature reserve and the Baicaopan nature reserve in Beijing, the Wulingshan nature reserve in Hebei, the Heihe forest park and Huashan park in Shaanxi, and the Majijishan forest park and the Xiaolongshan nature reserve in Gansu. 7 localities (Fig. 88) between 950–1992 m (IAB).



FIGURES 88–89. 88. Map showing the distribution of *B. coreanus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 89. *B. coreanus* male visiting *Veronicastrum sibiricum* (Scrophulariaceae) in Beijing.

Distribution in China. Beijing, Hebei, Shaanxi, Gansu (IAB).

Forage plants. ASTERACEAE: *Cirsium monocephalum*, *Ixeridium sonchifolium*; SCROPHULARIACEAE: *Veronicastrum sibiricum*.

44. *Bombus (Psithyrus) bohemicus* Seidl

(Figs 90, 91)

Bombus bohemicus Seidl, 1837:73.

Psithyrus (Ashtonipsithyrus) chinganicus Reinig, 1936:8.

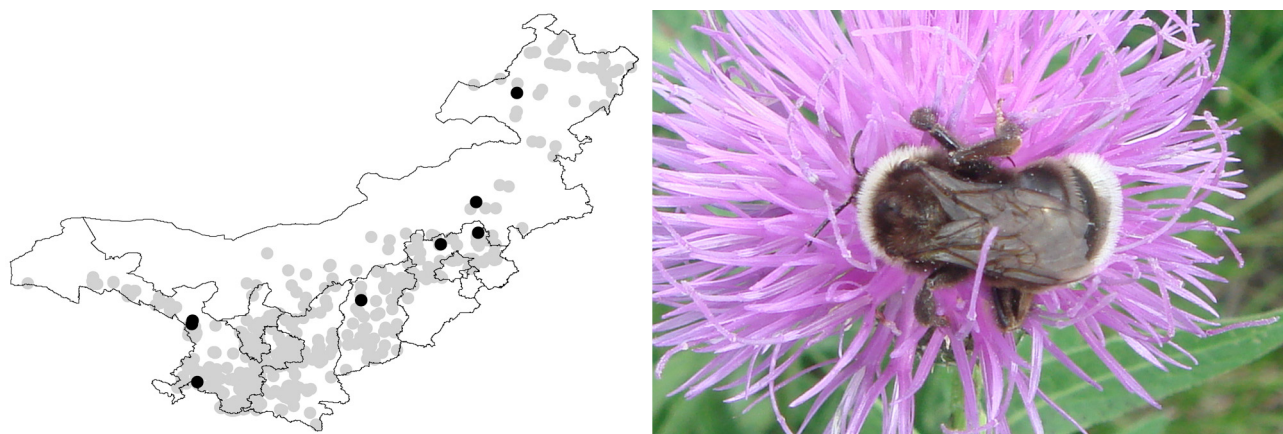
Psithyrus (Ashtonipsithyrus) distinctus ssp. *hedini* Bischoff, 1936:26 (not of Bischoff, 1936:15 = *B. hedini* Bischoff).

Material examined. 2 females, 9 males (IAB).

Distribution in North China. Rare at low to medium elevations of the Bashang plateau in northern Hebei, at medium elevations of the Lvliangshan mountains in Shanxi, at low elevations of the Hulunberli grasslands and at medium elevation of the Huangguangliang forest park in northeastern Neimenggu, at medium elevation of the Qilianshan nature reserve, and at high elevations of the Zhgana nature reserve of the Qinghai-Tibetan plateau in Gansu. 8 localities (Fig. 90) between 613–3524 m (IAB).

Distribution in China. Hebei, Shanxi, Neimenggu, Jilin, Heilongjiang, Sichuan, Xizang, Gansu, Qinghai, Xinjiang (IAB).

Forage plants. ASTERACEAE: *Carduus acanthoides*, *Helianthus annuus*, *Stemmacantha uniflora*.



FIGURES 90–91. 90. Map showing the distribution of *B. bohemicus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 91. *B. bohemicus* female visiting *Stemmacantha uniflora* (Asteraceae) in Hebei.

45. *Bombus (Psithyrus) barbutellus* (Kirby)

(Figs 92, 93)

APIS barbutella Kirby, 1802:343.

Psithyrus (Allopsithyrus) barbutellus subsp. *richardsi* Popov, 1931:150, 190, not of Frison, 1930:6 = *B. rufipes* Lapeletier.

PSITHYRUS MAXILLOSUS f. *susterai* May, 1944:267, not infrasubspecific after Tkalců, 1977:224.

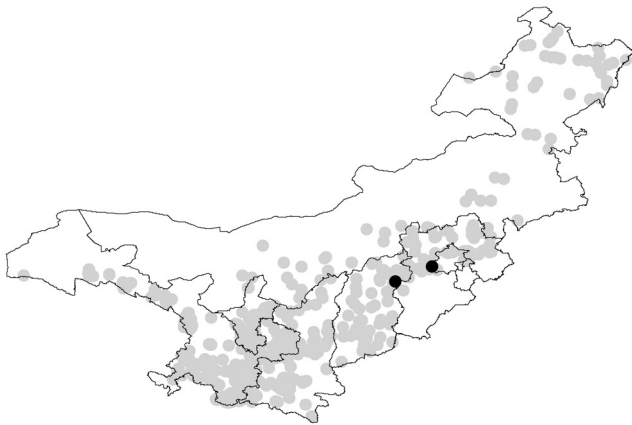
Psithyrus (Allopsithyrus) richardsi subsp. *licenti* Maa, 1948:34.

Material examined. 2 males (IAB).

Distribution in North China. Rare at medium elevations of the Baicaopan nature reserve in Beijing and the Wutaishan forest park in Shanxi. 2 localities (Fig. 92) between 1992–2590 m (IAB).

Distribution in China. Beijing, Shanxi (IAB).

Forage plants. DIPSACACEAE: *Scabiosa comosa*.



FIGURES 92–93. 92. Map showing the distribution of *B. barbutellus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 93. *B. barbutellus* male from Beijing.

46. *Bombus (Psithyrus) skorikovi* (Popov)
(Figs 94, 95)

Psithyrus skorikovi Popov, 1927:267.

Psithyrus (Fernaldaepsithyrus) gansuensis Popov, 1931:202.

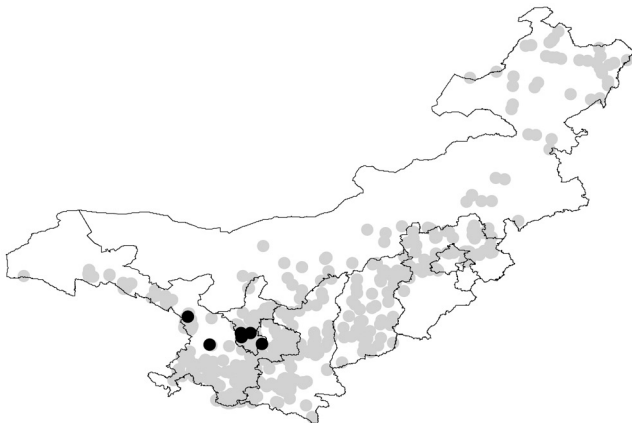
Psithyrus (Fernaldaepsithyrus) kuani Tkalců, 1961:362.

Material examined. 6 females, 48 males (IAB).

Distribution in North China. Common at medium elevations of the Liupanshan nature reserve in southern Ningxia. Rare at medium elevations of the Qilianshan nature reserve and the Xinglongshan nature reserve in Gansu. 7 localities (Fig. 94) between 1560–2834 m (IAB).

Distribution in China. Sichuan, Xizang, Gansu, Qinghai, Ningxia (IAB).

Forage plants. ASTERACEAE: *Cirsium setosum*; *Cosmos bipinnatus*.



FIGURES 94–95. 94. Map showing the distribution of *B. skorikovi* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 95. *B. skorikovi* female from Ningxia.

47. *Bombus (Psithyrus) norvegicus* (Sparre-Schneider)
(Figs 96, 97)

Psithyrus norvegicus Sparre-Schneider, 1918:40 (not of Friese, 1911:571 = *B. monticola* Smith).

Psithyrus norvegicus var. *transbaicalicus* Popov, 1927:269.

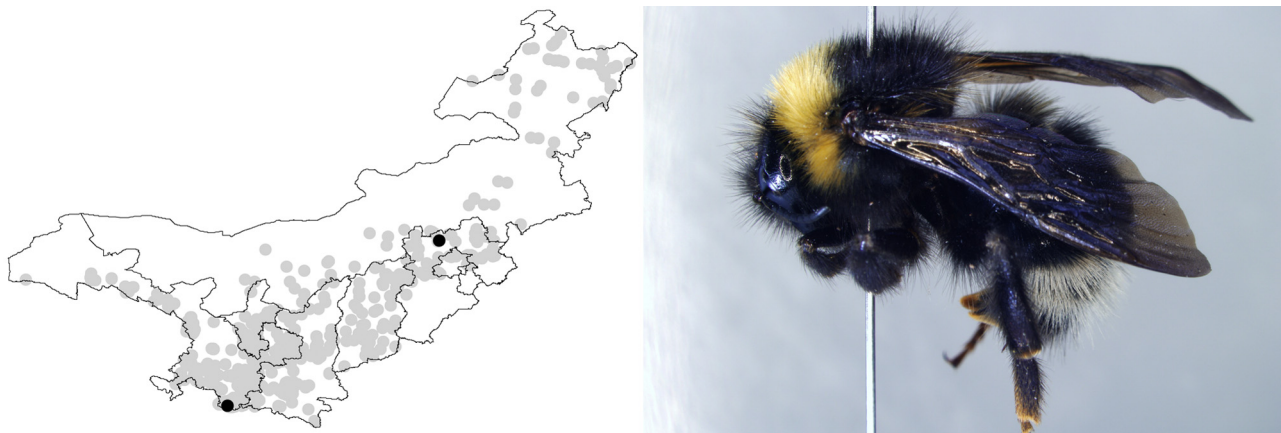
Nomenclature. For a discussion of nomenclatural problems see Williams *et al.* (2009).

Material examined. 3 females, 4 males (IAB).

Distribution in North China. Rare at medium elevations of the Bashang plateau in northern Hebei, and the Baishuijiang nature reserve in southern Gansu. 2 localities (Fig. 96) between 1557–1992 m (IAB).

Distribution in China. Hebei, Sichuan, Gansu, Xinjiang (IAB).

Forage plants. ASTERACEAE: *Echinops sphaerocephalus*; BUDDLEJACEAE: *Buddleja officinalis*.



FIGURES 96–97. 96. Map showing the distribution of *B. norvegicus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 97. *B. norvegicus* female from Gansu.

48. *Bombus (Psithyrus) sylvestris* (Lepeletier)

(Figs 98, 99)

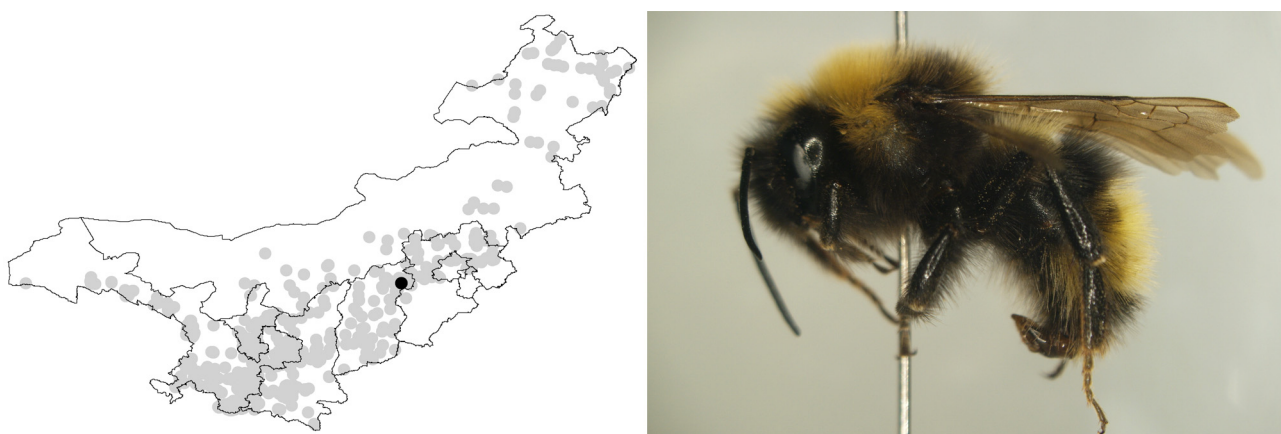
Psithyrus Sylvestris Lepeletier, 1832:377.

Material examined. 5 males (IAB).

Distribution in North China. Rare at medium elevations of the Wutaishan forest park of the Taihangshan mountains in Shanxi. 1 locality (Fig. 98) at 1490 m (IAB).

Distribution in China. Shanxi, Jilin (IAB).

Forage plants. DIPSACACEAE: *Scabiosa comosa*.



FIGURES 98–99. 98. Map showing the distributions of *B. sylvestris* in North China with record in black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 99. *Bombus (Psithyrus) sylvestris* male from Shanxi.

Subgenus *PYROBOMBUS* Dalla Torre

49. *Bombus (Pyrobombus) hypnorum* (Linnaeus)

(Figs 100, 101)

APIS Hypnorum Linnaeus, 1758:579.

Bombus calidus Erichson, 1851:65.

Taxonomy. For a discussion of the taxonomy of this species see Williams *et al.* (2009).

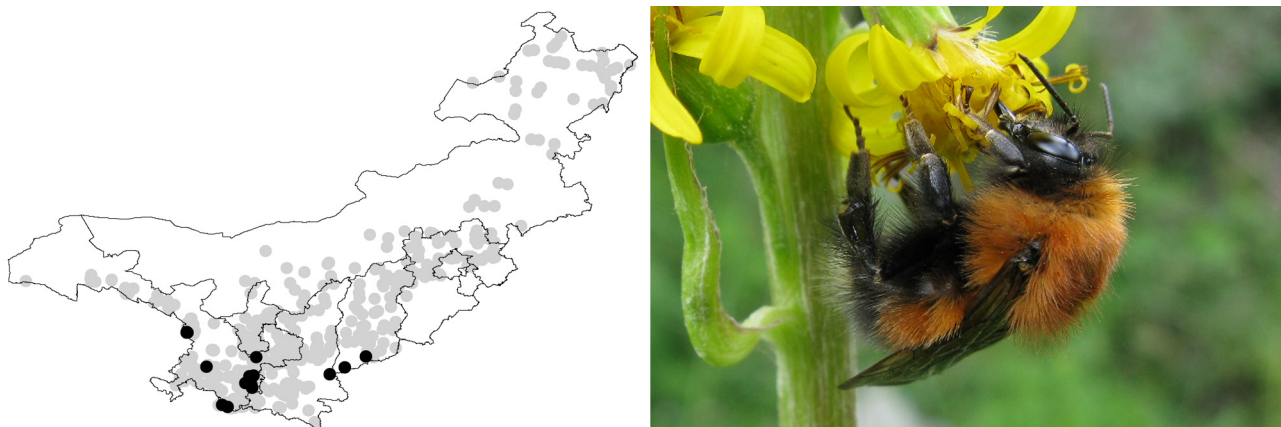
Material examined. 17 queens, 35 workers, 51 males (IAB).

Distribution in North China. Primarily in the west Qinling mountains and the Zhongtiaoshan mountains. Common at medium elevations of the Maijishan forest park, the Xiaolongshan nature reserve, the Liancheng nature reserve in Gansu. Rare at medium elevations of the Baishuijiang nature reserve and the Lianhuashan nature reserve in Gansu, at medium elevations of the Liupanshan nature reserve in southern Ningxia, at medium elevations of the Huashan park in Shaanxi, at low to medium elevations of the Wulaofeng nature reserve, and the Lishan nature reserve in southern Shanxi. 18 localities (Fig. 100) between 780–2923 m (IAB).

Similar species in North China. This species is similar in its brown colour pattern with a white tail to *B. consobrinus* and workers of *B. festivus* (see the key; Figs 37, 101, 143).

Distribution in China. Shanxi, Jilin, Chongqing, Sichuan, Yunnan, Xizang, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang (IAB).

Forage plants. ASTERACEAE: *Carduus acanthoides*, *Cirsium japonicum*, *Ligularia* sp., *Parasenecio roborowskii*, *Stemmacantha uniflora*; APIACEAE: *Angelica* sp.; BUDDLEJACEAE: *Buddleja officinalis*; CAPRIFOLIACEAE: *Lonicera elisae*; FABACEAE: *Oxytropis ochrocephala*, *Piptanthus concolor*; LAMIACEAE: *Nepeta prattii*, *Thymus mongolicus*, *Salvia przewalskii*, *Salvia* sp., *Scutellaria scordiifolia*; ONAGRACEAE: *Chamerion angustifolium*; ROSACEAE: *Cerasus campanulata*, *Amygdalus davidiana*, *A. persica*, *Cerasus tomentosa*.



FIGURES 100–101. 100. Map showing the distribution of *B. hypnorum* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 101. *B. hypnorum* worker visiting *Ligularia* sp. (Asteraceae) in Gansu.

50. *Bombus (Pyrobombus) lemniscatus* Skorikov

(Figs 102, 103)

Bombus lemniscatus Skorikov, 1912:607.

Bombus nursei var. *flavopilosus* Friese, 1918:84.

Bombus (Lapidariobombus) peralpinus Richards, 1930:646.

Material examined. 16 workers, 2 males (IAB).

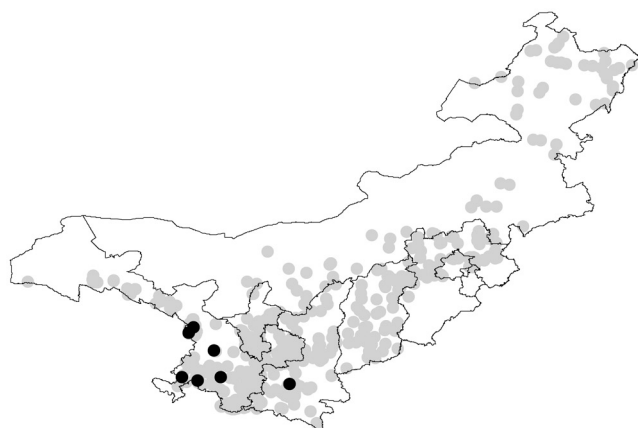
Distribution in North China. Primarily at the edge of the east Qinghai-Tibetan plateau. Common at medium elevations of the Liancheng nature reserve and high elevations of the Zhagana nature reserve of the east Qinghai-

Tibetan plateau in Gansu. Rare at medium elevations of the Taibai nature reserve of the Qinliang mountains in southern Shaanxi. 7 localities (Fig. 102) between 1303–3524 m (IAB).

Similar species in North China. This species is often similar in its white- and yellow-banded colour pattern to *B. rufofasciatus* (see the key; Figs 103, 145).

Distribution in China. Sichuan, Yunnan, Xizang, Shaanxi, Gansu, Qinghai (IAB).

Forage plants. ASTERACEAE: *Carduus acanthoides*, *Ligularia* sp., *Parasenecio roborowskii*, *Saussurea stella*, *Saussurea* sp.; LAMIACEAE: *Salvia przewalskii*; POLYGONACEAE: *Polygonum viviparum*; RANUNCULACEAE: *Aconitum gymnanthum*; SCROPHULARIACEAE: *Pseudolysimachion* sp.



FIGURES 102–103. 102. Map showing the distribution of *B. lemniscatus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 103. *B. lemniscatus* worker visiting *Saussurea stella* (Asteraceae) in Gansu (PW).

51. *Bombus (Pyrobombus) lepidus* Skorikov (Figs 104, 105)

Bombus lepidus Skorikov, 1912:606.

Bombus genitalis Friese, 1913:85.

Bombus nursei var. *tetrachromus* Friese, 1918:85 (not of Cockerell, 1909:397 = *B. kashmirensis* Friese).

Material examined. 8 queens, 321 workers, 115 males (IAB).

Distribution in North China. Primarily at the edge of the east Qinghai-Tibetan plateau, the Liupanshan mountains and the west Qinling mountains. Abundant at medium elevations of the Liupanshan mountains in southern Ningxia. Common at medium to high elevations of the Zhagana nature reserve, the Liancheng nature reserve, the Xinglongshan nature reserve and the Qilianshan nature reserve in western Gansu. Rare at medium elevations of the Maijishan forest park and the Xiaolongshan nature reserve in eastern Gansu, at medium to high elevations of the northern Qilianshan mountains in northwestern Gansu, and at medium elevations of the Luoshan nature reserve in central Niixing. 64 localities (Fig. 104) between 1049–3656 m (IAB).

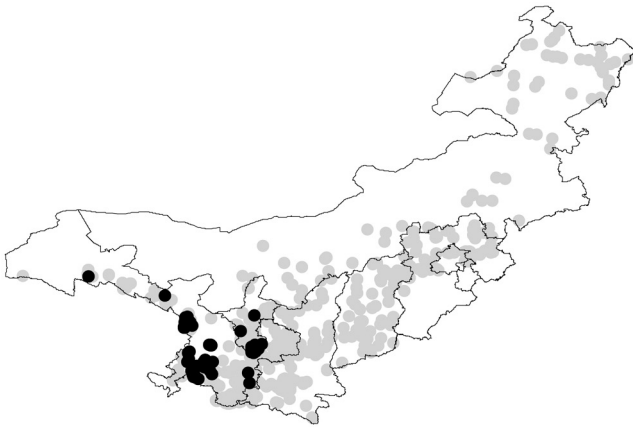
Variation in North China. This species shows strong variation in the colour of the pale hair bands in China but shows little variation in North China (Fig. 105).

Similar species in North China. This species is similar in its grey-banded colour pattern to *B. impetuosus* s. l. (see the key; Figs 65, 105).

Distribution in China. Sichuan, Yunnan, Xizang, Gansu, Qinghai, Ningxia (IAB).

Forage plants. ASTERACEAE: *Carduus acanthoides*, *Cirsium setosum*, *Ligularia* sp., *Saussurea* sp., *Sinacalia tangutica*; BORAGINACEAE: *Lappula myosotis*; CONVULVACEAE: *Ipomoea nil*; FABACEAE: *Astragalus bhotanensis*, *Astragalus* sp., *Hedysarum gmelinii*, *Medicago sativa*, *Melilotus albus*, *M. officinalis*, *Oxytropis kansuensis*, *O. ochrocephala*, *Vicia unijuga*; GENTIANACEAE: *Halenia elliptica*; GERANIACEAE: *Geranium* sp.; LAMIACEAE: *Caryopteris divaricata*, *Dracocephalum heterophyllum*, *D. isabellae*, *Elsholtzia fruticosa*, *Lamium album*, *Nepeta prattii*, *Phlomis umbrosa*, *Salvia przewalskii*, *Salvia* sp., *Thymus mongolicus*; ONAGRACEAE: *Chamerion angustifolium*; PAPAVERACEAE: *Corydalis* sp.; RANUNCULACEAE: *Aconitum flavum*, *A. gymnanthum*,

A. leucostomum, *Clematis akebioides*, *C. tangutica*, *Delphinium grandiflorum*; ROSACEAE: *Potentilla fruticosa*; SCROPHULARIACEAE: *Euphrasia pectinata*, *Pedicularis kansuensis*, *P. spicata*, *Pedicularis* sp.



FIGURES 104–105. 104. Map showing the distribution of *B. lepidus* in North China with record as black spot, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 105. *B. lepidus* worker visiting *Aconitum gymnandrum* (Ranunculaceae) in Gansu.

52. *Bombus (Pyrobombus) infirmus* (Tkalčů)
(Figs 106, 107)

Pyrobombus (Pyrobombus) infirmus Tkalčů, 1968:24.

Material examined. 1 male (IAB).

Distribution in North China. Only in the Qinling mountains. Rare at medium elevations of the Taibai nature reserve in southern Shaanxi. 1 locality (Fig. 106) at 2556 m (IAB).

Distribution in China. Sichuan, Xizang, Shaanxi (IAB).

Forage plants. No records.



FIGURES 106–107. 106. Map showing the distribution of *B. infirmus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 107. *B. infirmus* male from Shaanxi.

53. *Bombus (Pyrobombus) picipes* Richards
(Figs 108, 109)

Bombus pratorum ssp. *flavus* Friese, 1905:517 (not of Pérez, 1884:265 = *B. campestris* (Panzer)).

Bombus (Pratobombus) parthenius var. *picipes* Richards, 1934:90.

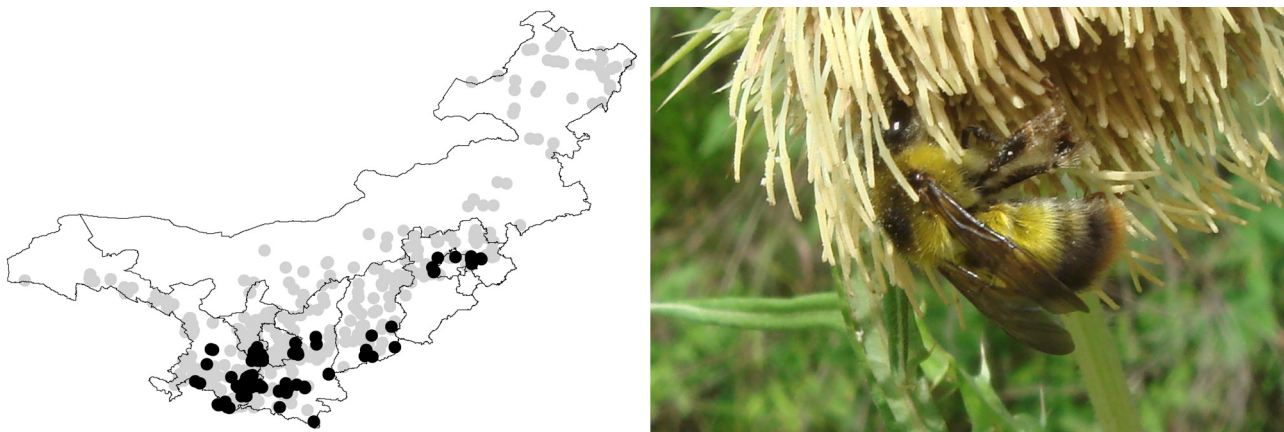
Bombus (Pratobombus) klapperichi Pittioni, 1949:266.

Material examined. 28 queens, 556 workers, 104 males (IAB).

Distribution in North China. Primarily in the Qinling mountains, the loess plateau and the Yanshan mountains. Abundant at medium elevations of the Maijishan forest park and the Xiaolongshan nature reserve in Gansu, and medium elevations of the Liupanshan mountains in southern Ningxia. Common at low to medium elevations of the Yanshan mountains in Beijing and northern Hebei, at medium elevations of the loess plateau in eastern Gansu and central Shaanxi, at medium elevations of the Baishuijiang river valley mountains in southernmost Gansu, at medium elevations of the eastern edge of the Qinghai-Tibetan plateau in western Gansu, at medium elevations of the south Taihangshan mountains in Shanxi, and at medium elevations of the Qinling mountains in southern Shaanxi. Rare at medium elevation of the Micangshan mountains and the Dabashan mountains in southernmost Shaanxi. 103 localities (Fig. 108) between 414–2788 m (IAB).

Similar species in North China. This species is similar in its yellow-grey colour pattern to some *B. remotus*, *B. infrequens* and *B. wangae* (see the key; Figs 63, 109, 111, 117).

Distribution in China. Beijing, Tianjin, Hebei, Shanxi, Fujian, Henan, Chongqing, Sichuan, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia (IAB).



FIGURES 108–109. 108. Map showing the distribution of *B. picipes* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 109. *B. picipes* queen visiting *Cirsium monocephalum* (Asteraceae) in Gansu.

Forage plants. ALLIACEAE: *Allium fistulosum*; ASTERACEAE: *Arctium lappa*, *Calendula officinalis*, *Callistephus chinensis*, *Cirsium leo*, *C. monocephalum*, *C. shansiense*, *Cosmos bipinnatus*, *Dahlia pinnata*, *Helianthus annuus*, *Ixeridium sonchifolium*, *Saussurea pulchella*, *Saussurea* sp., *Tagetes patula*; BUDDLEJACEAE: *Buddleja officinalis*; CLUSIACEAE: *Hypericum ascyron*; DIPSACACEAE: *Dipsacus japonicus*; FABACEAE: *Astragalus dahuricus*, *Astragalus* sp., *Lespedeza bicolor*, *Medicago sativa*, *Melilotus officinalis*, *Onobrychis viciifolia*, *Oxytropis ochrocephala*, *Vicia cracca*; LAMIACEAE: *Dracocephalum heterophyllum*, *Elsholtzia ciliata*, *E. stauntonii*, *Leonurus japonicus*, *L. sibiricus*, *Nepeta prattii*, *Phlomis umbrosa*; MALVACEAE: *Alcea rosea*, *Hibiscus syriacus*; ONAGRACEAE: *Oenothera biennis*; RANUNCULACEAE: *Aconitum kusnezoffii*, *Anemone tomentosa*, *Clematis tangutica*; ROSACEAE: *Duchesnea indica*, *Cerasus campanulata*, *Amygdalus davidiana*, *A. persica*, *Cerasus tomentosa*, *Rosa chinensis*, *Rubus crataegifolius*; SALICACEAE: *Salix caprea*; TILIACEAE: *Grewia biloba*.

54. *Bombus (Pyrobombus) infrequens* (Tkalčů)

(Figs 110, 111)

Pyrobombus (Pyrobombus) infrequens Tkalčů, 1989:56.

Material examined. 20 males (IAB).

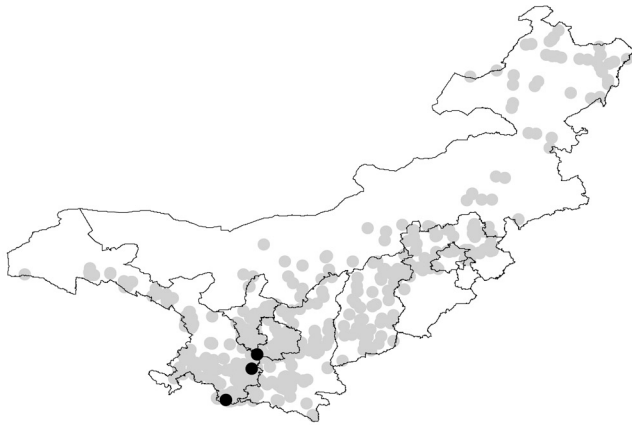
Distribution in North China. Only in the Qin-Ba mountains in southeastern Gansu. Common at medium elevations of the Baishuijiang nature reserve in southernmost Gansu. Rare at medium elevations of the Maijishan

forest park and the Guanshan forest park of the west Qinling mountains in eastern Gansu. 3 localities (Fig. 110) between 1770–2225 m (IAB).

Similar species in North China. This species is similar in its yellow-grey colour pattern to some *B. remotus*, *B. picipes* and *B. wangae* (see the key; Figs 63, 109, 111, 117).

Distribution in China. Chongqing, Sichuan, Yunnan, Xizang, Gansu (IAB).

Forage plants. ASTERACEAE: *Cirsium leo*; BUDDLEJACEAE: *Buddleja* sp.; FABACEAE: *Melilotus officinalis*.



FIGURES 110–111. 110. Map showing the distribution of *B. infrequens* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 111. *B. infrequens* worker visiting *Buddleja* sp. (Buddlejaceae) in Gansu.

55. *Bombus (Pyrobombus) flavescens* Smith

(Figs 112, 113)

Bombus flavescens Smith, 1852a:45.

Bombus rufocaudatus Friese, 1905:510.

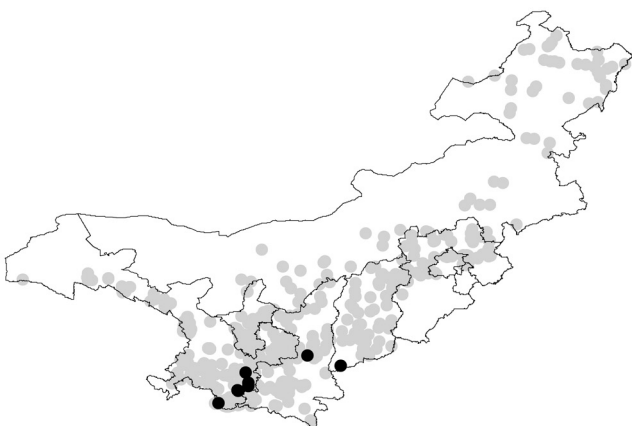
Bombus geei Cockerell, 1917:265.

Bremus (Pratobombus) mearnsi var. *dilutus* Frison, 1934:174.

Bombus (Pratobombus) mearnsi ssp. *chekiangensis* Bischoff, 1936:5.

Bombus (Pratobombus) flavescens f. *dilutior* Pittioni, 1949:264.

Material examined. 4 queens, 3 workers, 3 males (IAB).



FIGURES 112–113. 112. Map showing the distribution of *B. flavescens* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 113. *B. flavescens* worker from Gansu.

Distribution in North China. Rare at low elevations of the Zhongtiaoshan mountains in southernmost Shanxi, at medium elevations of the loess plateau in central Shaanxi, and at medium elevations of the Maijishan forest park,

the Xiaolongshan nature reserve, and the Baishuijiang nature reserve in southern Gansu. 8 localities (Fig. 112) between 780–1415 m (IAB).

Distribution in China. Shanxi, Anhui, Fujian, Henan, Guangdong, Chongqing, Sichuan, Yunnan, Shaanxi, Gansu (IAB).

Forage plants. ASTERACEAE: *Arctium lappa*, *Helianthus annuus*; MALVACEAE: *Alcea rosea*.

56. *Bombus (Pyrobombus) modestus* Eversmann

(Figs 114, 115)

Bombus modestus Eversmann, 1852:134.

Bombus Baikalensis Radoszkowski, 1877:203.

Bombus nymphae Skorikov, 1910b:409.

Material examined. 15 workers, 15 males (IAB).

Distribution in North China. Common at medium elevations of the Wulingshan nature reserve in Hebei. Rare at medium elevations of the Pangquangou nature reserve of the Lvliangshan mountains and at medium to high elevations of the Wutaishan forest park of the Taihangshan mountains in Shanxi, at medium elevations of the Huanggangliang forest park of the southernmost of the Great Khingan mountains in Neimenggu, at medium elevations of the Taibai nature reserve of the Qinling mountains in Shaanxi, and at medium elevations of the Liupanshan mountains in Ningxia. 13 localities (Fig. 114) between 511–3056 m (IAB).

Similar species in North China. This species is similar in its yellow-grey colour pattern to some *B. wangae* (see the key; Figs 115, 117).

Distribution in China. Hebei, Shanxi, Neimenggu, Jilin, Shaanxi, Ningxia (IAB).

Forage plants. ASTERACEAE: *Cirsium leo*, *C. pendulum*, *Echinops sphaerocephalus*; FABACEAE: *Lespedeza bicolor*, *Onobrychis viciifolia*; LAMIACEAE: *Elsholtzia densa*, *E. stauntonii*, *Leonurus sibiricus*; ONAGRACEAE: *Chamerion angustifolium*.



FIGURES 114–115. 114. Map showing the distribution of *B. modestus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 115. *B. modestus* male visiting *Echinops sphaerocephalus* (Asteraceae) in Neimenggu.

57. *Bombus (Pyrobombus) wangae* Williams *et al.*

(Figs 116, 117)

Bombus (Pyrobombus) wangae Williams *et al.*, 2009:159.

Material examined. 1 queen, 24 workers, 88 males (IAB).

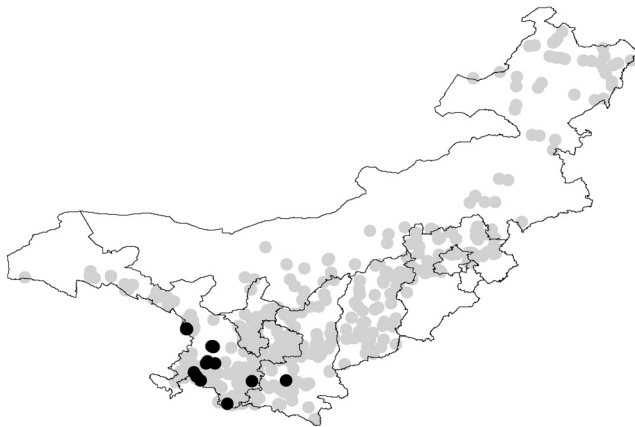
Distribution in North China. Primarily at the edge of the east Qinghai-Tibetan plateau in Gansu. Common at medium elevations of the Liancheng nature reserve, the Xinglongshan nature reserve and the Lianhuashan nature reserve in Gansu. Rare at medium to high elevations of the Zhagana nature reserve, at medium elevations of the

Xiaolongshan nature reserve and the Baishuijiang natural reserve in Gansu, and at medium elevations of the Taibai nature reserve of the Qinling mountains in Shaanxi. 17 localities (Fig. 116) between 1218–3050 m (IAB).

Similar species in North China. This species is similar in its yellow-grey colour pattern to some *B. remotus*, *B. picipes*, *B. infrequens* and *B. modestus* (see the key; Figs 63, 109, 111, 115, 117).

Distribution in China. Sichuan, Shaanxi, Gansu, Qinghai (IAB).

Forage plants. APIACEAE: *Angelica* sp.; ASTERACEAE: *Carduus acanthoides*, *Cirsium japonicum*, *Ligularia* sp., *Parasenecio roborowskii*, *Saussurea* sp., *Sinacalia tangutica*; LAMIACEAE: *Dracocephalum heterophyllum*, *D. isabellae*, *Lamium barbatum*, *Nepeta prattii*, *Salvia przewalskii*, *Thymus mongolicus*; MALVACEAE: *Alcea rosea*, *Malva cathayensis*; ONAGRACEAE: *Chamerion angustifolium*; POLYGONACEAE: *Polygonum viviparum*; RANUNCULACEAE: *Aconitum gymnandrum*; SCROPHULARIACEAE: *Euphrasia pectinata*, *Pedicularis spicata*.



FIGURES 116–117. 116. Map showing the distribution of *B. wangae* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 117. *B. wangae* worker visiting *Chamerion angustifolium* (Onagraceae) in Gansu.

Subgenus *BOMBUS* in the strict sense

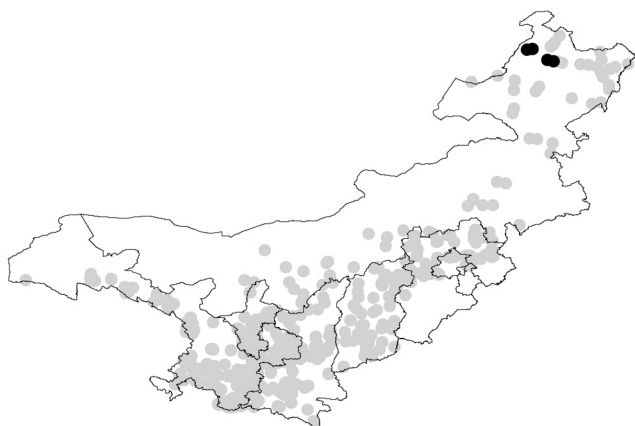
58. *Bombus (Bombus) sporadicus* Nylander

(Figs 118, 119)

Bombus sporadicus Nylander, 1848:233.

Bombus (Terrestribombus) terrestris czerskianus Vogt, 1911:56.

Taxonomy. Revised by Williams *et al.* (2012b).



FIGURES 118–119. 118. Map showing the distribution of *B. sporadicus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 119. *B. sporadicus* male visiting *Hieracium umbellatum* (Asteraceae) in Neimenggu.

Material examined. 5 workers, 3 males (IAB).

Distribution in North China. Rare at low elevations of the northernmost Great Khingan mountains in northeastern Neimenggu. 4 localities (Fig. 118) between 621–776 m (IAB).

Similar species in North China. This species is similar in its yellow-banded colour pattern to *B. lantschouensis* (see the key; Figs 119, 127).

Distribution in China. Neimenggu, Jilin, Heilongjiang (IAB).

Forage plants. ASTERACEAE: *Hieracium umbellatum*, *Serratula coronata*; ONAGRACEAE: *Chamerion angustifolium*; RANUNCULACEAE: *Aconitum kusnezoffii*; ROSACEAE: *Spiraea salicifolia*.

59. *Bombus (Bombus) ignitus* Smith

(Figs 120, 121)

Bombus ignitus Smith, 1869:207.

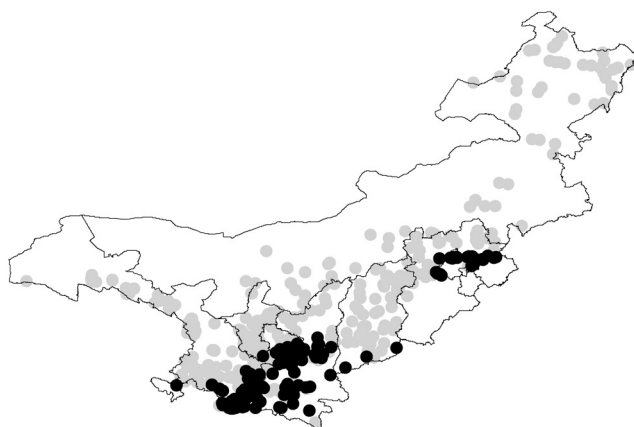
Taxonomy. Revised by Williams *et al.* (2012b).

Material examined. 36 queens, 871 workers, 285 males (IAB).

Distribution in North China. Primarily in the Yanshan mountains, the loess plateau and the Qinling mountains. Abundant at low to medium elevations of the Yanshan mountains in Beijing and northern Hebei, and at medium elevations of the Qinling mountains in southeastern Gansu and southern Shaanxi. Common at medium elevations of the loess plateau in eastern Gansu and central Shaanxi. Rare at low to medium elevations of the Zhongtiaoshan mountains in southernmost Shanxi, and at high elevations of the edge of the east Qinghai-Tibetan plateau in Gansu. 135 localities (Fig. 120) between 134–3432 m (IAB).

Similar species in North China. This species is similar in its red-tailed colour pattern to *B. koreanus* (see the key; Figs 39, 121).

Distribution in China. Beijing, Tianjin, Hebei, Shanxi, Liaoning, Jilin, Henan, Chongqing, Sichuan, Yunnan, Shaanxi, Gansu, Qinghai (IAB).



FIGURES 120–121. 120. Map showing the distribution of *B. ignitus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 121. *B. ignitus* worker visiting *Carduus acanthoides* (Asteraceae) in Shaanxi.

Forage plants. ALLIACEAE: *Allium fistulosum*; APIACEAE: *Foeniculum vulgare*; ARALIACEAE: *Aralia chinensis*, *Fatsia japonica*; ASTERACEAE: *Carduus acanthoides*, *Cirsium monocephalum*, *C. shansiense*, *Cosmos bipinnatus*, *Dahlia pinnata*, *Echinops sphaerocephalus*, *Helianthus annuus*, *Ligularia intermedia*, *Ixeridium sonchifolium*, *Rudbeckia hirta*, *R. laciniata*; *Saussurea pulchella*, *Saussurea* sp.; *Tagetes patula*; BEGONIACEAE: *Begonia grandis*; BUDDLEJACEAE: *Buddleja officinalis*; CLUSIACEAE: *Hypericum perforatum*; CONVULVULACEAE: *Convolvulus arvensis*, *Ipomoea nil*; CUCURBITACEAE: *Cucumis sativus*, *Cucurbita moschata*, *Thladiantha dubia*; FABACEAE: *Albizia julibrissin*, *Astragalus dahuricus*, *Campylotropis macrocarpa*, *Coronilla varia*, *Lablab purpureus*, *Lespedeza bicolor*, *L. daurica*, *Piptanthus concolor*, *Phaseolus vulgaris*, *Robinia pseudoacacia*, *Sophora davidii*, *S. japonica*, *Trifolium pretense*, *T. repens*, *Vicia amoena*, *V. cracca*, *V. unijuga*, *Wisteria villosa*;

LAMIACEAE: *Agastache rugosa*, *Caryopteris divaricata*, *Elsholtzia ciliata*, *Leonurus japonicus*, *L. macranthus*, *L. sibiricus*, *Nepeta cataria*, *Phlomis umbrosa*, *Salvia farinacea*, *Stachys sieboldii*, *Vitex negundo*; LYTHRACEAE: *Lagerstroemia indica*, *Lythrum salicaria*; MAGNOLIACEAE: *Yulania denudata*; MALVACEAE: *Abutilon theophrasti*, *Alcea rosea*, *Hibiscus syriacus*, *Hibiscus trionum*, *Malva cathayensis*; OLEACEAE: *Ligustrum lucidum*; ONAGRACEAE: *Chamerion angustifolium*, *Oenothera biennis*; PAPAVERACEAE: *Corydalis* sp., *Dicranostigma leptopodum*, *Macleaya microcarpa*; POLYGONACEAE: *Polygonum nepalense*; RANUNCULACEAE: *Anemone tomentosa*, *Trollius chinensis*; ROSACEAE: *Amygdalus davidiana*, *A. persica*, *A. triloba*, *Armeniaca sibirica*, *A. vulgaris*, *Cerasus campanulata*, *C. tomentosa*, *Malus pumila*, *Potentilla chinensis*, *Rosa chinensis*, *R. filipes*, *R. xanthina*, *Rubus crataegifolius*; SALICACEAE: *Salix caprea*; SCROPHULARIACEAE: *Paulownia elongata*, *Veronicastrum sibiricum*; SOLANACEAE: *Capsicum annuum*, *Petunia hybrida*, *Solanum japonense*, *S. melongena*; THYMELAEACEAE: *Wikstroemia chamaedaphne*; TILIACEAE: *Grewia biloba*.

60. *Bombus (Bombus) longipennis* Friese

(Figs 122, 123)

Bombus pratorum var. *longipennis* Friese, 1918:83.

Bombus (Bombus) terrestris ssp. *minshanicola* Bischoff, 1936:2.

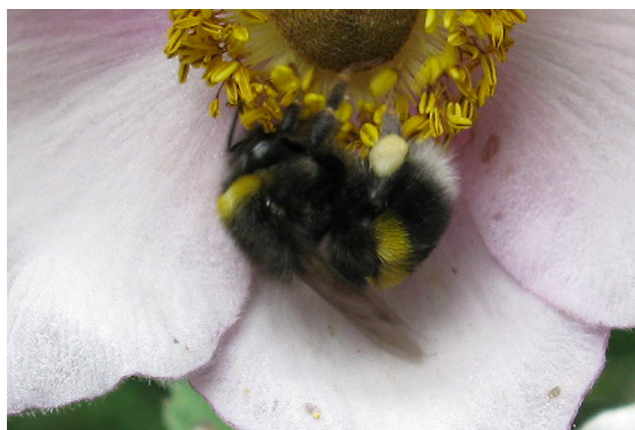
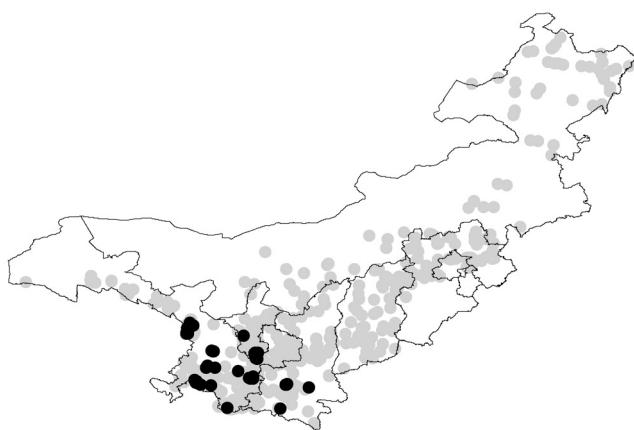
Taxonomy. Revised by Williams *et al.* (2012b). This species has been confused with *B. lucorum*.

Material examined. 14 queens, 122 workers, 251 males (IAB).

Distribution in North China. Primarily in the Liupanshan mountains, the edge of the east Qinghai-Tibetan plateau and the Qinling mountains. Abundant at medium elevations of the Liupanshan nature reserve in southern Ningxia, and at medium elevations of the Liancheng nature reserve in Gansu. Common at medium elevations of the the Lianhuashan nature reserve, the Maijishan forest park and the Baishuijiang nature reserve, at medium to high elevations of the Zhagana nature reserve in Gansu, and at medium elevations of the Taibai nature reserve of Qinling mountains in southern Shaanxi. Rare at medium elevations of the Micangshan mountains in southernmost Shaanxi and at medium elevations of the Quwushan mountains in Ningxia. 49 localities (Fig. 122) between 1303–4011 m (IAB).

Similar species in North China. This species is very similar in its yellow-banded colour pattern to *B. lucorum* and *B. cryptarum* (see the key; Figs 123, 125, 133).

Distribution in China. Sichuan, Yunnan, Xizang, Shaanxi, Gansu, Qinghai, Ningxia (IAB).



FIGURES 122–123. 122. Map showing the distribution of *B. longipennis* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 123. *B. longipennis* worker visiting *Anemone tomentosa* (Ranunculaceae) in Gansu.

Forage plants. ALLIACEAE: *Allium senescens*; APIACEAE: *Angelica* sp.; ASTERACEAE: *Anaphalis bicolor*, *Aster farreri*, *Carduus acanthoides*, *Cirsium japonicum*, *C. leo*, *C. monocephalum*, *Cosmos bipinnatus*, *Helianthus annuus*, *Ligularia przewalskii*, *Ligularia* sp., *Parasenecio roborowskii*, *Picris hieracioides*, *Saussurea leucoma*, *S. purpurascens*, *Saussurea* sp., *Stemmacantha uniflora*; BUDDLEJACEAE: *Buddleja officinalis*, *B. myriantha*; CRASSULACEAE: *Phedimus* sp.; FABACEAE: *Astragalus* sp., *Lathyrus pratensis*, *Oxytropis kansuensis*, *O.*

ochrocephala, *Oxytropis* sp.; GENTIANACEAE: *Gentiana straminea*; LAMIACEAE: *Nepeta prattii*, *Phlomis umbrosa*, *Phlomis* sp., *Salvia przewalskii*, *Thymus mongolicus*; MALVACEAE: *Alcea rosea*; ONAGRACEAE: *Chamerion angustifolium*; POLYGONACEAE: *Polygonum macrophyllum*, *P. viviparum*; RANUNCULACEAE: *Anemone rivularis*, *A. tomentosa*; ROSACEAE: *Sorbaria arborea*, *S. sorbifolia*; SCROPHULARIACEAE: *Pedicularis chinensis*, *P. kansuensis*, *P. torta*, *Pedicularis* sp., *Pseudolysimachion* sp.

61. *Bombus (Bombus) lucorum* (Linnaeus)

(Figs 124, 125)

APIS lucorum Linnaeus, 1761:425.

Taxonomy. Revised by Williams *et al.* (2012b). This species has been much confused with *B. cryptarum* and *B. longipennis*. The species is difficult to distinguish reliably from *B. cryptarum* in particular except from COI barcodes.

Material examined. 2 workers (IAB).

Distribution in North China. Rare at low elevations of the Moerdaoga forest park, the transition zone between the Hulunbeir grassland and the Great Khingan mountains forests, and at low elevations of the Nenjiang river valley in the northeast of Neimenggu. 2 localities (Fig. 124) between 419–649 m (IAB).

Similar species in North China. This species is very similar in its yellow-banded colour pattern to *B. longipennis* and *B. cryptarum* (see the key; Figs 123, 125, 133).

Distribution in China. Neimenggu, Xinjiang (IAB).

Forage plants. No records.



FIGURES 124–125. 124. Map showing the distribution of *B. lucorum* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 125. *B. lucorum* worker from Neimenggu.

62. *Bombus (Bombus) lantschouensis* Vogt

(Figs 126, 127)

Bombus lucorum var. *lan-tschouensis* Vogt, 1908:101.

Bombus vasilievi Skorikov, 1913:172.

Bombus lucorum ssp. *beickianus* Bischoff, 1936:2.

Bombus lucorum ssp. *pseudosporadicus* Bischoff, 1936:2.

Taxonomy. Revised by Williams *et al.* (2012a, b). This species has been confused with *B. patagiatus*.

Material examined. 20 queens, 1981 workers, 485 males (IAB).

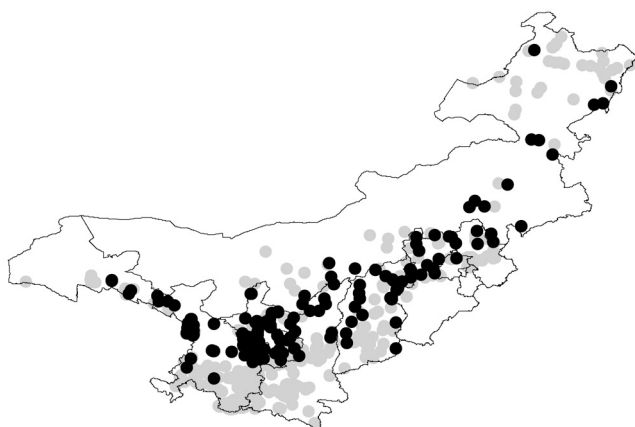
Distribution in North China. Widely distributed within North China, especially along the dry region of southern edge of Neimenggu plateau. Abundant at medium elevations of the Helanshan mountains, the Liupanshan mountains and the Luoshan mountains in Ningxia. Common at medium elevations of the Bashang plateau between

northern Hebei and southern Neimenggu, at medium elevations of the Lvliangshan mountains in Shanxi, at medium elevations of the Mu Us semi-desert edge between in southern Neimenggu and northern Ningxia and northern Shaanxi, at low to medium elevations of the south Great Khingan mountains and low elevations of the Nenjiang river valley in northeastern Neimenggu, at medium to high elevations of the Qilianshan mountains in northwestern Gansu, and at medium elevations of the loess plateau in eastern Gansu. Rare at low elevations of the Moerdaoga forest park, the transition zone between the Hulunbeir grassland and the Great Khingan mountains forests in northeastern Neimenggu, at medium elevations of the Yanshan mountains in Beijing, at medium elevations of the Taihangshan mountains in Shanxi and Hebei, and at medium to high elevations of the grasslands of the east Qinghai-Tibetan plateau in Gansu. 195 localities (Fig. 126) between 215–3386 m (IAB).

Similar species in North China. This species is similar in its yellow-banded colour pattern to *B. sporadicus* (see the key; Figs 119, 127).

Distribution in China. Beijing, Hebei, Shanxi, Neimenggu, Heilongjiang, Shaanxi, Gansu, Qinghai, Ningxia (IAB).

Forage plants. ASTERACEAE: *Cirsium leo*, *C. japonicum*, *Cosmos bipinnatus*, *Dahlia pinnata*, *Helianthus annuus*, *Saussurea parviflora*, *S. purpurascens*, *Serratula coronata*, *Sonchus oleraceus*, *Xanthopappus subacaulis*, *Zinnia elegans*, *Z. peruviana*; BALSAMINACEAE: *Impatiens balsamina*; BORAGINACEAE: *Symphytum officinale*; BRASSICACEAE: *Brassica rapa*, *Erysimum amurense*; CAMPANULACEAE: *Adenophora polyantha*, *Platycodon grandiflorus*; CRASSULACEAE: *Phedimus aizoon*; CUCURBITACEAE: *Benincasa hispida*, *Cucurbita moschata*, *C. pepo*; FABACEAE: *Astragalus melilotoides*, *Medicago sativa*, *Melilotus albus*, *M. officinalis*, *Onobrychis viciifolia*, *Oxytropis kansuensis*, *Vicia amoena*, *V. unijuga*, *Wisteria villosa*; GENTIANACEAE: *Gentiana macrophylla*; LAMIACEAE: *Dracocephalum moldavica*, *Elsholtzia densa*, *E. stauntonii*, *Nepeta coerulescens*, *Salvia farinacea*, *S. roborowskii*, *Scutellaria baicalensis*; LINACEAE: *Linum usitatissimum*; MALVACEAE: *Gossypium hirsutum*, *Malva cathayensis*; POLYGONACEAE: *Polygonum bistorta*; RANUNCULACEAE: *Aconitum barbatum*, *A. flavum*, *Trollius chinensis*; ROSACEAE: *Cerasus campanulata*, *Amygdalus davidiana*, *A. persica*, *Cerasus tomentosa*, *Potentilla chinensis*, *Rosa rugosa*, *R. xanthina*; SCROPHULARIACEAE: *Veronicastrum sibiricum*; SOLANACEAE: *Lycopersicon esculentum*, *Solanum japonense*, *S. melongena*.



FIGURES 126–127. 126. Map showing the distribution of *B. lantschouensis* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 127 *B. lantschouensis* worker visiting *Aconitum barbatum* (Ranunculaceae) in Gansu.

63. *Bombus (Bombus) minshanensis* Bischoff (Figs 128, 129)

Bombus (Bombus) patagiatus subsp. *minshanensis* Bischoff, 1936:3.

Taxonomy. Revised by Williams *et al.* (2012a, b). This species has been confused with *B. patagiatus*.

Material examined. 66 workers, 3 males (IAB).

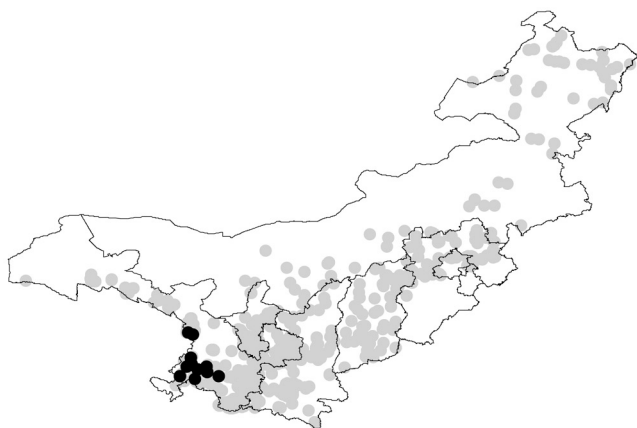
Distribution in North China. Only on the edge of the east Qinghai-Tibetan plateau in Gansu. Common at medium to high elevations of the east Qinghai-Tibetan plateau meadows in Xiahe, Hezuo, Luqu, Lintan and

Minxian. Rare at medium elevations of the Liancheng natural reserve in Yongdeng and at high elevations of the Zhagana nature reserve in Diebu. 11 localities (Fig. 128) between 2096–3963 m (IAB).

Similar species in North China. This species is very similar in its white-banded female colour pattern to some *B. patagiatus* (see the key; Figs 129, 131).

Distribution in China. Sichuan, Xizang, Gansu, Qinghai (IAB).

Forage plants. ASTERACEAE: *Carduus acanthoides*, *Cirsium japonicum*, *C. setosum*, *Ligularia* sp., *Saussurea* sp., FABACEAE: *Hedysarum gmelinii*, *Medicago sativa*, *Melilotus albus*, *M. officinalis*; LAMIACEAE: *Dracocephalum heterophyllum*, *Elsholtzia densa*, *E. fruticosa*, *Salvia* sp., *Thymus mongolicus*; ONAGRACEAE: *Chamerion angustifolium*; ROSACEAE: *Potentilla fruticosa*; SCROPHULARIACEAE: *Euphrasia pectinata*, *Pedicularis* sp.



FIGURES 128–129. 128. Map showing the distribution of *B. minshanensis* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 129. *B. minshanensis* worker visiting *Cirsium japonicum* (Asteraceae) in Gansu.

64. *Bombus (Bombus) patagiatus* Nylander

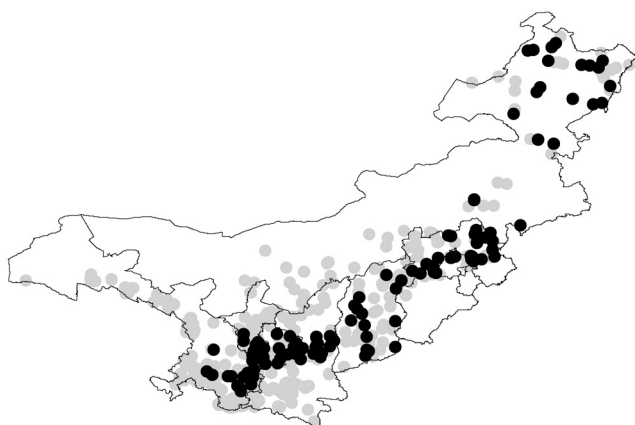
(Figs 130, 131)

Bombus patagiatus Nylander, 1848:234.

Bombus ikonnikovi var *ganjsuensis* Skorikov, 1913:172.

Taxonomy. Revised by Williams *et al.* (2012a, b). The white-tailed colour pattern of this species (*patagiatus* s. str.) has been confused with *B. lantschouensis* and *B. minshanensis*. The orange-tailed colour pattern of this species (*ganjsuensis*) has been confused with *B. hypocrita* Pérez.

Material examined. 23 queens, 1241 workers, 722 males (IAB).



FIGURES 130–131. 130. Map showing the distribution of *B. patagiatus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 131. *B. patagiatus* worker visiting *Clematis intricata* (Ranunculaceae) in Hebei.

Distribution in North China. Widely distributed within the zone between the Neimenggu plateau and the Qinghai-Tibetan plateau and the Qinling mountains, as well as the Great Khingan mountains. Abundant at low to medium elevations of the Yanshan mountains in northern Beijing and northern Hebei, at low to medium elevations of the Bashang plateau in north Hebei, at low to medium elevations of the Great Khingan mountains in northeastern Neimenggu, at medium elevations of the Liupanshan mountains in southern Ningxia, and at medium elevations of the west Qinling mountains and the loess plateau in eastern Gansu. Common at medium elevations of the Taihangshan mountains and the Lvliangshan mountains in Shanxi, at medium elevations of the loess plateau in western Shaanxi, and at low elevations of the Nenjiang river valley mountains in northeastern Neimenggu. Rare at low elevations of the Mianshan mountains in central Shanxi, at low elevations of the northern edge of the Guanzhong plain in central Shaanxi, and at medium elevations of the edge of the east Qinghai-Tibetan plateau in Gansu. 187 localities (Fig. 130) between 215–2872 m (IAB).

Variation in North China. This species shows strong variation in the colour pattern of the hair within North China (see the key; Williams *et al.*, 2012b).

Similar species in North China. This species can be very similar in its white-banded female colour pattern to *B. minshanensis* (see the key; Figs 129, 131).

Distribution in China. Beijing, Hebei, Shanxi, Neimenggu, Liaoning, Jilin, Heilongjiang, Shaanxi, Gansu, Qinghai, Ningxia (IAB).

Forage plants. ALLIACEAE: *Allium ramosum*, *A. przewalskianum*, *A. thunbergii*; ASTERACEAE: *Arctium lappa*, *Callistephus chinensis*, *Calendula officinalis*, *Centaurea cyanus*, *Cirsium leo*, *C. setosum*, *C. monocephalum*, *C. shansiense*, *Cosmos bipinnatus*, *Dahlia pinnata*, *Echinops sphaerocephalus*, *Helianthus annuus*, *H. tuberosus*, *Heteropappus hispidus*, *Hieracium umbellatum*, *Ligularia intermedia*, *Inula japonica*, *Ixeridium chinense*, *I. sonchifolium*, *Rudbeckia hirta*, *Saussurea amara*, *S. pulchella*, *Saussurea sp.*, *Serratula coronata*, *Siegesbeckia pubescens*, *Sonchus brachyotus*, *Zinnia peruviana*; BEGONIACEAE: *Begonia grandis*; BIGNONIACEAE: *Incarvillea sinensis*; BRASSICACEAE: *Erysimum amurense*; BUDDLEJACEAE: *Buddleja officinalis*; CAMPANULACEAE: *Adenophora elata*, *A. polyantha*, *A. stenanthina*, *A. wawreana*, *Campanula glomerata*; CLUSIACEAE: *Hypericum perforatum*; CONVULVACEAE: *Cuscuta japonica*, *Ipomoea purpurea*; CRASSULACEAE: *Hylotelephium erythrostictum*, *Orostachys fimbriata*, *O. malacophylla*, *Phedimus aizoon*; DIPSACACEAE: *Scabiosa comosa*; ERICACEAE: *Rhododendron micranthum*; FABACEAE: *Astragalus bhotanensis*, *A. complanatus*, *A. dahuricus*, *Campylotropis macrocarpa*, *Lespedeza bicolor*, *L. daurica*, *L. floribunda*, *L. juncea*, *Leonurus sibiricus*, *Medicago ruthenica*, *M. sativa*, *Melilotus albus*, *M. officinalis*, *Onobrychis viciifolia*, *Trifolium pretense*, *T. repens*, *Vicia amoena*, *V. cracca*, *V. pseudorobus*, *V. unijuga*, *Wisteria villosa*; GENTIANACEAE: *Gentiana dahurica*; GERANIACEAE: *Erodium stephanianum*, *Geranium sibiricum*; LAMIACEAE: *Caryopteris tangutica*, *Dracocephalum heterophyllum*, *Dracocephalum moldavica*, *Elsholtzia ciliata*, *E. densa*, *E. stauntonii*, *Leonurus japonicus*, *L. macranthus*, *Mentha canadensis*, *Nepeta multifida*, *Phlomis umbrosa*, *Salvia deserta*, *Vitex negundo*; MALVACEAE: *Malva cathayensis*, *M. verticillata*; NYCTAGINACEAE: *Mirabilis jalapa*; ONAGRACEAE: *Chamerion angustifolium*, *Oenothera biennis*; PAPAVERACEAE: *papaver nudicaule*; POLYGONACEAE: *Fagopyrum gracilipes*, *Polygonum bistorta*, *P. divaricatum*; RANUNCULACEAE: *Aconitum gymnandrum*, *A. kusnezoffii*, *Anemone tomentosa*, *Clematis aethusifolia*, *C. brevicaudata*, *C. glauca*, *C. intricata*, *C. tangutica*, *Trollius chinensis*; ROSACEAE: *Agrimonia pilosa*, *Amygdalus davidiana*, *A. persica*, *Armeniaca sibirica*, *A. vulgaris*, *Cerasus campanulata*, *C. tomentosa*, *Potentilla chinensis*, *P. fruticosa*, *P. multicaulis*, *Rubus crataegifolius*, *Sanguisorba tenuifolia*; SALICACEAE: *Salix caprea*; SCROPHULARIACEAE: *Linaria vulgaris*, *Veronicastrum sibiricum*; SOLANACEAE: *Petunia hybrida*.

65. *Bombus (Bombus) cryptarum* (Fabricius)

(Figs 132, 133)

APIS cryptarum Fabricius, 1775:379.

Taxonomy. Revised by Williams *et al.* (2012b). This species has been much confused with *B. lucorum* and the two species are difficult to distinguish reliably except from COI barcodes.

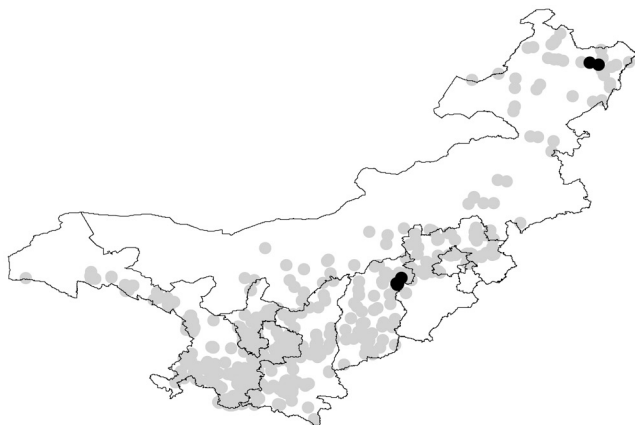
Material examined. 6 workers, 7 males (IAB).

Distribution in North China. Common at medium to high elevations of the Wutaishan forest park in Shanxi, and rare at low elevations of the Great Khingan mountains forests in Neimenggu. 6 localities (Fig. 132) between 401–3056 m (IAB).

Similar species in North China. This species is very similar in its yellow-banded colour pattern to *B. longipennis* and *B. lucorum* (see the key; Figs 123, 125, 133).

Distribution in China. Shanxi, Neimenggu, Heilongjiang, Xinjiang (IAB).

Forage plants. ASTERACEAE: *Cirsium leo*, *Saussurea purpurascens*; DIPSACACEAE: *Dipsacus japonicus*, *Scabiosa comosa*; LAMIACEAE: *Elsholtzia densa*; ONAGRACEAE: *Chamerion angustifolium*; ROSACEAE: *Spiraea salicifolia*.



FIGURES 132–133. 132. Map showing the distribution of *B. cryptarum* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 133. *B. cryptarum* worker from Shanxi.

Subgenus *ALPIGENOBOMBUS* Skorikov

66. *Bombus (Alpigenobombus) kashmirensis* Friese

(Figs 134, 135)

Bombus mastrucatus var. *kashmirensis* Friese, 1909[September, Tkalci, 1974b]:673.

Bombus mastrucatus var. *stramineus* Friese, 1909[September, Tkalci, 1974b]:673.

Bombus tetrachromus Cockerell, 1909 [November, Tkalci, 1974b]:397.

Alpigenobombus pulcherrimus Skorikov, 1914:128.

Alpigenobombus beresovskii Skorikov, 1933a:248.

Material examined. 4 queens, 145 workers, 6 males (IAB).

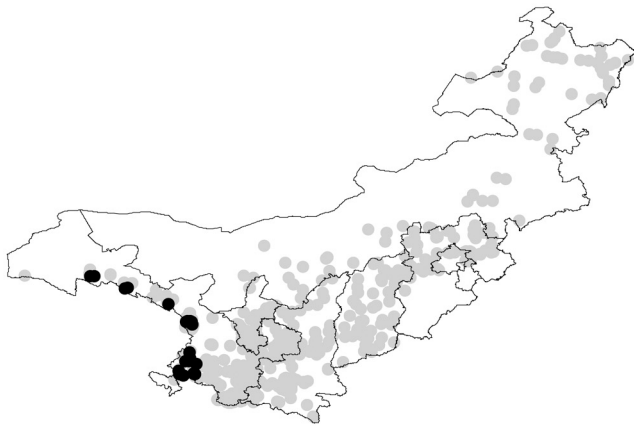
Distribution in North China. Only on the edge of the northeast Qinghai-Tibetan plateau in Gansu. Common at high elevations of the Zhagana nature reserve in Diebu, at medium to high elevations of the Qilianshan nature reserve in Sunan and Tianzhu, and at medium elevations of the Liancheng nature reserve in Yongdeng. Rare at medium to high elevations of the east Qinghai-Tibetan plateau meadows in Hezuo, Xiahe, Luqu and Lintan. 25 localities (Fig. 134) between 2272–4011 m (IAB).

Variation in North China. This species shows strong variation in the colour pattern of the hair across its global distribution (Williams, 1991) but with much less variation in North China (Fig. 135).

Similar species in North China. This species is often similar in its white-banded colour pattern to female *B. ladakhensis* (see the key; Figs 135, 149).

Distribution in China. Sichuan, Xizang, Gansu, Qinghai (IAB).

Forage plants. ALLIACEAE: *Allium cyaneum*, *A. sikkimense*; ASTERACEAE: *Anaphalis hancockii*, *Carduus acanthoides*, *Cirsium japonicum*, *Cosmos bipinnatus*, *Cremanthodium lineare*, *Leontopodium leontopodioides*, *Saussurea stella*, *Saussurea* sp.; CAMPANULACEAE: *Adenophora* sp.; FABACEAE: *Hedysarum gmelinii*, *H. tanguticum*, *Medicago sativa*, *Melilotus albus*, *M. officinalis*; GENTIANACEAE: *Gentiana algida*, *Gentiana* sp.; GERANIACEAE: *Geranium pratense*; LAMIACEAE: *Elsholtzia fruticosa*, *Salvia przewalskii*; POLYGONACEAE: *Polygonum viviparum*; RANUNCULACEAE: *Aconitum flavum*, *A. gymnandrum*, *Clematis tangutica*; ROSACEAE: *Rubus* sp.; SCROPHULARIACEAE: *Pedicularis kansuensis*, *P. spicata*, *Pedicularis* sp., *Pseudolysimachion* sp.; TAMARICACEAE: *Myricaria* sp.



FIGURES 134–135. 134. Map showing the distribution of *B. kashmirensis* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 135. *B. kashmirensis* worker visiting *Pedicularis kansuensis* (Scrophulariaceae) in Gansu.

67. *Bombus (Alpigenobombus) validus* Friese
(Figs 136, 137)

Bombus validus Friese, 1905:510.

Taxonomy. Analysis of COI barcodes for the subgenus *Alpigenobombus* shows *B. validus* to be a species separate from *B. nobilis*, contrary to the interpretations of Williams *et al.* (2009) and An *et al.* (2011), which were based solely on morphology.

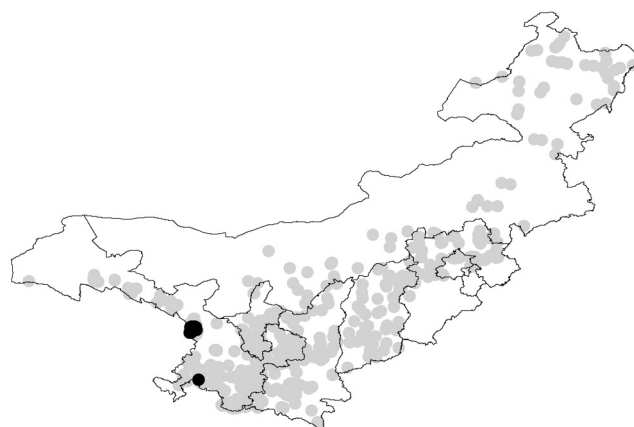
Material examined. 99 workers, 5 males (IAB).

Distribution in North China. Only on the edge of the east Qinghai-Tibetan plateau in Gansu. Abundant at medium to high elevations of the Qilianshan nature reserve in Tianzhu, common at medium elevations of the Liancheng nature reserve in Yongdeng, and rare at high elevations of the Zhagana nature reserve in Diebu. 11 localities (Fig. 136) between 2196–3524 m (IAB).

Similar species in North China. This species is often similar in its white-banded colour pattern to *B. pyrosoma* (see the key; Figs 137, 147).

Distribution in China. Yunnan, Xizang, Gansu (IAB).

Forage plants. ASTERACEAE: *Carduus acanthoides*, *Ligularia przewalskii*, *Ligularia* sp., *Parasenecio roborowskii*, *Saussurea* sp.; FABACEAE: *Oxytropis kansuensis*, *O. ochrocephala*; ONAGRACEAE: *Chamerion angustifolium*; RANUNCULACEAE: *Aconitum flavum*; SCROPHULARIACEAE: *Pedicularis kansuensis*.



FIGURES 136–137. 136. Map showing the distribution of *B. validus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 137. *B. validus* worker visiting *Ligularia* sp. (Asteraceae) in Gansu.

68. *Bombus (Alpigenobombus) grahami* (Frison)

(Figs 138, 139)

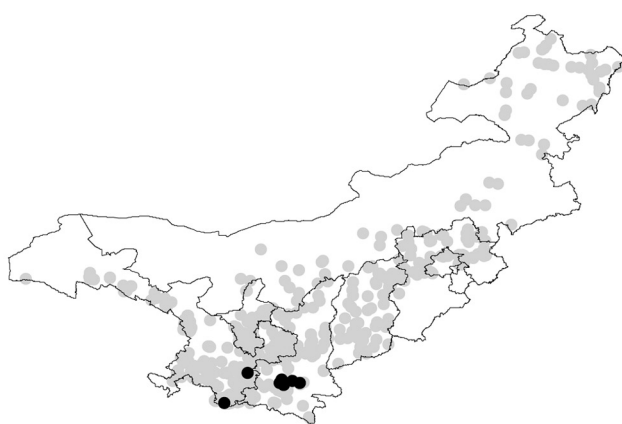
Bremus (Alpigenobombus) grahami Frison, 1933:334.

Material examined. 12 workers, 2 males (IAB).

Distribution in North China. Only in the Qin-Ba mountains in southern Gansu and southern Shaanxi. Rare at medium elevations of the Maijishan forest park and the Baishuijiang nature reserve in Gansu, at medium elevations of the Zhouzhi nature reserve, the Taibai nature reserve, and the Niubeiliang nature reserve in Shaanxi. 7 localities (Fig. 138) between 1284–2026 m (IAB).

Distribution in China. Chongqing, Sichuan, Yunnan, Shaanxi, Gansu (IAB).

Forage plants. ASTERACEAE: *Cirsium leo*, *Cosmos bipinnatus*; BUDDLEJACEAE: *Buddleja officinalis*; RANUNCULACEAE: *Anemone tomentosa*.



FIGURES 138–139. 138. Map showing the distribution of *B. grahami* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. **139. *B. grahami* worker from Gansu.**

69. *Bombus (Alpigenobombus) breviceps* Smith

(Figs 140, 141)

Bombus nasutus Smith, 1852a:44.

Bombus breviceps Smith, 1852a:44.

Bombus laticeps Friese, 1905:513.

BOMBUS RUFOCOGNITUS Cockerell, 1922:4.

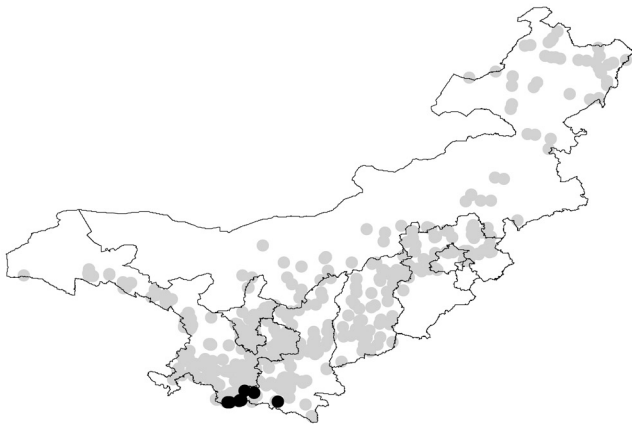
Material examined. 31 workers (IAB).

Distribution in North China. Only in the Qin-Ba mountains in southern Gansu and southern Shaanxi. Common at low to medium elevations of the Baishuijiang nature reserve in southernmost Gansu, and at low elevations of the Qingmuchuan nature reserve in southern Shaanxi. Rare at low to medium elevations of the Micangshan mountains in southern Shaanxi. 8 localities (Fig. 140) between 719–1320 m (IAB).

Variation in North China. This species shows strong variation in the colour pattern of the hair across its global distribution (Hines & Williams, 2012). In North China the principal variation is in the relative extent of yellow and black hair on T2 (Fig. 141).

Distribution in China. Chongqing, Sichuan, Yunnan, Shaanxi, Gansu (IAB).

Forage plants. BUDDLEJACEAE: *Buddleja officinalis*; CLUSIACEAE: *Hypericum perforatum*; CUCURBITACEAE: *Cucumis sativus*, *Cucurbita moschata*; FABACEAE: *Melilotus albus*; LAMIACEAE: *Salvia* sp., *Vitex negundo*; NYCTAGINACEAE: *Mirabilis jalapa*.



FIGURES 140–141. 140. Map showing the distribution of *B. breviceps* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 141. *B. breviceps* worker visiting *Mirabilis jalapa* (Nyctaginaceae) in Shaanxi.

Subgenus *MELANOBOMBUS* Dalla Torre

70. *Bombus* (*Melanobombus*) *festivus* Smith (Figs 142, 143)

Bombus festivus Smith, 1861:152.

BOMBUS ATROCINCTUS Smith, 1870:193.

BOMBUS TERMINALIS Smith, 1870:193.

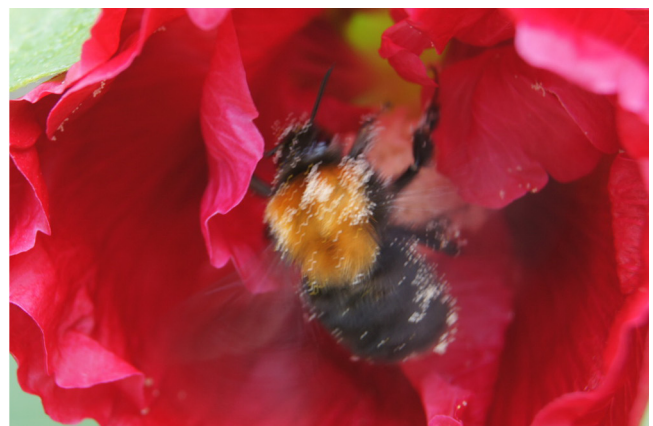
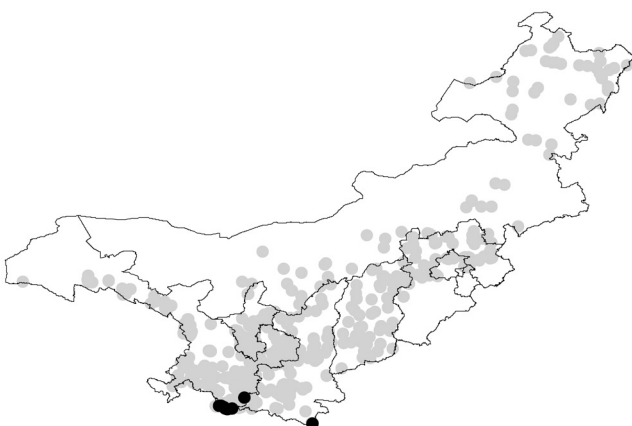
Bombus (*Alpigenobombus*) *handel-mazettii* Pittioni, 1939:260.

Material examined. 43 workers, 53 males (IAB).

Distribution in North China. Only in the Qin-Ba mountains in southern Gansu and southern Shaanxi. Common at low to medium elevations of the Baishuijiang nature reserve in southernmost Gansu, and at medium elevations of the Hualongshan nature reserve in southernmost Shaanxi. 9 localities (Fig. 142) between 719–2179 m (IAB).

Similar species in North China. Workers of this species are similar in their brown colour pattern with a white tail to *B. consobrinus* and *B. hypnorum* (see the key; Figs 37, 101, 143).

Distribution in China. Chongqing, Sichuan, Yunnan, Xizang, Shaanxi, Gansu (IAB).



FIGURES 142–143. 142. Map showing the distribution of *B. festivus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 143. *B. festivus* worker visiting *Alcea rosea* (Malvaceae) in Gansu.

Forage plants. ASTERACEAE: *Arctium lappa*, *Cirsium leo*, BIGNONIACEAE: *Incarvillea sinensis*; BUDDLEJACEAE: *Buddleja officinalis*; LAMIACEAE: *Vitex negundo*; MALVACEAE: *Alcea rosea*.

71. *Bombus (Melanobombus) rufofasciatus* Smith

(Figs 144, 145)

Bombus rufo-fasciatus Smith, 1852b:48.

Bombus Prshewalskyi Morawitz, 1880:342.

Bombus rufocinctus Morawitz, 1880:343 (not of Cresson, 1863:106 = *B. rufocinctus* Cresson).

Bombus chinensis Dalla Torre, 1890[June 25]:139, replacement name for *rufocinctus* Morawitz, 1880:343 (not of Morawitz, 1890[April 30]:352 = *B. chinensis* (Morawitz)).

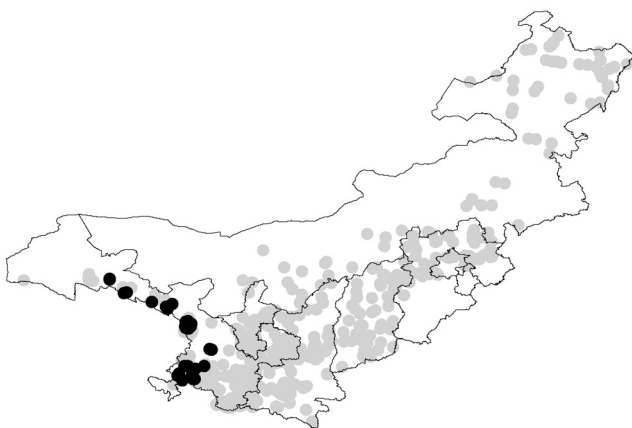
Material examined. 3 queens, 287 workers, 93 males (IAB).

Distribution in North China. Only on the edge of the northeast Qinghai-Tibetan plateau in Gansu. Abundant at high elevations of the Zhagana nature reserve in Diebu, and at medium to high elevations of the Qilianshan nature reserve in Tianzhu. Common at medium to high elevations of the Qilianshan nature reserve in Jiuquan, Minle, Sunan and Yongchang, and at high elevations of the east Qinghai-Tibetan plateau meadows in Xiahe, Luqu, Lintan and Zhuoni. Rare at medium elevations of the Xinglongshan nature reserve in Yuzhong. 37 localities (Fig. 144) between 1776–4011 m (IAB).

Similar species in North China. This species is similar in its white- and yellow-banded colour pattern to *B. lemniscatus* (see the key; Figs 103, 145).

Distribution in China. Sichuan, Yunnan, Xizang, Gansu, Qinghai (IAB).

Forage plants. ALLIACEAE: *Allium cyaneum*; ASTERACEAE: *Artemisia lancea*, *Carduus acanthoides*, *Carpesium* sp., *Cirsium japonicum*, *Filifolium sibiricum*, *Ligularia przewalskii*, *Olgaea tangutica*, *Saussurea leucoma*, *S. purpurascens*, *S. stella*? *Saussurea* sp., *Taraxacum mongolicum*; CRASSULACEAE: *Phedimus* sp.; FABACEAE: *Hedysarum gmelinii*, *Oxytropis* sp.; GENTIANACEAE: *Comastoma pulmonarium*, *Gentiana aristata*, *G. macrophylla*, *G. straminea*, *Halenia elliptica*; GERANIACEAE: *Geranium pratense*; LAMIACEAE: *Dracocephalum heterophyllum*, *Salvia przewalskii*, *Salvia* sp., *Thymus mongolicus*; POLYGONACEAE: *Polygonum macrophyllum*, *P. viviparum*; RANUNCULACEAE: *Aconitum flavum*, *A. gymnantrum*, *Clematis tangutica*, *Delphinium grandiflorum*; ROSACEAE: *Potentilla fruticosa*; SCROPHULARIACEAE: *Euphrasia pectinata*, *Pedicularis kansuensis*, *P. torta*, *P. spicata*, *Pedicularis* sp., *Pseudolysimachion* sp.



FIGURES 144–145. 144. Map showing the distribution of *B. rufofasciatus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 145. *B. rufofasciatus* worker from Gansu.

72. *Bombus (Melanobombus) pyrosoma* Morawitz

(Figs 146, 147)

Bombus pyrosoma Morawitz, 1890:349.

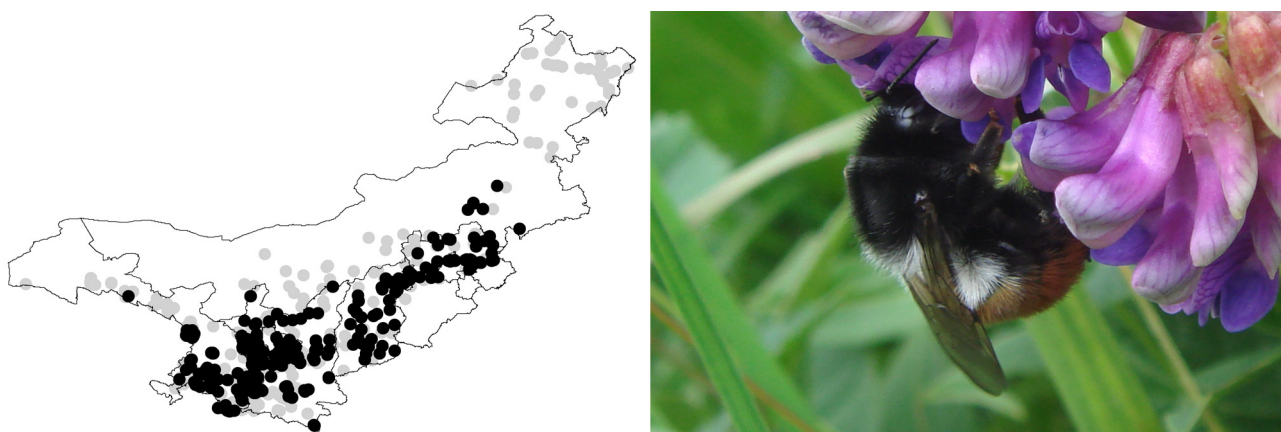
Bombus pyrrhosoma Dalla Torre, 1896:544, unjustified emendation.
Bombus rufus Friese, 1905:511 (not of Villers, 1789:328 = *B. pascuorum* (Scopoli)).
Pyrobombus (*Lapidariobombus*) *wutaishanensis* Tkalců, 1968:39.

Material examined. 21 queens, 4088 workers, 380 males (IAB).

Distribution in North China. Widely distributed within the zone between the Neimenggu, the Qinghai-Tibetan plateau, and the Qinling mountains. Abundant at low to medium elevations of the Yanshan mountains in Beijing and Heibai, at medium elevations of the Bashang plateau between northern Hebei and southern Neimenggu, at medium elevations of the Taihangshan mountains in Shanxi, at medium elevations of the Liupanshan mountains in southern Ningxia, at medium elevations of the loess plateau in eastern Gansu and western Shaanxi, at medium elevations of the west Qinling mountains in Gansu, and at medium to high elevations of the east Qinghai-Tibetan plateau meadows in Gansu. Common at medium elevations of the Helanshan mountains in northern Ningxia, at medium elevations of the Huanggangliang forest park of the southernmost of the Great Khingan mountains in Neimenggu, at medium elevations of the Lvliangshan mountains in western Shanxi, and at medium elevations of the Qinling mountains in Shaanxi. Rare at medium to high elevations of the northwest Qilianshan mountains in Gansu, and at the medium elevations of the edge of the Mu Us semi-desert in northern Shaanxi and northern Ningxia. 325 localities (Fig. 146) between 159–4011 m (IAB).

Similar species in North China. This species is often similar in its white-banded colour pattern to *B. validus* (see the key; Figs 137, 147).

Distribution in China. Beijing, Tianjin, Hebei, Shanxi, Neimenggu, Liaoning, Henan, Hubei, Chongqing, Sichuan, Shaanxi, Gansu, Qinghai, Ningxia (IAB).



FIGURES 146–147. 146. Map showing the distributions of *B. pyrrhosoma* in North China with record in black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 147. *Bombus* (*Melanobombus*) *pyrrhosoma* worker visiting *Vicia unijuga* (Fabaceae) in Beijing.

Forage plants. ALLIACEAE: *Allium chrysanthum*, *A. ramosum*, *A. przewalskianum*; AMARANTHACEAE: *Amaranthus retroflexus*; ARALIACEAE: *Fatsia japonica*; ASTERACEAE: *Anaphalis sinica*, *Arctium lappa*, *Artemisia palustris*, *Aster tataricus*, *Calendula officinalis*, *Callistephus chinensis*, *Carduus acanthoides*, *Centaurea cyanus*, *Cirsium leo*, *C. monocephalum*, *C. pendulum*, *C. setosum*, *C. shansiense*, *Cosmos bipinnatus*, *Dahlia pinnata*, *Echinops sphaerocephalus*, *Helianthus annuus*, *Heteropappus altaicus*, *Ixeridium sonchifolium*, *Leontopodium longifolium*, *Ligularia intermedia*, *L. przewalskii*, *Ligularia* sp., *Rudbeckia hirta*, *Saussurea pulchella*, *S. purpurascens*, *S. stella*, *Saussurea* sp., *Senecio jacobaea*, *S. nemorensis*, *Senecio* sp., *Sinacalia tangutica*, *Solidago canadensis*, *Stemmacantha uniflora*, *Tagetes patula*, *Zinnia peruviana*; BEGONIACEAE: *Begonia grandis*; BRASSICACEAE: *Erysimum amurense*; BUDDLEJACEAE: *Buddleja officinalis*; CAMPANULACEAE: *Adenophora divaricata*, *Adenophora* sp.; CLUSIACEAE: *Hypericum ascyron*, *H. perforatum*; COMMELINACEAE: *Commelina communis*; CONVULVACEAE: *Calystegia hederacea*, *Cuscuta japonica*, *Ipomoea nil*, *I. purpurea*; CRASSULACEAE: *Phedimus aizoon*; CUCURBITACEAE: *Thladiantha dubia*; DIPSACACEAE: *Dipsacus japonicus*, *Scabiosa comosa*; FABACEAE: *Albizia julibrissin*, *Astragalus adsurgens*, *A. bhotanensis*, *A. complanatus*, *A. dahuricus*, *Astragalus* sp., *Campylotropis macrocarpa*, *Coronilla varia*, *Hedysarum mongolicum*, *H. multijugum*,

Lathyrus pratensis, *Lespedeza bicolor*, *L. floribunda*, *L. juncea*, *Medicago ruthenica*, *M. sativa*, *Melilotus albus*, *M. officinalis*, *Onobrychis viciifolia*, *Oxytropis caerulea*, *O. ochrocephala*, *Trifolium pratense*, *T. repens*, *Vicia amoena*, *V. cracca*, *V. pseudorobus*, *V. unijuga*, *Wisteria villosa*; GENTIANACEAE: *Halenia elliptica*, *Gentiana dahurica*; GERANIACEAE: *Geranium pratense*, *G. sibiricum*, *G. wilfordi*; HYDRANGEACEAE: *Hydrangea macrophylla*; LAMIACEAE: *Agastache rugosa*, *Caryopteris divaricata*, *C. incana*, *C. tangutica*, *Dracocephalum heterophyllum*, *Elsholtzia densa*, *E. stauntoni*, *Isodon japonicus*, *Lamium album*, *L. barbatum*, *Leonurus japonicus*, *L. sibiricus*, *Dracocephalum moldavica*, *Mentha canadensis*, *Nepeta cataria*, *N. prattii*, *Phlomis umbrosa*, *Phlomis* sp., *Salvia farinacea*, *S. deserta*, *S. przewalskii*, *S. roborowskii*, *Salvia* sp., *Stachys chinensis*, *Thymus mongolicus*, *Vitex negundo*; LILIACEAE: *Lilium brownii*; MALVACEAE: *Abutilon theophrasti*, *Alcea rosea*, *Hibiscus syriacus*, *Malva cathayensis*; NYCTAGINACEAE: *Mirabilis jalapa*; ONAGRACEAE: *Chamerion angustifolium*, *Oenothera biennis*; PAPAVERACEAE: *Corydalis* sp.; POLYGONACEAE: *Fagopyrum gracilipes*, *Polygonum bistorta*, *P. lapathifolium*?*P. nepalense*; RANUNCULACEAE: *Aconitum gymnanthum*, *A. kusnezoffii*, *Aconitum* sp., *Anemone tomentosa*, *Clematis aethusifolia*, *C. akebioides*, *C. brevicaudata*, *C. glauca*, *C. tangutica*, *Trollius chinensis*; ROSACEAE: *Agrimonia pilosa*, *Duchesnea indica*, *Cerasus campanulata*, *Amygdalus davidiana*, *A. persica*, *Cerasus tomentosa*, *Potentilla chinensis*, *P. multicaulis*, *Potentilla* sp., *Rubus crataegifolius*; SALICACEAE: *Salix caprea*; SCROPHULARIACEAE: *Linaria vulgaris*, *Pedicularis chinensis*, *P. spicata*, *P. torta*, *Pedicularis* sp., *Veronicastrum sibiricum*; SOLANACEAE: *Petunia hybrida*, *Solanum japonense*; THYMELAEACEAE: *Wikstroemia chamaedaphne*.

73. *Bombus (Melanobombus) ladakhensis* Richards

(Figs 148, 149)

Bombus (Lapidariobombus) rufofasciatus var. *ladakhensis* Richards, 1928:336.

Bombus (Lapidariobombus) rufofasciatus var. *phariensis* Richards, 1930:642.

Bombus variopictus Skorikov, 1933a:248.

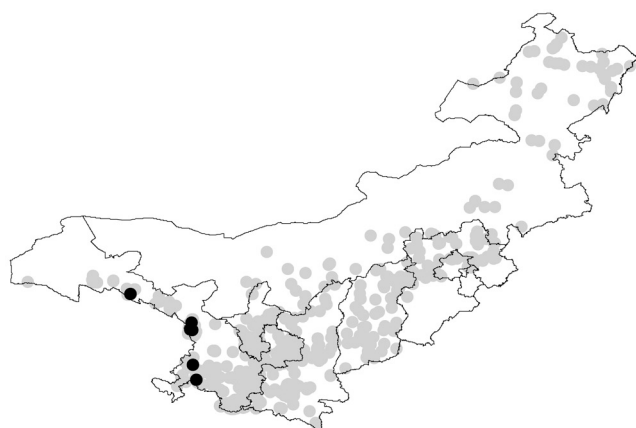
Bombus (Pratobombus) reticulatus Bischoff, 1936:7.

Material examined. 26 workers (IAB).

Distribution in North China. Only on the edge of the northeast Qinghai-Tibetan plateau in Gansu. Common at high elevations of the Qilianshan nature reserve in Sunan. Rare at high elevations of the Qilianshan nature reserve in Tianzhu, the Zhagana nature reserve in Diebu, and the edge of east Qinghai-Tibetan plateau meadows in Hezuo. 7 localities (Fig. 148) between 2524–4011 m (IAB).

Variation in North China. This species shows strong variation in the colour pattern of the hair across its global distribution (Williams, 1991) but with much less variation within North China (Fig. 149).

Similar species in North China. This species is often similar in its female white-banded colour pattern to *B. kashmirensis* (see the key; Figs 135, 149).



FIGURES 148–149. 148. Map showing the distribution of *B. ladakhensis* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 149. *B. ladakhensis* male visiting *Saussurea stella* (Asteraceae) in Gansu (PW).

Distribution in China. Sichuan, Yunnan, Xizang, Gansu, Qinghai (IAB).

Forage plants. ASTERACEAE: *Saussurea purpurascens*, *S. stella*; LAMIACEAE: *Caryopteris incana*; POLYGONACEAE: *Polygonum macrophyllum*; SCROPHULARIACEAE: *Pedicularis kansuensis*.

74. *Bombus (Melanobombus) keriensis* Morawitz

(Figs 150, 151)

Bombus keriensis Morawitz, 1887:199.

Bombus lapidarius var. *tenellus* Friese, 1913:86.

Bombus (Lapidariobombus) keriensis f. *richardsi* Reinig, 1935:341 (not of Frison, 1930:6 = *B. rufipes* Lepeletier).

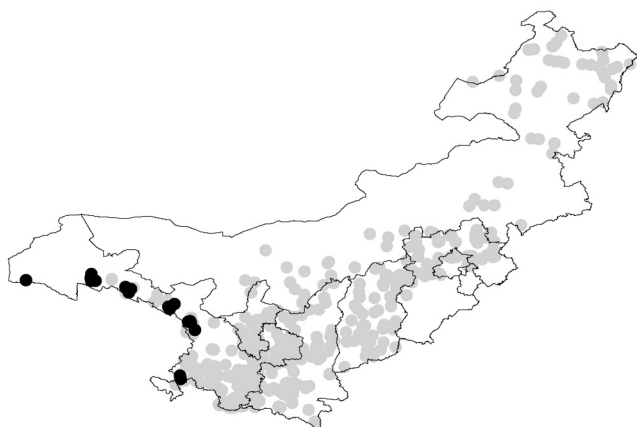
Bombus (Melanobombus) tenellus ssp. *tibetensis* Wang, 1982:439, replacement name for *richardsi* Reinig, 1935:341.

Bombus (Melanobombus) trilineatus Wang, 1982:441.

Material examined. 12 queens, 124 workers, 3 males (IAB).

Distribution in North China. Only on the edge of the northeast Qinghai-Tibetan plateau in Gansu. Common at medium to high elevations of the northern Qilianshan nature reserve in Sunan. Rare at medium elevations of the southern Qilianshan nature reserve in Yongchang and Tianzhu, at medium elevations of the Liancheng nature reserve in Yongdeng, at high elevations of the Gahai nature reserve in Luqu, and at high elevations of the Dangjinshan pass of Aerjinshan mountains in Aksai. 17 localities (Fig. 150) between 2148–3656 m (IAB).

Variation in North China. This species shows strong variation in the colour pattern of the hair across its global distribution (Williams, 1991). In North China it has a colour pattern with three yellow bands and a red tail without substantial variation (Fig. 151).



FIGURES 150–151. 150. Map showing the distribution of *B. keriensis* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 151. *B. keriensis* worker visiting *Allium senescens* (Alliaceae) in Gansu.

Similar species in North China. This species is similar in its red-tailed colour pattern to *B. asiaticus* (see the key; Figs 151, 157).

Distribution in China. Sichuan, Xizang, Gansu, Qinghai, Xinjiang (IAB).

Forage plants. ALLIACEAE: *Allium senescens*; ASTERACEAE: *Cosmos bipinnatus*, *Ixeridium gracile*, *Saussurea* sp.; GENTIANACEAE: *Gentiana algida*; FABACEAE: *Astragalus adsurgens*, *Hedysarum tanguticum*; LAMIACEAE: *Caryopteris mongholica*; MALVACEAE: *Alcea rosea*; ROSACEAE: *Rubus* sp.; SCROPHULARIACEAE: *Pedicularis kansuensis*; TAMARICACEAE: *Myricaria* sp.

75. *Bombus (Melanobombus) sichelii* Radoszkowski

(Figs 152, 153)

BOMBUS SICHELII Radoszkowski, 1860:481.

Bombus sicheli ssp. *chinganicus* Reinig, 1936:6 (not of Reinig, 1936:8 = *B. bohemicus* Seidl).

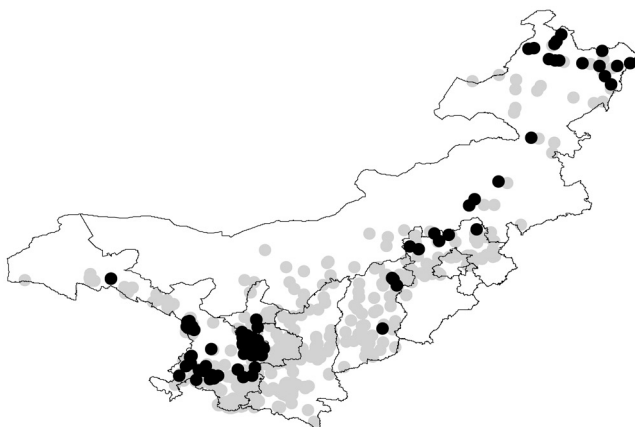
Material examined. 11 queens, 375 workers, 82 males (IAB).

Distribution in North China. Primarily in the Great Khingan mountains, the Bashang plateau, the loess plateau and edge of the northeast Qinghai-Tibetan plateau. Common at low elevations of the northern Great Khingan mountains in Elunchun, Genhe, Eerguna, Yakeshi and Keshiketeng, northeast of Neimenggu, at medium elevations of the Liupanshan mountains in southern Ningxia, and at medium elevations of the loess plateau in Gansu, at medium to high elevations of northern Qilianshan mountains in Gansu. Rare at medium elevations of the Bashang plateau in Hebei, at medium to high elevations of the Taihangshan mountains in Shanxi, and at high elevations of the east Qinghai-Tibetan plateau meadows in Gansu. 92 localities (Fig. 152) between 315–3454 m (IAB).

Similar species in North China. This species is similar in its orange-tailed colour pattern to some *B. patagiatus* (see the key; Figs 131, 153).

Distribution in China. Hebei, Shanxi, Neimenggu, Jilin, Heilongjiang, Sichuan, Xizang, Gansu, Qinghai, Ningxia, Xinjiang (IAB).

Forage plants. ALLIACEAE: *Allium thunbergii*; ASTERACEAE: *Achillea millefolium*, *Artemisia palustris*, *Bidens frondosa*, *Centaurea cyanus*, *Chrysanthemum chanelii*, *Cirsium setosum*, *Cosmos bipinnatus*, *Rudbeckia hirta*, *Saussurea* sp.; *Serratula coronata*; *Sonchus brachyotus*, *Tagetes patula*, *Sonchus oleraceus*, *Zinnia elegans*; CAMPANULACEAE: *Adenophora wawreana*; *Campanula glomerata*; CARYOPHYLLACEAE: *Dianthus chinensis*, *Gypsophila pacifica*, *Silene aprica*, *Silene vulgaris*, *Stellaria radians*; CRASSULACEAE: *Hylotelephium erythrostictum*, *Orostachys fimbriata*, *O. malacophylla*, *Phedimus aizoon*; FABACEAE: *Astragalus dahuricus*; *Hedysarum mongolicum*, *Melilotus officinalis*, *Vicia amoena*, *V. cracca*, *V. unijuga*; GENTIANACEAE: *Halenia elliptica*; LAMIACEAE: *Caryopteris incana*, *C. tangutica*, *Clinopodium urticifolium*, *Dracocephalum heterophyllum*, *Elsholtzia densa*, *Leonurus sibiricus*, *Salvia przewalskii*, *Salvia* sp.; MALVACEAE: *Gossypium hirsutum*; ONAGRACEAE: *Chamerion angustifolium*; PAPAVERACEAE: *papaver nudicaule*; POLEMONIACEAE: *Phlox drummondii*; RANUNCULACEAE: *Aconitum flavum*, *A. kusnezoffii*, *Delphinium grandiflorum*; ROSACEAE: *Sanguisorba tenuifolia*; SCROPHULARIACEAE: *Euphrasia pectinata*, *Pedicularis torta*, *Pedicularis* sp., *Pseudolysimachion linariifolium*; POLYGONACEAE: *Polygonum hydropiper*, *Polygonum* sp.; SOLANACEAE: *Petunia hybrida*.



FIGURES 152–153. 152. Map showing the distribution of *B. sichelii* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. **153.** *B. sichelii* worker visiting *Cosmos bipinnatus* (Asteraceae) Neimenggu.

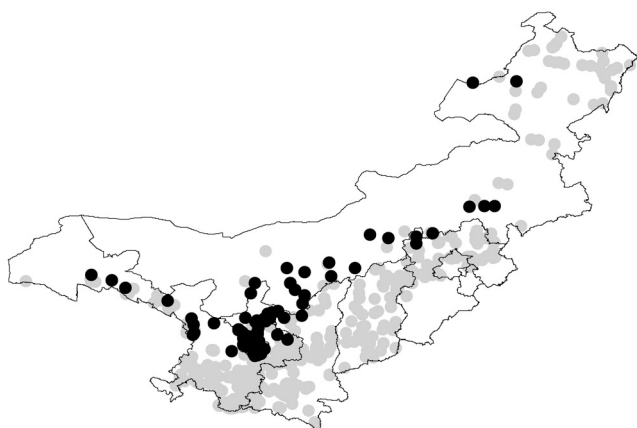
Subgenus *SIBIRICOBOMBUS* Vogt

76. *Bombus* (*Sibiricobombus*) *sibiricus* (Fabricius) (Figs 154, 155)

Apis fibirica [*sibirica*] Fabricius, 1781:478.

Material examined. 9 queens, 1301 workers, 80 males (IAB).

Distribution in North China. Widely distributed in the dry zone along the southern Neimenggu plateau, the loess plateau, to the edge of the northeast Qinghai-Tibetan plateau. Most abundant at medium elevations of the region from the edge of the Mu Us semi-desert in central Ningxia to the Liupanshan mountains of the loess plateau in southern Ningxia. Common at low elevations of the Hulunbeir grasslands in northeastern Neimenggu, at low to medium elevations of the southern Neimenggu plateau, at medium elevations of the loess plateau in eastern Gansu, and the south Qilianshan mountains in western Gansu. Rare at medium elevations of the Bashang plateau in northern Hebei, at medium elevations of the edge of the Mu Us semi-desert in northern Shaanxi, and at medium elevations of the northern Qilianshan mountains in northwestern Gansu. 87 localities (Fig. 154) between 602–2604 m (IAB).



FIGURES 154–155. 154. Map showing the distribution of *B. sibiricus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 155. *B. sibiricus* worker visiting *Cosmos bipinnatus* (Asteraceae) in Gansu.

Distribution in China. Hebei, Neimenggu, Shaanxi, Gansu, Ningxia, Xinjiang (IAB).

Forage plants. ASTERACEAE: *Carduus acanthoides*, *Cirsium setosum*, *Cosmos bipinnatus*, *Helianthus annuus*, *Olgaea tangutica*, *Saussurea* sp., *Zinnia elegans*; FABACEAE: *Astragalus adsurgens*, *Hedysarum mongolicum*, *H. tanguticum*, *Onobrychis viciifolia*, *Vicia cracca*; LAMIACEAE: *Leonurus japonicus*, *L. sibiricus*; MALVACEAE: *Gossypium hirsutum*; ROSACEAE: *Rubus* sp.; TAMARICACEAE: *Myricaria* sp.

77. *Bombus* (*Sibiricobombus*) *asiaticus* Morawitz (Figs 156, 157)

Bombus hortorum Var. *Asiatica* Morawitz in Fedtschenko, 1875:4.

Taxonomy. Revised by Williams (1991).

Material examined. 25 workers, 2 males (IAB).

Distribution in North China. Only on the edge of northeast Qinghai-Tibetan plateau in Gansu. Common at medium to high elevations of the Qilianshan mountains in Sunan and Tianzhu. Rare at high elevations of the Dangjinshan pass of Aertjinshan mountains in Aksai, and at medium elevations of the transition zone between the east Qinghai-Tibetan plateau and the west loess plateau in Minxian and Lintan. 9 localities (Fig. 156) between 2326–3656 m (IAB).

Variation in North China. This species shows strong variation in the colour pattern of the hair across its global distribution (Williams, 1991). In North China it has a colour pattern with three yellow bands and a red tail without substantial variation (Fig. 157).

Similar species in North China. This species is similar in its red-tailed colour pattern to *B. keriensis* (see the key; Figs 151, 157).

Distribution in China. Gansu, Qinghai, Xinjiang (IAB).

Forage plants. ASTERACEAE: *Carduus acanthoides*, *Cosmos bipinnatus*, *Ixeridium gracile*, *Saussurea* sp.;

FABACEAE: *Astragalus bhotanensis*, *Hedysarum tanguticum*; LAMIACEAE: *Caryopteris mongholica*; ROSACEAE: *Rubus* sp.



FIGURES 156–157. 156. Map showing the distribution of *B. asiaticus* in North China with records as black spots, the province boundaries in dark grey, and all sites with records of all bumblebee species in light grey. 157. *B. asiaticus* worker from Gansu.

Discussion

This is the first systematic survey of the bumblebee fauna to cover most of the different environmental regions within North China. It has added another one tenth of the species now listed for North China (Bischoff, 1936; Panfilov, 1957; Wang, 1982; Wang & Yao, 1985; Yao & Luo, 1997; Wang & Yao, 2004; Yao & Wang, 2005; Jiang, 2007; An *et al.*, 2008, 2010, 2011; Williams *et al.*, 2009). The 7 species new to the list are: *B. (St.) distinguendus*, *B. (Th.) anachoreta*, *B. (Th.) pseudobaicalensis*, *B. (Th.) exil*, *B. (Ps.) campestris*, *B. (Pr.) infirmus* and *B. (Ag.) validus*. One more species has been added to the North China list: an older specimen of *B. tibetanus* collected in 1987 from western Gansu is held in London. Eight specimens of this species were also collected between 2008–2011 from the neighbouring province of Qinghai, from four sites very close to Gansu (An *et al.*, 2011).

North China has 62% of China's bumblebee species (IAB, compared to Williams, 1998, updated online) and 31% of the world's bumblebee species. This total is almost double that of USA and similar that of Europe, even though each of these regions has more than 4 times the area extent of North China (Williams, 2014). One reason that the fauna is so rich is that it overlaps with part of the greatest hotspot of bumblebee diversity world-wide. Gansu (56) ranks as the province with the highest bumblebee species diversity within the North China (An *et al.*, 2011), above Shaanxi (30), Ningxia (29), Neimenggu (28), Shanxi (28), Hebei (25), Beijing (17) and Tianjin (5). The North China bumblebee fauna is dominated by oriental species (49%), followed by widespread (oriental and palaearctic) species (31%), and then by palaearctic species (20%), sitting at the transition zone between the two regions (Williams, 1996).

Species geographic and elevational distributions within North China

Results of regional surveys such as this always need to be interpreted with care. Non-random sampling could have biased the results for the maps, diversity figures, and abundance comparisons. Except in large areas of the northern arid mountains (the Huoyanshan mountains and the Beishan mountains in northwestern Gansu), the deserts (the Badain Jaran desert and the Tengger desert in Neimenggu-Gansu) and the semi-deserts (the Mu Su semi-desert and the Otindag semi-desert in southern Neimenggu), bumblebees have been found to be distributed widely within North China, from the dry northern desert-edge scrub to the wet southern Qin-Ba mountain forests. The 21,636 specimens were collected from 570 sites, which cover the greater part of each of the 8 provinces (Fig. 3).

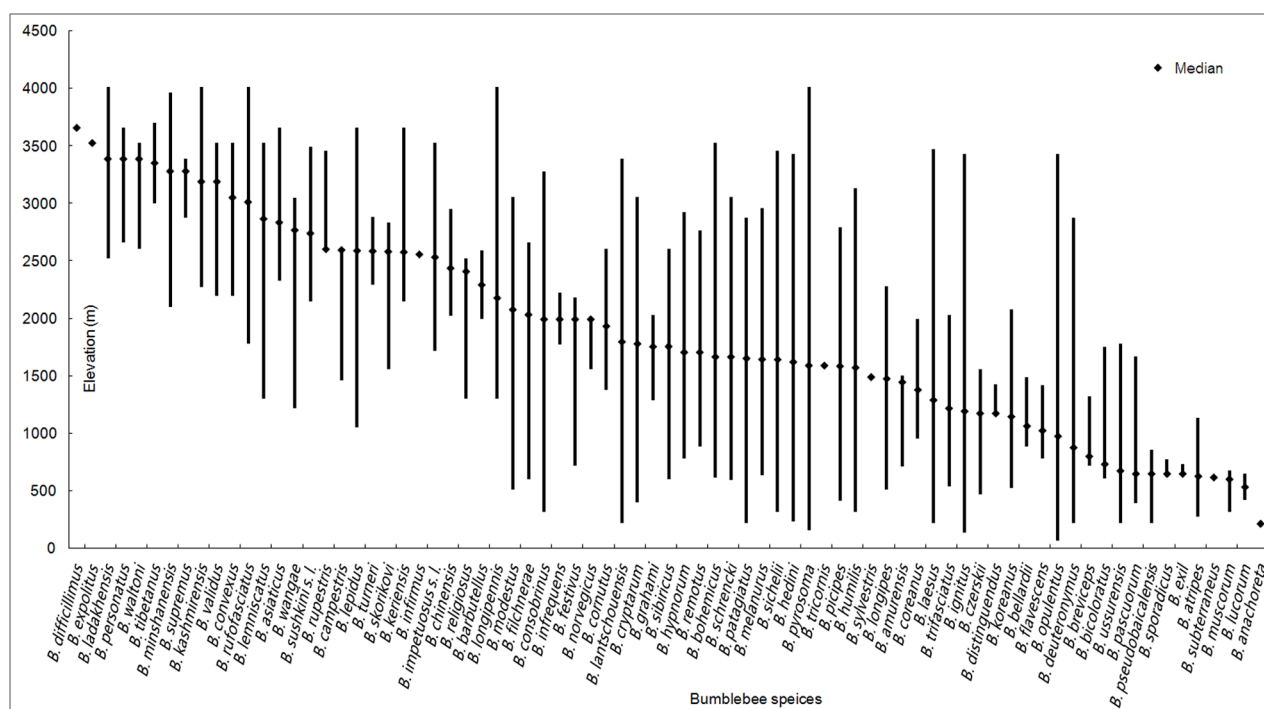


FIGURE 158. Graph showing the elevational range and median elevation of each bumblebee species in North China combined from all bumblebee records in North China.

Distribution patterns differ among the North China bumblebee species (Figs 4, 6, 8, 10, –, 156). Some highland species, such as *B. convexus*, *B. waltoni*, *B. personatus*, *B. difficillimus*, *B. supremus*, *B. tibetanus*, *B. expolitus*, *B. minshanensis*, *B. kashmirensis*, *B. validus*, *B. rufofasciatus*, *B. ladakhensis*, *B. keriensis* and *B. asiaticus*, are found only on the Qinghai-Tibetan plateau and/or the associated Qilianshan mountains. Some Qinghai-Tibetan plateau species extend further to the east, such as *B. sushkini s.l.*, *B. impetuosus*, *B. turneri*, *B. chinensis*, *B. rupestris*, *B. skorikovi* and *B. lepidus*, which have been found in the Liupanshan mountains of the loess plateau in Ningxia. Others, *B. religiosus*, *B. lemniscatus*, *B. infirmus*, *B. wangae* and *B. longipennis* have been found even in the Qinling mountains in Shaanxi. These records are the easternmost of these species' distributions in China (An *et al.*, 2008, 2011; Williams *et al.*, 2009).

Some oriental species, such as *B. trifasciatus*, *B. bicoloratus*, *B. atripes*, *B. bellardii*, *B. grahami*, *B. breviceps* and *B. festivus*, are more common in South China, in areas with subtropical climates. In North China these species have now been found only in the wet Qin-Ba mountains forests on the southern edge (southernmost Shaanxi-Gansu). A few oriental species extend further to the north, such as *B. cornutus* and *B. infrequens*, which cross the Qin-Ba mountains and have been found in the Liupanshan mountain forests of the loess plateau in southern Ningxia and eastern Gansu. *B. flavescens* crosses the Qin-Ba mountains and has also been found in the Ziwouling forests of the loess plateau in central Shaanxi, and *B. remotus* not only crosses the Qin-Ba mountains but is found even in the Taihang mountains in central Shanxi. These records are the northernmost of these species' distributions world wide (An *et al.*, 2008, 2011; Williams *et al.*, 2009).

Some palaearctic species, such as *B. amurensis*, *B. subterraneus*, *B. distinguendus*, *B. ussurensis*, *B. muscorum*, *B. anachoreta*, *B. pascuorum*, *B. schrencki*, *B. pseudobaicalensis*, *B. exil*, *B. sporadicus* and *B. lucorum*, have been found in the Great Khingan mountains and/or the associated Hulunbeir grassland and the Nenjiang river valley of NE Neimenggu. Some of the northern species extend further south across the oriental border. *B. amurensis* has also been found in the Bashang plateau, a transition zone between the Neimenggu plateau and the Yanshan mountains of Hebei. *B. ussurensis* and another three northern species (*B. tricornis*, *B. barbutellus* and *B. sylvestris*) have been found in the Taihang mountains of Hebei/Beijing/Shanxi. *B. schrencki* and *B. campestris* have been found further south in the Liupanshan mountains of the loess plateau in southern Ningxia and *B. lucorum* has even been found in Sichuan. These records are the southernmost in these species' distributions world-wide (An *et al.*, 2008, 2010, 2011, Williams *et al.*, 2009, 2012).

Other species widespread in North China, such as *B. melanurus*, *B. longipes*, *B. czerskii*, *B. consobrinus*, *B. koreanus*, *B. laesus*, *B. filchnerae*, *B. opulentus*, *B. deuteronymus*, *B. humilis*, *B. hedini*, *B. coreanus*, *B. bohemicus*, *B. norvegicus*, *B. hypnorum*, *B. picipes*, *B. modestus*, *B. ignitus*, *B. lantschouensis*, *B. patagiatus*, *B. cryptarum*, *B. pyrosoma*, *B. sichelii* and *B. sibiricus*, have been found in many different environmental regions. Among these species, *B. sibiricus* and *B. melanurus* predominate along the southern edge of the desert of the Neimenggu plateau.

TABLE 3. Distribution of numbers of bumblebee individuals and species by elevation zone within North China from specimen records with elevation data.

	Elevation (m)				
	65–999	1,000–1,999	2,000–2,999	3,000–3,999	4,000–4,011
Individuals	2409	13314	5071	773	70
Species	42	52	53	33	5
Species/Individuals (%)	1.74	0.39	1.05	4.27	7.14

Bumblebees are recorded from sites in North China at elevations between 65–4011 m. Their true elevational distribution range is likely to be greater because the highest mountains within the region, the Aerjinshan (Altyn mountains) in the northwestern desert of Gansu have yet to be sampled. These mountains are accessible only on foot because of the poor condition of the roads. In North China the largest number of bumblebee individuals is recorded at elevations between 1000–1999 m, the largest number of species is recorded at elevations between 2000–2999 m, while the highest proportion of species/individuals is recorded at elevations between 4000–4011 m (Table 3).

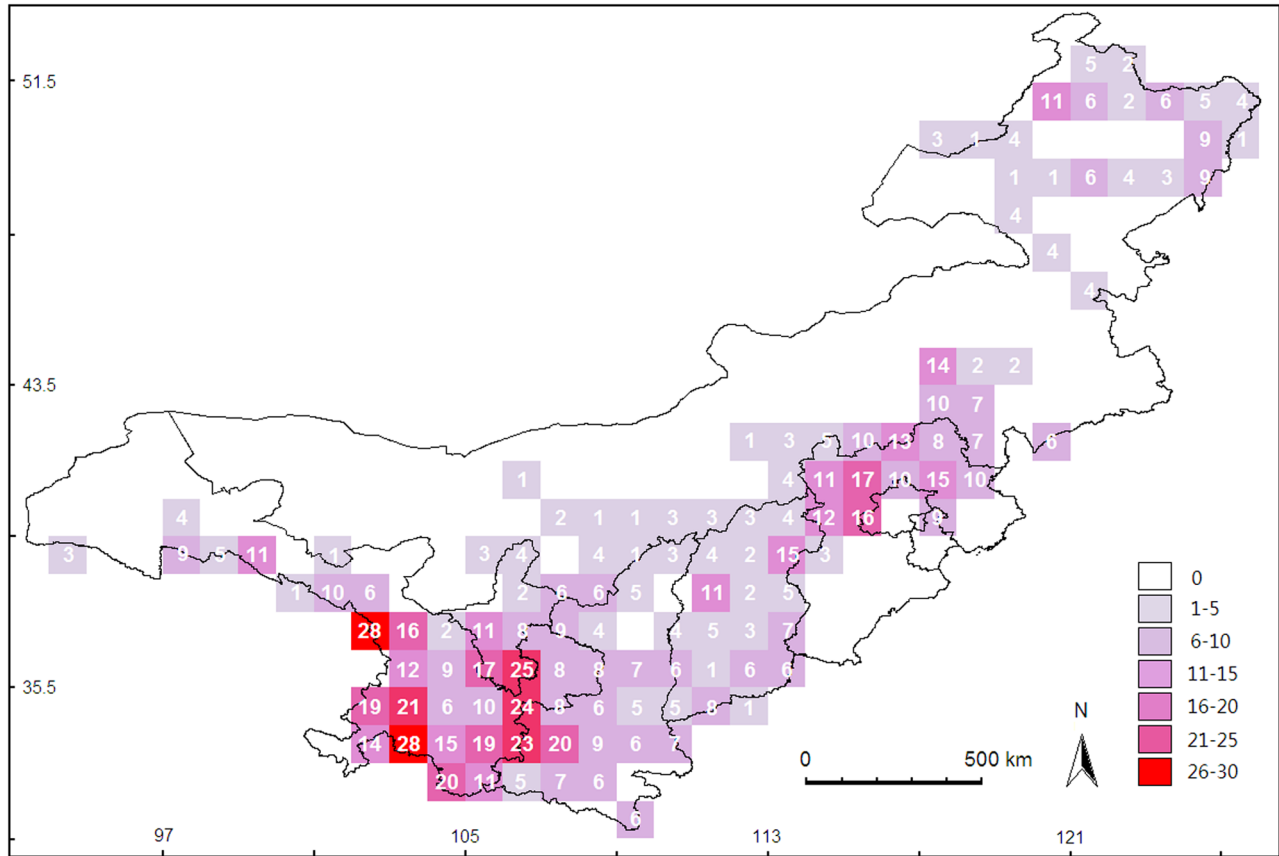


FIGURE 159. Graph showing variation in bumblebee species richness across North China as counts of the number of the species recorded within each grid cell of 1° longitude × 1° latitude.

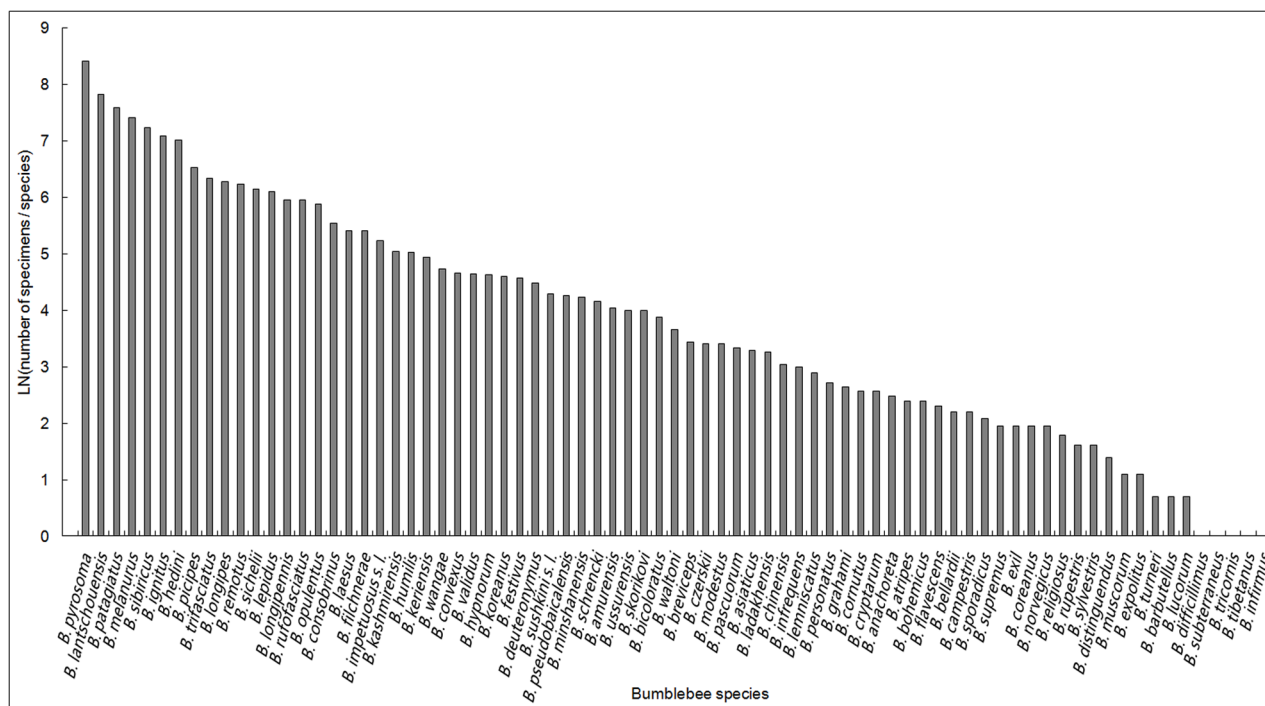


FIGURE 160. Graph showing the log-transformed relative abundances of each bumblebee species (grey bars) combined from all bumblebee records in North China.

Corresponding to their regional distribution patterns, patterns of elevational distribution also differ among bumblebee species within North China (Fig. 158). Some species, such as *B. difficillimus*, *B. expolitus*, *B. ladakhensis*, *B. personatus*, *B. waltoni*, *B. tibetanus*, *B. minshanensis*, *B. supremus*, *B. kashmirensis*, *B. validus*, *B. convexus*, and *B. rufofasciatus*, are found only on the high Qinghai-Tibetan plateau and/or the associated Qilianshan mountains in the west of the region, in areas with median elevations above 3000 m. At the opposite extreme, species such as *B. anachoreta*, *B. lucorum*, *B. muscorum*, *B. subterraneus*, *B. exil*, *B. sporadicus*, *B. pseudobaicalensis*, *B. pascuorum*, and *B. ussurensis*, are found only on the lower Great Khingan mountains and/or the surrounding grasslands and the Nenjiang river valley in the northeast of the region, in areas with median elevations below 1000 m. *B. atripes*, *B. bicoloratus* and *B. breviceps* are found only in the low Qin-Ba mountains in the south of the region, also in areas with median elevation below 1000 m. Other species have a broader elevational range, and *B. pyrosoma* has the broadest range, in areas between 159–4011 m, extending from low farmland on the edge of the North-China plain to the high Qinghai-Tibetan plateau.

Species richness within North China

Although bumblebees are found broadly within North China, species richness differs substantially (Fig. 159). No bumblebees were found in the arid mountains of northwesternmost Gansu, the desert areas and the central semi-deserts of northern Neimenggu, or in the agricultural fields of the Hebei plain. In contrast, the number of species per grid cell often exceeds 10 in the Qinghai-Tibetan plateau meadows and in many mountain forests in North China. The highest richness for bumblebees within North China is on the edge of the east Qinghai-Tibetan plateau and the associated Qilianshan mountains in southwestern Gansu. For example, the number of species for the cell (33.5–34.5N, 103–104E) containing the Zhagana nature reserve on the east Qinghai-Tibetan plateau is 28, and for the cell (36.5–37.5N, 102–103E) containing the Liancheng nature reserve in the southernmost Qilianshan mountains it is also 28. The second highest place within the region is in the Liupanshan mountain forest/scrub of the Loess plateau in southern Ningxia and eastern Gansu (the 2 cells associated with the Liupanshan nature reserve have 25 and 24 species) and in the Qin-Ba mountains forests in southern Gansu and southern Shaanxi (the 4 cells associated from west to east with the Baishuijiang nature reserve, the Maijishan forest park, the Xiaolongshan nature reserve, the Qingmuchuan nature reserve, the Taibaishan nature reserve, the Fuping nature reserve, and the Zhouzhi nature reserve, etc. have 20, 19, 23 and 20 species). There are also many bumblebee species in the Taihang

mountains, the Yanshan mountains and the Bashang plateau around Beijing from west to north (the cell containing the Wutaishan forest park has 15; the cell with the Baihuashan nature reserve, the Lingshan nature reserve, and the Xiaowutaishan nature reserve has 16; and the three cells covering the Yanshan mountains from west to east have 17, 10 and 15 species). Bumblebee species richness in most areas of the Neimenggu plateau is much lower than in the mountain forests of the provinces immediately to the south, but for the cell with the Huanggangliang forest park of the southern Great Khingan mountains it still reaches 14, and for the cell with the Moerdaoga forest park in the northern Great Khingan mountains it reaches 11. Bumblebees have been found on the edge of the desert, such as at the Dangjinshan pass of Aerjinshan mountains in Gansu, the westernmost cell with records within this region, which has three species.

Species abundances within North China

Bumblebee species vary greatly in abundances within North China (Fig. 160). *B. pyrosoma* with 4,489 specimens is by far the most abundant (20.7% of the total sample). Species including *B. lantschouensis* (11.5%), *B. patagiatus* (9.2%), *B. melanurus* (7.7%), *B. sibiricus* (6.4%), *B. ignitus* (5.5%), *B. hedini* (5.1%), and *B. picipes* (3.2%) are also abundant. *B. pyrosoma* is abundant in the region between the edge of the southern Neimenggu plateau and the edge of the east Qinghai-Tibetan plateau and the Qinling mountains. It is even more abundant in the Yanshan mountains, the Taihang mountains and the loess plateau. *B. lantschouensis* is most abundant in the Qilianshan mountains and the loess plateau. *B. patagiatus* is most abundant in the loess plateau and the Yanshan mountains. *B. melanurus* is most abundant in the dry mountains along the southern edge of the Neimenggu plateau. *B. sibiricus* is most abundant in the Liupanshan mountains of the central loess plateau. *B. ignitus* is abundant in the Yanshan mountains and the Qinling mountains. *B. hedini* is widely distributed within the region and most abundant on the loess plateau. *B. picipes* is abundant in the area from the Qinling mountains to the edge of the southern loess plateau. At the opposite extreme, some species are very rare in North China. For example, only one or two specimens of *B. difficillimus*, *B. subterraneus*, *B. tricornis*, *B. infirmus*, *B. turneri*, *B. barbutellus* and *B. lucorum* have been collected in the past 8 years. Among these rare species, some belong to the subgenus *Psithyrus* (*B. turneri* and *B. barbutellus*) which is generally rare in China (Williams *et al.*, 2009; An, *et al.*, 2010). *B. subterraneus* is well known from Europe and Central Asia (Wang & Yao, 1985; Williams *et al.*, 2011) and the specimen from NE Neimenggu is the easternmost record known world-wide. Many of the Qinghai-Tibetan species are rare in North China because their habitat is rare (e.g. *B. difficillimus* and *B. infirmus*). *B. tricornis* has been found in the Changbaishan mountains of NE China, but the specimen from Beijing is the only one known from North China. Cryptic species of the *lucorum*-group (including *B. cryptarum*, *B. longipennis* and *B. lucorum*) have only recently been recognised from COI barcodes, but specimens are few. Up to 2013, only two specimens from NE Neimenggu have been confirmed as true *B. lucorum* (Williams *et al.*, 2012). The remaining species are categorised as common in North China.

Forage plants within North China

A total of 337 plant species belonging to 49 families have been recorded between 2005–2012 as food plants for North China bumblebees. This shows how important bumblebees are as flower visitors and very likely as pollinators for the sustainability and conservation of natural ecosystems in this region. Among the 49 families, Asteraceae (74), Fabaceae (41), Lamiaceae (40), Rosaceae (25) and Ranunculaceae (17) are the 5 families with the largest total numbers of plant species for which bumblebee visits are recorded. Species of these 5 families include 58% of the total 337 species visited within North China. This abundance is very similar to that of the Hebei region and Gansu, it's might be the plants of those families are more common than others in this region (An *et al.*, 2010, 2011). Just as in the Nearctic, western Palaearctic, and Himalayan regions, queen and worker bumblebees of most species forage on Fabaceae, while males often forage on Asteraceae (Prys-Jones, 1982; Rasmont, 1988; Williams, 1991; Williams *et al.*, 2014). In contrast, each of the Amaranthaceae, Balsaminaceae, Begoniaceae, Bignoniaceae, Caprifoliaceae, Commelinaceae, Ericaceae, Hydrangeaceae, Liliaceae, Linaceae, Nyctaginaceae, Oleaceae, Polemoniaceae, Salicaceae, Saxifragaceae, Tamaricaceae, Thymelaeaceae, Tiliaceae, Tropaeolaceae, Valerianaceae and Verbenaceae had just one food-plant species recorded, and the species of these 22 families accounted for just 6.5% of the total (the other 22 families have 2–14 food-plant species recorded, Fig. 161).

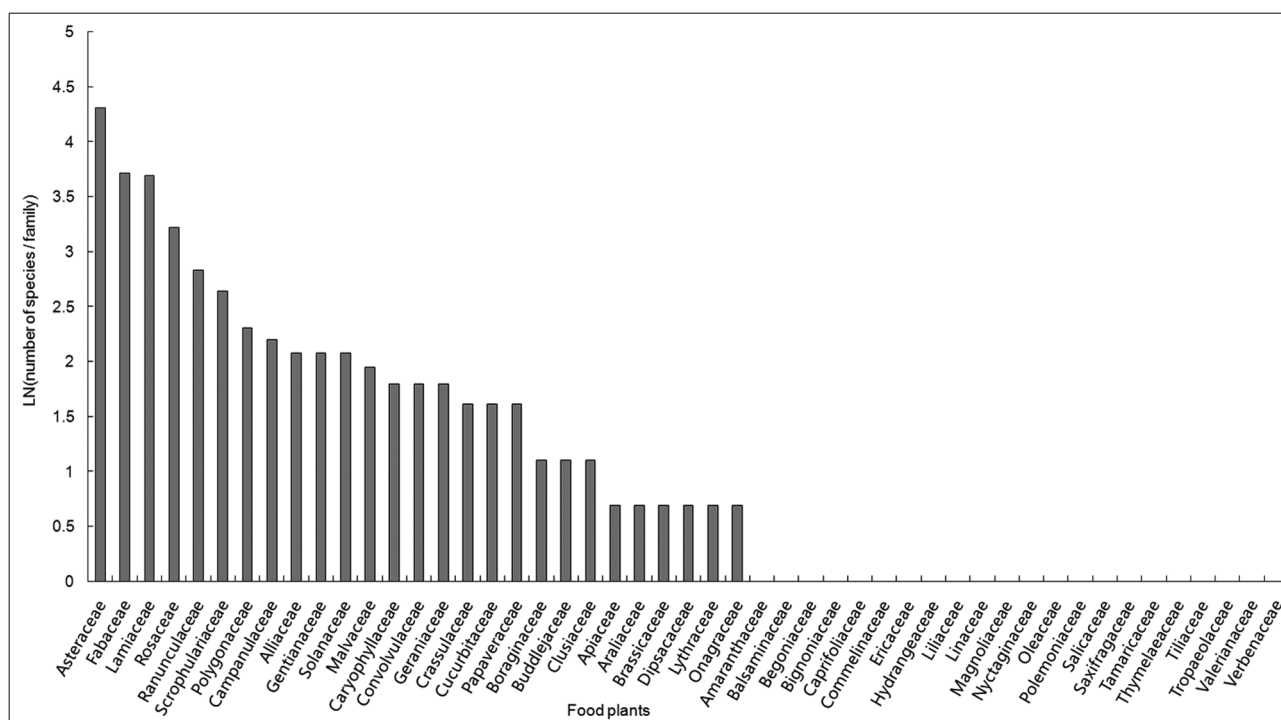


FIGURE 161. Graph showing the log-transformed relative frequencies of plant species per family for the food plants recorded from all bumblebee records in North China.

There is large variation in the diversity of food-plant species recorded among the 77 bumblebee species from North China. For example, 160 forage-plant species of 31 families have been recorded for the most abundant bumblebee species, *B. pyrosoma*. At the opposite extreme, some rare bumblebee species (e.g. *B. subterraneus*, *B. rupestris*, *B. infirmus*, and *B. lucorum*) have no recorded food-plants in this region. This is mainly the result of differences in the numbers of individuals of each bumblebee species observed. But it is also apparent that *B. pyrosoma* has an unusually broad range of food-plants. The proportions of food-plant species for *B. pyrosoma* among families (Asteraceae (36), Fabaceae (28), Lamiaceae (28), Rosaceae (10) and Ranunculaceae (10)) are very similar to the proportions of the total food-plants record for all 77 bumblebee species in North China. A similar pattern is shown by *B. patagiatus* (1986 specimens), with 117 forage-plant species belonging to 26 plant families recorded. In contrast, some other bumblebee species prefer a particular group of food-plants. For example, *B. convexus* and *B. consobrinus* are most likely to visit the long corolla flowers of Lamiaceae and Ranunculaceae. But in northern Europe *B. consobrinus* is reported that just foraging the particular plant *Aconitum septentrionale* in this season (Mjelde, 1983).

Conservation and utilization of the native bumblebee species in China

Bumblebees are especially important pollinators of wildflowers and crops. But many bumblebee species have declined in recent decades in Europe (Williams & Osborne, 2009), North America (Grixti *et al.*, 2009; Cameron *et al.*, 2011), and recently in South America (Morales *et al.*, 2013). The reasons include not only habitat loss and declines in floral abundance and diversity caused by agricultural intensification, but also the introduction of exotic bumblebees used for the pollination of greenhouse crops. For example, the most popular commercial species from Europe, *Bombus terrestris*, has been introduced into Japan, Australia, Chile and Argentina. There, they not only compete with native bee species for food, nest sites, and mates, but they may also have introduced non-native pathogens, affecting local ecosystems (Semmens *et al.*, 1993; Hingston *et al.*, 2007; Kenta *et al.*, 2007; Kanbe *et al.*, 2008; Inoue *et al.*, 2008; Meeus *et al.*, 2011; Arbetman *et al.*, 2013; Graystock *et al.*, 2013; Morales *et al.*, 2013). Given the importance of bumblebees as pollinators of wildplants and agricultural crops, steps need to be taken to prevent further declines in many countries (Goulson *et al.*, 2008). China has imported *B. terrestris* from

Europe for pollination of greenhouse crops since 1996 (especially for winter crops in northern China), even though this species is not native (except in the far northwest of China). So far this species has not been found surviving in the field in the east. But because China is the richest country for bumblebee species world-wide, and because pollination by other native and possibly sensitive bumblebee species plays such a vital role in natural and agricultural ecosystems, it would be unwise to see *B. terrestris* (even the native western bees) introduced into east China. Measures regulating importation or the movement between regions of any bumblebee species in China should be made in advance to prevent decline of native. Otherwise, devastating losses of native bees and reductions in pollination services could occur in China. At the same time, conservation and utilization strategies for native bumblebees should be prioritized, in order to improve pollination for agricultural production and to maintain natural ecosystems.

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Author Contributions

JA, planning and execution of the surveys, data analysis, preparation of the manuscript; JH, surveys and preliminary identification of bees, data analysis; YS, SZ, BW, XL, regional coordinators and bee surveys; JW, supervision of project; PW, identification/confirmation of bees, preparation of manuscript, writing identification keys.

References

- An, J.-D. & Chen, W.-F. (2011) Economic value of insect pollination for fruits and vegetables in China. *Acta Entomologica Sinica*, 54, 443–450.
- An, J.-D., Huang, J.-X., Williams, P.H., Wu, J. & Zhou, B.-F. (2010) Species diversity and colony characteristics of bumblebees in the Hebei region of North China. *Chinese Journal of Applied Ecology*, 21, 1542–1550.
- An, J., Williams, P.H., Zhou, B., Miao, Z. & Qi, W. (2011) The bumblebees of Gansu, Northwest China (Hymenoptera, Apidae). *Zootaxa*, 2865, 1–36.
- An, J.-D., Yao, J., Huang, J.-X., Shao, Y.-Q., Wu, J., Li, J.-L. & Shi, H.-Y. (2008) *Bombus* fauna (Hymenoptera, Apidae) in Shanxi, China. *Acta Zootaxonomica Sinica*, 33, 80–88.
- Arbetman, M.P., Meeus, I., Morales, C.R., Alzen, M.A. & Smagghe, G. (2013) Alien parasite hitchhikes to Patagonia on invasive bumblebee. *Biological Invasions*, 15 (3), 489–494.
<http://dx.doi.org/10.1007/s10530-012-0311-0>
- Baker, D.B. (1996) On a collection of *Bombus* and *Psithyrus* principally from Sutherland, with notes on the nomenclature or status of three species (Hymenoptera, Apoidea). *British Journal of Entomology and Natural History*, 9, 7–19.
- Bischoff, H. (1936) Schwedisch-chinesische wissenschaftliche Expedition nach den nordwestlichen Provinzen Chinas, unter Leitung von Dr. Sven Hedin und Prof. Sü Ping-chang. Insekten gesammelt vom schwedischen Arzt der Expedition Dr. David Hummel 1927-1930. 56. Hymenoptera. 10. Bombinae. *Arkiv för zoologi*, 27A (38), 1–27.
- Bommarco, R., Marini, L. & Vaissière, B.E. (2012) Insect pollination enhances seed yield, quality, and market value in oilseed

- rape. *Oecologia*, 169, 1025–1032.
<http://dx.doi.org/10.1007/s00442-012-2271-6>
- Cameron, S.A., Lozier, J.D., Strange, J.P., Koch, J.B., Cordes, N., Solter, L.F. & Griswold, T.L. (2011) Patterns of widespread decline in North American bumble bees. *Proceedings of the National Academy of Sciences of the United States of America*, 108 (2), 662–667.
<http://dx.doi.org/10.1073/pnas.1014743108>
- Chacoff, N.P., Morales, C.L., Garibaldi, L.A., Ashworth, L. & Aizen, M.A. (2010) Pollinator dependence of Argentinean agriculture: current status and temporal analysis. *The Americas Journal of Plant Science and Biotechnology*, 3 (Special Issue 1), 106–116.
- Cockerell, T.D.A. (1909) XLIII.—Descriptions and records of bees.—XXIII. *Annals and Magazine of Natural History*, Series 8, 4, 393–404.
- Cockerell, T.D.A. (1910) Some bees from high altitudes in the Himalaya mountains. *Entomologist*, 43, 238–239.
- Cockerell, T.D.A. (1917) Two new humble-bees from China. *The Entomologist*, 50, 265–266.
- Cockerell, T.D.A. (1922) Bees in the collection of the United States National Museum. 4. *Proceedings of the United States National Museum*, 60 (18), 1–20.
<http://dx.doi.org/10.5479/si.00963801.60-2413.1>
- Cresson, E.T. (1863) List of the North American species of *Bombus* and *Apathus*. *Proceedings of the Entomological Society of Philadelphia*, 2, 83–116.
- Dahlbom, G. (1832) *Bombi Scandinaviae monographice tractati et ionibus illustrati*. London, 55 pp.
- Dalla Torre, K.W.V. (1890) Hymenopterologische Notizen. *Wiener entomologische Zeitung*, 9, 139.
- Dalla Torre, K.W.V. (1896) *Catalogus hymenopterorum hucusque descriptorum systematicus et synonymicus*. Vol. X. *Apidae (anthophila)*. Lipsiae, 643 pp.
- Erichson, W.F. (1851) Hymenoptera. In: Middendorff, A.T.v. (Eds.), *Reise in den Äussersten Norden und Osten Sibiriens, während der Jahre 1843 und 1844 mit allerhöchster Genehmigung auf Veranstaltung der kaiserlichen Akademie der Wissenschaften zu St. Petersburg ausgeführt und in Verbindung mit vielen Gelehrten herausgegeben*. Band II. Zoologie. Theil I, St Petersburg, pp. 60–65.
- Eversmann, E. (1852) Fauna hymenopterologica Volgo-Uralensis. (Continuatio). Familia anthophilium seu apidarum. *Izvēstiya Moskovskago entomologicheskago obshchestva*, 25 (3), 3–137.
- Fabricius, J.C. (1775) *Systema entomologiae, sistens insectorum classes, ordines, genera, species, adiectis synonymis, locis, descriptionibus, observationibus*. Flensburgi and Lipsiae, 832 pp.
- Fabricius, J.C. (1781) *Species insectorum exhibentes eorum differentias specificas, synonyma auctorum, loca natalia, metamorphosin adiectis observationibus, descriptionibus*. Vol. 1. Hamburg, 552 pp.
- Fabricius, J.C. (1787) *Mantissa insectorum sistens eorum species nuper detectas adiectis characteribus genericis, differentiis specificis, emendationibus, observationibus*. Vol. 1. Hafniae, 348 pp.
- Fabricius, J.C. (1793) *Entomologia systematica emendata et aucta. Secundum classes, ordines, genera, species adiectis synonymis, locis observationibus, descriptionibus*. Vol. 2. Hafniae, 519 pp.
- Fedtschenko, A.P. (1875) *Reise in Turkestan. II Zoologischer Teil. Vol. II*. Moscow, 160 pp.
- Friese, H. (1905) Neue oder wenig bekannte Hummeln des russischen Reiches (Hymenoptera). *Ezhegodnik Zoologicheskago muzeya*, 9, 507–523.
- Friese, H. (1909) Neue Varietäten von *Bombus* (Hym.). *Deutsche entomologische Zeitschrift*, 1909, 673–676.
- Friese, H. (1911) Neue Varietäten von *Bombus*, III. *Deutsche entomologische Zeitschrift*, 1911, 571–572.
- Friese, H. (1913) Über einige neue Apiden (Hym.). *Archiv für Naturgeschichte*, 78, 85–89.
- Friese, H. (1918) Über Hummelformen aus dem Himalaja. *Deutsche entomologische Zeitschrift*, 1918, 81–86.
- Friese, H. (1924) Über auffallende Hummelformen. (Hym. Apid.). *Deutsche entomologische Zeitschrift*, 1924(5), 437–439.
- Frison, T.H. (1930) The bumblebees of Java, Sumatra and Borneo (Bremidae: Hymenoptera). *Treubia*, 12, 1–22.
- Frison, T.H. (1933) Records and descriptions of *Bremus* and *Psithyrus* from India (Bremidae: Hymenoptera). *Record of the Indian Museum*, 35, 331–342.
- Frison, T.H. (1934) Records and descriptions of *Bremus* and *Psithyrus* from Formosa and the asiatic mainland. *Transactions of the Natural History Society of Formosa*, 24, 150–185.
- Frison, T.H. (1935) Records, notes and descriptions of *Bremus* from Asia (Bremidae: Hymenoptera). *Record of the Indian Museum*, 37, 339–363.
- Gallai, N., Salles, J.M., Settele, J. & Vaissière, B.E. (2009) Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. *Ecological Economics*, 68, 810–821.
<http://dx.doi.org/10.1016/j.ecolecon.2008.06.014>
- Gill, R.J., Ramos-Rodriguez, O. & Raine, N.E. (2012) Combined pesticide exposure severely affects individual- and colony-level traits in bees. *Nature*, 491, 105–108.
- Goulson, D., Lye, G.C. & Darvill, B. (2008) Decline and conservation of bumble bees. *Annual Review of Entomology*, 53, 191–208.
<http://dx.doi.org/10.1146/annurev.ento.53.103106.093454>
- Graystock, P., Yates, K., Evison, S.E.F., Darvill, B., Goulson, D. & Hughes W.O.H. (2013) The Trojan hives: pollinator pathogens, imported and distributed in bumblebee colonies. *Journal of Applied Ecology*, 50 (5), 1207–1215.

<http://dx.doi.org/10.1111/1365-2664.12134>

- Gribodo, G. (1892) Contribuzioni imenotterologiche. Sopra alcune specie nuove o poco conosciute di imenotteri antofili (generi *Ctenoplectra*, *Xylocopa*, *Centris*, *Psithyrus*, *Trigona*, e *Bombus*). *Bolletino della Società Entomologica Italiana*, 23, 102–119.
- Grixti, J.C., Wong, L.T., Cameron, S.A. & Favret, C. (2009) Decline of bumble bees (*Bombus*) in the North American Midwest. *Biological Conservation*, 142, 75–84.
<http://dx.doi.org/10.1016/j.biocon.2008.09.027>
- Guo, X-S., Li, B. & Li, J-C. (2005) Preliminary study on the characteristics of pteridophyte flora in the loess plateau. *Acta Botanica Boreali-Occidentalia Sinica*, 25 (7), 37–42.
- Hines, H.M. & Williams, P.H. (2012) Mimetic colour pattern evolution in the highly polymorphic *Bombus trifasciatus* (Hymenoptera: Apidae) species complex and its comimics. *Zoological Journal of the Linnean Society*, 166, 805–826.
<http://dx.doi.org/10.1111/j.1096-3642.2012.00861.x>
- Hingston, A.B. (2006) Is the exotic bumblebee *Bombus terrestris* really invading Tasmanian native vegetation? *Journal of Insect Conservation*, 10, 289–293.
<http://dx.doi.org/10.1007/s10841-006-6711-7>
- Illiger, J.C.W. (1806) William Kirby's Familien der bienenartigen Insekten, mit Zusätzen, Nachweisungen und Bemerkungen. *Magazin für Insektenkunde*, 5, 28–175.
- Inoue, M.N., Yokoyama, J. & Washitani, I. (2008) Displacement of Japanese native bumblebees by the recently introduced *Bombus terrestris* (L.) (Hymenoptera: Apidae). *Journal of Insect Conservation*, 12, 135–146.
<http://dx.doi.org/10.1007/s10841-007-9071-z>
- Jiang, S.-L. (2007) A preliminary investigation on bumblebee in the Ziwuling forest region of eastern Gansu Province. *Shaanxi Forest Science and Technology*, 3, 96–98.
- Jung, C. (2008) Economic value of honey bee pollination on major fruit and vegetable crops in Korea. *Korea Journal of Apiculture*, 23, 147–152.
- Kanbe, Y., Okada, I., Yoneda, M., Goka, K. & Tsuchida, K. (2008) Interspecific mating of the introduced bumblebee *Bombus terrestris* and the native Japanese bumblebee *Bombus hypocrita sapporoensis* results in inviable hybrids. *Naturwissenschaften*, 95, 1003–1008.
<http://dx.doi.org/10.1007/s00114-008-0415-7>
- Kenta, T., Inari, N., Nagamitsu, T., Goka, K. & Hiura T. (2007) Commercialized European bumblebee can cause pollination disturbance: An experiment on seven native plant species in Japan. *Biological Conservation*, 134, 298–309.
<http://dx.doi.org/10.1016/j.biocon.2006.07.023>
- Kirby, W. (1802) *Monographia apum Angliae; or, an attempt to divide into their natural genera and families, such species of the Linnean genus Apis as have been discovered in England: with descriptions and observations. Vol. 2.* Ipswich, 388 pp.
- Klein, A.M., Vaissière, B.E., Cane, J.H., Steffan-Dewenter, I., Cunningham, S.A., Kremen, C. & Tscharntke, T. (2007) Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society B: Biological Sciences*, 274, 303–313.
<http://dx.doi.org/10.1098/rspb.2006.3721>
- Kriechbaumer, J. (1870) Vier neue Hummelarten. *Verhandlungen der Zoologisch-botanischen Gesellschaft in Wien*, 20, 157–160.
- Lepeletier de Saint-Fargeau, A.L.M. (1832) Observations sur l'ouvrage intitulé: 'Bombi scandinavie monographice tractato, etc., à Gustav. Dahlbom.'. *Annales de la Société Entomologique de France*, 1, 366–382.
- Lepeletier de Saint-Fargeau, A.L.M. (1835) *Histoire naturelle des insectes. Hyménoptères. Vol. 1.* Paris, 547 pp.
- Laycock, I., Lenthall, K.M., Barratt, A.T. & Cresswell, J.E. (2012) Effects of imidacloprid, a neonicotinoid pesticide, on reproduction in worker bumble bees (*Bombus terrestris*). *Ecotoxicology*, 21 (7), 1937–1945.
<http://dx.doi.org/10.1007/s10646-012-0927-y>
- Linnaeus, C. (1758) *Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis.* Holmiae, 823 pp.
- Linnaeus, C. (1761) Fauna Suecica sistens animalia Suecica regni: Mammalia, Aves, Amphibia, Pisces, Insecta, Vermes. Distributa per classes & ordines, genera & species, cum differentiis specierum, synonymis auctorum, nominibus incolarum, locis natalium, descriptionibus insectorum. Stockholmiae, 578 pp.
- Liu, G-X., Zhao, Y.-Z., Liu, L.-H. & Liu, D.-Q. (2002) Analysis of floral ecological and geographical distribution of *Scorzonera* genus in the Mongolian plateau. *Acta Prataculturae Sinica*, 11 (2), 37–42.
- Løken, A. (1973) Studies on Scandinavian bumble bees (Hymenoptera, Apidae). *Norsk entomologisk Tidsskrift*, 20, 1–218.
- Losey, J.E. & Vaughan, M. (2008) Conserving the ecological services provided by insects. *American Entomologist*, 54, (2), 113–115.
- Maa, T. (1948) On some eastern asiatic species of the genus *Psithyrus* Lepel. (Hymenoptera: Bombidae). *Notes d'entomologie chinoise*, 12, 17–37.
- May, J. (1944) Beitrag zur Systematik einiger Arten der Schmarotzerhummeln - *Psithyrus* Lep. (Hyemn. Apoid.). *Sborník Entomologického oddeleni Národního musea v Praze*, 21–22, 231–275.
- Meeus, I., Brown, M.J.F., De Graaf, D.C. & Smagghe, G. (2011) Effects of invasive parasites on bumblebee declines. *Conservation Biology*, 25 (4), 662–671.

- Milliron, H.E. (1961) Revised classification of the bumblebees - a synopsis (Hymenoptera: Apidae). *Journal of the Kansas Entomological Society*, 34, 49–61.
- Mjelde, A. (1983) The foraging strategy of *Bombus consobrinus* (Hymenoptera, Apidae). *Acta Entomologica Fennica*, 42, 51–56.
- Morales, C.L., Arbetman, M.P., Cameron, S.A. & Aizen M.A. (2013) Rapid ecological replacement of a native bumble bee by invasive species. *Frontiers in Ecology and the Environment*, 11, 529–534.
<http://dx.doi.org/10.1890/120321>
- Morawitz, F.F. (1869) Die Bienen des Gouvernements von St. Petersburg. *Trudy Russkago éntomologicheskago obshchestva*, 6 (2), 27–71.
- Morawitz, F.F. (1875) Bees. (Mellifera). In: Fedtschenko, A.P. (Eds.), *Reise in Turkestan, II Zoologischer Teil. Vol. II*. Moscow, 160 pp.
- Morawitz, F.F. (1880) Ein Beitrag zur Bienen-Fauna mittel-Asiens. *Izvěstiya Imperatorskoi akademii nauk*, 26 (22/36), 337–379.
- Morawitz, F.F. (1881) Die russischen *Bombus*-Arten in der Sammlung der Kaiserlichen Akademie der Wissenschaften. *Izvěstiya Imperatorskoi akademii nauk*, 27 (2), 213–265.
- Morawitz, F.F. (1887) Insecta in itinere cl. N. Przewalskii in Asia centrali novissime lecta. I. Apidae. *Trudy Russkago éntomologicheskago obshchestva*, 20 (1886) (3/4), 195–229.
- Morawitz, F.F. (1890) Insecta a cl. G. N. Potanin in China et in Mongolia novissime lecta. XIV. Hymenoptera Aculeata. II). III. Apidae. *Trudy Russkago éntomologicheskago obshchestva*, 24 (3/4), 349–385.
- Morse, R.A. & Calderone, N.W. (2000) The value of honey bees as pollinators of US crops in 2000. *Bee Culture*, 128, 1–15.
- Nylander, W. (1848) Adnotationes in expositionem monographicam apum borealium. *Meddelanden af Societatis pro fauna et flora fennica*, 1, 165–282.
- Panfilov, D.V. (1956) Contribution to the taxonomy of bumblebees (Hymenoptera, Bombinae), including the description of new forms. *Zoologicheskii Zhurnal*, 35 (9), 1325–1334.
- Panfilov, D.V. (1957) On the geographical distribution of bumblebees (*Bombus*) in China. *Acta geographica sinica*, 23 (3), 221–239.
- Panzer, G.W.F. (1801) *Faunae insectorum Germanicae initia oder Deutschlands Insecten gesammelt und herausgegeben. Heft. Nürnberg*, pp. 73–84.
- Pérez, J. (1884) Contribution à la faune des apiaires de France. Deuxième partie. Parasites. *Actes de la Société linnéenne de Bordeaux*, 37, 205–380.
- Pittioni, B. (1949) Beiträge zur Kenntnis der Bienenfauna SO-Chinas. Die Hummeln und Schmarotzerhummeln der Ausbeute J. Klapperich (1937/38). (Hym., Apoidea, Bombini). *Eos*, 25, 241–284.
- Popov, V.B. (1927) New forms of the genus *Psithyrus* Lep. *Konowia*, 6 (4), 267–274.
- Popov, V.B. (1931) Zur Kenntnis der paläarktischen Schmarotzerhummeln (*Psithyrus* Lep.). *Eos*, 7 (2), 131–209.
- Prys-Jones, O.E. (1982) *Ecological studies of foraging and life history in bumblebees*. Ph.D. thesis, University of Cambridge, 000 pp. (Please cite the total page number)
- Radoszkowski, O. (1860) Sur quelques hyménoptères nouveaux ou peu connus de la collection du Musée de l'Académie des sciences de St. Pétersbourg. *Byulleten' Moskovskogo obshchestva ispytatelei prirody*, 32 (1859) (2/4), 479–486.
- Radoszkowski, O. (1862) Sur quelques hyménoptères nouveaux ou peu connus. *Byulleten' Moskovskogo obshchestva ispytatelei prirody*, 35 (1/2), 589–598.
- Radoszkowski, O. (1876) Matériaux pour servir à une faune hyménoptérologique de la Russie. *Trudy Russkago éntomologicheskago obshchestva*, 12 (1), 82–110.
- Radoszkowski, O. (1877) Essai d'une nouvelle méthode pour faciliter la détermination des espèces appartenant au genre *Bombus*. *Byulleten' Moskovskogo obshchestva ispytatelei prirody*, 52 (2/4), 169–219.
- Radoszkowski, O. (1888) Etudes hyménoptérologiques. I. Révision des armures copulatrices des mâles. II. Description de nouvelles espèces russes. *Trudy Russkago éntomologicheskago obshchestva*, 22 (3/4), 315–337.
- Rasmont, P. (1988) *Monographie écologique et zoogéographique des bourdons de France et de Belgique (Hymenoptera, Apidae, Bombinae)*. Ph.D. thesis, Faculté des Sciences agronomiques de l'Etat, Gembloux.
- Reinig, W.F. (1930) Phaenoanalytische Studien über Rassenbildung. I. *Psithyrus rupestris* Fabr. *Zoologische Jahrbücher, Abteilung für Systematik, Geographie und Biologie der Tiere*, 60, 257–280.
- Reinig, W.F. (1935) On the variation of *Bombus lapidarius* L. and its cuckoo, *Psithyrus rupestris* Fabr., with notes on mimetic similarity. *Journal of Genetics*, 30, 321–356.
<http://dx.doi.org/10.1007/bf02982243>
- Reinig, W.F. (1936) Beiträge zur Kenntnis der Hummelfauna von Mandschukuo (Hym. Apid.). *Mitteilungen der Deutschen entomologischen Gesellschaft*, 7, 2–10.
- Richards, O.W. (1928) On a collection of humble-bees (Hymenoptera, Bombidae) made in Ladakh by Col. R. Meinertzhagen. *Annals and Magazine of Natural History*, Series 10, 2, 333–336.
<http://dx.doi.org/10.1080/00222932808672888>
- Richards, O.W. (1929) On two new species of humble-bees in the collection of the British Museum, constituting a new group of the genus *Psithyrus*, Lep. (Hymenoptera, Bombidae). *Annals and Magazine of Natural History*, Series 10, 3, 139–143.
<http://dx.doi.org/10.1080/00222932908672947>

- Richards, O.W. (1930) The humble-bees captured on the expeditions to Mt. Everest (Hymenoptera, Bombidae). *Annals and Magazine of Natural History*, Series 10, 5, 633–658.
<http://dx.doi.org/10.1080/00222933008673177>
- Richards, O.W. (1934) Some new species and varieties of oriental humble-bees (Hym. Bombidae). *Stylops*, 3, 87–90.
- Schmiedeknecht, H.L.O. (1883) *Apidae Europaeae (Die Bienen Europa's) per genera, species et varietates. Dispositae atque descriptae. Vol. I. fascicule 6*. Berlin, pp. 9(393)–29(413), 1(415)–56(470).
- Schrank, F.d.P. (1781) *Enumeratio insectorum Austriae indigenorum*. Vienna, 548 pp.
- Schrank, F.d.P. (1802) *Fauna boica. Durchgedachte Geschichte der in Baiern einheimischen und zahmen Thiere*. Ingolstadt, 412 pp.
- Schulz, W.A. (1906) *Spolia hymenopterologica*. Paderborn, 356 pp.
- Scopoli, J.A. (1763) *Entomologia Carniolica exhibens insecta Carnioliae indigena et distributa in ordines, genera, species, varietates*. Vindobonae, 420 pp.
- Seidl, W.B. (1837) Die in Böhmen vorkommenden Hummelarten. *Beiträge zur gesamten Natur- und Heilwissenschaft*, 2, 65–73.
- Semmens, T.D., Turner, E. & Buttermore, R. (1993) *Bombus terrestris* (L.) (Hymenoptera: Apidae) now established in Tasmania. *Journal of the Australian Entomological Society*, 32, 346.
- Skorikov, A.S. (1910a) [Intraspecific forms of *Bombus mendax* Gerst.] (Hymenoptera, Bombidae). *Russkoe éntomologicheskoe Obozrénie*, 9 (1909) (3), 328–330.
- Skorikov, A.S. (1910b) [New forms of bumblebees] (Hymenoptera, Bombidae). ([Preliminary diagnoses]). III. *Russkoe éntomologicheskoe Obozrénie*, 9 (1909) (4), 409–413.
- Skorikov, A.S. (1912) Neue Hummelformen (Hymenoptera, Bombidae). IV. *Russkoe éntomologicheskoe Obozrénie*, 12 (3), 606–610.
- Skorikov, A.S. (1913) Neue Hummelformen (Hymenoptera, Bombidae). V. *Russkoe éntomologicheskoe Obozrénie*, 13 (1), 171–175.
- Skorikov, A.S. (1914) Les formes nouvelles des bourdons (Hymenoptera, Bombidae). VI. *Russkoe éntomologicheskoe Obozrénie*, 14 (1), 119–129.
- Skorikov, A.S. (1922) [Bumblebees of the Petrograd Province]. In: *Faunae Petropolitanae catalogus. Vol. 2. Petrogradskii agronomicheskii institut, Petrograd*, 51 pp.
- Skorikov, A.S. (1923) [Palearctic bumblebees. Part I. General biology (including zoogeography)]. *Izvestiya Severnoi oblastnoi stantsii zashchity rastenii ot vreditel', 4* (1922) (1), 1–160.
- Skorikov, A.S. (1926) Neue Hummel-Formen (Hymenoptera, Bombidae), VII. *Russkoe éntomologicheskoe Obozrénie*, 19 (1925) (2), 115–118.
- Skorikov, A.S. (1931) Die Hummelfauna Turkestans und ihre Beziehungen zur zentralasiatischen Fauna (Hymenoptera, Bombidae). In: Lindholm, V.A. (Eds.), *Abhandlungen der Pamir-Expedition 1928. Vol. 8*. Academy of Sciences of the USSR, Leningrad, pp. 175–247.
- Skorikov, A.S. (1933a) Zur Fauna und Zoogeographie der Hummeln des Himalaya. *Doklady Akademii nauk SSSR*, 1933 (5), 243–248.
- Skorikov, A.S. (1933b) Zur Hummelfauna Japans und seiner Nachbarländer. *Mushi*, 6 (2), 53–65.
- Smith, F. (1852a) Descriptions of some new and apparently undescribed species of hymenopterous insects from north China, collected by Robert Fortune, Esq. *Transactions of the Entomological Society of London*, 2 (2), 33–45.
- Smith, F. (1852b) Descriptions of some hymenopterous insects from northern India. *Transactions of the Entomological Society of London*, 2 (2), 45–48.
- Smith, F. (1854) *Catalogue of hymenopterous insects in the collection of the British Museum. Part II. Apidae*. Trustees of the British Museum, London, pp. 199–465.
- Smith, F. (1861) Descriptions of new genera and species of exotic Hymenoptera. *Journal of Entomology*, 1 (3), 146–155.
- Smith, F. (1869) Descriptions of Hymenoptera from Japan. *Entomologist*, 4 (62), 205–208.
- Smith, F. (1870) [V. Notes on the habits of some hymenopterous insects from the North-west Provinces of India. By Charles Horne, Esq., B.C.S., F.Z.S.] With an appendix, containing descriptions of some new species of Apidae and Vespidae collected by Mr. Horne: by Frederick Smith, of the British Museum. Illustrated by plates from drawings by the author of the notes. *Transactions of the Zoological Society of London*, 7 (3), 161–196.
- Smith, F. (1871) Descriptions of some new insects collected by Dr. Anderson during the expedition to Yunan [sic]. *Proceedings of the Zoological Society of London*, 1871 (1), 244–249.
- Smith, F. (1879) *Descriptions of new species of Hymenoptera in the collection of the British Museum*. Trustees of the British Museum, London, 240 pp.
- Sparre-Schneider, J. (1918) Die Hummeln der Kristiana-Gegend. *Tromsø museums årshæfter*, 40, 1–45.
- Tkalčů, B. (1959) Eine neue Art der Gattung *Psithyrus* Lep. aus Korea (Hymenoptera, Bombinae). *Casopis Československé společnosti entomologické*, 56, 251–254.
- Tkalčů, B. (1961) Zur Hummelfauna der Umgebung Kuku-Nors (Hymenoptera, Bombinae). *Casopis Československé společnosti entomologické*, 58, 344–379.
- Tkalčů, B. (1968) Neue Arten der Unterfamilie Bombinae der paläarktischen Region (Hymenoptera, Apoidea). *Sborník Entomologického oddělení Národního musea v Praze*, 65, 21–51.

- Tkalců, B. (1974a) Ergebnisse der 1. und 2. mongolisch-tschechoslowakischen entomologisch-botanischen Expedition in der Mongolei. Nr. 29: Hymenoptera, Apoidea, Bombinae. *Sborník faunistických prací Entomologického oddelení Národního musea v Praze*, 15, 25–57.
- Tkalců, B. (1974b) Eine Hummel-Ausbeute aus dem Nepal-Himalaya (Insecta, Hymenoptera, Apoidea, Bombinae). *Senckenbergiana biologica*, 55, 311–349.
- Tkalců, B. (1977) Taxonomisches Notizen zu einigen paläarktischen Bienenarten (Hymenoptera: Apoidea). *Vestník Československé společnosti zoologické*, 41, 223–239.
- Tkalců, B. (1989) Neue Taxa asiatischer Hummeln (Hymenoptera, Apoidea). *Acta entomologica bohemoslovaca*, 86, 39–60.
- Velthuis, H.H.W. & van Doorn, A. (2006) A century of advances in bumblebee domestication and the economic and environmental aspects of its commercialization for pollination. *Apidologie*, 37, 421–451.
- Villers, C.J.D. (1789) *Caroli Linnæi entomologia, faunæ Suecicæ descriptionibus aucta; DD. Scopoli, Geoffroy, de Geer, Fabricii, Schrank, &c. speciebus vel in systemate non enumeratis, vel nuperrime detectis, vel speciebus Galliæ australis locupletata, generum specierumque rariorum iconibus ornata; curante & augente Carolo de Villers, Acad. Lugd. Maffil. Villa-Fr. Rhotom. necnon geometriæ regio professore. Vol. 3. Piestre et Delamolliere, Lugduni*, 657 pp.
- Vogt, O. (1908) Bombi (Hummeln). In: *Wissenschaftliche Ergebnisse von Expedition Filchner nach China und Tibet 1903–1905, X. Band - I. Teil, 1. Abschnitt: Zoologische Sammlungen*, Berlin, pp. 100–101.
- Vogt, O. (1909) Studien über das Artproblem. 1. Mitteilung. Über das Variieren der Hummeln. 1. Teil. *Sitzungsberichte der Gesellschaft naturforschender Freunde zu Berlin*, 1909, 28–84.
- Vogt, O. (1911) Studien über das Artproblem. 2. Mitteilung. Über das Variieren der Hummeln. 2. Teil. (Schluss). *Sitzungsberichte der Gesellschaft naturforschender Freunde zu Berlin*, 1911, 31–74.
- Wang, S.-F. (1979) Three new species of bumble [sic] bees from Tibet. *Acta entomologica sinica*, 22 (2), 188–191.
- Wang, S.-F. (1982) Hymenoptera: Apidae-Bombus. In: Qinghai-Tibet plateau Comprehensive Scientific Investigation Team of the Chinese Academy of Sciences (Eds.), *Insects of Xizang. Vol. II*. Science Press, Beijing, pp. 427–447.
- Wang, S.-F. & Yao, J. (1985) Apidae-Bombus. In: *Organisms of the Tuomuerfeng region of Tianshan*. Sinkiang Renmin Publishing House, Urumchi, pp. 160–165.
- Wang, S.-F. & Yao, J. (2004) Bombini. In: He, J.-H. (Eds.), *Hymenopteran Insect Fauna of Zhejiang*. Science Press, Beijing, pp. 1058–1070.
- Whitehorn, P.R., O'Connor, S., Wackers, F.L. & Goulson, D. (2012) Neonicotinoid pesticide reduces bumble bee colony growth and queen production. *Science*, 336 (6079), 351–352.
<http://dx.doi.org/10.1126/science.1215025>
- Williams, I.H. (1994) The dependence of crop production within the European Union on pollination by honey bees. *Agricultural Zoology Review*, 6, 229–257.
- Williams, P.H. (1982) The distribution and decline of British bumblebees (*Bombus* Latr.). *Journal of Apicultural Research*, 21, 236–245.
- Williams, P.H. (1991) The bumble bees of the Kashmir Himalaya (Hymenoptera: Apidae, Bombini). *Bulletin of the British Museum (Natural History) (Entomology)*, 60, 1–204.
- Williams, P.H. (1996) Mapping variations in the strength and breadth of biogeographic transition zones using species turnover. *Proceedings of the Royal Society of London (B)*, 263, 579–588.
- Williams, P.H. (1998) An annotated checklist of bumble bees with an analysis of patterns of description (Hymenoptera: Apidae, Bombini). *Bulletin of The Natural History Museum (Entomology)*, 67, 79–152 (updated online at nhm.ac.uk/bombus/subgenericlist.html, accessed 2013).
- Williams, P.H. (2007) The distribution of bumblebee colour patterns world-wide: possible significance for thermoregulation, crypsis, and warning mimicry. *Biological Journal of the Linnean Society*, 92, 97–118.
<http://dx.doi.org/10.1111/j.1095-8312.2007.00878.x>
- Williams, P.H. (2011) Bumblebees collected by the Kyushu University Expeditions to Central Asia (Hymenoptera, Apidae, genus *Bombus*). *Esakia*, 50, 27–36.
- Williams, P.H., An, J., Brown, M.J.F., Carolan, J.C., Goulson, D., Huang, J. & Ito, M. (2012a) Cryptic bumblebee species: consequences for conservation and the trade in greenhouse pollinators. *PLoS ONE*, 7, 1–8.
<http://dx.doi.org/10.1371/journal.pone.0032992>
- Williams, P.H., An, J. & Huang, J. (2011) The bumblebees of the subgenus *Subterraneobombus*: integrating evidence from morphology and DNA barcodes (Hymenoptera, Apidae, *Bombus*). *Zoological Journal of the Linnean Society*, 163, 813–862.
<http://dx.doi.org/10.1111/j.1096-3642.2011.00729.x>
- Williams, P., An, J., Huang, J. & Yao, J. (2010) BBCI: A new initiative to document Chinese bumble bees for pollination research. *Journal of Apicultural Research*, 49, 221–222.
<http://dx.doi.org/10.3896/ibra.1.49.2.15>
- Williams, P.H., Brown, M.J.F., Carolan, J.C., An, J., Goulson, D., Aytekin, A.M., Best, L.R., Byvaltsev, A.M., Cederberg, B., Dawson, R., Huang, J., Ito, M., Monfared, A., Raina, R.H., Schmid-Hempel, P., Sheffield, C.S., Šima, P. & Xie, Z. (2012b) Unveiling cryptic species of the bumblebee subgenus *Bombus s. str.* world-wide with COI barcodes (Hymenoptera: Apidae). *Systematics and Biodiversity*, 10, 21–56.
<http://dx.doi.org/10.1080/14772000.2012.664574>

- Williams, P.H., Cameron, S.A., Hines, H.M., Cederberg, B. & Rasmont, P. (2008) A simplified subgeneric classification of the bumblebees (genus *Bombus*). *Apidologie*, 39, 46–74.
- Williams, P.H. & Osborne, J.L. (2009) Bumblebee vulnerability and conservation world-wide. *Apidologie*, 40, 367–387.
- Williams, P.H., Tang, Y., Yao, J. & Cameron, S. (2009) The bumblebees of Sichuan (Hymenoptera: Apidae, Bombini). *Systematics & Biodiversity*, 7 (2), 101–190.
<http://dx.doi.org/10.1017/s1477200008002843>
- Williams, P.H., Thorp, R.W., Richardson, L.L. & Colla, S.R. (2014) *Bumblebees of North America, an identification guide*. Princeton University Press, Princeton, 208 pp.
- Wu, J. & Pei, J. (2011) Bats (Chiroptera) and their zoogeographic distribution characteristics in the Qinling and Daba mountain ranges. *Acta Theriologica Sinica*, 31, (4), 358–370.
- Yao, J. & Luo, C.-Y. (1997) Hymenoptera: Apidae: Bombini. In: Yang, X.-K. (Eds.), *Insects of the Three Gorge Reservoir Area of Yangtze River. Vol. 2*. Chongqing Publishing House, Chongqing, pp. 1686–1696.
- Yao, J. & Wang, S.-F. (2005) Hymenoptera, Apidae, Bombini. In: Yang X.-K. (Eds), *Insect fauna of middle-west Qinling range and south mountains of Gansu Province*. Science Press, Beijing, pp. 890–896.
- Yasumatsu, K. (1934) Eine neue, *Bombus ignitus* ähnliche Schmarotzerhummel aus Korea (Hymenoptera, Bombidae). *Annotationes zoologicae japonensis*, 14, 399–403.
- Yasumatsu, K. (1940) Contributions to the hymenopterous fauna of Inner Mongolia and North China. *Transactions of the Sapporo Natural History Society*, 16, 90–95.
- Zhao, J. (Eds.) (1995) *China physical geography* (third Ed). Higher Education Press, Beijing, 324 pp.