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The bumblebees of Gansu, Northwest China (Hymenoptera, Apidae)

JIANDONG AN[1, 2], PAUL H. WILLIAMS[3], BINGFENG ZHOU[1,5], ZHENGYING MIAO[4] & WENZHONG QI[4]

[1]*College of Bee Science, Fujian Agriculture and Forestry University, Fuzhou 350002, China*
[2]*Institute of Apiculture, Chinese Academy of Agricultural Sciences, Beijing 100093, China. E-mail: anjiandong@yahoo.com.cn*
[3]*Department of Entomology, The Natural History Museum, London SW7 5BD, UK. E-mail: paw@nhm.ac.uk*
[4]*Gansu Institute of Apiculture, Tianshui 741022, China. E-mail: yfsmzy@163.com; yfsqwz@163.com*
[5]*Corresponding author. E-mail: bfymshj@pub3.fz.fj.cn*

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Abstract

Bumblebees are important pollinators for agricultural and natural ecosystems. Gansu province, China, is located in part of the greatest hotspot of bumblebee diversity worldwide, a region of very varied geomorphology and vegetation. We report on a recent field survey of the bumblebees of Gansu made between 2007–2010. A sample of 5941 bumblebee specimens from Gansu are assigned to 49 species. Two older specimens held in London add two more species to this list. Together, these 51 species belong to 10 subgenera of the genus *Bombus*, and 10 species (nearly one fifth of the fauna) are recorded for the first time from Gansu: *B. asiaticus*, *B. bicoloratus*, *B. chinensis*, *B. coreanus*, *B. deuteronymus*, *B. expolitus*, *B. festivus*, *B. grahami*, *B. hypocrita*, and *B. opulentus*. None of the species is endemic to Gansu. We provide distribution maps and describe variation in local species richness and abundance and list the food plants used in Gansu. The highest bumblebee richness for the province is in the southeastern mountains and Qinghai-Tibetan plateau in the southwest. We describe how the fauna of Gansu is transitional between the fauna of North China and the fauna of the more southern Sichuan-Himalayan region.

Key words: *Bombus*, fauna, biogeography, distribution, abundance, pollinator

Introduction

Bumblebees are important pollinators in agricultural and natural ecosystems (Velthuis & van Doorn, 2006; Huang *et al.*, 2007; Goulson *et al.*, 2008; Xie *et al.*, 2008; Grixti *et al.*, 2009). The mountains around the edges of the Qinghai-Tibetan plateau form the greatest hotspot of bumblebee diversity in the world (Williams, 1998). The problem is that the bumblebee fauna in the region has been insufficiently studied, so there is a serious taxonomic impediment to recognising which species occur where. A major part of this problem is that the different species often mimic one another closely in colour pattern (Williams, 2007), while some are very variable in colour pattern within species (Williams *et al.*, 2009).

Gansu province is located at the northeastern edge of the Qinghai-Tibetan plateau, in a transition zone between the Neimenggu (Inner Mongolian) plateau, the Qinghai-Tibetan plateau, and the Loess plateau (Fig. 1). There is a broad diversity of habitats in Gansu, including the southern mountains with a subtropical climate, the southeastern mountains with a temperate humid climate, the Qinghai-Tibetan plateau in the southwest with a high elevation humid cold climate, the eastern loess plateau with a temperate sub-humid to semi-arid climate, the northern and

northwestern Hixi corridor with a temperate desert climate, and the western Wuqiaoling mountains and northwestern Qilianshan mountains with a cold semi-arid climate (Fig. 2). This variety makes Gansu a good area for studying species' distribution patterns in relation to latitude, longitude and elevation.

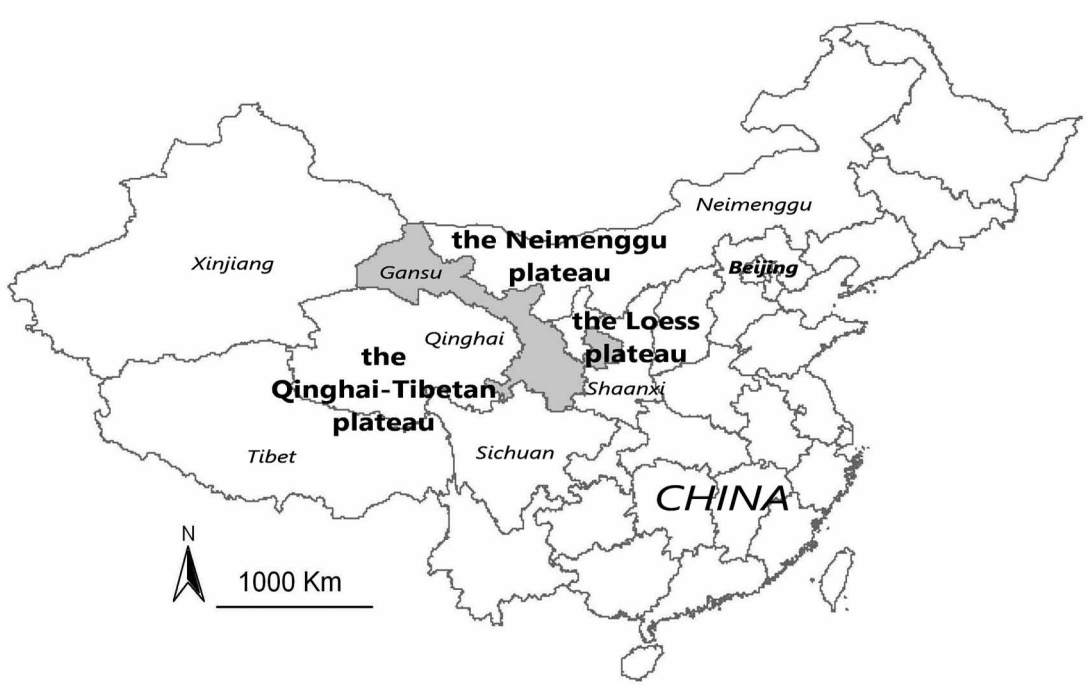

FIGURE 1. Map of China showing the location of Gansu (in grey). Names of neighbouring provinces are shown in italics, names of geomorphological features are shown in bold.

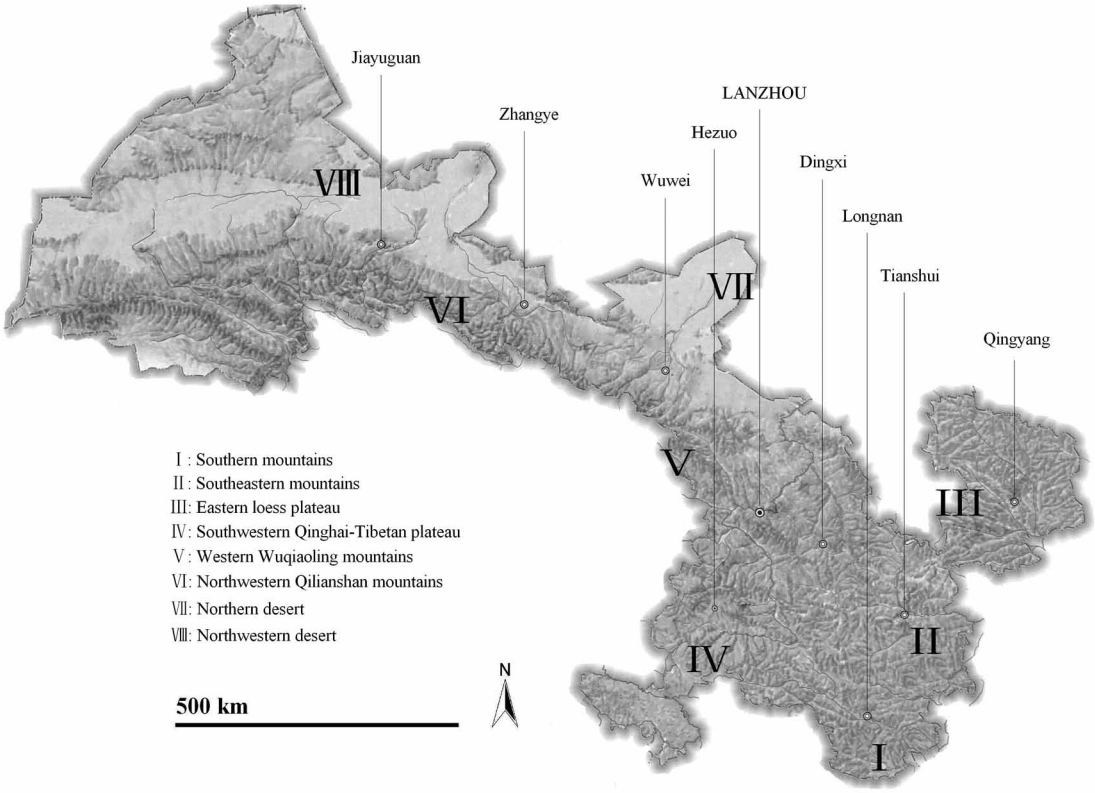

FIGURE 2. Relief map of Gansu as an indication of different habitats. Names of selected major cities are marked with a dot. The main physiographic regions are marked from I to VIII .

Previous reports on the bumblebees of Gansu have been based on collections that are much smaller (Bischoff, 1936; Panfilov, 1957) and often from very stricted parts of the province (Yao & Wang, 2005; Jiang, 2007). Other faunal reviews with substantial overlap with Gansu include those by Tkalců (1961), Wang (1982, 1985), Williams (1991), Yao & Luo (1997), Wang & Yao (2004), An *et al.* (2008), Wu *et al.* (2009), and Williams *et al.* (2009). None of these papers describe distribution patterns within Gansu.

We aim to describe the current distribution and taxonomic status of bumblebees in Gansu, and to compare this fauna with others to the north and to the south within China. A systematic survey of field sites was made between 2007 and 2010. From this largest sample available so far, we summarize available information on the geographic and elevational distributions of species. We then compare the bumblebee fauna of Gansu with the recently revised bumblebee faunas to the north in the Shanxi-Hebei-Beijing-Tianjin region (An *et al.*, 2008, 2010) and to the south in the Sichuan-Chongqing region (Williams *et al.*, 2009).

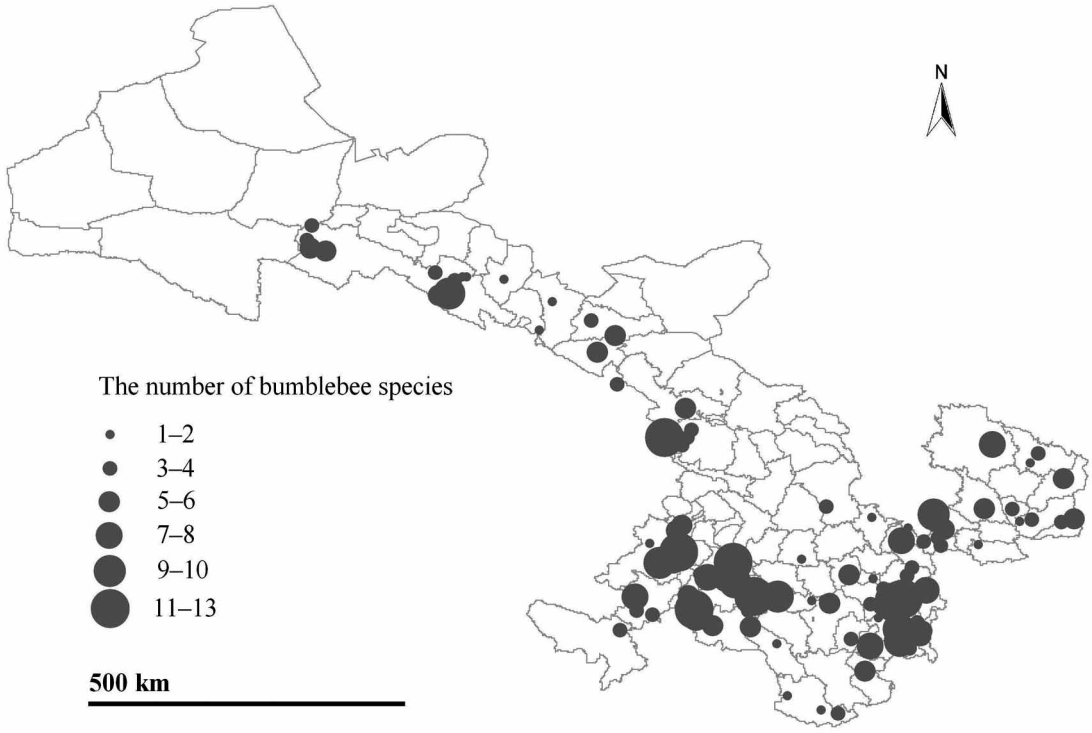

FIGURE 3. Map of Gansu showing the relative species richness of the recorded sites as grey spots of different sizes with county boundaries shown in grey.

Material and methods

Material examined. The sample sites were chosen preferentially from natural reserves, forest parks, or scenic spots with relatively undisturbed vegetation, which cover six of the eight different environmental regions within Gansu (no bumblebees have been found in the other two). These sites include the Baishuijiang natural reserve (river valley) in the southern mountains with a subtropical climate; the Xiaolongshan natural reserve and Maijishan scenic spots in the southeastern mountains with a temperate humid climate; the Zhagana forest park, the Gahai natural reserve, and Lianhuashan natural reserve on the Qinghai-Tibetan plateau in the southwest with a high elevation humid cold climate; the Ziwuling natural reserve and the Kongdongshan scenic spots on the eastern loess plateau with a temperate sub-humid to semi-arid climate; and the Liancheng natural reserve in the western Wuqiaoling mountains and the Qilianshan natural reserve in the northwestern mountains with a cold semi-arid climate.

Most field visits were made travelling from south to north between June and September each year. Bumblebees were collected at random for 1–2 hours within an area of 0.25 km^2 by 3–4 non-specialists (most without identification training), and on sunny or cloudy but bright days. Each site was visited at least three times during the four 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 specimens were pinned, labelled, and given individual identifier numbers in the laboratory before being identified. Secimens were identified by comparison with type and reference material and from the key to Sichuan bumblebees (Williams *et al.*, 2009). Specimens were then databased using the individual identifier number as a reference and deposited in the collection of the Institute of Apiculture, Chinese Academy of Agricultural Sciences, Beijing, China. Food plants were identified based on the photographs by Prof. Dr. Gangmin Zhang of the Beijing Forest University and all plant names were checked against the International Plant Names Index (http://www.ipni.org, accessed March 3, 2011).

Analysis. The distribution and richness maps were drawn using ESRI ArcView version 3.3. Abundance classes for rare/common/abundant were based on quartiles of species <25% / 25–75% / >75% after the species were ranked by their numbers of records. Elevation classes for low/medium/high elevation were based on quartiles of species <25% / 25–75% / >75% after the species were ranked by their mean elevations of records.

Results

In this review, 5941 bumblebee specimens, collected from 125 sites (Fig. 3) in Gansu between 2007 and 2010, were assigned to 49 species. Two older specimens held in London added two more species to this list. Together, these 51 species belong to 10 subgenera of the genus *Bombus*. Related specimens from 15 depositories (Table 1) have been examined for this study.

TABLE 1. Collections from which material has been examined.

Abbreviation	Address
BMNH	Natural History Museum, London, UK
BT	Dr Borek Tkalců, Prague, Czech Republic
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

Genus *BOMBUS* Latreille

Subgenus *MENDACIBOMBUS* Skorikov

1. *Bombus* (*Mendacibombus*) *convexus* Wang
(Fig. 4)

Bombus lugubris Morawitz, 1880:339 (not of Kriechbaumer, 1870:159 = *B. maxillosus* Klug), holotype worker ZISP examined. China: ‘Gan-su’, probably Qinghai.

Bombus (Mendacibombus) convexus Wang, 1979:190, holotype queen IZB examined. Synonymised with *Bombus lugubris* Morawitz by Williams (1991). China: Xizang.

Material examined. 2 queens 64 workers 29 males (IAB).

Distribution in Gansu. Common at medium to high altitudes of the Qinghai-Tibetan plateau in the southwest, rare at medium altitudes of the western mountains (Fig. 4); 14 localities between 2196 and 3524 m (IAB).

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

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

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

(Fig. 5)

Bombus mendax ssp. *chinensis* Skorikov, 1910a:330 (not of Morawitz, 1890:352 = *B. chinensis* (Morawitz)), holotype queen ZISP examined. China: Qinghai.

Bombus waltoni Cockerell, 1910:239, holotype queen BMNH examined. Synonymised with *Bombus mendax* ssp. *chinensis* Skorikov by Skorikov in Cockerell (1911). India.

Bombus rufitarsus Friese, 1913:85, type not seen. Synonymised with *Bombus waltoni* Cockerell by Skorikov (1914). 'Zentralasien', believed incorrect.

Bombus asellus Friese, 1924:438, type not seen. Regarded as conspecific with *Bombus waltoni* Cockerell by Bischoff (1936). 'Mongolei bei Tippeti', believed incorrect.

Material examined. 33 workers 1 male (IAB).

Distribution in Gansu. Common at high altitudes of the Qinghai-Tibetan plateau in the southwest and northwestern Qilianshan mountains, rare at medium altitudes of the western mountains (Fig. 5); 6 localities between 2604 and 3524 m (IAB).

Distribution in China. Gansu, Qinghai (IAB).

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

Subgenus *SUBTERRANEOBOMBUS* Vogt

3. *Bombus* (*Subterraneobombus*) *personatus* Smith

(Fig. 6)

Bombus personatus Smith, 1879:132, lectotype queen (Richards, 1930:656) BMNH examined. India.

Bombus Roborowskyi Morawitz, 1887:197, syntype queen ZISP examined. Synonymised with *Bombus personatus* Smith by Williams (1991). China: Qinghai.

Material examined. 11 workers 2 males (IAB).

Distribution in Gansu. Common at medium to high altitudes of the northwestern Qilianshan mountains and the Qinghai-Tibetan plateau in the southwest (Fig. 6); 5 localities between 2753 and 3656 m (IAB).

Distribution in China. Gansu, Qinghai (IAB).

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

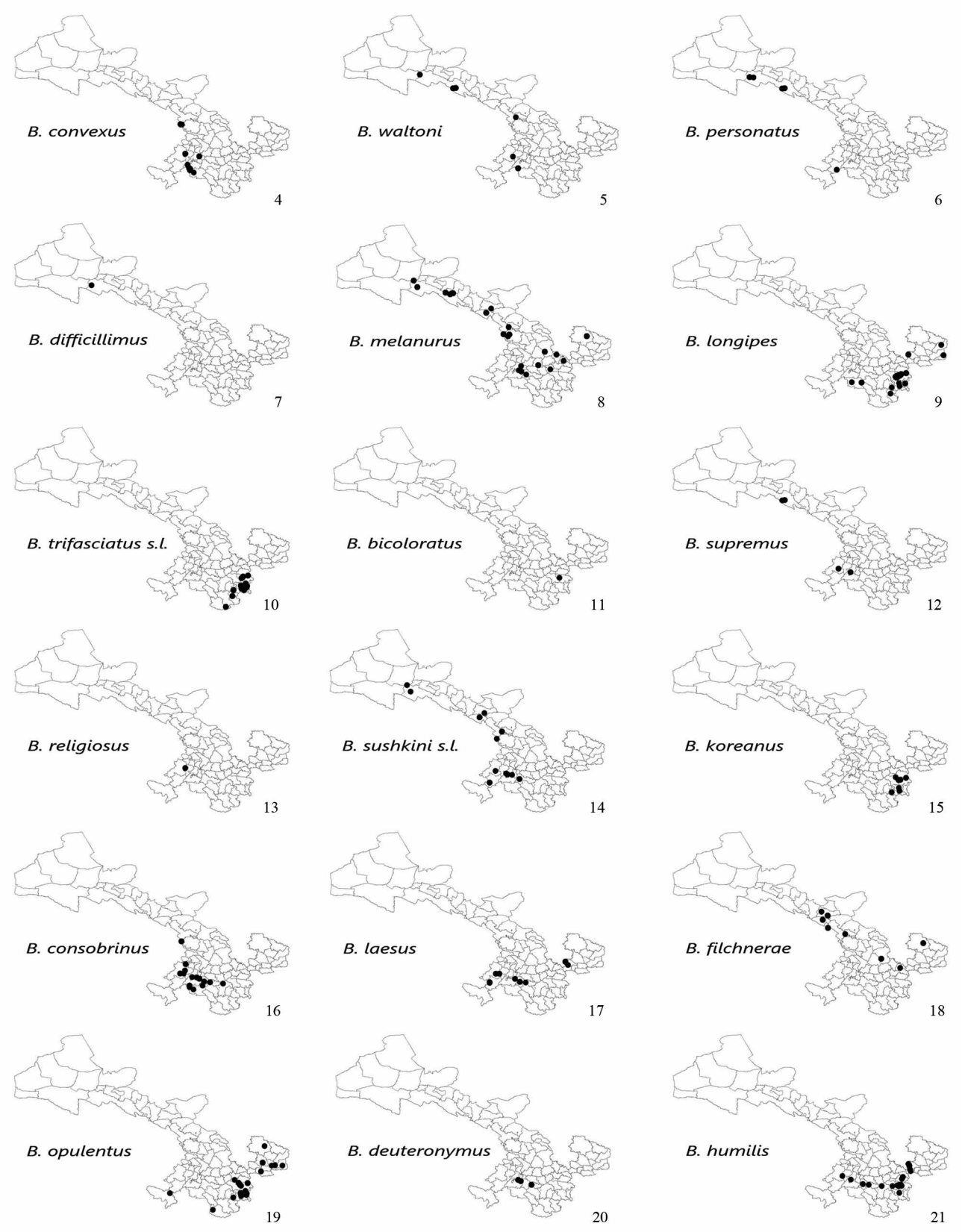

FIGURE 4–21. Maps of Gansu showing the recorded presences of the species as black spots with county boundaries shown in grey.

4. *Bombus* (*Subterraneobombus*) *difficillimus* Skorikov
(Fig. 7)

Bombus difficillimus Skorikov, 1912:609, syntype queen ZISP examined.

Material examined. 1 worker (IAB).

Distribution in Gansu. Rare at high altitude in the northwestern Qilianshan mountains (Fig. 7); 1 locality 3656 m (IAB).

Distribution in China. Gansu, Qinghai (IAB).

Forage plants. FABACEAE: *Hedysarum tanguticum*.

5. *Bombus* (*Subterraneobombus*) *melanurus* Lepeletier
(Fig. 8)

Bombus melanurus Lepeletier de Saint-Fargeau, [1835]:469, lectotype queen by designation of Tkalců (1969:202), UMO examined. Syria.

Bombus altaicus Eversmann, 1846:436, holotype queen by monotypy (Skorikov, 1910c:572), ZISP not seen. Altai. Synonymised with *Bombus melanurus* Lepeletier by Morawitz (in Fedtschenko 1875:5).

Bombus Tschitscherini Behr in Radoszkowski, 1862:591, by indication of Radoszkowski (1860:485), holotype queen by monotypy, ISEAK examined. Russia: Siberia. Regarded as conspecific (in the form *Bombus melanurus tschitscherini* Behr) by Vogt (1909:53); synonymised with *Bombus melanurus* Lepeletier by Williams (1991:62).

Material examined. 6 queens 146 workers 31 males (IAB).

Distribution in Gansu. Abundant at low to medium altitudes of the eastern loess plateau, western mountains, northwestern Qilianshan mountains (Fig. 8); 23 localities between 1423 and 2923 m (IAB).

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

Forage plants. ASTERACEAE: *Olgaea tangutica*, *Cosmos bipinnatus*, *Saussurea* sp., *Sinacalia tangutica*; BRASSICACEAE: *Brassica napus*; CAMPANULACEAE: *Adenophora polyantha*; FABACEAE: *Astragalus bhotanensis*, *A. adsurgens*, *Hedysarum tanguticum*, *Oxytropis ochrocephala*; LAMIACEAE: *Dracocephalum heterophyllum*, *Thymus mongolicus*; MALVACEAE: *Althaea rosea*; PAPAVERACEAE: *Corydalis* sp.; ROSACEAE: *Rubus* sp.

Subgenus *MEGABOMBUS* Dalla Torre

6. *Bombus* (*Megabombus*) *longipes* Friese
(Fig. 9)

Bombus longipes Friese, 1905:511, type not seen. China: Sichuan.

Bombus (Diversobombus) hummeli Bischoff, 1936:18, paralectotype male (Tkalců, 1987:63) MNHU examined. Synonymised with *Megabombus longipes* (Friese) by Tkalců (1987). China: Gansu.

Material examined. 2 queens 131 workers 12 males (IAB).

Distribution in Gansu. Abundant at low to medium elevations of the southeastern mountains, rare at low to medium elevations of the eastern loess plateau and Qinghai-Tibetan plateau in the southwest (Fig. 9); 18 localities between 1011 and 2241 m (IAB).

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

Forage plants. ASTERACEAE: *Cirsium monocephalum*, *Helianthus annuus*; BUDDLEJACEAE: *Buddleja officinalis*; FABACEAE: *Campylotropis macrocarpa*, *Melilotus albus*, *Vicia cracca*; LAMIACEAE: *Phlomis umbrosa*, *Phlomis* sp., *Salvia przewalskii*, *Salvia* sp.; PAPAVERACEAE: *Corydalis* sp.; RANUNCULACEAE: *Aconitum gymnandrum*, *Anemone tomentosa*; SCROPHULARIACEAE: *Pedicularis torta*.; SOLANACEAE: *Solanum septemlobum*; THYMELAEACEAE: *Wikstroemia chamaedaphne*.

7. *Bombus* (*Megabombus*) *trifasciatus* Smith *s. l.*

(Fig. 10)

Bombus trifasciatus Smith, 1852a:43, lectotype queen (Williams, 1991:52) BMNH examined. China: Zhejiang.

Bombus ningpoënsis Friese, 1909:676, type not seen. Synonymised with *Bombus trifasciatus* Smith by Tkalců (1961). China: Zhejiang.

Bombus (Diversobombus) ningpoensis ssp. *minshanicus* Bischoff, 1936:19, lectotype worker (Williams, 1991:52) MNHU examined. Synonymised with *Bombus trifasciatus* Smith by Williams (1991). China: Gansu.

Taxonomy: see Williams *et al.* (2009).

Material examined. 104 workers (IAB).

Distribution in Gansu. Common at low to medium elevations of the southern and southeastern mountains (Fig. 10); 13 localities between 719 and 1770 m (IAB).

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

Forage plants. ASTERACEAE: *Arctium lappa*, *Cosmos bipinnatus*, *Dahlia pinnata*, *Erigeron annuus*, *Helianthus annuus*; BUDDLEJACEAE: *Buddleja officinalis*; CONVOLVULACEAE: *Pharbitis nil*; CUCURBITACEAE: *Cucumis sativus*, *Cucurbita moschata*, *Thladiantha dubia*; LAMIACEAE: *Caryopteris divaricata*, *Leonurus artemisia*, *Vitex negundo*; MALVACEAE: *Althaea rosea*; NYCTAGINACEAE: *Mirabilis jalapa*; SOLANACEAE: *Capsicum annuum*, *Solanum septemlobum*.

8. *Bombus* (*Megabombus*) *bicoloratus* Smith

(Fig. 11)

Bombus bicoloratus Smith, 1879:132, holotype queen BMNH examined. Taiwan.

Bombus kulingensis Cockerell, 1917:266, holotype worker USNM examined. Synonymised with *Bombus trifasciatus* Smith by Williams *et al.* (2009). China: Jiangxi.

Material examined. 1 worker (IAB).

Distribution in Gansu. Rare at low elevations of the southeastern mountains (Fig. 11); 1 locality 1336 m (IAB).

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

Forage plants. No records.

9. *Bombus* (*Megabombus*) *supremus* Morawitz

(Fig. 12)

Bombus supremus Morawitz, 1887:196, holotype queen ZISP not found (Y. Pesenko, *in litt*.). China: Qinghai.

Bombus linguarius Morawitz, 1890:351, holotype worker ZISP examined. Synonymised provisionally with *Bombus supremus* Morawitz by Williams (1998), confirmed by Williams *et al.* (2009). China: 'Kan-ssu', probably Qinghai.

Material examined. 7 workers (IAB).

Distribution in Gansu. Common at medium to high elevations of the Qinghai-Tibetan plateau in the southwest and northwestern Qilianshan mountains (Fig. 12); 4 localities between 2874 and 3386 m (IAB).

Distribution in China. Gansu, Qinghai (IAB).

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

10. *Bombus* (*Megabombus*) *religiosus* (Frison)
(Fig. 13)

Bremus (Hortobombus) religiosus Frison, 1935:344, holotype male USNM examined. China: Sichuan.

Material examined. 3 workers (IAB).

Distribution in Gansu. Rare at medium elevations of the Qinghai-Tibetan plateau in the southwest (Fig. 13); 1 locality 2524 m (IAB).

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

Forage plants. LAMIACEAE: *Caryopteris incana*.

11. *Bombus* (*Megabombus*) *sushkini* (Skorikov) *s. l.*
(Fig. 14)

Hortobombus sushkini Skorikov, 1931:235, paralectotype queen (Podbolotskaya, 1988:117) ZISP examined. Kazakhstan.
Bombus (Hortobombus) hortorum ssp. *morawitzianus* Pittioni, 1939:244 (not of Popov, 1931:183 = *B. morawitzianus* (Popov)), lectotype queen (Tkalců, 1974a:52) BMNH examined. Synomymised with *Megabombus sushkini* (Skorikov) by Tkalců (1974a). Mongolia.

Material examined. 13 queens 27 workers 3 males (IAB).

Distribution in Gansu. Common at medium to high elevations of the Qinghai-Tibetan plateau in the southwest and northwestern Qilianshan mountains, rare at medium elevations of the western mountains (Fig. 14); 13 localities between 2148 and 3490 m (IAB).

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

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

12. *Bombus* (*Megabombus*) *koreanus* (Skorikov)
(Fig. 15)

Hortobombus koreanus Skorikov, 1933b:59, type not seen. Korea.

Material examined. 10 workers 1 male (IAB).

Distribution in Gansu. Common at low to medium elevations of the southeastern mountains (Fig. 15); 7 localities between 1011 and 1705 m (IAB).

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

Forage plants. FABACEAE: *Vicia cracca*.

13. *Bombus* (*Megabombus*) *consobrinus* Dahlbom
(Fig. 16)

Bombus consobrinus Dahlbom, 1832:49, type not seen. Sweden.

Material examined. 37 workers 8 males (IAB).

Distribution in Gansu. Common at medium to high elevations of the Qinghai-Tibetan plateau in the southwest, rare at medium elevations of the western mountains (Fig. 16); 16 localities between 1659 and 3279 m (IAB).

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

Forage plants. ASTERACEAE: *Carduus crispus*, *Cirsium setosum*, *Saussurea* sp.; LAMIACEAE: *Dracocephalum heterophyllum*, *Elsholtzia fruticosa*, *Salvia* sp.; RANUNCULACEAE: *Clematis tangutica*.

Subgenus *THORACOBOMBUS* Dalla Torre

14. *Bombus* (*Thoracobombus*) *laesus* Morawitz

(Fig. 17)

Bombus laesus Morawitz, 1875:3, syntype queen (lectotype by designation of P. Rasmont, in prep.) ZMMU examined. Kazakhstan.

Bombus Mocsáryi Kriechbaumer, 1877:253, type not seen. Regarded as conspecific with *Bombus laesus* Morawitz by Dalla Torre (1896). Hungary.

Agrobombus (Laesobombus) laesus subsp. *mocsàryi* var. *maculidorsis* Skorikov, 1922:23, not infrasubspecific after Panfilov, 1956:1328, syntype queen (lectotype by designation of Podbolotskaya, unpublished) ZISP examined. Synonymised provisionally with *Bombus laesus* Morawitz by Williams (1998), confirmed by Williams *et al.* (2009). Russia.

Bombus (Laesobombus) tianschanicus Panfilov, 1956:1327, type not seen. Synonymised provisionally with *Bombus laesus* Morawitz by Williams (1998). Kyrgyzstan.

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

Material examined. 4 queens 31 workers 1 male (IAB).

Distribution in Gansu. Common at medium to high elevations of the eastern loess plateau and Qinghai-Tibetan plateau in the southwest (Fig. 17); 10 localities between 1764 and 3472 m (IAB).

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

Forage plants. ASTERACEAE: *Saussurea stella*; FABACEAE: *Hedysarum gmelini*, *Medicago sativa*; GENTIANACEAE: *Gentiana* sp.; LAMIACEAE: *Caryopteris tangutica*, *Dracocephalum heterophyllum*, *Elsholtzia fruticosa*; RANUNCULACEAE: *Aconitum gymnandrum*, *Delphinium grandiflorum*.

15. *Bombus* (*Thoracobombus*) *filchnerae* Vogt

(Fig. 18)

Bombus Filchnerae Vogt, 1908:100, lectotype worker (Tkalců, 1974a:39) MNHU examined. China: Gansu.

Agrabombus adventor Skorikov, 1914:119, type not seen. Synonymised with *Megabombus filchnerae* (Vogt) by Tkalců (1974a). Mongolia.

Bombus (Agrobombus) lii Tkalců, 1961:355, type not seen. Synonymised with *Megabombus filchnerae* (Vogt) by Tkalců (1974a). China: Qinghai.

Material examined. 19 queens 37 workers 2 males (IAB).

Distribution in Gansu. Common at medium elevations of the northwestern Qilianshan mountains and low to medium elevations of the eastern loess plateau, rare at medium elevations of the western mountains (Fig. 18); 8 localities between 1423 and 2659 m (IAB).

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

Forage plants. ASTERACEAE: *Ligularia sagitta*, *Olgaea tangutica*.

16. *Bombus* (*Thoracobombus*) *opulentus* Smith

(Fig. 19)

Bombus opulentus Smith, 1861:153, holotype queen BMNH examined. China 'North'.

Material examined. 2 queens 92 workers (IAB).

Distribution in Gansu. Common at low to medium elevations of the southeastern mountains and eastern loess plateau, rare at low elevations of the southern mountain, rare at high elevations of the Qinghai-Tibetan plateau in the southwest (Fig. 19); 19 localities between 890 and 3432 m (IAB).

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

Forage plants. ASTERACEAE: *Arctium lappa*, *Helianthus annuus*; CUCURBITACEAE: *Thladiantha dubia*; FABACEAE: *Melilotus albus*, *Vicia cracca*; LAMIACEAE: *Leonurus Artemisia*, *Phlomis umbrosa*, *Vitex negundo*; SOLANACEAE: *Solanum septemlobum*.

17. *Bombus* (*Thoracobombus*) *deuteronymus* Schulz
(Fig. 20)

Bombus senilis Smith, 1879:131, holotype queen BMNH examined (not of Fabricius, 1775:382, = *B. pascuorum* (Scopoli)). Japan.
Bombus deuteronymus Schulz, 1906:267, replacement name for *senilis* Smith, 1879:131.

Material examined. 19 workers 2 males (IAB).

Distribution in Gansu. Common at medium elevations of the Qinghai-Tibetan plateau in the southwest (Fig. 20); 3 localities between 2835 and 2872 m (IAB).

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

Forage plants. ASTERACEAE: *Cirsium leo*, *Saussurea* sp., *Sinacalia tangutica*; CAMPANULACEAE: *Adenophora potaninii*; FABACEAE: *Astragalus bhotanensis*, *Lespedeza floribunda*, *Melilotus officinalis*; LAMIACEAE: *Caryopteris tangutica*, *Dracocephalum heterophyllum*; RANUNCULACEAE: *Aconitum gymnandrum*.

18. *Bombus* (*Thoracobombus*) *humilis* Illiger
(Fig. 21)

Apis fulve/cens [*fulvescens*] Schrank, 1802:367. *Nomen oblitum* (Williams *et al.*, 2009). Germany.
Bombus humilis Illiger, 1806:171, holotype worker MNHU examined. Synonymised provisionally with *Apis fulvescens* Schrank by Warncke (1986). *Nomen protectum* (Williams *et al.*, 2009). Germany.
Bombus (Agrobombus) helferanus var. *subbaicalensis* Vogt, 1911:42, 54, 10 queen and 1 worker syntypes ZMA examined. Regarded as conspecific with *Megabombus humilis* (Illiger) by Tkalců (1974a). Russia: ?Primorskiy Kray.

Material examined. 55 workers 2 males (IAB).

Distribution in Gansu. Common at low to medium elevations of the southeastern mountains and eastern loess plateau, rare at medium elevations of the Qinghai-Tibetan plateau in the southwest (Fig. 21); 20 localities between 1113 and 3130 m (IAB).

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

Forage plants. ASTERACEAE: *Cirsium leo*, *Cirsium monocephalum*; FABACEAE: *Astragalus bhotanensis*; LAMIACEAE: *Caryopteris tangutica*, *Dracocephalum heterophyllum*, *Mentha haplocalyx*; RANUNCULACEAE: *Clematis tangutica*.

19. *Bombus* (*Thoracobombus*) *hedini* Bischoff
(Fig. 22)

Bombus silvarum ssp. *unicolor* Friese, 1905:514 (not of Kriechbaumer, 1870:159 = *B. maxillosus* Klug), lectotype worker (Tkalců, 1968:49) MNHU examined. China: 'Sz'-tschwan', but probably Neimenggu (Williams *et al.*, 2009).
Bombus (Agrobombus) hedini Bischoff, 1936:15 (not of Bischoff, 1936:25 = *B. bohemicus* Seidl), type not seen. Synonymised with *Megabombus unicolor* (Friese) by Tkalců (1968). China: Gansu.

Material examined. 4 queens 262 workers 7 males (IAB).

Distribution in Gansu. Abundant at low to medium elevations of the eastern loess plateau, common at low to medium elevations of the southeastern mountains and medium to high elevations of the Qinghai-Tibetan plateau in the southwest (Fig. 22); 27 localities between 1011 and 3432 m (IAB).

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

Forage plants. ASTERACEAE: *Helianthus annuus*, *Saussurea* sp.; FABACEAE: *Astragalus bhotanensis*, *Melilotus albus*, *M. officinalis*; GENTIANACEAE: *Halenia elliptica*; LAMIACEAE: *Dracocephalum heterophyllum*, *Phlomis* sp., *Salvia* sp.; PAPAVERACEAE: *Corydalis* sp.; SCROPHULARIACEAE: *Euphrasia pectinata*; THYMELAEACEAE: *Wikstroemia chamaedaphne*.

20. *Bombus* (*Thoracobombus*) *remotus* (Tkalců)

(Fig. 23)

Megabombus (Agrobombus) remotus Tkalců, 1968:45, holotype queen BMNH examined. China: Sichuan.

Material examined. 5 queens 197 workers 19 males (IAB).

Distribution in Gansu. Abundant at low to medium elevations of the southern and southeastern mountains, rare at medium elevations of the eastern loess plateau and Qinghai-Tibetan plateau in the southwest (Fig. 23); 16 localities between 1114 and 2766 m (IAB).

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

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

21. *Bombus* (*Thoracobombus*) *impetuosus* Smith

(Fig. 24)

BOMBUS IMPETUOSUS Smith, 1871:249, lectotype queen (Tkalců, 1987:61) BMNH examined. China: Yunnan.

Bombus Potanini Morawitz, 1890:350, type ZISP not found (Y. Pesenko, *in litt*.). Synonymised provisionally with *Bombus impetuosus* Smith by Williams (1998). China: 'Kan-ssu', probably Qinghai.

Bombus silvarum var. *subrufescens* Friese, 1913:87, holotype male MNHU examined. Synonymised with *Megabombus potanini* (Morawitz) by Tkalců (1987). China: 'Tibet', ?Xizang.

Bombus (Agrobombus) yuennanensis Bischoff, 1936:14, lectotype queen (Tkalců, 1987:61) MNHU examined. Synonymised with *Megabombus impetuosus* (Smith) by Tkalců (1987). China: Yunnan.

Bombus (Agrobombus) combai Tkalců, 1961:357, type not seen. Synonymised with *Megabombus potanini* (Morawitz) by Tkalců (1987). China: Qinghai.

Material examined. 1 queen 97 workers 11 males (IAB).

Distribution in Gansu. Common at medium to high elevations of the Qinghai-Tibetan plateau in the southwest, rare at medium elevations of the western mountains (Fig. 24); 19 localities between 1719 and 3524 m (IAB).

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

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

Subgenus *PSITHYRUS* Lepeletier

22. *Bombus* (*Psithyrus*) *tibetanus* (Morawitz)

(Fig. 25)

Apathus tibetanus Morawitz, 1887:202, lectotype female (Pesenko, 2000:20) ZISP examined. China: 'Bassin des gelben Flusses,' probably Qinghai.

Material examined. 1 female (PHW).

Distribution in Gansu. Rare at high elevations of the Qinghai-Tibetan plateau in the southwest (Fig. 25); 1 locality between 3000 and 3700 m (PHW).

Distribution in China. Gansu, Qinghai (IAB).

Forage plants. No records.

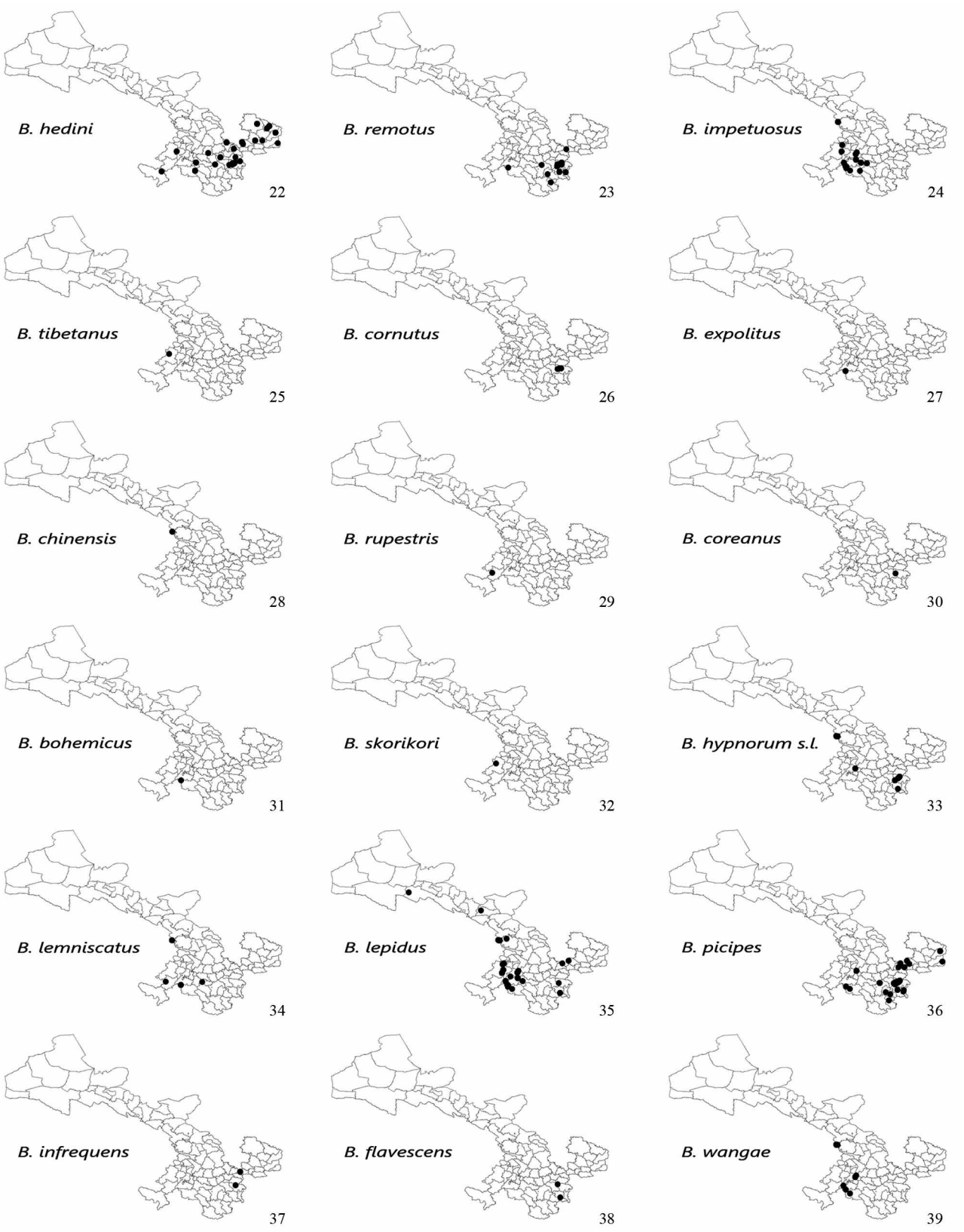

FIGURE 22–39. Maps of Gansu showing the recorded presences of the species as black spots with county boundaries shown in grey.

23. *Bombus* (*Psithyrus*) *cornutus* (Frison)

(Fig. 26)

Psithyrus (Psithyrus) cornutus Frison, 1933:338, type not seen. India.

Psithyrus (Psithyrus) pyramideus Maa, 1948:19, paratype male IZB examined. Regarded as conspecific with *Psithyrus cornutus* Frison by Tkalců (1989). China: Fujian.

Psithyrus (Psithyrus) acutisquameus Maa, 1948:21, holotype male IZB examined. Synonymised with *Psithyrus cornutus* ssp. *pyramideus* Maa by Tkalců (1989). China: Anhui.

Psithyrus (Ceratopsithyrus) klapperichi Pittioni, 1949:273 (not of Pittioni, 1949:266 = *B. picipes* Richards), paratype female BMNH examined. Synonymised with *Psithyrus cornutus* ssp. *pyramideus* Maa by Tkalců (1989). China: Fujian.

Psithyrus (Eopsithyrus) cornutus ssp. *canus* Tkalců, 1989:42 (not of Schmiedeknecht, 1883:359 = *B. pomorum* (Panzer), paratype female MNHU examined. China: Yunnan.

Material examined. 1 female 3 males (IAB).

Distribution in Gansu. Common at medium elevations of the southeastern mountains (Fig. 26); 3 localities between 1705 and 1770 m (IAB).

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

Forage plants. ASTERACEAE: *Cirsium monocephalum*.

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

(Fig. 27)

Psithyrus (Eopsithyrus) expolitus Tkalců, 1989:44, holotype female MNHU examined. 'Turkestan Kashgar,' believed incorrect.

Material examined. 3 females (IAB).

Distribution in Gansu. Rare at high elevations of the Qinghai-Tibetan plateau in the southwest (Fig. 27); 1 locality 3524 m (IAB).

Distribution in China. Gansu, Qinghai (IAB).

Forage plants. ASTERACEAE: *Carduus crispus*.

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

(Fig. 28)

Apathus rupestris var. *chinensis* Morawitz, 1890[April 30]:352 (not of Dalla Torre, 1890[June 25]:139 = *B. rufofasciatus* Smith), holotype female ZISP examined. China: 'Kan-ssu', probably Qinghai.

Psithyrus morawitzi Friese, 1905:516 (not of Radoszkowski, 1876:101 = *B. morawitzi* Radoszkowski), paralectotype female (Pesenko, 2000:14; see also Tkalců, 1987:59) MNHU examined. Regarded as conspecific with *Psithyrus chinensis* (Morawitz) by Tkalců (1987). China: Sichuan.

Psithyrus (Psithyrus) chinensis ssp. *hönei* Bischoff, 1936:26 (not of Bischoff, 1936:10 = *B. friseanus* Skorikov), lectotype female (Tkalců, 1987:59) MNHU examined. China: Yunnan.

Material examined. 3 males (IAB).

Distribution in Gansu. Rare at medium elevations of the western mountains (Fig. 28); 1 locality 2767 m (IAB).

Distribution in China. Gansu, Ningxia (IAB).

Forage plants. ASTERACEAE: *Ligularia* sp.

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

(Fig. 29)

APIS rupe/tris [*rupestris*] Fabricius, 1793:320, lectotype female (Løken, 1966:203) ZMC examined. Germany.

Psithyrus rupestris f. *buyssoni* Vogt, 1911:64, 2 syntype females ZMA examined. China: Xinjiang.

Psithyrus rupestris ssp. *orientalis* Reinig, 1930:276, 66 syntype females ZMA examined. Russia: Respublika Buryatiya.

Material examined. 1 female (IAB).

Distribution in Gansu. Rare at high elevations of the Qinghai-Tibetan plateau in the southwest (Fig. 29); 1 locality 3454 m (IAB).

Distribution in China. Sichuan, Gansu (IAB).

Forage plants. No records.

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

(Fig. 30)

Psithyrus (Ashtonipsithyrus) coreanus Yasumatsu, 1934:399, type not seen. Korea.

Material examined. 1 male (IAB).

Distribution in Gansu. Rare at medium elevations of the southeastern mountains (Fig. 30); 1 locality 1738 m (IAB).

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

Forage plants. ASTERACEAE: *Cirsium monocephalum*.

28. *Bombus* (*Psithyrus*) *bohemicus* Seidl

(Fig. 31)

Bombus bohemicus Seidl, 1837:73, type not found (Tkalců, 1969). Czech Republic.

Psithyrus distinctus Pérez, 1884:268, type not seen. Synonymised with *Psithyrus bohemicus* (Seidl) by Blüthgen (1918). France.

Psithyrus distinctus Pérez; Popov, 1927b:130. China: Sichuan.

Psithyrus (Ashtonipsithyrus) chinganicus Reinig, 1936:8, type not seen. Synonymised provisionally with *Bombus bohemicus* Seidl by Williams (1998). China: Neimenggu.

Psithyrus (Ashtonipsithyrus) distinctus ssp. *hedini* Bischoff, 1936:26 (not of Bischoff, 1936:15, see nomenclatural note on *B. (Thoracobombus) hedini* Bischoff), paratype female MNHU examined. Synonymised provisionally with *Bombus bohemicus* Seidl by Williams (1998). China: Gansu.

Material examined. 1 male (IAB).

Distribution in Gansu. Rare at high elevations of the Qinghai-Tibetan plateau in the southwest (Fig. 31); 1 locality 3524 m (IAB).

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

Forage plants. ASTERACEAE: *Carduus crispus*

29. *Bombus* (*Psithyrus*) *skorikovi* (Popov)

(Fig. 32)

Psithyrus skorikovi Popov, 1927a:267, holotype female ZISP examined. China: Qinghai.

Psithyrus (Fernaldaepsithyrus) gansuensis Popov, 1931:202, holotype male ZISP examined. Synonymy with *Psithyrus skorikovi* Popov suggested by Popov (1931), confirmed by Williams *et al.* (2009). China: Qinghai.

Psithyrus (Fernaldaepsithyrus) kuani Tkalců, 1961:362, holotype female BT examined. Synonymised provisionally with *Bombus skorikovi* (Popov) by Williams (1998), confirmed by Williams *et al.* (2009). China: Qinghai.

Material examined. 1 female (PHW).

Distribution in Gansu. Rare at high elevations of the Qinghai-Tibetan plateau in the southwest (Fig. 32); 1 locality between 3000 and 3700 m (PHW).

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

Forage plants. No records.

Subgenus *PYROBOMBUS* Dalla Torre

30. *Bombus* (*Pyrobombus*) *hypnorum* (Linnaeus) *s. l.*

(Fig. 33)

APIS Hypnorum Linnaeus, 1758:579, lectotype queen (Day, 1979:64) LSL examined. Sweden.
Bombus calidus Erichson, 1851:65, type not seen. Regarded as conspecific with *Bombus hypnorum* (Linnaeus) by Schmiedeknecht (1883). Russia: Khabarovskiy Kray.
Bombus hypnorum var. *calidus* Erichson; Morawitz, 1890:349. China: 'Sse-tschuan', probably Qinghai.
Taxonomy: for a discussion of the taxonomy of this species see Williams *et al.*(2009).

Material examined. 7 queens 26 workers 23 males (IAB).

Distribution in Gansu. Common at low to medium elevations of the southeastern and western mountains, rare at medium elevations of the Qinghai-Tibetan plateau in the southwest (Fig. 33); 9 localities between 1049 and 2923 m (IAB).

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

Forage plants. ASTERACEAE: *Carduus crispus*, *Cirsium japonicum*, *Ligularia* sp., *Parasenecio roborowskii*, *Stemmacantha uniflora*; APIACEAE: *Angelica* sp.; FABACEAE: *Oxytropis ochrocephala*; LAMIACEAE: *Nepeta prattii*, *Thymus mongolicus*, *Salvia przewalskii*, *Salvia* sp., *Scutellaria scordiifolia*; ONAGRACEAE: *Epilobium angustifolium*.

31. *Bombus* (*Pyrobombus*) *lemniscatus* Skorikov

(Fig. 34)

Bombus lemniscatus Skorikov, 1912:607, holotype queen ZISP examined. China: Qinghai.
Bombus nursei var. *flavopilosus* Friese, 1918:84, lectotype queen (Williams, 1991:73) MNHU examined. Synonymised with *Bombus lemniscatus* Skorikov by Williams (1991). Probably India.
Bombus (Lapidariobombus) peralpinus Richards, 1930:646, holotype queen BMNH examined. Synonymised with *Pyrobombus lemniscatus* (Skorikov) by Tkalců (1974b). China: Xizang.

Material examined. 13 workers (IAB).

Distribution in Gansu. Common at medium to high elevations of the western mountains and Qinghai-Tibetan plateau in the southwest (Fig. 34); 4 localities between 2835 and 3524 m (IAB).

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

Forage plants. ASTERACEAE: *Carduus crispus*, *Parasenecio roborowskii*, *Saussurea* sp.; LAMIACEAE: *Salvia przewalskii*; POLYGONACEAE: *Polygonum viviparum*; RANUNCULACEAE: *Aconitum gymnandrum*; SCROPHULARIACEAE: *Veronica* sp.

32. *Bombus* (*Pyrobombus*) *lepidus* Skorikov

(Fig. 35)

Bombus lepidus Skorikov, 1912:606, syntype queen ZISP examined. China: Qinghai.
Bombus genitalis Friese, 1913:85, holotype male MNHU examined. Synonymised with *Bombus lepidus* Skorikov by Williams (1991). China: 'Tibet', ?Xizang.
Bombus nursei var. *tetrachromus* Friese, 1918:85 (not of Cockerell, 1909:397 = *B. kashmirensis* Friese), lectotype queen (Williams, 1991:75) MNHU examined. Synonymised with *Bombus lepidus* Skorikov by Williams (1991). India.

Material examined. 2 queens 132 workers 20 males (IAB).

Distribution in Gansu. Abundant at medium to high elevations of the Qinghai-Tibetan plateau in the southwest and western mountains; rare at low to medium elevations of the southeastern mountains, eastern loess plateau and northwestern Qilianshan mountains (Fig. 35); 27 localities between 1049 and 3656 m (IAB).

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

Forage plants. ASTERACEAE: *Carduus crispus*, *Cirsium setosum*, *Ligularia* sp., *Saussurea* sp., *Sinacalia tang-*

utica; CONVOLVULACEAE: *Pharbitis nil*; FABACEAE: *Astragalus bhotanensis*, *Astragalus* sp., *Hedysarum gmelini*, *Medicago sativa*, *Melilotus albus*, *M. officinalis*, *Oxytropis ochrocephala*, *Vicia unijuga*; GENTIANACEAE: *Halenia elliptica*; LAMIACEAE: *Caryopteris divaricata*, *Dracocephalum heterophyllum*, *Elsholtzia fruticosa*, *Lamium album*, *Nepeta prattii*, *Phlomis umbrosa*, *Salvia przewalskii*, *Salvia* sp., *Thymus mongolicus*; ONAGRACEAE: *Epilobium angustifolium*; PAPAVERACEAE: *Corydalis* sp.; RANUNCULACEAE: *Aconitum gymnandrum*, *A. leucostomum*, *Clematis tangutica*, *Delphinium grandiflorum*; ROSACEAE: *Potentilla fruticosa*; SCROPHULARIACEAE: *Euphrasia pectinata*, *Pedicularis kansuensis*, *P. spicata*, *Pedicularis* sp.

33. *Bombus* (*Pyrobombus*) *picipes* Richards
(Fig. 36)

Bombus pratorum ssp. *flavus* Friese, 1905:517 (not of Pérez, 1884:265 = *B. campestris* (Panzer)), holotype male MNHU examined. 'Turkestan Kashgar', believed incorrect.

Bombus (Pratobombus) parthenius var. *picipes* Richards, 1934:90, holotype worker BMNH examined. Synonymised with *Bombus flavus* Friese by Tkalců in Sakagami (1972). China: Shaanxi.

Bombus (Pratobombus) klapperichi Pittioni, 1949:266, holotype queen BMNH examined. Synonymised with *Bombus flavus* Friese by Sakagami (1972). China: Fujian.

Material examined. 20 queens 253 workers 30 males (IAB).

Distribution in Gansu. Abundant at low to medium elevations of the southeastern mountains and eastern loess plateau, rare at medium elevations of the Qinghai-Tibetan plateau in the southwest (Fig. 36); 25 localities between 1113 and 2526 m (IAB).

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

Forage plants. ALLIACEAE: *Allium fistulosum*; ASTERACEAE: *Arctium lappa*, *Cirsium monocephalum*, *Cosmos bipinnatus*, *Dahlia pinnata*, *Helianthus annuus*, *Saussurea* sp., *Tagetes patula*; BUDDLEJACEAE: *Buddleja officinalis*; FABACEAE: *Astragalus* sp., *Lespedeza bicolor*, *Oxytropis ochrocephala*, *Vicia cracca*; LAMIACEAE: *Dracocephalum heterophyllum*, *Nepeta prattii*, *Phlomis umbrosa*; MALVACEAE: *Althaea rosea*; RANUNCULACEAE: *Anemone tomentosa*, *Clematis tangutica*.

34. *Bombus* (*Pyrobombus*) *infrequens* Tkalců
(Fig. 37)

Pyrobombus (Pyrobombus) infrequens Tkalců, 1989:56, holotype worker BMNH examined. Myanmar.

Material examined. 7 workers (IAB).

Distribution in Gansu. Common at medium elevations of the southeastern mountains and eastern loess plateau (Fig. 37); 2 localities between 1770 and 2225 m (IAB).

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

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

35. *Bombus* (*Pyrobombus*) *flavescens* Smith
(Fig. 38)

Bombus flavescens Smith, 1852a:45, holotype male BMNH examined. China: Zhejiang.

Bombus rufocaudatus Friese, 1905:510, type not seen. Synonymised with *Pyrobombus flavescens* (Smith) by Tkalců (1974b). China: Sichuan.

BOMBUS MEARNSI Ashmead, 1905:959, type not seen. Regarded as conspecific with *Bombus flavescens* Smith by Pittioni (1949). Philippines.

Bombus geei Cockerell, 1917:265, type not seen. Regarded as conspecific with *Bremus mearnsi* (Ashmead) by Frison (1934). Regarded as conspecific with *Bombus flavescens* Smith by Pittioni (1949). China: Jiangxi.

Bremus (Pratobombus) mearnsi var. *dilutus* Frison, 1934:174, holotype worker INHS examined. Regarded as conspecific with *Bombus flavescens* Smith by Pittioni (1949). China: Zhejiang.

Bombus (Pratobombus) mearnsi ssp. *chekiangensis* Bischoff, 1936:5, type not seen. Regarded as conspecific with *Bombus flavescens* Smith by Pittioni (1949). China: Zhejiang.

Bombus (Pratobombus) flavescens f. *dilutior* Pittioni, 1949:264, holotype male BMNH examined. China: Fujian.

Material examined. 2 workers (IAB).

Distribution in Gansu. Rare at low elevations of the southeastern mountains (Fig. 38); 2 localities between 1049 and 1118 m (IAB).

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

Forage plants. MALVACEAE: *Althaea rosea*.

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

(Fig. 39)

Bombus (Pyrobombus) wangae Williams *et al.*, 2009:159, holotype male IZB examined. China: Sichuan.

Material examined. 11 workers 54 males (IAB).

Distribution in Gansu. Common at medium elevations of the western mountains and Qinghai-Tibetan plateau in the southwest (Fig. 39); 8 localities between 2053 and 3050 m (IAB).

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

Forage plants. APIACEAE: *Angelica* sp.; ASTERACEAE: *Carduus crispus*, *Cirsium japonicum*, *Ligularia* sp., *Parasenecio roborowskii*, *Saussurea* sp., *Sinacalia tangutica*; LAMIACEAE: *Dracocephalum heterophyllum*, *Lamium barbatum*, *Nepeta prattii*, *Salvia przewalskii*, *Thymus mongolicus*; MALVACEAE: *Althaea rosea*, *Malva sinensis*; POLYGONACEAE: *Polygonum viviparum*; SCROPHULARIACEAE: *Euphrasia pectinata*, *Pedicularis spicata*;

Subgenus *BOMBUS* in the strict sense

37. *Bombus* (*Bombus*) *ignitus* Smith

(Fig. 40)

Bombus ignitus Smith, 1869:207, holotype queen BMNH examined. Japan.

Material examined. 32 queens 388 workers 198 males (IAB).

Distribution in Gansu. Abundant at low to medium elevations of the southeastern mountains and eastern loess plateau, common at low elevations of the southern mountains, rare at high elevations of the Qinghai-Tibetan plateau in the southwest (Fig. 40); 37 localities between 719 and 3432 m (IAB).

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

Forage plants. ALLIACEAE: *Allium fistulosum*; APIACEAE: *Foeniculum vulgare*; ASTERACEAE: *Arctium lappa*, *Cirsium monocephalum*, *Cosmos bipinnatus*, *Dahlia pinnata*, *Helianthus annuus*, *Tagetes patula*; BUDDLEJACEAE: *Buddleja officinalis*; CONVOLVULACEAE: *Convolvulus arvensis*, *Pharbitis nil*; CUCURBITACEAE: *Cucumis sativus*, *Thladiantha dubia*; FABACEAE: *Lespedeza bicolor*, *Vicia cracca*; LAMIACEAE: *Caryopteris divaricata*, *Leonurus Artemisia*, *Phlomis umbrosa*, *Stachys sieboldii*, *Vitex negundo*; MALVACEAE: *Althaea rosea*, *Malva sinensis*; OLEACEAE: *Ligustrum lucidum*; ONAGRACEAE: *Oenothera biennis*; PAPAVERACEAE: *Corydalis* sp., *Dicranostigma leptopodum*, *Macleaya microcarpa*; RANUNCULACEAE: *Anemone tomentosa*; ROSACEAE: *Rosa filipes*; SOLANACEAE: *Capsicum annuum*, *Solanum melongena*; THYMELAEACEAE: *Wikstroemia chamaedaphne*.

38. *Bombus* (*Bombus*) *lucorum* (Linnaeus) *s. l.*
(Fig. 41)

APIS lucorum Linnaeus, 1761:425, lectotype male (Day, 1979:66) LSL examined. Sweden.
Bombus (Bombus) terrestris ssp. *minshanicola* Bischoff, 1936:2, type not seen. Regarded as conspecific with *Bombus lucorum* (Linnaeus) by Krüger (1951). China: Gansu.
Taxonomy: this is a complex of morphologically very similar taxa that cannot at present be diagnosed reliably for all individuals (Williams *et al.*, 2009).

Material examined. 6 queens 84 workers 69 males (IAB).

Distribution in Gansu. Abundant at medium to high elevations of the western mountains and Qinghai-Tibetan plateau in the southwest, common at medium elevations of the southeastern mountains (Fig. 41); 20 localities between 1506 and 4011 m (IAB).

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

Forage plants. ALLIACEAE: *Allium senescens*; APIACEAE: *Angelica* sp.; ASTERACEAE: *Anaphalis lactea*, *Aster farreri*, *Carduus crispus*, *Cirsium japonicum*, *Cosmos bipinnatus*, *Helianthus annuus*, *Ligularia przewalskii*, *Ligularia* sp., *Parasenecio roborowskii*, *Picris hieracioides*, *Saussurea gossypiphora*, *S. purpurascens*, *Saussurea* sp., *Stemmacantha uniflora*; BUDDLEJACEAE: *Buddleja officinalis*; CRASSULACEAE: *Sedum* sp.; FABACEAE: *Astragalus* sp., *Lathyrus pratensis*, *Oxytropis kansuensis*, *O. ochrocephala*, *Oxytropis* sp.; GENTIANACEAE: *Gentiana straminea*; LAMIACEAE: *Nepeta prattii*, *Phlomis umbrosa*, *Salvia przewalskii*, *Thymus mongolicus*; MALVACEAE: *Althaea rosea*; ONAGRACEAE: *Epilobium angustifolium*; POLYGONACEAE: *Polygonum macrophyllum*, *P. viviparum*; RANUNCULACEAE: *Anemone rivularis*; ROSACEAE: *Sorbaria arborea*; SCROPHULARIACEAE: *Pedicularis kansuensis*, *P. torta*, *Pedicularis* sp., *Veronica* sp.

39. *Bombus* (*Bombus*) *patagiatus* Nylander *s. l.*
(Fig. 42)

Bombus patagiatus Nylander, 1848:234, type not found (Tkalců, 1967). Russia: 'E Sibiria'.
Bombus terrestris var. *patagiatus* Nylander; Morawitz, 1890:349. China: 'Sse-tschuan', probably Qinghai.
Bombus lucorum var. *lan-tschouensis* Vogt, 1908:101, syntype queen ZMA examined. Regarded as conspecific with *Bombus patagiatus* Nylander by Tkalců (1967). China: Gansu.
Bombus vasilievi Skorikov, 1913:172, type not seen. Regarded as conspecific with *Bombus patagiatus* Nylander by Tkalců (1967). China: Gansu and Heilongjiang.
Bombus lucorum ssp. *beickianus* Bischoff, 1936:2, type not seen. Regarded as conspecific with *Bombus patagiatus* Nylander by Tkalců (1967). China: Gansu.
Bombus lucorum ssp. *pseudosporadicus* Bischoff, 1936:2, type not seen. Regarded as conspecific with *Bombus patagiatus* Nylander by Tkalců (1967). China: Gansu.
Bombus (Bombus) patagiatus ssp. *minshanensis* Bischoff, 1936:3, type not seen. China: Gansu.

Material examined. 2 queens 132 workers 61 males (IAB).

Distribution in Gansu. Abundant at low to high elevations of the eastern loess plateau, Qinghai-Tibetan plateau in the southwest, western mountains and northwestern Qilianshan mountains (Fig. 42); 31 localities between 1193 and 3963 m (IAB).

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

Forage plants. ASTERACEAE: *Carduus crispus*, *Cirsium japonicum*, *C. setosum*, *Ligularia sagitta*, *Ligularia* sp., *Olgaea tangutica*, *Saussurea amara*, *Saussurea* sp., *Stemmacantha uniflora*; BORAGINACEAE: *Symphytum officinale*; CRASSULACEAE: *Sedum* sp.; FABACEAE: *Astragalus adsurgens*, *Hedysarum gmelini*, *Medicago sativa*, *Melilotus albus*, *M. officinalis*; LAMIACEAE: *Dracocephalum heterophyllum*, *Elsholtzia densa*, *E. fruticosa*, *Salvia* sp., *Thymus mongolicus*; ONAGRACEAE: *Epilobium angustifolium*; ROSACEAE: *Potentilla fruticosa*; SCROPHULARIACEAE: *Euphrasia pectinata*.

40. *Bombus* (*Bombus*) *hypocrita* Pérez
(Fig. 43)

BOMBUS IGNITUS var. *HYPOCRITA* Pérez, 1905:30, type not seen. Japan (not Transbaikal).

Material examined. 6 queens 232 workers 200males (IAB).

Distribution in Gansu. Abundant at low to medium elevations of the southeastern mountains and eastern loess plateau (Fig. 43); 32 localities between 1057 and 2872 m (IAB).

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

Forage plants. ASTERACEAE: *Cirsium monocephalum*, *Saussurea amara*, *Saussurea* sp.; BUDDLEJACEAE: *Buddleja officinalis*; CLUSIACEAE: *Hypericum perforatum*; FABACEAE: *Astragalus bhotanensis*, *Lespedeza bicolor*, *Melilotus albus*, *M. officinalis*, *Vicia cracca*; LAMIACEAE: *Caryopteris tangutica*; *Dracocephalum heterophyllum*, *Mentha haplocalyx*, *Phlomis umbrosa*; RANUNCULACEAE: *Aconitum gymnandrum*, *Anemone tomentosa*, *Clematis tangutica*.

Subgenus *ALPIGENOBOMBUS* Skorikov

41. *Bombus* (*Alpigenobombus*) *grahami* (Frison)
(Fig. 44)

Bremus (Alpigenobombus) grahami Frison, 1933:334, holotype queen USNM examined. China: Sichuan.

Material examined. 1 male (IAB).

Distribution in Gansu. Rare at low elevations of the southeastern mountains (Fig. 44); 1 locality 1566 m (IAB).

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

Forage plants. ASTERACEAE: *Cirsium leo*.

42. *Bombus* (*Alpigenobombus*) *kashmirensis* Friese
(Fig. 45)

Bombus mastrucatus var. *kashmirensis* Friese, 1909[September, Tkalců, 1974b]:673, lectotype queen (Tkalců, 1974b:327) MNHU examined. India.

Bombus mastrucatus var. *stramineus* Friese, 1909[September, Tkalců, 1974b]:673, type not found (Tkalců, 1974b:327). Synonymised with *Alpigenobombus kashmirensis* (Friese) by Tkalců (1974b). India.

Bombus tetrachromus Cockerell, 1909 [November, Tkalců, 1974b]:397, holotype queen BMNH examined. Synonymised with *Alpigenobombus kashmirensis* (Friese) by Tkalců (1974b). Pakistan.

Alpigenobombus pulcherrimus Skorikov, 1914:128, type not seen. Synonymised with *Bombus tetrachromus* Cockerell by Richards (1930). Synonymised with *Alpigenobombus kashmirensis* (Friese) by Tkalců (1974b). India.

Alpigenobombus beresovskii Skorikov, 1933a:248, syntype queen ZISP examined. Synonymised with *Bombus kashmirensis* Friese by Williams (1991). China: Sichuan.

Material examined. 3 queens 75 workers 4 males (IAB).

Distribution in Gansu. Common at medium to high elevations of the Qinghai-Tibetan plateau in the southwest and northwestern Qilianshan mountains (Fig. 45); 17 localities between 2272 and 4011 m (IAB).

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

Forage plants. ALLIACEAE: *Allium cyaneum*; ASTERACEAE: *Carduus crispus*, *Cirsium japonicum*, *Cosmos bipinnatus*, *Saussurea stella*, *Saussurea* sp.; CAMPANULACEAE: *Adenophora* sp.; FABACEAE: *Hedysarum gmelini*, *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 gymnandrumm*, *Clematis tangutica*; ROSACEAE: *Rubus* sp.; SCROPHULARIACEAE: *Pedicularis kansuensis*, *P. spicata*, *Pedicularis* sp., *Veronica* sp.; TAMARICACEAE: *Myricaria germanica*.

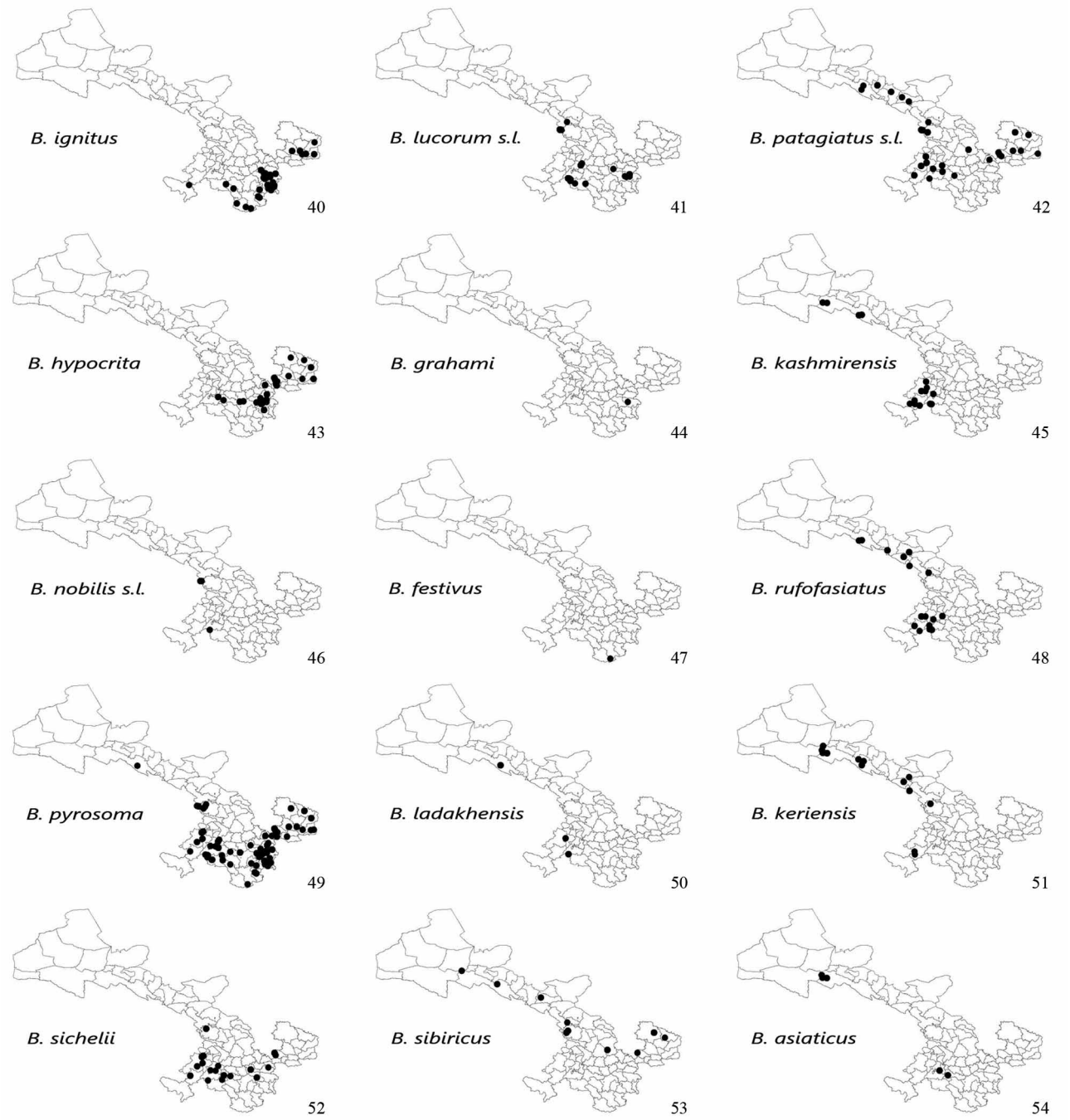

FIGURE 40–54. Maps of Gansu showing the recorded presences of the species as black spots with county boundaries shown in grey.

43. *Bombus* (*Alpigenobombus*) *nobilis* Friese *s. l.*

(Fig. 46)

Bombus validus Friese, 1905:510, syntype queen (Tkalců, 1987:60) MNHU examined. Synonymised provisionally with *Bombus nobilis* Friese by Williams (1998). 'Turkestan Kashgar', believed incorrect.

Bombus nobilis Friese, 1905:513, type not found (Williams *et al.*, 2009). China: Sichuan.

Bombus sikkimi Friese, 1918:82, syntype queen MNHU examined. Synonymised provisionally with *Bombus nobilis* Friese by Williams (1998). [India]

Nobilibombus morawitziides Skorikov, 1933b:62, holotype worker ZISP examined. Synonymised with *Alpigenobombus validus* (Friese) by Tkalců (1987). Synonymised provisionally with *Bombus nobilis* Friese by Williams (1998). China: 'Gansu', probably Qinghai.

Bombus (Nobilibombus) xizangensis Wang, 1979:188, holotype worker IZB examined. Synonymised provisionally with *Bombus nobilis* Friese by Williams (1998). China: Xizang.

Bombus (Nobilibombus) chayaensis Wang, 1979:189, holotype queen IZB examined. Synonymised provisionally with *Bombus nobilis* Friese by Williams (1998). China: Xizang.

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

Material examined. 8 workers 1 male (IAB).

Distribution in Gansu. Common at medium to high elevations of the Qinghai-Tibetan plateau in the southwest and western mountains (Fig. 46); 4 localities between 2196 and 3524 m (IAB).

Distribution in China. Yunnan, Gansu (IAB).

Forage plants. ASTERACEAE: *Carduus crispus*, *Ligularia* sp., *Saussurea* sp.; ONAGRACEAE: *Epilobium angustifolium*.

Subgenus *MELANOBOMBUS* Dalla Torre

44. *Bombus* (*Melanobombus*) *festivus* Smith

(Fig. 47)

Bombus festivus Smith, 1861:152, lectotype queen (Tkalců, 1974b:342) BMNH examined. India.

BOMBUS ATROCINCTUS Smith, 1870:193, holotype male BMNH examined. Synonymised with *Bombus festivus* Smith by Richards (1968). India.

BOMBUS TERMINALIS Smith, 1870:193, lectotype worker (Williams *et al.*, 2009) BMNH examined. Synonymised with *Bombus atrocinctus* Smith by Richards (1930). Synonymised with *Pyrobombus festivus* (Smith) by Tkalců (1974b). India.

Bombus (Alpigenobombus) handel-mazettii Pittioni, 1939:260, lectotype male (Tkalců, 1974b:342) BMNH examined. Synonymised with *Pyrobombus festivus* (Smith) by Tkalců (1974b). China: Yunnan.

Material examined. 1 worker (IAB).

Distribution in Gansu. Rare at low elevations of the southern mountains (Fig. 47); 1 locality 719 m (IAB).

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

Forage plants. LAMIACEAE: *Vitex negundo*.

45. *Bombus* (*Melanobombus*) *rufofasciatus* Smith

(Fig. 48)

Bombus rufo-fasciatus Smith, 1852b:48, lectotype queen (Tkalců, 1974b:340) BMNH examined. India.

Bombus Prshewalskyi Morawitz, 1880:342, type not seen. Regarded as conspecific with *Bombus rufofasciatus* Smith by Richards (1930). China: 'Gan-su', probably Qinghai.

Bombus rufocinctus Morawitz, 1880:343 (not of Cresson, 1863:106 = *B. rufocinctus* Cresson), syntype queen ZISP examined. Synonymised with *Bombus rufofasciatus* Smith by Handlirsch (1888). China: 'Gan-su', probably Qinghai.

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)). Synonymised with *Bombus rufofasciatus* Smith by Richards (1930).

Material examined. 2 queens 224 workers 34 males (IAB).

Distribution in Gansu. Abundant at medium to high elevations of the Qinghai-Tibetan plateau in the southwest and northwestern Qilianshan mountains (Fig. 48); 21 localities between 2148 and 4011 m (IAB).

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

Forage plants. ALLIACEAE: *Allium cyaneum*; ASTERACEAE: *Carduus crispus*, *Cirsium japonicum*, *Ligularia przewalskii*, *Olgaea tangutica*, *Saussurea gossypiphora*, *S. purpurascens*, *Saussurea* sp., *Taraxacum mongolicum*; CRASSULACEAE: *Sedum* sp.; FABACEAE: *Hedysarum gmelini*, *Oxytropis* sp.; GENTIANACEAE: *Gentiana aristata*, *G. straminea*, *Halenia elliptica*; GERANIACEAE: *Geranium pratense*; LAMIACEAE: *Dracocephalum heterophyllum*, *Salvia przewalskii*, *Salvia* sp., *Thymus mongolicus*; POLYGONACEAE: *Polygonum macrophyllum*, *P. viviparum*; RANUNCULACEAE: *Aconitum gymnandrum*, *Clematis tangutica*, *Delphinium grandiflorum*; ROSACEAE: *Potentilla fruticosa*; SCROPHULARIACEAE: *Euphrasia pectinata*, *Pedicularis kansuensis*, *P. torta*, *P. spicata*, *Pedicularis* sp., *Veronica* sp.

46. *Bombus* (*Melanobombus*) *pyrosoma* Morawitz
(Fig. 49)

Bombus pyrosoma Morawitz, 1890:349, syntype queen ZISP examined. China: 'Kan-ssu', probably Qinghai.
Bombus pyrrhosoma Dalla Torre, 1896:544, unjustified emendation.
Bombus rufus Friese, 1905:511 (not of Villers, 1789:328 = *B. pascuorum*), type not seen. Synonymised with *Bombus pyrrhosoma* Morawitz [sic] by Skorikov ([1923]). China: Sichuan.
Pyrobombus (Lapidariobombus) wutaishanensis Tkalců, 1968:39, holotype queen MNHU examined. Synonymised with *Bombus pyrosoma* Morawitz by Williams (1991). China: Shanxi.

Material examined. 5 queens 1495 workers 150 males (IAB).

Distribution in Gansu. Abundant at low to medium elevations of the southeastern mountains and eastern loess plateau, common at medium elevations of the western mountains and Qinghai-Tibetan plateau in the southwest, rare at low elevations of the southern mountains and high elevations of the northwestern Qilianshan mountains (Fig. 49); 76 localities between 719 and 4011 m (IAB).

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

Forage plants. ALLIACEAE: *Allium chrysanthum*, ASTERACEAE: *Anaphalis margaritacea*, *Arctium lappa*, *Aster tataricus*, *Carduus crispus*, *Cirsium leo*, *C. monocephalum*, *C. setosum*, *Cosmos bipinnatus*, *Dahlia pinnata*, *Helianthus annuus*, *Leontopodium longifolium*, *Ligularia przewalskii*, *Ligularia* sp., *Saussurea japonica*, *S. stella*, *Saussurea* sp., *Senecio jacobaea*, *Sinacalia tangutica*, *Stemmacantha uniflora*, *Tagetes patula*; BUDDLEJACEAE: *Buddleja officinalis*; CAMPANULACEAE: *Adenophora* sp.; CLUSIACEAE: *Hypericum ascyron*, *H. perforatum*; CONVOLVULACEAE: *Calystegia hederacea*, *Pharbitis nil*; CUCURBITACEAE: *Thladiantha dubia*; FABACEAE: *Astragalus bhotanensis*, *A. dahuricus*, *Astragalus* sp., *Lathyrus pratensis*, *Lespedeza bicolor*, *L. floribunda*, *Melilotus albus*, *M. officinalis*, *Oxytropis ochrocephala*, *Trifolium repens*, *Vicia cracca*, *V. unijuga*; GENTIANACEAE: *Halenia elliptica*; GERANIACEAE: *Geranium pratense*; HYDRANGEACEAE: *Hydrangea macrophylla*; LAMIACEAE: *Caryopteris divaricata*, *C. incana*, *C. tangutica*, *Dracocephalum heterophyllum*, *Lamium album*, *L. barbatum*, *Leonurus Artemisia*, *Mentha haplocalyx*, *Nepeta prattii*, *Phlomis umbrosa*, *Phlomis* sp., *Salvia przewalskii*, *S. roborowskii*, *Salvia* sp., *Thymus mongolicus*, *Vitex negundo*; LILIACEAE: *Lilium brownii*; MALVACEAE: *Althaea rosea*; ONAGRACEAE: *Epilobium angustifolium*; PAPAVERACEAE: *Corydalis* sp.; RANUNCULACEAE: *Aconitum gymnandrum*, *Aconitum* sp., *Anemone tomentosa*, *Clematis tangutica*; SCROPHULARIACEAE: *Pedicularis spicata*, *P. torta*, *Pedicularis* sp.; THYMELAEACEAE: *Wikstroemia chamaedaphne*.

47. *Bombus* (*Melanobombus*) *ladakhensis* Richards
(Fig. 50)

Bombus (Lapidariobombus) rufofasciatus var. *ladakhensis* Richards, 1928:336, not infrasubspecific after Tkalců, 1974b:335, holotype queen BMNH examined. India.
Bombus (Lapidariobombus) rufofasciatus var. *phariensis* Richards, 1930:642, not infrasubspecific after Tkalců, 1974b:336, holotype queen BMNH examined. Regarded as conspecific with *Pyrobombus ladakhensis* (Richards) by Tkalců (1974b). China: Xizang.
Bombus variopictus Skorikov, 1933a:248, syntype queen ZISP examined. Regarded as conspecific with *Pyrobombus ladakhensis* (Richards) by Tkalců (1974b). China: Qinghai.
Bombus (Pratobombus) reticulatus Bischoff, 1936:7, paralectotype workers (Tkalců, 1974b:336) MNHU examined. Regarded as conspecific with *Pyrobombus ladakhensis* (Richards) by Tkalců (1974b). China: Gansu.

Material examined. 22 workers (IAB).

Distribution in Gansu. Common at medium to high elevations of the Qinghai-Tibetan plateau in the southwest and northwestern Qilianshan mountains (Fig. 50); 4 localities between 2524 and 4011 m (IAB).

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

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

48. *Bombus* (*Melanobombus*) *keriensis* Morawitz
(Fig. 51)

Bombus keriensis Morawitz, 1887:199, syntype queen ZISP examined. China: Xinjiang.
Bombus separandus Vogt, 1909:61, lectotype queen (Williams, 1991:96) ZMA examined. Regarded as conspecific with *Bombus keriensis* Morawitz by Reinig (1935). China: Xinjiang.
Bombus kohli Vogt, 1909:61 (not of Cockerell, 1906:75 = *B. morio* (Swederus)), 3 syntype workers ZMA examined. Synonymised with *Bombus keriensis* Morawitz by Williams (1991). Mongolia.
Bombus kozlovi Skorikov, 1910b:413, replacement name for *kohli* Vogt, 1909:61.
Bombus lapidarius var. *tenellus* Friese, 1913:86, type not seen. Synonymised provisionally with *Bombus keriensis* Morawitz by Williams (1991). Russia: Zapadnyy Sayan.
Bombus (Lapidariobombus) keriensis f. *richardsi* Reinig, 1935:341 (not of Frison, 1930:6 = *B. rufipes* Lepeletier), holotype queen ZMA examined. Pakistan.
Bombus (Melanobombus) tenellus ssp. *tibetensis* Wang, 1982:439, replacement name for *richardsi* Reinig, 1935:341.
Bombus (Melanobombus) trilineatus Wang, 1982:441, holotype queen IZB examined. Synonymised with *Bombus keriensis* Morawitz by Williams (1998). China: Xizang.

Material examined. 12 queens 109 workers 3 males (IAB).

Distribution in Gansu. Abundant at medium to high elevations of the northwestern Qilianshan mountains, rare at medium to high elevations of western mountains and Qinghai-Tibetan plateau in the southwest (Fig. 51); 13 localities between 2148 and 3656 m (IAB).

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

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

49. *Bombus* (*Melanobombus*) *sichelii* Radoszkowski
(Fig. 52)

BOMBUS SICHELII Radoszkowski, 1860:481, lectotype queen (Tkalců, 1974a:34) MNHU examined. Russia: Kamchatskaya Oblast'.
Bombus sicheli f. *uniens* Vogt, 1909:62, 26 queen 94 worker syntypes ZMA examined. 'Zentralasien', probably Mongolia.
Bombus sicheli ssp. *chinganicus* Reinig, 1936:6 (not of Reinig, 1936:8 = *B. bohemicus* Seidl), type not seen. China: Neimenggu.

Material examined. 107 workers 10 males (IAB).

Distribution in Gansu. Common at low to high elevations of the eastern loess plateau and Qinghai-Tibetan plateau in the southwest; rare at low to medium elevations of the southeastern and western mountains (Fig. 52); 18 localities between 1506 and 3454 m (IAB).

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

Forage plants. FABACEAE: *Melilotus officinalis*, *Vicia unijuga*; GENTIANACEAE: *Halenia elliptica*; LAMIACEAE: *Caryopteris incana*, *C. tangutica*, *Dracocephalum heterophyllum*, *Salvia przewalskii*, *Salvia* sp.; RANUNCULACEAE: *Cosmos bipinnatus*, *Saussurea* sp.; SCROPHULARIACEAE: *Euphrasia pectinata*, *Pedicularis torta*, *Pedicularis* sp.

Subgenus *SIBIRICOBOMBUS* Vogt

50. *Bombus* (*Sibiricobombus*) *sibiricus* (Fabricius)
(Fig. 53)

Apis ſibirica [*sibirica*] Fabricius, 1781:478, type not seen. Russia: 'Sibiria'.

Material examined. 1 queen 67 workers 11 males (IAB).

Distribution in Gansu. Common at low to medium elevations of the eastern loess plateau, western mountains, rare at medium elevations of the northwestern Qilianshan mountains (Fig. 53); 10 localities between 1161 and 2604 m (IAB).

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

Forage plants. ASTERACEAE: *Carduus crispus*, *Cirsium setosum*, *Cosmos bipinnatus*, *Olgaea tangutica*; FABACEAE: *Astragalus adsurgens*, *Hedysarum tanguticum*; LAMIACEAE: *Leonurus Artemisia*.

51. *Bombus* (*Sibiricobombus*) *asiaticus* Morawitz

(Fig. 54)

Bombus hortorum var. asiatica Morawitz in Fedtschenko, 1875:4, lectotype worker (Williams, 1991:87) ZMMU examined. ?Tajikistan.

Bombus longiceps Smith, 1878:8, type not seen. Synonymised with *Bombus asiaticus* Morawitz by Reinig (1940). India.

Bombus Regeli Morawitz, 1880:337, syntype queen ZISP examined. Synonymised with *Sibiricobombus asiaticus* (Morawitz) by Skorikov (1923). China: Xinjiang.

Bombus (Sibiricobombus) regeli miniatocaudatus Vogt, 1911:61, holotype male ZMA examined (not of Vogt, 1909:56 = *B. soroeensis* (Fabricius)). Synonymised with *Bombus asiaticus* Morawitz by Reinig (1940). Mongolia.

Sibiricobombus flavodorsalis Skorikov, 1933a:248, type not seen. Synonymised with *Pyrobombus longiceps* (Smith) by Tkalcu (1969). India.

Sibiricobombus oshanini Skorikov, 1933a:248, type not seen. Synonymised with *Pyrobombus longiceps* (Smith) by Tkalcu (1969). India.

Bombus (Sibiricobombus) heicens Wang, 1982:430, holotype queen IZB examined. Synonymsed with *Bombus (Sibiricobombus) asiaticus* Morawitz by Williams (1998). China: Xizang.

Bombus (Sibiricobombus) huangcens Wang, 1982:430, holotype queen IZB examined. Synonymsed with *Bombus (Sibiricobombus) asiaticus* Morawitz by Williams (1998). China: Xizang.

Bombus (Sibiricobombus) flavicollis Wang, 1985:163, holotype queen IZB examined. Synonymsed with *Bombus (Sibiricobombus) asiaticus* Morawitz by Williams (1998). China: Xinjiang.

Bombus (Sibiricobombus) asiaticus baichengensis Wang, 1985:164, holotype queen IZB examined. Synonymsed with *Bombus (Sibiricobombus) asiaticus* Morawitz by Williams (1998). China: Xinjiang.

Material examined. 19 workers (IAB).

Distribution in Gansu. Common at medium to high elevations of the Qinghai-Tibetan plateau in the southwest and northwestern Qilianshan mountains (Fig. 54); 5 localities between 2326 and 3656 m (IAB).

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

Forage plants. ASTERACEAE: *Cosmos bipinnatus*, *Saussurea* sp.; FABACEAE: *Astragalus bhotanensis*, *Hedysarum tanguticum*; ROSACEAE: *Rubus* sp.

Discussion

Results of regional surveys such as this always need to be interpreted with care. Non-random sampling may have biassed the results for the maps, diversity figures, and abundance comparisons. Large areas of Gansu are desert, where access and working conditions are difficult. No bumblebees have been found there, but sampling effort has not been as high there either. For example, we visited the Minqin natural reserve in the northern desert without finding any bumblebees. Other planned sites at Dunhuangxihu and Anxi in the northwestern desert were not visited because they are difficult to access and because there was insufficient time.

Nonetheless, this is the first systematic survey of the bumblebee fauna that covers most counties of Gansu. It has added nearly a fifth (19.6%) of the 51 species to the current list for the province (Bischoff, 1936; Panfilov, 1957; Wang, 1982, 1985; Yao & Luo, 1997; Wang & Yao, 2004; Yao & Wang, 2005; Jiang, 2007; An *et al.*, 2008; Williams *et al.*, 2009; Wu *et al.*, 2009). The 10 species new to the Gansu list are: *B. asiaticus*, *B. bicoloratus*, *B. chinensis*, *B. coreanus*, *B. deuteronymus*, *B. expolitus*, *B. festivus*, *B. grahami*, *B. hypocrita*, and *B. opulentus*.

Older specimens of *B. skovikori* and *B. tibetanus* held in London add two more species to the Gansu list. These two species have also been collected in neighbouring provinces very close to Gansu in the past four years. *B. sko-*

vikori has been found in the Qilianshan mountains (Qinghai), Ruoergai plateau (Sichuan), and Guyuan (Ningxia). *B. tibetanus* has also been found in the Qilianshan mountains (Qinghai).

Another two species (*B. imitator* and *B. friseanus*) are likely to occur in Gansu because they have been reported in recent faunal reviews of neighbouring provinces (Yao & Wang, 2005; Williams *et al.*, 2009). In the last four years, *B. imitator* has been found in Daxueshan (Sichuan) and *B. friseanus* has been found in Meigu (Sichuan), which are close to Gansu. However, no specimens from Gansu are present in the IAB collection.

Gansu is part of the greatest hotspot of regional bumblebee diversity worldwide, with 44% of China's species and 20% of the world's total species. This total is greater than 1.8 times that of Neimenggu (Inner Mongolia) which has more than 2.5 times the area extent of Gansu (unpublished data of IAB); it is also greater than the bumblebee diversity of France (Rasmont, 1983), which has a larger area; and double the bumblebee diversity of California (Thorp, *et al.*, 1983), with approximately the same area. However, none of the bumblebee species is endemic to Gansu, and all of these species are broadly distributed outside the region. Gansu is richer than a comparable area of France, but at a local scale, there is no single locality within Gansu that is known to be as rich as Eyne in France (Iserbyt, *et al.*, 2009).

We can compare the composition of the bumblebee fauna of Gansu with that of the faunas in the mountains to the south (SCR, Sichuan + Chongqing region) and to the north (SHBTR, Shanxi + Heibei + Beijing + Tianjin region) using recent reviews of these faunas (Tables 3, 4). The results show that Gansu (51 species) and SCR (56 species) share 64.6% of the same species, Gansu and SHBTR (36 species) share 38.1%, and SCR and SHBTR share 22.7%. The main regional components of Gansu bumblebees are compared in Table 3, with those to the south in Sichuan-Chongqing, and with those to the north in Shanxi-Hebei-Beijing-Tianjin. Therefore although the Gansu fauna is transitional, it is more similar in composition to the southern Sichuan-Chongqing fauna, because of their shared rich high-mountain faunas.

Species geographic and elevational distribution within Gansu. Except in the desert areas of the north and the northwest, bumblebees have been found to be distributed widely within Gansu, from the wet southern forests to the dry northwestern desert-edge scrub. The 5943 specimens have been collected from 125 sites in six of the eight environmental regions where bumblebees have been recorded during the past four years, which cover the major part of the province (Fig. 3). Specimens are recorded here from sites at elevations between 719–4011 m, from the low southern Baishuijiang river valley to the high Qinghai-Tibetan plateau in the southwest and the northwestern Qilianshan mountains. Their true elevational distribution range is likely to be greater because the highest mountains within the province, the Aerjinshan (Altyn mountains), located in the northwestern desert, have yet to be visited.

Unsurprisingly, distribution patterns differ among Gansu bumblebee species (Fig. 4–54). Some oriental species, such as *B. bicoloratus*, *B. festivus* and *B. grahami*, that are more common in Southern China, have now been found in Gansu. These three species, just like the oriental species *B. flavescens* and *B. trifasciatus*, are found only in the wet southeastern or southern mountains of the province, and this is the northern edge of their distribution in China. Some species, such as *B. convexus*, *B. waltoni*, *B. personatus*, *B. difficillimus*, *B. supremus*, *B. impetuosus*, *B. lemniscatus*, *B. wangae*, *B. kashmirensis*, *B. nobilis*, *B. rufofasciatus*, *B. ladakhensis*, *B. keriensis*, and *B. asiaticus*, are found only on the Qinghai-Tibetan plateau in the southwest and/or the associated northwestern Qilianshan mountains. Some species, such as *B. sibiricus* and *B. melanurus*, predominate on the edge of the desert. Other species, such as *B. laesus*, *B. filchnerae*, *B. opulentus*, *B. humilis*, *B. hedini*, *B. lepidus*, *B. picipes*, *B. ignitus*, *B. lucorum*, *B. patagiatus*, *B. hypocrita*, *B. pyrosoma*, and *B. sichelii*, are more broadly distributed among environmental regions in Gansu. The largest number of bumblebee individuals is recorded at elevations between 1000–1999 m, while the largest number of species is recorded at elevation between 2000–3999 m (Table 2).

TABLE 2. Distribution of numbers of individuals and species by elevation zone within Gansu from specimen records with elevation data.

	Elevation (m)				
	≤999	1,000–1,999	2,000–2,999	3,000–3,999	≥4,000
Individuals	109	3690	1484	589	70
Species	5	28	35	31	5

Species richness within Gansu. Although bumblebees are found broadly within Gansu, the richness of bumblebee species differs strongly among the sites (Fig. 3). No bumblebees were found in the desert areas of the north and the northwest, whereas the species number per site often exceeded 10 in the southeastern mountains, western mountains and Qinghai-Tibetan plateau in the southwest. Differences were found among the main natural reserve / forest park / scenic spots in the different environmental regions. For example, only 5 species were recorded in the Baishuijiang natural reserve in the southern river valley with a subtropical climate. In contrast, 20 species were recorded in the Maijishan scenic spots in the southeastern mountains with a temperate humid climate; 18 species in the Zhagana forest park, 10 species in the Gahai natural reserve, and 19 species in the Lianhuashan natural reserve in the Qinghai-Tibetan plateau in the southwest with a high elevation humid cold climate; 6 species in the Ziwuling natural reserve, and 11 species in the Kongdongshan scenic spots in the eastern loess plateau with a temperate subhumid to semi-arid climate; 14 species in the Liancheng natural reserve in the western Wuqiaoling mountains and 16 species in the Qilianshan natural reserve in the northwestern mountains with a cold semi-arid climate. Therefore the highest species richness and abundance for bumblebees within Gansu is in the southeastern mountains (the West Qinling mountains, a transition zone between the temperate loess plateau and the subtropical southern mountains) and on the southwestern edge of the Qinghai-Tibetan plateau (a transition zone between the temperate loess plateau and the high level cold Qinghai-Tibetan plateau).

TABLE 3. Geographical area and number of bumblebee taxa for the Gansu region, Sichuan-Chongqing region and the Shanxi-Hebei-Beijing-Tianjin region, with the simplified subgeneric classification of Williams *et al.* (2008). O, Oriental; P, Palaearctic; W, Widespread.

	Area in km^2	Number of species	Number of subgenera	Regional components	Source
Gansu	454,000	51	10	O 45.1%; W 54.9%; P 0%	This study
Sichuan + Chongqing	567,000	56	10	O 62.5%; W 37.5%; P 0%	Williams *et al.* (2009)
Shanxi + Hebei + Beijing + Tianjin	373,000	36	8	O 8.3%; W 83.3%; P 8.3%	An *et al.* (2008, 2010)

Species abundances within Gansu. The abundances of the bumblebee species within Gansu also differ (Fig. 55). Species including *B. pyrosoma*, *B. ignitus*, *B. hypocrita*, *B. picipes*, *B. hedini*, *B. rufofasciatus*, *B. remotus*, *B. patagiatus*, *B. melanurus*, *B. lucorum*, *B. lepidus*, *B. longipes*, and *B. keriensis* are abundant in Gansu. *B. pyrosoma* is especially abundant in the east on the loess plateau, on the Qinghai-Tibetan plateau in the southwest, and in the southeastern and western mountains. *B. rufofasciatus* is abundant on the Qinghai-Tibetan plateau in the southwest and in the northwestern Qilianshan mountains. At the opposite extreme, some species are rare in Gansu. For example, our results are similar to those from a survey of North China (An, *et al.*, 2008, 2010) in that species of the subgenus *Psithyrus* are generally rare in Gansu. Also rare are many of the southern species (*B. flavescens*, *B. grahami*, *B. bicoloratus*, *B. festivus*) and some Qinghai-Tibetan species (*B. difficillimus*). The remaining species are categorised as common in Gansu.

Forage plants within Gansu. A total of 144 forage-plant species belonging to 29 plant families have been recorded for Gansu bumblebees between June and September of 1997–2010. Among the 29 families, Asteraceae (35), Lamiaceae (21), Fabaceae (20), Scrophulariaceae (8) and Ranunculaceae (8) are the 5 main families based on the total numbers of plant species with recorded bumblebee visits, while the Brassicaceae, Buddlejaceae, Crassulaceae, Hydrangeaceae, Liliaceae, Nyctaginaceae, Oleaceae and Tamaricaceae have just one food-plant species recorded (the other families have 2–5 food-plant species recorded).

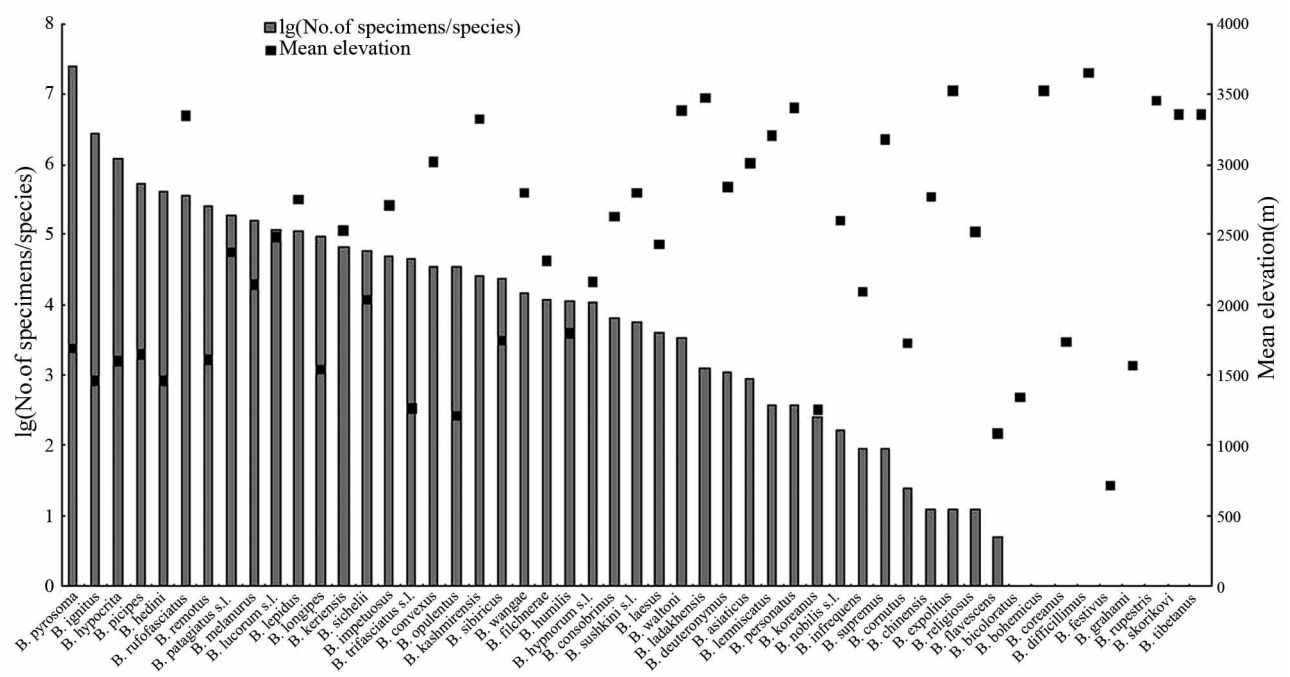

FIGURE 55. Graph showing log-transformed relative abundance (grey bars) and mean elevation (black squares) of each species, the species ranked by their relative abundance in the samples.

TABLE 4. Species list and their world distribution of bumblebees from Gansu and SCR (Sichuan-Chongqing region) and SHBTR (Shanxi-Hebei-Beijing-Tianjin region). *Md.*: *Mendacibombus*; *Or.*: *Orientalibombus*; *St.*: *Subterraneobombus*; *Mg.*: *Megabombus*; *Th.*: *Thoracobombus*; *Ps.*: *Psithyrus*; *Pr.*: *Pyrobombus*; *Bo.*: *Bombus*; *Ag.*: *Alpigenobombus*; *Ml.*: *Melanobombus*; *Sb.*: *Sibiricobombus*. O, Oriental; P, Palaearctic; W, Widespread.

Species	Gansu (this study)	SHBTR (An *et al*, 2008, 2010)	SCR (Williams *et al*, 2009)	World distribution
B.(Md.) convexus	●		●	O
B.(Md.) waltoni	●		●	O
B.(Or.) braccatus			●	O
B.(Or.) funerarius			●	O
B.(St.) amurensis		●		W
B.(St.) personatus	●		●	O
B.(St.) difficillimus	●		●	W
B.(St.) melanurus	●	●		W
B.(Mg.) longipes	●	●	●	W
B.(Mg.) trifasciatus	●		●	O
B.(Mg.) bicoloratus	▲		●	O
B.(Mg.) supremus	●		●	O
B.(Mg.) religiosus	●		●	O
B.(Mg.) sushkini	●		●	O
B.(Mg.) securus			●	O
B.(Mg.) czerskii		●		W
B.(Mg.) przewalskiellus		●		P
B.(Mg.) ussurensis		●		W
B.(Mg.) koreanus	●	●		W

continued next page

TABLE 4. (continued)

Species	Gansu (this study)	SHBTR (An *et al*, 2008, 2010)	SCR (Williams *et al*, 2009)	World distribution
B.(Mg.) consobrinus	●	●		W
B.(Th.) atripes			●	O
B.(Th.) laesus	●	●	●	W
B.(Th.) filchnerae	●	●	●	W
B.(Th.) opulentus	▲	●		W
B.(Th.) deuteronymus	▲	●		W
B.(Th.) humilis	●	●	●	W
B.(Th.) hedini	●	●	●	W
B.(Th.) remotus	●	●	●	O
B.(Th.) impetuosus	●		●	O
B.(Th.) imitator			●	O
B.(Th.) schrencki		●		W
B.(Th.) tricornis		●		W
B.(Th.) muscorum		●		P
B. (Ps.) tibetanus	●		●	O
B. (Ps.) cornutus	●	●	●	O
B. (Ps.) expolitus	▲		●	O
B. (Ps.) chinensis	▲		●	O
B. (Ps.) rupestris	●		●	W
B. (Ps.) bohemicus	●	●	●	W
B. (Ps.) coreanus	▲	●		W
B. (Ps.) skorikovi	●		●	O
B. (Ps.) turneri			●	O
B. (Ps.) branickii			●	W
B. (Ps.) bellardii			●	O
B. (Ps.) norvegicus		●	●	W
B. (Ps.) sylvestris		●		W
B. (Ps.) barbutellus		●		P
B.(Pr.) hypnorum	●	●	●	W
B.(Pr.) lemniscatus	●		●	O
B.(Pr.) lepidus	●		●	O
B.(Pr.) picipes	●	●	●	W
B.(Pr.) infrequens	●		●	O
B.(Pr.) flavescens	●	●	●	O
B.(Pr.) wangae	●		●	O
B.(Pr.) avanus			●	O
B.(Pr.) infirmus			●	O
B.(Pr.) modestus		●		W
B.(Bo.) ignitus	●	●	●	W
B.(Bo.) lucorum	●	●	●	W
B.(Bo.) hypocrita	▲	●		W

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TABLE 4. (continued)

Species	Gansu (this study)	SHBTR (An *et al*, 2008, 2010)	SCR (Williams *et al*, 2009)	World distribution
B.(Bo.) patagiatus	●	●	●	W
B.(Bo.) sporadicus		●		W
B.(Ag.) breviceps			●	O
B.(Ag.) grahami	▲		●	O
B.(Ag.) kashmirensis	●		●	W
B.(Ag.) nobilis	●		●	O
B.(Ml.) eximius			●	O
B.(Ml.) festivus	▲		●	O
B.(Ml.) rufofasciatus	●		●	W
B.(Ml.) pyrosoma	●	●	●	W
B.(Ml.) friseanus			●	O
B.(Ml.) ladakhensis	●		●	W
B.(Ml.) keriensis	●		●	W
B.(Ml.) sichelii	●	●	●	W
B.(Sb.) sibiricus	●	●		W
B.(Sb.) asiaticus	▲			W

▲: New record for Gansu.

FIGURE 56. *Bombus* (*Sibiricobombus*) *sibiricus* visiting an introduced *Cosmos bipinnatus* (Asteraceae) in Gansu, China.

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