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THE BUMBLEBEES OF THE NEPAL HIMALAYA (HYMENOPTERA: APIDAE)

By PAUL H. WILLIAMS, MASAO ITO, TAKESHI MATSUMURA, and IWAO KUDO

Abstract

WILLIAMS, P. H., ITO, M., MATSUMURA, T. and KUDO, I., 2010. The bumblebees of the Nepal Himalaya (Hymenoptera: Apidae). *Ins. matsum. n. s.* 66: 115–151, 36 figs, 3 tabs.

Among 2,762 specimens of bumblebees (genus *Bombus*) from Nepal, a total of 34 species is recorded. *Bombus abnormis*, *B. branickii*, *B. grahami*, *B. personatus*, and *B. pressus* are recorded from Nepal for the first time. None of the species is endemic. A key to females, colour-pattern diagrams for females, and distribution maps are provided. Bumblebees in Nepal tend to have colour patterns of the thoracic dorsum that are black at low elevations, unbanded pale at mid elevations, and banded at high elevations, with the pale parts tending to become lighter at higher elevations. A western, an eastern, and a larger widespread fauna are described.

Key words. Bumblebee, *Bombus*, taxonomy, distribution, elevation, altitude, pollinators, Nepal.

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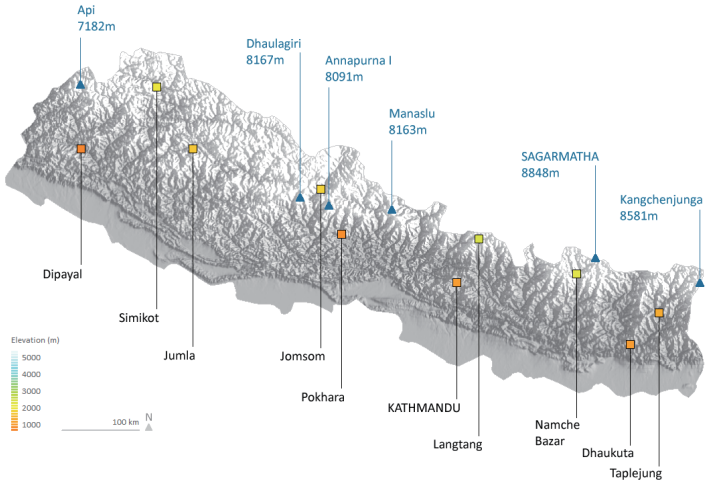
Introduction

Bumblebees are abundant and important pollinators in the Himalaya for both crops and natural ecosystems. The problem is that there has been a serious taxonomic impediment to recognising which species occur where. A major part of this is that the different species often mimic one another closely in colour pattern (Tkalců, 1968b; 1989; Williams, 2007), confounding the many attempts to identify species simply by colour pattern alone.

Previous reviews focusing on the bumblebee fauna of Nepal have been based on smaller collections (Tkalců 1974; Burger et al. 2009). Other faunal reviews with substantial overlap with Nepal include those by Skorikov (1933), Williams (1991; 2004), and Williams et al. (2009). Unfortunately, Tkalců's synoptic *Monographie der Unterfamilie Bombinae des Himalaya* (referred to in Tkalců, 1974: 348) has never been



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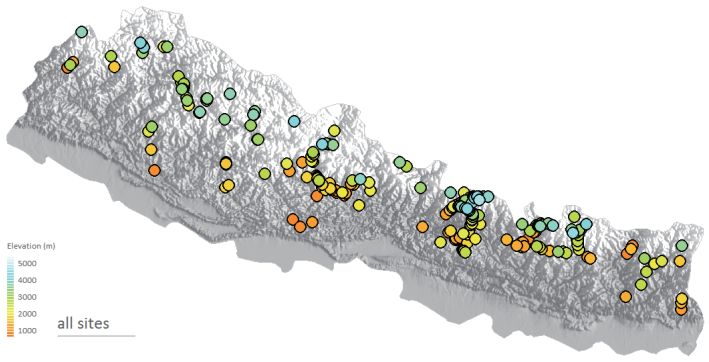

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Figs 1–2. 1: Relief map of Nepal showing a selection of landmark higher mountains (in blue, with elevations) and towns (colour-coded for elevation, scale shown to the left). From SRTM data (see text) with the projection from GCS_WGS_1984, elevation shown on a grey scale, but with added hill shading as though illuminated from the east. 2: Relief map of Nepal showing the 350 locatable sample sites with bumblebee records as spots colour-coded for their elevation (scale bar shown to the left). The grey scale-bar line represents 100 km.

published. Most of the material reported from the early Everest Expeditions by Richards (1930) actually comes from Tibet, Sikkim, or Kashmir.

Nepal spans the transition zone between the drier western Himalayan region and the wetter eastern Himalayan region, which differ in their vegetation (Schweinfurth, 1957) and in their bumblebee faunas (Williams, 1991). This provides opportunities to differentiate habitat associations among the Oriental bumblebee fauna. Nepal is situated next to the high Tibetan plateau and consequently has a relatively large area at high elevations (Fig. 1). But being at the edge, it also has a complex topology, so sites at a broad range of elevations are located in close horizontal proximity to one another across much of the country. This makes Nepal ideal for studying species' distribution patterns in relation to latitude, longitude, and elevation.

This contribution addresses the taxonomic impediment by revising the bumblebee fauna of Nepal and providing a key to females. It summarises available information on the geographical and elevational distribution of species from the largest sample available so far.

Material examined

In this review, 2,762 specimens from 459 samples (447 locatable at 350 sites, Fig. 2)

Table 1. Collections from which material has been examined.

Abbreviation	Address
BMNH	Natural History Museum, London, UK
BT	Borek Tkalců, Prague, Czech Republic
IZB	Institute of Zoology, Chinese Academy of Sciences, Beijing, China
LSL	Linnean Society, London, UK
MCSN	Museo Civico di Storia Naturale, Genova, Italy
MNHU	Museum für Naturkunde an der Humboldt-Universität, Berlin, Germany
NME	Naturkundemuseum Erfurt, Erfurt, Germany
NMS	Naturmuseum Senckenberg, Frankfurt am Main, Germany
PHW	Paul Williams, London, UK
SEHU	Systematic Entomology, Faculty of Agriculture, Hokkaido University & Hokkaido University Museum, Sapporo, Japan
SMNS	Staatliches Museum für Naturkunde, Stuttgart, Germany
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
ZMMU	Zoological Museum of the Moscow State University, Moscow, Russia
ZSM	Zoologische Staatssammlung, München, Germany

in seven collections (Table 1) have been examined and databased, using Microsoft Access version 2003. The full Access specimen database can be downloaded (www.nhm.ac.uk/bombus/downloads/nepal_review.mdb) and queried directly for maximum flexibility.

Species

Diagnosis of bumblebees (Bombini), terminology for morphology, and criteria for recognising species follow Williams et al. (2009).

Our interpretation of the material examined recognizes a list of 34 species for Nepal (listed below), which includes five species new to the national list: *B. abnormis*, *B. branickii*, *B. grahami*, *B. personatus*, and *B. pressus*. This brings the total to more species than have been recorded for the much more intensively studied faunas of Japan (Sakagami and Ishikawa, 1969), Britain (Benton, 2006), or California (Thorp et al., 1983), which are all substantially larger in area.

Three additional species (*B. keriensis*, *B. sibiricus*, and *B. tanguticus*) are likely to occur in Nepal because they have been found within 4 km of the border, just inside Tibet (= China: Xizang), from a camp on the West Rongbuk Glacier (BMNH). This area shares with Nepal the highest mountain in the world, Sagarmatha (known as Qomolangma to the Chinese, or formerly as Mount Everest to the British), and these are currently the highest known records for bumblebees from anywhere in the world. At least another five species may also occur in Nepal, but so far have not been recorded (genuinely) from there: *B. bohemicus*, *B. difficillimus*, *B. genalis*, *B. oberti*, and *B. simillimus*. Again, *B. difficillimus* and *B. oberti* are expected to occur on or near the edge of the high Tibetan plateau border zone. In the accounts of species distributions here, countries or provinces where species are as yet unrecorded but where they can reasonably be expected to occur as interpolations of the observed range where suitable habitat is known to occur are shown in brackets and with question marks.

The list of synonyms for each species is not exhaustive, but covers only the valid name of the species, any names used recently or prominently in the literature for these species, and especially any references from papers on the Nepalese fauna.

Species accounts are presented in an order that represents their evolutionary relationships. More reliable estimates of bumblebee phylogeny from DNA data have been published recently by Kawakita et al. (2004) and by Cameron et al. (2007). The order of the species is derived from these estimates using the ordering convention of Nelson (1972). We use the simplified subgeneric system of Williams et al. (2008), which is also based on these estimates.

Mapping

In order to convey differences in the elevations inhabited by the different species, the species' distribution maps here are colour coded for the elevation of each sample-site record (Fig. 2). Background maps were drawn with ESRI ArcMap version 9.3 using data from the SRTM 90 m Digital Elevation Model version 4 (srtm.csi.cgiar.org). Individual species' distribution maps were then drawn with a program written in C by PW. Each of these maps includes grey spots to show all sites with bumblebee records. The coloured spots show presence records for a particular species, but absence of a record cannot be

Table 2. Mean elevations among records for each *Bombus* species.

Species	Elevation (m)	Figure no.	Species	Elevation (m)	Figure no.
rotundiceps	1,021	3	*lucorum*	3,291	20
breviceps	1,296	4	*lepidus*	3,327	21
haemorrhoidalis	1,622	5	*cornutus*	3,436	22
eximius	1,713	6	*asiaticus*	3,475	23
trifasciatus	2,016	7	*avinoviellus*	3,513	24
luteipes	2,162	8	*pressus*	3,658	25
turneri	2,250	9	*branickii*	3,700	26
flavescens	2,359	10	*nobilis*	3,751	27
festivus	2,639	11	*abnormis*	3,788	28
funerarius	2,696	12	*lemniscatus*	3,835	29
grahami	2,725	13	*personatus*	3,867	30
tunicatus	2,731	14	*novus*	3,876	31
hypnorum	2,825	15	*kashmirensis*	3,946	32
parthenius	2,872	16	*mirus*	4,031	33
miniatus	3,207	17	*rufofasciatus*	4,081	34
melanurus	3,250	18	*waltoni*	4,300	35
skorikovi	3,250	19	*ladakhensis*	4,350	36

interpreted as indicating the absence of a species. Nonetheless, the grey spots do help to compare a species' presence records in relation to the geographical distribution of sampling effort.

Distribution maps are presented in an order of increasing mean elevation of the species' records (Table 2). This indicates broadly the habitat associations of the species and the other species with which they are most likely to co-occur.

Key to the Nepalese species of the genus Bombus (females)

Nearly 79% of specimens in the database are females, so an identification key for these more abundant females (which are often much more difficult to identify) is provided below. The scarcer males are either similar in colour pattern to the workers (Figs 3–36) or are more uniformly yellow. A key for males is not included because they can already be identified easily and reliably from their genitalia, by comparing specimens with the photographic images of the male genitalia that are available online (www.nhm.ac.uk/bombus/genitalia.html).

1 Outer surface of the hind tibia flat or partially concave, without long hairs on the posterior part of the lower or distal half of the outer surface (corbicula), but with a comb of stout spines along the distal margin (rastellum); S6 (metasomal sternum 6) without a pair of ventro-lateral keels 6

– Outer surface of the hind tibia convex, with moderate to long hairs throughout, but without a comb of stout spines along the distal margin (rastellum); S6 with a pair of ventro-lateral keels ... 2

2 (1) Lateral keels of S6 strongly swollen and converging to a point only just before the apex of S6, which is broadly triangular and curved ventrally but not anteriorly, not narrowed and spine-like, and which does not project beyond the apex of T6 (metasomal tergum 6) 3
– Lateral keels of S6 small and converging to a point well before the apex of S6, which is curved ventrally and often anteriorly as a narrow spinose hook that projects strongly beyond the apex of T6 ..... *B. skorikovi*
3 (2) Labral lamella broad and weakly produced with the apex rounded and not reaching beyond the labral margin; crest of the lateral keels of S6 projecting strongly beyond T6 laterally from the dorsal aspect 4
– Labral lamella narrow and strongly produced with the apex at least triangular and reaching beyond the apical margin; crest of the lateral keels of S6 projecting weakly or not at all beyond T6 laterally from the dorsal aspect 5
4 (3) Labrum with the median furrow narrow, about a fifth of the total labral breadth, labral tubercles moderately prominent with the inner corner obtusely angled; pubescence of the thoracic dorsum entirely yellow ..... *B. branickii*
– Labrum with the median furrow broad, nearly a third of the total labral breadth, labral tubercles very prominent with the inner corner acutely angled; pubescence of the thoracic dorsum with a broad black band between wing bases, otherwise yellow, grey-white, sometimes intermixed with black ..... *B. novus*
5 (3) Labral lamella narrow and strongly produced with the apex acute and reaching beyond the apical margin; pubescence of the thoracic dorsum with broad yellow or grey-white bands ..... *B. cornutus*
– Labral lamella projecting strongly above the apex of the labrum as a broad rounded triangle; pubescence of the thoracic dorsum black with yellow hairs sparsely intermixed anteriorly and posteriorly ..... *B. turneri*
6 (1) Hind tibia with the outer (corbicular) surface coarsely sculptured (imbricate), appearing very rough, and with widely-spaced long stout hairs or bristles arising from near the middle of the outer surface throughout the proximal half; hind basitarsus with the proximal posterior corner rounded, the projection no longer than its own basal breadth; labrum with a narrow transverse basal depression, leaving a straight transverse ridge joining the weak lateral tubercles, so that there is no median furrow and no apical lamella 7
– Hind tibia with the outer (corbicular) surface usually smooth and shining or only weakly sculptured (reticulate coriaceous), without any long stout hairs arising from the posterior part of outer surface below the proximal quarter; hind basitarsus with the proximal posterior corner strongly and acutely produced, the projection longer than its own basal breadth; labrum with the basal transverse depression extending apically as a deep median furrow between the pronounced lateral tubercles, displacing the ridge between them to form a lamella which overhangs the apical margin 8
7 (6) Labrum with the ridge between the lateral tubercles, at its mid point, narrower (anterior to posterior) than the basal depression; wings clouded with brown (moderately infuscated); pubescence of the thoracic dorsum dull yellow, but with a black band between the wing bases; T2 posteriorly and T3 anteriorly black, T3 posteriorly to T5 orange-red ..... *B. avinoviellus*
– Labrum with the ridge between lateral tubercles, at its mid point, broader (anterior to posterior) than the basal depression; wings nearly clear (subhyaline); pubescence of the thoracic dorsum and T1 entirely black (hairs often with grey tips), T2–5 orange-red ..... *B. waltoni*
8 (6) Mandible apex with six large teeth, although these are subject to wear 9
– Mandible apex broadly rounded, with a basal tooth, one pre-basal tooth and often an apical tooth 12
9 (8) Oculo-malar distance shorter than half of the basal breadth of the mandible 10
– Oculo-malar distance about equal to the basal breadth of the mandible ..... *B. nobilis* s. l.

10 (9) Ocello-ocular area with many dense micropunctures reaching almost to the lateral ocelli; labrum with the median furrow about 0.5× as broad as the total labral breadth; pubescence of the thoracic dorsum grey-white with an intermixture of black which often forms a pair of obscure longitudinal bands ..... *B. grahami*

– Ocello-ocular area with few micropunctures lateral to the ocelli, which have unpunctured or sparsely punctured lateral areas in the inner third; labrum with the median furrow about 0.33× as broad as the total labral breadth; pubescence of the thoracic dorsum black or black with distinct anterior and posterior pale bands 11

11 (10) Pubescence of the thoracic dorsum entirely black, sides of the thorax (pleura) white; ocello-ocular area with the band of punctures along the inner eye margin poorly defined with sparse, weak, medium and large punctures which are separated by distances of more than their own widths; pubescence short and even ..... *B. breviceps*

– Pubescence of the thoracic dorsum black with narrow grey-white bands anteriorly and posteriorly; ocello-ocular area with the band of punctures along the inner eye margin well defined with dense strong and medium to large punctures, which are separated by distances of less than their own widths; pubescence long and uneven ..... *B. kashmirensis*

12 (8) Mid basitarsus with the distal posterior corner angle less than 45°, often spinose; oculo-malar distance at least 1.2× longer than the basal breadth of the mandible 13

– Mid basitarsus with the distal posterior corner angle more than 45°, often broadly rounded; oculo-malar distance shorter than 1.2× the basal breadth of mandible, or *if* longer, *then either* the ocello-ocular unpunctured area is very large and includes most of the area anterior to the lateral ocelli for a distance of one ocellar breadth, *or* the hind basitarsus with the dense pubescence of the proximal margin (auricle) continuing onto the outer surface of the proximal posterior projection as a dense long brush 15

13 (12) Antennomere 4 (flagellomere 2) shorter than broad; pubescence of T4–5 orange-red .... *B. trifasciatus* s. l.

– Antennomere 4 (flagellomere 2) longer than broad; pubescence of T4–5 black or with a white posterior fringe 14

14 (13) Clypeus with very sparse micropunctures, most separated by more than 2× their own breadths; pubescence of T3–5 entirely black ..... *B. melanurus*

– Clypeus with sparse micropunctures, many separated by only 2× their own breadths; pubescence of T3–5 black with broad posterior fringes of long white hairs ..... *B. personatus*

15 (12) Hind basitarsus with the dense pubescence of the proximal margin (auricle) not or scarcely continuing onto the outer surface of the proximal posterior projection as just a few sparse hairs; oculo-malar distance *either* shorter *or* longer than 1.2× the basal breadth of the mandible, but the anterior part of the malar area smooth, at most the larger individuals with only a narrow diagonal band of few very small punctures 16

– Hind basitarsus with the dense pubescence of the proximal margin (auricle) continuing onto the outer surface of the proximal posterior projection as a dense long brush; oculo-malar distance longer than 1.2× the basal breadth of the mandible, and for larger individuals at least, the anterior part of the oculo-malar area uneven with many moderate to large but widely-separated punctures almost throughout ..... *B. asiaticus*

16 (15) Oculo-malar distance longer than 1.2× the basal breadth of the mandible; ocello-ocular area with the unpunctured areas very large and including most of the area anterio-laterally to the lateral ocellus for a distance of nearly two ocellar diameters; labrum with the lamella broad, more than 0.5× the basal breadth of the labrum; clypeus with almost no large punctures on the flattened central area 17

– Oculo-malar distance shorter than 1.2× the basal breadth of the mandible; ocello-ocular area with the unpunctured areas small or large, but *if* large *then* without including most of the area anterio-laterally to the lateral ocellus for a distance of even one ocellar diameter;

labrum with the lamella narrow, about equal to or less than 0.5× the basal breadth of the labrum; clypeus usually with large punctures scattered over the flattened central area 18

17 (16) Pubescence of the thoracic dorsum entirely black, T2 pale cream or yellow ..... *B. haemorrhoidalis*

– Pubescence of the thoracic dorsum with black and pale grey extensively intermixed, giving a dark olive-greyish appearance with a paler band longitudinally on the midline, T2 black ..... *B. funerarius*

18 (16) Hind basitarsus with the posterior edge strongly and evenly convex; oculo-malar distance slightly shorter than the basal breadth of the mandible; mandible with the apical notch (incisura) often as deep as broad at least in queens 19

– Hind basitarsus with the posterior edge in the proximal half strongly convex or nearly straight but in the distal half always nearly straight or concave; oculo-malar distance *either* nearly equal to *or* longer than the basal breadth of the mandible; mandible with the apical notch (incisura) scarcely marked, not as deep as broad 20

19 (18) Pubescence of the thoracic dorsum with a broad black band between the wing bases, with white to white-grey bands anteriorly and posteriorly; T2 anterio-laterally black or brown; wings strongly clouded with brown (moderately infuscated) ..... *B. tunicatus*

– Pubescence of the thoracic dorsum black, anteriorly with a yellow band; T2 anterio-laterally pale yellow; wings nearly clear (subhyaline) ..... *B. lucorum* s. l.

20 (18) Labrum with the median furrow equal to or broader than 0.33× the basal labral breadth; labral lamella with its apical margin nearly straight or only weakly curved; hind tibia distal posterior corner sometimes produced as a spine that is longer than its basal breadth; T6 with a distinct subapical median boss or furrow (queens only) 21

– Labrum with the median furrow equal to or less than 0.33× the basal labral breadth; labral lamella with its apical margin strongly curved; hind tibia distal posterior corner never produced as a spine, always shorter than its basal breadth; T6 without a distinct subapical median boss or furrow (queens only) 25

21 (20) Hind tibia with the outer (corbicular) surface with sparsely scattered short hairs (queens only); labral lamellar breadth at least 0.5× the basal labral breadth; pubescence of the thorax and T1–4 black or nearly black; the mid and hind tibiae with the outer surface and the long hairs bright orange ..... *B. eximius*

– Hind tibia with the outer (corbicular) surface without short hairs (queens only); labral lamellar breadth less than 0.5× the basal labral breadth; pubescence of the thorax and T1–4 pale in part; the mid and hind tibiae with the outer surface and the long hairs predominantly black 22

22 (21) Pubescence of the thoracic dorsum at least between the wing bases either white or orange-brown, but without a central black band ..... *B. festivus*

– Pubescence of the thoracic dorsum with a black band between the wing bases, anterior and posterior pale bands either dull yellow or grey-white 23

23 (22) Ocello-ocular areas with a dense band of punctures along the inner margin of the eye opposite the lateral ocellus, anteriorly the punctures small but strong, posteriorly the punctures large and separated by less than their own breadths; pubescence of the thoracic dorsum with the pale anterior band very distinctly broader than the pale posterior band; many pale hairs of the tail orange-red at the base and white at the tip ..... *B. ladakhensis*

– Ocello-ocular areas with a sparse band of punctures along the inner margin of the eye opposite the lateral ocellus, anteriorly the punctures small and often weak, posteriorly the punctures large but mostly separated by more than their own breadths; pubescence of the thoracic dorsum with the pale anterior band nearly equal in breadth to the pale posterior band; pale hairs of the tail usually either orange-red or white but not both 24

24 (23) Pubescence of the head entirely black, pale thoracic bands and T1 white ..... *B. rufofasciatus*

– Pubescence of the head with the short branched hairs yellow, pale thoracic bands and T1

yellow ..... *B. miniatus*

25 (20) T6 with the apex broadly truncate or divided, slightly turned up and fringed with a tuft of dense short hairs; labrum with the apices of the tubercles strongly angled, labral furrow about 0.33× the total labral breadth, labral lamella 0.5× the total labral breadth; pubescence of the thoracic dorsum with a black band between the wing bases, otherwise dull yellow intermixed with many black hairs ..... *B. pressus*

– T6 with the apex rounded or narrowly truncate and not divided; labrum with the apices of the tubercles rounded or only weakly angled, labral furrow less than 0.33× the total labral breadth, labral lamella less than 0.5× the total labral breadth; pubescence of the thoracic dorsum often without a black band between the wing bases, but *if* banded *then* the pale hairs on the thoracic dorsum grey-white, intermixed with a few black hairs 26

26 (25) Pubescence of the thoracic dorsum predominantly yellow with black hair intermixed throughout, although never forming a distinct band or spot, the lateral and ventral parts of the thorax predominantly yellow 27

– Pubescence of the thoracic dorsum entirely black, with pale bands, or entirely brown, but *if* brown *then* there are few or no black hairs and the lateral and ventral parts of the thorax are extensively black 28

27 (26) S2–5 posterior integument with the narrow hairless margins yellow and a band about 2x as broad of the adjacent hairy region orange-brown; mid tibia with both the outer surface and the pubescence light orange-brown, hind tibia with the outer surface proximally with long hairs only orange; pubescence of T2 bright lemon yellow with only one or two black hairs ..... *B. luteipes*

– S2–5 posterior integument with only the narrow hairless margins orange-brown, otherwise dark brown; mid tibia with the outer surface brown to dark brown, with its pubescence predominantly yellow to light orange but with dark hairs intermixed to variable degrees, hind tibia with the outer surface proximally usually with at least a few long hairs dark brown; pubescence of T2 grey yellow densely intermixed with black hairs ..... *B. parthenius*

28 (26) Pubescence of the thoracic dorsum orange-brown to yellow-brown, T4–5 extensively white 29

– Pubescence of the thoracic dorsum entirely or at least predominantly black, T4–5 extensively orange-red or black, any white confined to the lateral areas 30

29 (28) Ocello-ocular area with the band of dense punctures along the inner margin of the eye very broad and reaching almost to the lateral ocellus, leaving almost no unpunctured area ..... *B. abnormis*

– Ocello-ocular area with a band of scattered punctures occupying less than half of the distance between the eye and the lateral ocellus ..... *B. hypnorum* s. l.

30 (28) Pubescence of the thoracic dorsum entirely black; ocello-ocular area with only a very narrow band of a few widely spaced punctures along the inner margin of the eye 31

– Pubescence of the thoracic dorsum with broad pale bands, at least along the anterior margin; ocello-ocular area with a broad to very broad band of moderately dense punctures along the inner margin of the eye 32

31 (30) Mid tibia and hind tibia with the long hairs bright orange, pubescence of the thorax laterally and ventrally and T1–2 black ..... *B. flavescens* s. l.

– Mid tibia and hind tibia with the long hairs black, pubescence of the thorax laterally and ventrally mostly white, T1–2 yellow ..... *B. rotundiceps*

32 (30) Ocello-ocular area with the band of punctures along the inner margin of the eye very broad, about three quarters of the distance to the lateral ocellus, with medium to large punctures mostly separated by distances of less than their own widths; hind basitarsus on the outer surface near the anterior proximal margin with long erect hairs, the longest of which are equal to or longer than the greatest breadth of the basitarsus ..... *B. mirus*

– Ocello-ocular area with the band of punctures along the inner margin of the eye narrow, less

than half of the distance to the lateral ocellus, with medium punctures mostly separated by distances equal to their own widths; hind basitarsus on the outer surface near the anterior proximal margin with the longest hairs shorter than greatest breadth of basitarsus 33

33 (32) Thoracic scutum mid-dorsally with an area as large as the tegula around the posterior end of the longitudinal median groove smooth with few or no punctures; pubescence of the ventral parts of the thorax and of the metasoma predominantly grey-white, and on the top and front of the head often with many pale hairs intermixed ..... *B. lepidus*

– Thoracic scutum mid-dorsally with punctures and sculpturing almost throughout the area around the posterior end of the longitudinal median groove; pubescence of the ventral parts of the thorax and of the metasoma predominantly black, and on the top and front of the head often without pale hairs intermixed ..... *B. lemniscatus*

Genus Bombus Latreille, 1802

Bombus (*Mendacibombus*) *avinoviellus* (Skorikov, 1914)

Mendacibombus avinoviellus Skorikov, 1914: 126, syntype queen ZISP examined.

Bombus niveatus subsp. *callophenax* Cockerell, 1917: 122, holotype queen USNM examined, synonymised by Williams (1991).

Bombus (*Sibiricobombus*) *avinoviellus* (Skorikov) [cited as Cockerell]; Burger et al., 2009: 457.

Specimens examined. (Fig. 24) 3 queens 1 worker, 4 localities 3,200–3,700 m (NME).

Distribution. Pakistan, Kashmir, Himachal Pradesh, Uttaranchal, Nepal.

Bombus (*Mendacibombus*) *waltoni* Cockerell, 1910

Bombus mendax subsp. *chinensis* Skorikov, 1910: 330, holotype queen ZISP examined (not of Morawitz, 1890).

Bombus waltoni Cockerell, 1910: 239, holotype queen BMNH examined, synonymised by Skorikov in Cockerell (1911).

Bombus rufitarsus Friese, 1913: 85, type not seen, synonymised by Skorikov (1914).

Bombus asellus Friese, 1924: 438, type not seen, synonymised by Bischoff (1936).

Bombus (*Mendacibombus*) *waltoni* Cockerell; Burger et al., 2009: 462.

Specimen examined. (Fig. 35) 1 worker, 4,300 m (NME).

Distribution. Nepal, Sikkim, Tibet, southwestern China.

Bombus (*Orientalibombus*) *funerarius* Smith, 1852

Bombus funerarius Smith, 1852a: 47, holotype queen BMNH examined.

Bremus (*Agrobombus*) *priscus* Frison, 1935:349, type not seen, synonymised by Richards (1968).

Bombus (*Orientalibombus*) *funerarius* Smith; Burger et al., 2009: 458.

Specimens examined. (Fig. 12) 6 queens 22 workers 23 males, 20 localities 2,050–4,300 m (NMS, PHW, SEHU, SMNS).

Distribution. Uttaranchal, Nepal, Darjiling Bengal, Sikkim, [Bhutan? Arunachal Pradesh?], Myanmar, Tibet, southwestern China.

Bombus (*Orientalibombus*) *haemorrhoidalis* Smith, 1852

Bombus hæmorrhoidalis Smith, 1852b: 43, type lost not seen.

Bombus orientalis Smith, 1854: 402, lectotype queen BMNH examined, synonymised by Williams (1991).

Bombus buccinatoris Smith, 1879: 132, lectotype worker BMNH examined, synonymised by Williams (1991).

Bombus assamensis Bingham, 1897: 550, lectotype male BMNH examined, synonymised by

Williams (1991).

Orientalibombus haemorrhoidalis (Smith); Tkalců, 1974: 320.

Bombus (*Orientalibombus*) *haemorrhoidalis* (Smith); Burger et al., 2009: 458.

Bombus (*Megabombus*) *trifasciatus* Smith; Burger et al., 2009: 461, in part, misidentification.

Specimens examined. (Fig. 5) 62 queens 293 workers 47 males, 106 localities 850–3,400 m (BMNH, NME, PHW, SEHU, SMNS).

Distribution. Pakistan, Kashmir, Himachal Pradesh, Uttaranchal, Nepal, Darjiling Bengal, Sikkim, Bhutan, Arunachal Pradesh, Meghalaya, Myanmar, Tibet, southwestern China, Laos, Thailand, Vietnam.

Bombus (*Subterraneobombus*) *melanurus* Lepeletier, 1835

Bombus melanurus Lepeletier, [1835]: 469, lectotype queen UMO examined.

Bombus (*Subterraneobombus*) *melanurus* subsp. *subdistinctus* Richards, 1928: 333, holotype queen BMNH examined.

Megabombus (*Subterraneobombus*) *difficillimus* (Skorikov); Tkalců, 1974: 345, misidentification.

Bombus (*Subterraneobombus*) *melanurus* Lepeletier; Burger et al., 2009: 459.

Specimens examined. (Fig. 18) 4 queens 1 worker, 4 localities 2,850–3,850 m (BMNH, NME, NMS).

Distribution. Turkey, Armenia, Lebanon, Syria, Iran, Afghanistan, Uzbekistan, Tajikistan, Kyrgyzstan, Kazakhstan, Russia, Mongolia, Pakistan, Kashmir, Himachal Pradesh, Uttaranchal, Nepal, Sikkim, Tibet, northwestern and northern China.

Bombus (*Subterraneobombus*) *personatus* Smith, 1879

Bombus personatus Smith, 1879: 132, lectotype queen BMNH examined.

Bombus Roborowskyi Morawitz, 1887: 197, syntype queen ZISP examined, synonymised by Williams (1991).

Specimens examined. (Fig. 30) 2 workers 1 male, 3 localities 3,800–3,950 m (SEHU). This is the first record of this species for Nepal.

Distribution. Kashmir, Himachal Pradesh, [Uttaranchal?], Nepal, Sikkim, Tibet, southwestern China.

Bombus (*Megabombus*) *trifasciatus* Smith, 1852, complex

Bombus trifasciatus Smith, 1852b: 43, lectotype queen BMNH examined.

Bombus haemorrhoidalis var. *albopleuralis* Friese, 1916: 108, lectotype queen MNHU examined, synonymised by Williams (1991).

Bombus (*Hortobombus*) *mimeticus* Richards, 1931: 529, holotype queen BMNH examined, synonymised by Williams (1991).

Megabombus (*Diversobombus*) *albopleuralis* (Friese); Tkalců, 1974: 344.

Bombus (*Megabombus*) *trifasciatus* Smith; Burger et al., 2009: 461.

Taxonomy. See Williams et al. (2009). This complex is currently being explored using COI (DNA) barcodes and is likely to consist of two species, only one of which occurs in Nepal.

Specimens examined. (Fig. 7) 6 queens 19 workers 2 males, 19 localities 950–3,280 m (BMNH, NME, NMS, PHW, SEHU, SMNS).

Distribution. Pakistan, Kashmir, Himachal Pradesh, Uttaranchal, Nepal, Darjiling Bengal, Sikkim, [Bhutan?], Arunachal Pradesh, Manipur, Meghalaya, Myanmar, Tibet, central and southern China, Laos, Peninsular Malaysia, Taiwan, Thailand, Vietnam.

Bombus (*Psithyrus*) *cornutus* (Frison, 1933)

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

Psithyrus (*Eopsithyrus*) *cornutus* subsp. *canus* Tkalců, 1989: 42, paratype female MNHU examined.

Specimens examined. (Fig. 22) 11 males, 7 localities 3,200–3,390 m (PHW, SEHU).

Distribution. Himachal Pradesh, Uttaranchal, Nepal, southwestern and central China.

Bombus (*Psithyrus*) *turneri* (Richards, 1929)

Psithyrus turneri Richards, 1929a: 141, holotype male BMNH examined.

Psithyrus (*Eopsithyrus*) *martensi* Tkalců, 1974: 314, holotype female NMS examined, synonymised by Williams (1998).

Bombus (*Psithyrus*) *martensi* (Tkalců); Burger et al., 2009: 459.

Specimen examined. (Fig. 9) 1 female, 2,250 m (NMS).

Distribution. Nepal, [Sikkim? Bhutan?], Arunachal Pradesh, southwestern and central China.

Bombus (*Psithyrus*) *novus* (Frison, 1933)

Psithyrus novus Frison, 1933:340, type not seen.

Psithyrus (*Psithyrus*) *novus* subsp. *nepalensis* Tkalců, 1974: 318, holotype female ZSM examined.

Bombus (*Psithyrus*) *novus* (Frison); Burger et al., 2009: 460.

Specimens examined. (Fig. 31) 6 females 3 males, 6 localities 3,650–4,300 m (NME, PHW, SEHU, ZSM).

Distribution. Pakistan, Kashmir, Himachal Pradesh, [Uttaranchal?], Nepal.

Bombus (*Psithyrus*) *branickii* (Radoszkowski, 1893)

Psithyrus Branickii Radoszkowski, 1893: 241, lectotype female MNHU examined.

Apathus *chloronotus* Morawitz, 1893: 6, holotype female ZISP examined, synonymised by Popov (1931).

Psithyrus rupestris var. *eriophoroides* Reinig, 1930: 110, type not seen, synonymised by Tkalců (1969).

Psithyrus (*Psithyrus*) *rupestris* ssp. *elisabethae* Reinig, 1940: 231, holotype female ZSM examined, synonymised by Tkalců (1969).

Specimen examined. (Fig. 26) 1 female, 3,700 m (SEHU). This is the first record of this species for Nepal.

Distribution. Afghanistan, Kazakhstan, Kyrgyzstan, Tajikistan, Pakistan, Kashmir, Himachal Pradesh, [Uttaranchal?], Nepal, Sikkim, Tibet, northwestern and southwestern China, Mongolia, Russia.

Bombus (*Psithyrus*) *skorikovi* (Popov, 1927)

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

Psithyrus (*Fernaldaepsithyrus*) *gansuensis* Popov, 1931: 202, holotype male ZISP examined, synonymised by Williams et al. (2009).

Psithyrus (*Fernaldaepsithyrus*) *kuani* Tkalců, 1961: 362, holotype female BT examined, synonymised by Williams (1998).

Bombus (*Psithyrus*) *skorikovi* (Popov); Burger et al., 2009: 461.

Specimen examined. (Fig. 19) 1 female, 3,250 m (NME).

Distribution. Pakistan, Kashmir, [Himachal Pradesh? Uttaranchal?], Nepal, Sikkim, Tibet, southwestern China.

Bombus (*Pyrobombus*) *hypnorum* (Linnaeus, 1758) complex

APIS Hypnorum Linnaeus, 1758: 579, lectotype queen LSL examined.

Bombus (*Pratobombus*) *hypnorum* var. *bryorum* Richards, 1930: 650, holotype queen BMNH examined.

Bombus fletcheri Richards, 1934: 90, holotype queen BMNH examined, synonymised by Williams (1991).

Pyrobombus (*Pyrobombus*) *bryorum* (Richards); Tkalců, 1974: 328.

Bombus (*Pyrobombus*) *hypnorum* (Linnaeus); Burger et al., 2009: 458.

Bombus (*Pyrobombus*) *parthenius* Richards; Burger et al., 2009: 460, in part, misidentification.

Taxonomy. See Williams et al. (2009). This complex is currently being explored using COI (DNA) barcodes and is likely to consist of at least two species, only one of which occurs in Nepal.

Specimens examined. (Fig. 15) 4 queens 21 workers 32 males, 17 localities 2,286–3,900 m (BMNH, NME, NMS, SEHU).

Distribution. Pakistan, Kashmir [Himachal Pradesh? Uttaranchal?], Nepal, Sikkim, [Bhutan?], Arunachal Pradesh, Myanmar, Tibet, northeastern, central, and southwestern China, Europe, Japan, Korea, Mongolia, Russia, Taiwan.

Bombus (*Pyrobombus*) *abnormis* (Tkalců, 1968)

Pyrobombus (*Pyrobombus*) *abnormis* Tkalců, 1968a: 33, holotype queen MNHU examined.

Bombus (*Pyrobombus*) *festivus* Smith; Burger et al., 2009: 457, in part, misidentification.

Specimens examined. (Fig. 28) 1 queen 3 workers, 3 localities 3,600–3,900 m (PHW, SEHU). This is the first record of this rare species for Nepal.

Distribution. Nepal, Sikkim.

Bombus (*Pyrobombus*) *mirus* (Tkalců, 1968)

Bombus pratorum var. *tibetanus* Friese, 1913: 86, holotype male MNHU examined (not of Morawitz, 1887).

Pyrobombus (*Pyrobombus*) *mirus* Tkalců, 1968a: 37, holotype queen MNHU examined, synonymised by Williams (1991).

Specimens examined. (Fig. 33) 2 queens 15 workers, 11 localities 3,450–4,877 m (BMNH, PHW, SEHU).

Distribution. Nepal, Sikkim, Tibet.

Bombus (*Pyrobombus*) *lemniscatus* Skorikov, 1912

Bombus lemniscatus Skorikov, 1912: 606, holotype queen ZISP examined.

Bombus nursei var. *flavopilosus* Friese, 1918: 84, lectotype queen MNHU examined, synonymised by Williams (1991).

Bombus (*Lapidariobombus*) *peralpinus* Richards, 1930: 646, holotype queen BMNH examined, synonymised by Tkalců (1974).

Bombus (*Pyrobombus*) *lemniscatus* Skorikov; Burger et al., 2009: 459.

Bombus (*Pyrobombus*) *rufofasciatus* Smith; Burger et al., 2009: 461, in part, misidentification.

Specimens examined. (Fig. 29) 6 queens 11 workers 21 males, 15 localities 3,000–4,300 m (BMNH, NME, SEHU).

Distribution. Kashmir, [Himachal Pradesh?], Uttaranchal, Nepal, Sikkim, [Bhutan? Arunachal Pradesh?], Tibet, southwestern China.

Bombus (*Pyrobombus*) *lepidus* Skorikov, 1912

Bombus lepidus Skorikov, 1912: 606, syntype queen ZISP examined.

Bombus genitalis Friese, 1913:85, holotype male MNHU examined, synonymised by Williams (1991).

Bombus nursei var. *tetrachromus* Friese, 1918: 85, lectotype queen MNHU examined (not of Cockerell, 1909), synonymised by Williams (1991).

Pyrobombus (*Pyrobombus*) *lepidus* subsp. *semiperalpinus* Tkalců, 1974: 328, type not seen.

Pyrobombus (*Pyrobombus*) *lepidus* subsp. *hilaris* Tkalců, 1989: 48, holotype queen ZSM examined.

Bombus (*Pyrobombus*) *lepidus* Skorikov; Burger et al., 2009: 459.

Specimens examined. (Fig. 21) 5 queens 3 workers, 7 localities 2,850–3,871 m (BMNH, NME, PHW).

Distribution. Pakistan, Kashmir, Himachal Pradesh, [Uttaranchal?], Nepal, [Sikkim? Bhutan? Arunachal Pradesh?], Tibet, southwestern China.

Bombus (*Pyrobombus*) *pressus* (Frison, 1935)

Bremus (*Pressibombus*) *pressus* Frison, 1935: 342, type not seen.

Specimens examined. (Fig. 25) 1 queen 107 workers 9 males, 23 localities 3,250–3,950 m (PHW, SEHU). This is the first record of this distinctive species for Nepal.

Distribution. Uttaranchal, Nepal, Darjiling Bengal, Sikkim.

Bombus (*Pyrobombus*) *parthenius* Richards, 1934

Bombus (*Pratobombus*) *parthenius* Richards, 1934: 89, holotype queen BMNH examined.

Pyrobombus (*Pyrobombus*) *parthenius* (Richards); Tkalců, 1974: 335.

Bombus (*Pyrobombus*) *parthenius* Richards; Burger et al., 2009: 460.

Specimens examined. (Fig. 16) 7 queens 100 workers 41 males, 52 localities 1,300–4,070 m (BMNH, NME, NMS, PHW, SEHU).

Distribution. Himachal Pradesh, Uttaranchal, Nepal, Sikkim, Bhutan, Tibet.

Bombus (*Pyrobombus*) *luteipes* Richards, 1934

Bombus (*Pratobombus*) *parthenius* var. *luteipes* Richards, 1934: 89, holotype worker BMNH examined.

Pyrobombus (*Pyrobombus*) *signifer* Tkalců, 1989: 52, paratype worker BMNH examined, synonymised by Williams (1991).

Specimens examined. (Fig. 8) 56 workers 30 males, 20 localities 1,524–2,804 m (BMNH, PHW, SEHU). No queens have been recognised for this (moderately common) species from Nepal. It is possible that they have a colour pattern that differs from the workers (Tkalců, 1989), but they are likely to be recognisable by yellow margins to S2–5.

Distribution. Nepal, Sikkim, Darjiling Bengal, Bhutan, Arunachal Pradesh, Myanmar, Tibet.

Bombus (*Pyrobombus*) *flavescens* Smith, 1852, complex

Bombus flavescens Smith, 1852b: 45, holotype male BMNH examined.

Pyrobombus (*Pyrobombus*) *flavescens* (Smith); Tkalců, 1974: 331.

Bombus (*Pyrobombus*) *eximius* Smith; Burger et al., 2009: 457, in part, misidentification.

Bombus (*Pyrobombus*) *flavescens* Smith; Burger et al., 2009: 458.

Taxonomy. See Williams et al. (2009).

Specimens examined. (Fig. 10) 9 queens 72 workers 17 males, 15 localities 1,400–2,950 m (BMNH, NMS, SEHU, SMNS).

Distribution. Uttaranchal, Nepal, Sikkim, Darjiling Bengal, [Bhutan? Arunachal Pradesh?],

Myanmar, central and southern China, Peninsular Malaysia, Philippines, Taiwan, Thailand, Vietnam.

Bombus (*Pyrobombus*) *rotundiceps* Friese, 1916

Bombus rotundiceps Friese, 1916: 108, lectotype male MNHU examined.

Pyrobombus (*Pyrobombus*) *rotundiceps* subsp. *shillongensis* Tkalců, 1974: 334, holotype queen BMNH examined.

Bombus (*Pyrobombus*) *rotundiceps* Friese; Burger et al., 2009: 461.

Specimens examined. (Fig. 3) 5 workers 1 male, 5 localities 762–1,350 m (BMNH, NME, SEHU).

Distribution. Himachal Pradesh, Uttaranchal, Nepal, Sikkim, Darjiling Bengal, [Bhutan? Arunachal Pradesh?], Meghalaya, Myanmar, southwestern China, Laos, Thailand.

Bombus (*Bombus*) *tunicatus* Smith, 1852

Bombus tunicatus Smith, 1852b: 43, lectotype queen BMNH examined.

Bombus gilgitensis Cockerell, 1905: 223, holotype queen BMNH examined, synonymised by Williams (1991).

Bombus terrestris var. *simlaënsis* Friese, 1909: 674, lectotype queen MNHU examined, synonymised by Tkalců (1974).

Bombus terrestris var. *fulvocinctus* Friese, 1909: 674, type lost not seen, synonymised by Tkalců (1974).

Bombus tunicatus Smith; Tkalců, 1974: 324.

Bombus (*Bombus*) *tunicatus* Smith; Burger et al., 2009: 461.

Specimens examined. (Fig. 14) 18 queens 13 workers 1 male, 16 localities 1,829–3,650 m (BMNH, NME, NMS, PHW, SEHU, SMNS).

Distribution. Afghanistan, Pakistan, Kashmir, Himachal Pradesh, Uttaranchal, Nepal, Sikkim.

Bombus (*Bombus*) *lucorum* (Linnaeus, 1761) complex

APIS lucorum Linnaeus, 1761: 425, lectotype male LSL examined.

Bombus reinigi Tkalců, 1974: 322, holotype queen NMS examined, synonimised by Williams (1991).

Bombus (*Bombus*) *reinigi* Tkalců; Burger et al., 2009: 460.

Taxonomy. This is a complex of morphologically very similar taxa that cannot at present be diagnosed reliably from morphology for all individuals (Williams et al., 2009). They are currently being explored using COI (DNA) barcodes and the complex is likely to consist of several species, only one of which occurs in Nepal.

Specimens examined. (Fig. 20) 5 queens 1 worker, 4 localities 3,048–3,700 m (BMNH, NME, NMS).

Distribution. Europe, Russia, Turkey, Iran, Afghanistan, Tajikistan, Kyrgyzstan, Kazakhstan, Mongolia, Pakistan, Kashmir, Himachal Pradesh, Uttaranchal, Nepal, Sikkim, [Bhutan? Arunachal Pradesh?], Myanmar, Tibet, northern and central China, Korea, Japan, Alaska, Canada.

Bombus (*Alpigenobombus*) *breviceps* Smith, 1852

Bombus nasutus Smith, 1852b: 44, lectotype queen BMNH examined.

Bombus breviceps Smith, 1852b: 44, holotype worker BMNH examined, synonymised by Tkalců (1968b), precedence by the action of Tkalců (1968b) as first reviser.

Bombus dentatus Handlirsch, 1888: 227, type not seen, synonymised by Williams (1991).

Bombus simulus Gribodo, 1892: 114, holotype worker MCSN examined, synonymised by Williams (1998).

Bombus orichalceus Friese, 1916: 107, holotype queen MNHU examined, synonymised by Williams (1991).

Bombus (*Alpigenobombus*) *breviceps* Smith; Burger et al., 2009: 457.

Specimens examined. (Fig. 4) 10 queens 198 workers 8 males, 31 localities 980–3,000 m (BMNH, NME, PHW, SEHU).

Distribution. Himachal Pradesh, Uttaranchal, Nepal, Sikkim, Darjiling Bengal, [Bhutan?], Arunachal Pradesh, Meghalaya, Myanmar, Tibet, central and southern China, Laos, Thailand, Vietnam.

Bombus (*Alpigenobombus*) *grahami* (Frison, 1933)

Bremus grahami Frison, 1933: 334, holotype queen USNM examined.

Specimens examined. (Fig. 13) 1 queen 1 male, 2 localities 2,650–2,800 m (SEHU). This is the first record of this species for Nepal.

Distribution. Nepal, Sikkim, [Bhutan? Arunachal Pradesh?], Tibet, central and south-western China.

Bombus (*Alpigenobombus*) *kashmirensis* Friese, 1909

Bombus mastrucatus var. *kashmirensis* Friese, 1909: 673, lectotype queen MNHU examined, precedence by the action of Tkalců (1974) as first reviser.

Bombus mastrucatus var. *stramineus* Friese, 1909: 673, type lost not seen, synonymised by Tkalců (1974).

Bombus tetrachromus Cockerell, 1909: 397, holotype queen BMNH examined, synonymised by Tkalců (1974).

Alpigenobombus pulcherrimus Skorikov, 1914: 128, type not seen, synonymised by Tkalců (1974).

Bombus (*Mastrucatobombus*) *mastrucatus* subsp. *meinertzhageni* Richards, 1928: 335, holotype queen BMNH examined, synonymised by Tkalců (1974).

Alpigenobombus kashmirensis (Friese); Tkalců, 1974: 326.

Bombus (*Alpigenobombus*) *kashmirensis* Friese; Burger et al., 2009: 458.

Specimens examined. (Fig. 32) 2 queens 10 workers 9 males, 11 localities 3,400–4,572 m (NMS, PHW, SEHU).

Distribution. Pakistan, Kashmir, Himachal Pradesh, Uttaranchal, Nepal, Sikkim, [Bhutan? Arunachal Pradesh?], Tibet, southwestern China.

Bombus (*Alpigenobombus*) *nobilis* Friese, 1905, complex

Bombus validus Friese, 1905: 510, syntype queen MNHU examined.

Bombus nobilis Friese, 1905: 513, type not found not seen, synonymised by Williams (1998), precedence by the action of Williams (1998) as first reviser.

Bombus sikkimi Friese, 1918: 82, syntype queen MNHU examined, synonymised by Williams (1998).

Nobilibombus morawitziides Skorikov, 1933: 62, holotype worker ZISP examined, synonymised by Tkalců (1987).

Bombus (*Nobilibombus*) *xizangensis* Wang, 1979: 188, holotype worker IZB examined, synonymised by Williams (1998).

Bombus (*Nobilibombus*) *chayaensis* Wang, 1979: 189, holotype queen IZB examined, synonymised by Williams (1998).

Bombus (*Alpigenobombus*) *nobilis* Friese; Burger et al., 2009: 460.

Taxonomy. See Williams et al. (2009).

Specimens examined. (Fig. 27) 27 workers 16 males, 20 localities 2,700–4,300 m (NME,

PHW, SEHU).

Distribution. Himachal Pradesh, Uttaranchal, Nepal, Sikkim, [Bhutan? Arunachal Pradesh?], Myanmar, Tibet, southwestern China.

Bombus (*Melanobombus*) *eximius* Smith, 1852

Bombus eximius Smith, 1852a: 47, holotype queen BMNH examined.

Bombus (*Pyrobombus*) *eximius* Smith; Burger et al., 2009: 457.

Specimens examined. (Fig. 6) 22 queens 69 workers 23 males, 28 localities 914–2,700 m (BMNH, NME, PHW, SEHU, SMNS).

Distribution. Nepal, Sikkim, Darjiling Bengal, [Bhutan?], Arunachal Pradesh, Meghalaya, Myanmar, Tibet, central and southern China, Taiwan, Thailand, Vietnam.

Bombus (*Melanobombus*) *festivus* Smith, 1861

Bombus festivus Smith, 1861: 152, lectotype queen BMNH examined.

Bombus atrocinctus Smith, 1870: 193, holotype male BMNH examined, synonymised by Richards (1968).

Bombus terminalis Smith, 1870: 193, lectotype worker BMNH examined, synonymised by Richards (1930).

Bombus (*Alpigenobombus*) *handel-mazettii* Pittioni, 1939: 260, lectotype male BMNH examined, synonymised by Tkalců (1974).

Pyrobombus (*Festivobombus*) *festivus* (Smith); Tkalců, 1974: 341.

Bombus (*Pyrobombus*) *festivus* Smith; Burger et al., 2009: 457.

Taxonomy. See Ito et al. (1984).

Specimens examined. (Fig. 11) 13 queens 169 workers 110 males, 54 localities 1,400–3,850 m (BMNH, NME, NMS, PHW, SEHU, SMNS).

Distribution. Himachal Pradesh, Uttaranchal, Nepal, Sikkim, Darjiling Bengal, [Bhutan? Arunachal Pradesh?], Myanmar, Tibet, southern China.

Bombus (*Melanobombus*) *rufofasciatus* Smith, 1852

Bombus rufo-fasciatus Smith, 1852a: 48, lectotype queen BMNH examined.

Bombus Prshewalskyi Morawitz, 1880: 342, type not seen, synonymised by Richards (1930).

Bombus rufocinctus Morawitz, 1880: 343, syntype queen ZISP examined (not of Cresson, 1863), synonymised by Handlirsch (1988).

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

Bombus rufofasciatus var. *championi* Richards, 1928: 107, holotype queen BMNH examined.

Bombus (*Lapidariobombus*) *waterstoni* Richards, 1934: 88, holotype queen BMNH examined, synonymised by Tkalců (1974).

Pyrobombus (*Melanobombus*) *rufofasciatus* (Smith); Tkalců, 1974: 339.

Bombus (*Pyrobombus*) *rufofasciatus* Smith; Burger et al., 2009: 461.

Specimens examined. (Fig. 34) 21 queens 318 workers 42 males, 52 localities 2,700–4,572 m (BMNH, NME, NMS, PHW, SEHU).

Distribution. Pakistan, Kashmir, Himachal Pradesh, Uttaranchal, Nepal, Sikkim, [Bhutan?], Arunachal Pradesh, Myanmar, Tibet, southwestern China.

Bombus (*Melanobombus*) *miniatus* Bingham, 1897

Bombus flavothoracicus Bingham, 1897: 552, lectotype queen BMNH examined (not of Hoffer, 1889).

Bombus miniatus Bingham, 1897: 553, holotype male BMNH examined, synonymised by Tkalců (1974).

Bombus (*Melanobombus*) *eurythorax* Wang, 1982: 435, holotype queen IZB examined, synonymised by Williams (1998).

Bombus (*Melanobombus*) *stenothorax* Wang, 1982: 439, holotype queen IZB examined, synonymised by Williams (1998).

Pyrobombus (*Melanobombus*) *flavothoracicus* (Bingham); Tkalců, 1974: 338.

Bombus (*Pyrobombus*) *miniatus* Bingham; Burger et al., 2009: 459.

Specimens examined. (Fig. 17) 15 queens 392 workers 137 males, 90 localities 1,905–4,225 m (BMNH, NME, PHW, SEHU, SMNS).

Distribution. Pakistan, Kashmir, Himachal Pradesh, Uttaranchal, Nepal, Sikkim, [Bhutan?], Tibet.

Bombus (*Melanobombus*) *ladakhensis* Richards, 1928

Bombus (*Lapidariobombus*) *rufofasciatus* var. *ladakhensis* Richards, 1928: 336, holotype queen BMNH examined.

Bombus (*Lapidariobombus*) *rufofasciatus* var. *phariensis* Richards, 1930: 642, holotype queen BMNH examined, synonymised by Tkalců (1974).

Bombus variopictus Skorikov, 1933: 248, syntype queen ZISP examined, synonymised by Tkalců (1974).

Bombus variopictus subsp. *bianchii* Skorikov, 1933: 248, types not seen, synonymised by Tkalců (1974).

Bombus (*Pratobombus*) *reticulatus* Bischoff, 1936: 7, paralectotype workers MNHU examined, synonymised by Tkalců (1974).

Pyrobombus (*Melanobombus*) *ladakhensis* (Richards); Tkalců, 1974: 336.

Bombus (*Melanobombus*) *ladakhensis* Richards; Burger et al., 2009: 459.

Specimen examined. (Fig. 36) 1 queen, 4,350 m (NMS).

Distribution. Kashmir, [Himachal Pradesh?], Uttaranchal, Nepal, Sikkim, [Bhutan? Arunachal Pradesh?], Tibet, southwestern China.

Bombus (*Sibiricobombus*) *asiaticus* Morawitz, 1875

Bombus hortorum var. *asiatica* Morawitz in Fedtschenko, 1875: 4, lectotype worker ZMMU examined.

Bombus longiceps Smith, 1878: 8, types not seen, synonymised by Reinig (1940).

Bombus Regeli Morawitz, 1880: 337, syntype queen ZISP examined, synonymised by Skorikov (1923).

Bombus (*Sibiricobombus*) *regeli miniatocaudatus* Vogt, 1911: 61, holotype male ZMA examined (not of Vogt, 1909), synonymised by Reinig (1940).

Sibiricobombus flavodorsalis Skorikov, 1933: 248, types not seen, synonymised by Tkalců (1969).

Sibiricobombus oshanini Skorikov, 1933: 248, types not seen, synonymised by Tkalců (1969).

Pyrobombus (*Sibiricobombus*) *callophenax* (Cockerell); Tkalců, 1974: 341, misidentification.

Bombus (*Sibiricobombus*) *huangcens* Wang, 1982: 430, holotype queen IZB examined, synonymised by Williams (1998).

Bombus (*Sibiricobombus*) *heicens* Wang, 1982: 430, holotype worker IZB examined, synonymised by Williams (1998).

Bombus (*Sibiricobombus*) *flavicollis* Wang, 1985: 163, holotype worker IZB examined, synonymised by Williams (1998).

Bombus (*Sibiricobombus*) *asiaticus baichengensis* Wang, 1985: 164, holotype queen IZB examined, synonymised by Williams (1998).

Table 3. Distribution of numbers of individuals and numbers of species by elevation zones within Nepal from specimen records with elevation data

	Elevation (m)				
	≤ 999	1,000 -- 1,999	2,000 -- 2,999	3,000 -- 3,999	≥ 4,000
Individuals	13	717	821	874	332
Species	5	11	18	27	11

Bombus (*Sibiricobombus*) *asiaticus* Morawitz; Burger et al., 2009: 456.

Specimens examined. (Fig. 23) 2 queens 8 workers, 7 localities 3,048–3,900 m (BMNH, NME, NMS).

Distribution. Afghanistan, Tajikistan, Kyrgyzstan, Kazakhstan, Mongolia, Pakistan, Kashmir, Himachal Pradesh, Uttaranchal, Nepal, Sikkim, Tibet, western and southwestern China.

Discussion

Unsurprisingly, bumblebee species in Nepal differ in their distributions, with different mean elevations for each species (Table 2). Specimens are recorded here from between 671–4,877 m above sea level, although their true altitudinal range is likely to be greater, reaching approximately 5,639 m just across the border in Tibet (BMNH; Richards, 1930). The largest numbers of both bumblebee individuals and bumblebee species are recorded at elevations between 3,000–3,999 m (Table 3). These figures have not been adjusted for the differing land area in the different elevation zones, which would be expected to affect them because of the general species-area relationship (e.g. Connor and McCoy, 1979). Adjusting for equal areas would make the excess species richness at higher elevations even more exaggerated. Similarly, the figures have not been adjusted for the differing sampling efforts deployed in the different elevation zones (e.g. Colwell and Coddington, 1994). The observed pattern agrees broadly with reports from mountains both elsewhere in the Himalaya (Williams, 1991) and at the eastern edge of the Tibetan plateau (Williams et al., 2009) insofar as the highest abundance and species richness of bumblebees both occur at similar elevations in the higher mountains.

Bumblebees show a tendency to converge on one or a few colour patterns of their pile locally and these patterns are often characteristic of particular geographical regions (Plowright and Owen, 1980; Williams, 2007). The Himalayan fauna shows some of the most impressive examples of this convergence, with some species covarying closely from west to east (Richards, 1929b; Tkalců, 1968b; 1989; Williams, 2007). Our analysis is confined to females following suggestions that convergence may be driven in part at least by Müllerian mimicry among the females with stings (Plowright and Owen, 1980). In Kashmir, different colour patterns tend to be associated with different elevation zones (Williams, 1991), and the same appears to be true in Nepal (Figs 3–36). Considering just the colour pattern of the pile on the thoracic dorsum as an example (Fig. 37), the bees with this part of the thorax entirely black are most frequent between 1,000–2,000 m, in the lower warmer forests. The bees with the thoracic dorsum predominantly pale are most

frequent between 2,000–3,000 m, in the higher cooler forests. The bees with the strongly banded thoracic dorsum (i.e. with a black band or spot between the wing bases) are most frequent above 3,000 m, in the upper forest, subalpine, and alpine zones. Looking in more detail at the palest component of this thoracic pattern (Fig. 38), there appears to be a trend for the pale pile to show increasing lightness (through the series black – brown – olive – yellow – white) with increasing elevation. Increasingly light pile might confer an advantage by increasing reflectance of incident solar radiation in habitats with brighter sunlight and less shade at higher elevations. The possible significance of the black thorax at low elevations and of banded patterns at high elevations have been discussed (Williams, 1991; 2007), but the processes involved remain far from clear (Williams, 2007; Stelzer et al., 2010). Consequently much work remains to be done to explore the processes that shape bumblebee colour patterns.

As well as elevational patterns in the distributions of different species, there are also faunal differences between the west and east of Nepal. Three broad biogeographic elements can be recognised. First, a west-Himalayan element, of species reaching their eastern limits within Nepal (two species: *B. avinoviellus*, *B. novus*). Second, an east-Himalayan element, of species reaching their western limits within Nepal (eight species: *B. abnormis*, *B. eximius*, *B. grahami*, *B. luteipes*, *B. mirus*, *B. turneri*, *B. waltoni*). Third, a widespread Himalayan element, of species found throughout much of the Himalaya (the remaining majority of 24 species).

With improvements in identification aids, we look forward to field biologists in the Himalaya being able to collect many more records for critically identified bumblebee specimens in combination with precise GPS data. This should allow a much more thorough and accurate description of the Himalayan fauna to be achieved in the near future.

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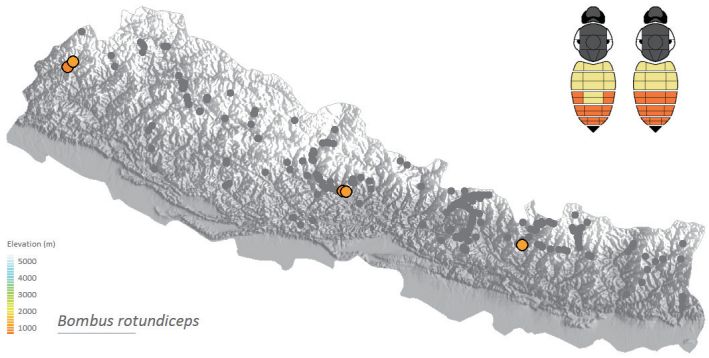

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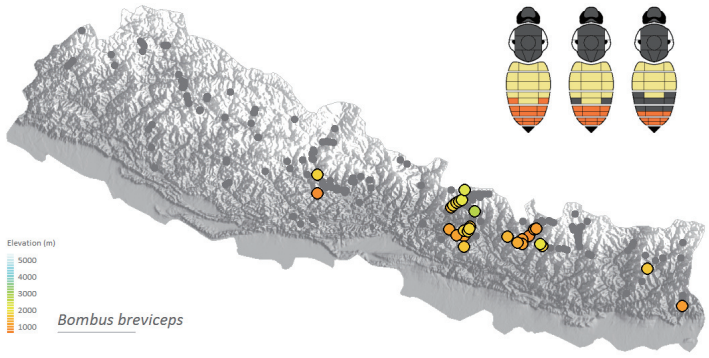

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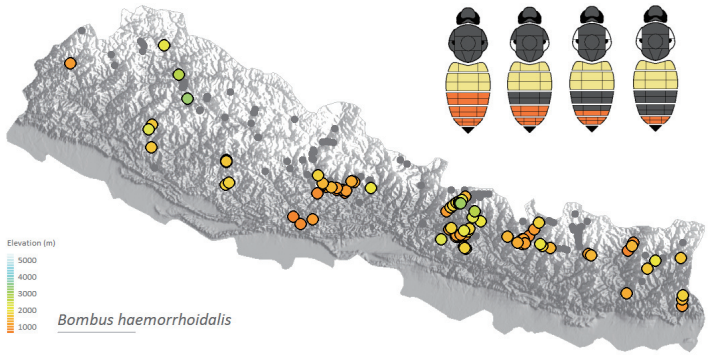

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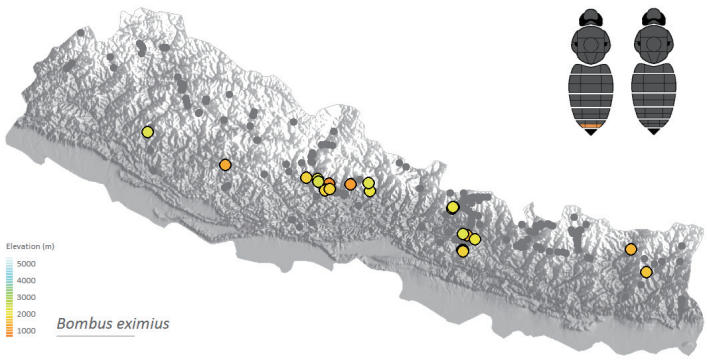
Figs 3–36. Relief maps of Nepal showing records of each bumblebee species as spots colour-coded for their elevation (scale bar shown to the left) against a background of the 350 locatable sample sites with bumblebee records (Fig. 2) shown as grey spots. Species are ordered by increasing mean elevation of their records (Table 2). The grey scale-bar line represents 100 km. For details of the base map, see Figs 1–2.



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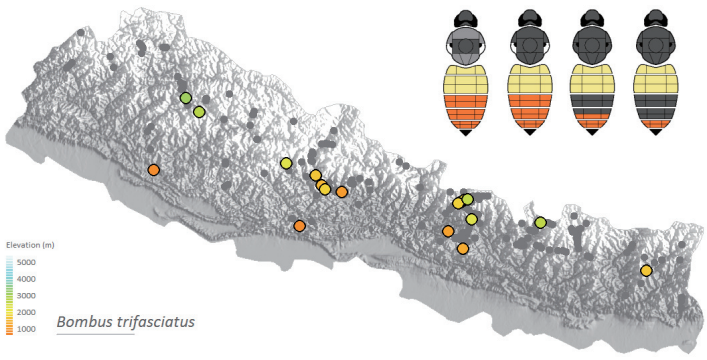

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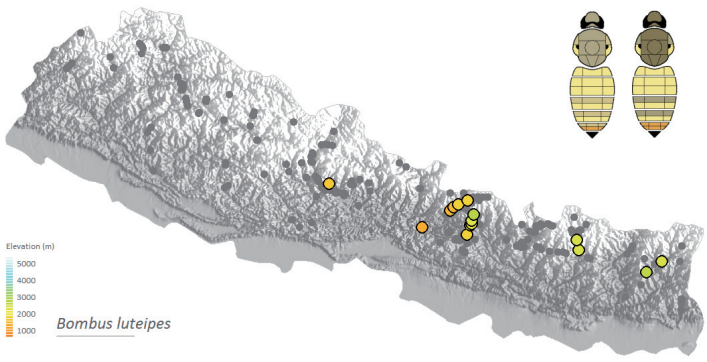

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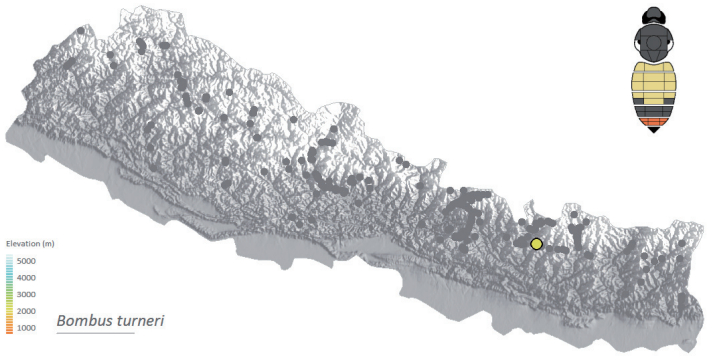
Figs 3–36. *Continued*



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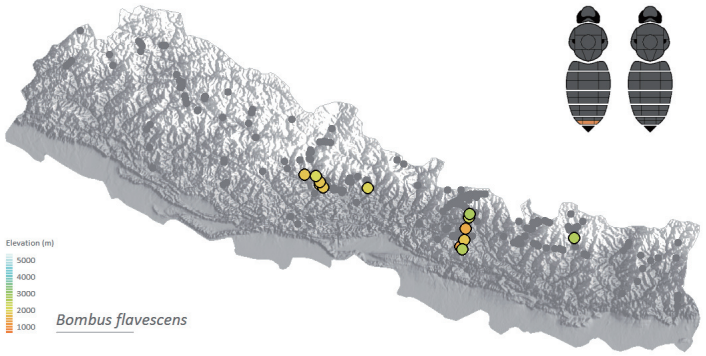

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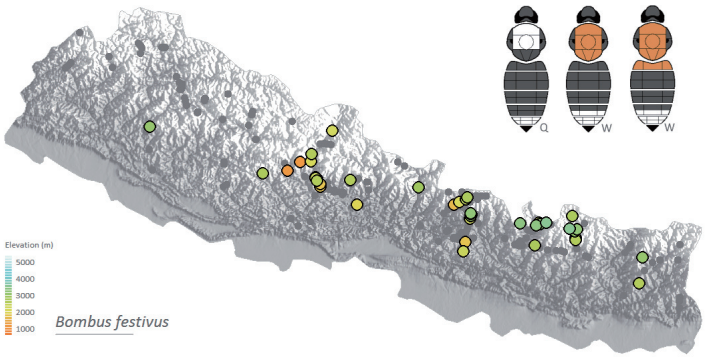

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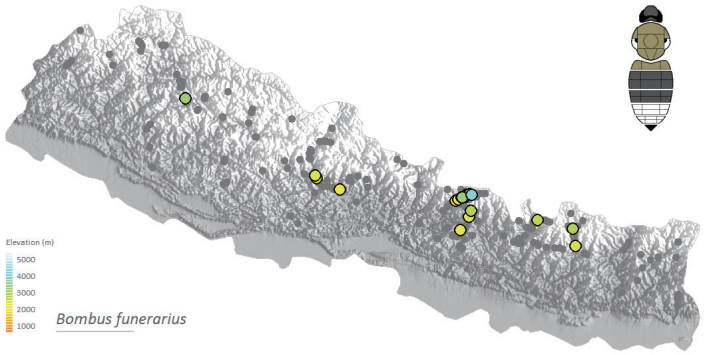
Figs 3–36. *Continued*



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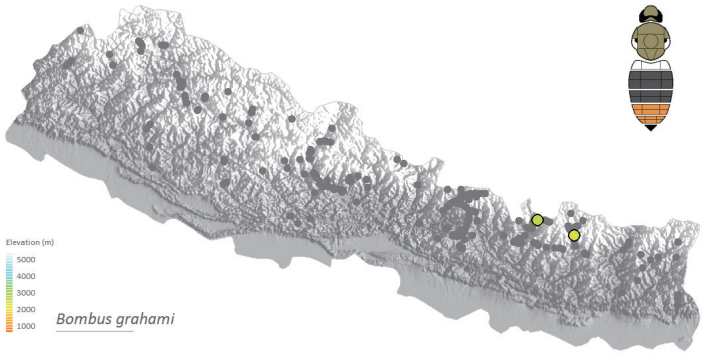

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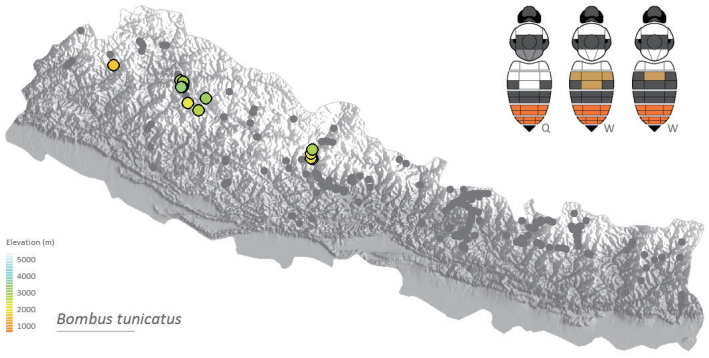

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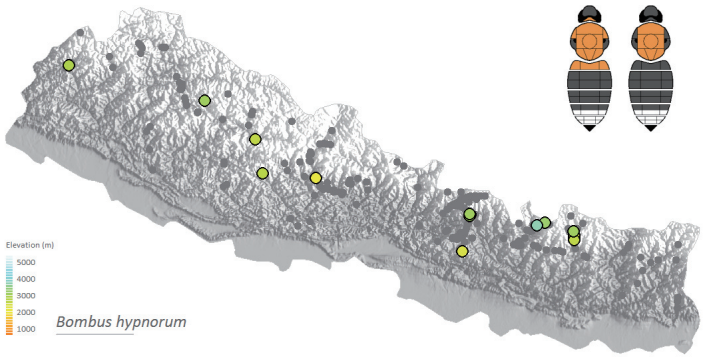

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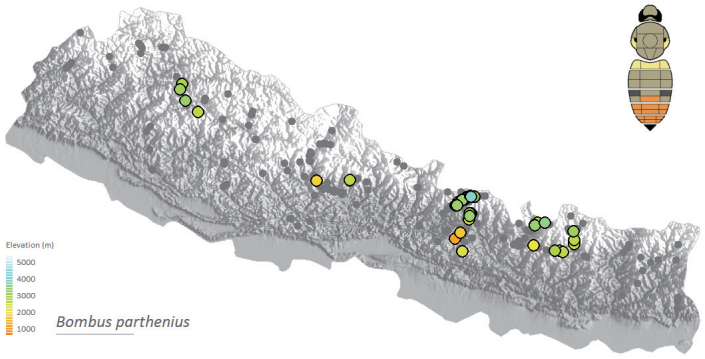

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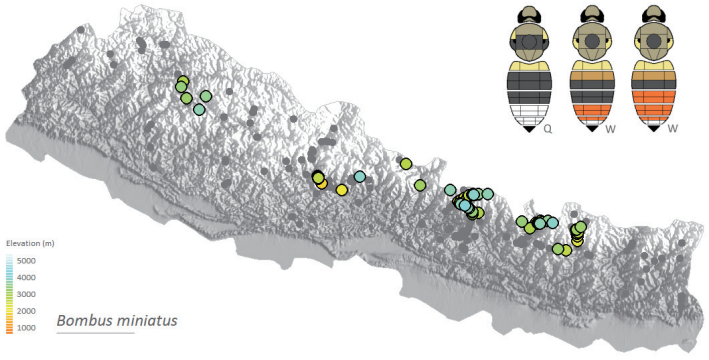

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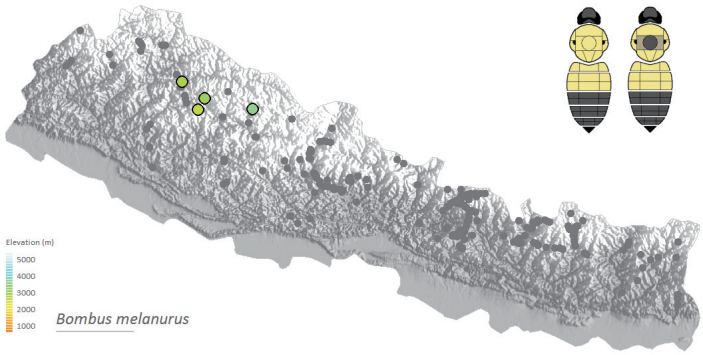

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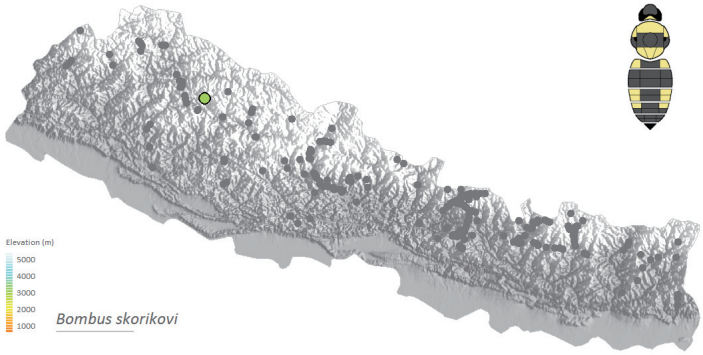

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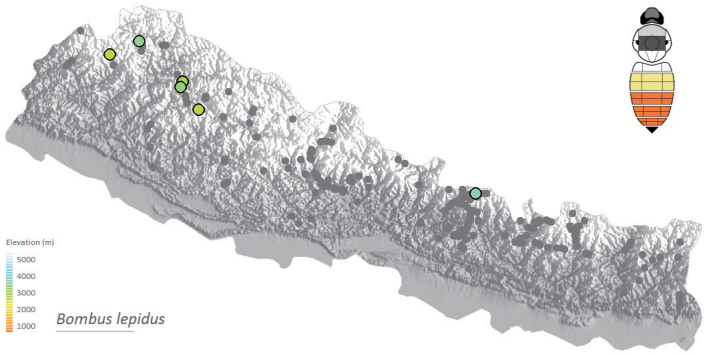

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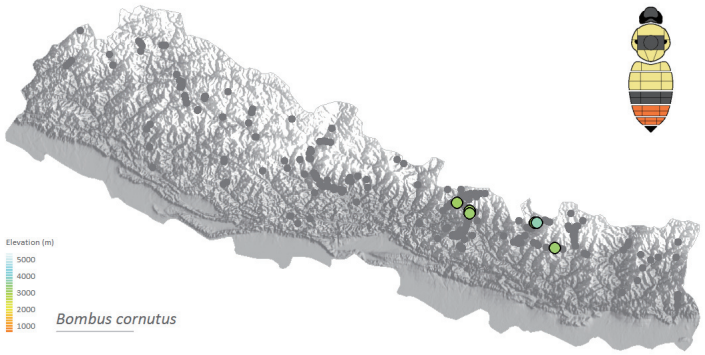

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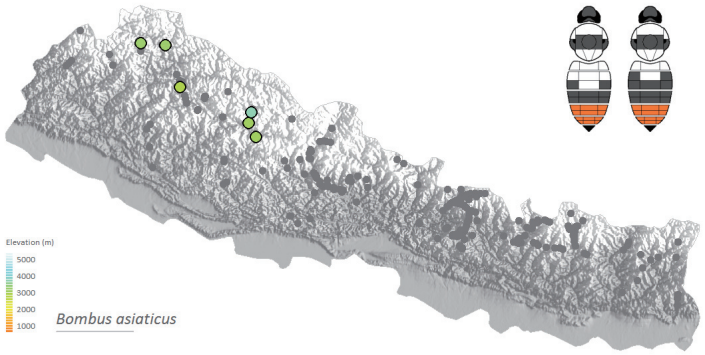

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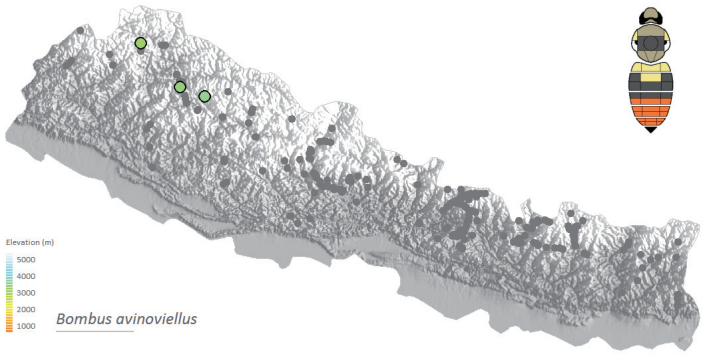

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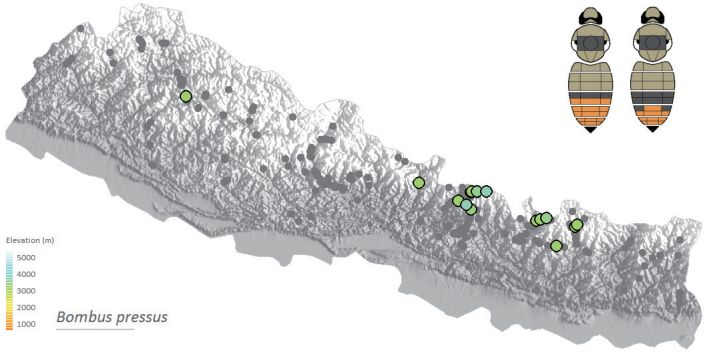

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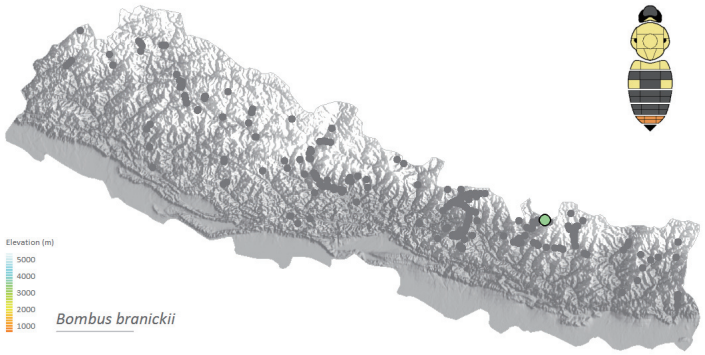

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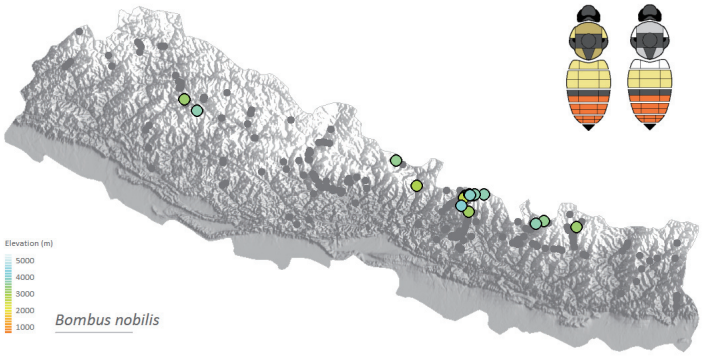

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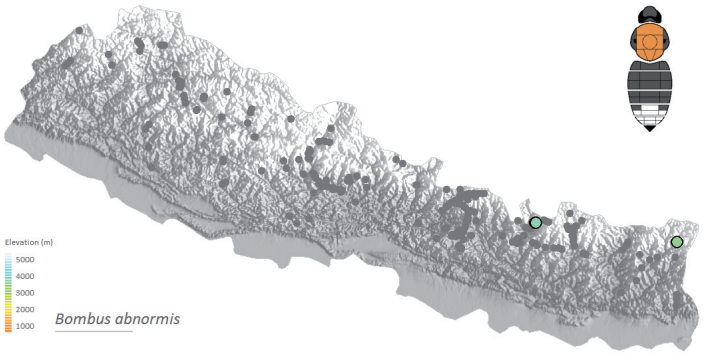

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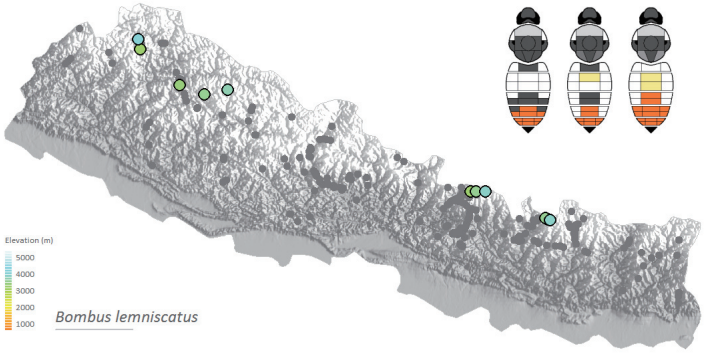

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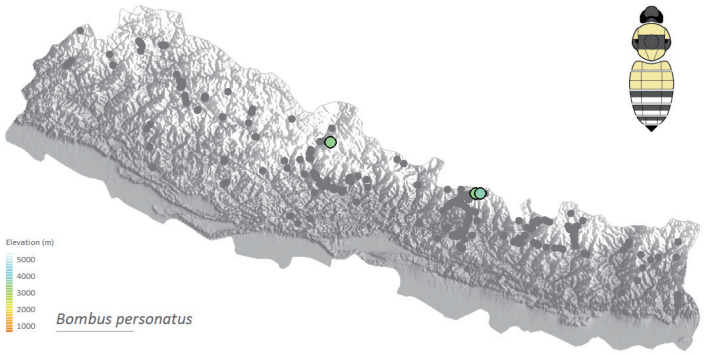

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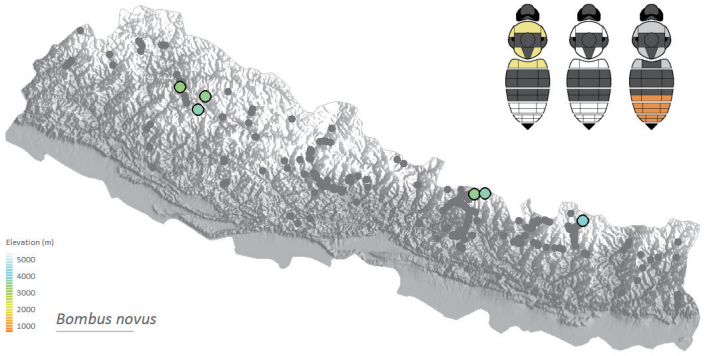

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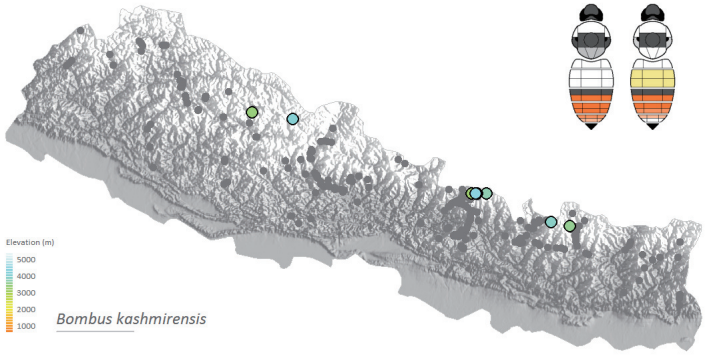

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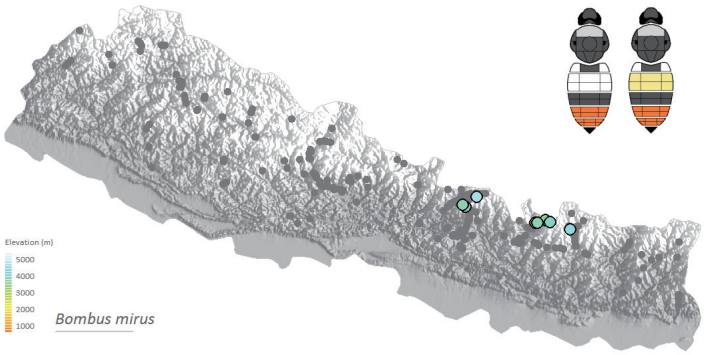

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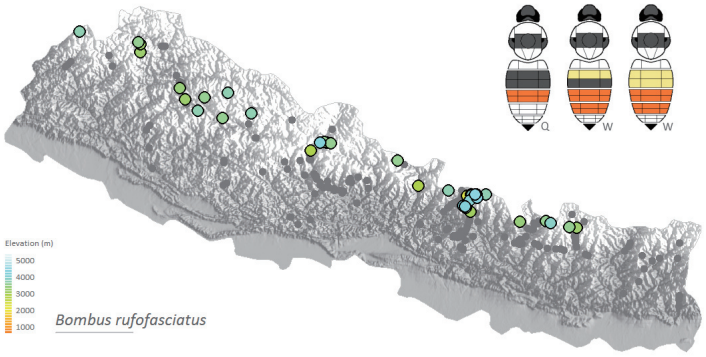

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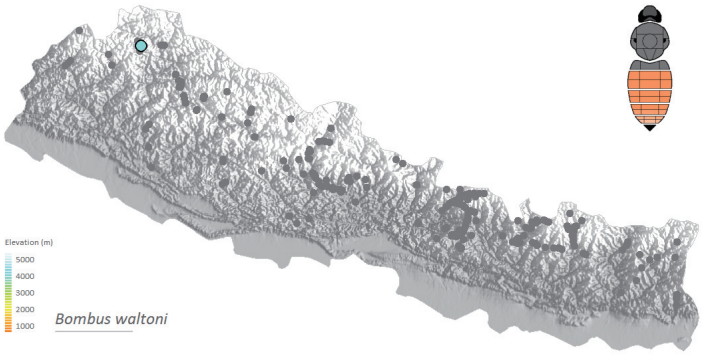

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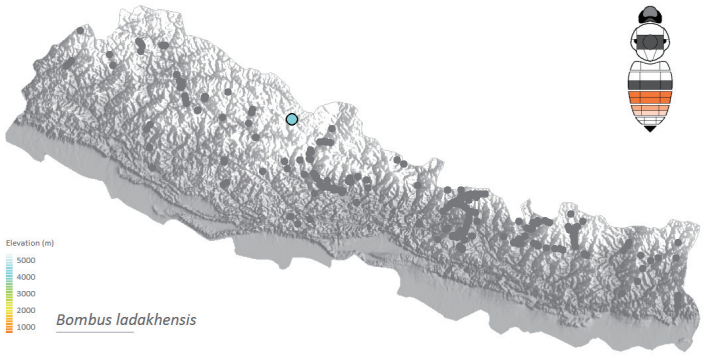

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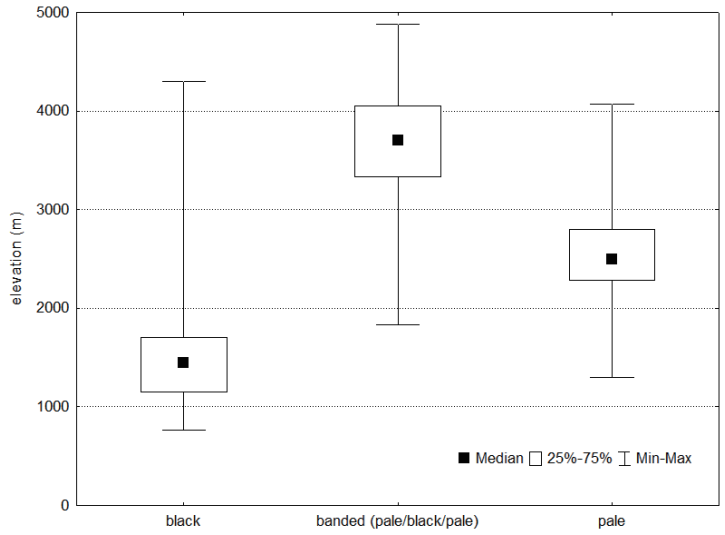

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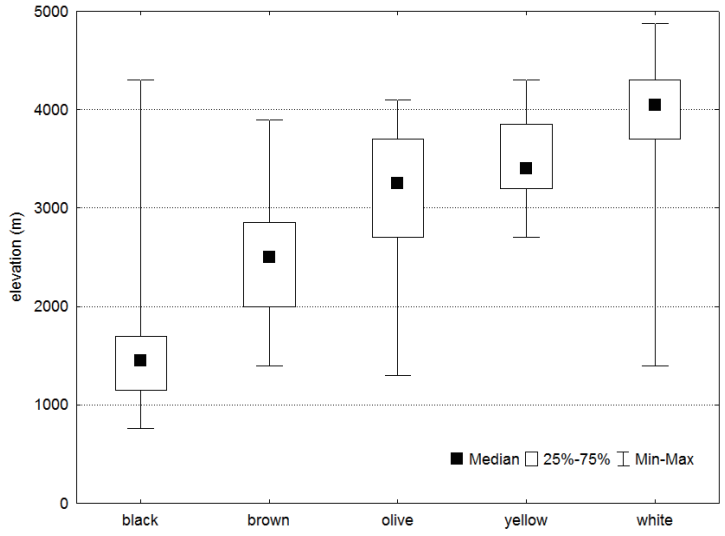

38

Figs 37–38. Distribution with elevation of female (queen and worker) specimens with different colour-pattern character states for the pile on the dorsum of the thorax. 37: Colour pattern — specimens with the thoracic dorsum (left) entirely black; (centre) pale with a black band or spot between the wing bases; or (right) predominantly pale. 38: Pale colour hue and lightness — specimens with the palest pile on the thoracic dorsum black, brown, olive (yellow or grey with a dense mixture of black hairs), yellow, or white (sometimes with a few grey hairs intermixed). Black squares show the median records, boxes show the range of the mid 50 percentile of records, and bars show the maximum and minimum records.