Bumblebee Sub Group Annual Report 2021

of the IUCN Wild Bee Specialist Group

Edited by Paul Williams (WBSG Deputy Chair for Bumblebees)

BBSG IN 2021

The BBSG exists to foster the conservation of bumblebees and their habitats around the world. In this eighth report of the BBSG's activities, 2021 has been another unusual year as the pandemic has continued to interfere with field work for many people. But despite the difficulties, there has been progress towards our goal of evaluating the extinction risk of all species of bumblebees worldwide using the IUCN Red List Criteria.

bumblebeespecialistgroup.org

THE BBSG AND THE NEW *WILD BEE SPECIALIST GROUP* (WBSG) IN 2021

Paul Williams

The BBSG is commissioned by the IUCN Species Survival Commission (SSC), with responsibilities centred around the Red List assessment of all bumblebee species world-wide (currently interpreted at *ca* 290 species). It has been running for more than two IUCN quadrennia and has completed the first assessments for most of the species of the New World and Europe. These assessments have greatly advanced conservation action by focusing on these species, allowing the most imperiled species to be listed on national, state, and local lists, with resulting projects on restoring and managing their habitats. However, Asia, with many more species and fewer specialists, remains more of a challenge, although surveys to map species distributions are now under way in the larger countries, which are compiling growing data bases of information on their bumblebees.

During 2020 a growing need was recognised by the IUCN-SSC for providing information on threats and conservation for all wild bees (*ca* 20,000 species), not just bumblebees. The SSC proposed for its *Species Strategic Plan Framework* for the next quadrennium that it would commission a more inclusive **Wild Bee Specialist Group** (WBSG), to cover all bees. The WBSG will retain the BBSG as a subgroup within the WBSG, with Paul Williams as Deputy Chair for Bumblebees and Sarina Jepsen as Deputy Chair for Conservation. With the new, greatly broadened responsibilities, leadership of the WBSG for the next quadrennium will be held jointly by Simon Potts (University of Reading, UK) and Rémy Vandame (ECOSUR, Mexico) as Co-Chairs. Oscar Martinez and Rich Hatfield will serve as Red List Authorities for the new WBSG.

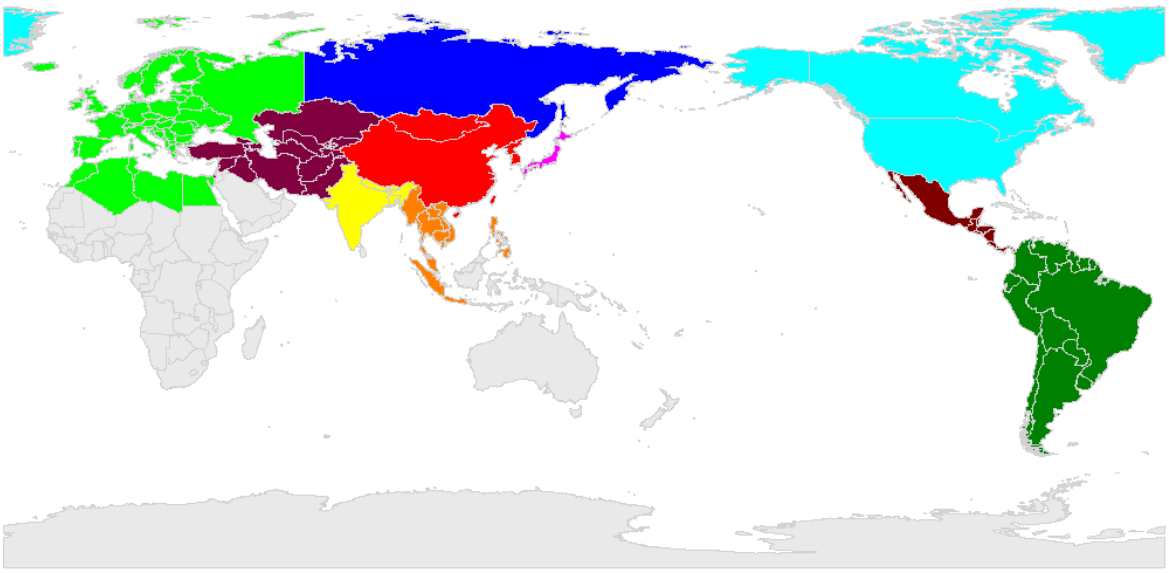
As BBSG Regional Coordinators, in the Himalaya, Dr Rifat Raina has succeeded Prof. Malkiat Saini; in Japan, Dr Tomoyuki Yokoi has succeeded Dr Koichi Goka; in Mesoamerica, Oscar Martínez has succeeded Dr Rémy Vandame; in Europe, Dr Guillaume Ghisbain has succeeded Prof. Pierre Rasmont; and in Southeast Asia, Chawatat Thanoosing is assisting Dr Panuwan Chantawannakul. We are all immensely grateful for the time and effort that everyone contributes.

The formation of the WBSG is an exciting new opportunity to achieve more for the conservation of all bees world-wide. Sarina and I very much hope that BBSG members will not only continue to contribute to the work on bumblebees, but will also help to make a difference for the conservation of all other wild bees as well. ●

One of the most northerly distributed of all arctic bumblebees, B. pyrrhopygus. (Photo by G. Holmström.)

UPDATE ON PROGRESS TOWARDS GATHERING DATA INTO REGIONAL DATABASES FOR REGIONAL RED-LIST ASSESSMENTS

Paul Williams



BBSG regions.

Below is an overview of the progress so far in compiling database information on species distributions across our different BBSG regions. This is a challenging long-term process, requiring a lot of work to achieve good representative coverage and to do it with precision.

Please do contact me or other groups to see what can be done if you need help or advice. Many of the problems are experienced by all, so solutions may be out there to be shared! Let us know what information is most needed to help with their regional process. ●

BBSG region as at end 2021	Approximate number of species present*	Number of species with database records	Total number of records	Number of species Red-List assessed	Number of species assessed 'Data Deficient'
East Asia	124	122	50,341	0	-
Europe	79	79	757,510	68	6
West Asia	73	33	5500	0	-
North Asia	68	24	2,392	0	-
Himalaya	63	17	1,775	0	-
North America	49	49	845,735	46	5
Southeast Asia	27	23	1,157	0	-
South America	25	1	>3000	22	12
Mesoamerica	18	18	32,984	18	1
Japan	14	-	-	-	-

** affected by variations in the species concepts adopted*

EAST ASIA

Approximately 124 species are currently recognised, although several species groups are being revised, with the promise that more species will be added soon. No species have yet been assessed for Red List status within East Asia. At least 23 species are considered endemic, so that more than 100 need to be assessed beyond East Asia (some species just cross the border into the Himalaya region or into the Southeast Asia region). Within East Asia, much effort has been put into recording and databasing distributions, so that Red List assessments should be possible within the next few years.

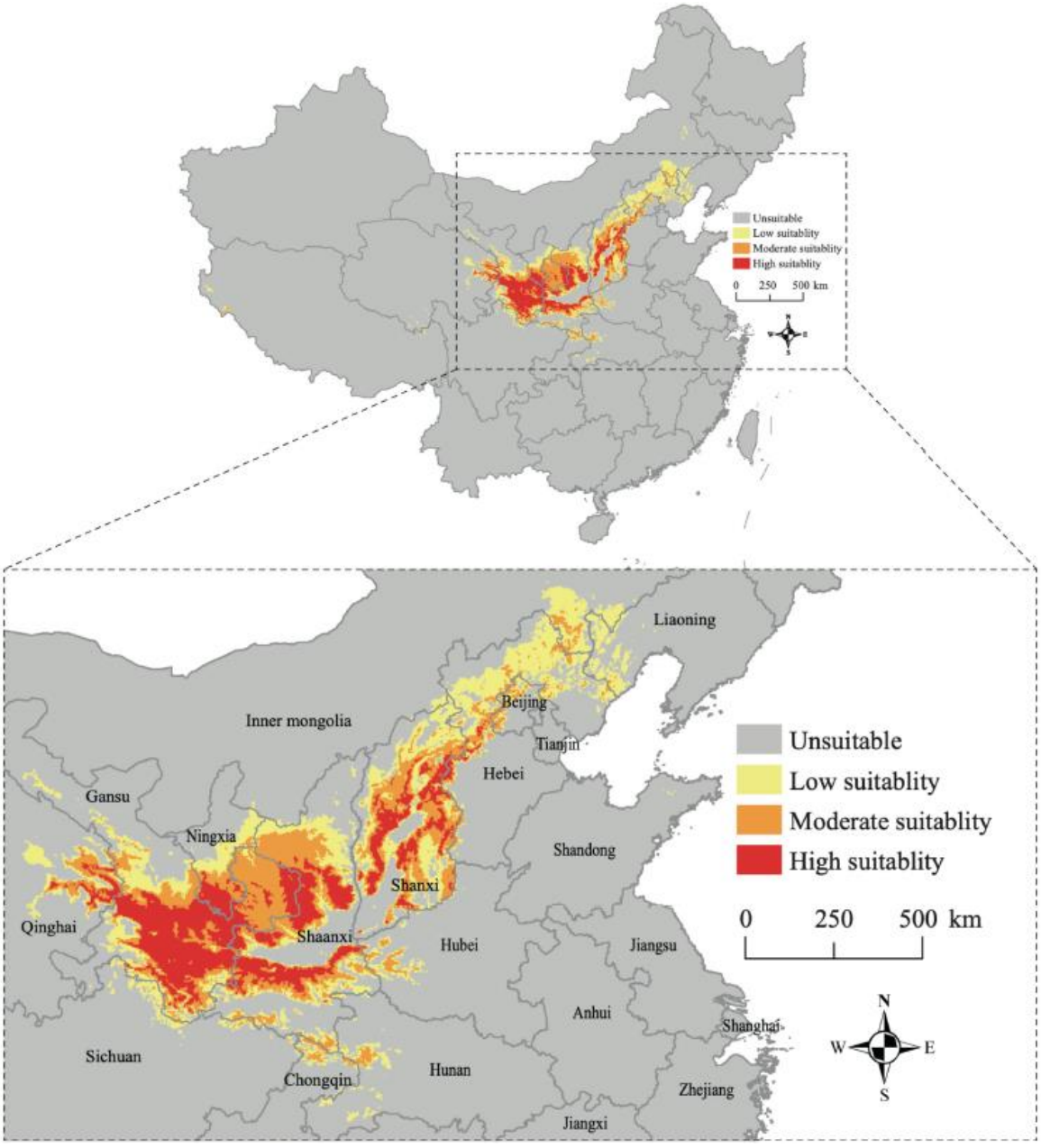
East Asian Region in 2021
Jiandong An / Jiaxing Huang / Hong Zhang / Guiling Ding / Yanjie Liu

During 2021, more bumblebees from southern China have been added to the IAR collection. A survey of bumblebees was made in the Nanling mountains (Guangdong and Hunan) and the Wuyishan mountains (Fujian and Jiangxi) in the subtropical region of southern China, supported by the Zhilan Foundaton. A total of 486 specimens of nine species (*B. flavescens*, *B. breviceps*, *B. trifasciatus*, *B. bicoloratus*, *B. haemorrhoidalis*, *B. eximius*, *B. braccatus*, *B. imitator*, and *B. atripes*) were collected during six field visits between Oct 2020-Dec 2021. The results of the survey show that it is much more difficult to discover and to collect bumblebees in subtropical southern China than in temperate northern China. The most abundant bumblebee species is *B*. *flavescens* with 221 bees. *Bombus breviceps* (100 bees) and *B. trifasciatus* (83) are also very common, while *B. imitator* and *B. atripes* are very rare: for both only one individual was collected in the region of the Nanling-Wuyishan mountains (below).

Bombus atripes visiting Liriope sp. (Convallariaceae) in Jiangsu of southern China in 2019. (Photo by Hong Zhang.)

We also evaluated the habitats and their implications for the conservation of the most abundant endemic bumblebee species in China, *B. pyrosoma*, based on records of 8436 bees collected between 1905-2019. These were divided into three groups, historical (1905-2000), current (2000-2016), and a test sample (2019). The results showed that more than 85% of

the sampling sites in 2019 were found to be suitable under the current climate and management. The area with low to moderate suitability for *B. pyrosoma* increased, while the area with high suitability decreased under the future A1B and A2 climate-change scenarios in 2050 and 2100. Furthermore, regions covering seven provinces in north-central China were the most important for developing nature reserves for *B. pyrosoma*, with the following order of suitability: Gansu, Shanxi, Ningxia, Qinghai, Shaanxi, Hebei and Beijing (below). This study highlights the expected impact of future climate changes on the distribution of *B. pyrosoma*. Conservation strategies will need to mitigate the threats posed by environmental changes, particularly in the current high-suitability areas. ●



Map of China shows the current distribution of B. pyrosoma predicted using MaxEnt (Hu et al, 2021).

Reference

Hu X, Liu J, Ding G, Naeem M, Li J, Ma F, Huang J, An J. (2021) An evaluation of habitat uses and their implications for the conservation of the Chinese bumblebee *Bombus pyrosoma* (Hymenoptera: Apidae). *Frontiers in Ecology and Evolution*, 9, 667949. https://doi.org/10.3389/fevo.2021.667949

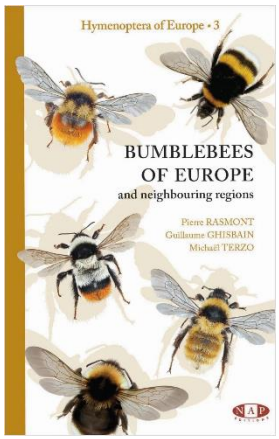
EUROPE

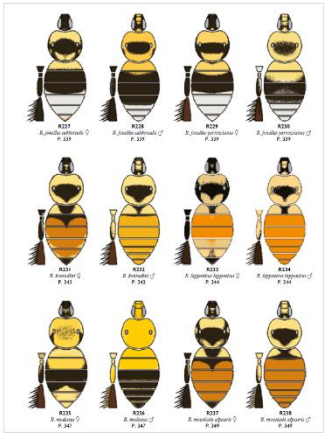
Approximately 79 species have been recognised in Europe (West Palaearctic) recently (depending on the species concept accepted). Within Europe, distributions are relatively well recorded and databased, so that baseline data are available (by arrangement) for comparison in the future.

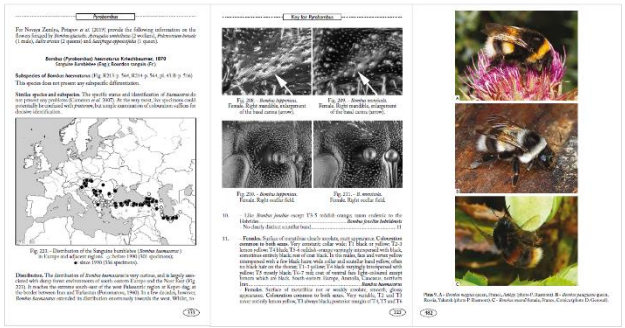
European Region in 2021

Guillaume Ghisbain / Pierre Rasmont

A new book about the bumblebees of the West Palaearctic







Pierre Rasmont, Guillaume Ghisbain and Michaël Terzo are delighted to announce the publication of their new book *Bumblebees of Europe and neighbouring regions*, available in English and French versions at the editions NAP (Verrières-le-Buisson, France).

After an introduction on the ethology, ecology, taxonomy and conservation of bumblebees, the book provides identification keys for the 14 subgenera and 79 species present in the West Palaearctic region. Each species is presented with notes on its distribution, habitats, cohabitations, courtship behaviour, nesting behaviour, flower preferences, inquiline relations and conservation. Taxonomic remarks are also provided for all species of the region, considering the most recent findings. Original photos are included for each of the West Palaearctic species, with some extremely rare bumblebees being pictured for the very first time. The book also features many colour plates to help readers recognize over 240 infraspecific taxa in the region.

Data records for the bumblebees of the West Palaearctic

Atlas Hymenoptera Database

The Atlas Hymenoptera database (*Banque de Données de Gembloux et Mons*, UMons, Belgium) presently includes data on 1,379,237 bumblebee specimens aggregated in 757,510 entries. There are few new entries compared to 2021, and the last months have not been very active in field observations and collections because of the pandemic.

Publications with new data records

Bąk-Badowska et al. (2021) provide information about >6000 bumblebee specimens from 25 species found in southern Poland.

Boustani et al. (2021), in their checklist of the bees of Lebanon, provide detailed data records for *B. argillaceus, B. melanurus, B. niveatus,* and *B. terrestris* in the country.

Potapov & Kolosova (2021) summarized the data on the distribution of *B. consobrinus* in north European Russia.

There are still several bumblebee species for which recent data remain especially scarce. Any verified observations of the following bumblebees are welcome:

• *B.* (*Alpinobombus*) *polaris pyrrhopygus* (*B. pyrrhopygus* could also be considered as a species separate from the Nearctic *B. polaris* depending on the species concept used [Williams et al. 2019]): to look for in Scandinavia and the European part of Russia.

• *B.* (*Bombias*) *confusus*: to look for across the whole West Palaearctic.

• *B.* (*Bombus*) *patagiatus*: to look for close to the Finnish border, near Lake Ladoga.

• *B.* (*Cullumanobombus*) *cullumanus*: to look for in the whole West Palaearctic. The last record was in 2009 for the ssp. *cullumanus*.

• *B.* (*Megabombus*) *saltuarius:* to look for near the Ural Mountains (Russia). Last record in 1992.

• *B.* (*Melanobombus*) *eriophorus s.str.* (may be conspecific with *B. caucasicus* [see Williams et al. 2020]) to look for in the mountains of the Caucasus. Last record in 1953.

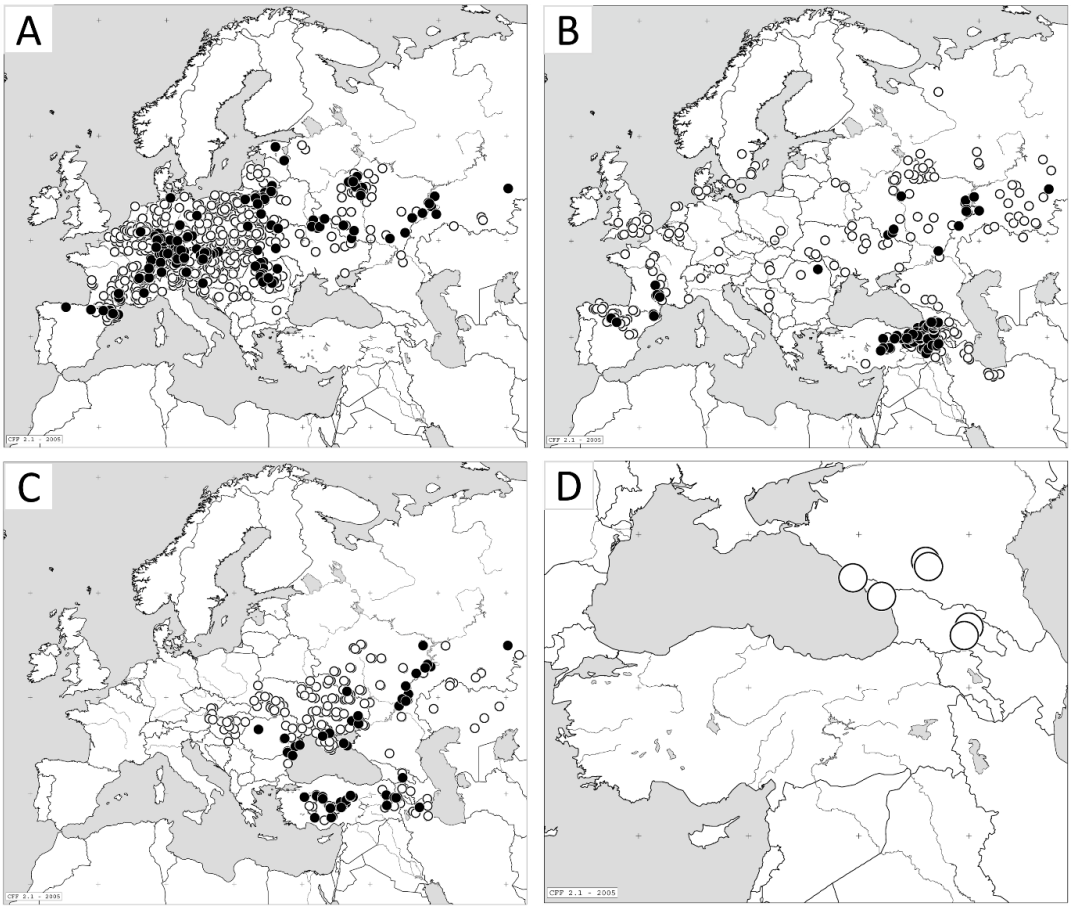
• *B.* (*Pyrobombus*) *konradini*: to look for in the Central Apennines (Italy).

• *B.* (*Pyrobombus*) *modestus*: to look for between Moscow and the Ural (Russia), within the boreal forest.

• *B.* (*Subterraneobombus*) *fragrans*: to look for in in the steppes of eastern Austria, Hungary, Romania, Ukraine, Russia, Turkey and Iran.

• *B.* (*Thoracobombus*) *pomorum*: to look for across the whole West Palaearctic.

• *B.* (*Thoracobombus*) *ruderarius tunensis*: to look for in Tunisia and Algeria.



Maps of selected declining bumblebee species in Europe and neighbouring regions. White points correspond to data before 1970, black points to data from 1970 to 2021. A – B. confusus, B – *B. cullumanus*, C – *B. fragrans*, D – *B. eriophorus* (*s. str.*). *All maps from Rasmont et al. (2021) in NAP Editions.*

Taxonomy of West Palaearctic bumblebees

Bombus hortorum reinigiellus. (Photo by Thomas Wood.)

An expedition led by Guillaume Ghisbain and Diego Cejas in the Sierra Nevada mountains (Southern Spain) allowed collection of males and workers of the taxon *reinigiellus*, then considered as a rare, endemic and endangered species. However, through an integrative taxonomic approach including genetics, morphometrics and semio-chemistry, Ghisbain et al. (2021) demonstrated the conspecificity of this taxon with one of the most common and widespread bumblebee species of Europe, *B. hortorum*. The authors assign a subspecies status to this taxon (*B. hortorum reinigiellus*), shown to be different in colour and morphology but also in wing shape and relative wing size compared to the other conspecific subspecies. Following their taxonomic revision, the authors re-assessed the IUCN conservation status of *B. hortorum* both at the continental and Spanish scale. They discuss how historic climatic oscillations of the last Ice age could explain such a phenotypic divergence in a post-glacial refugium and highlight the critical role of establishing unambiguous taxonomic revision prior to any conservation assessment.

Bombus mucidus pittioniellus. (Photo by Pierre Rasmont in NAP Editions.)

In a study based on genetic and semio-chemical traits, Brasero et al. (2021) conducted an integrative taxonomic analysis to evaluate species-delimitation hypotheses within a monophyletic group of bumblebees including the formerly recognised subgenera *Eversmannibombus*, *Laesobombus* and *Mucidobombus,* which are now included in the subgenus *Thoracobombus*.

Their results demonstrate the conspecificity of the taxa *persicus* and *eversmaniellus* (as part of *B. persicus*), the taxa *laesus* and *mocsaryi* (as part of *B. laesus*) and the taxa *mollis, mucidus* and *pittioniellus* (as part of *B. mucidus*). The authors also formally recognize the subspecies *B. laesus aliceae*, endemic to North Africa, based on its allopatry, unique mitochondrial haplotype and divergent cephalic labial gland secretions. Following their taxonomic revision, the authors re-assessed the IUCN conservation status of *B. laesus* as Near Threatened at the European level.

Bombus xanthopus. (Photo by Pierre Rasmont in NAP Editions.)

Williams (2021) re-assessed the taxonomic status of the bumblebees of the subgenus *Bombus s.str.* based on genetic sequences published in an earlier study (Williams et al. 2012). The previous analysis of the data recognized a total of 17 species. The same global sample of 559 COI-barcodes was re-assessed for evidence of species' coalescents using Poisson-tree-process models applied to the longest available unique haplotypes.

In addition to giving improved species support for four Asian and one American taxa, the author discusses the difficult case of the taxon *xanthopus* from Corsica, that could be elevated or not to species status depending on the species concept used. An assessment of the taxon *renardi* from Corsica (considered either as subspecific in *B. lucorum* or as a separate species) in the light of this global dataset would be useful for future faunal and conservation studies.

Bombus terrestris canariensis. (Photo by Pierre Rasmont in NAP Editions.)

Ruiz et al. (2021) characterized the mitogenome of the endemic taxon *canariensis* from the Canary Islands, confirming its subspecies status within *B. terrestris* and its close phylogenetic relationship with the North African subspecies *africanus*. The Bayesian phylogenetic tree presented in the study makes the taxon *xanthopus* from Corsica appear within the *B. terrestris* clade.

Global change and conservation

a. Bumblebees under climate and habitat change (selected publications)

Two studies investigated the recent expansion of the Tree Bumblebee (*B. hypnorum*) in the United Kingdom. Using microsatellite genotyping and estimates of diploid male production, Brock et al. (2021) highlighted that population did not undergo a severe genetic bottleneck, showing levels of genetic diversity comparable to that of other widespread and range-restricted bumblebees. These results could suggest a continued gene flow from the continental source population of *B. hypnorum.* In another study, Huml et al. (2021) reconstructed the likely pattern of colonization of *B. hypnorum* in the UK based on RAD-seq population genomic data combined with Bayesian modelling. The authors report a dynamic and complex colonization pattern that is likely to still be ongoing. They suggest that either a shift in migration potential, transport, and/or other genomic changes have contributed to the recent expansion of the species in the country.

Observations from bird-migration sites have documented mass-migration events in bumblebee queens, with peak migration of 70 individuals per minute. The database trektellen.org contains daily counts of >1,000 migrating queens past single points in the UK and the Netherlands, mostly in early spring. Queens were observed flying towards the sea, at sea, and coming from sea, and they suggested that they can cross important water bodies and migrate for several hundreds of kilometers. Implications for bumblebee conservation are far-reaching, as these migration events could imply that bumblebees in highly disturbed areas (e.g. agricultural landscapes) may be continuously supplemented by queens from distant productive natural areas (Fijen, 2021).

Martinet et al. (2021) assessed the resistance to heat stress in 39 bumblebee species from 3 continents, 6 biomes and 20 regions, for a total of >2300 specimens tested. Interspecific variability in time before heat stupor was significant, in contrast to intraspecific variability, which is consistent with heat resistance being a species-specific trait. In their study, cold-adapted species were shown to be much more sensitive to heat stress than temperate and Mediterranean species. The results of this study can help to explain recent population declines and range shifts in bumblebees following climate change. Recent results from Maebe et al. (2021a) also confirm that thermal tolerance in the workers of several subspecies of *B. terrestris* were similar, except for the insular *B. terrestris canariensis* queens, which were the least cold tolerant.

In Ireland, Phelan and colleagues (2021) investigated the ecology of *B. distinguendus*, a bumblebee classified as Endangered on the Irish Red List and Vulnerable at the European level. The authors report that the highest numbers of *B. distinguendus* were found in two natural reserves, and only in a few species-rich and ecologically suitable sites outside these reserves. Smaller suitable habitats along roads and in urban areas were not used by the species, suggesting issues with habitat connectivity and/or availability of resources (nesting, hibernation) and/or patch size. Phelan et al. suggest that conservation management should focus on delaying cutting grasslands until late September, winter grazing of stock, improve landscape connectivity between suitable habitats and reduce pesticide and fertilizer input to restore forage ability late in the season.

Theodorou et al. (2021) found workers of *B. terrestris* to be larger in cities and the body size of *B. terrestris, B. lapidarius* and *B. pascuorum* to be positively correlated with road density. Higher temperatures at sampling were associated with smaller body sizes and an increase in body size variation in the studied species. The authors also found that community-weighted

mean body size and its variation increased with urbanization. Urbanization is suggested to have an indirect positive effect on pollination services through its effects on flower visitation rate and on community-weighted body size and its variation.

Investigating the collection patterns of 58 bumblebee species from Europe and North America, Wood et al. (2021) aimed to determine whether bumblebees displayed specific patterns of pollen collection. Results demonstrate that a conserved pattern of dietary dissimilarity across species driven by collection of pollen from Fabaceae. The authors show that despite being generalists, bumblebees are subject to dietary restrictions that constrain their foraging choices. These constraints have important implications for their persistence in altered environments if their resources come to decline.

b. Reviews on bumblebee conservation and resilience

Integrating evidence from the comparative ecology and resilience of bumblebees and other wild bees, Ghisbain (2021) discusses the relevance of using *Bombus* as 'radar' for wild bee decline worldwide. Using many examples from the European literature on these organisms, this work highlights the need for a more extensive sampling of bumblebees and other wild bees, reinforces the need for conservation actions that consider a higher level of understanding of their ecological diversity, and emphasizes that caution is needed when extrapolating trends from model groups such as bumblebees.

Maebe et al. (2021b) provide an up-to-date review on the ways by which bumblebees overcome threats associated with global changes, using examples relevant to the fields of bumblebee behaviour, dispersal, morphology, phenology and physiology. The authors also speculate on which adaptive responses to climate change should be influenced by the capacity of bumblebees to disperse and track suitable conditions.

c. European project ORBIT

The year 2021 marked the beginning of **ORBIT**, a three-year project commissioned by the Directorate General for Environment of the European Commission to develop resources for European bee inventory and taxonomy. **The objective of this European project is to generate a centralised taxonomic facility that lays the groundwork for the identification of all European wild bees, including all bumblebee species**. This project will support other European projects such the EU Pollinator Monitoring Scheme (EU-PoMS), the Preparatory Action for EU Pollinator Monitoring Scheme and Indicators (SPRING project), the Horizon 2020 Europe research projects (POSHBEE, SAFEGUARD), national action plan for pollinators, and finally the European Red List of Bees. Through ORBIT, the European Commission aims to make tools accessible to researchers to identify all European bees to facilitate large-scale studies on trait-based biodiversity patterns and responses of wild bees to global change in Europe.

The project is managed and coordinated by Denis Michez and Paolo Rosa from the University of Mons (Belgium). Guillaume Ghisbain and Pierre Rasmont are the expert taxonomists responsible for generating the material related to the identification of all European bumblebees. More information can be found at https://orbit-project.eu.

References

Bąk-Badowska J, Wojciechowska A, Czerwik-Marcinkowska J (2021) Effects of open and forest habitats on distribution and diversity of bumblebees (*Bombus*) in the Małopolska Upland (Southern Poland): case study. *Biology* 10, 1266. https://doi.org/10.3390/biology10121266

Boustani M, Rasmont P, Dathe HH, Ghisbain G, Kasparek M, Michez D, Müller A, Pauly A, Risch S, Straka J, Terzo M, Van Achter X, Wood TJ, Nemer N (2021) The bees of Lebanon (Hymenoptera: Apoidea: Anthophila). *Zootaxa* 4976, 1–146. https://doi.org/10.11646/zootaxa.4976.1.1

Brasero N, Ghisbain G, Lecocq T, Michez D, Valterová I, Biella P, Monfared A, Williams PH, Rasmont P, Martinet B (2021) Resolving the species status of overlooked West-Palaearctic bumblebees. *Zoologica Scripta* 50, 616–632. https://doi.org/10.1111/zsc.12486

Brock RE, Crowther LP, Wright DJ, Richardson DS, Carvell C, Taylor MI, Bourke AFG (2021) No severe genetic bottleneck in a rapidly range-expanding bumblebee pollinator. *Proceedings of the Royal Society B: Biological Sciences* 288, 20202639. https://doi.org/10.1098/rspb.2020.2639

Ghisbain G (2021) Are bumblebees relevant models for understanding wild bee decline? *Frontiers in Conservation Science* 2, 752213. https://doi.org/10.3389/fcosc.2021.752213

Ghisbain G, Martinet B, Wood TJ, Przybyla K, Cejas D, Gérard M, Rasmont P, Monfared A, Valterová I, Michez D (2021) A worthy conservation target? Revising the status of the rarest bumblebee of Europe. *Insect Conservation and Diversity* 14, 661–674. https://doi.org/10.1111/icad.12500

Huml JV, Ellis JS, Lloyd K, Benefer CM, Kiernan M, Brown MJF, Knight ME (2021) Bucking the trend of pollinator decline: the population genetics of a range expanding bumblebee. *Evolutionary Ecology* 35, 413–442. https://doi.org/10.1007/s10682-021-10111-2

Maebe K, De Baets A, Vandamme P, Vereecken NJ, Michez D, Smagghe G (2021a) Impact of intraspecific variation on measurements of thermal tolerance in bumble bees. *Journal of Thermal Biology* 99, 103002. https://doi.org/10.1016/j.jtherbio.2021.103002

Maebe K, Hart AF, Marshall L, Vandamme P, Vereecken NJ, Michez D, Smagghe G (2021b) Bumblebee resilience to climate change, through plastic and adaptive responses. *Global Change Biology* 27, 4223–4237. https://doi.org/10.1111/gcb.15751

Martinet B, Dellicour S, Ghisbain G, Przybyla K, Zambra E, Lecocq T, Boustani M, Baghirov R, Michez D, Rasmont P (2021) Global effects of extreme temperatures on wild bumblebees. *Conservation Biology* 35, 1507–1518. https://doi.org/10.1111/cobi.13685

Phelan N, Suddaby D, Stanley DA (2021) Investigating the ecology of the Great Yellow Bumblebee (*Bombus distinguendus*) within the wider bumblebee community in North-West Ireland. Journal of Insect Conservation 25: 297–310. https://doi.org/10.1007/s10841-021-00299-7

Potapov G, Kolosova Y (2021) *Bombus* (*Megabombus*) *consobrinus* Dahlbom, 1832 in the European North of Russia: its distribution and foraging preference. *Fauna norvegica* 41, 27–33. https://doi.org/10.5324/fn.v41i0.3903

Rasmont P, Ghisbain G, Terzo M (2021). Bumblebees of Europe and neighbouring regions. N.A.P. Editions, Verrières-le-Buisson, France, 632 pp. https://www.napeditions.com/en/65-bum.html

Ruiz C, Cejas D, Muñoz I, De la Rua P (2021) Characterizing the Mitogenome of the Endemic Bumblebee Subspecies from the Canary Islands for Conservation Purposes. *Sociobiology* 68, e5910. https://doi.org/10.13102/sociobiology.v68i3.5910

Theodorou P, Baltz LM, Paxton RJ, Soro A (2021) Urbanization is associated with shifts in bumblebee body size, with cascading effects on pollination. *Evolutionary Applications* 14, 53–68. https://doi.org/10.1111/eva.13087

Williams PH (2021) Not just cryptic, but a barcode bush: PTP re-analysis of global data for the bumblebee subgenus *Bombus s. str.* supports additional species (Apidae, genus *Bombus*). *Journal of Natural History* 55, 271-282. https://www.tandfonline.com/doi/abs/10.1080/00222933.2021.1900444

Williams PH, Altanchimeg D, Byvaltsev A, De Jonghe R, Jaffar S, Japoshvili G, Kahono S, Liang H, Mei M, Monfared A, Nidup T, Raina R, Ren Z, Thanoosing C, Zhao Y, Orr M (2020) Widespread polytypic species or complexes of local species? Revising bumblebees of the subgenus *Melanobombus* world-wide (Hymenoptera, Apidae, Bombus). *European Journal of Taxonomy* 719: 1-120. https://doi.org/10.5852/ejt.2020.719.1107

Williams PH, Berezin MV, Cannings SG, Cederberg B, Ødegaard F, Rasmussen C, Richardson LL, Rykken J, Sheffield CS, Thanoosing C, Byvaltsev AM (2019) The arctic and alpine bumblebees of the subgenus *Alpinobombus* revised from integrative assessment of species' gene coalescents and morphology (Hymenoptera, Apidae, *Bombus*). *Zootaxa* 4625: 1-68. https://doi.org/10.11646/zootaxa.4625.1.1

Williams PH, Brown MJF, Carolan JC, An J, Goulson D, Aytekin AM, Best LR, Byvaltsev AM, Cederberg B, Dawson R, Huang J, Ito M, Monfared A, Raina RH, Schmid-Hempel P, Sheffield CS, Šima P, Xie Z (2012) Unveiling cryptic species of the bumblebee subgenus *Bombus s. str.* worldwide with COI barcodes (Hymenoptera: Apidae). *Systematics and Biodiversity* 10, 21–56. https://doi.org/10.1080/14772000.2012.664574

Wood TJ, Ghisbain G, Rasmont P, Kleijn D, Raemakers I, Praz C, Killewald M, Gibbs J, Bobiwash K, Boustani M, Martinet B, Michez D (2021) Global patterns in bumble bee pollen collection show phylogenetic conservation of diet. *Journal of Animal Ecology* 90, 2421–2430. https://doi.org/10.1111/1365-2656.13553

WEST ASIA

Approximately 73 species are currently recognised. No species have yet been assessed for Red List status within West Asia. Of the total, 10 species are considered endemic, so 63 need to be assessed beyond West Asia. Within West Asia, the fauna of Turkey is already well mapped (many species shared with Europe) and excellent progress is being made in Iran. In Central Asia there are many records in collections and in the literature that could be mobilised if funding were available.

West Asian Region in 2021
Alireza Monfared for Iran

The examination of more then 5500 specimens in the bumblebee collection of the Iranian Pollinator Insect Museum of Yasouj University, indicates that there are 11 subgenera and 33 species of bumblebees by comparison with the last species list of Williams et al. (2008) (Table below). Species with specimens examined are shown by ✓.

Updated list of the bumblebees of Iran (2020) (Q= Queen, W= Worker, F= Female, M=Male). Table provided by Bahareh Goodarzi, a previous student.

No	Species	Q	W	M
1	*B.* (*Bombus*) *cryptarum*	✓	✓	✓
2	*B.* (*Bombus*) *lucorum*	✓	✓	✓
3	*B.* (*Bombus*) *terrestris*	✓	✓	✓
4	*B.* (*Cullumanobombus*) *cullumanus*	✓	✓	-
5	*B.* (*Kallobombus*) *soroeensis*	✓	✓	✓
6	*B.* (*Megabombus*) *argillaceus*	✓	✓	✓
7	*B.* (*Megabombus*) *hortorum*	✓	✓	✓
8	*B.* (*Megabombus*) *portchinsky*	✓	✓	✓
9	*B.* (*Melanobombus*) *keriensis* [*alagesianus*]	✓	-	-
10	*B.* (*Melanobombus*) *incertus*	✓	✓	-
11	*B.* (*Melanobombus*) *sichelii*	✓	✓	✓
12	*B.* (*Mendacibombus*) *handlirschianus*	✓	✓	-
13	*B.* (*Psithyrus*) *bohemicus*	-	F	M
14	*B.* (*Psithyrus*) *maxillosus*	-	F	-
15	*B.* (*Psithyrus*) *quadricolor*	-	-	M
16	*B.* (*Psithyrus*) *rupestris*	-	F	-
17	*B.* (*Psithyrus*) *sylvestris*	-	F	-
18	*B.* (*Psithyrus*) *vestalis*	-	F	M
19	*B.* (*Pyrobombus*) *haematurus*	✓	✓	✓

20	*B.* (*Sibricobombus*) *niveatus*	✓	✓	✓
21	*B.* (*Sibricobombus*) *sulfureus*	✓	✓	✓
22	*B.* (*Subterraneobombus*) *fragrans*	✓	✓	-
23	*B.* (*Subterraneobombus*) *melanurus*	✓	✓	✓
24	*B.* (*Subterraneobombus*) *subterraneus*	✓	✓	✓
25	*B.* (*Thoracobombus*) *armeniacus*	✓	✓	✓
26	*B.* (*Thoracobombus*) *humilis*	✓	✓	✓
27	*B.* (*Thoracobombus*) *laesus*	✓	✓	✓
28	*B.* (*Thoracobombus*) *mesomelas*	✓	✓	✓
29	*B.* (*Thoracobombus*) *pascuorum*	✓	✓	✓
30	*B.* (*Thoracobombus*) *persicus*	✓	✓	✓
31	*B.* (*Thoracobombus*) *ruderarius*	✓	✓	✓
32	*B.* (*Thoracobombus*) *sylvarum*	✓	✓	✓
33	*B.* (*Thoracobombus*) *zonatus*	✓	✓	✓

Table provided by Bahareh Goodarzi, previous student.

First release of reared bumblebees in a greenhouse

In recent months, we released the first colonies of *B. terrestris* that had been reared by our company **'Zist Gardehafshan- e Dena (=ZGD)'** into a tomato greenhouse in Servak county, close to Yasouj.

A worker of B. terrestris pollinating a greenhouse tomato.

Dr Reza Amiri Fahliani and Syedeh Tahereh Hosseini evaluating the efficiency of reared colonies in greenhouse.

Collecting data on bumblebee pollination of tomatoes in a greenhouse: (far left) students collecting data; (mid left) tomatoes develop and ripen as a result of bumblebee pollination; (mid right) worker foraging on a tomato flower; (far right) Alireza Monfared examining flowers visited by workers.

ZGD lab - staff working on the quality of B. terrestris colonies.

NORTH ASIA

Approximately 68 species are recognised. No species have yet been assessed for Red List status within North Asia. Of the total, only two species are currently considered endemic. Low endemism may in part reflect the region's position at the crossroads among several other regions. Within North Asia, species distributions are being recorded and databased, so that some Red List assessments should be possible in the next few years.

North Asian Region in 2021
Alexandr Byvaltsev

Bumblebees of the *Red Book of Animals of the Russian Federation*

The second edition of the *Red Book of Animals of the Russian Federation* has been prepared and will be published in 2022. Unlike the previous edition, IUCN categories and criteria were used to assess the status of species, as well as national categories. Two taxa (*proteus* and *paradoxus*) were excluded from the list. Thus, there are six species of bumblebees in the Russian Red List now. These are summarized below.

B. anachoreta - Vulnerable D1

This species is known from the Primorsky Territory in Russia (northern limit 46.20° N), north-eastern China, and from the central part of the Korean peninsula. Most observations in Russia were made in the extreme south of Primorsky, in coastal areas on fixed sands and ridges, occupied by rare coppice oak forests and shrubs. The main reasons for decrease in this species are unclear. Probably its low abundance is associated with a decrease in the area suitable for nesting and foraging. If assumptions about this species being confined to habitat in coastal areas are correct, then the widespread development of such plots in the Primorsky Territory for building and recreational zones are likely to have reduced its range and abundance.

B. armeniacus - **V**ulnerable A2c+3c+4c

This species is widely distributed in the steppes of Russia and Europe. A decrease in the number of mature individuals and a shift southwards of the northern border in the European part of Russia were recorded. At the same time, in the south of western Siberia, in Khakassia and in the south of the Krasnoyarsk Territory, its abundance has remained high. The main reason for its decrease is probably agricultural intensification and a reduction in the amount of available habitat.

B. czerskii - Vulnerable D1

In Russia, this bumblebee is known reliably from Buryatia and the Primorsky Territory, where it is very rare. I have seen only 10 specimens, collected between the end of the 19th century and the 1930s: eight females from the Primorsky Territory (Lake Khanka, Khasan, Vladivostok, Ussuriysk, and from Pokrovka village of the Oktyabrsky District) and two females from the vicinity of Kyakhta. There are no recent data for this species from these areas, although this may be due to a lack of visits there by bumblebee researchers (which is a more likely explanation than extinction).

Limiting factors have not been determined because of a lack of knowledge about the peculiarities of the biology of this species. Possibly, low abundance is associated with human activity at the northern limit of its range.

B. wurflenii - Vulnerable A4ac

According to the available data, this species was common in the Caucasus until the end of the 20th century. Data for last two decades are absent. The state of the populations in the southern Urals is possibly critical, or close to it. I have seen only two specimens collected in the Urals at the begining of 20th century and a single specimen was recorded in the Ilmensky Nature Reserve in 1987.

B. fragrans - Endangered A3c+4c

This species is widely distributed in the steppes of Russia, Europe, and Kazakhstan, and is also known from Kyrgyzstan and northern China.

It is a rare bumblebee, known from few records. It is possible that small populations are a biological feature of this species. Based on the material in the Zoological Institute in Saint Petersburg, until the 1950s a stable population existed in the Volgograd region (around Kamyshin), near Orenburg and near the lake Tambukan on the border of the Stavropol Territory and Kabardino-Balkaria. Single recent records are known from the Chuvashia, Lipetsk, and Penza regions. No specimens were seen during my observations in 2013-2014 and in 2021 in Khakassia, but the species has been known from this region. In the last 10 years it has been recorded regularly in the Altai Territory and in the south of the Omsk Region.

Recently the species was found near Yeniseisk (Krasnoyarsk Territory), from two workers in 2009. This is far to the north of its main range. Probably this observation is the result of casual transport with a load that contained soil with wintering queens, some of which were subsequently able to produce offspring. Natural range expansion is also not excluded, since the natural landscapes of the Yenisei Valley have been significantly affected by cutting and by the construction of a hydroelectric power station, which has led to their conversion to steppe. Confirmation of the existence of stable populations in the area is required.

The factors influencing population decrease are as for *B. armeniacus*.

B. unicus **-** Vulnerable D1

Endemic to Russia. Known from the Amur Region, Khabarovsk and Primorsky Territories. I have seen only 44 specimens. Most of them (39) were collected before 1975 and are deposited in the collections of the Zoological Institute in St. Peterburg and in the Federal Research Center for Biodiversity in Vladivostok. Others have been collected in 2000-2012, the most recent of them (two workers) having been collected by my student near Komsomolsk-na-Amure in 2012. No specimens were collected during my field work in 2019 and 2021 in the Primorsky Territory, but probably because it was the end of August and beginning of September.

Database of species distributions

There are a total of 2392 records for 10,967 specimens of 24 species in my database now. Distribution maps are available for 18 species at the http://bombus.nsu.ru. Unfortunately, I

had no time for databasing during 2020-2021, although I plan to work on this in the next few years.

We have tried hard to make progress but we are very far from the assessment of our bumblebees for the IUCN Red List of Threatened Species for several reasons. The main issue is that most of the available data on bumblebee distributions across Northern Asia are very fragmented and discontinuous. For example, there are good data for bumblebees from the south of western Siberia in the last two decades, but there are no earlier data. This is the exact opposite of the situation for the Russian Far East. ●

HIMALAYA

Approximately 62 species are currently recognised. No species has yet been assessed for Red List status within the Himalaya. Of the total, approximately 19 species are considered endemic (or near endemic, just crossing into the Qinghai-Tibetan Plateau), so at least 43 need to be assessed beyond the Himalaya (most in East Asia). There are many records in collections and in the literature that could be mobilised if funding were available. More field surveys are urgently needed.

Himalayan Region in 2021
Rifat Raina / Malkiat Saini

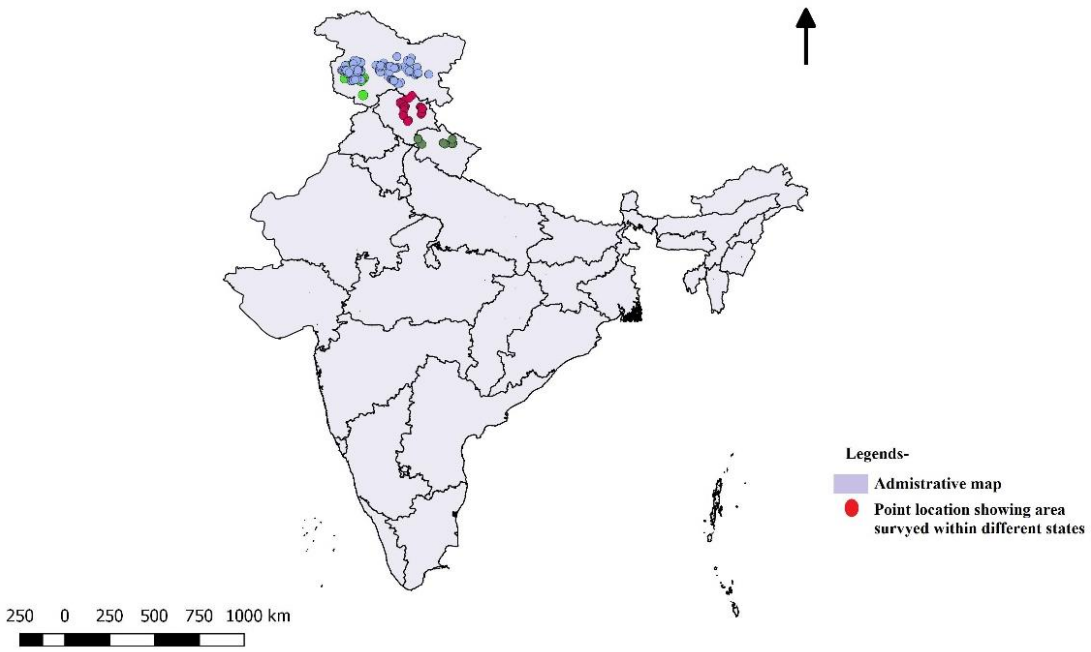
Bumblebees of the Himalaya are of particular interest because this corridor of mountains is one of the most important connections between the large and divergent Oriental and Palearctic bumblebee faunas.

Bumblebee populations are declining in the Himalayan region due to urbanization, tourism, over grazing, deforestation, habitat fragmentation, and excessive use of pesticides. There is now a dire need for rapid assessment of bumblebees in the Himalaya. The number of bumblebee species that have been recorded as endemic will need to be re-assessed.

New survey of Himalayan bumblebees

During 2021, three extensive surveys were undertaken by two different groups under the leadership of Rifat Raina. Sample collection was made with the help of project-team members Ajaz Parey, B. Malik, and Aishish Mehra in Uttarakhand, Himachal Pradesh, and in the two Union Territories of Jammu and Kashmir and Ladakh (from 15/04/2021 to 17/10/2021 and from 01/07/2021 to 01/09/2021), exploring targeted habitats in localities covering 20 districts. A total of 4414 bumblebee specimens were collected at different elevations ranging from 900–5000 m asl. The Union Territory of Jammu and Kashmir contributed the largest samples (1583 specimens), followed by Himachal Pradesh (1251 specimens), Ladakh (999 specimens), and Uttrakhand (580). However, no bumblebees were encountered at Changla Pass at 5360 m. GPS handsets were used to record the coordinates of different habitats within the study sites (map below). The extraordinary adaptation (morphological and behavioural) of bumblebees allows them to survive in harsh situations, such as the low temperatures at high elevations, where other insects are noticeably scarce.

The collected samples were processed by Ms Purnima Pathak JPF for detailed analysis. So far, a total of 1775 specimens of bumblebees have been examined and identified to 17 species (*B. albopleuralis*, *B. asiaticus*, *B. ferganicus*, *B. festivus*, *B. flavescens, B. haemorrhoidalis, B. himalayanus*, *B. jacobsoni*, *B. kashmirensis*, *B. keriensis*, *B. melanurus*, *B. miniatus*, *B. pressus*, *B. rufofasciatus*, *B. semenovianus*, *B. simillimus*, *B. tunicatus*). The rest of the collection is now being identified. Current distribution status has been recorded and updated for the assessment of species distributions in the Himalaya. The identification of bumblebees is not straightforward because of mimicry and colour variation, so proper care must be taken during collection and preservation.



Map showing the new survey localities in the Indian Himalayan Region for 2021.

Pollination, crops, and medicinal plants

The distribution status of Himalayan bumblebees is being updated along with comparative inventories of the bumblebee species prevalent in the different mountain systems, together with their food plants. The greatest diversity of bumblebee species was observed between elevations of 2500-4000 m. A process to scan the pollen of some of the more important species of bumblebees has been initiated in order to link foodplants with the particular bumblebee species to establish their feeding relationships.

Bumblebees are valuable pollinators, which are needed to sustain the diversity of the medicinal, crop and wild flowering plants in the Himalaya. Because of their role as pollinators, bumblebees are considered as beneficial insects that greatly increase the crop yield and so are called farmer's friends. Several studies have revealed that the Himalaya are rich in medicinal plants. The current study is providing information on bumblebees for their conservation and for helping to maintain the diversity of medicinal plants in the Himalaya. Bumblebees are known to pollinate some important plants used to make medicine for curing diseases in the northwestern Himalaya, including *Dactylorhiza hatagirea, Podophyllum hexandrum, Polygonatum multiflorum, Fritillaria roylei, Picrorhiza kurrooa* and *Aconitum violaceum*. Ten species of bumblebees have been noted as potential pollinators of medicinal, aromatic, ornamental, and agricultural plants in the Himalaya. These species are *B. asiaticus*, *B. jacobsoni*, *B. rufofasciatus*, *B. haemorrhoidalis*, *B. simillimus*, *B. tunicatus*, *B. keriensis*, *B. miniatus*, *B. albopleuralis* and *B. melanurus*.

Public outreach

During 2021, 27 awareness programmes or outreach activities were carried out at the village level to enhance bumblebee populations in the Indian Himalayan region, especially in Uttarakhand, Himachal Pradesh, Ladakh, and Jammu and Kashmir. Pamphlets of advice for improving pollination practices for farmers and growers have been distributed to local communities and to the general public. The benefits of bumblebee pollination and of

conservation strategies were also demonstrated to the local communities during awareness programmes.

Bumblebee populations are declining each year due to gradual changes in climate and anthropogenic activities. The conservation of bumblebees and the maintenance of crops in the Himalayan region requires much more attention.

Kaza (Himachal Pradesh) 3800 m.

Valley of Flowers (Uttarakhand) 4300 m.

Awareness programme at Leh (Ladakh).

Pansilla Pass (Ladakh) 4400 m.

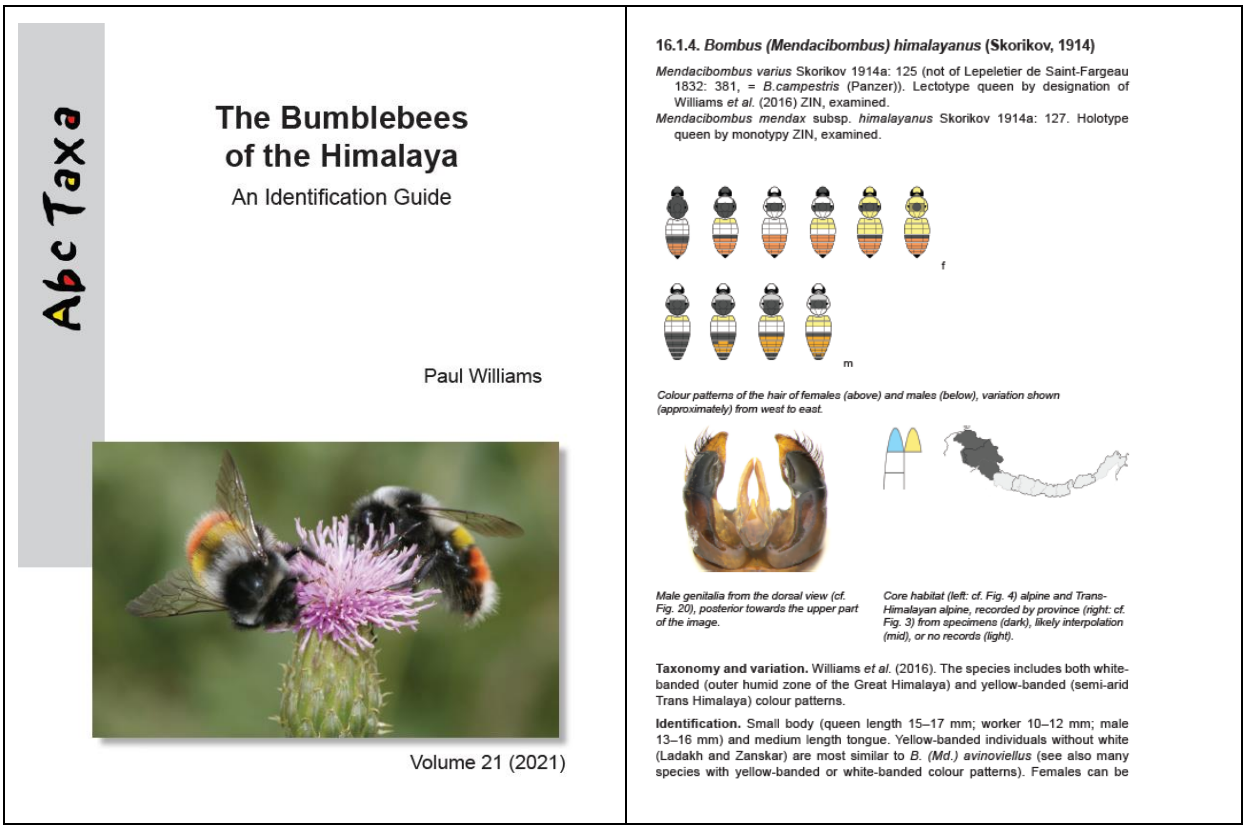
Bombus tunicatus.

Bombus semenovianus. (Photos by Rifat Raina.)

Rifat Raina is greatly indebted to Dr Dhriti Banerjee, Director ZSI Kolkata, for providing the necessary facilities. Thanks also to NMHS, MoEF&CC Govt. of India, for providing financial support under the project *Documentation, conservation and utilization of indigenous mountain pollinators – with special reference to Himalayan bumblebees*.

New! - *The Bumblebees of the Himalaya: An Identification Guide*

Paul Williams is happy to announce that this new book is about to be published as volume 21 by *AbcTaxa* (www.abctaxa.be) and will shortly be freely available to download as a PDF. It is hoped that this will provide a useful resource for students wishing to explore these bees, their interactions with plants, and their conservation in the Himalaya – and generally as an aid for helping people to discover more about bumblebees.



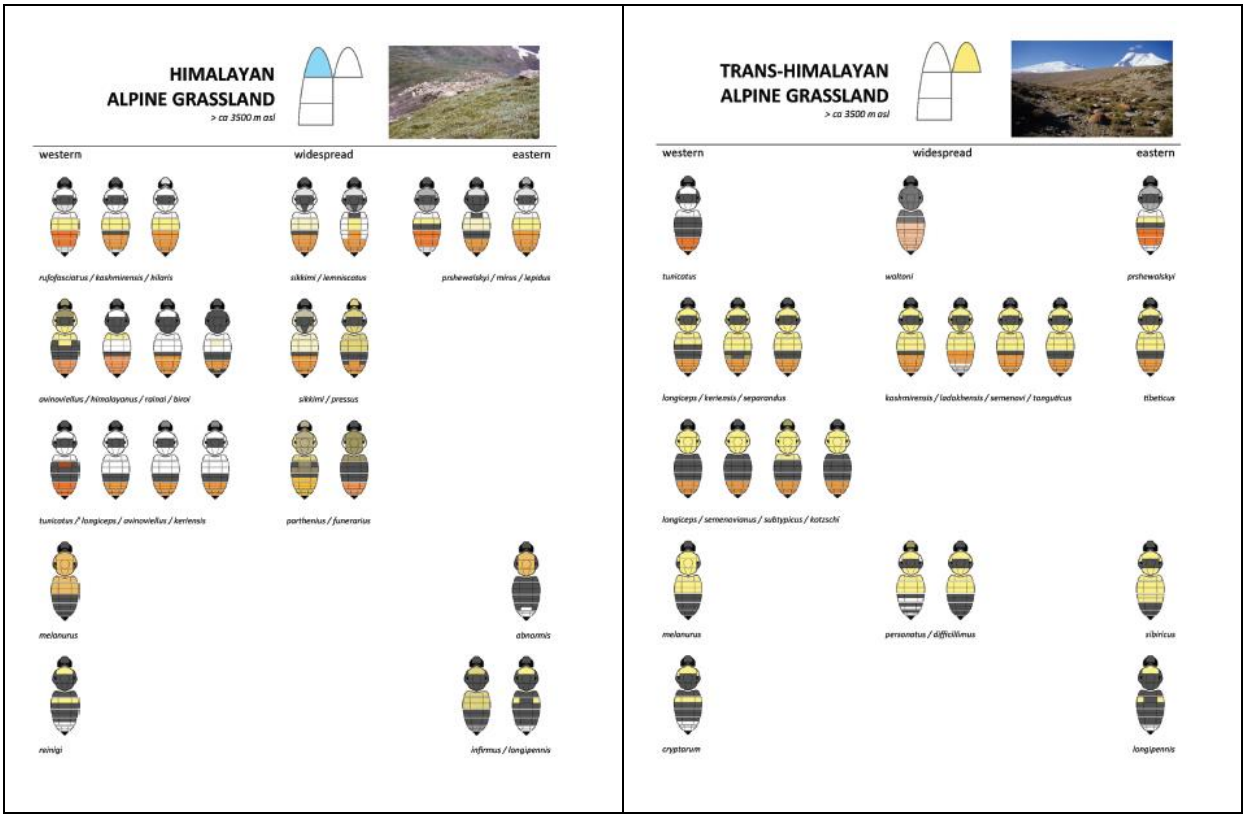
This is the first bumblebee guide to cover the entire region extending from the far west of Pakistan, through India, Nepal, and Bhutan, to the far east of Arunachal Pradesh.

The guide is based on more than 40 years of research and draws on the latest genetic and taxonomic results on Asian bumblebees to set out an extensively revised understanding of the Himalayan fauna of 62 species. This includes: one new species; six species with revised taxonomic status; and 12 species not included in previous guides for the region; all illustrated with 337 colour-pattern diagrams (the use of subspecies to name regional colour patterns is not considered useful). The problem, perhaps even more challenging than in other parts of the world, is the many kinds of variation in colour patterns within species (locally and regionally), combined with the close regional convergences among species.

After a general introduction on bumblebees, the Himalayan region, how to collect bumblebees, on what species are, the need for and the challenges with formal names, there are then keys to the 10 subgenera in the region and keys to the species within each subgenus. For each of the 62 species (an example is shown in part above) there is a summary of the names used in the literature, simple colour-pattern diagrams, a photo of the male genitalia, a preliminary sketch map of its distribution by core habitat zone and within

the Himalaya, with brief notes on taxonomy, distinguishing characters, habitat, and global distribution.

Cross-checks on occurrence by core habitat are provided to help reduce ID errors (but NOT to make initial IDs) for workers of some of the more common species in the different elevation zones within the Himalaya. For example, in the alpine zones:



This guide aims to improve identifications in order to help support the new survey of Himalayan bumblebees. New material from that survey will greatly improve knowledge of the species, so that a revised multi-author illustrated guide will follow, which will include many photos of live bumblebees and high-resolution distribution maps (and more images to support keys, which could not be provided for this guide because of the pandemic). We have reached a time in which the majority of Himalayan bumblebee species are likely already to be known, because the rate of discovery of completely unknown species is now low. However, the status of a few taxa, either as separate species or as parts of other species, still have a degree of uncertainty. It is hoped that this guide will help to stimulate the studies that will investigate and clarify these issues.

Identification of many Himalayan bumblebee species can be difficult with current technology (even with genetic 'barcodes'). Much as everyone would like identification to be easier, there is currently no easy way around this. Consequently, this book cannot be an easy beginner's guide or a field guide. If used with care, the finer details of morphology may at least help towards obtaining reliable and representative species' occurrence data for the urgently needed studies of bumblebee ecology and conservation in the Himalaya. For thse studies, correct species identification is crucial. ●

NORTH AMERICA

49 species are listed here up to the end of 2021. Almost all of these species have now been assessed for Red List status globally, although assessments of the species of the subgenus *Alpinobombus* and of the *lapponicus*-group need to be revised. Assessments of species listed as Data Deficient will be improved in future years as data gaps are filled, especially from parts of species ranges beyond North America (e.g. by bringing together experts from around the world). Within North America, distributions are relatively well recorded and databased, so that baseline data are readily available for comparison in the future.

North American Region in 2021

Sheila Colla / John Mola / Elaine Evans / Tamara Smith / Leif Richardson

In 2021, many components of North American bumblebee research and conservation management continue to be impacted by the global COVID19 pandemic. Below we report on only the current status of conservation efforts and the legal designations of at-risk bumblebees. In addition, the Commission for Environmental Cooperation (CEC, a tri-national governmental organization), is in the process of drafting an Operational Plan for conserving pollinators. Stakeholders and experts met in Mexico in February of 2020 to help inform this document. More about this effort can be found here: http://www.cec.org/strengthening-regional-pollinator-conservation-to-secure-local-benefits-1/.

USA policy and management update

Public engagement in monitoring has contributed records of bumblebees of conservation concern from broad efforts including BumbleBeeWatch and iNaturalist, as well as regional and state-wide efforts in the Pacific Northwest, California, Nebraska, Missouri, Wisconsin, and Minnesota. These efforts have extended the known occupancy for bumblebees of conservation concern including *B. affinis*, *B. terricola*, and *B. fraternus*.

Led by James Strange, in collaboration with the NAPPC *Bombus* task force, a new framework for a Clean Stock bumblebee program and risk assessment matrix is being drafted for relevant US government agencies.

Listed and Proposed Species – Rusty patched bumble bee (B. affinis)

There is now a final USFWS Recovery Plan for *B. affinis*. This document sets the downlisting criteria for *B. affinis* and provides a roadmap for recovery actions. The USFWS is developing step-down recovery implementation strategies for the five conservation units identified in the final recovery plan. Several conservation projects are already underway or being planned.

The discovery of five *B. affinis* nests in 2020 and two nests in 2021 in Minnesota and Wisconsin added to our knowledge of nesting habits and nest associates. Nests were located in between the foundation and a layer of insulation in an urban residence, in an urban backyard near a house foundation, in a degraded semi-wooded, riparian natural area, and in a forested bluff area. These finding indicate the potential importance of urban and degraded habitats for recovery of the endangered Rusty patched bumble bee. The USFWS Rusty Patched Bumble Bee Outreach Team created guidance aimed at the public about

bumblebee nesting, with a focus on what to do if you find a nest as well as the importance of recording nesting information for Rusty patched bumble bee recovery efforts.

Ongoing efforts to examine *B. affinis* population genetic 'health' have been largely successful, with the collection of over 300 tarsal clips from five states. These samples are being genotyped by the The United States Department of Agriculture - Agricultural Research Service - Pollinating Insects - Biology, Management, and Systematics Research Unit (USDA-ARS-PIBMSRU) in Logan, Utah, USA. Preliminary results from 2020 suggest evidence of inbreeding within populations (observed heterozygosity << expected heterozygosity) and moderate differentiation across the extant range. The USDA-ARS-PIBMSRU continues its efforts to generate a *B. affinis* genome.

Western bumble bee (B. occidentalis)

The Western bumble bee (*B. occidentalis*) Species Status Assessment (SSA) Expert Group has finished its monthly meetings. USFWS will finalize its modeling process and begin writing the SSA as a further step towards a listing decision for this species.

Franklin's bumble bee (B. franklini)

Franklin's bumble bee (*B. franklini*) is now the second bumblebee listed under the US Endangered Species Act. The species was officially listed in September 2021. USFWS lead Jeff Everett is organizing a variety of search activities for the 2022 field season with the top priority in Franklins' recovery being the location of extant populations.

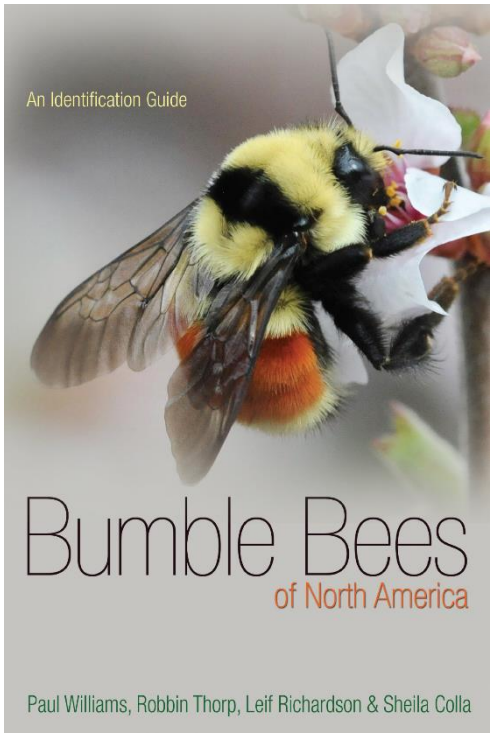
Canadian policy and management update

There are approximately 42 bumblebee species known to occur in Canada. Some of these species have been considered and processed for federal protection by the Species At Risk Act, which legislates the listing and protection process. In Canada, species are assessed by an arms-length committee of scientists (COSEWIC), after which the government chooses to list the species after consideration of socio-economic consequences. Once listed, a species has a recovery strategy and management plan listed and is protected on federal property (but not private or provincial property). There are also funds allocated for its conservation. Despite intense public interest, none of the assessed at-risk bumblebee species have been fully protected, despite over a decade from the first listing. The last known Canadian record for *B. affinis* was in 2009. Below lists the current status of the species which have been assessed in Canada. It should be noted that the jurisdiction for wildlife protection falls largely to the provinces, many of which do not have endangered species legislation or have recently had legislation gutted (e.g. Ontario where *B. affinis* and *B. bohemicus* are listed as Endangered) (see Munoz & Obrist 2020).

On the ground conservation management in Canada includes work by Wildlife Preservation Canada (WPC), the main ENGO working on at-risk bumblebee conservation. They have developed a captive breeding program and work with universities on various research projects and field surveys. BumbleBeeWatch is run primarily in partnership with York University, WPC and the Xerces Society for Invertebrate Conservation. York University is working with the Canadian Wildlife Service to help develop a framework for minimizing pathogen spillover from the managed bee industries to wild insects.

1. *B. pensylvanicus*, assessed at Special Concern 2018, not yet listed by the government
2. *B. bohemicus*, assessed as Endangered 2014, listed 2018, Recovery Strategy being drafted
3. *B. affinis*, Assessed Endangered 2010, Listed 2012, Recovery strategy finalized in 2020, Currently undergoing 10 year re-assessment by COSEWIC
4. *B. suckleyi*, Assessed Threatened, 2019, not yet listed by government
5. *B. occidentalis mckayi*, Assessed Special Concern 2014, not yet listed by government
6. *B. occidentalis occidentalis*, Assessed Threatened 2014, not yet listed by government
7. *B. terricola*, Assessed Special Concern, 2015, Listed 2018, Management Plan being drafted

Identification guide update



An update to the identification guide to the bumblebee species of North America is now being planned, to include revised taxonomy and a great wealth of new and revised distribution data.

Relevant publications

Averill, A.L., Couto, A.V., Andersen, J.C. and Elkinton, J.S. (2021) Parasite Prevalence May Drive the Biotic Impoverishment of New England (USA) Bumble Bee Communities. *Insects*, *12*(10), p.941.

Boone, M.L., Evans, E., Wolf, A., Minser, H., Watson, J. & Smith, T.A. (2022) Notes from rusty patched bumble bee (*Bombus affinis* Cresson) nest observations. *Insect Conservation and Diversity*, 1– 5. Available from: https://doi.org/10.1111/icad.12564

Bruninga-Socolar, B., S. R. Griffin, Z. M. Portman, and J. Gibbs (2021) Variation in prescribed fire and bison grazing supports multiple bee nesting groups in tallgrass prairie. *Restoration Ecology* n/a:e13507.

Burnham, P.A., Alger, S.A., Case, B., Boncristiani, H., Hébert-Dufresne, L. and Brody, A.K. (2021) Flowers as dirty doorknobs: Deformed wing virus transmitted between *Apis mellifera* and *Bombus impatiens* through shared flowers. *Journal of Applied Ecology*, *58*(10), pp.2065-2074.

Butler, R.G., Lage, C., Dobrin, S.E., Staples, J.K., Venturini, E., Frank, J. and Drummond, F.A. (2021) Maine's Bumble Bee (Hymenoptera: Apidae) Assemblage—Part 1: Composition, Seasonal and Regional Distribution, and Resource Use. *Environmental Entomology*, *50*(6), pp.1344-1357.

Butler, R.G., Lage, C., Dobrin, S.E., Staples, J.K., Venturini, E., Frank, J. and Drummond, F.A. (2021) Maine's Bumble Bees (Hymenoptera: Apidae)—Part 2: Comparisons of a Common (*Bombus ternarius*) and a Rare (*Bombus terricola*) Species. *Environmental Entomology*, *50*(6), pp.1358-1369.

Calhoun, A.C., Harrod, A.E., Bassingthwaite, T.A. and Sadd, B.M. (2021) Testing the multiple stressor hypothesis: chlorothalonil exposure alters transmission potential of a bumblebee pathogen but not individual host health. *Proceedings of the Royal Society B*, *288*(1947), p.20202922.

Camp, A.A. and Lehmann, D.M. (2021) Impacts of Neonicotinoids on the Bumble Bees *Bombus terrestris* and *Bombus impatiens* Examined through the Lens of an Adverse Outcome Pathway Framework. *Environmental Toxicology and Chemistry*, *40*(2), pp.309-322.

Christmas, M.J., Jones, J.C., Olsson, A., Wallerman, O., Bunikis, I., Kierczak, M., Peona, V., Whitley, K.M., Larva, T., Suh, A. and Miller-Struttmann, N.E. (2021) Genetic barriers to historical gene flow between cryptic species of alpine bumblebees revealed by comparative population genomics. *Molecular Biology and Evolution*.

Dede, N. (2021) Surveys of bees at Midewin National Tallgrass Prairie with special focus on the possible presence of a rusty patched bumble bee populations.

Dominey, K.A. (2021) Are Yellow-banded Bumble Bee (YBBB) *Bombus terricola* and Gypsy Cuckoo Bumble Bee (GCBB) *Bombus bohemicus* at risk in Cape Breton?

Fearon, M.L. and Tibbetts, E.A. (2021) Pollinator community species richness dilutes prevalence of multiple viruses within multiple host species. *Ecology*, *102*(5), p.e03305.

Figueroa, L.L., Compton, S., Grab, H. and McArt, S.H. (2021) Functional traits linked to pathogen prevalence in wild bee communities. *Scientific reports*, *11*(1), pp.1-12.

Fredenburg, A.N., Gibbs, J. and Henne, D.C. (2021) A Survey of Wild Bees (Hymenoptera: Anthophila) in Thunder Bay, Ontario, and Their Floral Associations. *Journal of the Kansas Entomological Society*, *93*(3), pp.211-229.

Gelles, R.V., Davis, T.S. and Stevens-Rumann, C.S., Wildfire and Forest Thinning Shift Floral Resources and Nesting Substrates to Impact Native Bee Biodiversity in Ponderosa Pine Forests of the Colorado Front Range. *Available at SSRN 3968773*.

Gervais, A., Bélisle, M., Mazerolle, M.J. and Fournier, V. (2021) Landscape Enhancements in Apple Orchards: Higher Bumble Bee Queen Species Richness, but No Effect on Apple Quality. *Insects*, *12*(5), p.421.

Giacomini, J.J., Connon, S.J., Marulanda, D., Adler, L.S. and Irwin, R.E. (2021) The costs and benefits of sunflower pollen diet on bumble bee colony disease and health. *Ecosphere*, *12*(7), p.e03663.

Giacomini, J.J., Adler, L.S., Reading, B.J. and Irwin, R.E. (2021) Differential Bumble Bee Gene Expression Associated With Pathogen Infection And Pollen Diet.

Guezen, J.M. and Forrest, J.R. (2021) Seasonality of floral resources in relation to bee activity in agroecosystems. *Ecology and evolution*, *11*(7), pp.3130-3147.

Guzman, L.M., Johnson, S.A., Mooers, A.O. and M'Gonigle, L.K. (2021) Using historical data to estimate bumble bee occurrence: Variable trends across species provide little support for community-level declines. *Biological Conservation*, *257*, p.109141.

Hammer, T.J., Le, E., Martin, A.N. and Moran, N.A. (2021) The gut microbiota of bumblebees. *Insectes Sociaux*, *68*(4), pp.287-301.

Hicks, Barry, and Cory Sheffield (2021) "Native bees (Hymenoptera; Apoidea) collected from Labrador, Canada." *Journal of the Acadian Entomological Society* 17: 20-24.

Ingwell, L.L., Ternest, J.J., Pecenka, J.R. and Kaplan, I. (2021) Supplemental forage ameliorates the negative impact of insecticides on bumblebees in a pollinator-dependent crop. *Proceedings of the Royal Society B*, *288*(1953), p.20210785.

Krueger, A.J., Early, T.M., Ripperger, R.J., Cabrera, A.R. and Schmehl, D.R. (2021) The Utility of a Bumble Bee (*Bombus* spp.[Hymenoptera: Apidae]) Brood Test for Evaluating the Effects of Pesticides. *Environmental Entomology*, *50*(5), pp.1105-1117.

Kuhlmey, E.E., Boone, M., Lindsey, A. and Rao, S. (2021) Non-lethal DNA extraction methods for genetic analyses of endangered bumble bee species.

Lhomme, P., Williams, S.D., Ghisbain, G., Martinet, B., Gérard, M. and Hines, H.M. (2021) Diversification Pattern of the Widespread Holarctic Cuckoo Bumble Bee, *Bombus flavidus* (Hymenoptera: Apidae): The East Side Story. *Insect Systematics and Diversity*, *5*(2), p.5.

Liczner, A.R., MacPhail, V.J., Woollett, D.A., Richards, N.L. and Colla, S.R. (2021) Training and usage of detection dogs to better understand bumble bee nesting habitat: Challenges and opportunities. *PloS one*, *16*(5), p.e0249248.

Lozier, J.D., Parsons, Z.M., Rachoki, L., Jackson, J.M., Pimsler, M.L., Oyen, K.J., Strange, J. and Dillon, M.E. (2021) Divergence in body mass, wing loading, and population structure reveals species-specific and potentially adaptive trait variation across elevations in montane bumble bees. *Insect Systematics and Diversity*, *5*(5), p.3.

Martinet, B., Ghisbain, G., Przybyla, K., Zambra, E., Brasero, N., Kondakov, A.V., Tomilova, A.A., Kolosova, Y.S., Bolotov, I.N., Rasmont, P. and Potapov, G. (2021) Distant but related: genetic structure in the circum-boreal bumblebee *Bombus jonellus* (Kirby, 1802). *Polar Biology*, *44*(10), pp.2039-2047.

Martínez-López, O., Koch, J.B., Martínez-Morales, M.A., Navarrete-Gutiérrez, D., Enríquez, E. and Vandame, R. (2021.) Reduction in the potential distribution of bumble bees (Apidae: *Bombus*) in Mesoamerica under different climate change scenarios: Conservation implications. *Global Change Biology*, *27*(9), pp.1772-1787.

McCullough, C.T., Angelella, G.M. and O'Rourke, M.E. (2021) Landscape Context Influences the Bee Conservation Value of Wildflower Plantings. *Environmental Entomology*.

McGregor, B.L., Giordano, B.V., Runkel IV, A.E., Nigg, H.N., Nigg, H.L. and Burkett-Cadena, N.D. (2021) Comparison of the Effect of Insecticides on Bumble Bees (*Bombus impatiens*) and Mosquitoes (*Aedes aegypti* and *Culex quinquefasciatus*) by Standard Mosquito Research Methods. *Journal of Economic Entomology*, *114*(1), pp.24-32.

Mola, J.M., Stuligross, C., Page, M.L., Rutkowski, D. and Williams, N.M. (2021) Impact of "non-lethal" tarsal clipping on bumble bees (*Bombus vosnesenskii*) may depend on queen stage and worker size. *Journal of Insect Conservation*, *25*(2), pp.195-201.

Mola, J.M., Richardson, L.L., Spyreas, G., Zaya, D.N. and Pearse, I.S. (2021) Long-term surveys support declines in early season forest plants used by bumblebees. *Journal of Applied Ecology*.

Mola, J.M., Hemberger, J., Kochanski, J., Richardson, L.L., and Pearse, I.S. (2021) The Importance of Forests in Bumble Bee Biology and Conservation, *BioScience*, Volume 71, Issue 12, Pages 1234–1248, https://doi.org/10.1093/biosci/biab121

Mullan, F. and Penick, C. (2021) Connecting aboveground and underground effects of temperature on bumble bee colonies (*Bombus impatiens*).

Mundy-Heisz, K. (2021) *Pressure on pollinators: an examination of bumblebees (Bombus spp.) and systemic insecticides, parasites, and agricultural habitats* (Doctoral dissertation).

Muth, F., Tripodi, A.D., Bonilla, R., Strange, J.P. and Leonard, A.S. (2021) No sex differences in learning in wild bumblebees. *Behavioral Ecology*.

Newhouse, A.E., Allwine, A.E., Oakes, A.D., Matthews, D.F., McArt, S.H. and Powell, W.A. (2021) Bumble bee (*Bombus impatiens*) survival, pollen usage, and reproduction are not affected by oxalate oxidase at realistic concentrations in American chestnut (*Castanea dentata*) pollen. *Transgenic Research*, pp.1-14.

Nicholson, C.C., J.-M. Hayes, J., Connolly, S. and Ricketts, T.H. (2021) Corridors through time: Does resource continuity impact pollinator communities, populations, and individuals?. *Ecological Applications*, *31*(3), p.e02260.

Novotny, J.L., Reeher, P., Varvaro, M., Lybbert, A., Smith, J., Mitchell, R.J. and Goodell, K. (2021) Bumble bee species distributions and habitat associations in the Midwestern USA, a region of declining diversity. *Biodiversity and Conservation*, *30*(3), pp.865-887.

Pritchard, Z.A., Hendriksma, H.P., St Clair, A.L., Stein, D.S., Dolezal, A.G., O'Neal, M.E. and Toth, A.L. (2021) Do viruses from managed honey bees (Hymenoptera: Apidae) endanger wild bees in native prairies?. *Environmental Entomology*, *50*(2), pp.455-466.

Pugesek, G., Burtt, C.N. and Crone, E.E. (2021) The effects of commercial propagation on bumble bee (*Bombus impatiens*) foraging and worker body size. *Apidologie*, *52*(5), pp.887-898.

Pugesek, G. and Crone, E.E. (2021) Contrasting effects of land cover on nesting habitat use and reproductive output for bumble bees. *Ecosphere*, *12*(7), p.e03642.

Purvis, E.E., Best, L.R. and Galpern, P. (2021) Identifying key forage plants to support wild bee diversity and a species at risk in the Prairie Pothole Region. *Insect Conservation and Diversity*, *14*(6), pp.851-861.

Quinlan, G.M., Milbrath, M.O., Otto, C.R. and Isaacs, R. (2021) Honey bee (*Apis mellifera*) colonies benefit from grassland/pasture while bumble bee (*Bombus impatiens*) colonies in the same landscapes benefit from non-corn/soybean cropland. *PloS one*, *16*(9), p.e0257701.

Ressler, A. and Wicke, M.R. (2021) Exploratory Cluster Analysis of Bumblebee and Plant Interaction Data.

Richman, S.K., Muth, F. and Leonard, A.S. (2021) Measuring foraging preferences in bumble bees: a comparison of popular laboratory methods and a test for sucrose preferences following neonicotinoid exposure. *Oecologia*, *196*(4), pp.963-976.

Schoenfeldt, A. (2021) The effect of roadside mowing and road traffic on bumble bee abundance and pollinating insect habitat quality in New York highway rights-of-way.

Simanonok, M.P., Otto, C.R., Cornman, R.S., Iwanowicz, D.D., Strange, J.P. and Smith, T.A. (2021) A century of pollen foraging by the endangered rusty patched bumble bee (*Bombus affinis*): inferences from molecular sequencing of museum specimens. *Biodiversity and Conservation*, *30*(1), pp.123-137.

Simon, A. and Starzomski, B.M. (2021) Landscape Integrity Eclipses Local Effects of Floral Resource Availability on Bumble Bee (*Bombus* Spp.) Abundance in a Water-Limited Island Ecosystem.

Siviter, H., Johnson, A.K. and Muth, F. (2021) Bumblebees Exposed to a Neonicotinoid Pesticide Make Suboptimal Foraging Decisions. *Environmental Entomology*, *50*(6), pp.1299-1303.

Spiesman, B. J., C. Gratton, R. G. Hatfield, W. H. Hsu, S. Jepsen, B. McCornack, K. Patel, and G. Wang (2021) Assessing the potential for deep learning and computer vision to identify bumble bee species from images. Scientific Reports 11:7580.

Thomson, D.M. (2021) Novel data support model linking floral resources and honey bee competition with bumble bee abundances in coastal scrub. *Journal of Pollination Ecology*, *27*(4), pp.47-56.

Treanore, E., Barie, K., Derstine, N., Gadebusch, K., Orlova, M., Porter, M., Purnell, F. and Amsalem, E. (2021) Optimizing Laboratory Rearing of a Key Pollinator, *Bombus impatiens*. *Insects*, *12*(8), p.673.

Tsvetkov, N., MacPhail, V.J., Colla, S.R. and Zayed, A. (2021) Conservation genomics reveals pesticide and pathogen exposure in the declining bumble bee *Bombus terricola*. *Molecular ecology*, *30*(17), pp.4220-4230.

Van Wyk, J.I., Amponsah, E.R., Ng, W.H. and Adler, L.S. (2021) Big bees spread disease: body size mediates transmission of a bumble bee pathogen. *Ecology*, *102*(8), p.e03429.

Vizza, K., Beresford, D., Hung, J., Schaefer, J. and MacIvor, S. (2021) Wild bees (Hymenoptera: Apoidea) from remote surveys in northern Ontario and Akimiski Island, Nunavut including four new regional records. *The Journal of the Entomological Society of Ontario*, *152*, pp.57-80.

Williams, P.H. (2021) Not just cryptic, but a barcode bush: PTP re-analysis of global data for the bumblebee subgenus *Bombus s. str*. supports additional species (Apidae, genus Bombus). *Journal of Natural History*, *55*(5-6), pp.271-282.

Williams, P.H., Thorp, R.W., Richardson, L.L. and Colla, S.R. (2014) *Bumble Bees of North America*. Princeton University Press.

SOUTHEAST ASIA

Approximately 27 species are currently recognised. No species has yet been assessed for Red List status within Southeast Asia. Of the total, five species are considered endemic, so 22 need to be assessed beyond Southeast Asia. Many of these non-endemic species are restricted in Southeast Asia to the border regions with the East Asia region. Within Southeast Asia, plans are being made for recording and databasing of bumblebee distributions.

Southeast Asian Region in 2021
Chawatat Thanoosing

During 2021, the COVID19 pandemic has restricted our research, constraining bumblebee monitoring and surveys. However, we have continued to conduct research, both on-site and remotely, to provide important data for bumblebee conservation in our region.

In Thailand, a bumblebee survey was conducted in Doi Inthanon National Park in May by researchers from the Department of Biology, Chulalongkorn University. A nest of *B*. *eximius* was recorded for the first time in Thailand. The nest entrance was covered with moss. Activity at the nest entrance was monitored every two weeks from May to the end of August by the national park officers. *Bombus eximius* from this nest were active not only when conditions were clear but also when it was cloudy, foggy, or showery.

In addition, 287 Thai bumblebee specimens were digitized and deposited at the Chulalongkorn University Natural History Museum collection (CUNHM). These records are available in the GBIF database within the project on the Database and Digitization of Bees in Thailand (Nalinrachatakan et al., 2021).

In the Philippines, Dr Jonathan Koch is conducting a systematic study on the phylogenetic placement of *B*. *irisanensis*, an endemic bumblebee, together with David General. It is expected that this study will be completed in 2022. It will add to our knowledge of this Philippine endemic bumblebee. ●

Entrance of a nest of B. eximius (red arrow). (Photo by Nontawat Chatthanabun.)

Habitat around the nest entrance. (Photo by Nontawat Chatthanabun.)

Reference

Nalinrachatakan P, Chatthanabun N, Thanoosing C, Warrit N (2021). *Database and digitization of bees in Thailand*. Version 1.22. Chulalongkorn University, Department of Biology. Occurrence dataset https://doi.org/10.15468/tf4ejd accessed via GBIF.org on 2021-12-19.

SOUTH AMERICA

Approximately 25 species are currently recognised. Most species have now been assessed for Red List status globally. Within South America, distributions are being recorded and databased, so that assessments may be updated in the next few years.

The South American Region in 2021

Carolina Morales / Marina Arbetman / Victoria Campopiano / Claus Rassmusen / Rodrigo Barahona

Regional databases – where are we now?

There are no data-gathering programmes specifically aimed towards Red List assessment or re-assessment in our BBSG region or sponsored by IUCN. However, during the last year there have been various independent initiatives by research groups specifically from southern South America aimed to gather new bumblebee data occurrences through citizen science tools and to mobilize and share existing data in public platforms:

- Citizen Science Initiative 'Vi un Abejorro' (in Spanish "I saw a bumblebee") https://www.abejorros.ar/ (below). This project was launched in May 2021 by the Grupo de Ecología de la Polinización (INIBIOMA, CONICET-Universidad Nacional del Comahue, Argentina) and aims to improve our knowledge of the distribution, seasonal phenology, and floral associations, of bumblebees by gathering data on occurrences in Argentina. This information will allow us to monitor the status and trends of native species and the spread of the European introduced species, in particular, the highly invasive *B. terrestris.* Since the total richness of bumblebees in Argentina is low (eight native species and two species introduced from Europe) and few species coexist per region, species identification is relatively straightforward, but remains challenging for the two all-black bumblebees, *B. pauloensis* (formerly *B. atratus*) and *B. morio*. Since the launch of this platform, 807 data on the occurrences of 8 species have been reported from 21 out of the 23 Argentine provinces: *B. dahlbomii* (360), *Bombus* 'negro' (276) (meaning all black bumblebees that are not possible to identify from the picture), *B. terrestris* (206), *B. ruderatus* (42), *B. bellicosus* (18), *B. opifex* (9), *B. tucumanus* (4), *B. brasiliensis* (1), and *B. baeri* (1). Approximately one quarter of records identified by contributors as bumblebees belong to a different group of insects. The taxa usually misidentified as *Bombus* are *Xylocopa*, *Cadeguala*, *Diphaglossa* and *Chalepogenus*. This example illustrates the power of the citizen science approach for gathering massive numbers of data from vast regions, as well as the challenges in terms of species' identifications.

- Two recent papers document data-mobilization efforts to digitize and share the largest collection of wild bees of Chile, at the Pontifica Universidad de Valparaiso (Chile). This data-mobilization drastically increased the number of records available in GBIF for bees in Chile, (12,001 and 36,010 records respectively; Lopez-Aliste and Fonturbel, 2021a, 2021b). This will certainly contribute to increasing the number of records available for the two native bumblebee species (*B. dahlbomii* and *B. funebris*) and the two invasive species (*B. terrestris* and *B. ruderatus*) occurring in this country.

- In the case of southern South American *B. dahlbomii* Red-Listed as Endangered in 2015 and 2016, an upcoming paper in the *Journal of Insect Conservation* by Morales et al. (in press) is

based on the largest dataset for this species (>3,000 data occurrences with duplicates), of this species in Argentina and Chile, comprising 521 spatially unique data occurrences over a time span of 144 years.

Regarding Andean species of bumblebees (Bolivia, Peru, Ecuador, Colombia and Venezuela), no targeted surveys or initiatives have been carried out in this period. Recently, Clauss Rassmussen began revising all citizen scientist reports of bumblebees in the iNaturalist app for the included countries. From this revision, very uncommonly encountered species, like *B. excellens*, appeared documented from multiple images across Peru. In addition, an unconfirmed field record of *B. terrestris* from Peru has been uploaded to this platform. This highlights the need for continued taxonomic support to iNaturalist with identifications (as the data becomes research grade if multiple experts suggest the same identification). This will both encourage further uploads of georeferenced and dated images, while at the same time document the spread of invasive taxa, and thus we encourage colleagues to support the identifications. In particular, since many all-black bumblebee species occur in South America, species identification based on photographic records remains challenging.

To date, there are 5,582 records for 21 *Bombus* species in South America in Inaturalist: https://www.inaturalist.org/observations?place_id=97389&subview=map&taxon_id=52775.

All this information will allow us in the future to gather information on the numbers of bumblebee species for which there are database records (the number of sites for which there are records available identified to species) and the numbers of identified-species-in-site database records in total. Although the information is increasingly available, the process of compiling and curating these data is still challenging, because it is highly time-consuming.

Homepage of the "Vi un abejorro" website: www.abejorros.ar

Other news

Evidence for the impact of invasive *B. terrestris* on plant-pollinator interactions and on the pollination of native plants and crops in South America keeps accumulating. Smith-Ramirez et al. (2021) report high levels of nectar robbery by *B. terrestris* for *Vicia faba* in Chile, while Chalcoff et al. (2022) demonstrated that after *B. terrestris* invasion in Argentina, visitation of native *B. dahlbomii* to native *Vicia nigricans* dropped by 50%, fruit set by 43%, and seeds per fruit by 32%, as a consequence of intense nectar robbing by the invasive species.

The project 'Saving the Patagonian Giant Bumblebee from extinction by removing its main threat, the invasive buff-tailed bumblebee', conducted by a research team lead by Dra Carolina Morales, has been supported by a small research grant of the MBZ Species Conservation Fund (https://www.speciesconservation.org/). The project aims to encourage recovery of endangered *B. dahlbomii* populations by boosting the success of emerging foundress queens through culling invasive bumblebees, to reduce pathogen spillover and competition for nesting and food resources. While the viability of this approach will be tested at specific target sites and thus cover a local scale, target sites have high visibility by visitors, enabling their use as case examples in community science and public outreach programs reaching a much broader area. We expect that by combining on-site actions with broad communication, we can foster awareness about the problem of invasive species, and thus enhance our final objective of promoting instances of dialogue between Argentinian and Chilean authorities to downregulate the importation of European bumblebee colonies in Chile. ●

References

Chalcoff, V.R., Sasal, Y., Graham, L.E., Vazquez, D.P. and Morales C.L.(2022). Invasive bumble bee disrupts a pollination mutualism over space and time. *Biological Invasions*. https://doi.org/10.1007/s10530-022-02729-2

Lopez-Aliste, M. and Fonturbel, F. (2021a) *Chilean flower visitors*. Pontificia Universidad Católica de Valparaíso. Occurrence dataset. https://doi.org/10.15468/wwjm5s

Lopez-Aliste, M. and Fonturbel, F. (2021b) *Wild bees of Chile - The PUCV collection*. Version 1.5. Pontificia Universidad Católica de Valparaíso. Occurrence dataset. https://doi.org/10.15468/6knwyq

Morales C.L, Montalva J., Arbetman M.P, Aizen M.A., Martins A and Silva D.P. (in press) Does climate change influence the current and future projected distribution of an endangered species? The case of the southernmost bumblebee in the world

Smith-Ramirez, C., Rendón-Funes, A., Barahona-Segovia, R. and Moya, W. (2021) Consequences of the high abundance of *Bombus terrestris* on the pollination of *Vicia faba*. *Journal of Pollination Ecology*, 29: 258-272.

MESOAMERICA

Approximately 18 species are currently recognised, although several species groups are being revised, with the promise of several more species to be added soon. The Red List status for all 18 current species has now been assessed globally. Within Mesoamerica, distributions are being recorded and databased, so that improved Red List assessments should be possible in the next few years.

The Mesoamerican region in 2021

Oscar Martínez (ogmartinez@ecosur.edu.mx)

The year 2021 brought a change within the BBSG group in the region. Rémy Vandame was the regional coordinator of Mesoamerica for the BBSG and became Co-chair of the Wild Bee Specialist Group (WBSG) along with Simon Potts. This led to the role of Regional Coordinator being transferred to Oscar Martínez, although Rémy will continue to be a member of the BBSG. The regional group wants to congratulate Rémy for his efforts to foster this group and to succeed in the first assessments for bumblebees in the Mesoamerican region.

I am a PhD Candidate at El Colegio de la Frontera Sur (ECOSUR), working with conservation of bees and bumblebees in the region. I've been part of the BBSG group since 2015 and my focus since 2010 has been working with bumblebees on different topics including distribution, climate change, taxonomy, genetics, and red listing. It will be great to continue the great work that Rémy made during all these years as Regional Coordinator and hopefully we will understand more about bumblebees in the coming years from the different projects throughout the region. We also welcome two new members to the group, Alejandra Martínez from Mexico and Eduardo Herrera from Costa Rica. Alejandra finished her Master's degree with bumblebees and pesticides and has overseen the rearing facility of native bumble bees in El Colegio de la Frontera Sur (ECOSUR) for the last 4 years. Eduardo Herrera is working at Centro de Investigaciones Apícolas Tropicales (CINAT) and is part of the regional program of Apiculture and Meliponiculture where they are also doing research with bumblebees.

Oscar Martínez (left), Alejandra Martínez de Castro (centre), and Eduardo Herrera (right).

Regional database

We have a database comprising 39,512 records for bumblebees from 1842–2021, although some of those records do not have year or coordinates. 32,984 records do have year and coordinates and span the period 1867–2021. These records comprise 18 recognized species for Mesoamerica, but also new data are being used to revise the taxonomy and phylogeny of the group, which will be an important step to better understand the bumblebee fauna for the region.

Work in the region for 2021

The ECOSUR team has focused on breeding of the native bumble bee *B. ephippiatus* as an alternative for pollination services since 2012. Currently, *B. impatiens* is being used in Mexico and Central America, although it is an exotic species in the Mesoamerican region. Thanks to the work from different people across the years and to the efforts of Alejandra Martínez from 2018 to 2021, the complete cycle of this bumblebee species has now been managed under controlled conditions, achieving good reproductive levels in captivity. By 2020, there was a reproductive success of approximately 45%. Efforts are now being made to reach an acceptable level for the replacement of exotic species for crop pollination.

Mating of B. ephippiatus under lab conditions. (Photo by Alejandra Martínez de Castro.)

In addition, in 2019 the team held a bumblebee breeding course as part of the XI Mesoamerican Native Bee Congress. This was an important effort where we shared experiences and knowledge and learned collectively about bumblebee breeding. This will hopefully be the first step in making it possible to combine the use of native colonies for crop pollination and the protection of our native bumblebees. We are planning on giving a second course in 2022.

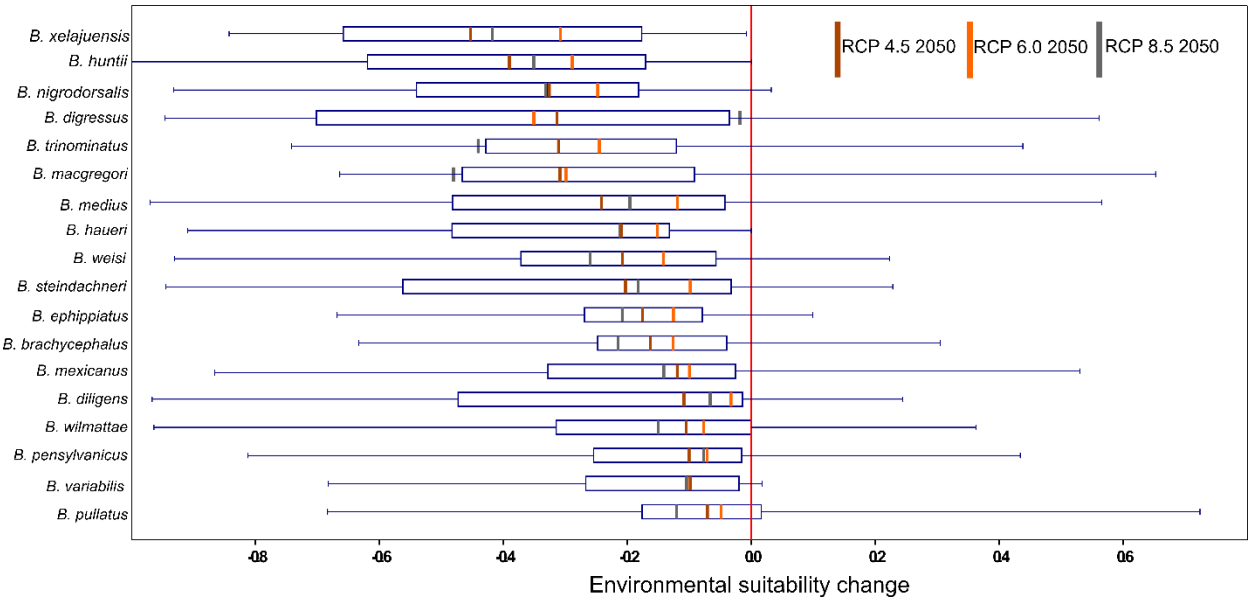
Rearing facilities at ECOSUR (left) and native bumblebee rearing course at ECOSUR (right). (Photos by Alejandra Martínez de Castro.)

The breeding work done so far allowed Alejandra to defend her Master's thesis in December of 2021, titled *Effects of imidacloprid on survival and nest development in the neo-tropical bumblebee Bombus ephippiatus*. Alejandra's committee included Dave Goulson (University of Sussex), Lislie Solís (ECOSUR), and Rémy Vandame as her thesis supervisor. Results showed that exposure to field-realistic doses of imidacloprid has a significant effect on both survival and nest development, as for temperate species. The thesis also showed a negative relationship between the amount of imidacloprid in food and the worker survival rates, and in the numbers of brood and numbers of workers in nests. Behavioural changes were also observed, such as loss of coordination, inability to fly and to defend the nest, abandonment of brood and loss of incubation.

A part of Oscar Martínez's PhD thesis consists of trying to understand the relationship of an indigenous group called Mam with bumblebees in the agroecosystems in two communities, one in Mexico and one in Guatemala. These two communities are located near the Tacaná volcano, an important region for bumblebee fauna. The field work consists of interviewing people (men, women, children) and recording their perception and emotions towards these bees. At the same time, they usually find bumblebee nests during their work in their crops, and this information will be the basic input for other measurements in the field, like calculating nest density. This work will eventually generate information for conservation purposes at the local scale, which will complement future assessments that should consider the traditional knowledge of indigenous cultures and their relationship toward bumblebees. If you are interested in seeing a small video of two workers of the species *B. wilmattae* leaving their nest in Chiapas, Mexico you can follow this link: 10.6084/m9.figshare.18131393 [NB coalescent analysis of COI barcodes by Duennes, et al. (2017) does not support *B. wilmattae* as a species separate from *B. ephippiatus* so further analysis is needed.]

Tacaná Volcano viewed from Guatemala. (Photo by Oscar Martínez.)

Last year we published expected climate-change effects on the potential distribution of 18 bumblebee species in Mesoamerica (Martínez-López et al. 2021) in *Global Change Biology*: https://onlinelibrary.wiley.com/doi/abs/10.1111/gcb.15559. Using ecological niche modeling we found that bumblebee species from Mesoamerica are predicted to undergo a reduction in their potential distribution and habitat suitability due to projected climate change.



If you would like a copy of this article, you can send me an email and I'll gladly share it with you.

Guatemala

The team led by Natalia Escobedo from the Universidad de San Carlos de Guatemala - Unidad de Biodiversidad have made important efforts towards collecting bees and bumblebees throughout the country in 2021. They have visited different locations in the western highlands (mostly in the Chimaltenango department), as well as in the dry thorn scrub corridor and mountain areas of the eastern side of the country. Although most of the sampling effort has been made in areas with very few bumblebees, they have collected approximately 30 specimens from 5 species. As a side note, they collected specimens of *B. pullatus,* which is a poorly known bumblebee for the region (classified as DD) and one for which no specimens had been collected since 2010.

Bombus pullatus. (Photo by Denisse Escobar.)

Sampling in Guatemala. (Photo by Edson Cardona.)

Significant effort was dedicated to curating the bumblebee specimens in the Colección de Abejas Nativas de Guatemala (CANG). The biological information for at least 800 specimens was carefully reviewed and updated. Approximately 700 new records of specimens collected since 2012 were added to the database. Approximately 150 specimens of *B.*

ephippiatus, *B. wilmattae,* and *B. weisi* awaiting identification were classified and identified taxonomically. In 2022, the team will continue to sample the dry thorn scrublands and plans to continue to register the bee diversity of the agricultural highlands of Chimaltenango.

Sampling in Guatemala. (Photo by Alfredo Mejía.)

Costa Rica

In Costa Rica in 2021, as part of the regional program of Apiculture and Meliponiculture and the program of Integrated Meliponiculture, Eduardo Herrera, alongside Johan van Veen, Ingrid Aguilar, and Mario Gallardo worked with bumblebees. The two theses related to bumblebees within these two programs are: (1) *Amount of food required by a colony of Bombus ephippiatus during the stages of its development and the feeding behavior of young workers,* which was completed, and another thesis: (2) *Breeding of Bombus ephippiatus (Apidae, Bombini) under controlled conditions in Costa Rica,* which is continuing. Observations have been made in the field at different times of the year to monitor the female castes or the presence of males found in the vegetation.

Where are they working?

The collections and observations have been carried out mainly in the Barva volcano area and the *Bombus* laboratory has been established at the CINAT, located in Barreal de Heredia.

What do they expect for this year?

During 2022 it is expected to conclude the thesis that is in progress and to continue observations in the laboratory on the life cycle of *B. ephippiatus*. In addition, it is intended to establish nests in natural areas and to monitor them throughout the year. The other project that we intend to develop is to monitor the wild populations of bumblebees in the Barva volcano area. ●

Bombus ephippiatus observations in the field (left) and mating in a cage in Costa Rica (right). (Photos by Eduardo Herrera.)

Initiation of colonies in the Bombus laboratory at CINAT. (Photo by Eduardo Herrera.)

References

Duennes, M. A., Petranek, C., Diez de Bonilla, E. P., Merida-Rivas, J., Martinez-Lopez, O., Sagot, P., . . . Cameron, S. A. (2017) Population genetics and geometric morphometrics of the *Bombus ephippiatus* species complex with implications for its use as a commercial pollinator. *Conservation Genetics, 18*, 553-572.

Martínez de Castro, A. (2021) *Effects of imidacloprid on survival and nest development in the neo-tropical bumblebee* Bombus ephippiatus. M.Sc. Thesis. El Colegio de la Frontera Sur, San Cristóbal de Las Casas, Chiapas, Mexico.

Martínez-López O, Koch JB, Martínez-Morales MA, Navarrete-Gutiérrez D, Enríquez E, Vandame R. (2021) Reduction in the potential distribution of bumble bees (Apidae: *Bombus*) in Mesoamerica under different climate change scenarios: Conservation implications. *Global Change Biology*, 27(9):1772–1787. doi:10.1111/gcb.15559.

JAPAN

Approximately 16 species are currently recognized. No species have yet been assessed for IUCN Red List status within Japan. There are about 14 species of native bumblebees living in Japan, and one species, *B. terrestris*, has invaded and colonized some regions such as in the Hokkaido area. The estimated distribution of six native bumblebees has already been reported by Suzuki-Ohno et al. (2020). Moreover, bee occurrence data for 16 bumblebee species from 2013 to 2018 in Japan is being reported (Suzuki-Ohno, in press). There are no species that are currently in danger of extinction and require urgent conservation measures. However, according to the information from the Japanese Ministry of the Environment Red List 2020, two bumblebee species are rank in the category NT (Near Threatened): *B. ignitus* and *B. florilegus*. We review the actions to conserve these bumblebees and current trends for bee conservation in Japan.

Japanese Region in 2021

Tomoyuki Yokoi

The distribution of *B. ignitus* in Japan has been investigated (Iijima et al. 2002, Suzuki-Ohno et al., 2020). Suzuki-Ohno et al. (2020) reported that increasing temperature due to global warming is the major factor for the depression of the estimated distribution area of native bumblebees. On the other hand, colonies of *B. ignitus* are commercialized and used for crop pollination in Japan. In tomato production, another bumblebee species, *B. terrestris*, which has been imported to Japan since the 1990s, is also used by many farmers. However, permission for the use of *B. terrestris* is regulated under the Invasive Alien Species Act and in 2019 the Ministry of the Environment changed the permit criteria. In 2020, the number of shipped *B. ignitus* will exceed that of *B. terrestris*, and the switch from *B. terrestris* to *B. ignitus* is gradually taking place. Moreover, *B. ignitus* is used in areas that it does not normally inhabit and there is a great risk that it will become a domestic invasive species. It is strongly recommended that we continue to take precautions when using this species.

As for *B. florilegus*, its distribution in Hokkaido has been reported in a study by Takahashi et al. (2010). Moreover, Takahashi et al. (2008) reported the presence of diploid males and suggests the occurrence of high inbreeding within local populations. Since the extinction risk of *B. florilegus* is correspondingly higher, it is necessary to confirm the detailed distribution status and genetic diversity in the future. [The taxon *florilegus* is likely to be a black-tailed part of the widespread (Holarctic) and variable species *B. cryptarum,* at least as supported by evidence for species coalescents from the COI gene*:* Williams et al., 2012; Williams 2021]

Bombus ignitus (left) and B. florilegus (right). (Photos by Masahiro Mitsuhata.)

In Japan, the general awareness of bumblebees, unlike honeybees, is not deeply established, and there are few major conservation projects or conservation organizations. In recent years, the number of researchers studying the ecology and life history of bees, including bumblebees, in Japan has been decreasing, and it is essential to have a sufficient number of academics in order to conduct future conservation projects and surveys.

Efforts to conserve bumblebees and other bee species are being promoted from the citizen level. As reported by Suzuki-Ohno et al. (2020), bumblebee habitat monitoring using public participation data is still underway. To raise awareness of conservation, the Pollination Services Society of Japan (PSSJ) is producing 'Guidelines for Giving Habitat to Bees' in 2021 (below).

In addition, The Bee Summit was held in 2017 and 2019 as a large-scale event to connect bee experts and citizens (below). The aims of The Bee Summit are to learn more about bees, other pollinators, and the natural environment based on the accumulated scientific knowledge, to appreciate the value of bees, and to consider our food, agriculture, environment, and the future in light of the current situation for bees. In 2019, the executive committee of the summit had an event at which more than 3,000 people including apiarists, farmers, students, scientists, many companies, and interested people of all ages who love bees, honey, and nature, came together and discussed many topics related to bees, pollinators, biodiversity, and the environment. The executive committee will hold The Bee Summit 2022 in Japan. It is hoped that these efforts will continue in the future. ●

私たちの健康に重要な野生ハナバチ

ハナバチというのは、花に訪れる、花の蜜や花粉を食糧とする蜂です。日本には ハナバチが約 400 種も生息しています。人間が飼育できるハナバチは、セイヨウミツバチなどの数種で、ほとんどが野生で生息しています。

野生ハナバチ（図 1, 2）は、野生の植物や作物の花粉を花から花へ運んで送粉を行い、実や種をつける手助けをしています。このような働きをする動物を、ポリネーター（送粉者）と呼びます。多くの植物が、美しい花をつけ、種を作って、次の世代を残していけるのは、野生ハナバチのようなポリネーターのおかげです。また、野生ハナバチは人々の健康に欠かせない食糧も提供しています。世界の主要な作物 115 種のうちの 75%以上は、野生ハナバチなどのポリネーターによる送粉によって実や種が作られています（IPBES 2016）。

野生ハナバチの危機

そんな重要な野生ハナバチが、全世界的に減少傾向にあります（Winfree et al. 2009; Potts et al. 2010; Ollerton et al. 2014, 2017 など）。原因は、人間活動のために、生息環境・花資源が減少しているためだと言われています。また、病気や寄生者、農薬も、ハナバチの死亡率を増加させたり、行動の異常を引き起こしています。温暖化によって、ヨーロッパや北アメリカでは、野生ハナバチの一種のマルハナバチの分布が縮小していることも報告されました（Kerr et al. 2015）。日本でも、野生ハナバチの保全活動を進めていく必要があります。

野生ハナバチを守るために

野生ハナバチの保全活動のために、まずは、野生ハナバチについての知識を増やしましょう（2 章）。そして、野生ハナバチの採餌（食べる）場所と営巣（棲む）場所を見つけて保護しましょう。採餌場所や営巣場所が十分ではない場合は、ハナバチの好む花を育てたり、ハナバチの営巣場所を作ったりしてみましょう（3・4 章）。農地ではハナバチへの悪影響が小さい農業の方法に変更するといった工夫もできます（5・6 章）。

図 1：日本に生息する野生の単独性ハナバチの例。上からバラハナリバチ、ニッポンヒゲナガハナバチ、キムネクマバチ、スジボソフトハナバチ。

4

在来種

写真	名前・科名属名	花期	特徴・注意
	ウツボグサ シソ科ウツボグサ属	5 月～7 月	薬草 乾燥にやや弱い 似た園芸種（外来種）が存在する（セイヨウウツボグサ）
	オカトラノオ サクラソウ科オカトラノオ属	6 月～7 月	地下茎で増えて群生する
	オトギリソウ オトギリソウ科オトギリソウ属	7 月～8 月	薬草 似た園芸種（外来種）が存在する（ガーデンヒペリカム） 似た帰化種が存在する
	オトコエシ オミナエシ科オミナエシ属	8 月～10 月	春に地上茎を出して増える
	ゲンノショウコ フウロソウ科フウロソウ属	7 月～10 月	薬草 似た帰化植物が存在する（アメリカフウロ）
	コバノタツナミ シソ科タツナミソウ属	5 月～6 月	
	ツリガネニンジン キキョウ科ツリガネニンジン属	8 月～10 月	薬草

13

ハナバチの棲む場所を作る

地面に巣を作るハナバチの営巣場所

実は、ミツバチやスズメバチのように人の目につく巣を作るハチは少なく、ほとんどのハチは地中に巣を作ります（図 19）。地中に巣を作るハチは、水はけのいい、草があまり生えていない、日当たりのいいまが露出した斜面や土手、土壁を好みます。巣の入り口は、アリの巣に似ていて、直径が 3mm から 6 mm くらいのものまで、様々です。近くに複数巣まっていることもあります。あなたの庭などで、このような穴がないか、探してみましょう。Xerces Society は、そのような穴から小さなハチが出てきたら、その巣を保護することを推奨しています。旗を使用して巣の周りをマークすると、巣が封をされて、見えなくなったときにも、その位置がわかり、その場所の地面を掘り返したりすることを避けることができます。そのような斜面がない場合は、自分で作ってみましょう。土に砂や小石を混ぜると水はけが良くなり、適向きに作ると日当たりが良くなります（Xerces Society for Invertebrate Conservation 2015）。

トンネルの巣を作るハナバチの営巣場所

トンネルの巣を作るハチの多くは、細い竹や葦、細い資材の人工物、食害のある木材に巣を作ることがあります（図 20, 21）。小さなハチが出入りしているのを見たときは、翌春まで廃棄せずに観察してみましょう。

人工の巣を作る

Xerces Society は、トンネルの巣を作るハチが棲みつくような人工の巣を作ることを推奨しています。タケやアシなどの中空になっている植物の茎、または木製のブロックや丸太などを使用して、人工の巣を作成することができます。

中空になっている植物の茎を使用する場合は、縛る紐や針金、または、茎を入れる塩化ビニルの管や大きめの金属缶なども必要になります。タケやアシの中空の茎を見て、節の位置を確認してください（外側からでも茎の隆起や筋でわかります）。節が確認できたら、茎を節のすぐ隣の位置で切断して、一方だけ端が開いた筒を何本も作ります。穴の大きさが 1 cm 以上の大きな筒があったら、それはハナ

20

Guidelines for Giving Habitat to Bees, which is published by Pollination Services Society of Japan (PSSJ).

Photographs at The Bee Summit 2019. (Photos provided by the Executive Committee of The Bee Summit.)

References

Iijima, K., Mitsuhata, M., and Higashiyama, S. (2002) The distribution report of *Bombus ignitus* Smith in Japan 2001. *Japanese Journal of Conservation Ecology* 7: 25-31.

Suzuki-Ohno, Y. (2021). *Bee occurrence data collected in "Hanamaru-Maruhana national census (Bumble bee national census)" in Japan*. Version 1.2. National Institute of Genetics, ROIS. Occurrence dataset https://doi.org/10.1111/1440-1703.12261 accessed via GBIF.org on 2021-08-31.

Suzuki-Ohno, Y., Yokoyama, J., Nakashizuka, T., and Kawata, M. (2020) Estimating possible bumblebee range shifts in response to climate and land cover changes. *Scientific Reports*, 10: 19622

Takahashi, J., Ayabe, T., Mitsuhata, M., Shimizu, I., and Ono, M. (2008) Diploid male production in a rare and locally distributed bumblebee, *Bombus florilegus* (Hymenoptera, Apidae). *Insectes Sociaux*, 55: 43-50.

Takahashi, J., Yamasaki, K., Mitsuhata, M., Martin, S. J., Ono, M., and Tsubaki, Y. (2010) Bumblebee fauna of the Nemuro Peninsula, Hokkaido, Japan: with special reference to the effect of the invasive *Bombus terrestris* on the rare *B. florilegus*. *Japanese Journal of Conservation Ecology* 15: 101-110.

Williams, P.H. (2021) Not just cryptic, but a barcode bush: PTP re-analysis of global data for the bumblebee subgenus *Bombus s. str*. supports additional species (Apidae, genus *Bombus*). *Journal of Natural History* 55**:** 271-282.

Williams, P. H., Brown, M. J. F., Carolan, J. C., An, J.-D., Goulson, D., Aytekin, A. M., . . . Xie, Z.-H. (2012) Unveiling cryptic species of the bumblebee subgenus *Bombus s. str.* world-wide with COI barcodes (Hymenoptera: Apidae). *Systematics and Biodiversity,* 10(1), 21-56

The BBSG is making progress with species assessments in much of the world, but much still remains to be done, especially in some of the most species-rich regions. This is a good time to share experiences on how best to overcome problems in applying IUCN Red List criteria to bumblebee data. We are especially looking forward to exploring ways to combine our quantitative analyses from different regions into global Red List assessments for the widespread species. As ever, let us know what you need and we will try to find a way to help. ●

London 22 February 2022