JHR 98: 861–870 (2025)
doi: 10.3897/jhr.98.163217
https://jhr.pensoft.net

RESEARCH ARTICLE

JOURNAL OF Hymenoptera RESEARCH
A peer-reviewed open-access journal
The International Society of Hymenopterists

On the nomenclature of *Bombus flavifrons* Smith, 1866 (Hymenoptera, Apidae, Bombini)

Cory S. Sheffield[1], Jennifer M. Heron[2], Paul H. Williams[3]

1 *Royal Saskatchewan Museum, Regina, Saskatchewan, Canada* **2** *British Columbia Ministry of Water, Land and Resource Stewardship, Surrey, British Columbia, Canada* **3** *The Natural History Museum, London, UK*

Corresponding author: Cory S. Sheffield (Cory.Sheffield@gov.sk.ca)

Academic editor: Jack Neff | Received 25 June 2025 | Accepted 19 September 2025 | Published 8 October 2025

https://zoobank.org/25F6E6F3-B042-4A6E-AEFE-350FF940BC65

Citation: Sheffield CS, Heron JM, Williams PH (2025) On the nomenclature of *Bombus flavifrons* Smith, 1866 (Hymenoptera, Apidae, Bombini). Journal of Hymenoptera Research 98: 861–870. https://doi.org/10.3897/jhr.98.163217

Abstract

The name *Bombus flavifrons* has been applied to two different bumble bee species in North America, one described by Ezra Cresson in 1863, the other by Frederick Smith in 1866. *Bombus flavifrons* Cresson, 1863 is currently considered the valid name for a common and widespread species in western North America, while *B. flavifrons* Smith, 1866 is considered a junior homonym of *B. flavifrons* Cresson, and thus not available. Consequently, *B. columbicus* Dalla Torre, 1890 was offered as a replacement name for *B. flavifrons* Smith. Smith's taxon was described from a now-lost type specimen taken on Vancouver Island, British Columbia, Canada but has been considered a junior synonym of *B. vosnesenskii* Radoszkowski, 1862 since 1888. Prior to 2012 no other records of *B. vosnesenskii* were known from Vancouver Island, and it was considered very rare in Canada up until the early 2000s, known only from a few specimens from the southcentral mainland of British Columbia adjacent to the United States border. *Bombus caliginosus* (Frison, 1927) was not recorded in the literature from Canada until 2014 and is known only from five specimens collected in the 1970s at Victoria, Vancouver Island. *Bombus caliginosus* is distinguishable from *B. vosnesenskii* with some difficulty.

Due to the morphological similarity of *B. vosnesenskii* and *B. caliginosus*, and their historical scarcity and disjunct distributions in Canada, we propose that *B. flavifrons* Smith is conspecific with *B. caliginosus*, a species that was not described until almost 40 years after the synonymy of *B. flavifrons* Smith under *B. vosnesenskii*. As the type specimen of Smith's taxon is seemingly lost, we also designate a neotype of *B. flavifrons* Smith from Vancouver Island to support the proposed nomenclature. Though *Bombus columbicus* is here considered a senior synonym of *B. caliginosus* **syn. nov.**, under Article 23.9.1 of the ICZN Code, we designate the name **nomen oblitum** to maintain the prevailing use of *B. caliginosus* for this taxon.

Keywords
Bombus caliginosus, *Bombus vosnesenskii*, bumble bees, extirpated species, nomenclature, North America, taxonomy

Introduction

Bombus flavifrons Cresson, 1863, also known as the yellow-fronted or yellow head bumble bee, is a common species of western North America, ranging well into the western Arctic, with records from as far east as the Hudson's Bay region of Ontario (Laverty and Harder 1988; Williams et al. 2014; but see Sheffield and Williams 2025). Frederick Smith (in Lord 1866) also used the name *Bombus flavifrons* for another yellow-faced North American species, describing *B. flavifrons* Smith, 1866 as being similar to *Bombus californicus* Smith, 1854 but differing in having darker wings, the face and vertex being pale yellow, and having a narrower yellow band on the metasoma (i.e. tergum 4). This specimen(s) was collected sometime between 1858–1862, during which time J.K. Lord was stationed on Vancouver Island, and it was the only new bee species described in that work, though four other bumble bee species were mentioned*.

Handlirsch (1888) synonymized *B. vosnesenskii* Radoszkowski, 1862 (as *Bombus Wosnesenskyi*) and *B. flavifrons* Smith under *B. californicus*. However, the type specimen of *B. californicus* is a female, and is now considered by some (i.e., Williams et al. 2014; Sheffield and Heron 2019) to be a junior synonym of *B. fervidus* (Fabricius, 1798), while the male allotype was not conspecific and is consistent with concepts of *B. vosnesenskii* (see Franklin 1913). Though the common name of *B. vosnesenskii* should be Vosnesensky bumble bee (Williams et al. 2014), yellow-faced bumble bee has also been used (e.g., Fraser et al. 2012); this is consistent with Smith's use of the species epithet *flavifrons* for this taxon. However, it seems unlikely that *B. flavifrons* Smith is a junior synonym of *B. vosnesenskii* as no older publications mentioning *B. vosnesenskii* from British Columbia (i.e., Scullen 1927; Hicks 1929; Buckell 1951; Stephen 1957; Thorp 1970) recorded it from Vancouver Island; in fact, only Buckell (1951) provided specific locality information for this species in Canada, recording just three specimens from Osoyoos from 1925. Though all these works document a long history of this species in the province, Scudder (1992, 1994) indicated that *B. vosnesenskii* was rare in the province and possibly deserving of conservation status assessment as even at that time it was known nationally from only Osoyoos (i.e., the specimens reported by Buckell in 1951). Since then, *B. vosnesenskii* has undergone rapid range expansion, and is now known to occur in the province from the central mainland to south coastal regions, including Vancouver Island (Fraser et al. 2012; Williams et al. 2014); it is possible that this is due, in part, to the use of commercially available colonies of *B. vosnesenskii* in British Columbia, though more recent natural spread into the province from the

* *Bombus vinatus* Smith, 1866, also appearing in Lord (1866: 342), is hereby considered nomen nudum, as the name was not accompanied with a description.

adjacent USA may also be a contributing factor. Oddly, a single specimen now at the Royal Saskatchewan Museum, Regina, Saskatchewan, Canada was found in a head of lettuce in a grocery store in New Minas, Nova Scotia, Canada. Our main purpose here is to resolve the nomenclature of Smith's taxon based on the historic distribution of these species in Canada.

Methods

A wide range of taxonomic, faunistic, and ecological literature was mined for use of the names *B. flavifrons*, *B. caliginosus*, and *B. vosnesenskii*, and other names associated with these valid species; these were also searched for in the Biodiversity Heritage Library (BHL, https://www.biodiversitylibrary.org/). Descriptions, distribution, and other details linked to species epithets were reviewed; past synonymies were reviewed, and type material, or photos of types, were examined when possible.

All Canadian records of *B. caliginosus* (GBIF.org 2024a) and *B. vosnesenskii* (GBIF.org 2024b) were mined from the Global Biodiversity Information Facility (https://www.gbif.org/) to determine capture times and distribution history in Canada. In addition, over 400 specimens of *B. vosnesenskii* collected in Canada and held at the Royal Saskatchewan Museum and Royal British Columbia Museum, Victoria, British Columbia were examined and their identifications verified (using Williams et al. 2014, and characters discussed below). In addition, the specimen database and collections at The Natural History Museum, U.K. were searched for potential type material corresponding to Smith's species. The known specimens of *B. caliginosus* from Canada were borrowed from the American Museum of Natural History, New York, to verify the identity of those occurrences. Lastly, the AMNH-Bee – Collaborative databasing of North American bee collections within a global informatics network project (Ascher 2025) and the Bumble bees of North America occurrence records database (Richardson 2025) were also utilized.

Results

There is no evidence that *B. vosnesenskii* was found on Vancouver Island until the early 2000s (Fraser et al. 2012; Williams et al. 2014; GBIF.org 2024b). By contrast, in Canada *B. caliginosus* is only known from southernmost Vancouver Island (Williams et al. 2014; GBIF.org 2024a; Richardson 2025), these occurrences are based on five female specimens in the American Museum of Natural History. *Bombus caliginosus* is also known from adjacent Stuart Island in the San Juan Islands, and the Olympic Peninsula, Washington, USA.

Though there is currently no type specimen of *B. flavifrons* Smith to examine, we believe that there is a high probability that *B. caliginosus* is conspecific with *B. columbicus* so we designate a neotype specimen from Vancouver Island to fix the name to a

specimen. *Bombus columbicus* is thus considered a senior synonym of *B. caliginosus* but based on Article 23.9.1 of the Code (ICZN 1999), the prevailing usage must be maintained if the senior synonym (i.e., *B. columbicus*) has not been used as a valid name after 1899, which is the case as *B. flavifrons* Smith was already, albeit seemingly incorrectly, considered a synonym of *B. vosnesenskii* at the time Dalla Torre (1890) proposed *B. columbicus* as a replacement name, so the conditions of Article 23.9.1.1 are met. The name *B. caliginosus* has subsequently appeared in numerous taxonomic and faunistic papers (e.g., Scullen 1927; Frison 1929; Burks 1951; Stephen 1957; Krombein 1967; Thorp et al. 1983; Dobson 1993; Williams 1998; Cameron et al. 2007; Fraser et al. 2012; Koch et al. 2012, 2015; Williams et al. 2014; Sheffield and Heron 2019; Fisher et al. 2022; Bartholomew et al. 2024), in addition to many ecological studies (e.g., Pitelka 1954; Hicks 1959; Moldenke 1976; Ackerman 1981; Patten et al. 1993; Knops and Barthell 1996; McFrederick and LeBuhn 2006; Rao and Stephen 2010; Kissinger et al. 2011; Thomson 2016; Strange and Tripodi 2019; MacPhail et al. 2020; Spiesman et al. 2021), so the conditions of Article 23.9.1.2 are also met.

Bombus caliginosus (Frison, 1927), nomen protectum

Bombus flavifrons Smith, 1866, in Lord, 1866: 343 (appendix) [♀]. Preoccupied, not *Bombus flavifrons* Cresson, 1863. Neotype: ♀ (designated here; Fig. 1). Canada, British Columbia, Vancouver Island, Victoria [Island], Butchart Gardens, 30 May 1973, by S. Gittelman [American Museum of Natural History, no. AMNH_BEE 00120464].

Bombus columbicus Dalla Torre, 1890: 139. Replacement name for *Bombus flavifrons* Smith, 1866. Nomen oblitum.

Bremus caliginosus Frison, 1927: 376 [♂]. Syn. nov. Holotype: ♂. USA, California, Arcata, 16 September 1920, by C.D. Duncan [Illinois Natural History Survey, no. 179514].

Bremus caliginosus var. *tardus* Frison, 1927: 380 [♂]. Synonymy of *Bremus caliginosus* Frison, 1927 by Stephen (1957: 100). Holotype: ♂. USA, California, Carmel, 20 July 1921, by L.S. Slevin [California Academy of Sciences no. 2438].

Remark. The original description of *Bombus flavifrons* Smith was of a female with a body length of 8½ lines (ca 18 mm), consistent with the neotype selected here (Fig. 1).

Diagnosis. Females of *B. caliginosus* have a longer malar space (length:width = 0.90, Fig. 2a) than those of *B. vosnesenskii* (length:width = 0.71, Fig. 2b) and in many specimens sternum 4 of the former has a weak apical (posterior) band of pale hairs, at least laterally (Thorp et al. 1983; Williams et al. 2014) (Fig. 1d), though as cautioned by Williams et al. (2014) this is also true for some specimens of *B. vosnesenskii*. Williams et al. (2014) also noted that tergum 4 of *B. caliginosus* often has some dark hairs basally, especially medially, while in *B. vosnesenskii* the black hairs are lacking, or few. Stephen (1957) noted that the relative lengths of flagellomeres 1 and 3 also differed,

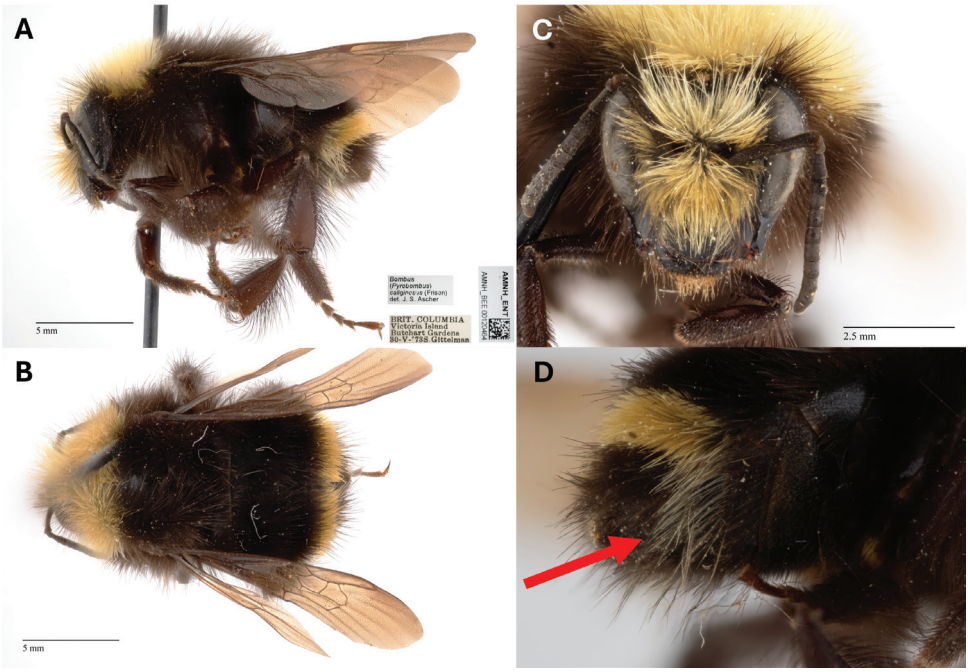

Figure 1. Neotype of *Bombus flavifrons* Smith, 1866 [= *Bombus caliginosus* (Frison, 1927)]; female, worker [American Museum of Natural History]. **A.** Lateral (with associated specimen labels) and **B.** Dorsal habitus; **C.** Face, and **D.** Metasoma in lateral view showing the posterior pale hairs of sternum 4 (red arrow).

flagellomere 1 longer than 3 (3:2) in *B. caliginosus*, but the lengths are subequal in *B. vosnesenskii*. Williams et al. (2014) made note of the size differences of punctures on the apical margin of the clypeus, being small in *B. caliginosus*, but large in *B. vosnesenskii*.

Males of the two species can be also distinguished by the relative lengths of flagellomeres 1 and 3, the lengths being subequal in *B. caliginosus*, but flagellomere 1 shorter than 3 in *B. vosnesenskii* (Stephen 1957; Thorp et al. 1983). The males also differ in the shape of the apical recurved portion of the penis-valve head, narrowing apically in *B. vosnesenskii*, but remaining subparallel in *B. caliginosus* (Stephen 1957; Williams et al. 2014). Thorp et al. (1983) also provided illustrations noting differences in the shapes of sterna 7 and 8, the latter gradually narrowing apically (i.e., triangular) in *B. caliginosus* (their fig. 63), while widely truncate apically in *B. vosnesenskii*, with the lateral margins subparallel to base of process (their fig. 72).

Discussion

Stephen (1957), Thorp et al. (1983), and Williams et al. (2014) have all stressed the difficulty of distinguishing *B. vosnesenskii* from *B. caliginosus*, especially for the females. Thorp (1969) even indicated that some of the specimens of *B. caliginosus* identified in

Figure 2. Malar space of females of **A.** *Bombus caliginosus* (Frison, 1927) and **B.** *B. vosnesenskii* Radoszkowski, 1862. White horizontal lines show the width of the malar space or distance between mandibular hinges; yellow vertical lines perpendicular to white horizonal lines show the height of the malar space from the lowest margin of the compound eye to the lower edge of malar space between the mandibular hinges); the parallel vertical yellow and white lines to the left of each figure are the same lengths as those measuring the malar space, and are added to facilitate visual comparison.

the revision by Stephen (1957) were actually *B. vandykei*. Despite the morphological similarity, Thorp (1969) included *B. caliginosus* and *B. vandykei*, but not *B. vosnesenskii*, in his *Flavifrons* species group of the subgenus *Pyrobombus*. The distinctiveness of this group was supported in the molecular phylogenies of Hines et al. (2006), Cameron et al. (2007), and Hines (2008).

Bombus caliginosus is very rare in Canada, known only from the five confirmed records from a single collecting event at Victoria, British Columbia (and see Williams et al. 2014). By contrast, *B. vosnesenskii*, though also once rare in Canada (Scudder 1992, 1994) and restricted in distribution to the Osoyoos area of southcentral British Columbia (Buckell 1951), with three additional specimens collected in 1909 now known from Revelstoke (Richardson 2025), has become one of the most common bumble bees in southern parts of the province, extending its range onto Vancouver Island (Fraser et al. 2012). Although online sites such as Bumble Bee Watch (www.bumblebeewatch.org) and iNaturalist (https://www.inaturalist.org/) typically offer excellent occurrence documentation for bumble bees, these two species are morphologically similar enough on a macro scale that identification from the colour patterns shown on photographs are likely not reliable as there are no consistent differences (Williams et al. 2014). Identification may only be possible when the images show malar space

length and/or in when the ventral surface of the metasoma is visible; males of these two species are even harder to reliably identify from photos. Though all 400+ specimens examined from British Columbia for this study have been identified as *B. vosnesenskii*, continued surveys and collection of specimens will be required to confirm the presence of *B. caliginosus* in, or its extirpation from, Canada.

Acknowledgements

Thanks to Dr. James Carpenter, American Museum of Natural History, New York, NY, for the loan of specimens of *Bombus caliginosus* from Vancouver Island, and Claudia Copely, Royal British Columbia Museum, Victoria, BC, for several loans of bumble bees from British Columbia. Thanks also to Doug Yanega, University of California, Riverside, CA, for past discussions on type materials and the ICZN Code. Thanks also to Leif Richardson (Xerces Society, Portland, OR) and John S. Ascher (National University of Singapore, Singapore) for helpful discussion and information on the historic distribution of these species in Canada, the identifications confirmed by John S. Ascher. We also thank the reviewers and the editor for helpful comments on the manuscript.

References

Ackerman JD (1981) Pollination biology of *Calypso bulbosa* var. *occidentalis* (Orchidaceae): a food-deception system. Madroño 28(3): 101–110.

Ascher JS (2025) AMNH-Bee – Collaborative databasing of North American bee collections within a global informatics network project. https://specieslink.net/col/AMNH-Bee/

Bartholomew CS, Murray EA, Bossert S, Gardner J, Looney C (2024) An annotated checklist of the bees of Washington state. Journal of Hymenoptera Research 97: 1007–1121. https://doi.org/10.3897/jhr.97.129013

Buckell ER (1951) Record of bees from British Columbia: Bombidae. Proceedings of the Entomological Society of British Columbia 47: 7–24.

Burks BD (1951) Tribe Bombini. In: Muesebeck CF, Krombein KV, Townes HK (Eds) Hymenoptera of America north of Mexico Synoptic Catalog. 2. United States Department of Agriculture Agricultural Monograph, Washington, 1247–1255.

Cameron SA, Hines HM, Williams PH (2007) A comprehensive phylogeny of the bumble bees (*Bombus*). Biological Journal of the Linnean Society 91(1): 161–181. https://doi.org/10.1111/j.1095-8312.2007.00784.x

Cresson ET (1863) List of the North American species of *Bombus* and *Apathus*. Proceedings of the Entomological Society of Philadelphia 2: 83−116.

Dalla Torre KW (1890) Hymenopterologische Notizen. Wiener entomologische Zeitung 9: 139.

Dobson HEM (1993) Bee fauna associated with shrubs in two California chaparral communities. The Pan-Pacific Entomologist 69(1): 77−94.

Fisher K, Watrous KM, Williams NM, Richardson LL, Woodard SH (2022) A contemporary survey of bumble bee diversity across the state of California. Ecology and Evolution 12(3): e8505. https://doi.org/10.1002/ece3.8505

Fraser DF, Copley CR, Elle E, Cannings RA (2012) Changes in the status and distribution of the Yellow-faced Bumble Bee (*Bombus vosnesenskii*) in British Columbia. Journal of the Entomological Society of British Columbia 109: 31–37.

Franklin HJ (1913) The Bombidae of the New World. Transactions of the American Entomological Society 38(3/4): 177–486. https://doi.org/10.5962/bhl.title.122585

Frison TH (1927) Records and descriptions of western bumblebees (Bremidae). Proceedings of the California Academy of Sciences, Series 4 16(12): 365–380.

Frison TH (1929) Addition descriptions, synonymy and records of North American bumblebees (Hymenoptera: Bremidae). Transactions of the American Entomological Society 55(2): 103–118. https://www.jstor.org/stable/25077215

GBIF.org (2024a) [06 December] GBIF Occurrence Download. https://doi.org/10.15468/dl.2h958j

GBIF.org (2024b) [06 December] GBIF Occurrence Download. https://doi.org/10.15468/dl.5spgmx

Handlirsch A (1888) Die Hummelsammlung des k. k. naturhistorischen Hofmuseums. Annalen des Naturhistorischen Museums in Wien 3: 209–250.

Hicks CH (1929) Notes on a nest of *Bremus vosnesenskii* (Radoszkowski). The Pan-Pacific Entomologist 5(3): 97–100.

Hicks EA (1959) Check-list and Bibliography on the Occurrence of Insects in Birds‘ Nests. Iowa State College Press, Ames. Iowa, 681 pp. https://doi.org/10.5962/bhl.title.6819

Hines HM (2008) Historical biogeography, divergence times, and diversification patterns of bumble bees (Hymenoptera: Apidae: *Bombus*). Systematic Biology 57(1): 58–75. https://doi.org/10.1080/10635150801898912

Hines HM, Cameron SA, Williams PH (2006) Molecular phylogeny of the bumble bee subgenus *Pyrobombus* (Hymenoptera: Apidae: *Bombus*) with insights into gene utility for lower-level analysis. Invertebrate Systematics 20: 289–303. https://doi.org/10.1071/IS05028

ICZN [International Commission on Zoological Nomenclature] (1999) International Code of Zoological Nomenclature. Fourth Edition. The International Trust for Zoological Nomenclature, London. xxix + 306 pp.

Kissinger CN, Cameron SA, Thorp RW, White B, Solter LF (2011) Survey of bumble bee (*Bombus*) pathogens and parasites in Illinois and selected areas of northern California and southern Oregon. Journal of Invertebrate Pathology 107(3): 220–224. https://doi.org/10.1016/j.jip.2011.04.008

Knops JMH, Barthell JF (1996) Flower abundance in a population of sky lupine (*Lupinus nanus*) over three years in central coastal California. Madroño 43(1): 85–92.

Koch J, Strange J, Williams PH (2012) Bumble Bees of the Western United States. United States Department of Agriculture, Forest Service, Washington, 143 pp.

Koch JB, Lozier J, Strange JP, Ikerd H, Griswold T, Cordes N, Solter L, Stewart I, Cameron SA (2015) USBombus, a database of contemporary survey data for North American Bumble

Bees (Hymenoptera, Apidae, *Bombus*) distributed in the United States. Biodiversity Data Journal 3: e6833. https://doi.org/10.3897/BDJ.3.e6833

Krombein KV (1967) Superfamily Apoidea. In: Krombein KV, Burks BD (Eds) Hymenoptera of America North of Mexico Synoptic Catalog (Agriculture Monograph No. 2). Second Supplement. United States Government Printing Office, Washington, 422–520. https://doi.org/10.5962/bhl.title.63670

Laverty TM, Harder LD (1988) The bumble bees of eastern Canada. The Canadian Entomologist 120(11): 965–987. https://doi.org/10.4039/Ent120965-11

Lord JK (1866) The Naturalist in Vancouver Island and British Columbia. In Two Volumes – Vol. II. R. Bentley, London. vii + 375 pp. https://doi.org/10.5962/bhl.title.48504

MacPhail VJ, Gibson SD, Hatfield R, Colla SR (2020) Using Bumble Bee Watch to investigate the accuracy and perception of bumble bee (*Bombus* spp.) identification by community scientists. PeerJ 8: e9412. https://doi.org/10.7717/peerj.9412

McFrederick QS, LeBuhn G (2006) Are urban parks refuges for bumble bees *Bombus* spp. (Hymenoptera: Apidae)? Biological Conservation 129(3): 372–382. https://doi.org/10.1016/j.biocon.2005.11.004

Moldenke AR (1976) California pollination ecology and vegetations types. Phytologia 34: 305–361.

Patten KD, Shanks CH, Mayer DF (1993) Evaluation of herbaceous plants for attractiveness to bumble bees for use near cranberry farms. Journal of Apicultural Research 32(2): 73–79. https://doi.org/10.1080/00218839.1993.11101290

Pitelka FA (1954) Use of bird nest by bumblebee. The Pan-Pacific Entomologist 30(3): 220.

Rao S, Stephen WP (2010) Abundance and diversity of native bumble bees associated with agricultural crops: the Willamette Valley Experience. Psyche 2010: 354072. https://doi.org/10.1155/2010/354072

Richardson L (2025) Bumble bees of North America occurrence records database. https://www.leifrichardson.org/bbna.html [Data accessed 09-11-2025]

Scudder GGE (1992) Threatened and endangered invertebrates of the South Okanagan. In: Rautio S (Ed.) Community Action for Endangered Species. Symposium proceedings, Northwest Wildlife Preservation Society and Federation of B.C. Naturalists, Vancouver, 47–57.

Scudder GGE (1994) An annotated systematic list of the potentially rare and endangered freshwater and terrestrial invertebrates in British Columbia. Occasional Papers of the Entomological Society of British Columbia 2: 1–92. https://doi.org/10.5962/bhl.title.110150

Scullen HA (1927) Bees belonging to the family Bremidae taken in western Oregon, with notes. The Pan-Pacific Entomologist 4(2): 69–76.

Sheffield CS, Heron JM (2019) The bees of British Columbia (Hymenoptera: Apoidea, Apiformes). Journal of the Entomological Society of British Columbia 115: 44–85.

Sheffield CS, Williams PH (2025) Case 3950 – *Bombus flavifrons* Cresson, 1863 (Insecta, Hymenoptera, Apidae): proposed reversal of precedence over *Bombus pleuralis* Nylander, 1848. Bulletin of Zoological Nomenclature [in press].

Spiesman BJ, Gratton C, Hatfield RG, Hsu WH, Jepsen S, McCornack B, Patel K, Wang G (2021) Assessing the potential for deep learning and computer vision to identify bumble

bee species from images. Scientific Reports 11(1): 7580. https://doi.org/10.1038/s41598-021-87210-1

Stephen WP (1957) Bumble bees of western America (Hymenoptera: Apoidea). Technical Bulletin, Oregon State College, Agricultural Experiment Station 40: 163 pp.

Strange JP, Tripodi AD (2019) Characterizing bumble bee (*Bombus*) communities in the United States and assessing a conservation monitoring method. Ecology and Evolution 9(3): 1061–1069. https://doi.org/10.1002/ece3.4783

Thomson DM (2016) Local bumble bee decline linked to recovery of honey bees, drought effects on floral resources. Ecology Letters 19(10): 1247–1255. https://doi.org/10.1111/ele.12659

Thorp RW (1969) The identity of *Bombus vandykei* (Hymenoptera: Apidae). The Pan-Pacific Entomologist 45: 87–96.

Thorp RW (1970) The type locality of *Bombus franklini* and notes on putative Arizona records of other Bombini (Hymenoptera: Apidae). The Pan-Pacific Entomologist 46(3): 177–180.

Thorp RW, Horning DS, Dunning LL (1983) Bumble bees and cuckoo bumble bees of California (Hymenoptera: Apidae). Bulletin of the California Insect Survey 23: 1–79.

Williams PH (1998) An annotated checklist of bumble bees with an analysis of patterns of description (Hymenoptera: Apidae, Bombini). Bulletin of the Natural History Museum, Entomology Series 67: 79–152.

Williams PH, Thorp RW, Richardson LL, Colla SR (2014) Bumble Bees of North America. An Identification Guide. Princeton University Press, Princeton, New Jersey, 208 pp.